HYDRO ENGINEERING & CONSULTING PTY LTD

REPORT

Metropolitan Coal
Surface Water Review
1 January to 31 December 2019

Prepared for: Metropolitan Coal Pty Ltd

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Revision	Description	Author	Reviewer	Approved	Date
a	Partial Draft	CAW	LMG	TSM	17/2/2020
b	Draft	CAW	TSM	TSM	26/3/2020
c	Final	CAW	TSM	TSM	31/3/2020

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1.0 INTRODUCTION AND BACKGROUND

Metropolitan Coal is wholly owned by Peabody Energy Australia Pty Ltd and is located adjacent to the township of Helensburgh and approximately 30 kilometres north of Wollongong in New South Wales (NSW). The Metropolitan Coal Project (the Project) comprises the continuation, upgrade and extension of underground coal mining operations and surface facilities at Metropolitan Coal. The current underground mining longwall layout is shown on Figure 1.

This report documents a review undertaken by Hydro Engineering & Consulting Pty Ltd (HEC) of the environmental performance of the Project in relation to surface water (water resources and watercourses) in the Metropolitan Coal underground mining area and surrounds for the reporting period (1 January to 31 December 2019), consistent with the Metropolitan Coal Longwalls 301-303 Water Management Plan[1], the Metropolitan Coal Longwall 304 Water Management Plan[2] and Metropolitan Coal Catchment Monitoring Program.

During the reporting period (i.e. 1 January to 31 December 2019), Longwall 303 was completed (in May 2019) and extraction of Longwall 304 commenced (in July 2019). For consistency with Metropolitan Coal's reporting requirements (i.e. six monthly) the reporting period has been split into two review periods; 1 January to 30 June 2019 and 1 July 2019 to 31 December 2019.

Environmental performance during the 1 January to 30 June 2019 review period has previously been assessed in accordance with the Metropolitan Coal Longwalls 301-303 Water Management Plan as detailed in HEC (2019a). The environmental performance of the Metropolitan Coal Project during the 1 July 2019 to 31 December 2019 review period has been assessed (this report) in accordance with the Metropolitan Coal Longwall 304 Water Management Plan.

2.0 CATCHMENT MONITORING AND SURFACE WATER MODELLING

2.1 BACKGROUND

The Metropolitan Coal Catchment Monitoring Program, Longwalls 301-303 Water Management Plan and Longwall 304 Water Management Plan include a program to monitor and assess impacts on surface water resources and watercourses. The meteorological sites, surface water quantity sites (i.e. streamflow gauging stations and pool water level monitoring) and surface water quality sites at which baseline data is available for the Metropolitan Coal underground mining area are shown on Figure 1 to Figure 3 respectively.

The Metropolitan Coal Catchment Monitoring Program also includes a program for the development, calibration and verification of catchment flow models.

2.2 STREAMFLOW

Surface water flow monitoring is conducted at the following sites:

- the existing WaterNSW gauging station on the Waratah Rivulet (GS 2132102), close to the inundation limits of the Woronora Reservoir;

[1] The Metropolitan Coal Longwalls 301-303 Water Management Plan includes post-mining monitoring and management of water resources and watercourses for Longwalls 20-27.

[2] The Metropolitan Coal Longwall 304 Water Management Plan includes post-mining monitoring and management of water resources and watercourses for Longwalls 20-27 and 301-303.

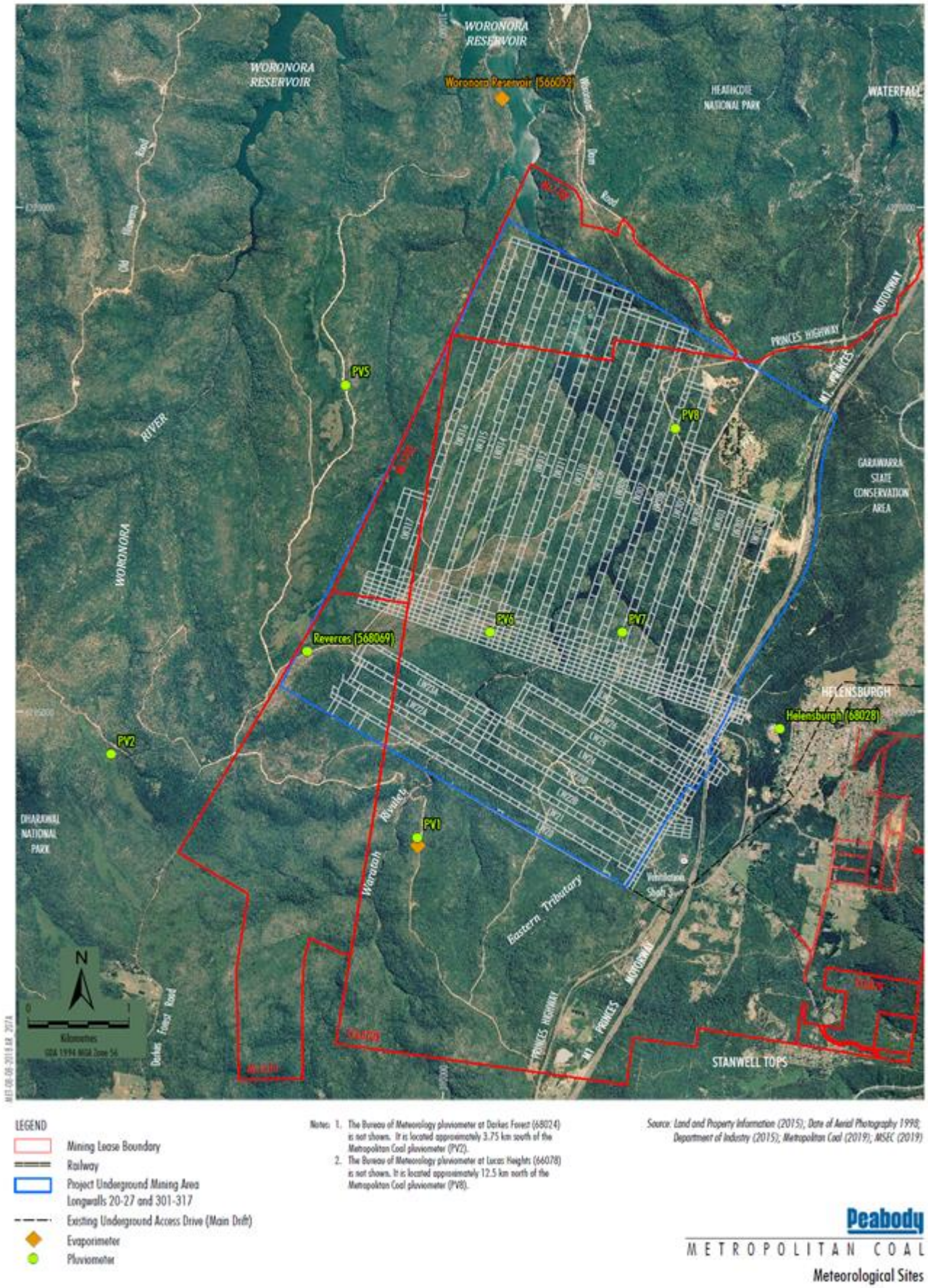

Figure 1 Meteorological Sites

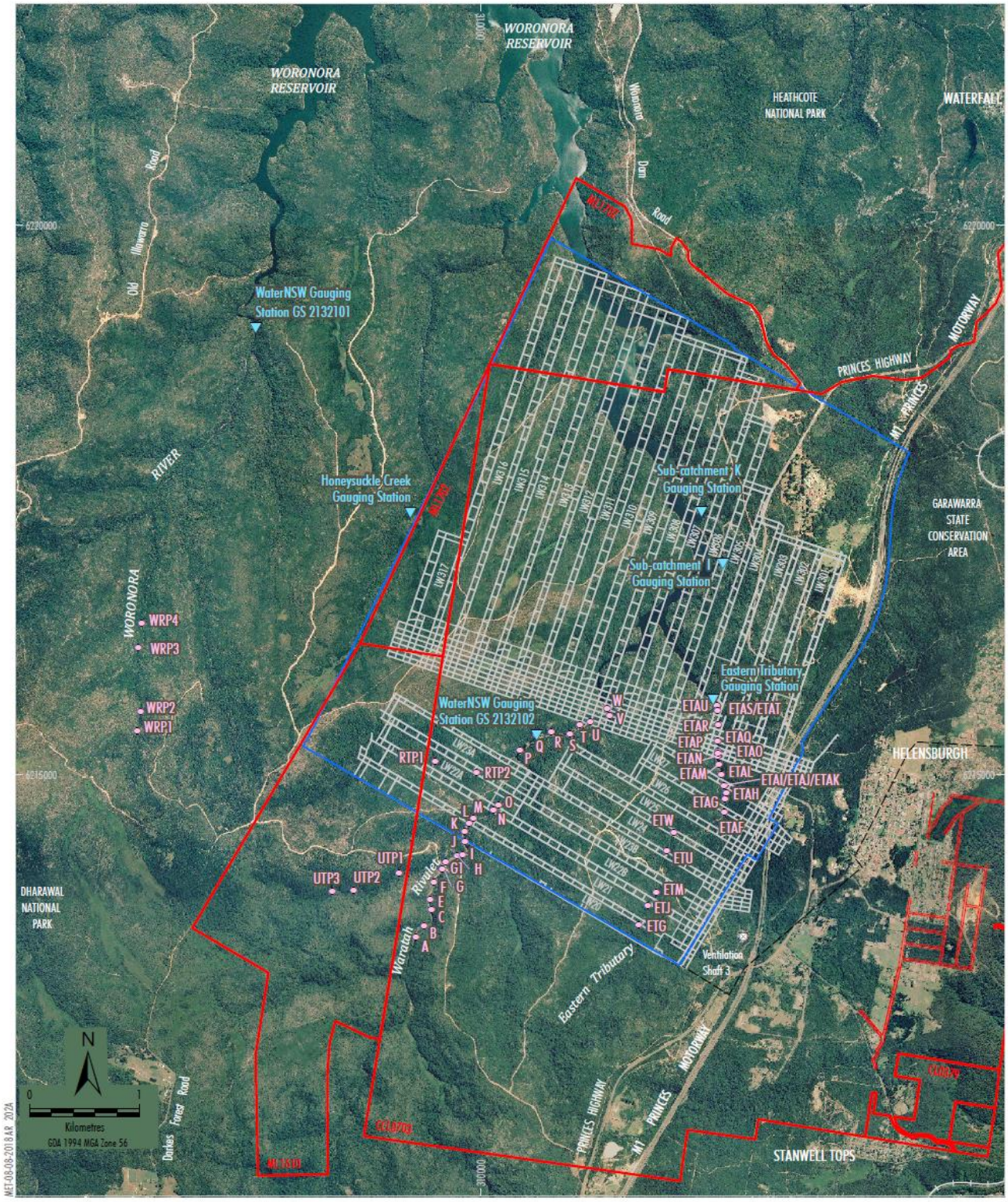

Figure 2 Surface Water Quantity Sites

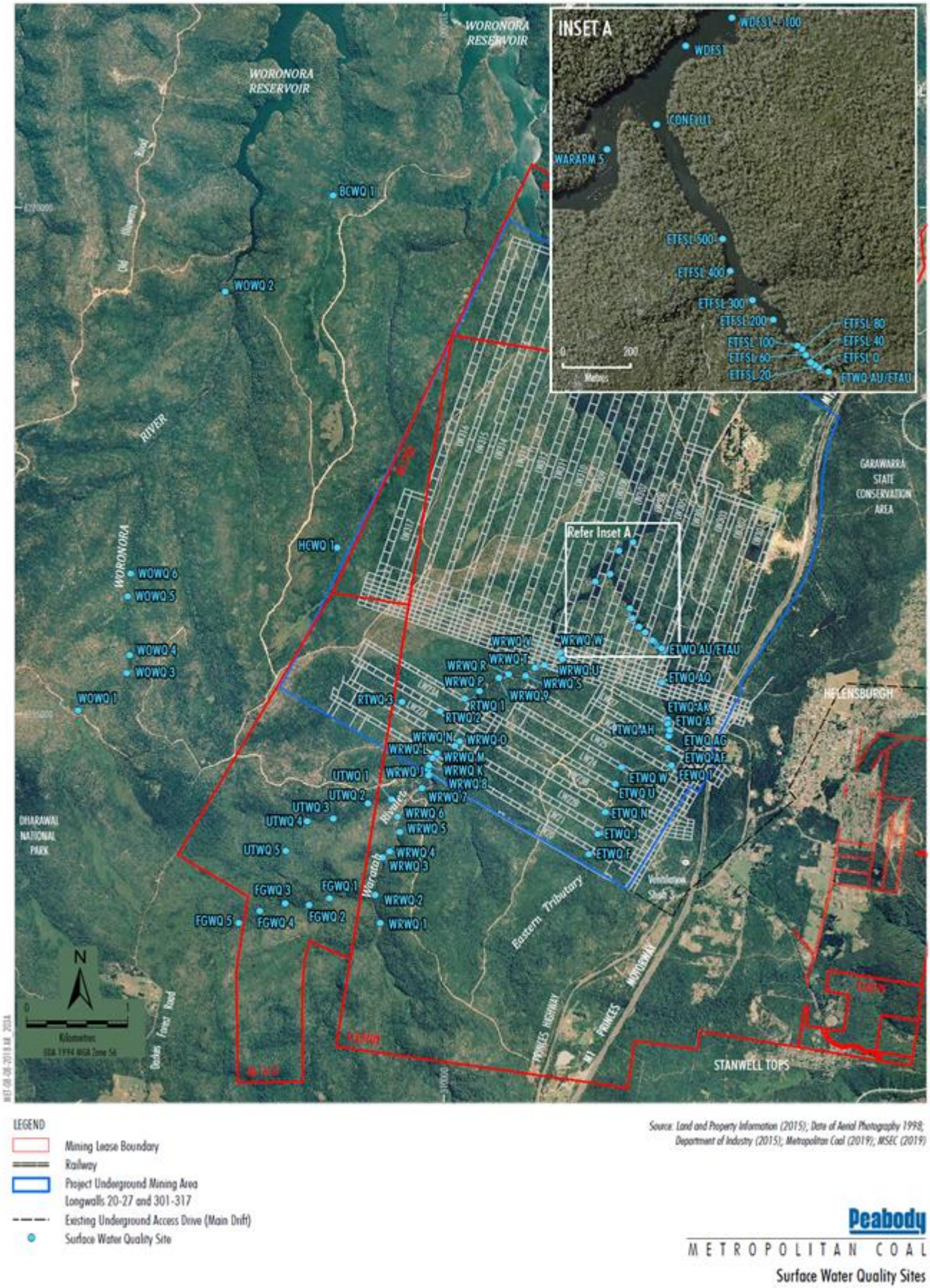

Figure 3 Surface Water Quality Sites

- the existing WaterNSW gauging station on the Woronora River (GS 2132101), close to the inundation limits of the Woronora Reservoir (control site);
- the existing WaterNSW gauging station on O'Hares Creek at Wedderburn (GS 213200) (control site);
- the existing Metropolitan Coal gauging station on the Eastern Tributary (GS 300078) close to the inundation limits of the Woronora Reservoir;
- the existing Metropolitan Coal gauging station on Honeysuckle Creek (GS 300077) (control site);
- the Sub-Catchment I gauging station on a tributary to the east of the Woronora Reservoir (GS 300092); and
- the Sub-Catchment K gauging station on a tributary to the east of the Woronora Reservoir (GS 300093).

Flow records from the Waratah Rivulet (GS 2132102), Woronora River (GS 2132101) and O'Hares Creek at Wedderburn (GS 213200) gauging stations were regenerated using amended rating relationships developed by Gilbert & Associates (2015a) on behalf of Metropolitan Coal (as described in HEC, 2016).

Numerical catchment models for the Waratah Rivulet and O'Hares Creek catchments have been developed based on the nationally recognised Australian Water Balance Model (AWBM) (Boughton, 2004). The AWBM is a catchment-scale water balance model that estimates streamflow from rainfall and evaporation. Revised and re-calibrated catchment models (Gilbert & Associates, 2015b) have been used to assess potential subsidence impacts on the quantity of water resources reaching the Woronora Reservoir (as described in HEC, 2016).

2.3 POOL WATER LEVELS

Water levels in a number of pools on the Waratah Rivulet (Pools A, B, C, E, F, G, G1, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V and W), Eastern Tributary (Pools ETG, ETJ, ETM, ETU, ETW, ETAF, ETAG, ETAH, ETAI/ETAJ/ETAK[3], ETAL, ETAM, ETAN, ETAO, ETAP, ETAQ, ETAR, ETAS/ETAT[4] and ETAU), Tributary B/Reference Tributary (Pools RTP1 and RTP2) and Woronora River (Pools WRP1, WRP2, WRP3 and WRP4) have been either manually monitored on a daily basis or monitored using a continuous water level sensor and logger. Recorded pool water level hydrographs are provided as a series of charts in Appendix A.

Pool water levels are controlled by different forms of natural controls with different hydraulic characteristics. Conceptually these can be grouped into the following three types:

1. An 'effectively impermeable' rock-bar control with limited continuous jointing and fracturing resulting in negligible flow either through or under the rock-bar;
2. A 'permeable' rock-bar control where the presence of fractures and open joints in the rock-bar permits significant flow through or under the rock-bar; and
3. A boulder-field which constricts downstream flow but where a significant flow occurs through the interstices between the boulder rock elements (i.e. braided flow).

[3] Only small rock bars separate Pools ETAI, ETAJ and ETAK, with the pools joining to become the one large pool as water levels rise. Pool ETAK is controlled by a more substantial rock bar. Readings from the water level sensor situated in Pool ETAI is considered to also be representative of the water level in Pools ETAJ and ETAK.

[4] Due to the nature of rock bar ETAS, Pool ETAS and Pool ETAT typically record the same water level.

A description of the water level behaviour for each pool during the 1 January to 31 December 2019 reporting period is provided in Table 1. In summary, all pools on Waratah Rivulet remained above the cease to flow level or historical minimum except for Pool A, Pool B, Pool L, Pool N and Pool U. Pool A fell below the cease to flow level from February until mid-March 2019 and in late December 2019, Pool B fell below the cease to flow level from mid-December 2019 and Pool N fell below the cease to flow level for a short period in March 2019 and from mid-December 2019. Records for Pool L indicate that the water level fell below the cease to flow level for two one-hour periods in November and one one-hour period in December 2019, though did not fall below the previously recorded minimum. The Pool U water level fell below the previously recorded minimum water level during periods in August, September, November and December 2019. The reduction in water level at these pools is consistent with a reduction in water level observed at control pools WRP1, WRP2, WRP3 and WRP4 on the Woronora River during the same periods (refer Chart A47 to Chart A50, Appendix A). Water level records for control pools WRP1, WRP2, WRP3 and WRP4 indicate that the pool water levels declined during these periods, with a substantial decline recorded between November and December 2019. The WRP1 water level declined below the historically recorded minimum for parts of October, November and December 2019, while the water level of WRP 2, WRP 3 and WRP 4 declined below the historically recorded minimum in December 2019.

Water levels in Pools ETG, ETJ, ETM, ETU, ETW, ETAF, ETAG, ETAH, ETAI/ETAJ/ETAK, ETAL, ETAM, ETAN, ETAO, ETAP and ETAQ on the Eastern Tributary were regularly recorded below the cease to flow levels or historically low water levels during the review period. These pools' water levels responded to rainfall events during the review period before returning to below the cease to flow levels or sensor levels. The water level of Pool ETAR was above the sensor level for the majority of the review period, except in late December 2019, where the water level fell below the sensor level. The water level of Pool ETAS/ETAT and Pool ETAU did not fall below the cease to flow level during the review period.

Consistent with historical behaviour, Pool RTP1 on Tributary B was not flowing for the majority of the review period except for a short duration following a rainfall event in September. Pool RTP2 was typically below the cease to flow level, however water levels rose for short durations following rainfall events.

Table 1 Summary of Pool Water Level Monitoring Results

Pool	Natural Control Characteristics	Recorded Water Level During 1 Jan to 31 Dec 2019	Comments
Monitored Pools on Waratah Rivulet			
A	Effectively impermeable rock bar. (Pool A impacted by previous mine subsidence and subject to previous stream remediation activities)	The water level of Pool A fell below the cease to flow level from February until mid-March 2019. Thereafter, until mid-November 2019, the water level remained fairly consistent during periods of no or low rainfall, with rises occurring in response to rainfall events. From mid-November 2019, the water level started to decline with flow ceasing in late December 2019 (Chart A1 [manual observations] and Chart A2 [logger data] in Appendix A). The reduction in water level at this pool is consistent with a reduction in water level observed at control pools WRP1, WRP2, WRP3 and WRP4 on the Woronora River during the same periods (Chart A47 to Chart A50 [logger data] in Appendix A).	Metropolitan Coal's visual inspections indicate that Pool A ceased to flow from the beginning of February until the middle of March and from 23 December 2019 until the end of the review period.
B	Effectively impermeable rock bar. (Pool B impacted by previous mine subsidence)	Water level records for Pool B indicate that the pool was flowing from January until mid-December 2019. From mid-December 2019, the water level record indicates that flow ceased (Chart A3 in Appendix A [manual observations]). The reduction in water level is consistent with the reduction in water level observed at control pools WRP1, WRP2, WRP3 and WRP4 on the Woronora River during the same period (Chart A47 to Chart A50 [logger data] in Appendix A).	Metropolitan Coal's visual inspections indicate that Pool B ceased to flow from 12 December 2019.
C	Effectively impermeable rock bar. (Pool C impacted by previous mine subsidence)	The Pool C water level was consistent with natural behaviour for the duration of the review period with water level records indicating that the pool continued to flow for the duration of the review period (Chart A4 in Appendix A [manual observations]).	Metropolitan Coal's visual inspections indicate that Pool C was overflowing the rock bar on all inspection occasions.

Table 1 (Continued) Summary of Pool Water Level Monitoring Results

Pool	Natural Control Characteristics	Recorded Water Level During 1 Jan to 31 Dec 2019	Comments
E	Effectively impermeable rock bar. (Pool E impacted by previous mine subsidence)	Water level records for Pool E were consistent with natural behaviour and indicate that the pool continued to flow for the duration of the review period (Chart A5 in Appendix A [manual observations]).	Metropolitan Coal's visual inspections indicate that Pool E was overflowing the rock bar on all inspection occasions.
F	Effectively impermeable rock bar. (Pool F impacted by previous mine subsidence and subject to previous stream remediation activities)	Water level records for Pool F were consistent with natural behaviour and indicate that the pool continued to flow for the duration of the review period (Chart A6 [manual observations] and Chart A7 [logger data] in Appendix A).	Metropolitan Coal's visual inspections indicate that Pool F was overflowing the rock bar on all inspection occasions.
G	Effectively impermeable rock bar. (Pool G impacted by previous mine subsidence and subject to previous stream remediation activities)	Water level records for Pool G were consistent with natural behaviour and indicate that the pool continued to flow for the duration of the review period (Chart A8 in Appendix A [manual observations]).	Metropolitan Coal's visual inspections indicate that Pool G was overflowing the rock bar on all inspection occasions.
G1	Effectively impermeable rock bar. (Pool G1 impacted by previous mine subsidence)	Water level records for Pool G1 were consistent with natural behaviour and indicate that the pool continued to flow for the duration of the review period (Chart A9 in Appendix A [manual observations]).	Metropolitan Coal's visual inspections indicate that Pool G1 was overflowing the rock bar on all inspection occasions.
H	Effectively impermeable rock bar.	Water level records for Pool H were consistent with natural behaviour and indicate that the pool continued to flow for the duration of the review period (Chart A10 in Appendix A [manual observations]).	Metropolitan Coal's visual inspections indicate that Pool H was overflowing the rock bar on all inspection occasions.
I	Effectively impermeable rock bar.	Water level records for Pool I were consistent with natural behaviour and indicate that the pool continued to flow for the duration of the review period (Chart A11 in Appendix A [manual observations]).	Metropolitan Coal's visual inspections indicate Pool I was overflowing the rock bar on all inspection occasions.

Table 1 (Continued) Summary of Pool Water Level Monitoring Results

Pool	Natural Control Characteristics	Recorded Water Level During 1 Jan to 31 Dec 2019	Comments
J	Effectively impermeable rock bar.	Pool water level records (stage levels from GS 300017) indicate that the pool continued to flow for the duration of the review period and were consistent with natural behaviour (Chart A12 in Appendix A [stage levels from the Metropolitan Coal gauging station]).	Metropolitan Coal's visual inspections indicate Pool J was overflowing the rock bar on all inspection occasions.
K	Effectively impermeable rock bar.	Pool K water levels were consistent with natural behaviour and indicate that the pool continued to flow for the duration of the review period (Chart A13 in Appendix A [logger data]).	Metropolitan Coal's visual inspections indicate Pool K was overflowing the rock bar on all inspection occasions.
L	Effectively impermeable rock bar.	Records for Pool L indicate that the water level fell below the cease to flow level for two one-hour periods in November and one one-hour period in December 2019, though did not fall below the previously recorded minimum. For the remainder of the review period, the water level was consistent with natural behaviour (Chart A14 in Appendix A [logger data]).	Metropolitan Coal's visual inspections indicate Pool L was overflowing the rock bar on all inspection occasions.
M	Effectively impermeable rock bar.	Pool M water levels were consistent with natural behaviour and indicate that the pool continued to flow for the duration of the review period (Chart A15 in Appendix A [logger data]).	Metropolitan Coal's visual inspections indicate Pool M was overflowing the rock bar on all inspection occasions.
N	Effectively impermeable rock bar. (Pool N impacted by mine subsidence; first ceased to overflow the rock bar in September 2012)	Water level records for Pool N indicate that the pool ceased to flow for a short period in March 2019 and from mid-December until the end of the review period. For the remainder of the review period, the pool water level was consistent with natural behaviour (Chart A16 in Appendix A [logger data]).	Metropolitan Coal's visual inspections indicate that Pool N ceased to flow from 8 to 14 March 2019 and from 13 December 2019 until the end of the review period. The pool was observed to be flowing on all other inspection occasions.

Table 1 (Continued) Summary of Pool Water Level Monitoring Results

Pool	Natural Control Characteristics	Recorded Water Level During 1 Jan to 31 Dec 2019	Comments
O	Boulder field.	Pool O water levels were consistent with natural behaviour for the duration of the review period (Chart A17 in Appendix A [logger data]).	Metropolitan Coal's visual inspections support the analysis of pool water level data.
P	Permeable rock bar.	Recorded pool water levels were near historically low recorded water levels for the duration of the review period. Consistent with natural behaviour, the water level rose in March, July and September 2019 in response to rainfall events, before returning to near the historical minimum for the remainder of the review period (Chart A18 in Appendix A [logger data]).	Metropolitan Coal's visual inspections indicate Pool P water levels appeared consistent with natural behaviour on all inspection occasions.
Q	Effectively impermeable rock bar.	Pool Q water levels were consistent with natural behaviour for the duration of the review period[1] (Chart A19 in Appendix A [logger data]).	Metropolitan Coal's visual inspections indicate Pool Q water levels appeared consistent with natural behaviour on all inspection occasions.
R	Effectively impermeable rock bar.	Recorded pool water levels were above the cease to flow level and consistent with natural behaviour for the duration of the review period[2] (Chart A20 in Appendix A [logger data]).	Metropolitan Coal's visual inspections indicate Pool R was overflowing on all inspection occasions.
S	Effectively impermeable rock bar.	Recorded pool water levels were at or above the cease to flow level and consistent with natural behaviour for the duration of the review period (Chart A21 in Appendix A [logger data]).	Metropolitan Coal's visual inspections indicate Pool S was overflowing the rock bar on all inspection occasions.

[1] The water level data from WaterNSW for Pool Q (GS 213102) was not available at the time of reporting and, as such, the Metropolitan Coal water level records for Pool Q have been adopted for the review.

[2] The sensor malfunctioned on 14 February 2019 and was replaced on 24 April 2019. As such, no data was recorded during this period.

Table 1 (Continued) Summary of Pool Water Level Monitoring Results

Pool	Natural Control Characteristics	Recorded Water Level During 1 Jan to 31 Dec 2019	Comments
T	Permeable rock bar.	Consistent with natural behaviour, the water level of Pool T rose in March, July and September 2019 in response to rainfall events before returning to near the historical minimum for the remainder of the review period (Chart A22 in Appendix A [logger data]).	Metropolitan Coal's visual inspections indicate Pool T was overflowing on all inspection occasions.
U	Boulder field.	Recorded pool levels fell below the previously recorded minimum water level during periods of August, September, November and December 2019[3]. The water levels were consistent with natural behaviour for the duration of the review period (Chart A23 in Appendix A [logger data[4]]). Water level records for control pools WRP1, WRP2, WRP3 and WRP4 indicate that those pool water levels declined substantially between November and December 2019, with WRP1 water level declining below the previously recorded minimum for parts of October, November and December 2019 (Chart A47 to Chart A50 [logger data] in Appendix A).	Metropolitan Coal's visual inspections indicate Pool U water levels were consistent with natural behaviour on all inspection occasions.
V	Permeable rock bar.	Consistent with natural behaviour, the water level of Pool V rose in March and September 2019 in response to rainfall events before returning to near the historical minimum for the remainder of the review period (Chart A24 in Appendix A [logger data]).	Metropolitan Coal's visual inspections indicate Pool V water levels were consistent with natural behaviour on all inspection occasions.
W	Boulder field (underlain by a rock bar).	Consistent with natural behaviour, the water level of Pool W rose in March and September 2019 in response to rainfall events before returning to near the historical minimum for the remainder of the review period (Chart A25 in Appendix A [logger data]).	Metropolitan Coal's visual inspections indicate Pool W water levels were consistent with natural behaviour on all inspection occasions.

[3] An investigation of Pool U water level was undertaken by HEC (2020) to assess the potential exceedance of the performance measure relating to Pool U, in accordance with the Metropolitan Coal Longwall 304 Water Management Plan.

[4] The sensor malfunctioned on 6 June 2019 and was replaced in July 2019. The sensor malfunctioned on 8 December 2019 and was replaced in February 2020. As such, no data was recorded during these periods.

Table 1 (Continued) Summary of Pool Water Level Monitoring Results

Pool	Natural Control Characteristics	Recorded Water Level During 1 Jan to 31 Dec 2019	Comments
Monitored Pools on Eastern Tributary			
ETG	Effectively impermeable rock bar. (Pool ETG impacted by previous mine subsidence)	Recorded pool water levels were at or slightly below the cease to flow level for the majority of the review period except for a short duration in March, July and September 2019 when the water level rose above the cease to flow level in response to rainfall events (Chart A26 in Appendix A [logger data]).	Metropolitan Coal's visual inspections support the analysis of pool water level data.
ETJ	Effectively impermeable rock bar. (Pool ETJ impacted by previous mine subsidence)	The pool water level fell below the sensor level from February to mid-March and from May to July 2019. The water level of Pool ETJ was predominately above the sensor level from July to November 2019 except for a short period towards the end of August and in mid-September 2019. The water level was below the sensor level for the duration of December 2019 (Chart A27 in Appendix A [logger data]).	Metropolitan Coal's visual inspections support the analysis of pool water level data.
ETM	Permeable rock bar. (Pool ETM impacted by previous mine subsidence)	The pool water level fell below the sensor level from mid-January until mid-March 2019 and from mid-April to early July 2019. The pool water level was above the sensor level for the majority of July 2019 and from mid-September to mid-November 2019. For the remainder of the review period, the water level was below the sensor level (Chart A28 in Appendix A [logger data]).	Metropolitan Coal's visual inspections support the analysis of pool water level data.

Table 1 (Continued) Summary of Pool Water Level Monitoring Results

Pool	Natural Control Characteristics	Recorded Water Level During 1 Jan to 31 Dec 2019	Comments
ETU	Boulder field. (Pool ETU impacted by previous mine subsidence)	The pool water level fell below the sensor level for a short period in early to mid-March 2019. The pool water level was above the sensor level for the remainder of the review period (although data was lost for a 20 day period from mid-November). From early December 2019, the water level began to decline though remained above the sensor level (Chart A29 in Appendix A [logger data]).	Metropolitan Coal's visual inspections support the analysis of pool water level data.
ETW	Effectively impermeable rock bar. (Pool ETW impacted by previous mine subsidence)	The pool water level fell below the sensor level during the first half of March and for a short period at the beginning of June 2019. For the remainder of the review period, the water level was above the sensor level and consistent with natural behaviour. From early December 2019, the water level began to decline though remained above the sensor level (Chart A30 in Appendix A [logger data]).	Metropolitan Coal's visual inspections support the analysis of pool water level data.
ETAF	Permeable rock bar before boulder field. (Pool ETAF impacted by previous mine subsidence)	The pool water level was below the sensor level from mid-February until mid-March, from early May to early June and for a short period at the end of August, in mid-September and mid-December 2019. For the remainder of the review period, the water level was above the sensor level and consistent with natural behaviour (Chart A31 in Appendix A [logger data]).	Metropolitan Coal's visual inspections support the analysis of pool water level data.
ETAG	Boulder field. (Pool ETAG impacted by previous mine subsidence)	The pool water level was predominately below the sensor level from mid-January until mid-March, from mid-April until early June, from early August until mid-September and from mid-November until the end of December 2019 (Chart A32 in Appendix A [logger data]).	Metropolitan Coal's visual inspections confirm that Pool ETAG water level was below the sensor level at the time of inspection in February, May, June, August, November and December 2019.

Table 1 (Continued) Summary of Pool Water Level Monitoring Results

Pool	Natural Control Characteristics	Recorded Water Level During 1 Jul to 31 Dec 2019	Comments
ETAH	Permeable rock bar. (Pool ETAH impacted by previous mine subsidence).	The pool water level was predominately below the sensor level except following rainfall events in March, April, June, July, August, September and October 2019. From late October to the end of December 2019 the pool water level was below the sensor level (Chart A33 in Appendix A [logger data]).	Metropolitan Coal's visual inspections confirm that Pool ETAH water level was below the sensor level at the time of inspection in January, February, May, June, August, November and December 2019.
ETAI/ ETAJ/ETAK	Effectively impermeable rock bar. (Pool ETAI/ETAJ/ETAK impacted by previous mine subsidence).	Pool water levels were below the sensor level for the majority of the review period except for short periods following rainfall events in March, April, June, July, August, September and October 2019 (Chart A34 in Appendix A [logger data]).	Metropolitan Coal's visual inspections confirm that Pool ETAI water level was below the sensor level at the time of inspection in January, February, April, May, June, August, October, November and December 2019.
ETAL	Boulder field/alluvial deposit. (Pool ETAL impacted by previous mine subsidence).	The pool water level was below the sensor level for the majority of the review period except for short periods following rainfall events in March, July, September and October 2019 (Chart A35 in Appendix A [logger data]).	Metropolitan Coal's visual inspections confirm that Pool ETAL water level was below the sensor level at the time of inspection in January, February, April, May, June, August, October, November and December 2019.
ETAM	Boulder field/ alluvial deposit. (Pool ETAM impacted by previous mine subsidence).	The pool water level rose above the sensor level following rainfall events in March, April, June, July, August, September and October 2019. For the remainder of the review period, the water level was below the sensor level (Chart A36 in Appendix A [logger data]).	Metropolitan Coal's visual inspections confirm that Pool ETAM water level was below the sensor level at the time of inspection in January, February, April, May, June, August, November and December 2019.

Table 1 (Continued) Summary of Pool Water Level Monitoring Results

Pool	Natural Control Characteristics	Recorded Water Level During 1 Jul to 31 Dec 2019	Comments
ETAN	Permeable rock bar. (Pool ETAN impacted by previous mine subsidence).	The pool water level rose above the sensor level following rainfall events in January, March, April, June, July, August, September and October 2019. For the remainder of the review period, the water level was below the sensor level (Chart A37 in Appendix A [logger data]).	Metropolitan Coal's visual inspections confirm that Pool ETAN water level was below the sensor level at the time of inspection in January, February, May, June, August, November and December 2019.
ETAO	Permeable rock bar. (Pool ETAO impacted by previous mine subsidence).	The pool water level rose above the sensor level following rainfall events in March, April, June, July, August, September, October and early November 2019. For the remainder of the review period, the water level was below the sensor level (Chart A38 in Appendix A [logger data]).	Metropolitan Coal's visual inspections confirm that Pool ETAO water level was below the sensor level at the time of inspection in January, February, May, June, August, November and December 2019.
ETAP	Boulder field. (Pool ETAP impacted by previous mine subsidence).	The pool water level rose above the sensor level following rainfall events in January, March, April, June, July, August, September, October and early November 2019. For the remainder of the review period, the water level was below the sensor level (Chart A39 in Appendix A [logger data]).	Metropolitan Coal's visual inspections confirm that Pool ETAP water level was below the sensor level at the time of inspection in January, February, May, June, August, November and December 2019.
ETAQ	Effectively impermeable rock bar. (Pool ETAQ impacted by previous mine subsidence).	Pool water levels were at or above the cease to flow level for the majority of the review period except in the first half of March, the beginning and end of June, early July and from mid-December 2019 (Chart A40 in Appendix A [logger data]).	Metropolitan Coal's visual inspections support the analysis of pool water level data.
ETAR	Permeable rock bar. (Pool ETAR impacted by previous mine subsidence).	The pool water level was above the sensor level for the duration of the review period except in late December 2019 when the water level fell below the sensor level (Chart A41 in Appendix A [logger data]).	Metropolitan Coal's visual inspections support the analysis of pool water level data.

Table 1 (Continued) Summary of Pool Water Level Monitoring Results

Pool	Natural Control Characteristics	Recorded Water Level During 1 Jul to 31 Dec 2019	Comments
ETAS/ETAT	Effectively impermeable rock bar.	Pool ETAT did not cease overflowing the rock bar for the duration of the review period and water levels were consistent with natural behaviour (Chart A42 in Appendix A [logger data]).	Metropolitan Coal's visual inspections support the analysis of pool water level data.
ETAU	Pool ETAU flows through Eastern Tributary gauging station, then over a rock bar and waterfall.	Pool ETAU water levels were consistent with natural behaviour during the review period (Chart A43 in Appendix A and Chart A44 in Appendix A [logger data]).	Metropolitan Coal's visual inspections indicate Pool ETAU was overflowing on all inspection occasions.
Monitored Pools on Reference Tributary/Tributary B			
RTP1	Effectively impermeable rock bar. (Pool RTP1 previously impacted by mine subsidence).	Records indicate that Pool RTP1 is typically dry with overflow events limited to significant rainfall periods. Pool RTP1 was not flowing for the majority of the review period except for a short duration following a rainfall event in September (Chart A45 in Appendix A [logger data]).	Metropolitan Coal's visual inspections are consistent with pool water level records.
RTP2	Effectively impermeable rock bar.	Records indicate that the water level of Pool RTP2 on Tributary B regularly falls to low levels except during and following rainfall events. The pool water level was below the rock bar for the majority of the review period though rose in response to rainfall events in mid-March, June, late August, mid-September and early November 2019 (Chart A46 in Appendix A [logger data]).	Metropolitan Coal's visual inspections support the analysis of pool water level data.

2.5 STREAM WATER QUALITY

Surface water quality monitoring and sampling has been conducted at the following sites – refer Figure 3:

- sites WRWQ 2, WRWQ 6, WRWQ 8, WRWQ 9, WRWQ M, WRWQ N, WRWQ P, WRWQ R, WRWQ T and WRWQ W on the Waratah Rivulet;
- site RTWQ 1 on Tributary B;
- site UTWQ 1 on Tributary D;
- sites ETWQ F, ETWQ J, ETWQ N, ETWQ U, ETWQ W, ETWQ AF, ETWQ AH, ETWQ AQ and ETWQ AU on the Eastern Tributary;
- site FEWQ 1 on the Far Eastern Tributary;
- site HCWQ 1 on Honeysuckle Creek;
- site BCWQ 1 on Bee Creek; and
- control sites WOWQ 1 and WOWQ 2 on the Woronora River.

Water quality parameters recorded include electrical conductivity (EC), pH, redox potential (Eh), dissolved oxygen (DO), turbidity, calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), chloride (Cl), sulphate (SO_4), bicarbonate (HCO_3), total nitrogen (N_{tot}), total phosphorus (P_{tot}), nitrate (NO_3), barium (Ba), strontium (Sr), manganese (Mn), iron (Fe), zinc (Zn), cobalt (Co) and aluminium (Al). Samples collected for metals analysis have been field filtered. Unfiltered water quality samples were also collected at a select number of sites on the Waratah Rivulet, Eastern Tributary and Woronora River and analysed for total iron.

Monitoring results for the sites listed above are shown on a series of plots in Appendix B.

2.4.1 Waratah Rivulet

Water quality patterns at monitoring sites over the 1 January to 31 December 2019 review period have generally been consistent with historical water quality data. Upstream sites on Waratah Rivulet (sites WRWQ 2 and WRWQ 6) recorded slightly acidic to neutral pH values, with higher (slightly alkaline) values being recorded at middle and lower reach sites (e.g. at sites WRWQ 8, WRWQ T and WRWQ W). The pH values at sites WRWQ 8 and WRWQ T have shown a generally increasing trend since mid-2016. Historically high pH values (field) were recorded at WRWQ 8 (8.26), WRWQ T (8.91) and WRWQ W (8.40) in December 2019.

Electrical conductivity values were generally elevated in comparison with pre-2018 values though were consistent with 2018 values. There were no historically high electrical conductivity values (laboratory) recorded during the review period. It should be noted that the field recorded electrical conductivity values for some sites indicate historically high electrical conductivity values, however, it was identified that the water quality meter was calibrated to a much lower temperature of water than that recorded in the Waratah Rivulet and, as such, the field recorded electrical conductivity values were found to be inaccurate.

Dissolved iron concentrations were typically below 0.5 mg/L during the reporting period with the exception of WRWQ M for which concentrations of 0.57 mg/L, 0.66 mg/L and 0.64 mg/L were recorded in in June, August and November 2019 respectively. Dissolved aluminium concentrations were either low (0.02 mg/L or less) or below the limit of detection (less than 0.01 mg/L). A slightly increasing trend in dissolved manganese concentrations has been recorded for WRWQ 2, WRWQ 6, WRWQ 8, WRWQ M and WRWQ N since 2016, however no historically high concentrations were recorded during the

review period. Dissolved manganese concentrations at other sites were generally low and consistent with historical values.

2.4.2 Woronora River

The sampling sites WOWQ 1 and WOWQ 2 generally recorded slightly acidic conditions, with the pH levels recorded during the review period consistent with historical values. The electrical conductivity values recorded at WOWQ 2 have increased in variability since 2016 and have tended to be more elevated, though the electrical conductivity values recorded during the review period did not exceed previously recorded maximum value.

Dissolved iron concentrations were generally low and similar to values recorded in Waratah Rivulet, with the exception of WOWQ 2 which recorded a dissolved iron concentration of 1.37 mg/L in March 2019. This concentration is less than the historically high dissolved iron concentration of 1.5 mg/L recorded at WOWQ 2 in March 2011. Dissolved aluminium concentrations were generally low at WOWQ 2 (less than 0.05 mg/L) except in September 2019 when a concentration of 0.11 mg/L was recorded. This concentration was less than the previously recorded maximum concentration of 0.18 mg/L. Manganese concentrations recorded at WOWQ 2 were consistently low (less than 0.1 mg/L).

Slightly elevated dissolved aluminium concentrations were recorded at WOWQ 1 though the concentrations were consistent with historical values. A historically high dissolved manganese concentration of 0.26 mg/L was recorded at WOWQ 1 in January 2019. Field notes reported that there was no flowing water at the time of sampling which may have contributed to the elevated concentration of dissolved manganese.

2.4.3 Eastern Tributary

The pH values recorded during the review period for the Eastern Tributary indicate slightly acidic to slightly alkaline conditions and were consistent with historical values. Variable pH levels were recorded at ETWQ AH though the lowest historically recorded value was not exceeded during the review period.

The electrical conductivity values recorded for the majority of Eastern Tributary sites have tended to be more elevated and variable relative to pre-2016 values, and this trend has continued through the review period. However, the highest historically recorded values were not exceeded during the review period.

Variable dissolved aluminium concentrations were recorded at all sites during the review period. Historically high concentrations of dissolved aluminium were recorded at ETWQ U (0.15 mg/L) in March 2019 and ETWQ F (0.34 mg/L), ETWQ N (0.26 mg/L) and ETWQ AU (0.27 mg/L) in September 2019.

Elevated concentrations of dissolved iron have been recorded in the Eastern Tributary since mid-2016, with similar concentrations reported for the review period. ETWQ AQ in particular recorded elevated dissolved iron concentrations ranging from 0.72 to 8.2 mg/L, though the highest historically recorded values were not exceeded during the review period. A highest historically recorded dissolved iron concentration of 3.98 mg/L was recorded at ETWQ N in December 2019. For all other sites in the Eastern Tributary, the highest historically recorded dissolved iron concentration was not exceeded during the review period.

Elevated concentrations of dissolved manganese have been recorded in the Eastern Tributary since mid-2016. During the review period the dissolved manganese concentrations recorded at most sites were less than 1 mg/L, with the exception of ETWQ AQ. At ETWQ AQ, a dissolved manganese concentration of 1.03 mg/L was recorded in February and 1.3 mg/L recorded in May 2019. No

exceedances of historically high dissolved manganese concentrations were recorded at any site during the review period.

2.4.4 Bee Creek, Honeysuckle Creek, Far Eastern Creek and Tributaries B and D

During the monitoring period, the pH levels recorded at Bee Creek (BCWQ 1) and Honeysuckle Creek (HCWQ 1) indicated slightly acidic conditions, while pH levels in Far Eastern Tributary (FEWQ 1), Tributary B/Reference Tributary (RTWQ 1) and Tributary D/Un-named Tributary (UTWQ 1) were generally near neutral. The pH levels recorded during the monitoring period were consistent with historical values except for RTWQ 1 for which the historically highest pH value of 8.6 was recorded at this site in December 2019. The electrical conductivity values at RTWQ 1 have tended to be more elevated and variable relative to pre-2013 values, with this trend continuing throughout the review period.

Dissolved iron and manganese concentrations recorded during the review period were generally consistent with historical values although the highest historically recorded dissolved manganese concentration of 0.36 mg/L was recorded at BCWQ 1 in November 2019, as well as a more elevated dissolved iron value (2.22 mg/L) than has been recorded since 2012. Dissolved aluminium concentrations at FEWQ 1, RTWQ 1 and UTWQ 1 were less than 0.1 mg/L during the reporting period, however, spikes of dissolved aluminium persisted at BCWQ 1 and HCWQ 1 over the review period.

2.6 WORONORA RESERVOIR WATER QUALITY

Metropolitan Coal has sourced water quality data for the Woronora Reservoir (at sampling location DWO1), Nepean Reservoir (at sampling location DNE2 or DNE1) and Cataract Reservoir (at sampling location DCA1) from WaterNSW in accordance with a data exchange agreement. Results in relation to total iron, aluminium and manganese at levels from 0 m to 9 m below the reservoir surface for Woronora Reservoir are presented in Chart 1 to Chart 3 below.

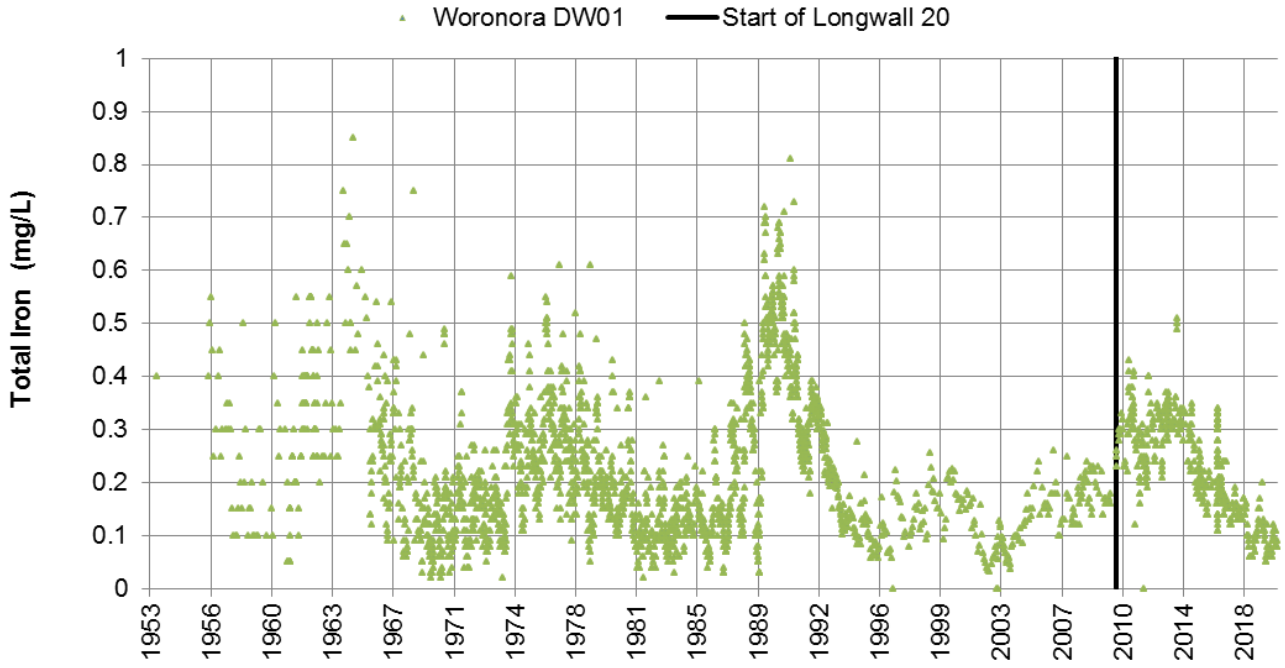

Chart 1 Total Iron Concentration Woronora Reservoir

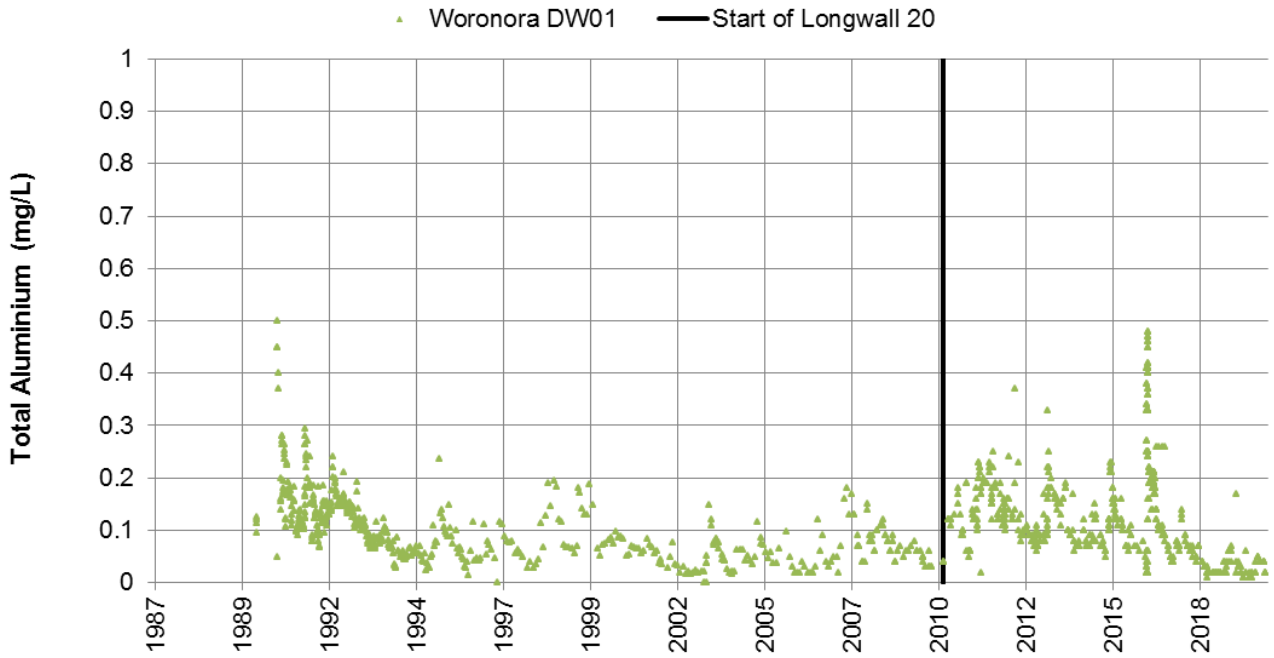

Chart 2 **Total Aluminium Concentration Woronora Reservoir**

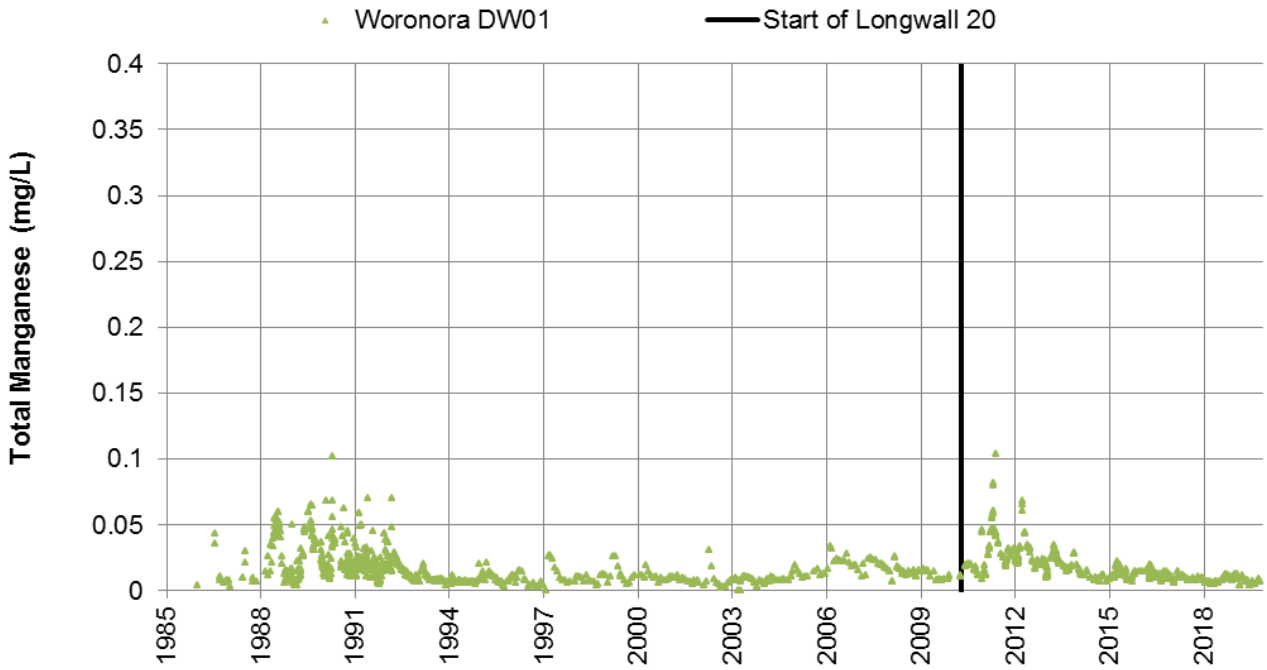

Chart 3 **Total Manganese Concentration Woronora Reservoir**

3.0 ASSESSMENT AGAINST SURFACE WATER SUBSIDENCE IMPACT PERFORMANCE INDICATORS AND MEASURES

The performance indicators and subsidence impact performance measures described below have been developed to address the predictions of subsidence impacts and environmental consequences on water resources and watercourses included in the Project Environmental Assessment (Helensburgh Coal, 2008), Preferred Project Report (PPR) (Helensburgh Coal, 2009) and Metropolitan Coal Extraction Plans.

3.1 QUANTITY OF WATER RESOURCES REACHING THE WORONORA RESERVOIR

Performance Indicator:

> *Changes in the quantity of water entering Woronora Reservoir are not significantly different post-mining compared to pre-mining, that are not also occurring in the control catchment(s).*

3.1.1 Assessment of Flow Reaching Woronora Reservoir from Waratah Rivulet at GS 2132102

Streamflow data has been analysed to assess whether a statistically significant reduction in the quantity of water entering Woronora Reservoir in the post-mine period relative to the pre-mine period has occurred, that has not also occurred in the control catchment(s).

Measured flows versus modelled flows in Waratah Rivulet have been analysed using a catchment model (a modified version of the AWBM), specifically:

- monitored flows have been filtered in order to assess low flows (i.e. flows of 1 millimetre per day [mm/day] or less[5]) by setting monitored flows that are greater than 1 mm/day to equal modelled flows;
- the filtered monitored flows on Waratah Rivulet have been integrated over successive 14 day periods to produce a smoothed set of data for comparison with the corresponding integrated flows (14 day totals) predicted by the modified AWBM for Waratah Rivulet; and
- the ratio of filtered monitored flows to the modified AWBM predicted flows has been calculated at 14 day intervals commencing at the beginning of the baseline period and advancing beyond the commencement of Longwall 20 secondary extraction - the median of the ratios has then been calculated over a moving window of 1 year.

The results for the review period, 1 January to 30 June 2019, have been assessed against the Longwalls 301 – 303 Water Management Plan significance levels/triggers (below):

Significance Levels/Triggers **Negligible Reduction to the Quantity of Water Resources Reaching the Woronora Reservoir**	
Level 1	The median of the ratios does not fall below the 35th percentile of the baseline data
Level 2	The median of the ratios falls below the 35th percentile but does not fall below the 20th percentile of the baseline data
Level 3	The median of the ratios falls below the 20th percentile of the baseline data

[5] Equivalent to a daily flow of 20.5 ML/day at the Waratah Rivulet gauging station.

The streamflow records for GS 2132102 provided by WaterNSW were incomplete for the review period and, as such, assessment of the results for the review period, 1 July to 31 December 2019, against the Longwall 304 Water Management Plan significance levels/triggers was unable to be conducted at the time of reporting. Assessment against the performance indicator for the review period, 1 July to 31 December 2019, will be undertaken in the next review period.

Chart 4 shows a plot of the sliding 12 month median of the ratio of 14 day sums of monitored flow at Waratah Rivulet (GS 2132102) and flows simulated via the modified AWBM to 30 June 2019.

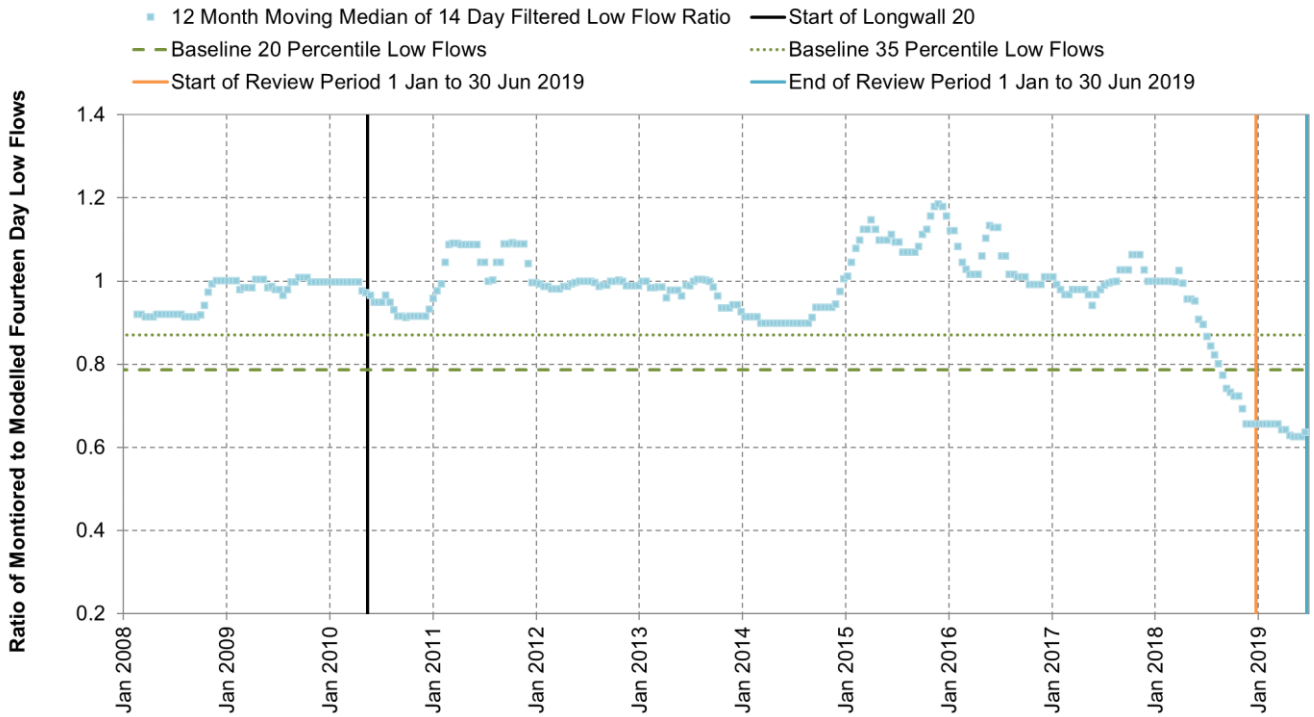

Chart 4 One Year Moving Median for the Ratios of the 14 Day Sums of Monitored and Modelled Flow Rates at Waratah Rivulet (GS 2132102)

The results show that the moving 12 month median of the 14 day filtered low flow ratio fell below the 20th percentile of the baseline data during 2018 and remained below the 20th percentile of the baseline data during the review period. To assess if similar conditions have occurred at the control site in the region, a comparison of the 12 month median of the ratio of 14 day sums of monitored flow at a control site on O'Hares Creek at Wedderburn (GS 213200) and flows simulated via the modified AWBM have been assessed.

Chart 5 shows a plot of the moving 12 month median of the ratio of 14 day sums of monitored flow at O'Hares Creek at Wedderburn (GS 213200) and flows simulated with the modified AWBM to 30 June 2019.

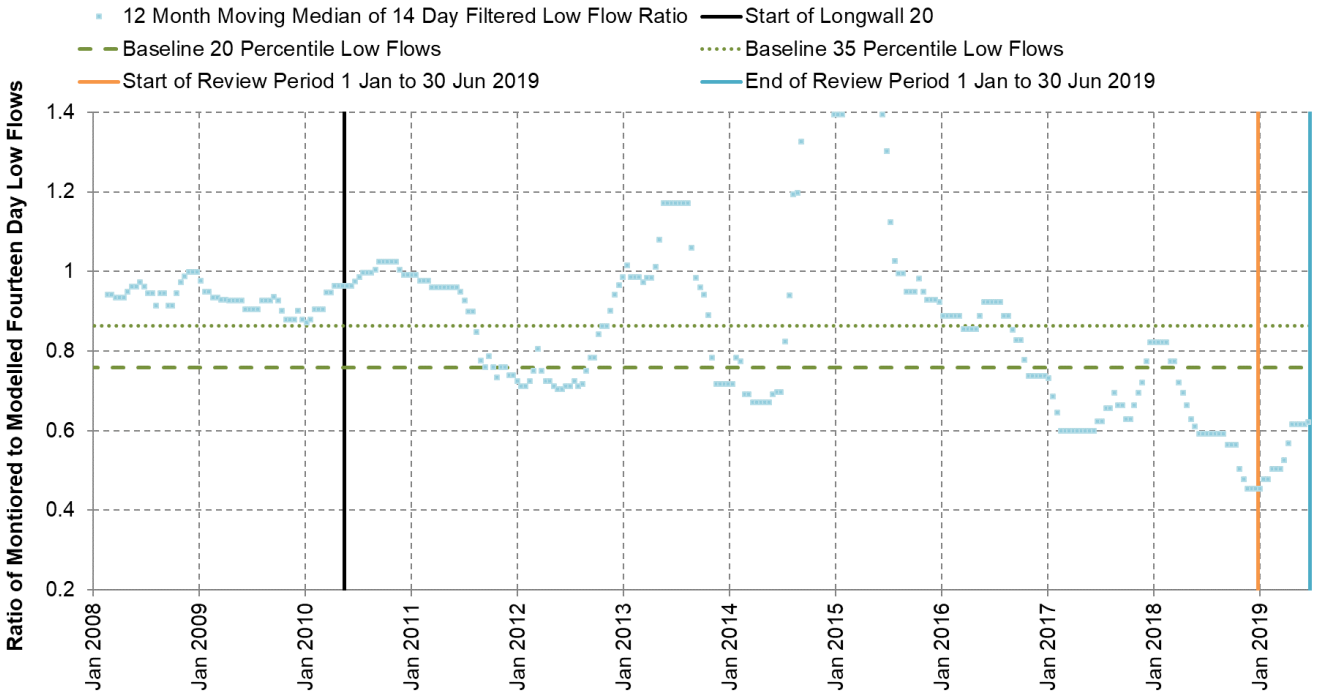

Chart 5 One Year Moving Median for the Ratios of the 14 Day Sums of Monitored and Modelled Flow Rates at O'Hares Creek at Wedderburn (GS 213200)

The results in Chart 5 show that the moving 12 month median of the 14 day filtered low flow ratio at O'Hares Creek at Wedderburn (GS 213200) also remained below the 20th percentile of the baseline data. This illustrates that similar flow conditions have occurred at both Waratah Rivulet and the control site (O'Hares Creek at Wedderburn). As such, while the Metropolitan Coal Longwalls 301-303 Water Management Plan Trigger Action Response Plan (TARP) has reached Level 3, it is considered that the performance indicator relating to the quantity of water entering Woronora Reservoir from Waratah Rivulet has not been exceeded and an assessment against the performance measure is not required.

3.1.2 Assessment of Flow Reaching Woronora Reservoir from Eastern Tributary at GS 300078

Flow data up to the 31 December 2019 has been provided from gauging station 300078 – Eastern Tributary upstream of Woronora Reservoir. Flow data is available from the time of station establishment on 23 September 2012. The available data is shown on Chart 6 below together with model predicted results.

Results show that streamflow recorded at the gauging station has been continuous and has generally been consistent with or above model predictions. This indicates that flows reaching the Woronora Reservoir have not been reduced by mining.

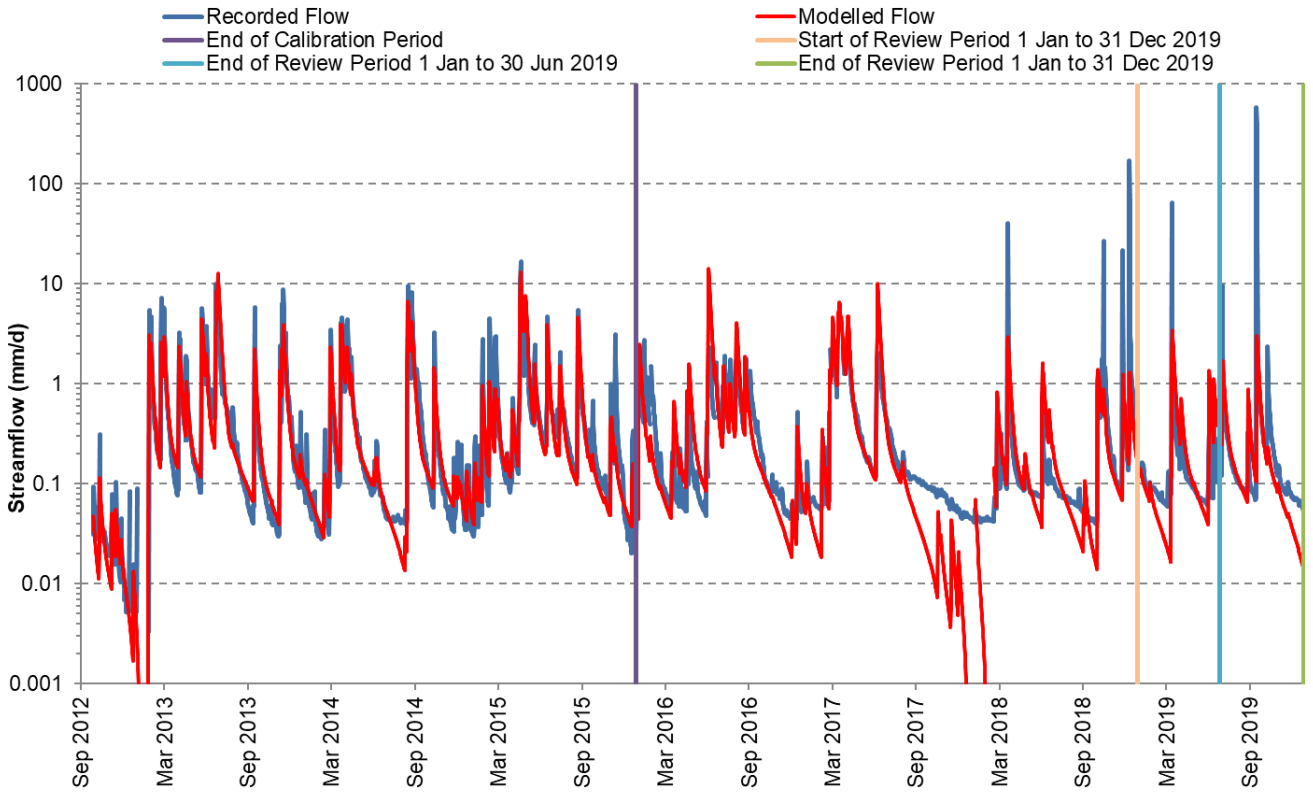

Chart 6 Monitored and Model Predicted Flows – Eastern Tributary Upstream of Woronora Reservoir

3.1.2 Assessment of Flow for Sub-Catchment I and Sub-Catchment K

Following recommendations made in the *Woronora Reservoir Impact Strategy – Stage 1 Report* (Hebblewhite et al., 2017), streamflow gauging stations were installed on small tributary catchments, Sub-Catchment I and Sub-Catchment K, on the eastern side of the Woronora Reservoir. Sub-catchment I overlies Longwall 301 to Longwall 304 and therefore may be impacted by associated subsidence movements, specifically upsidence. Sub-Catchment K is located north of the predicted subsidence zone of Longwall 301 to Longwall 304 and forms a control for the assessment of potential impacts to streamflow in Sub-Catchment I (refer Figure 2).

Secondary extraction from Longwall 302 was occurring at the commencement of monitoring and continued to 6 October 2018. Secondary extraction of Longwall 303 commenced on 13 November 2018 and was completed in June 2019, while mining of Longwall 304 commenced in July 2019.

The recorded stage data and the cease to flow (CTF) level for Sub-Catchment I and Sub-Catchment K are presented in Chart 7 and the streamflow records presented in Chart 8.

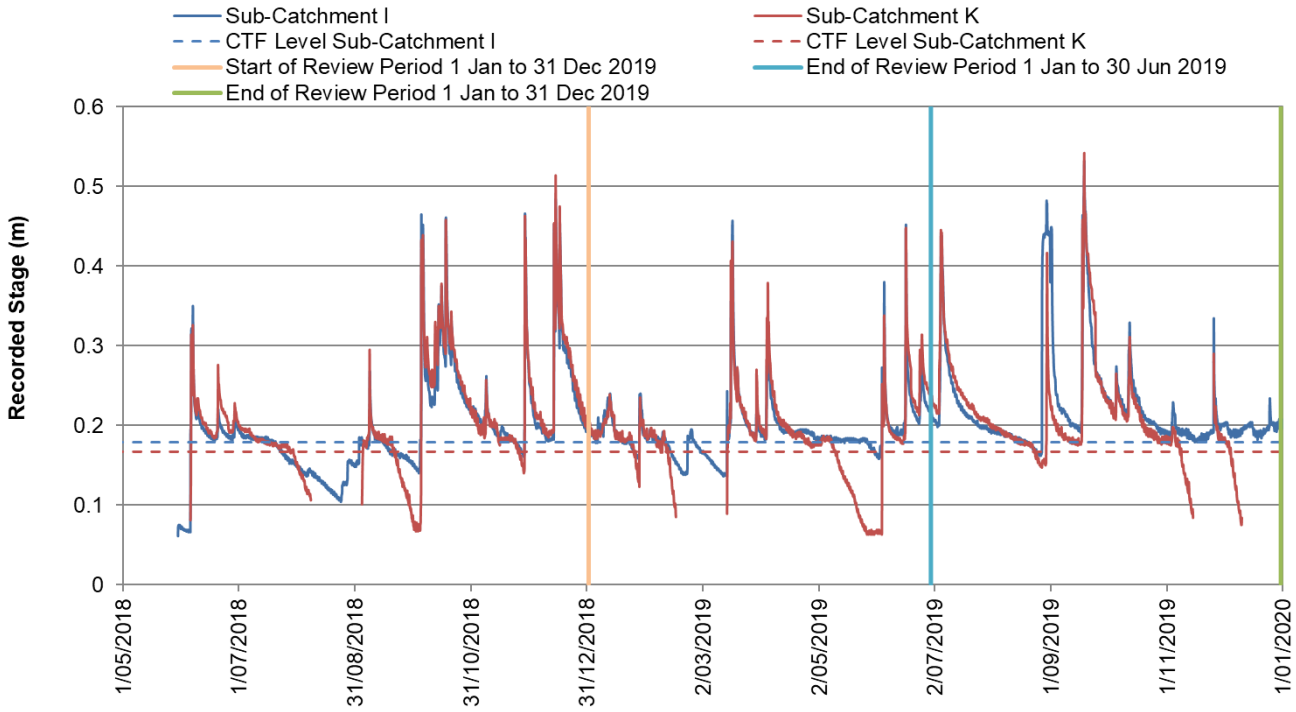

Chart 7 Sub-Catchment I and Sub-Catchment K Recorded Stage and Cease to Flow Level

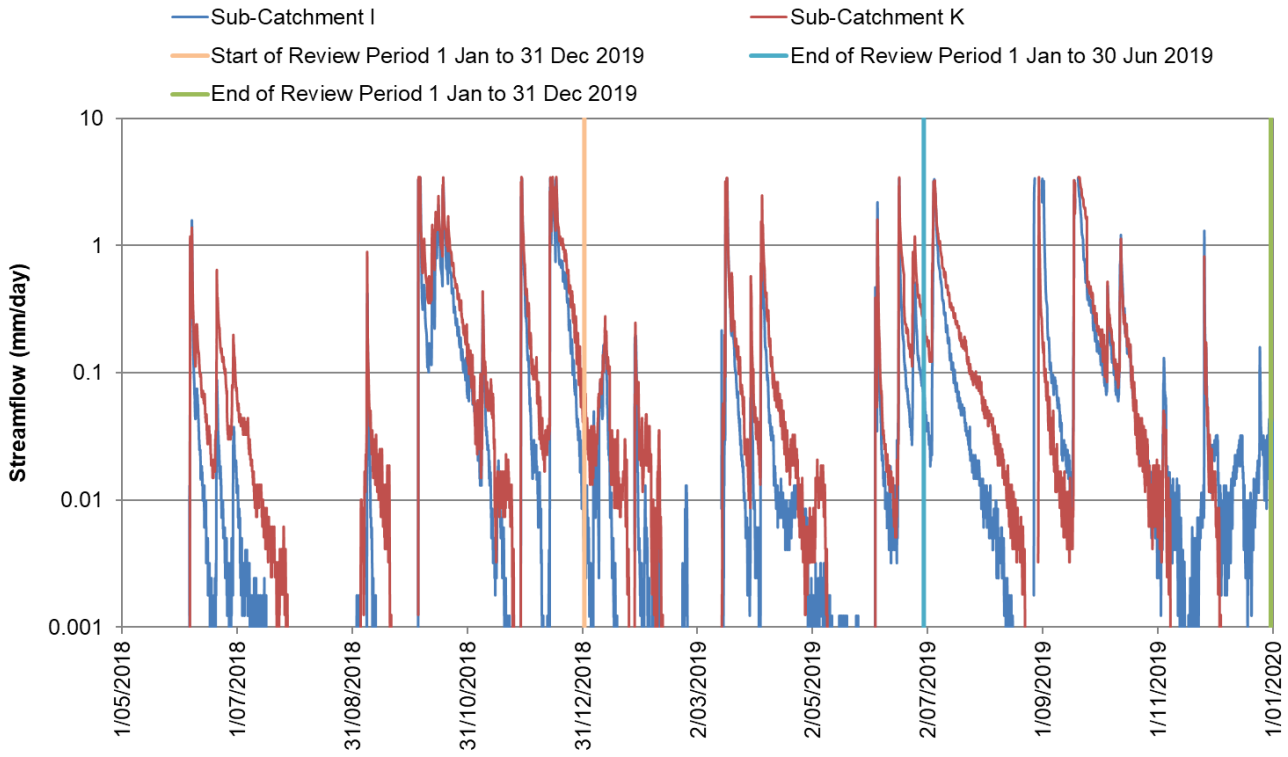

Chart 8 Sub-Catchment I and Sub-Catchment K Streamflow Rates

A detailed assessment of the water level and streamflow records for Sub-Catchment I and Sub-Catchment K for the period June 2018 to July 2019 (HEC, 2019b) identified that the water level and streamflow characteristics were consistent at both sites over the assessment period. The runoff recession during low flow periods was observed to be more rapid at the gauging station for Sub-Catchment I than for Sub-Catchment K however there was no indication of any change in the recessionary behaviour over the review period.

The water level and streamflow records for the period July to December 2019 (refer Chart 7 and Chart 8) illustrate similar characteristics at both sites to that observed during the June 2018 to July 2019 period. The water level recorded at the Sub-Catchment I gauging station fell below the cease to flow level in late August 2019 though the same was recorded at the Sub-Catchment K gauging station. There is no visual indication of a change in recessionary behaviour (i.e. rate of recession) for Sub-Catchment I (refer Chart 8) and no indication from the recorded stage and streamflow data that mining of Longwall 301 to Longwall 304 has impacted streamflow at the Sub-Catchment I gauging station.

3.1.3 Analysis against Subsidence Impact Performance Measure

Subsidence Impact Performance Measure:

Negligible reduction to the quantity of water resources reaching the Woronora Reservoir.

The subsidence impact performance measure is considered to have been exceeded if analysis of the monitoring and modelling results confirms that the Project has resulted in a greater than negligible reduction in the quantity of water resources reaching the Woronora Reservoir.

The performance measure of negligible reduction to the quantity of water resources reaching the Woronora Reservoir has been met.

3.2 QUALITY OF WATER RESOURCES REACHING THE WORONORA RESERVOIR

Performance Indicator:

Changes in the quality of water entering Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations that are not also occurring at control site WOWQ2.

Water quality data has been analysed for key water quality parameters of relevance to water supply and the effects of subsidence, namely dissolved (field filtered) iron, manganese and aluminium at site WRWQ 9 on Waratah Rivulet, site ETWQ AU on Eastern Tributary and at control site WOWQ 2 on the Woronora River.

The results for this review period (1 July to 31 December 2019) have been assessed against the Longwall 304 Water Management Plan significance levels/triggers (below):

Significance Levels/Triggers **Negligible Reduction to the Quality of Water Resources Reaching the Woronora Reservoir**	
Level 1	Data analysis indicates no water quality parameter exceeds the adjusted baseline mean plus two standard deviations.
Level 2	Data analysis indicates any water quality parameter exceeds the adjusted baseline mean plus two standard deviations for one month.
Level 3	Data analysis indicates: • any water quality parameter exceeds the adjusted baseline mean plus two standard deviations for two consecutive months; or • over a three month period the water quality parameter exceeds the adjusted mean plus two standard deviations in the first month, the adjusted mean plus one standard deviation in the next month and the adjusted mean plus two standard deviations in the third month; or • the six month mean exceeds the adjusted baseline mean plus one standard deviation for two consecutive assessment periods (i.e. over two six monthly reports); and • there was not a similar exceedance of the trigger at the control site.

The performance indicator is exceeded if the results indicate a Level 3 significance level/trigger.

3.2.1 *Assessment of Water Quality at Site WRWQ 9*

Plots showing the concentrations of dissolved iron, dissolved aluminium and dissolved manganese recorded at sampling site WRWQ 9 in relation to the adjusted baseline mean plus one and two standard deviations are shown on Chart 9 to Chart 11 below.

Chart 12 to Chart 14 show the concentrations of dissolved iron, dissolved aluminium and dissolved manganese recorded at control site WOWQ 2 in comparison to the adjusted baseline mean plus one and two standard deviations.

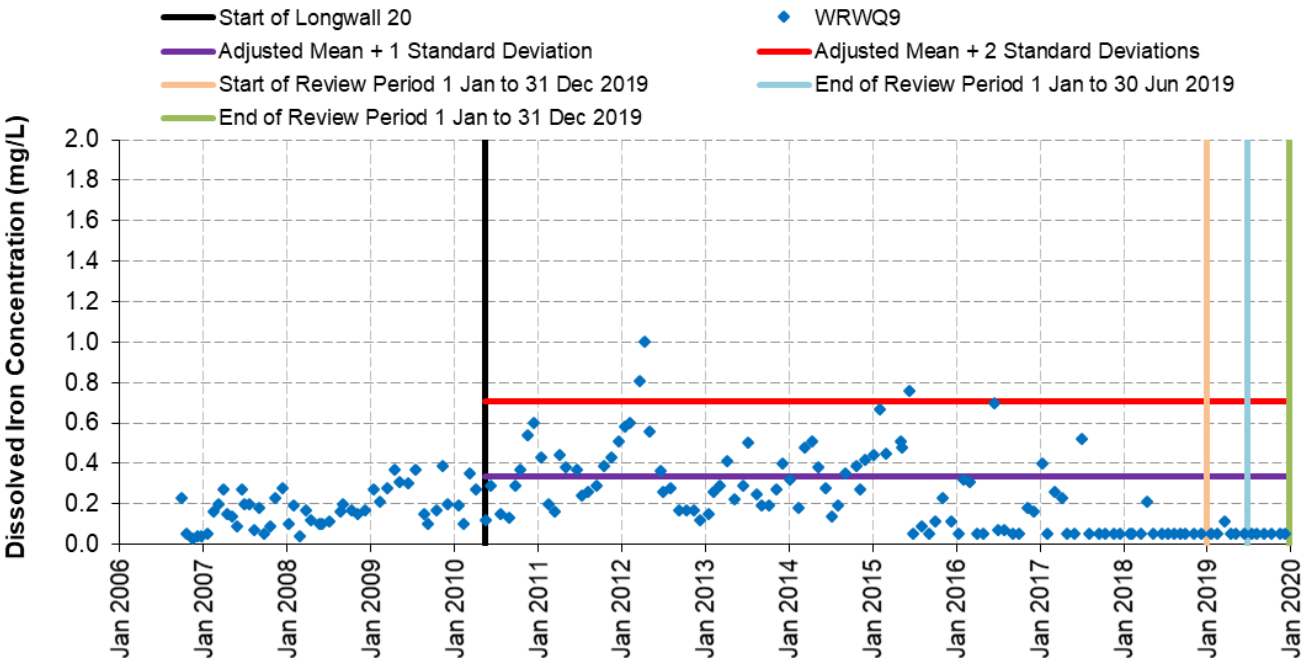

Chart 9 Dissolved Iron Concentrations in Waratah Rivulet at WRWQ9

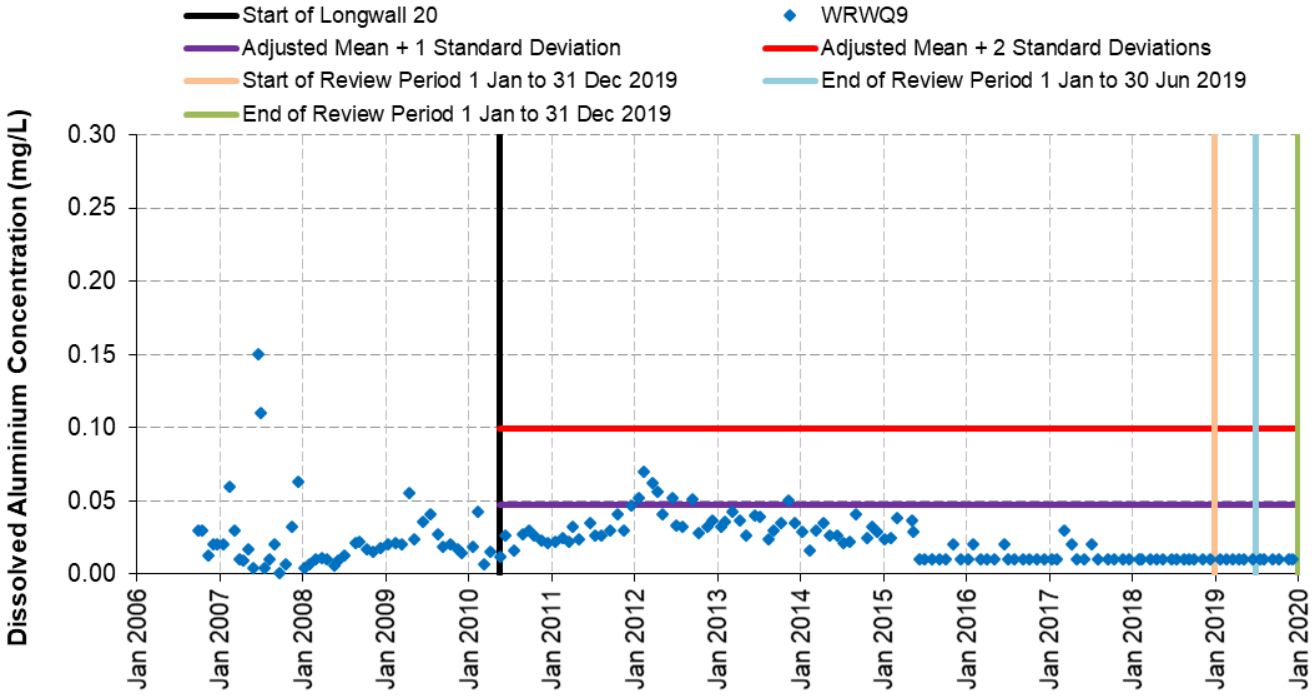

Chart 10 Dissolved Aluminium Concentrations in Waratah Rivulet at WRWQ9

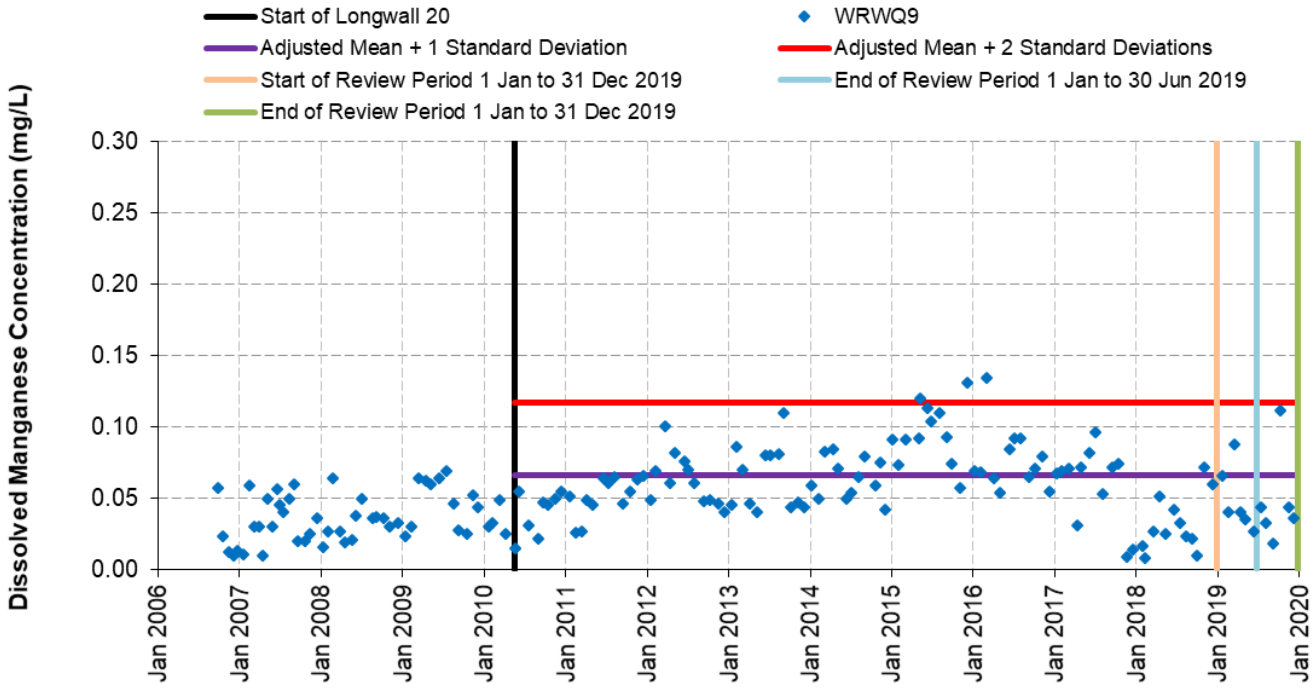

Chart 11 Dissolved Manganese Concentrations in Waratah Rivulet at WRWQ9

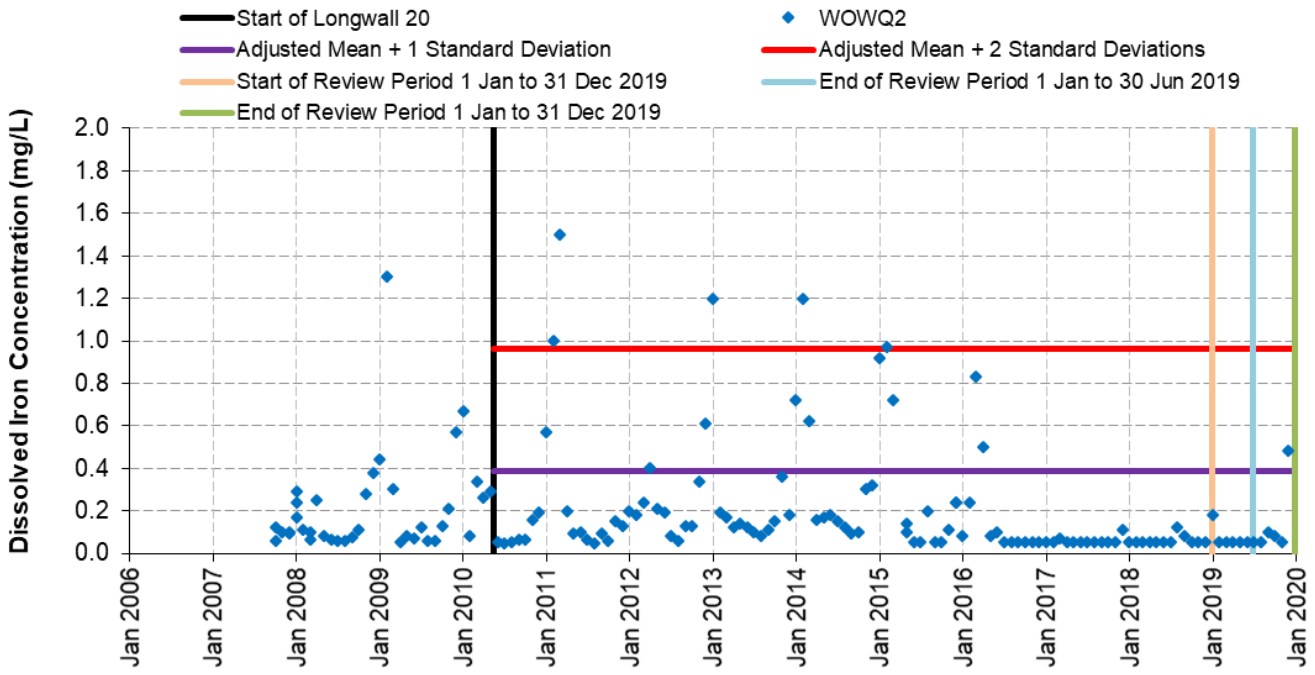

Chart 12 Dissolved Iron Concentrations in Woronora River at WOWQ2

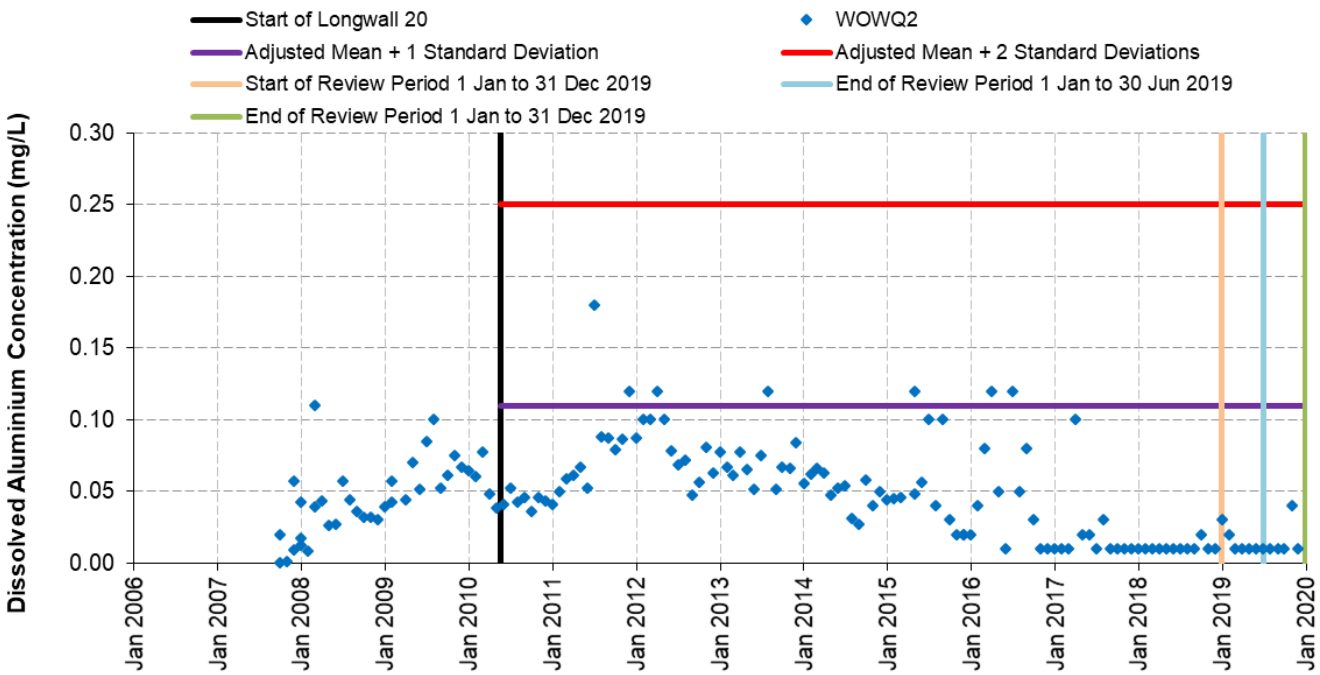

Chart 13 Dissolved Aluminium Concentrations in Woronora River at WOWQ2

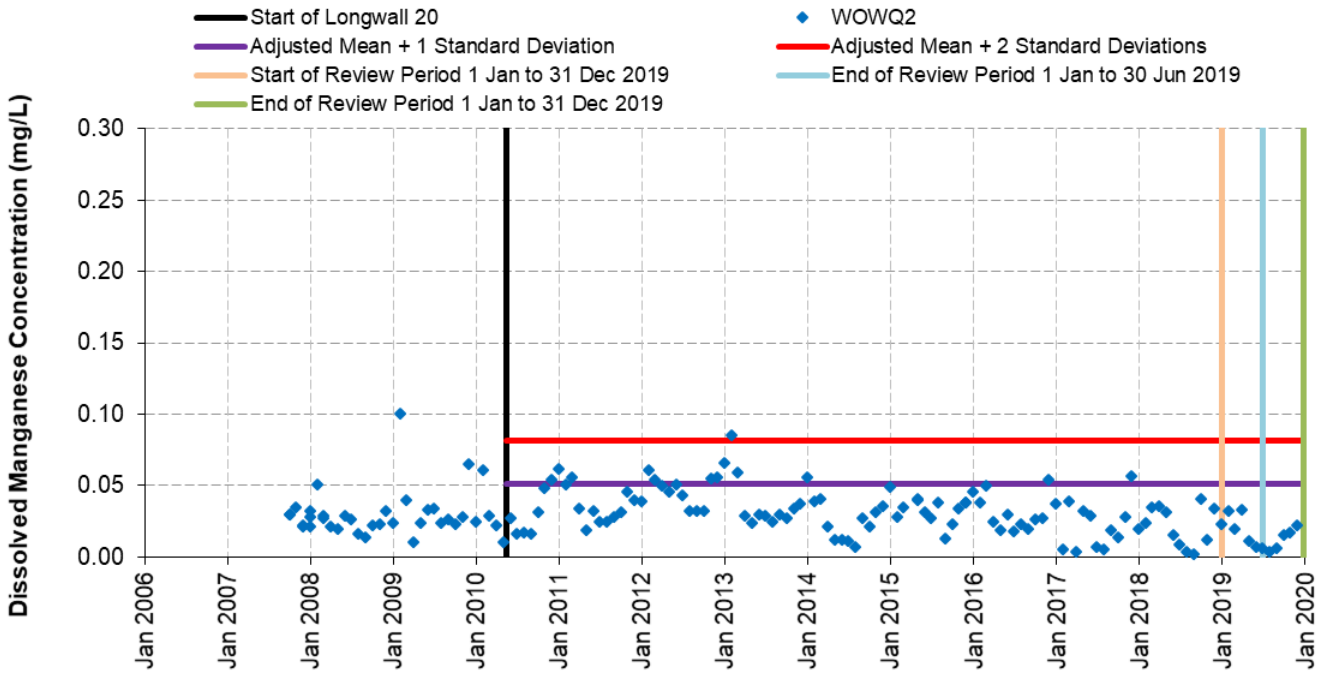

Chart 14 Dissolved Manganese Concentrations in Woronora River at WOWQ2

Chart 9 to Chart 11 indicate that there were no exceedances of the adjusted baseline mean plus two standard deviations for dissolved iron, dissolved aluminium or dissolved manganese in Waratah Rivulet at site WRWQ 9 during the reporting period. The results equate to a Level 1 significance level. There were also no exceedances of the adjusted baseline mean plus two standard deviations at control site WOWQ 2 on the Woronora River (Chart 12 to Chart 14).

Plots showing the six monthly mean concentrations for dissolved iron, dissolved aluminium and dissolved manganese recorded at site WRWQ 9 are shown on Chart 15 to Chart 17. For comparison,

plots showing the six monthly mean concentrations for the same water quality parameters at control site WOWQ 2 are shown on Chart 18 to Chart 20. Each plot shows the adjusted baseline mean plus one standard deviation value.

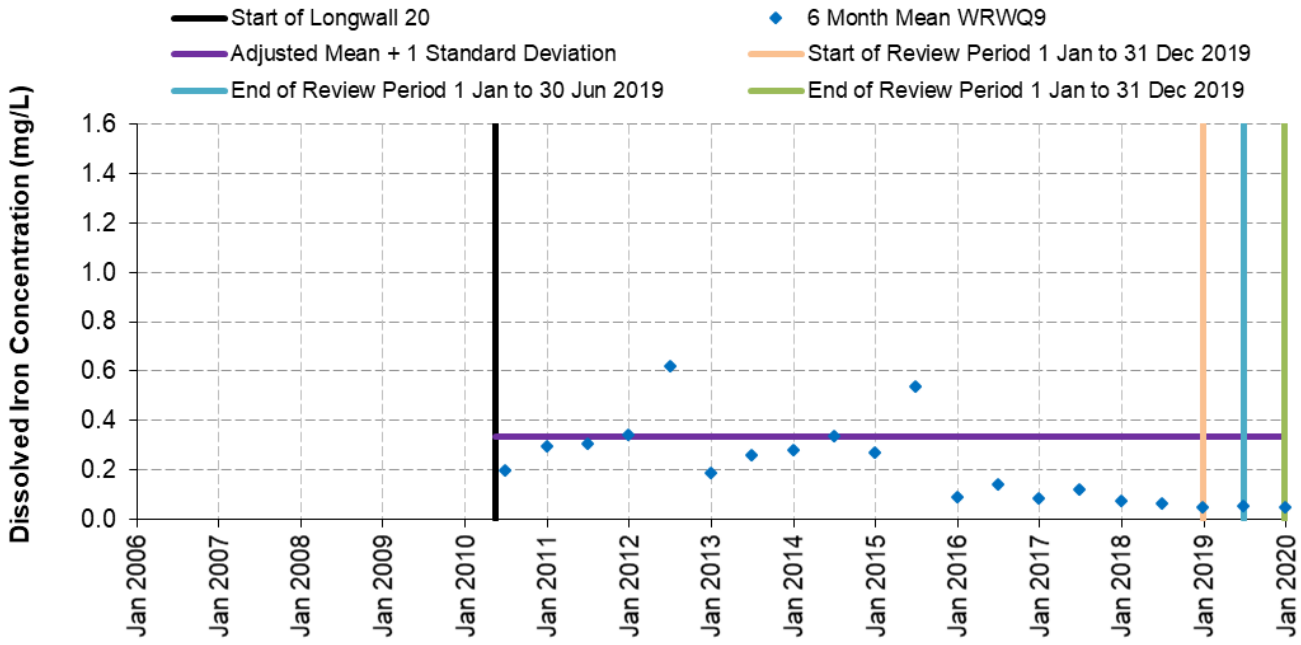

Chart 15 Six Monthly Means of Dissolved Iron Concentrations in Waratah Rivulet at WRWQ9

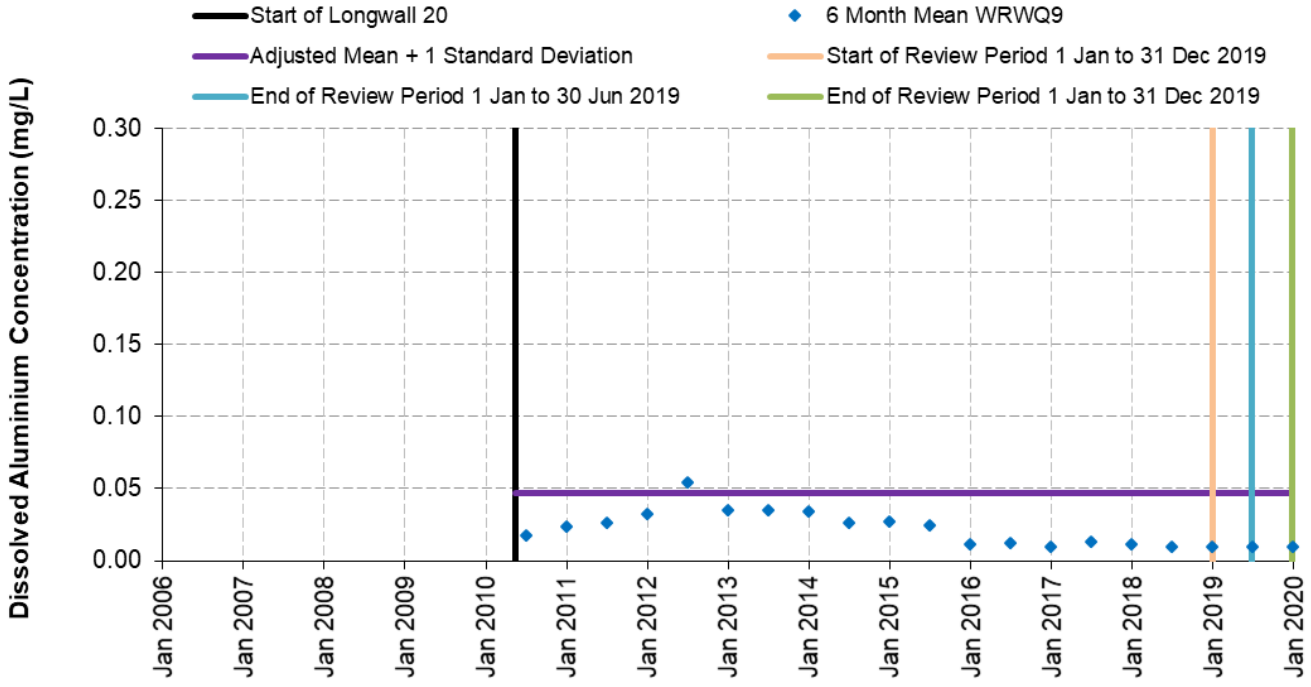

Chart 16 Six Monthly Means of Dissolved Aluminium Concentrations in Waratah Rivulet at WRWQ9

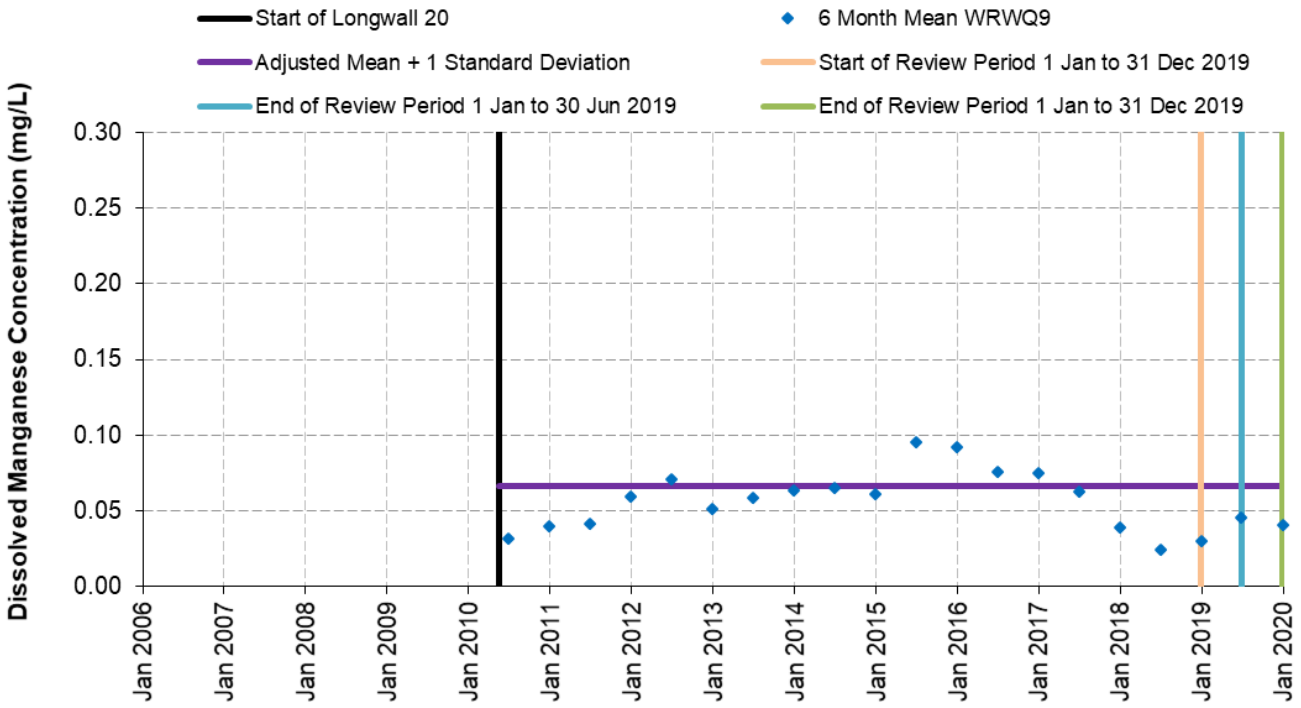

Chart 17 Six Monthly Means of Dissolved Manganese Concentrations in Waratah Rivulet at WRWQ9

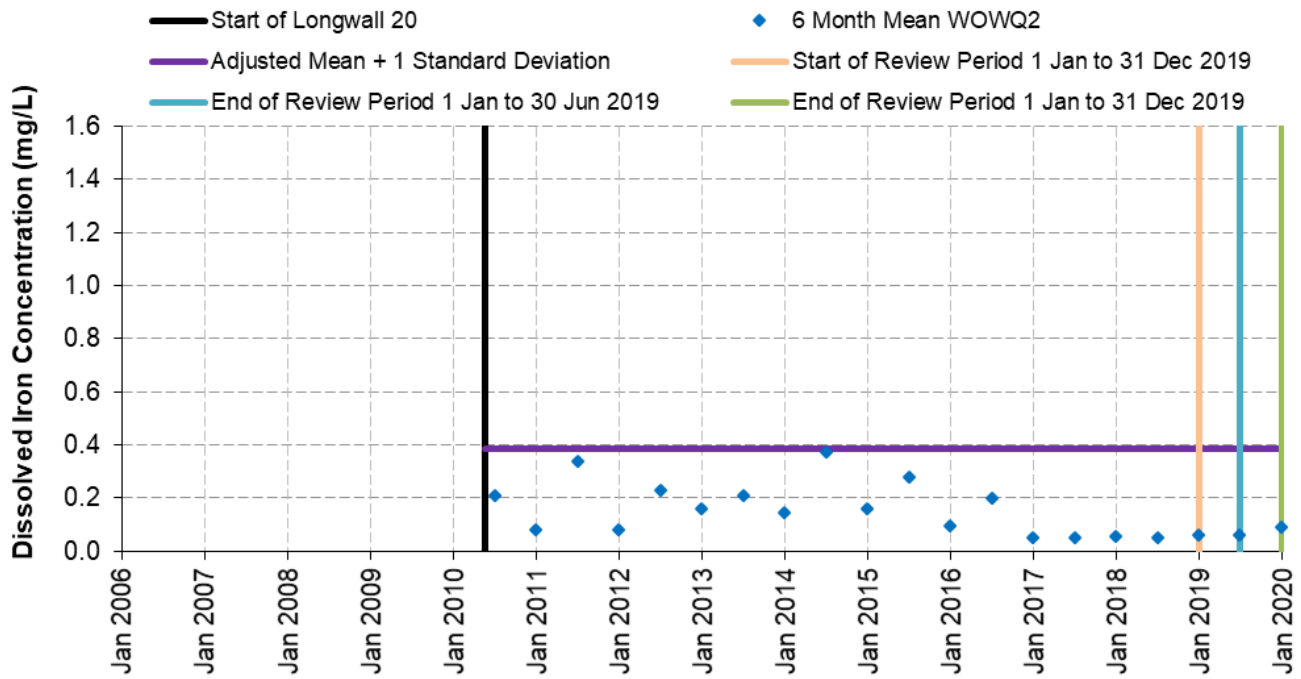

Chart 18 Six Monthly Means of Dissolved Iron Concentrations in Woronora River at WOWQ2

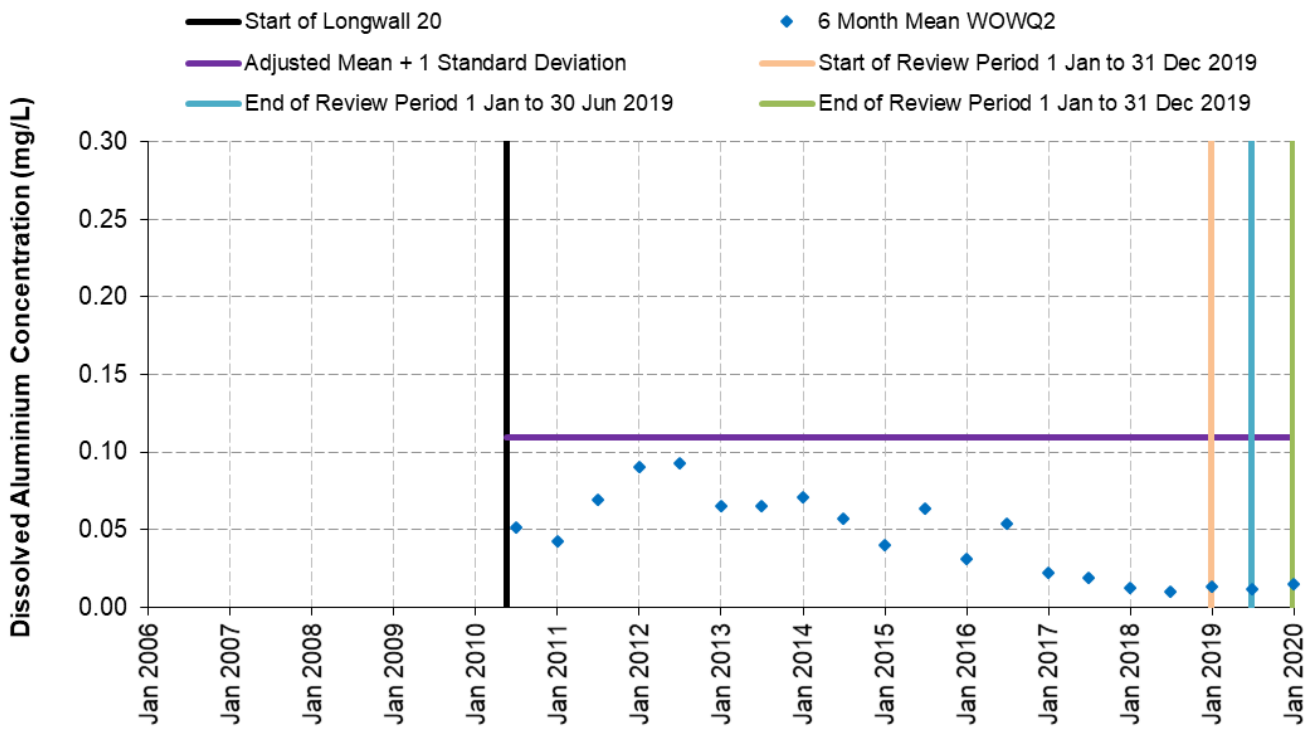

Chart 19 Six Monthly Means of Dissolved Aluminium Concentrations in Woronora River at WOWQ2

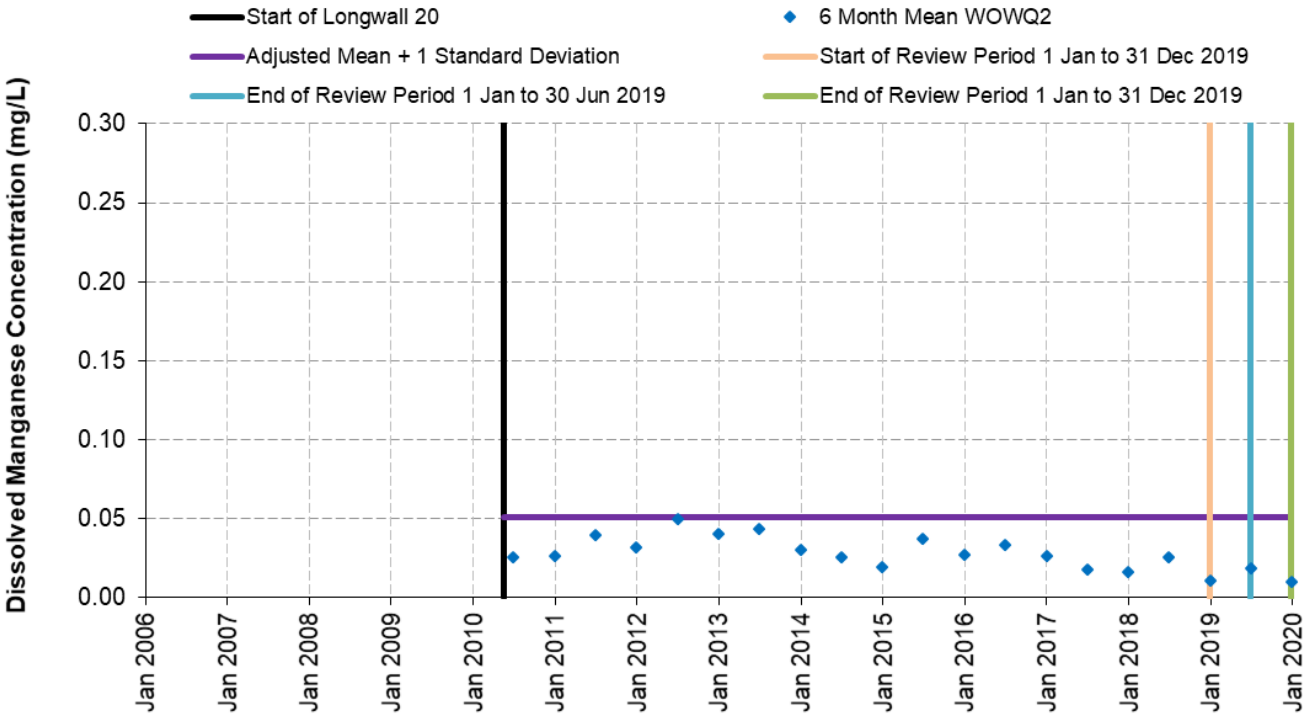

Chart 20 Six Monthly Means of Dissolved Manganese Concentrations in Woronora River at WOWQ2

There were no exceedances of the adjusted baseline mean plus one standard deviation for two consecutive six month means for dissolved iron, dissolved aluminium or dissolved manganese in Waratah Rivulet at site WRWQ 9 (Chart 15 to Chart 17) or Woronora River at site WOWQ2 (Chart 18 to Chart 20) during the reporting period.

3.2.2 *Assessment of Water Quality at Site ETWQ AU*

Plots showing the concentrations of dissolved iron, dissolved aluminium and dissolved manganese recorded at site ETWQ AU are shown on Chart 21 to Chart 23 in relation to the adjusted baseline mean plus one and two standard deviations calculated using data prior to potential subsidence effects from Longwall 20 on the Eastern Tributary.

Chart 24 to Chart 26 show the concentrations of dissolved iron, dissolved aluminium and dissolved manganese recorded at control site WOWQ 2 in comparison to the adjusted baseline mean plus one and two standard deviations calculated using data collected prior to potential subsidence effects from Longwall 20 on the Eastern Tributary.

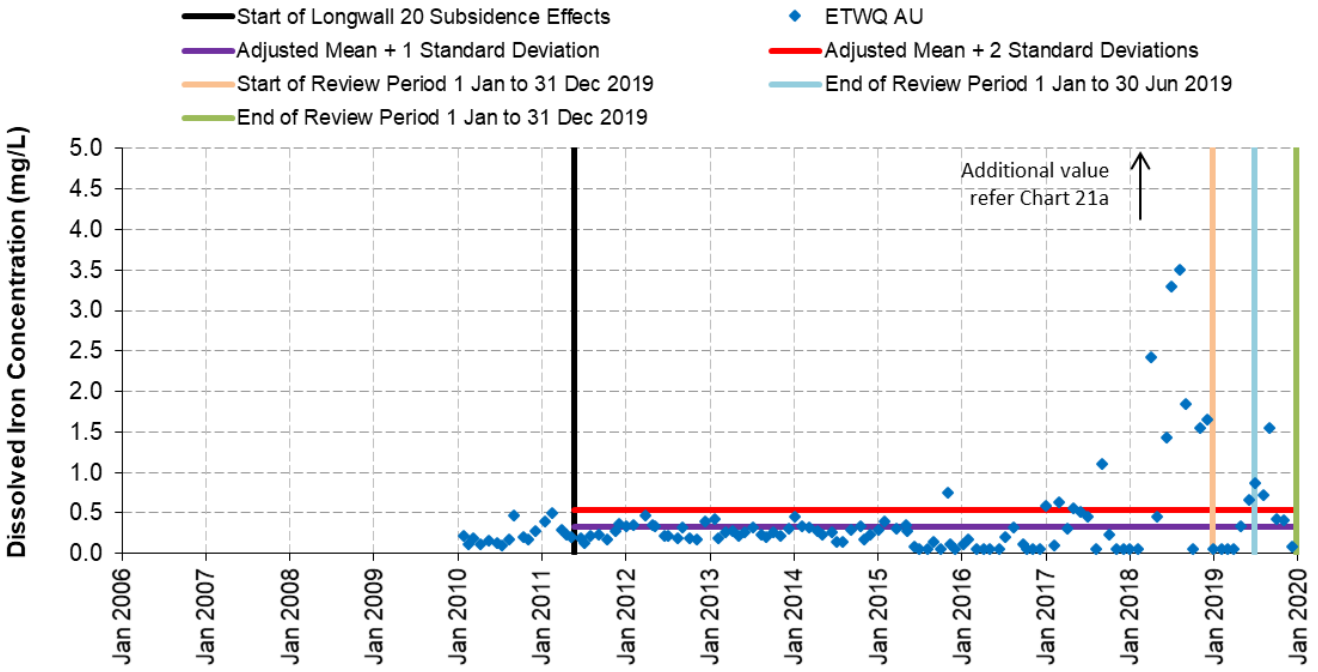

Chart 21 Dissolved Iron Concentrations in Eastern Tributary at ETWQ AU

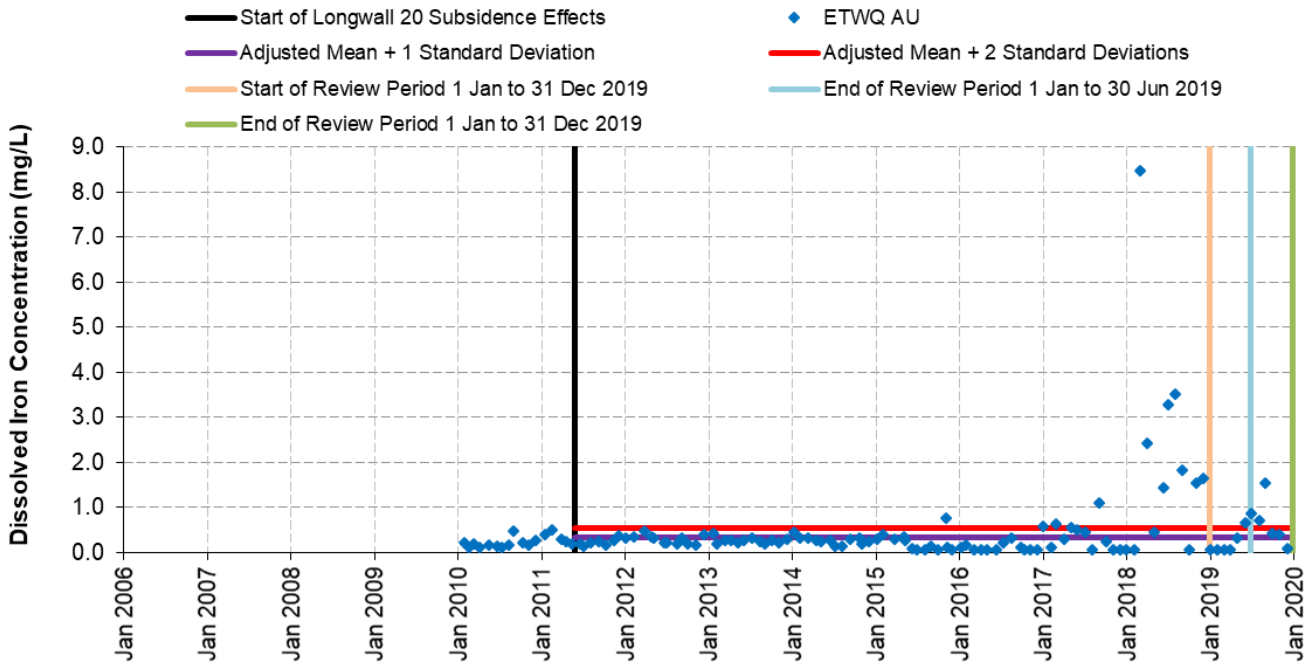

Chart 21a Dissolved Iron Concentrations in Eastern Tributary at ETWQ AU

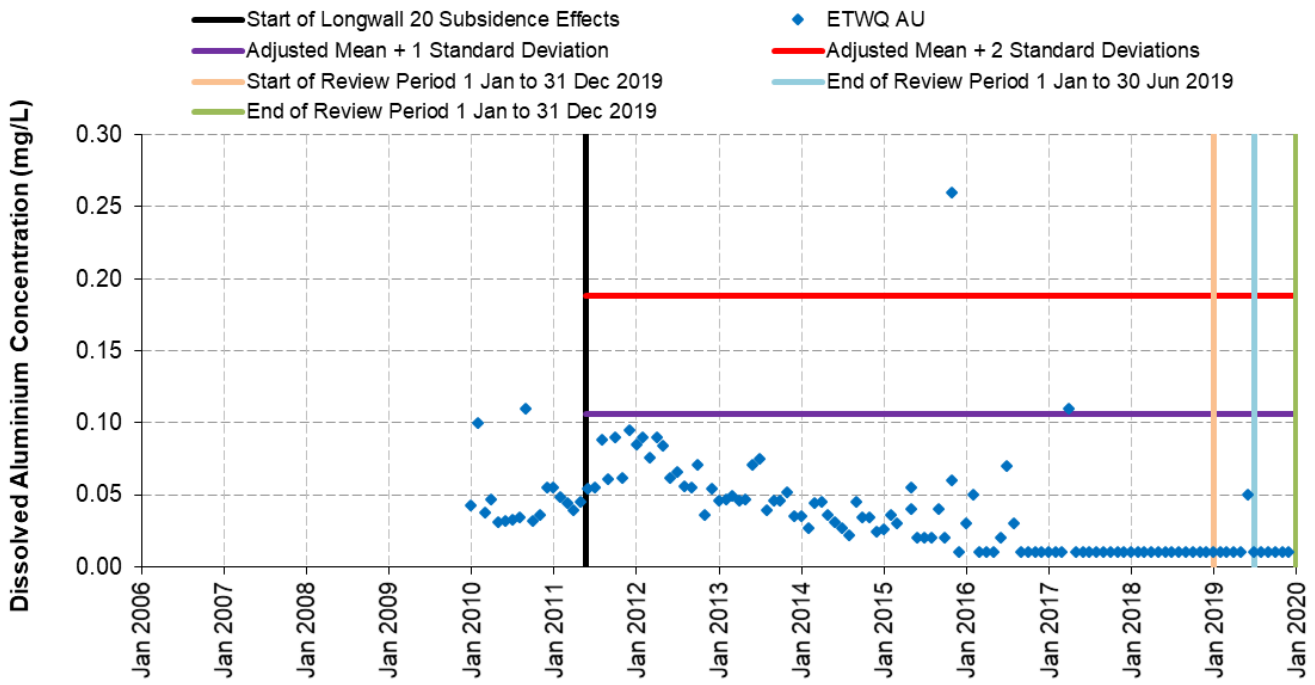

Chart 22 **Dissolved Aluminium Concentrations in Eastern Tributary at ETWQ AU**

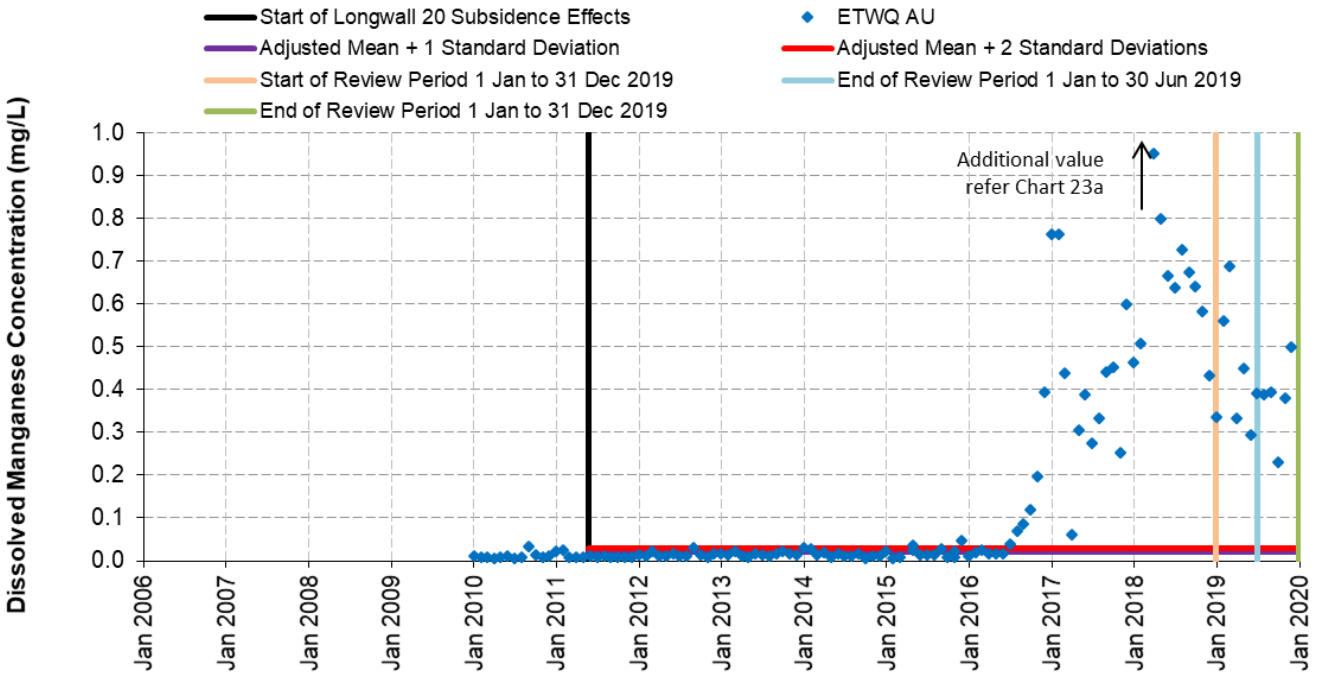

Chart 23 **Dissolved Manganese Concentrations in Eastern Tributary at ETWQ AU**

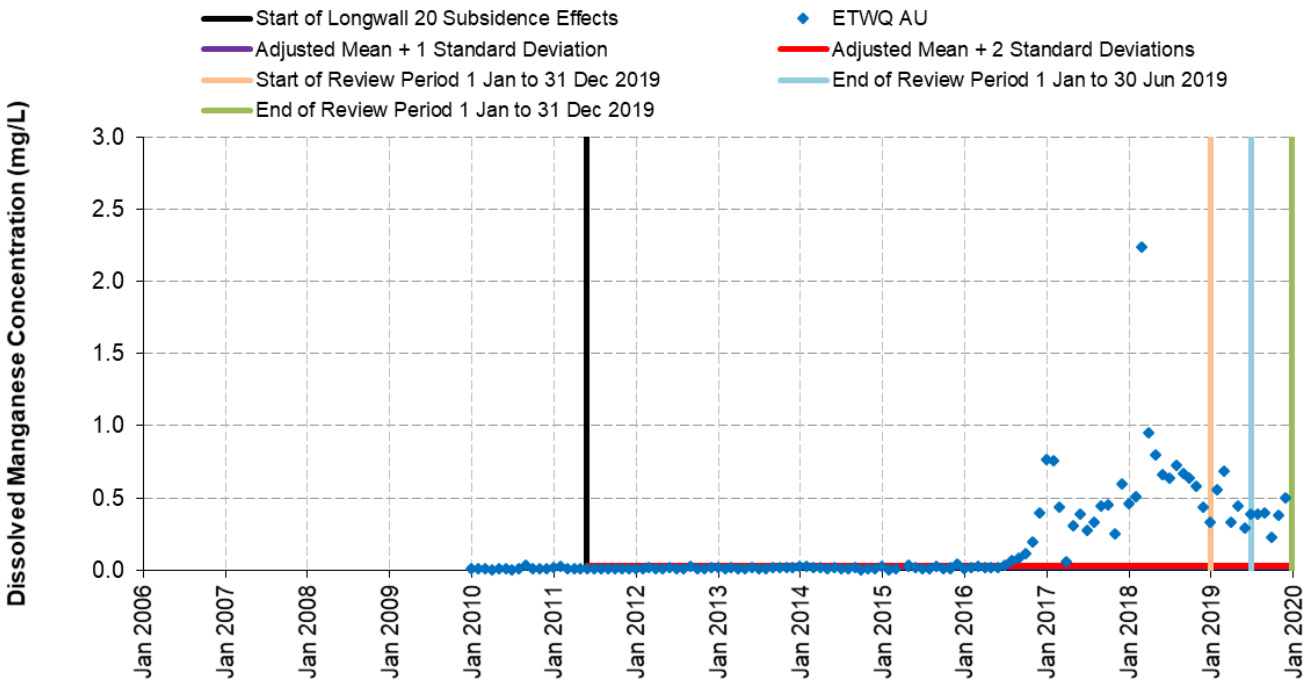

Chart 23a Dissolved Manganese Concentrations in Eastern Tributary at ETWQ AU

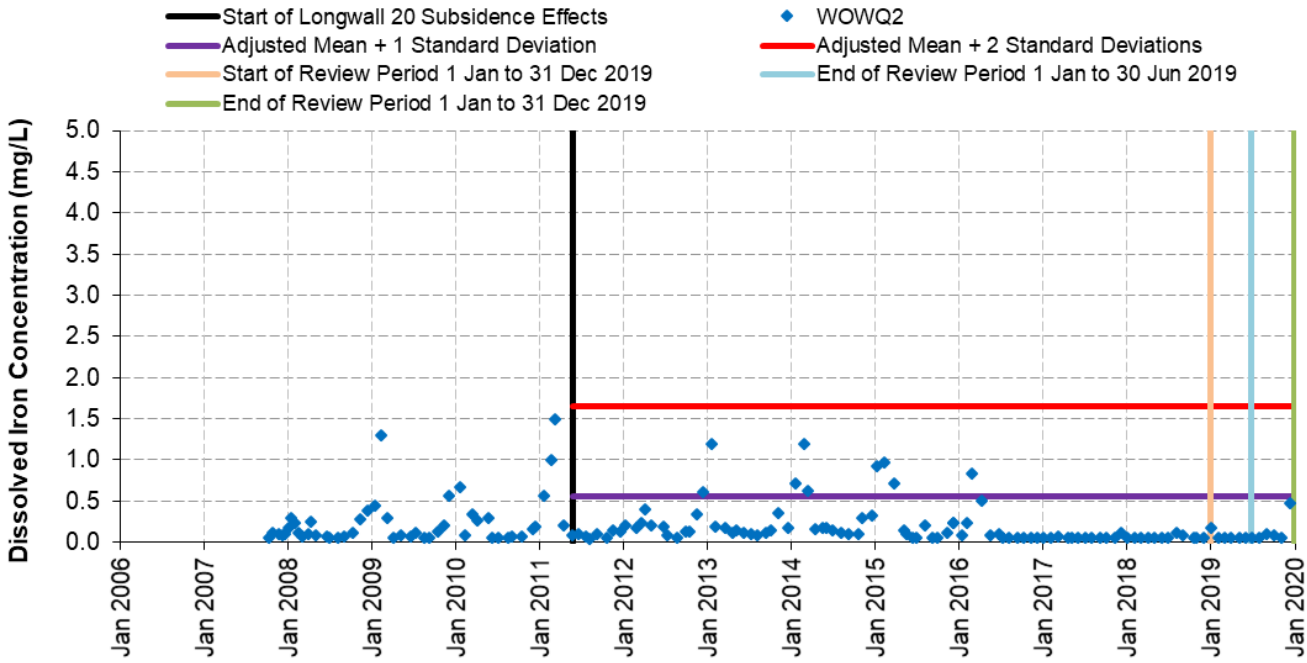

Chart 24 Dissolved Iron Concentrations in Woronora River at WOWQ2

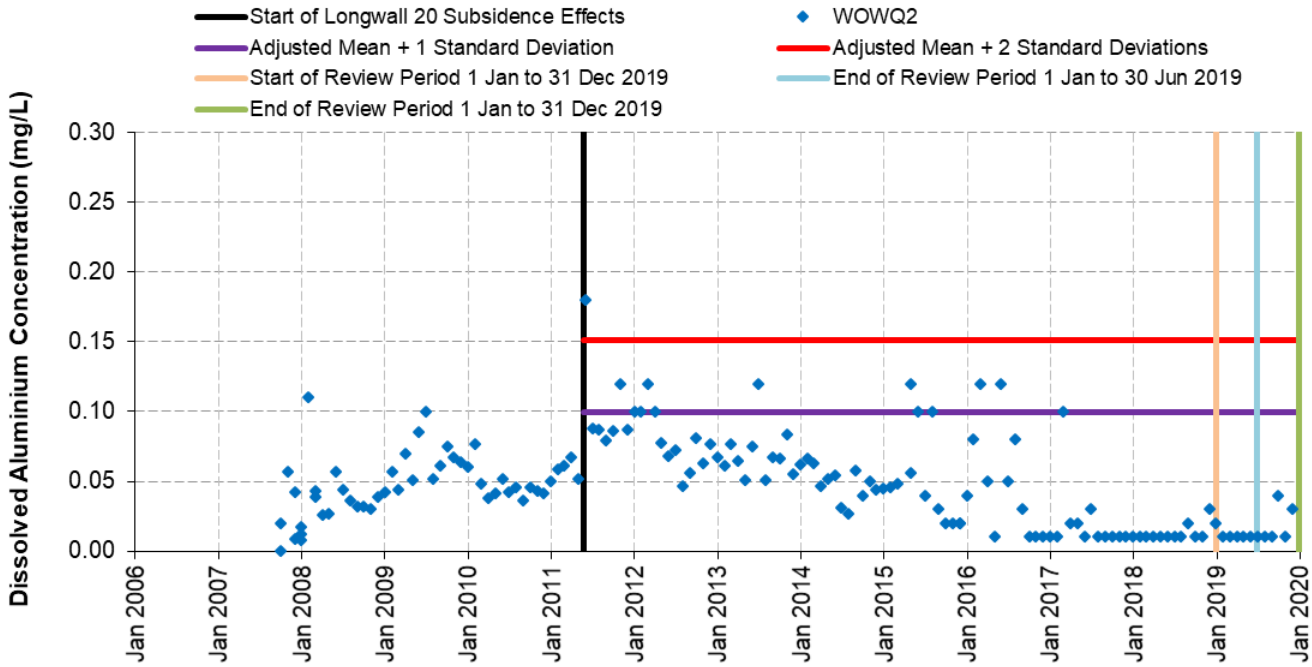

Chart 25 Dissolved Aluminium Concentrations in Woronora River at WOWQ2

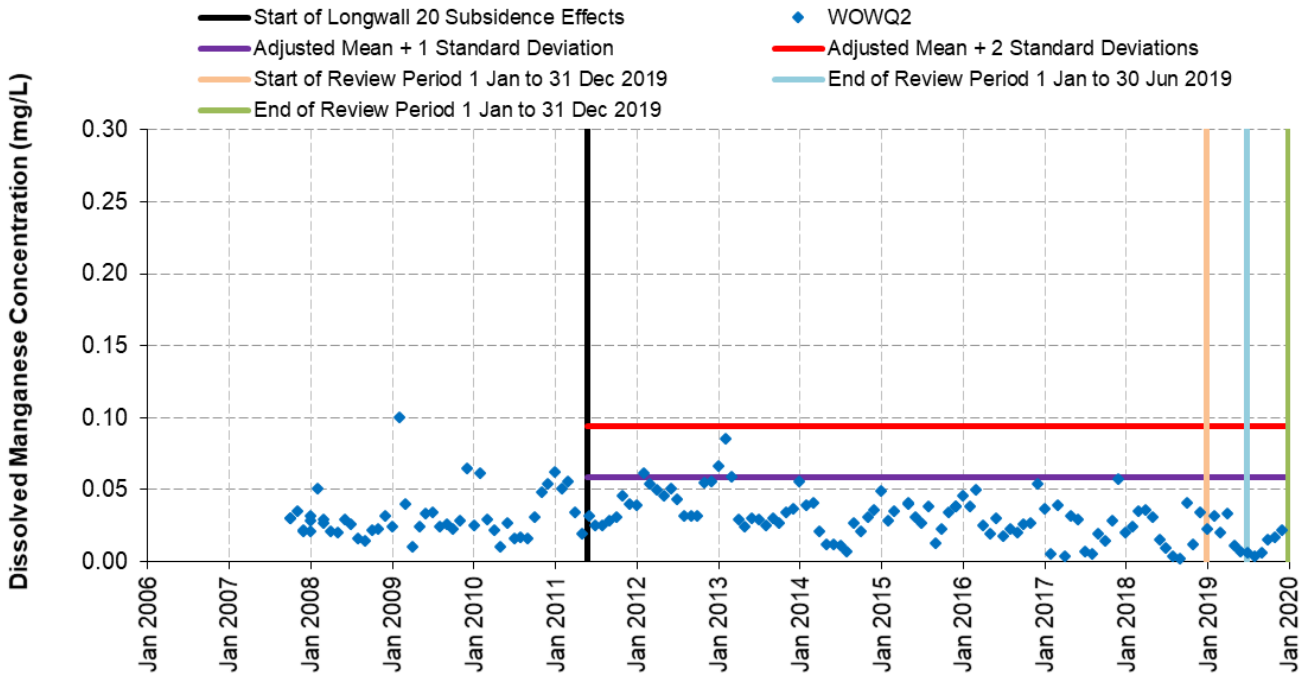

Chart 26 Dissolved Manganese Concentrations in Woronora River at WOWQ2

Chart 21/21a indicate that there was an exceedance of the adjusted baseline mean plus two standard deviations for dissolved iron at sampling site ETWQ AU in June, July, August and September 2019. This resulted in exceedances of the adjusted baseline mean plus two standard deviations for two consecutive months ending in July (June and July), August (July and August) and September (August and September).

Dissolved iron concentrations also exceeded the adjusted mean plus two standard deviations in one month, the adjusted mean plus one standard deviation in the second month and the adjusted mean plus two standard deviations in the third month, ending in August (June, July and August) and

September (July, August and September). As there was not a similar exceedance of these triggers at the control site WOWQ 2 on the Woronora River (Chart 24), the results equate to a Level 2 significance level in June 2019 and a Level 3 significance level in July, August and September 2019. For the remainder of the reporting period dissolved iron concentrations at site ETWQ AU were at a Level 1 significance level.

Chart 22 indicates there were no exceedances of the adjusted baseline mean plus two standard deviations for dissolved aluminium at sampling site ETWQ AU during the reporting period. The results for dissolved aluminium equate to a Level 1 significance level. There were also no exceedances of the adjusted baseline mean plus two standard deviations for dissolved aluminium at control site WOWQ 2 on the Woronora River (Chart 25).

The dissolved manganese concentrations continued to exceed the adjusted baseline mean plus two standard deviations at site ETWQ AU from January to December 2019 (Chart 23/23a). Dissolved manganese concentrations exceeded the adjusted mean plus two standard deviations in the first month, the adjusted mean plus one standard deviation in the next month and the adjusted mean plus two standard deviations in the third month throughout the reporting period. As there was not a similar exceedance of these triggers at the control site WOWQ 2 on the Woronora River (Chart 26), the results for dissolved manganese equate to a Level 3 significance level throughout the reporting period.

Plots showing the six monthly mean concentrations for dissolved iron, dissolved aluminium and dissolved manganese recorded at site ETWQ AU are shown on Chart 27 to Chart 29. For comparison, plots showing the six monthly mean concentrations for the same water quality parameters at control site WOWQ2 are shown on Chart 30 to Chart 32. Each plot shows the adjusted baseline mean plus one standard deviation value.

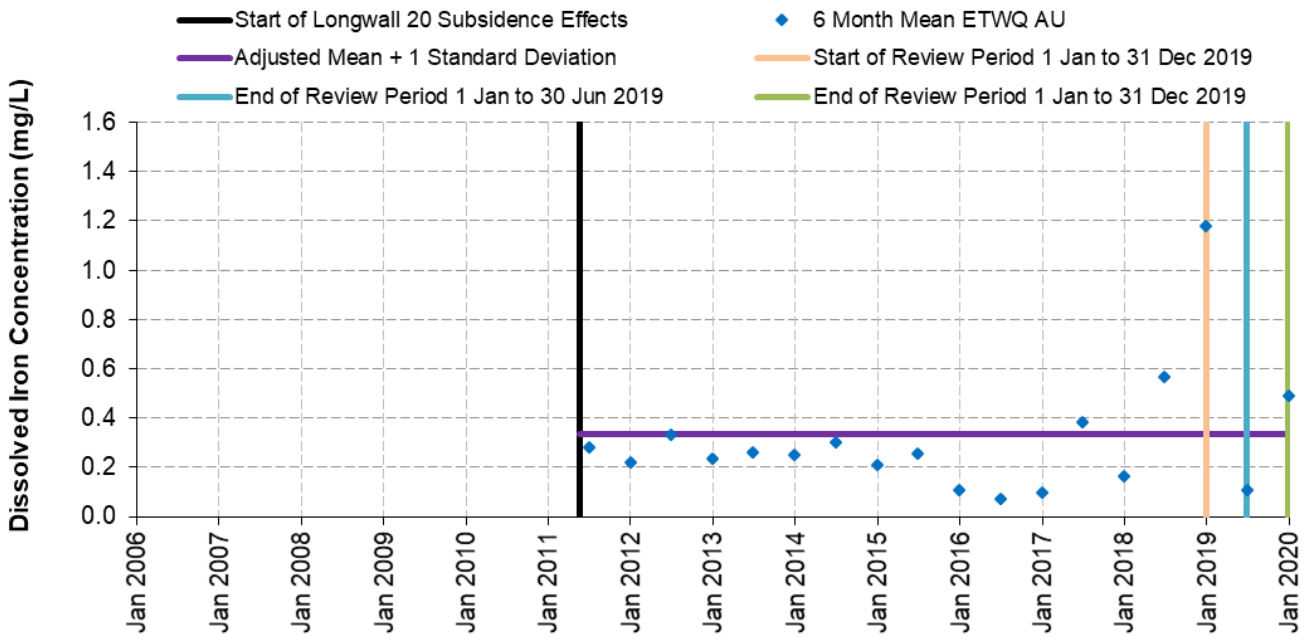

Chart 27 Six Month Means of Dissolved Iron Concentrations in Eastern Tributary at ETWQ AU

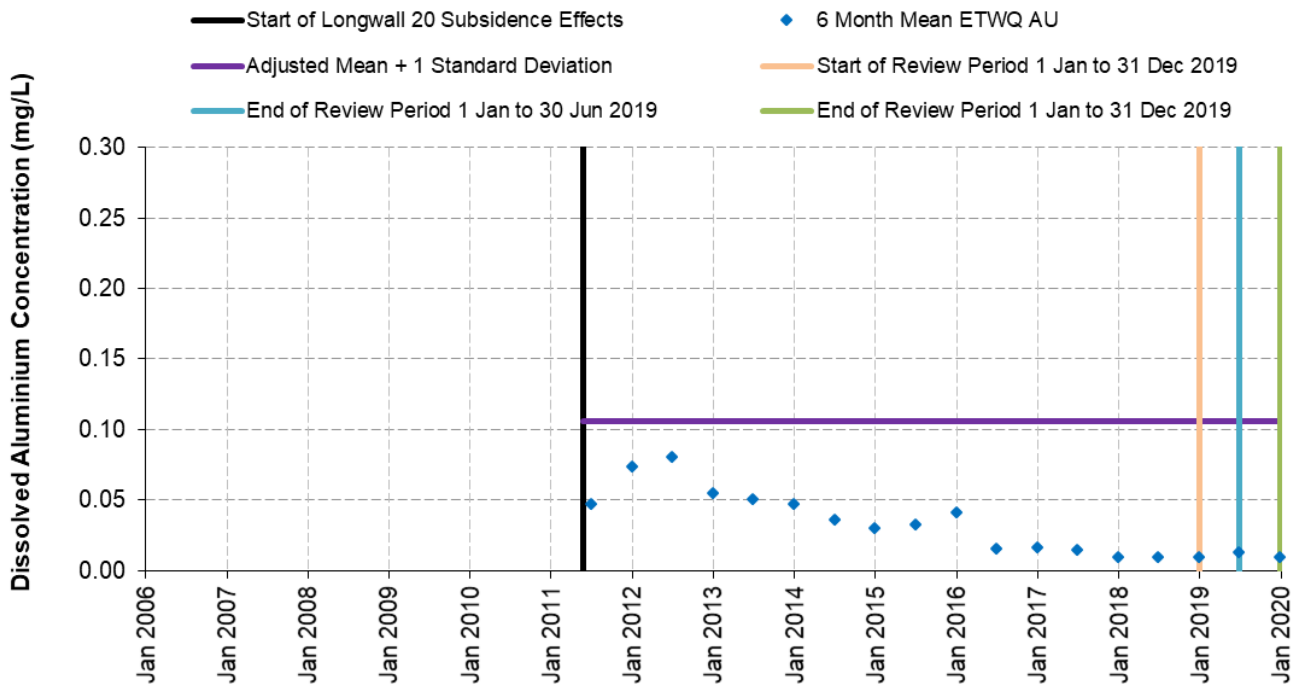

Chart 28 **Six Month Means of Dissolved Aluminium Concentrations in Eastern Tributary at ETWQ AU**

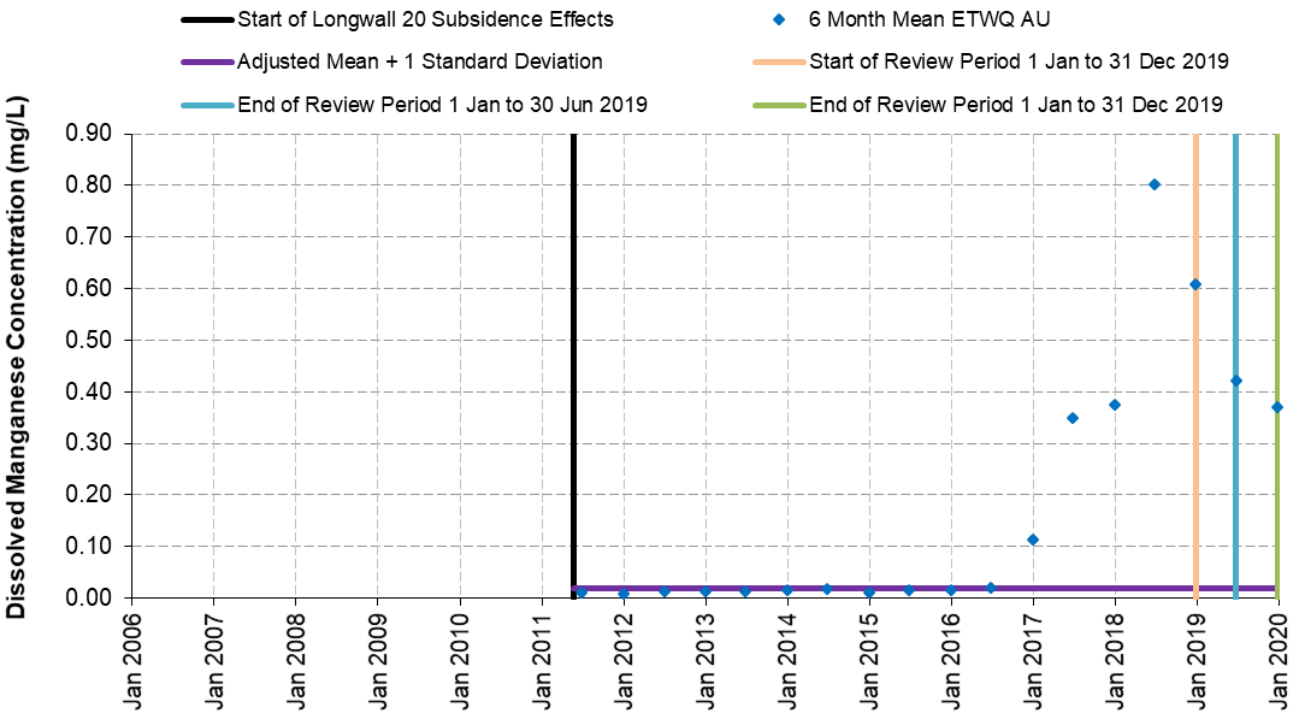

Chart 29 **Six Month Means of Dissolved Manganese Concentrations in Eastern Tributary at ETWQ AU**

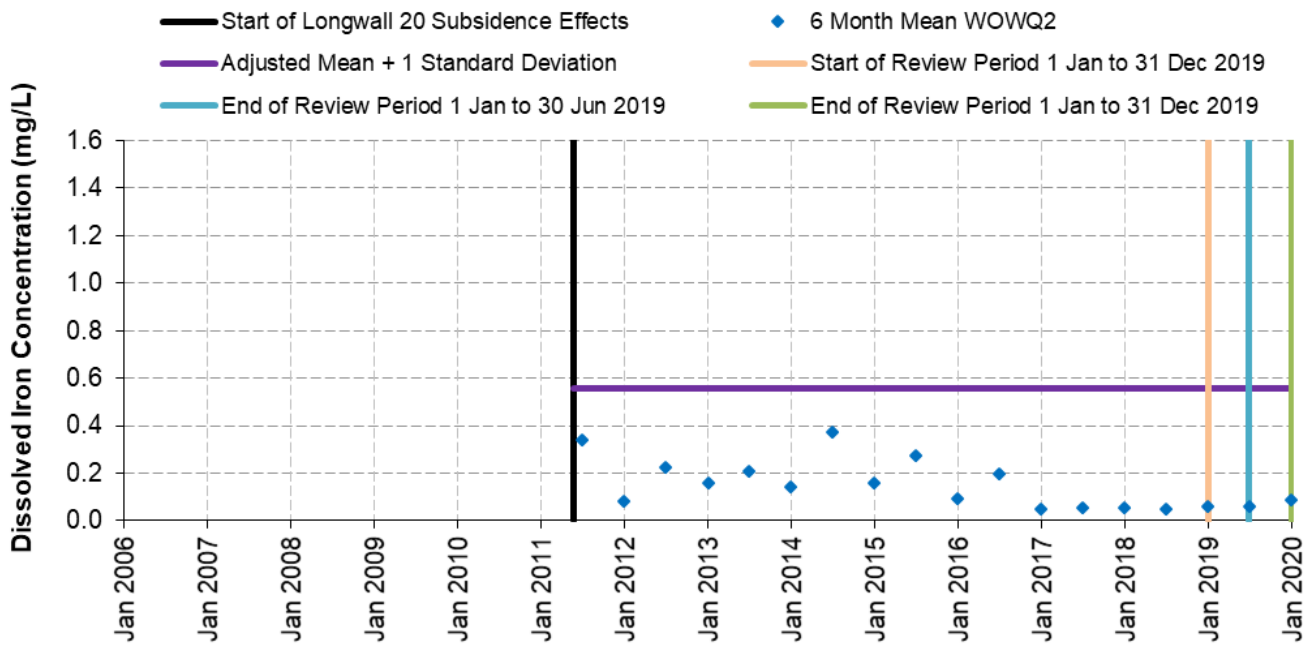

Chart 30 **Six Month Means of Dissolved Iron Concentrations in Woronora River at WOWQ2**

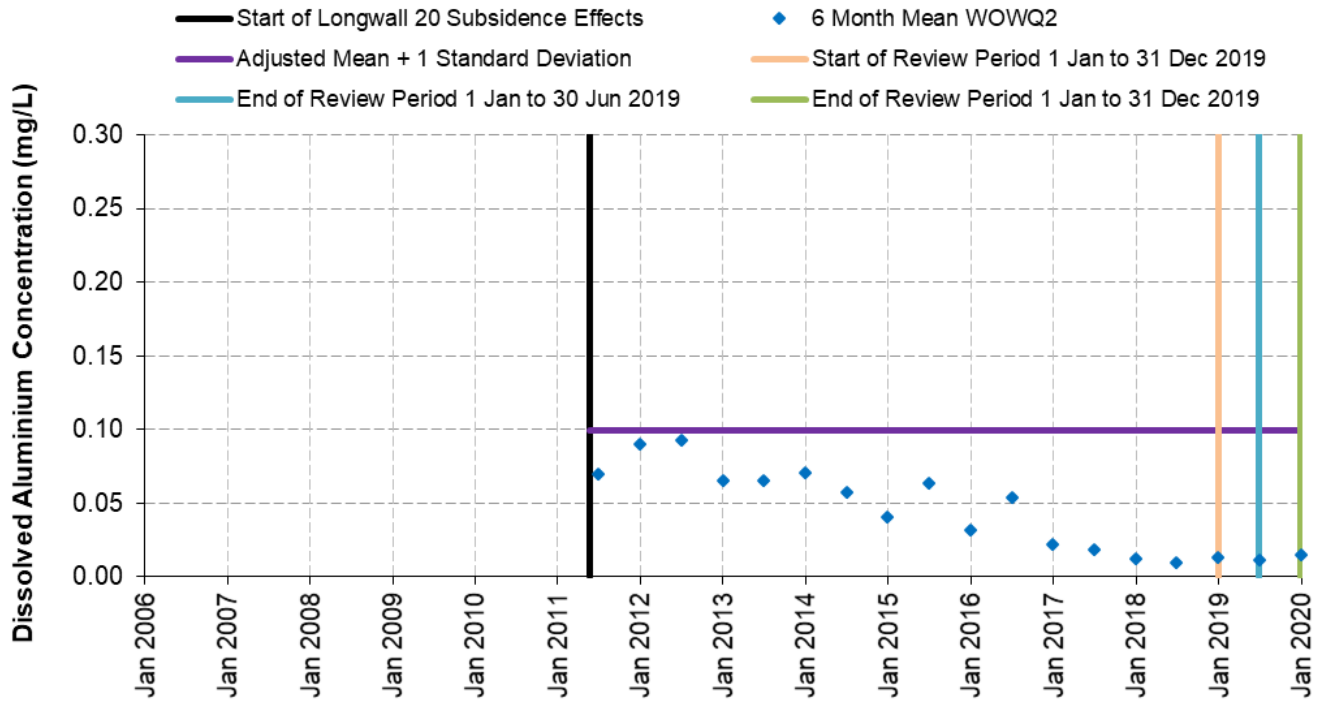

Chart 31 **Six Month Means of Dissolved Aluminium Concentrations in Woronora River at WOWQ2**

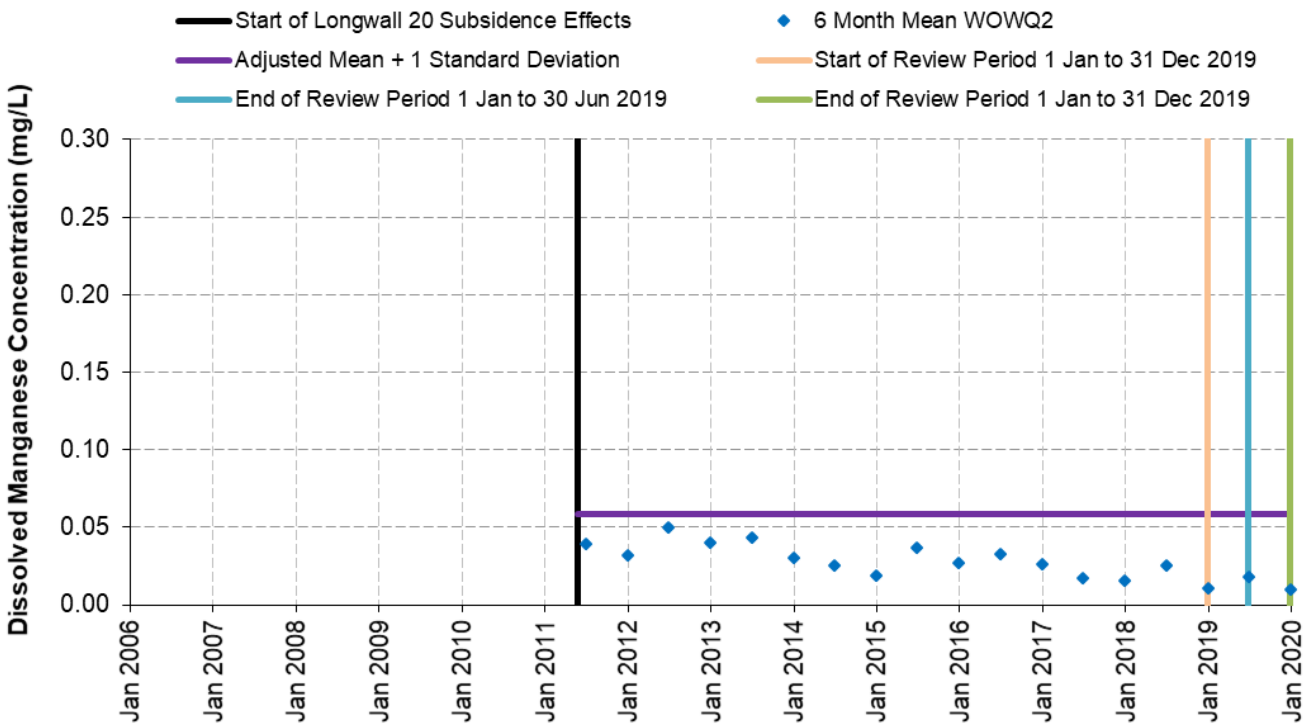

Chart 32 Six Month Means of Dissolved Manganese Concentrations in Woronora River at WOWQ2

There were no exceedances of the adjusted baseline mean plus one standard deviation for two consecutive six month means for dissolved iron or dissolved aluminium in Eastern Tributary at site ETWQ AU (Chart 27 and Chart 28). There continued to be an exceedance of the adjusted baseline mean plus one standard deviation for two consecutive six month means for dissolved manganese in Eastern Tributary at site ETWQ AU for the reporting period (Chart 29). There were no similar exceedances on the Woronora River at control site WOWQ2 (Chart 30 to Chart 32), accordingly the results for dissolved manganese equate to a Level 3 significance level. It is worth noting that there has been a steady decline in the six month mean for dissolved manganese at ETWQ AU from the peak value of 0.8 mg/L in mid-2018 to 0.37 mg/L at the end of the review period.

3.2.3 Analysis against Subsidence Impact Performance Measure – Eastern Tributary

Subsidence Impact Performance Measure:

Negligible reduction to the quality of water resources reaching the Woronora Reservoir.

The exceedance of the performance indicator in relation to dissolved iron (in June, July, August and September 2019) and dissolved manganese (from January to December 2019) has triggered assessments of whether the subsidence impact performance measure for catchment yield to the Woronora Reservoir has been exceeded in relation to water quality (i.e. whether the Project has resulted in a greater than negligible reduction in the quality of water resources reaching the Woronora Reservoir). These assessments have been undertaken by an environmental water quality expert: Professor Barry Noller from The University of Queensland.

3.3 WORONORA RESERVOIR WATER QUALITY

3.3.1 Assessment of Water Quality in Woronora Reservoir

Performance Indicator:

> *Changes in the quality of water in the Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations.*

Metropolitan Coal has sourced surface water quality data for the Woronora Reservoir (site DWO1) from WaterNSW in accordance with a data exchange agreement. Consistent with the monitoring of water reaching the Woronora Reservoir (Section 2.6), the water quality data has been analysed for key water quality parameters of relevance to water supply and the effects of subsidence, namely iron, manganese and aluminium.

The analysis of water quality data involves:

- water quality data analysed annually, following the receipt of data from WaterNSW;
- water quality parameters, measured in the same location on the same day are geometrically averaged;
- the parameter records are interpolated to provide daily records;
- concentration exceedance duration curves are calculated for each parameter by determining the concentration exceeded at each location by percentages of days of the year covering the full range from 0% to 100%, at 5% intervals;
- baseline data is analysed in an annual format to determine concentration exceeded with an estimated average recurrence interval (ARI[6]) curve of 20 years by percentages of days in the year from 0% to 100%. For each percentage of time selected from this range, an ARI curve is calculated by fitting a log Generalised Extreme Value distribution to the concentration exceeded each year of the baseline record by that percentage of days; and
- for each water quality parameter, the concentration exceedance curve for the current year of monitoring and the 20 year ARI exceedance curve calculated from the baseline records is plotted on a graph.

The results for this review period (1 July to 31 December 2019) are assessed against the Longwall 304 Water Management Plan significance levels/triggers (below):

Significance Levels/Triggers **Negligible Reduction to the Quality of Water Resources in the Woronora Reservoir**	
Level 1	The current year's duration exceedance curve for a water quality parameter in Woronora Reservoir (total iron, total manganese and total aluminium) is below the baseline 10 year ARI exceedance curve for any range of the duration percentages from 0% to 75%.
Level 2	The current year's duration exceedance curve for a water quality parameter in Woronora Reservoir (total iron, total manganese and total aluminium) is above the baseline 10 year ARI but below the baseline 20 year ARI exceedance curve for any range of the duration percentages from 0% to 75%.
Level 3	The current year's duration exceedance curve for a water quality parameter in Woronora Reservoir (total iron, total manganese and total aluminium) is above the baseline 20 year ARI exceedance curve for any range of the duration percentages from 0% to 75%.

[6] Average Recurrence Interval. This term has been used here for consistency with previous Annual Reviews. Based on recommendations by the Institution of Engineers Australia, the preferred terminology now involves the term Annual Exceedance Probability (AEP) expressed as a percentage probability. This is to avoid confusion that the term ARI has caused within the industry, community and other stakeholders. A 20 year ARI is equivalent to a 5% AEP.

The performance indicator is considered to have been exceeded if data analysis indicates a significant change in the quality of water post-mining, specifically if the current year's duration exceedance curve for a water quality parameter in Woronora Reservoir (total iron, total manganese and total aluminium) is above the baseline 20 year ARI exceedance curve for any range of the duration percentages from 0% to 75%.

Results of this assessment over the 2019 Annual Review period at the Woronora Reservoir are shown as Chart 33 to Chart 35 below.

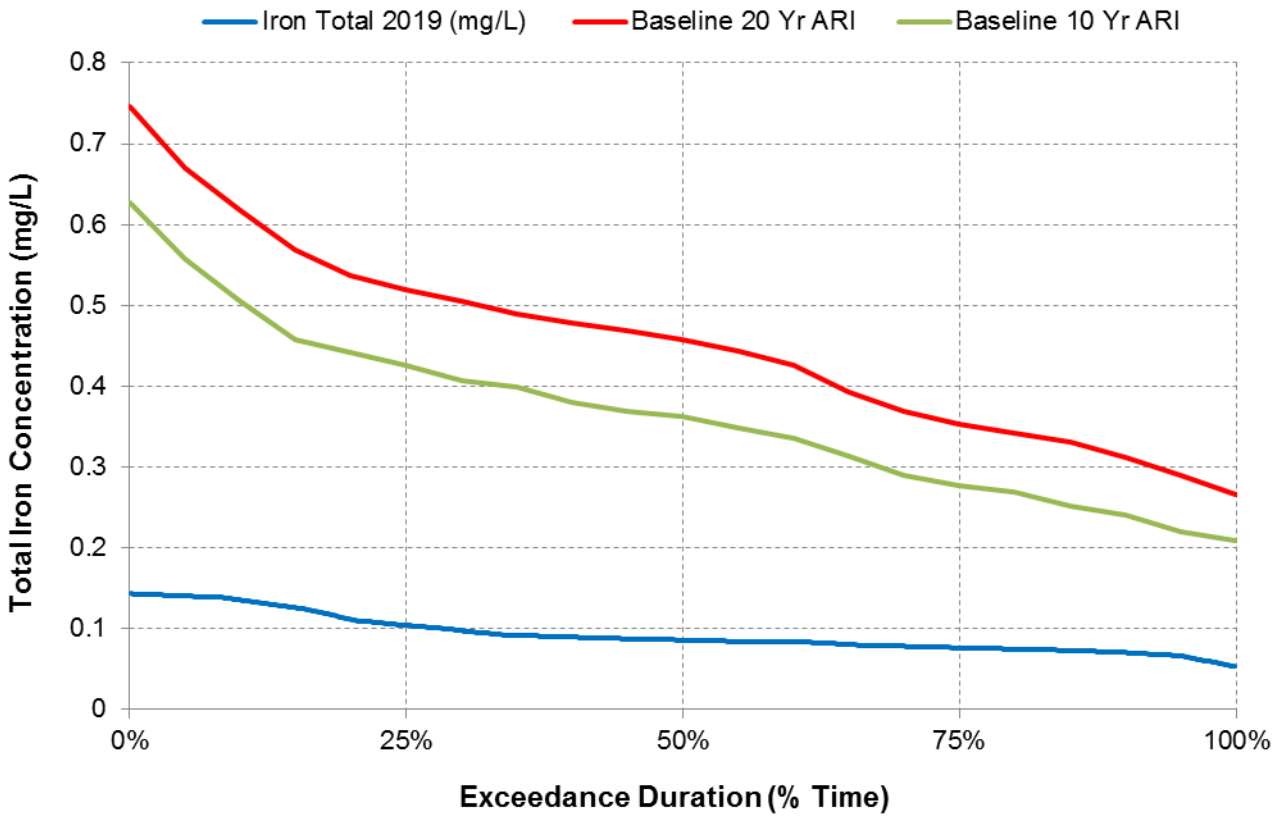

Chart 33 Total Iron Performance Indicator Woronora Reservoir 2019

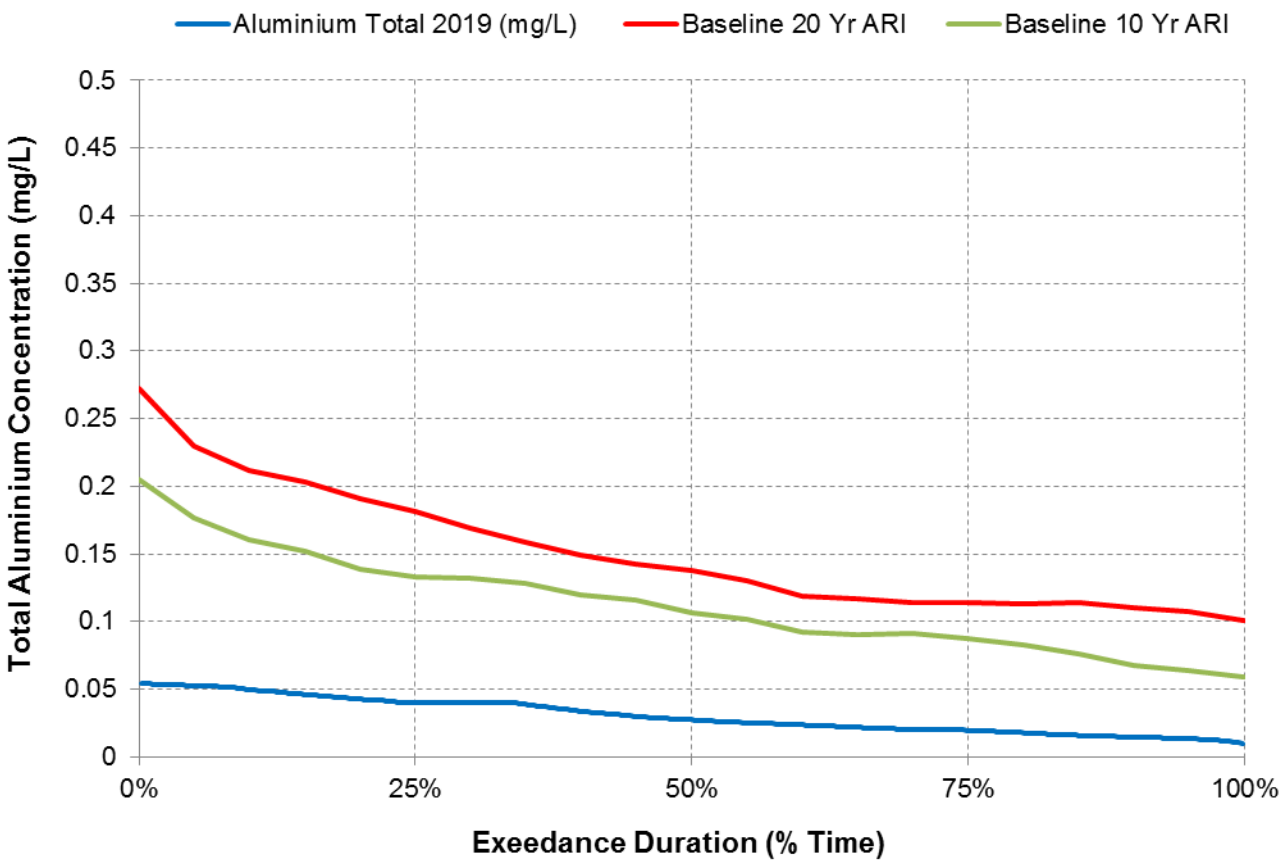

Chart 34 Total Aluminium Performance Indicator Woronora Reservoir 2019

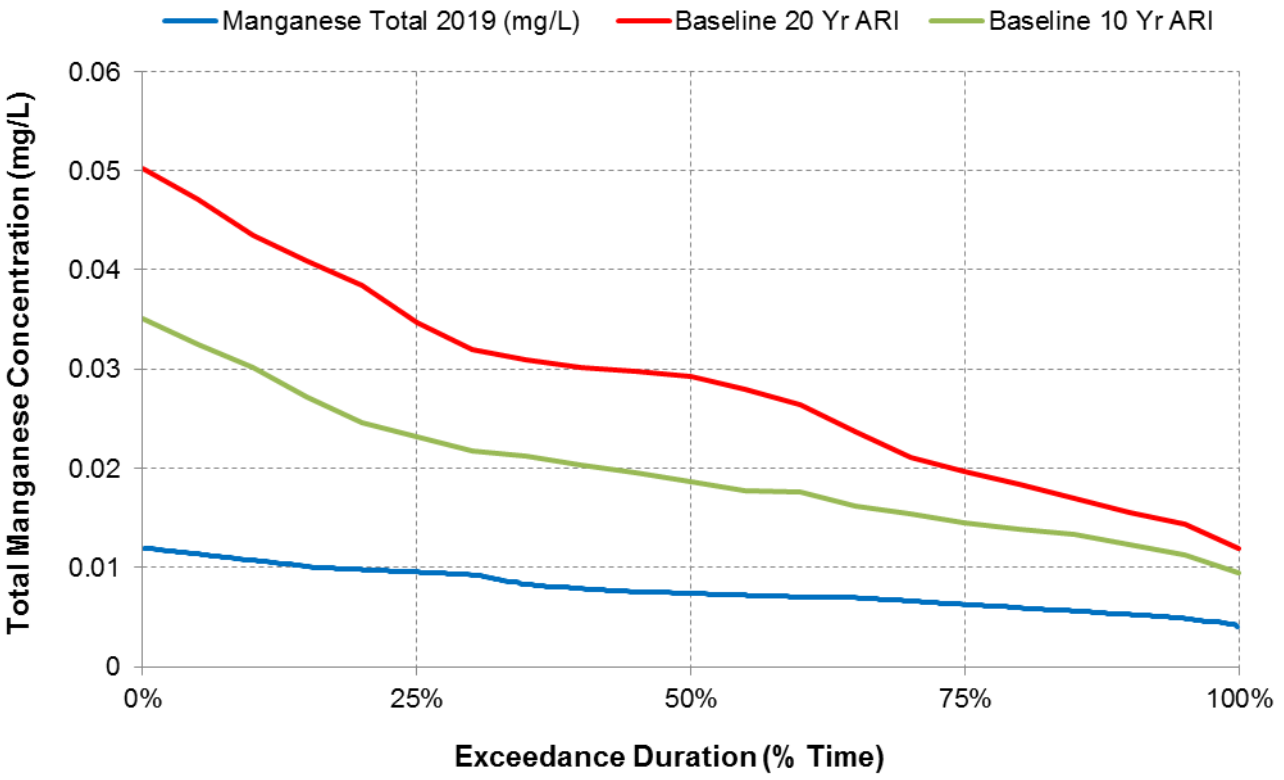

Chart 35 Total Manganese Performance Indicator Woronora Reservoir 2019

There were no exceedances of the 10 Year or 20 year ARI exceedance curve for total iron, total aluminium or total manganese (refer Chart 33, Chart 34 and Chart 35). The results for total iron, total aluminium and total manganese equate to a Level 1 significance level.

3.4 FLOW DIVERSION AND NATURAL DRAINAGE BEHAVIOUR OF DOWNSTREAM POOLS

3.4.1 Waratah Rivulet Downstream of Maingate of Longwall 23

Performance Indicators:

No change to the natural drainage behaviour of Pools P, Q, R, S, T, U, V and W.

Analysis of water level data for Pools P, T, U, V and W indicates the water level is at or above the pool's previous minimum.

Analysis of water level data for Pools Q, R and S indicates the water levels are above that required to maintain water over the downstream rock-bar.

The results for this review period (1 July to 31 December 2019) are assessed against the Longwall 304 Water Management Plan significance levels/triggers (below):

Negligible Environmental Consequences on Waratah Rivulet: No Diversion of Flows, No Change in the Natural Drainage Behaviour		
Performance Indicator	**Significance Levels/Triggers**	
No change to the natural drainage behaviour of Pools P, Q, R, S, T, U, V and W.	Level 1	No mine-induced surface cracking or impacts to natural drainage behaviour observed
	Level 2	Mine-induced surface cracking observed. No impacts to natural drainage behaviour observed.
	Level 3	There appear to be impacts to natural drainage behaviour such that: - a pool does not continue to flow over, through and/or below the rock bars (where relevant); or - surface flow is not evident along the length of Pools P or T prior to flowing through/below the rock bars; - surface flow is not evident along the length of Pools Q, R or S prior to flowing over the rock bars; - surface flow is not evident along the length of Pool V prior to flowing over/through/below the rock bar; and - surface flow is not evident along the length of Pools U or W prior to flowing through the downstream boulder field.
Analysis of water level data for Pools P, T, U, V and W indicates the water level is at or above the pool's previous minimum.	Level 1	The water level in Pools P, T, U, V or W has not been below the pool's previous minimum.
	Level 2	The water level in Pools P, T, U, V or W has been below the pool's previous minimum, however, is considered to be due to an error type.
	Level 3	The water level in Pools P, T, U, V or W has been below the pool's previous minimum and does not appear to be due to an error type; and the same is not occurring in control pool(s).
Analysis of water level data for Pools Q, R and S indicates the water levels are above that required to maintain water over the downstream rock bar.	Level 1	The water level in Pools Q, R or S has been above that required to maintain water over the downstream rock bar.
	Level 2	The water level in Pools Q, R or S has been below that required to maintain water over the downstream rock bar, however, appears to be due to an error type.
	Level 3	The water level in Pools Q, R or S has been below that required to maintain water over the downstream rock bar and does not appear to be due to an error type and the same is not occurring in control pool(s).

Metropolitan Coal's visual inspections of Pools P, Q, R, S, T, U, V and W downstream of the maingate of Longwall 23 indicate no mine-induced surface cracking and no observed changes to the natural drainage behaviour of the pools (Metropolitan Coal, pers. comm). The visual inspection results equate to a Level 1 significance level.

The recorded water levels in Pools P, T, V and W have remained at or above the pools' previously recorded minimums. The recorded water levels in Pools Q, R and S have remained above that required to maintain water over the downstream rock bar. The results equate to a Level 1 significance level for these pools.

The recorded pool level for Pool U fell below the previously recorded minimum water level during periods of August, September, November and December 2019. Control pool WRP1 water level was above the previously recorded minimum in August and September 2019 though declined below the previously recorded minimum for parts of October, November and December 2019. Consequently, this equates to a Level 3 significance level for Pool U in August and September 2019 and a Level 2 significance level in November and December 2019.

An investigation of Pool U water level was undertaken by HEC (2020) to assess the potential exceedance of the performance measure in accordance with the Metropolitan Coal Longwall 304 Water Management Plan. The investigation concluded that the performance measure relating to negligible environmental consequences on the Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P) was considered to have been met.

3.4.2 Analysis against Subsidence Impact Performance Measure – Waratah Rivulet Downstream of Maingate of Longwall 23

Subsidence Impact Performance Measure:

> *Negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining and minimal gas releases) on the Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P).*

Assessment against Performance Measure

The performance measure, *negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools ….)*, has been met.

3.4.3 Eastern Tributary Downstream of Maingate 26

Pools ETAG to ETAU on the Eastern Tributary are situated between the full supply level of the Woronora Reservoir and the maingate of Longwall 26. Pools ETAG and ETAH are situated above Longwall 27, Pools ETAI, ETAJ and ETAK are situated above the maingate of Longwall 27 and Pools ETAL to ETAU are situated downstream of the maingate of Longwall 27 (refer Figure 2)..

As reported in the Metropolitan Coal 2017 Annual Review, the natural drainage behaviour of Pools ETAG, ETAH, ETAI, ETAJ, ETAK, ETAL, ETAM, ETAN, ETAO, ETAP, ETAQ and ETAR have been impacted by mine subsidence (Metropolitan Coal, 2018). The observed impacts to the Eastern Tributary pools in December 2016/January 2017 resulted in the exceedance of the negligible environmental consequences performance measure for the Eastern Tributary in relation to diversion of flows and drainage behaviour.

Performance indicators have been developed for the Longwalls 301-303 Water Management Plan and Longwall 304 Water Management Plan for Pools ETAS, ETAT and ETAU and the results for the reporting period are assessed below.

Performance Indicators:

> *No change to the natural drainage behaviour of Pools ETAS, ETAT and ETAU.*

Analysis of water level data for Pool ETAS/ETAT and Pool ETAU indicates the water levels are above that required to maintain water over the downstream rock bar.

The results for this review period (1 July to 31 December 2019) are assessed against the Longwall 304 Water Management Plan significance levels/triggers (below):

Negligible Environmental Consequences on Eastern Tributary: No Diversion of Flows, No Change in the Natural Drainage Behaviour		
Performance Indicator	**Significance Levels/Triggers**	
No change to the natural drainage behaviour of Pools ETAS, ETAT and ETAU.	Level 1	No mine-induced surface cracking at Pool ETAS or Pool ETAT; no increase in previous cracking at Pool ETAU. No impacts to natural drainage behaviour observed.
	Level 2	Mine-induced surface cracking observed at Pool ETAS or Pool ETAT, or increase observed in previous cracking at Pool ETAU. No impacts to natural drainage behaviour observed.
	Level 3	There appear to be impacts to natural drainage behaviour such that there is not continual surface flow along the length of Pools ETAS, ETAT or ETAU.
Analysis of water level data for Pool ETAS/ETAT and Pool ETAU indicates the water levels are above that required to maintain water over the downstream rock bar.	Level 1	The water levels in Pool ETAS/ETAT and Pool ETAU have been above that required to maintain water over the downstream rock bar.
	Level 2	The water levels in Pool ETAS/ETAT and Pool ETAU has been below that required to maintain water over the downstream rock bar, however, appears to be due to an error type.
	Level 3	The water levels in Pool ETAS/ETAT and Pool ETAU has been below that required to maintain water over the downstream rock bar and does not appear to be due to an error type.

Metropolitan Coal's visual inspections of Pools ETAS, ETAT and ETAU (and associated rock bars) indicate no mine-induced surface cracking has been observed at Pools ETAS and ETAT during the reporting period, and no increase in the occurrence of cracking has been observed at Pool ETAU. There have been no observed changes to the natural drainage behaviour of Pools ETAS, ETAT or ETAU during the reporting period (Metropolitan Coal, pers. comm.). The visual inspection results equate to a Level 1 significance level for Pools ETAS, ETAT and ETAU.

The recorded water level hydrograph for Pool ETAU indicates that the water level in Pool ETAU has been above that required to maintain water over the downstream rock bar. The water level results equate to a Level 1 significance level for Pool ETAU.

The recorded water level hydrograph for Pool ETAS/ETAT indicates the water level in Pool ETAS/ETAT has been above that required to maintain water over the downstream rock bar. The water level results equate to a Level 1 significance level for Pool ETAS/ETAT.

3.4.4 Analysis against Subsidence Impact Performance Measure – Eastern Tributary Downstream of Maingate 26

Subsidence Impact Performance Measure:

Negligible environmental consequences over at least 70% of the stream length (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining and minimal gas releases) on the Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26.

Assessment against Performance Measure

The above performance measure for no diversion of flows or change in the natural drainage behaviour of pools has been exceeded during previous reporting periods and has been reported to the Department of Planning and Environment (now the Department of Planning, Industry and Environment) and other relevant agencies. The natural drainage behaviour of Pool ETAS, Pool ETAT and Pool ETAU has not been impacted by mine subsidence.

3.5 SUMMARY OF ASSESSMENT AGAINST SUBSIDENCE IMPACT PERFORMANCE INDICATORS AND PERFORMANCE MEASURES

The subsidence impact performance indicators and performance measures in Table 2 were developed to address the predictions of subsidence impacts and environmental consequences on surface water included in the Project Environmental Assessment, PPR and Metropolitan Coal Water Management Plans. Assessments against the subsidence impact performance indicators and performance measures have been conducted for the reporting period (1 January to 31 December 2019) in Table 2.

Table 2 Summary of Surface Water Environmental Performance Assessment

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Significance Level/Trigger		Comment	Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
Negligible reduction to the quantity of water resources reaching the Woronora Reservoir	*Changes in the quantity of water entering Woronora Reservoir are not significantly different post-mining compared to pre-mining, that are not also occurring in the control catchment(s).*	WaterNSW gauging station on Waratah Rivulet (GS 2132102)	Surface water flow.	Level 3	The median of the ratios falls below the 20th percentile of the baseline data.	Surface water flow was at Level 3 for the 1 January to 30 June 2019 review period, though the same was also occurring in the control catchment.	No[1]	No
Negligible reduction to the quality of water resources reaching the Woronora Reservoir	*Changes in the quality of water entering Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations that are not also occurring at control site WOWQ2.*	Site WRWQ9 on the Waratah Rivulet.	Iron (Fe). Manganese (Mn). Aluminium (Al). [Field filtered]	Level 1	Data analysis indicates no water quality parameter exceeds the adjusted baseline mean plus two standard deviations.	Dissolved iron, aluminium and manganese were at Level 1 throughout the reporting period.	No	No
Negligible reduction in the water quality of Woronora Reservoir	*Changes in the quality of water in the Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations.*	Woronora Reservoir (site DW01) (subject to data availability from WaterNSW)	Total Iron (Fe) Total Manganese (Mn) Total Aluminium (Al)	Level 1	The current year's duration exceedance curve for a water quality parameter in Woronora Reservoir (total iron, total manganese and total aluminium) is below the baseline 10 year ARI exceedance curve for any range of the duration percentages from 0% to 75%.	Total iron, total manganese and total aluminium were at Level 1 throughout the reporting period.	No	No

[1] The streamflow records for GS 2132102 provided by WaterNSW were incomplete for the review period and, as such, assessment of the results for the review period, 1 July to 31 December 2019, against the Longwalls 304 Water Management Plan significance levels/triggers was unable to be conducted at the time of reporting. Assessment against the performance indicator for the review period, 1 July to 31 December 2019, will be undertaken in the next review period.

Table 2 (Cont.) Summary of Surface Water Environmental Performance Assessment

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Significance Level/Trigger		Comment	Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
Negligible reduction to the quality of water resources reaching the Woronora Reservoir	*Changes in the quality of water entering Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations that are not also occurring at control site WOWQ2.*	Site ETWQ AU on the Eastern Tributary.	Iron (Fe). Manganese (Mn). Aluminium (Al). [Field filtered]	Level 1	Data analysis indicates no water quality parameter exceeds the adjusted baseline mean plus two standard deviations.	Dissolved aluminium was at Level 1 throughout the reporting period. Dissolved iron was at Level 1 from January to May and from October to December 2019.	No	No
				Level 2	Data analysis indicates any water quality parameters exceeds the adjusted baseline mean plus two standard deviations for one month.	Dissolved iron was at Level 2 in June 2019.	No	No
				Level 3	Data analysis indicates: • any water quality parameter exceeds the adjusted baseline mean plus two standard deviations for two consecutive months; or • over a three month period the water quality parameter exceeds the adjusted mean plus two standard deviations in the first month, the adjusted mean plus one standard deviation in the next month and the adjusted mean plus two standard deviations in the third month; or • the six month mean exceeds the adjusted baseline mean plus one standard deviation for two consecutive assessment periods (i.e. over two six monthly reports); and • there was not a similar exceedance of the trigger at the control site.	Dissolved iron was at Level 3 in July, August and September 2019. Dissolved manganese was at Level 3 throughout the reporting period.	Yes	Assessment to be conducted by Associate Professor Barry Noller.

Table 2 (Cont.) Summary of Surface Water Environmental Performance Assessment

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Significance Level/Trigger		Comment	Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
Negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases) on the Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P).	*No change to the natural drainage behaviour of Pools P, Q, R, S, T, U, V and W.*	Pools P to W on Waratah Rivulet.	Streambed cracking and drainage behaviour.	Level 1	No mine-induced surface cracking or impacts to natural drainage behaviour observed.	Pools P to W were at Level 1 throughout the reporting period.	No	No
	Analysis of water level data for Pools P, T, U, V and W indicates the water level is at or above the pool's previous minimum.	Pools P, T, U, V and W on Waratah Rivulet.	Pool water level.	Level 1	The water level in Pools P, T, U, V or W has not been below the pool's previous minimum.	Pools P, V and W were at Level 1 throughout the reporting period. Pool U was at Level 1 from January to July and in October 2019.	No	No
				Level 2	The water level in Pools P, T, U, V or W has been below the pool's previous minimum, however is considered to be due to an error type.	Pool U was at Level 2 in November and December 2019, as the same was occurring in control pool WRP1 in November and December 2019 and control pools WRP 2, WRP 3 and WRP 4 in December 2019.	No	No
				Level 3	The water level in Pools P, T, U, V or W has been below the pool's previous minimum and does not appear to be due to an error type; and the same is not occurring in control pool(s).	Pool U was at Level 3 in August and September 2019.	Yes	Refer Note 2

[2] An investigation of Pool U water level was undertaken by HEC (2020) to assess the potential exceedance of the performance measure in accordance with the Metropolitan Coal Longwall 304 Water Management Plan. The investigation identified that the performance measure relating to negligible environmental consequences on the Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P) was considered to have been met.

Table 2 (Cont.) Summary of Surface Water Environmental Performance Assessment

Performance Measure	Performance Indicator	Monitoring Site(s) being Assessed	Parameters	Significance Level/Trigger		Comment	Subsidence Impact Performance Indicator Exceeded?	Subsidence Impact Performance Measure Exceeded?
Negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases) on the Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P).	*Analysis of water level data for Pools Q, R and S indicates the water levels are above that required to maintain water over the downstream rock bar.*	Pools Q, R and S on the Waratah Rivulet.	Pool water level.	Level 1	The water level in Pools Q, R or S has been above that required to maintain water over the downstream rock bar.	Pools Q, R and S were at Level 1 throughout the reporting period.	No	No
Negligible environmental consequences over at least 70% of the stream length (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases) on the Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26	*No change to the natural drainage behaviour of Pools ETAS, ETAT and ETAU.*	Pools ETAS, ETAT and ETAU on the Eastern Tributary.	Stream cracking and drainage behaviour.	Level 1	No mine-induced surface cracking at Pool ETAS or Pool ETAT; no increase in previous cracking at Pool ETAU. No impacts to natural drainage behaviour observed.	Pools ETAS, ETAT and ETAU were at Level 1 throughout the reporting period.	No	Refer Note 3
	Analysis of water level data for Pool ETAS/ETAT and Pool ETAU indicates the water levels are above that required to maintain water over the downstream rock bar.	Pool ETAS/ETAT and Pool ETAU on the Eastern Tributary.	Pool water level.	Level 1	The water levels in Pool ETAS/ETAT and Pool ETAU has been above that required to maintain water over the downstream rock bar.	Pool ETAS/ETAT and Pool ETAU were at Level 1 throughout the reporting period.	No	Refer Note 3

[3] The no diversion of flows, no change in natural drainage behaviour component of this performance measure was exceeded during the mining of Longwalls 23-27, triggering contingency measures for the impacted pools. This TARP monitors pools not impacted during the mining of Longwalls 23-27. The minimal iron staining component of this performance measure was exceeded during the mining of Longwalls 23-27, triggering contingency measures for the impacted pools. The nature and extent of iron staining on the Eastern Tributary will continue to be monitored during the mining of Longwalls 301-303 and Longwall 304.

4.0 REFERENCES

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APPENDICES

Appendix A
Monitored Pool Water Level Hydrographs

Pools on Waratah Rivulet

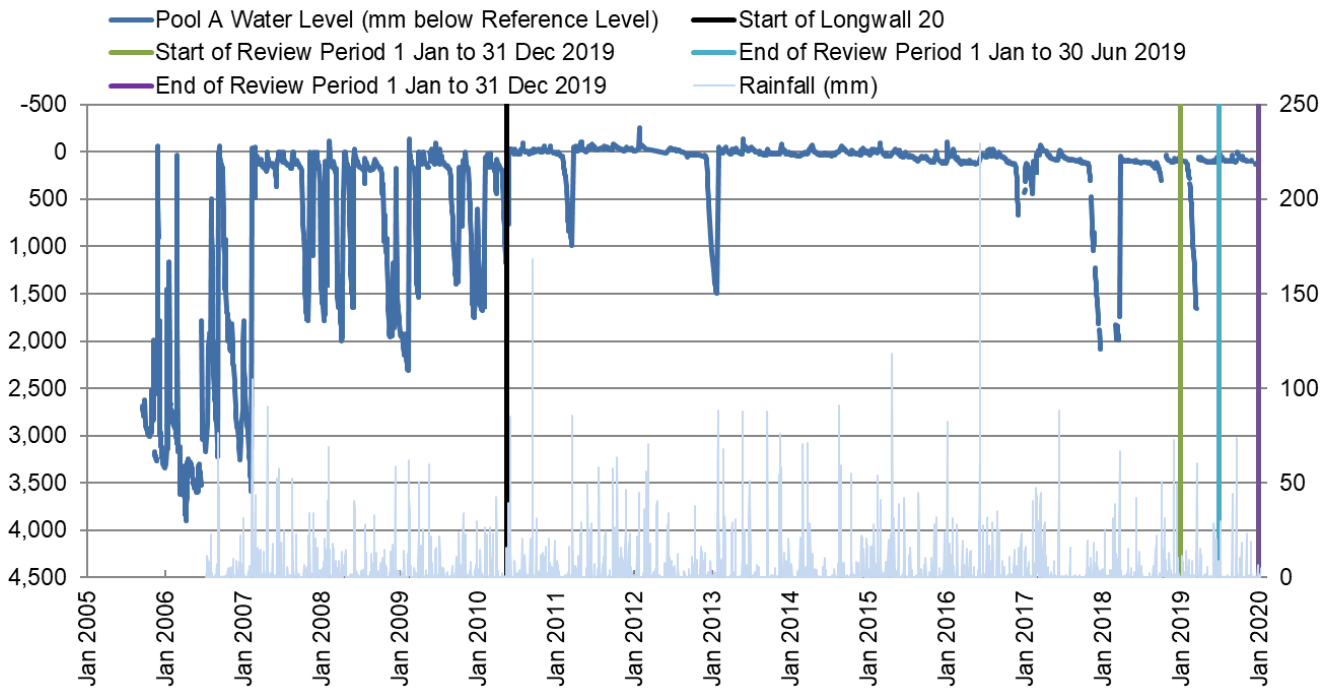

Chart A1 Pool A Waratah Rivulet (Manual Observations)

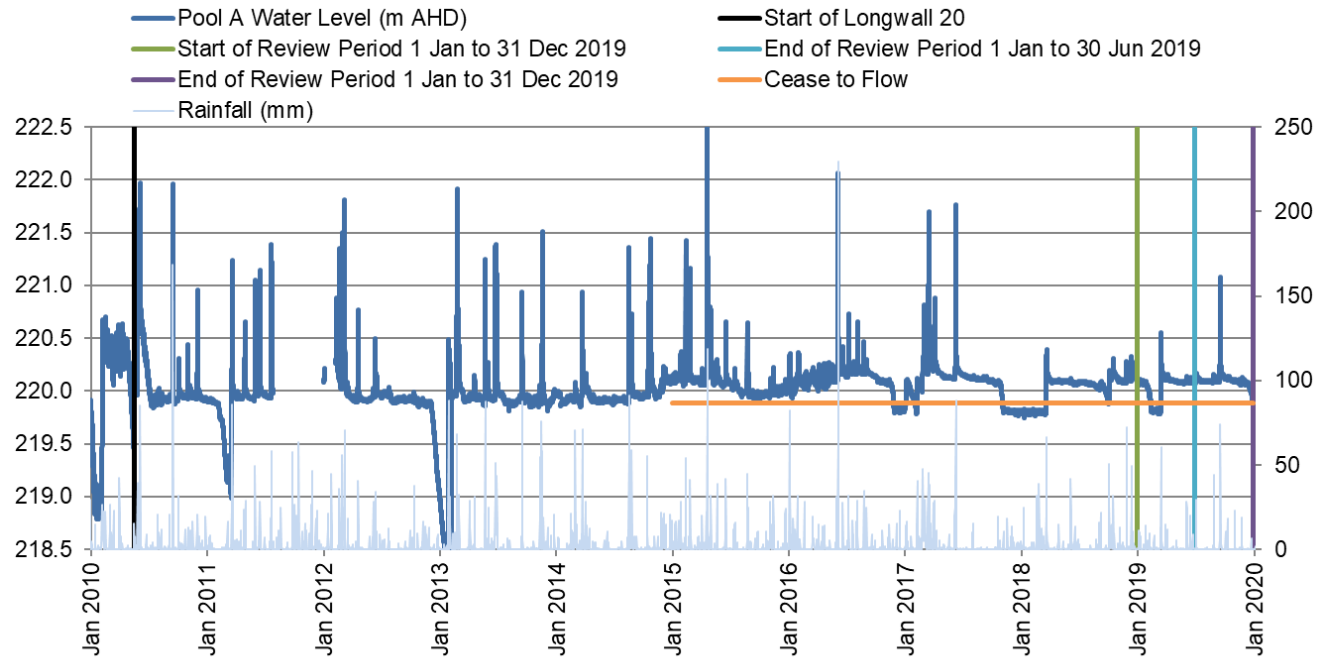

Chart A2 Pool A Waratah Rivulet

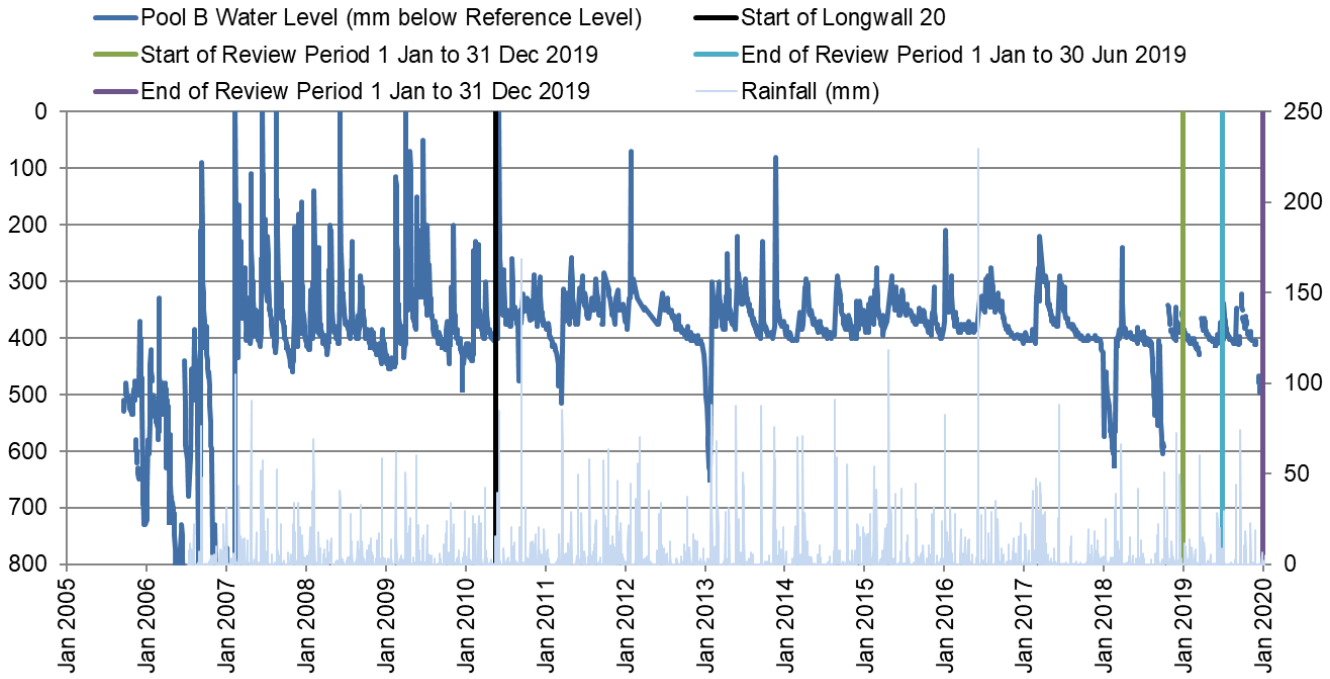

Chart A3 Pool B Waratah Rivulet (Manual Observations)[7]

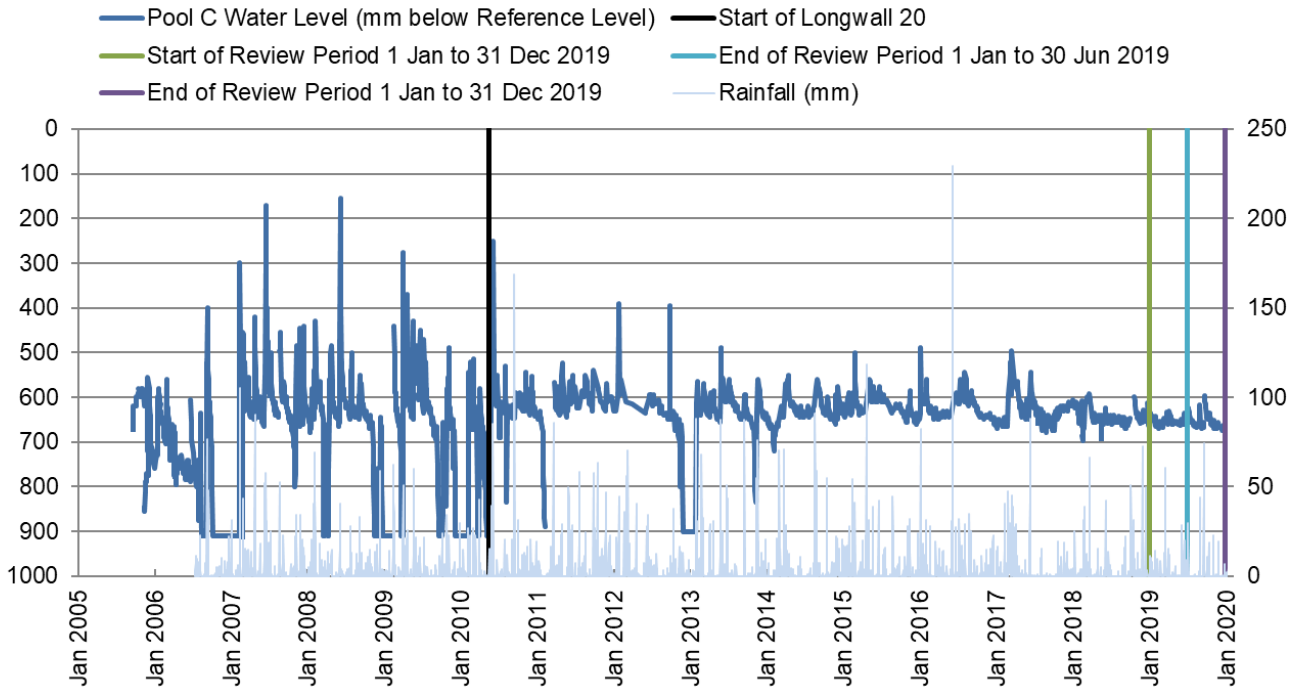

Chart A4 Pool C Waratah Rivulet (Manual Observations)

[7] Data gaps in the manual measurements for Pool B during the review period are due to periods in which high rainfall or fire restrictions prevented access to the monitoring site.

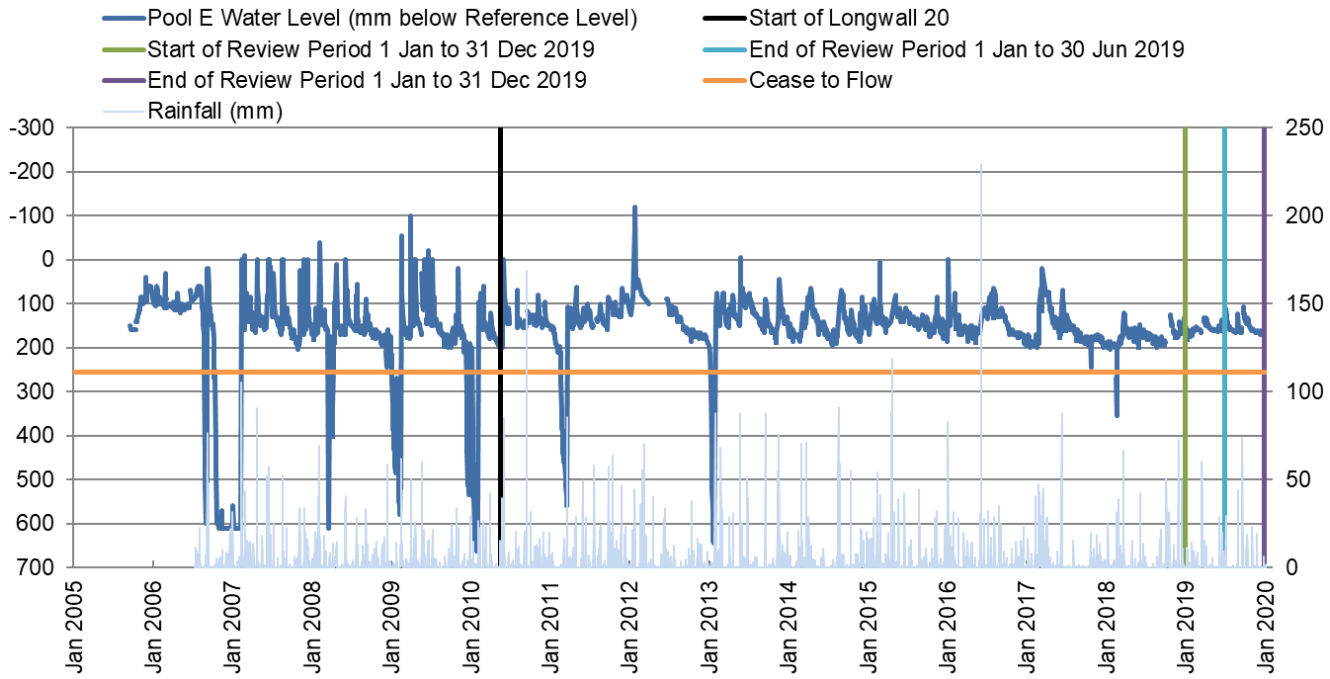

Chart A5 Pool E Waratah Rivulet (Manual Observations)

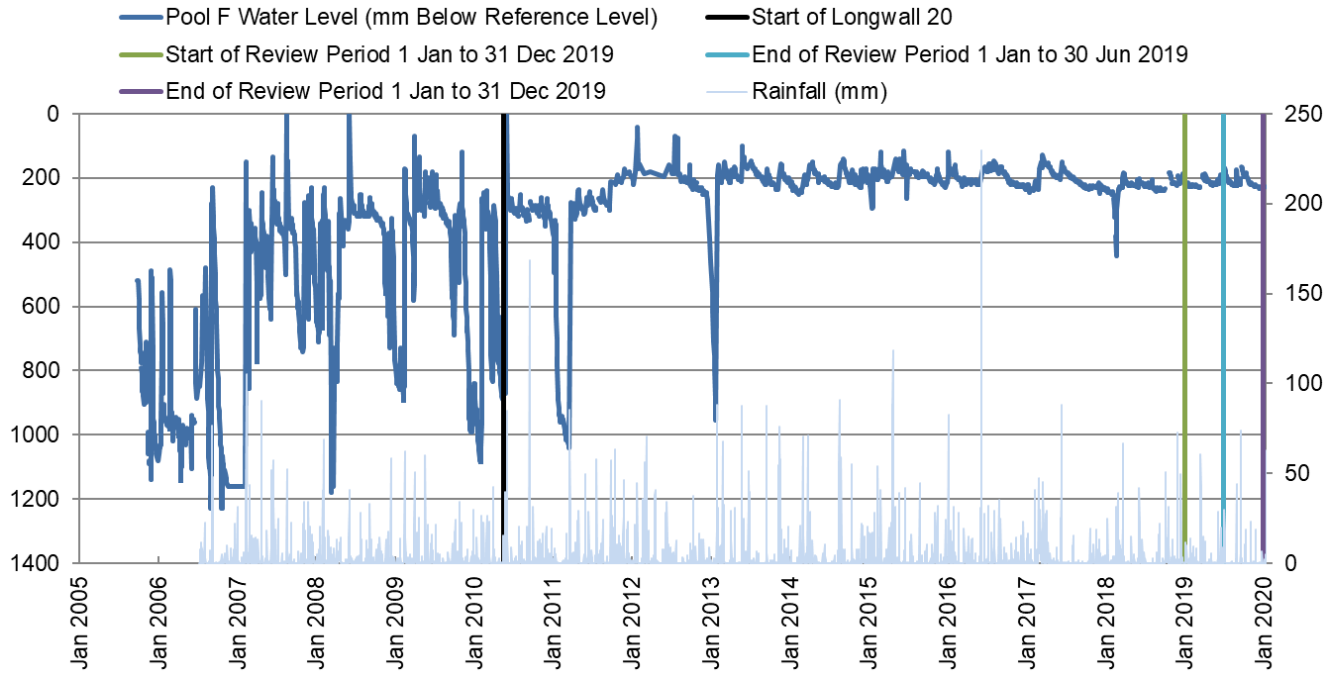

Chart A6 Pool F Waratah Rivulet (Manual Observations)

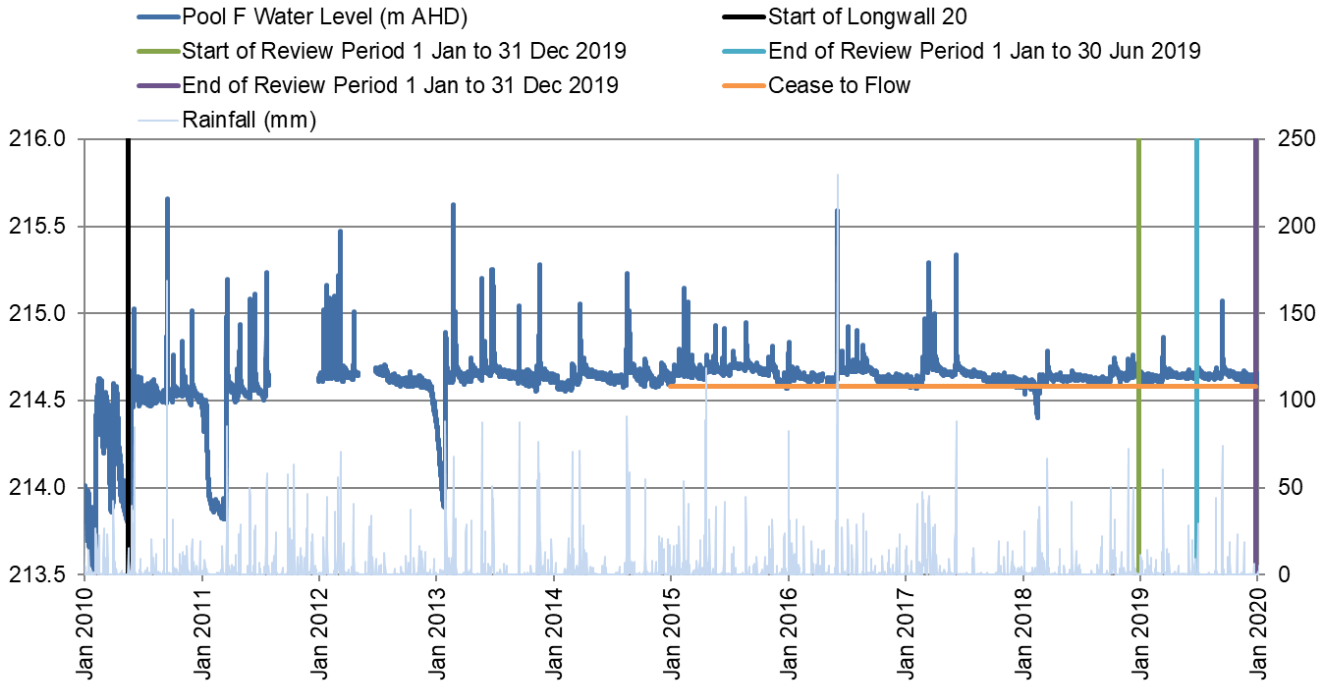

Chart A7 Pool F Waratah Rivulet

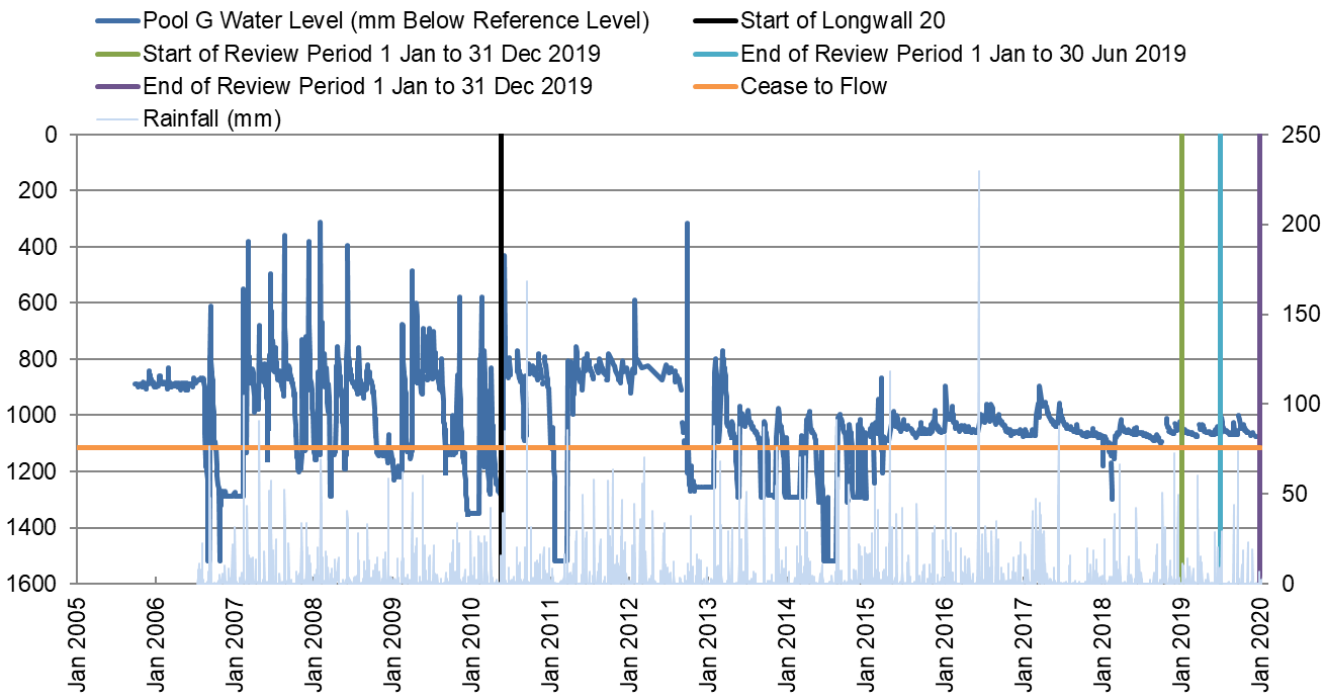

Chart A8 Pool G Waratah Rivulet (Manual Observations)

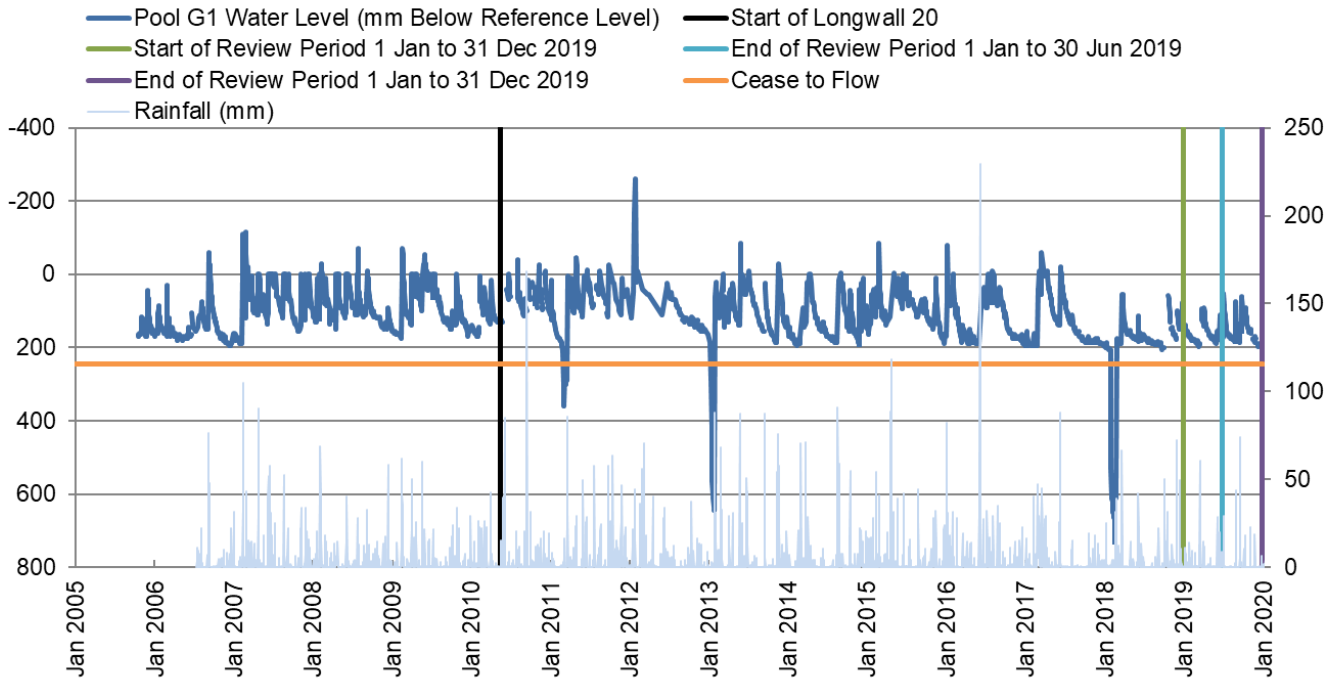

Chart A9 Pool G1 Waratah Rivulet (Manual Observations)

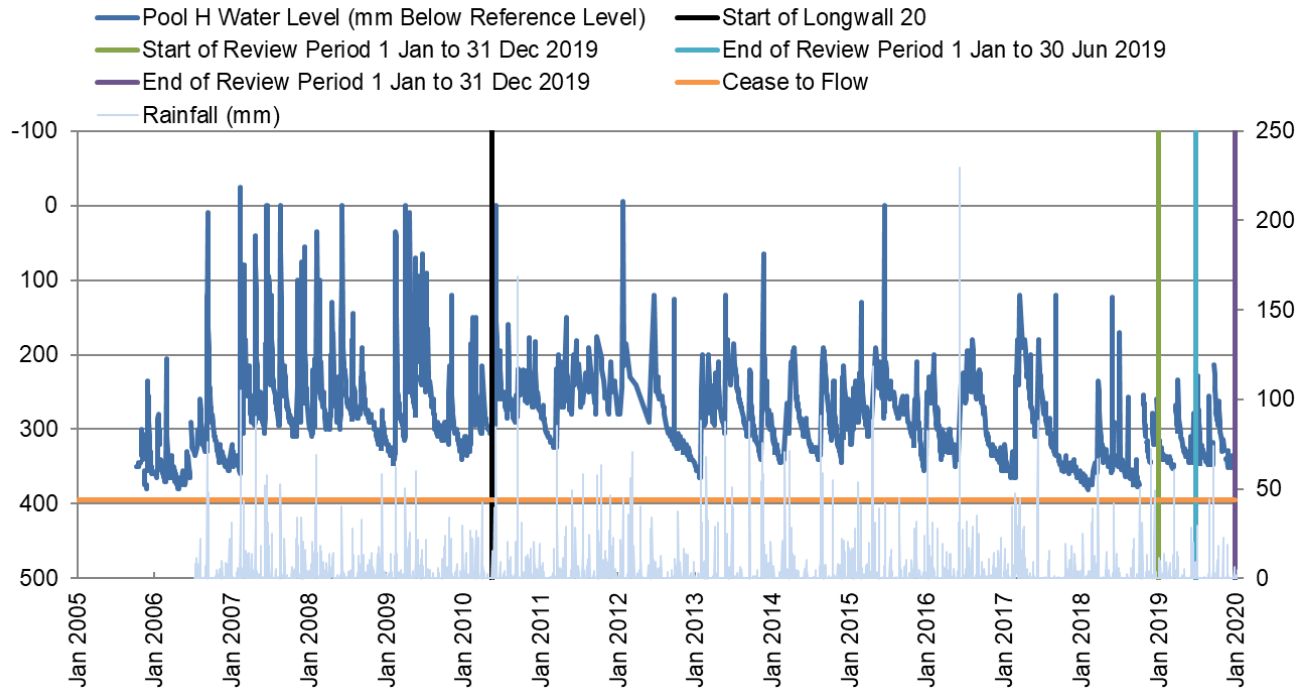

Chart A10 Pool H Waratah Rivulet (Manual Observations)

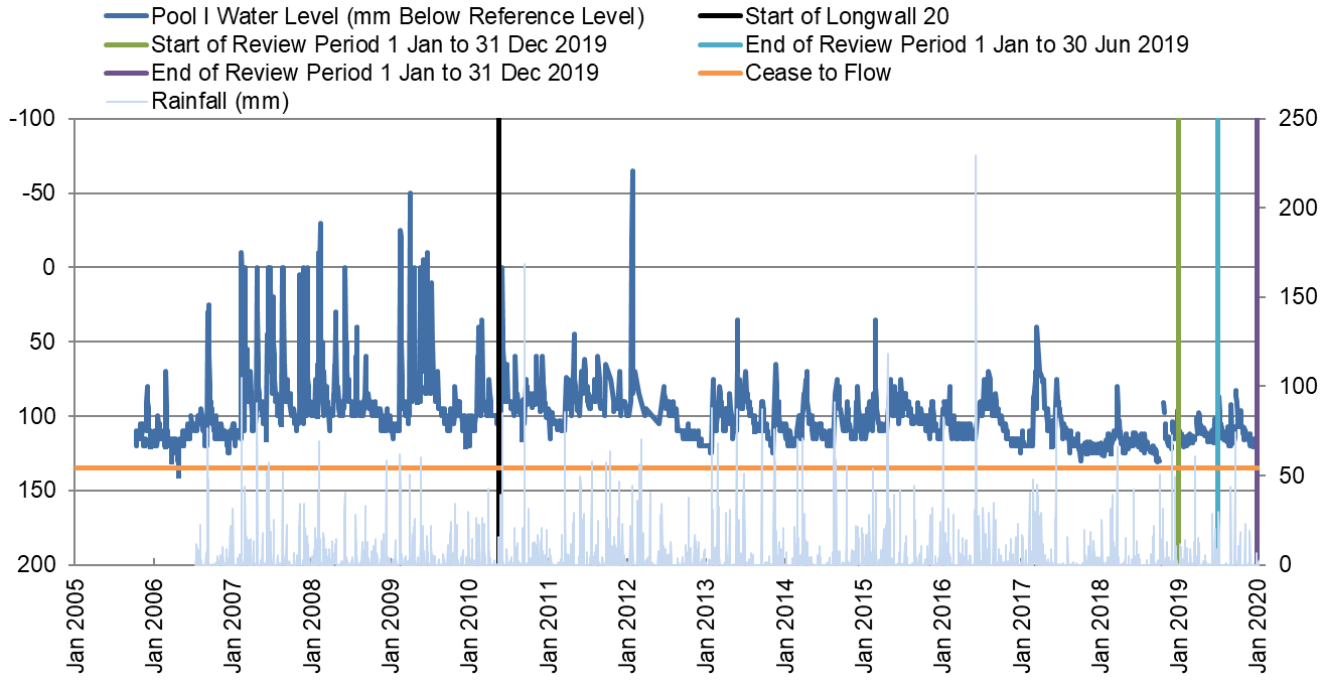

Chart A11 Pool I Waratah Rivulet (Manual Observations)

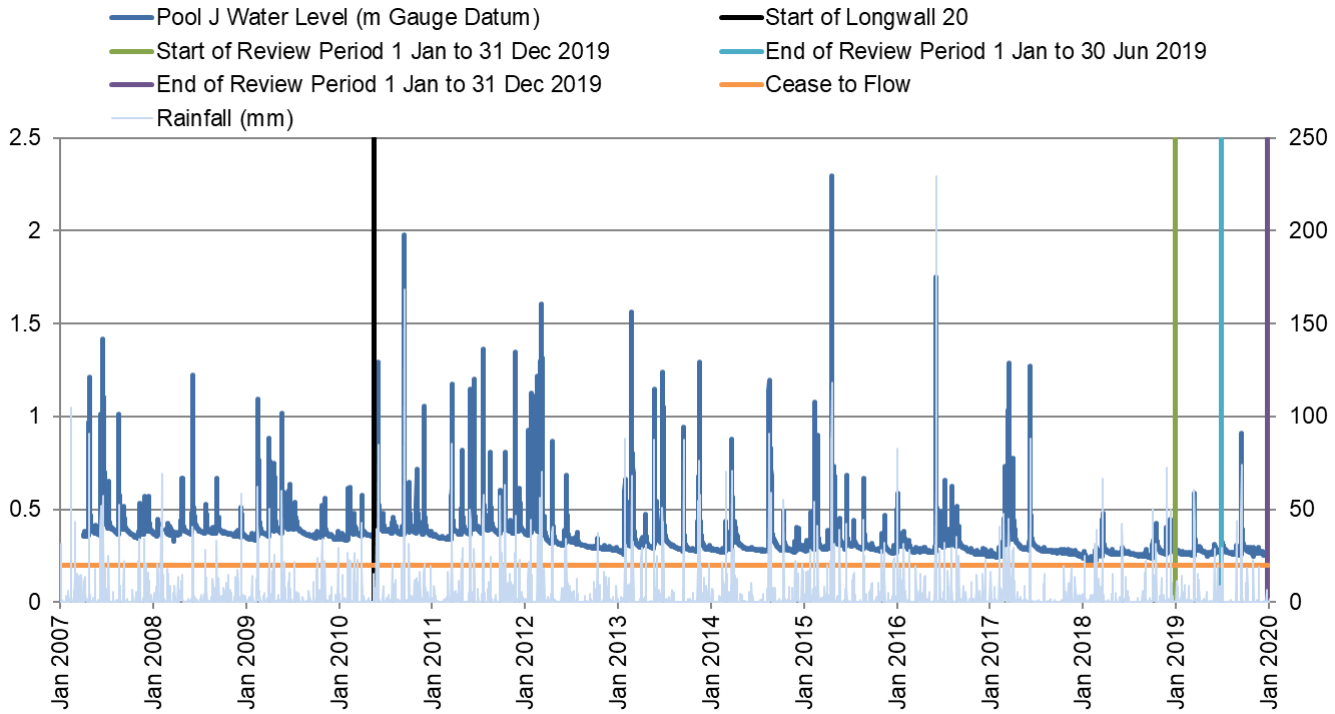

Chart A12 Pool J Waratah Rivulet

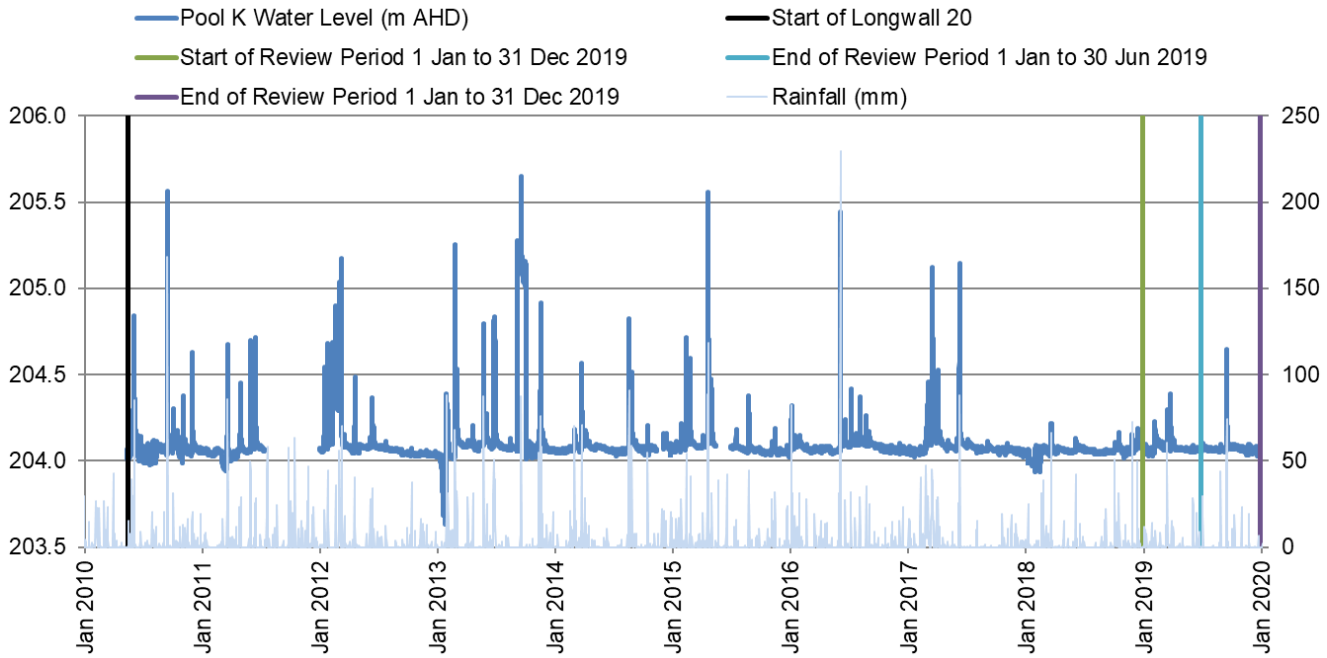

Chart A13 Pool K Waratah Rivulet

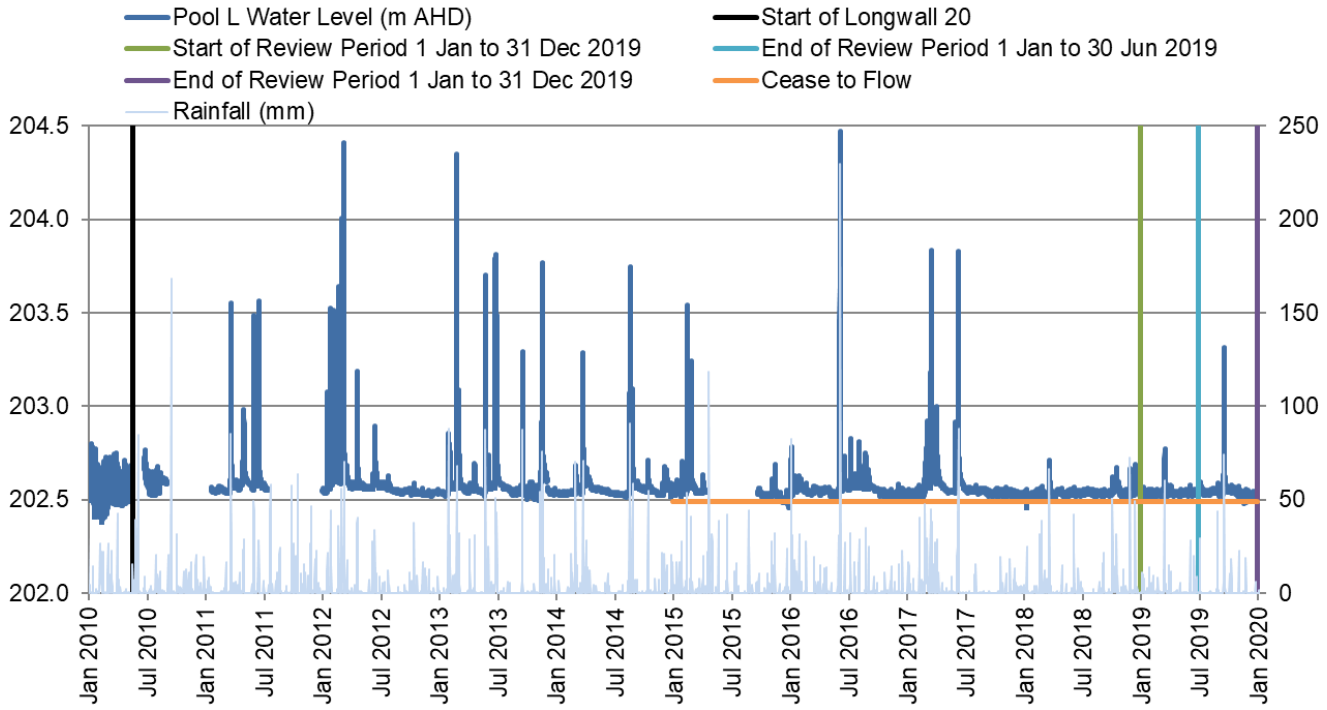

Chart A14 Pool L Waratah Rivulet

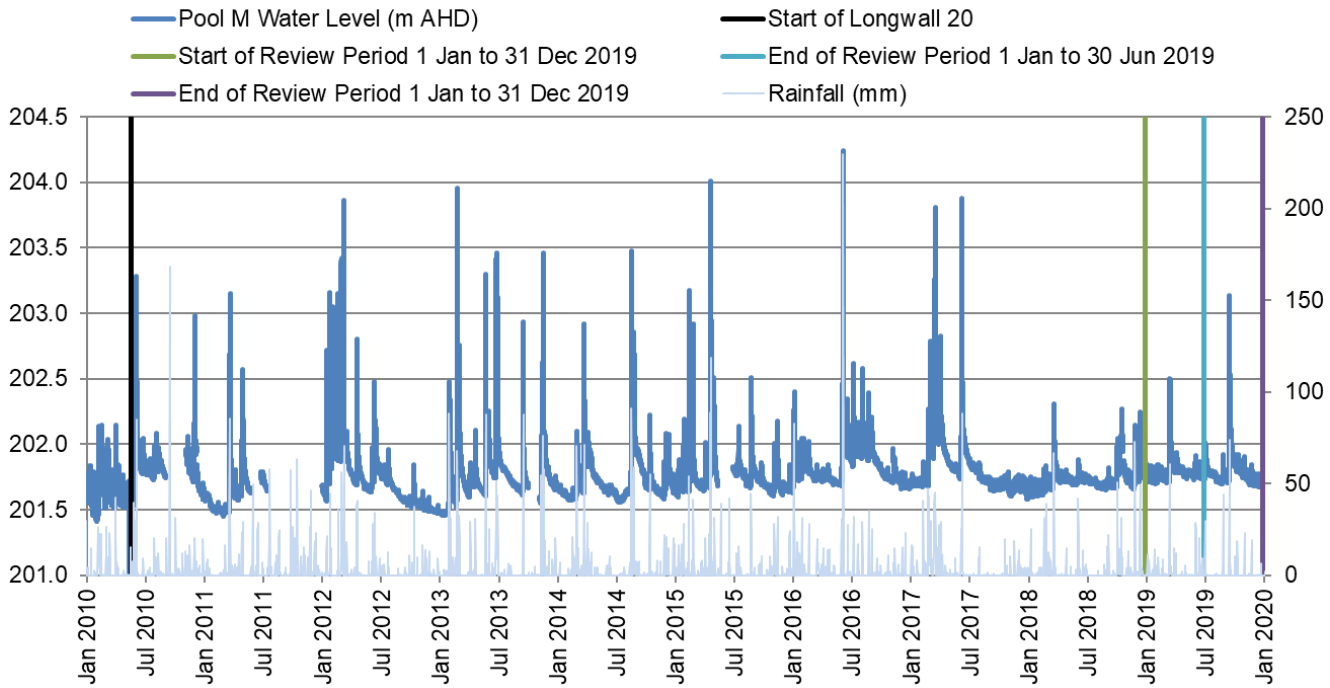

Chart A15 Pool M Waratah Rivulet

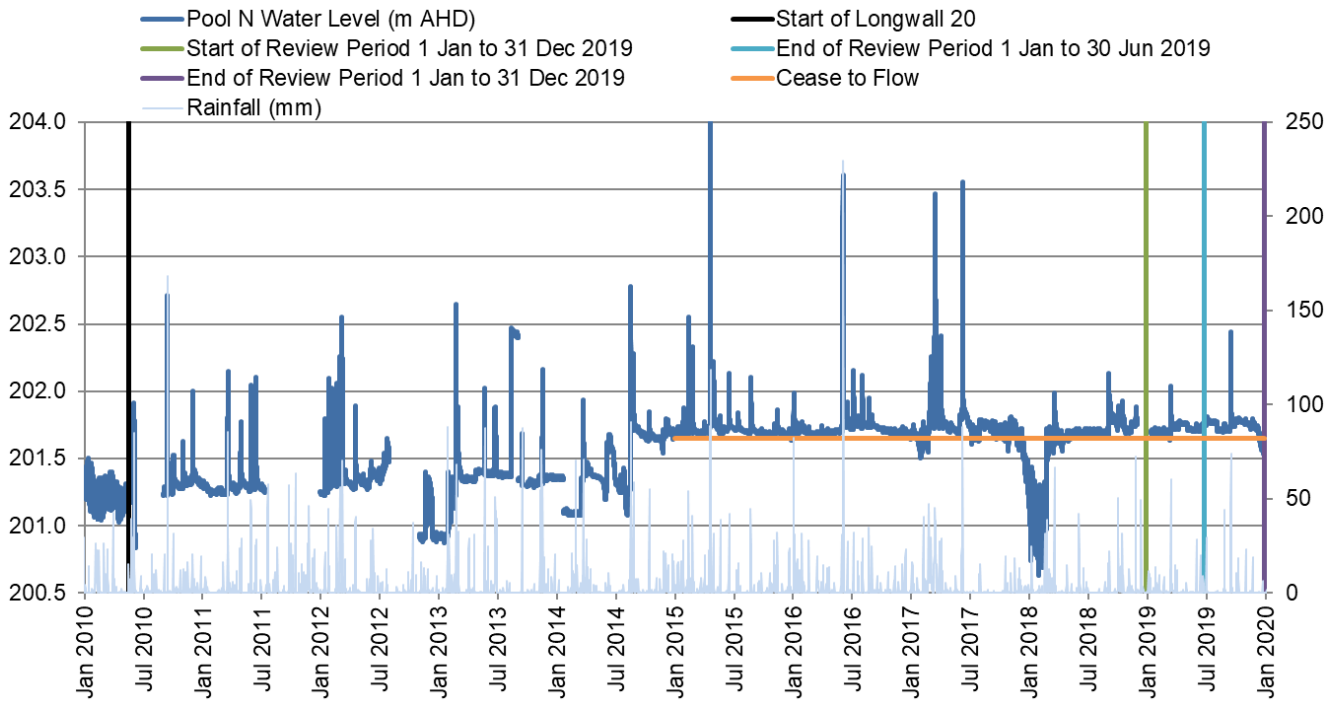

Chart A16 Pool N Waratah Rivulet[8]

[8] Pool N water level sensor did not record any data during December 2018. Subsequently, the sensor was replaced in January 2019.

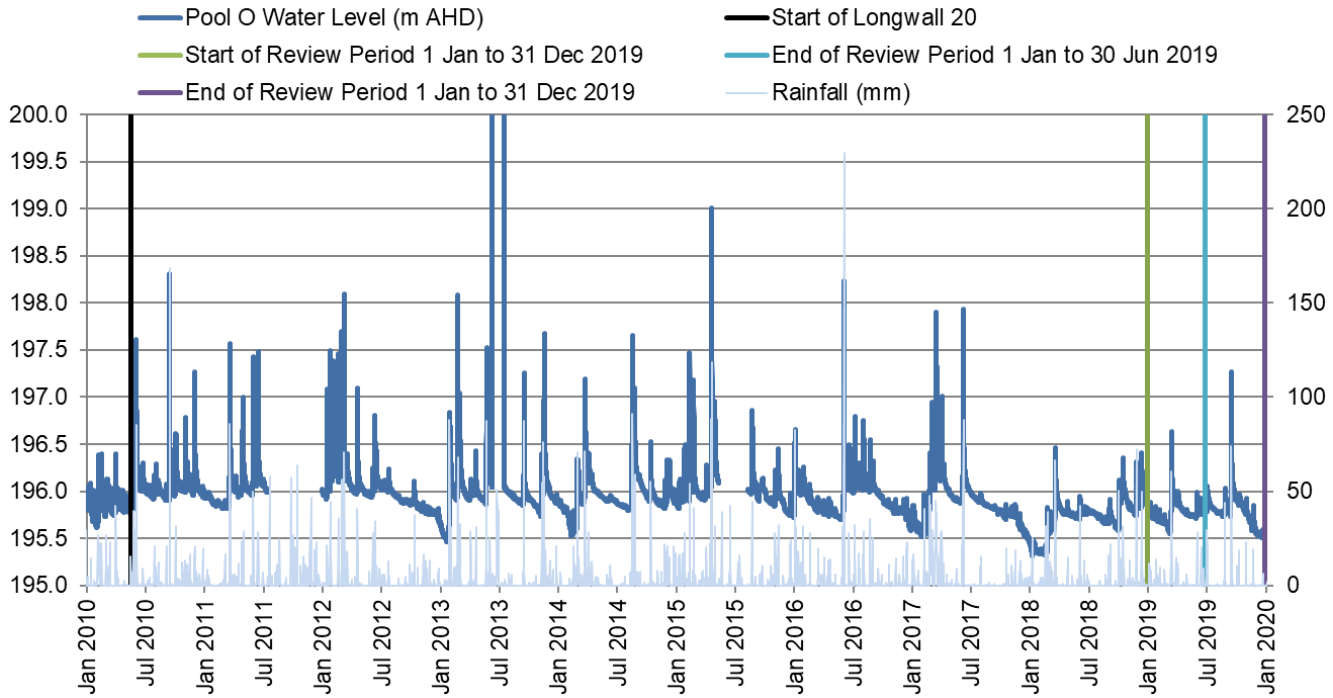

Chart A17 Pool O Waratah Rivulet

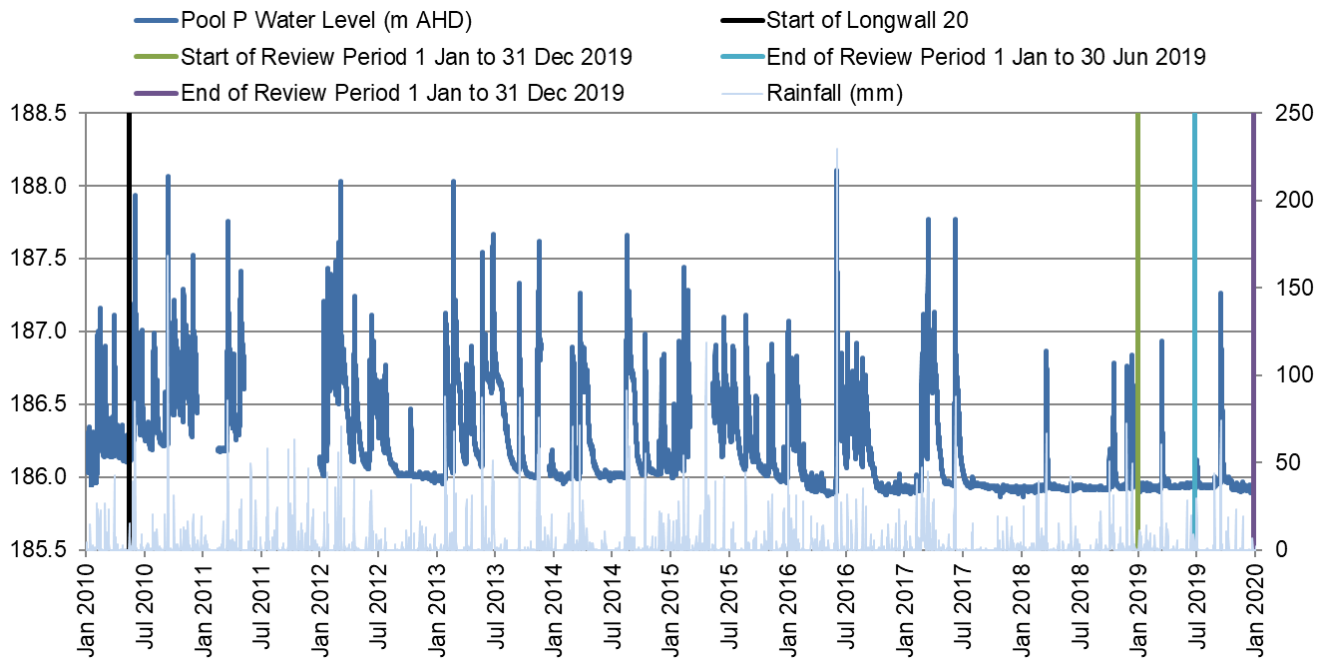

Chart A18 Pool P Waratah Rivulet

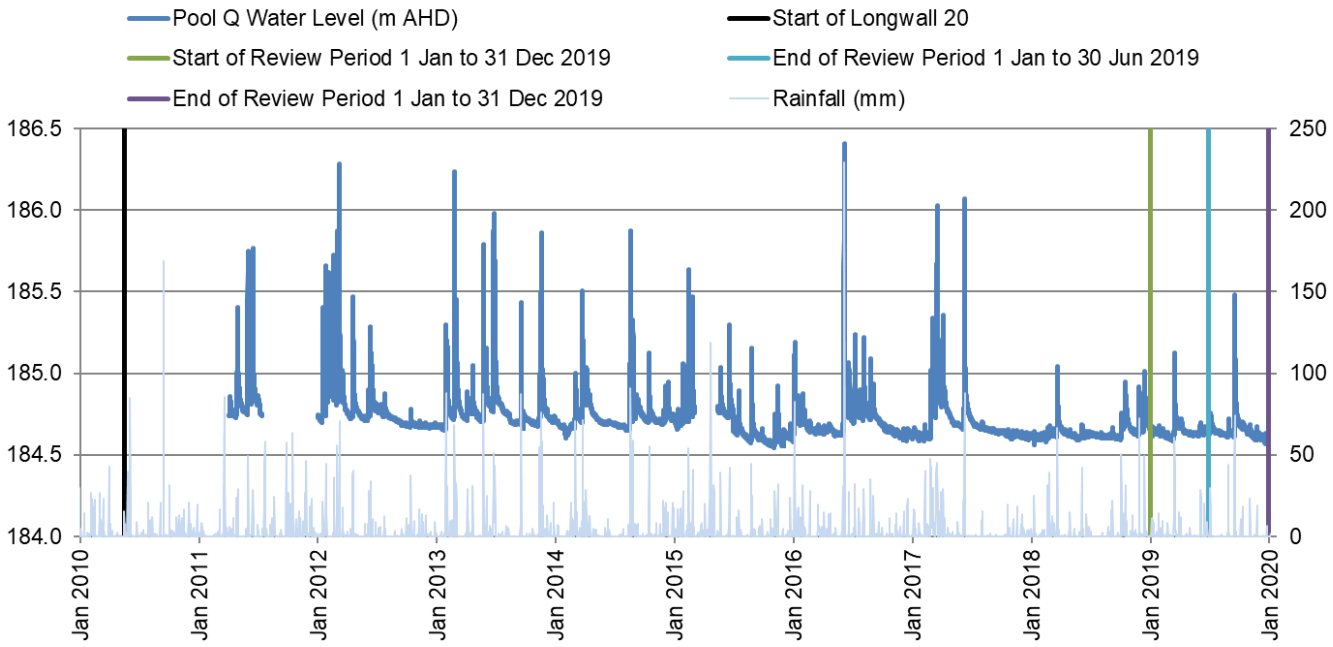

Chart A19 Pool Q Waratah Rivulet[9]

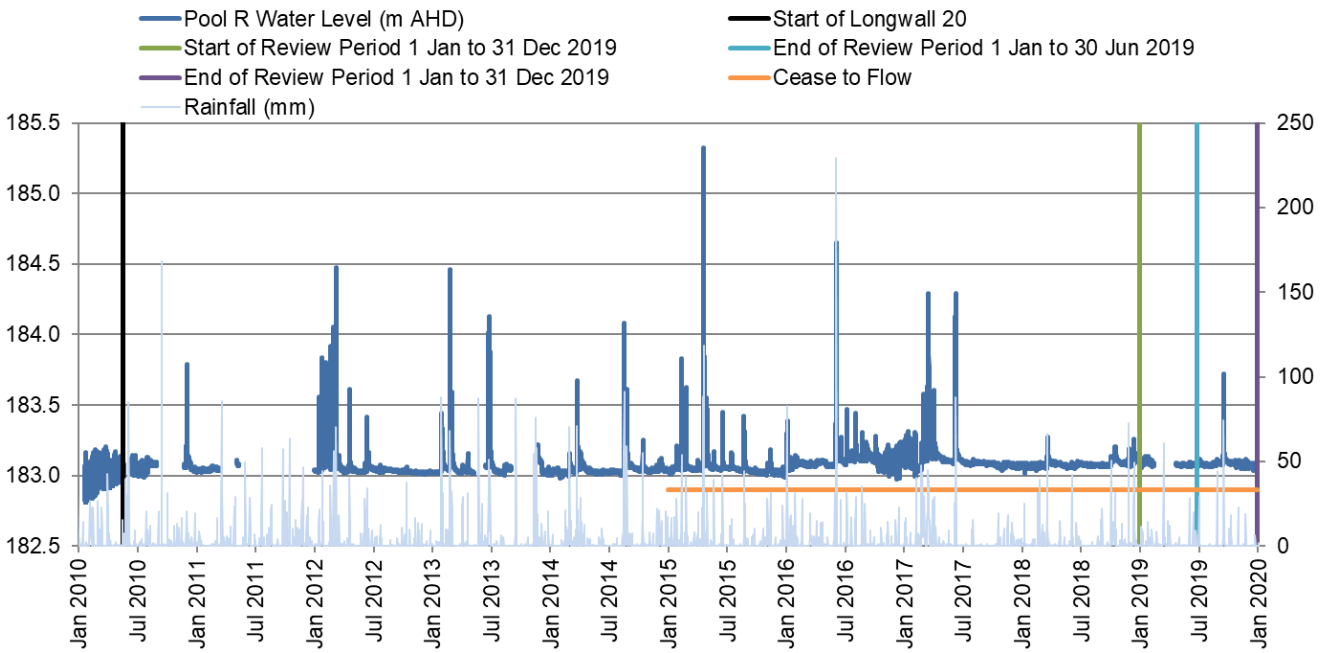

Chart A20 Pool R Waratah Rivulet[10]

[9] The water level data from WaterNSW for Pool Q (GS 213102) was not available at the time of reporting and, as such, the Metropolitan Coal water level records for Pool Q have been adopted for the review.

[10] The sensor malfunctioned on 14 February 2019 and was replaced on 24 April 2019. As such, no data was recorded during this period.

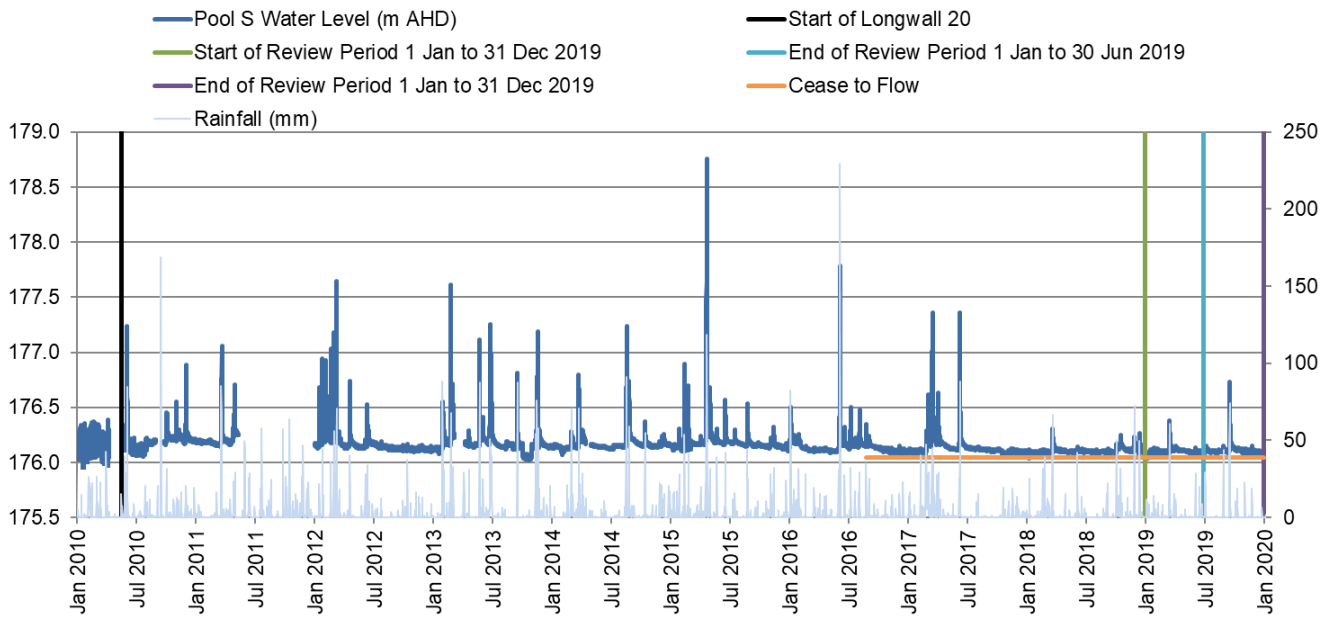

Chart A21 Pool S Waratah Rivulet

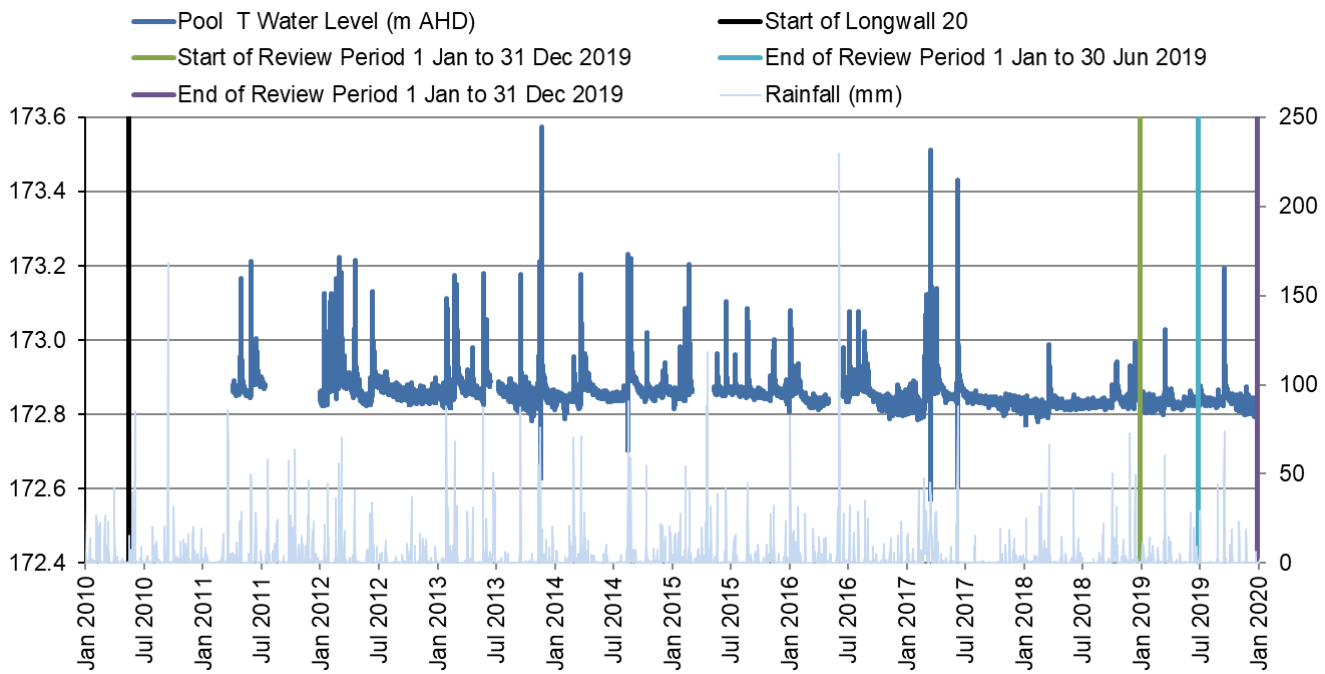

Chart A22 Pool T Waratah Rivulet

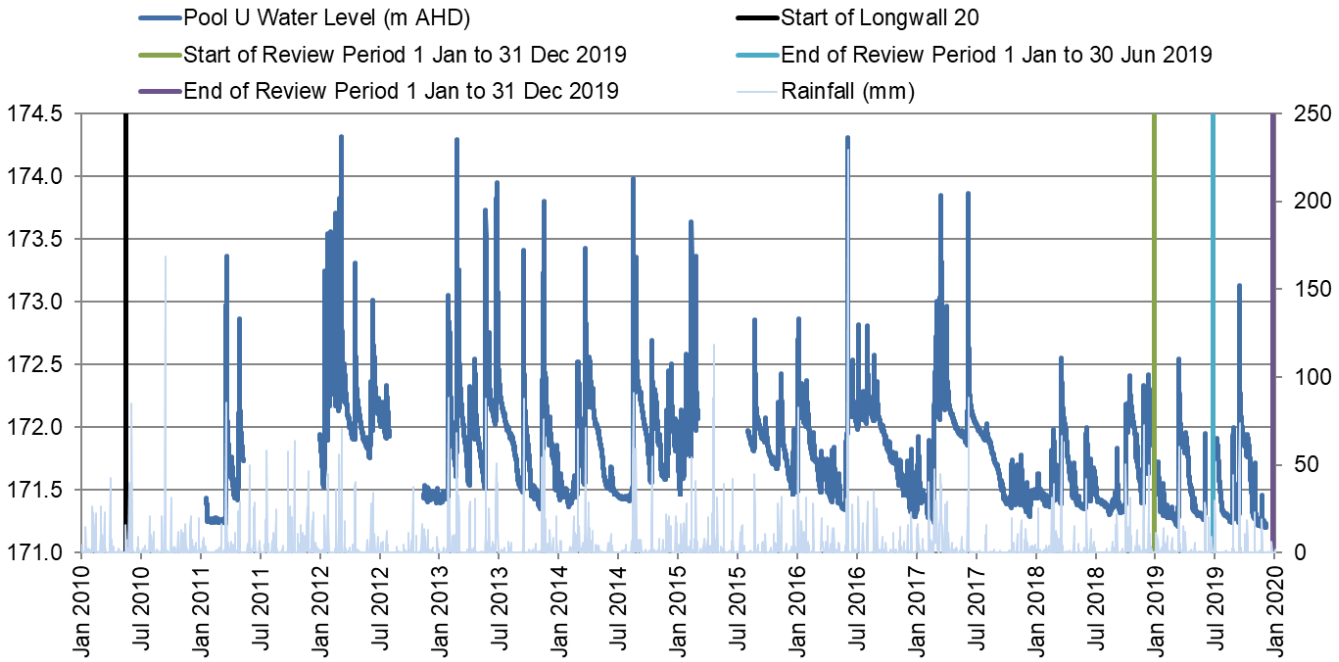

Chart A23 Pool U Waratah Rivulet[11]

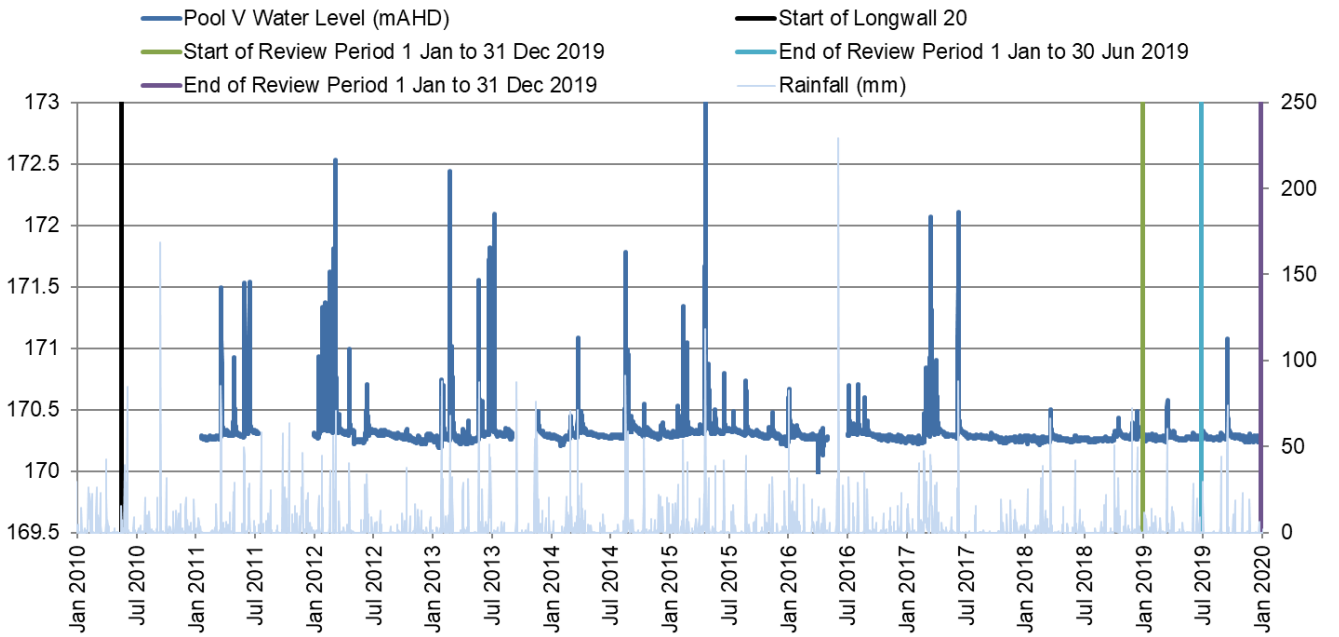

Chart A24 Pool V Waratah Rivulet

[11] The sensor malfunctioned on 6 June 2019 and was replaced in July 2019. The sensor malfunctioned on 8 December 2019 and was replaced in February 2020. As such, no data was recorded during this period.

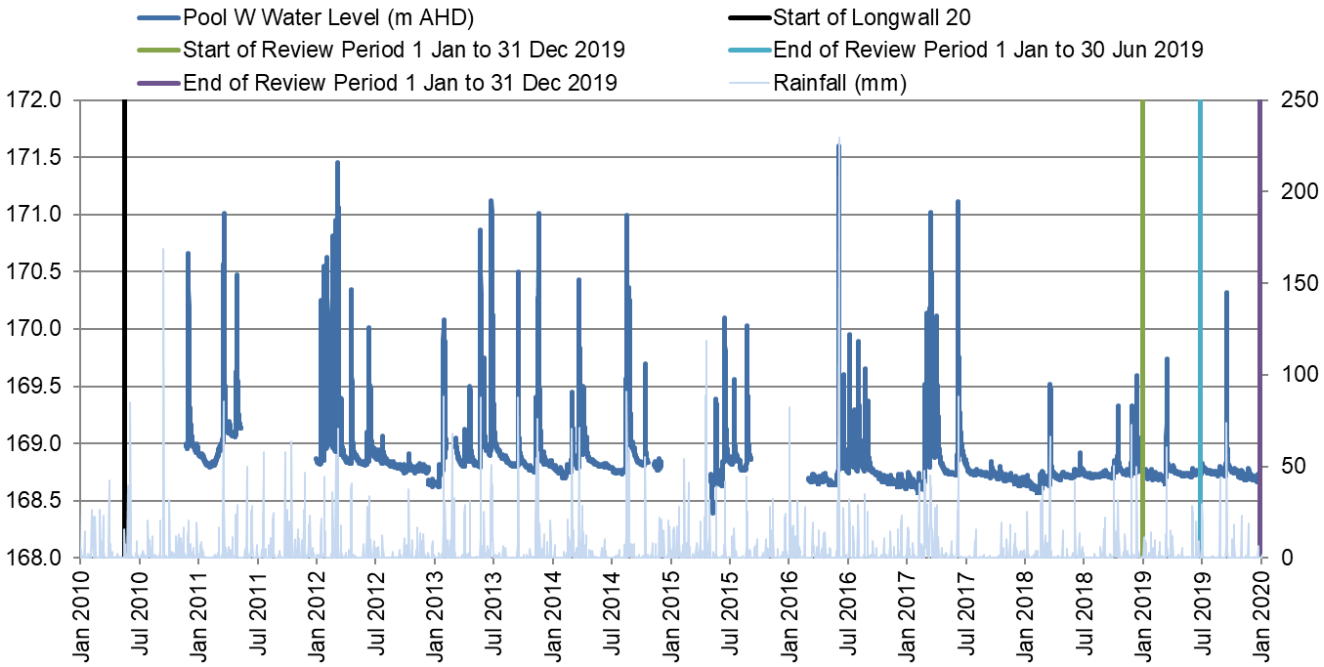

Chart A25 Pool W Waratah Rivulet

Pools on Eastern Tributary

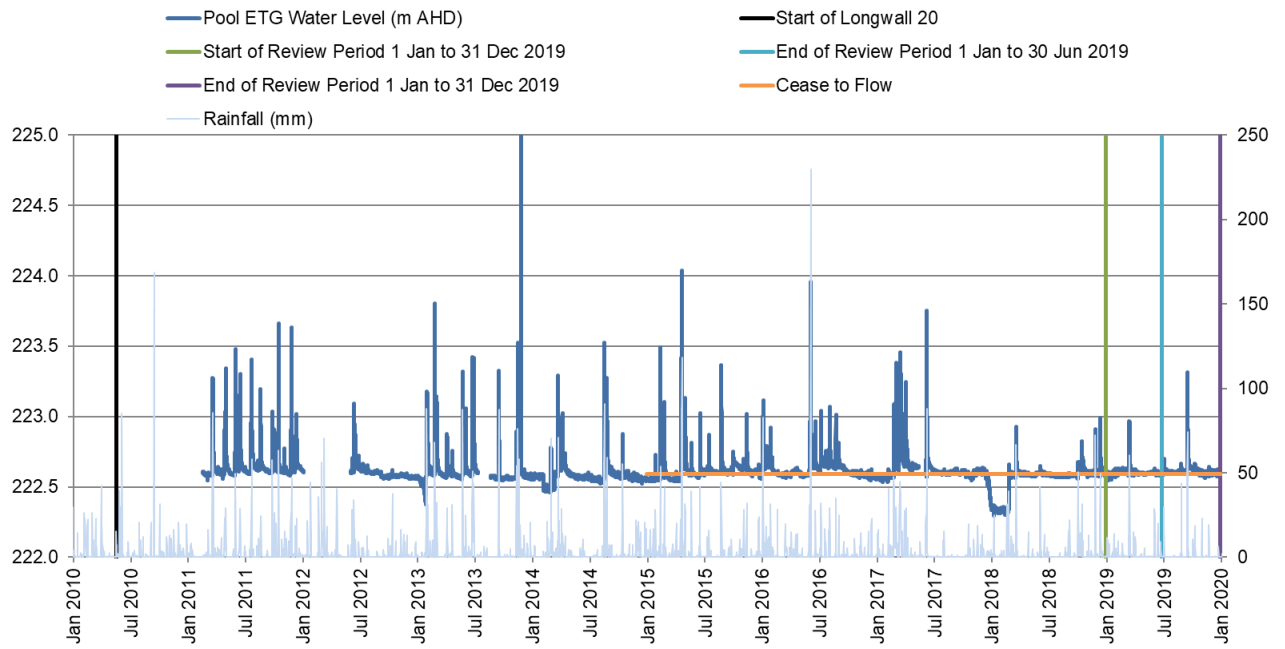

Chart A26 Pool ETG

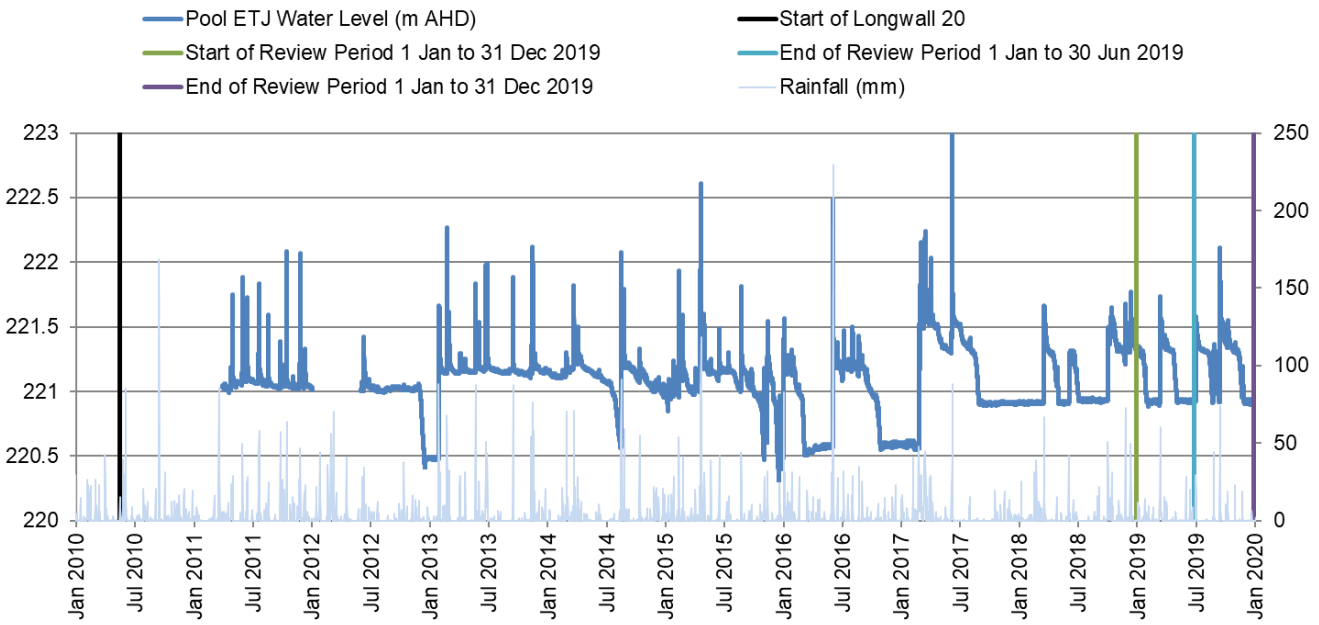

Chart A27 Pool ETJ

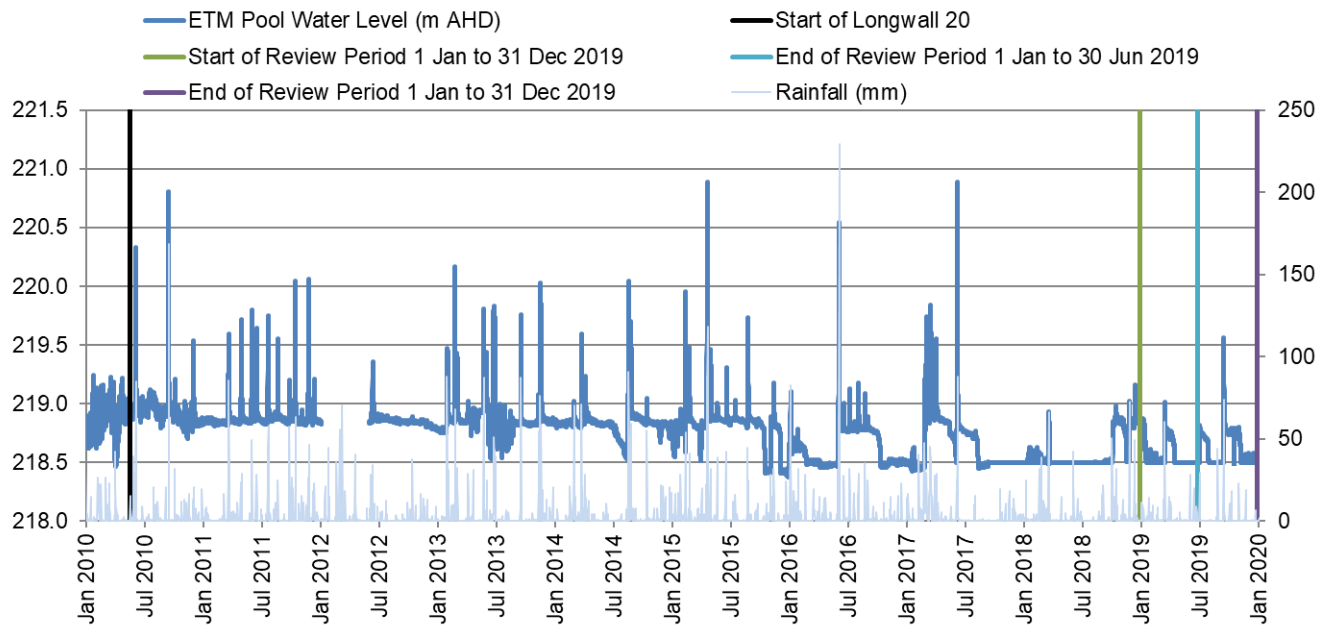

Chart A28 Pool ETM

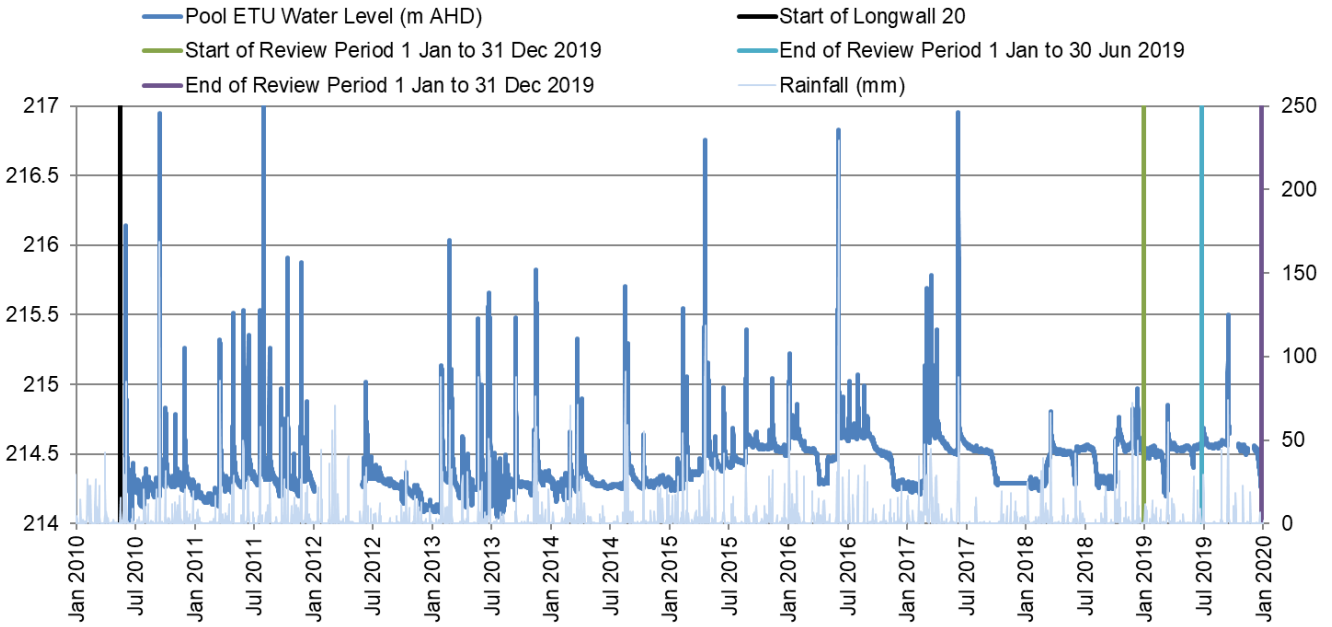

Chart A29 Pool ETU[12]

[12] The water level sensor was not restarted and hence data was not recorded between 23 September 2019 and 21 October 2019. A communication error with the sensor occurred resulting in lost data between 18 November 2019 and 8 December 2019.

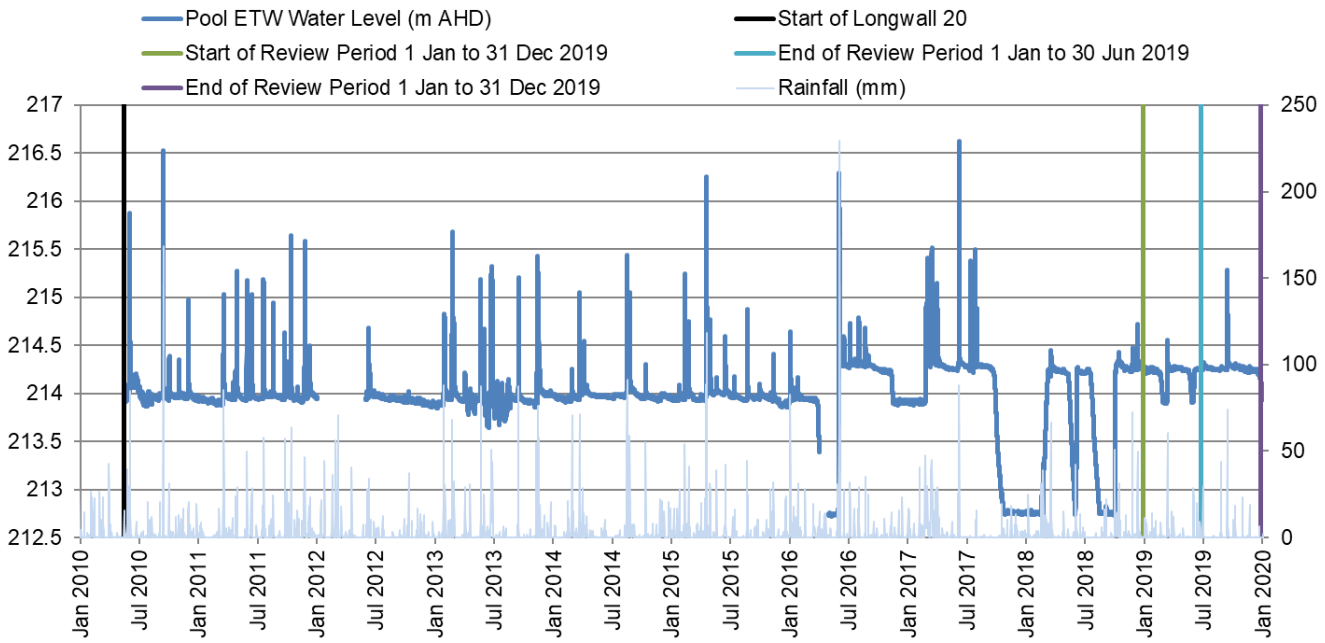

Chart A30 Pool ETW[13,14]

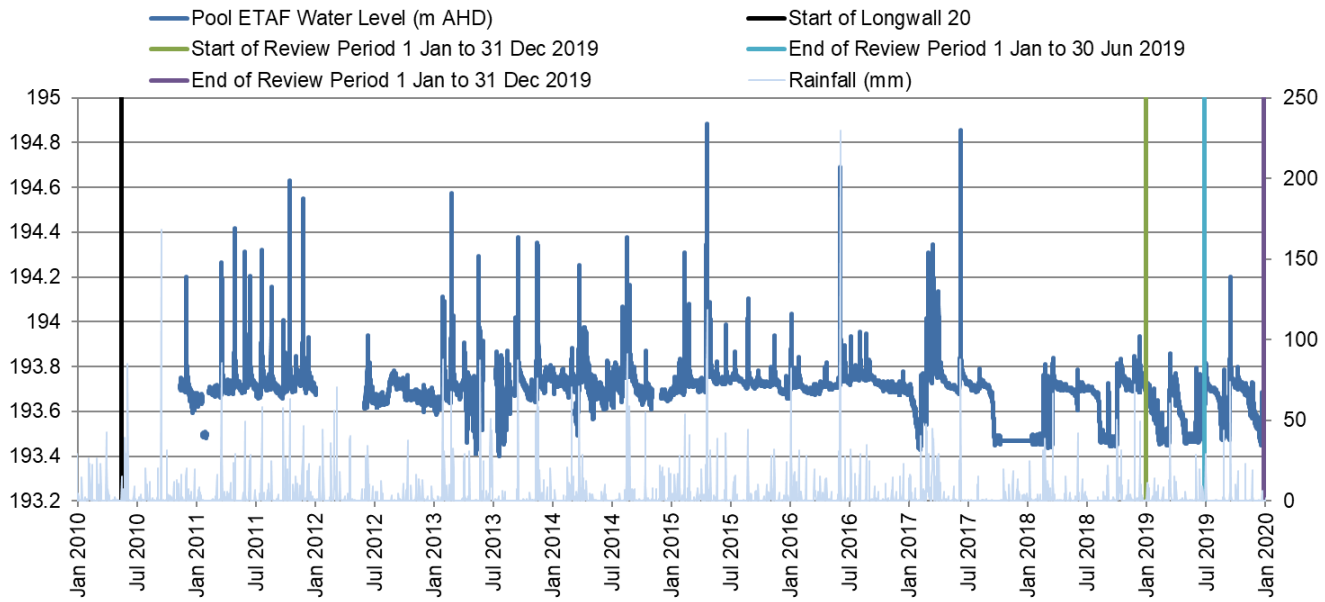

Chart A31 Pool ETAF

[13] Note discrepancies in water levels caused by the pool being dry and the water level sensor being exposed at time of download.

[14] After heavy rainfalls in early June 2016, the sensor stand at Pool ETW became clogged with sediment and the sensor was unable to reach the bottom. On 14 July 2016, a new sensor was installed at Pool ETW to replace the previous sensor. In September 2017, the old sensor was cleared of sediment and was able to be used again. The original sensor extends deeper into the pool, allowing additional information to be obtained during periods when the pool water level is below the cease to flow level. Data shown after September 2017 is from the original sensor.

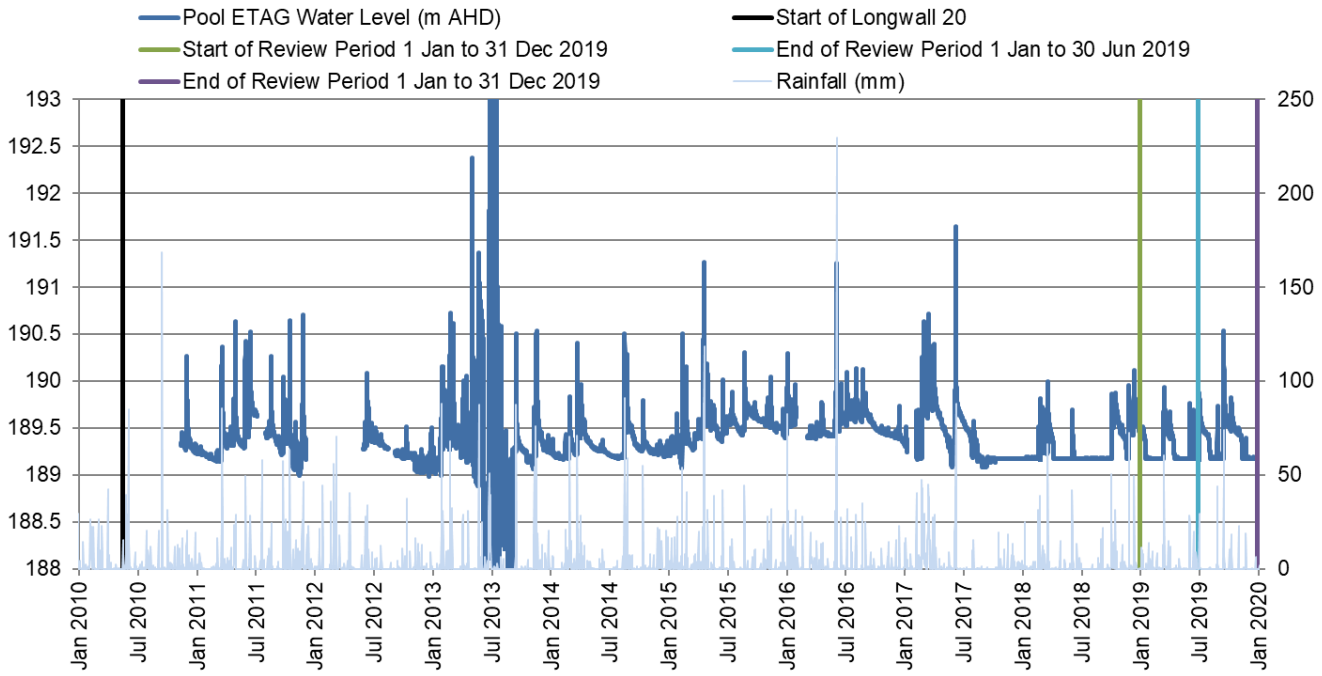

Chart A32 Pool ETAG

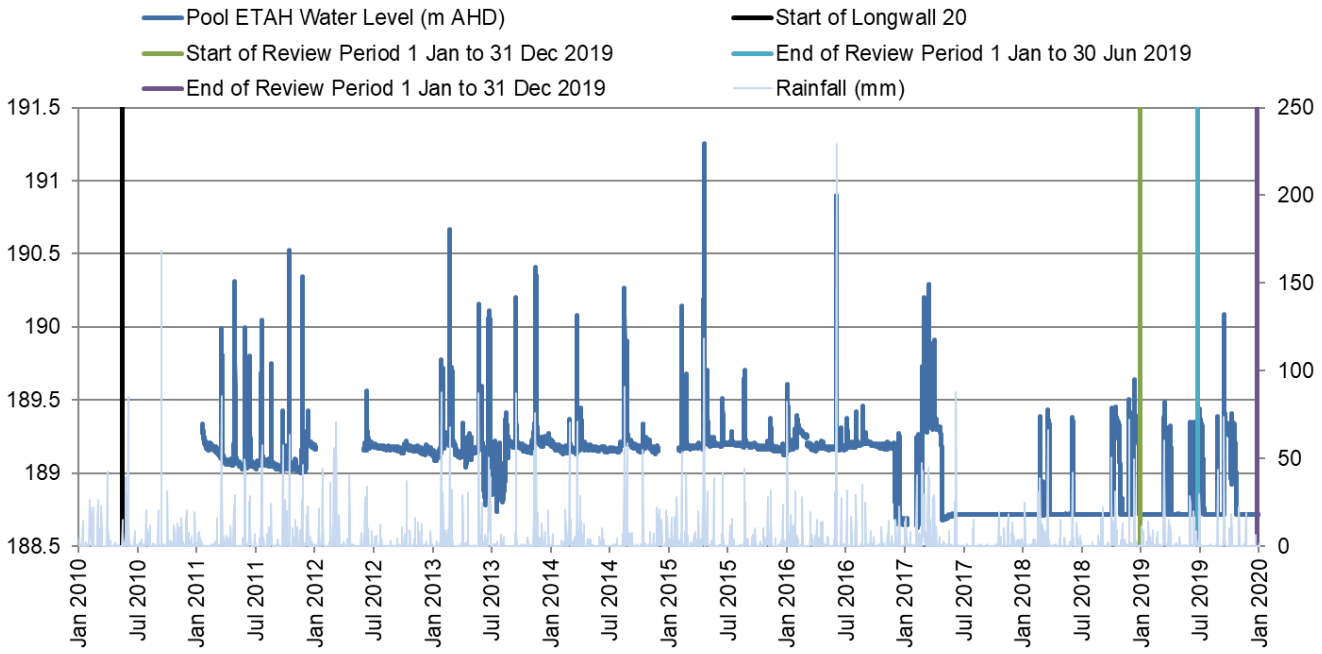

Chart A33 Pool ETAH

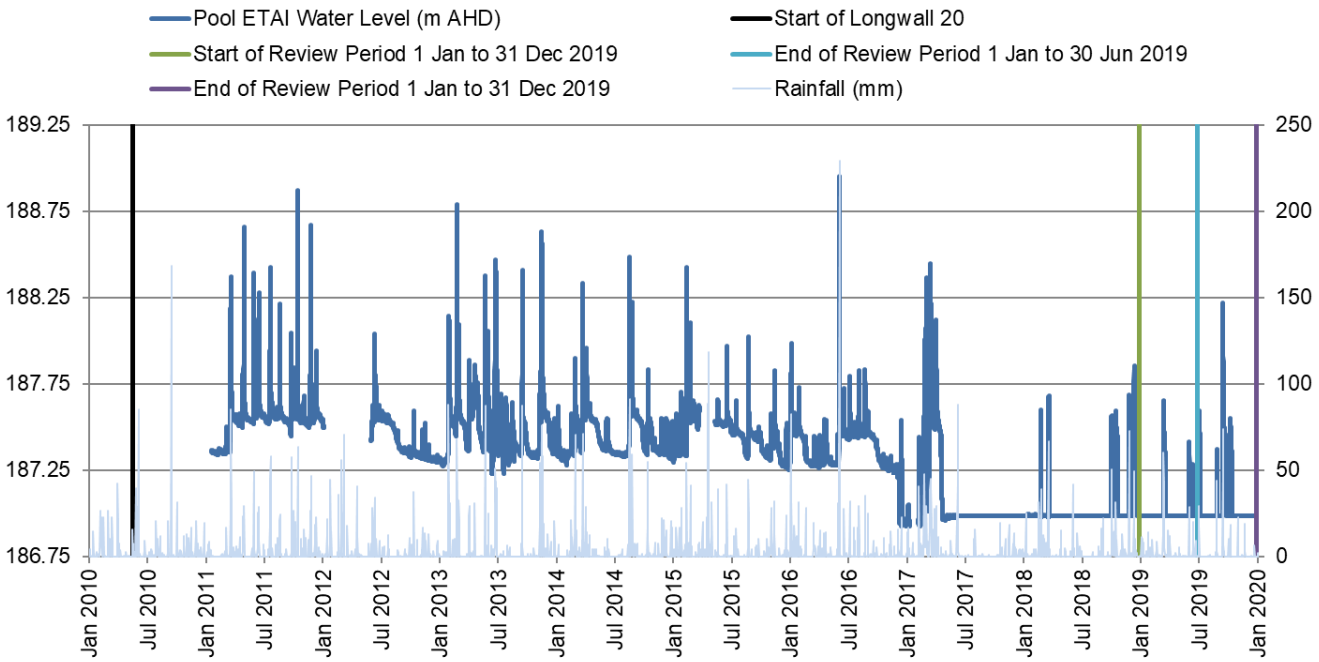

Chart A34 Pool ETAI

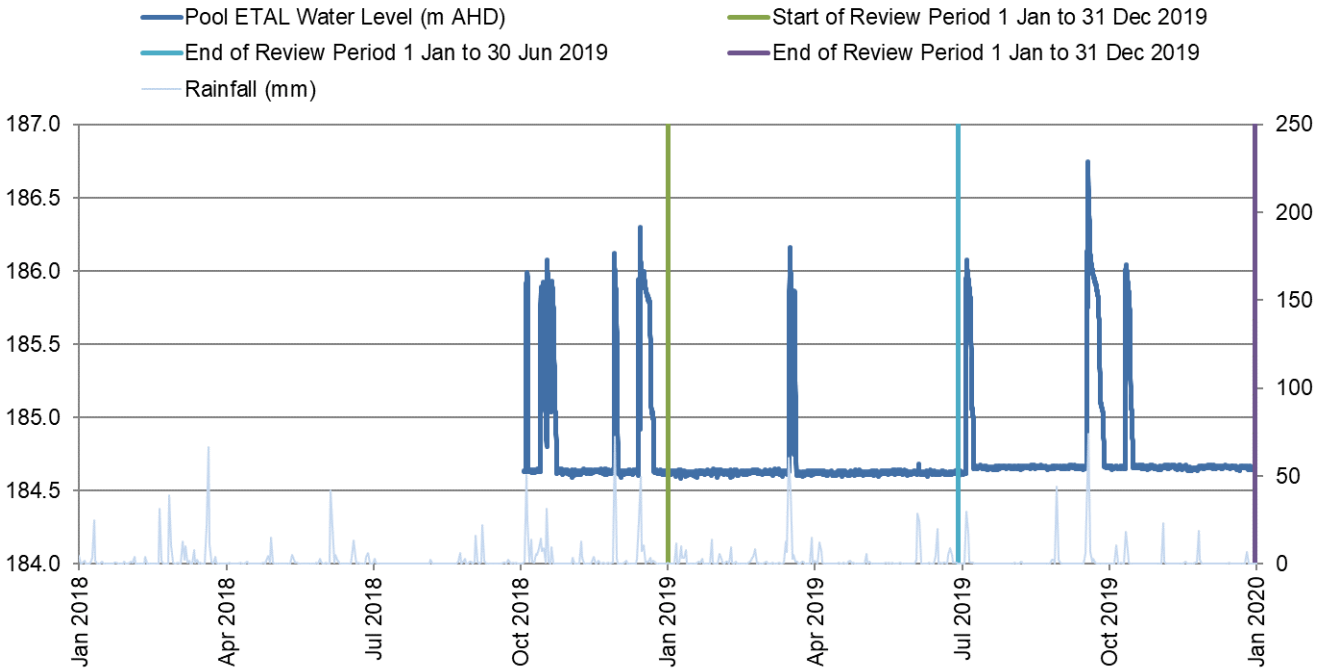

Chart A35 Pool ETAL

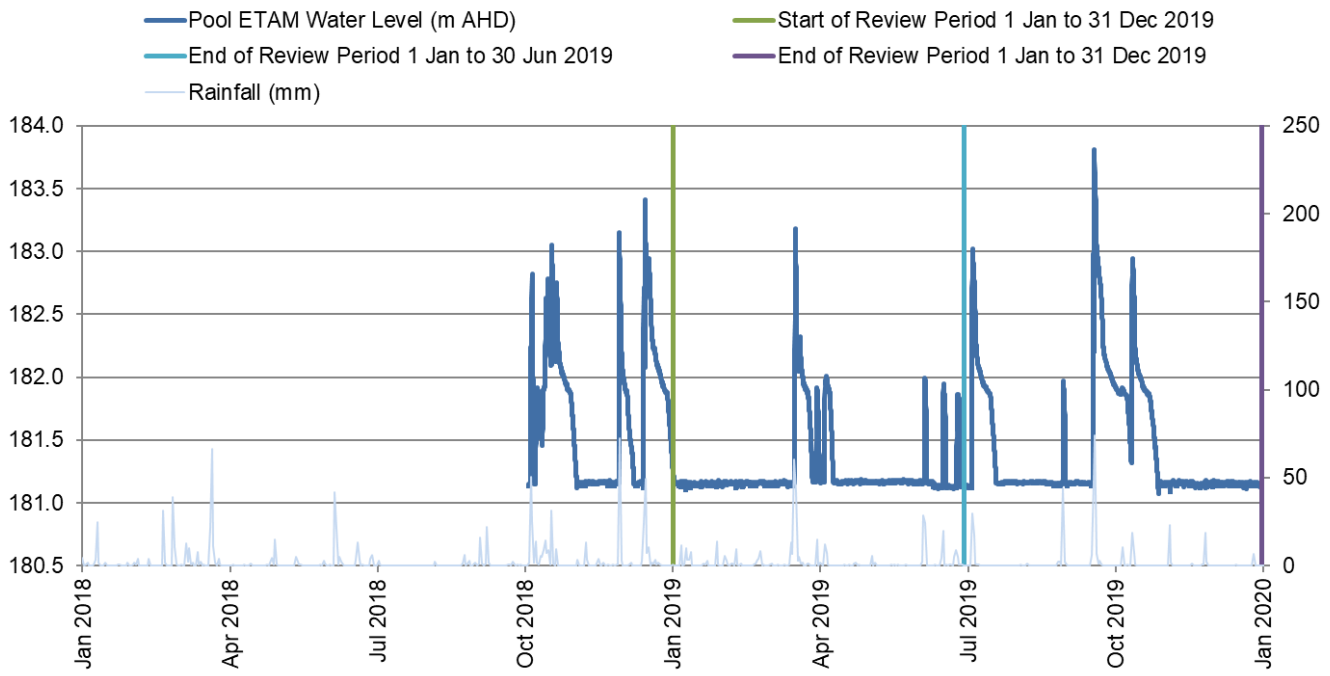

Chart A36 Pool ETAM

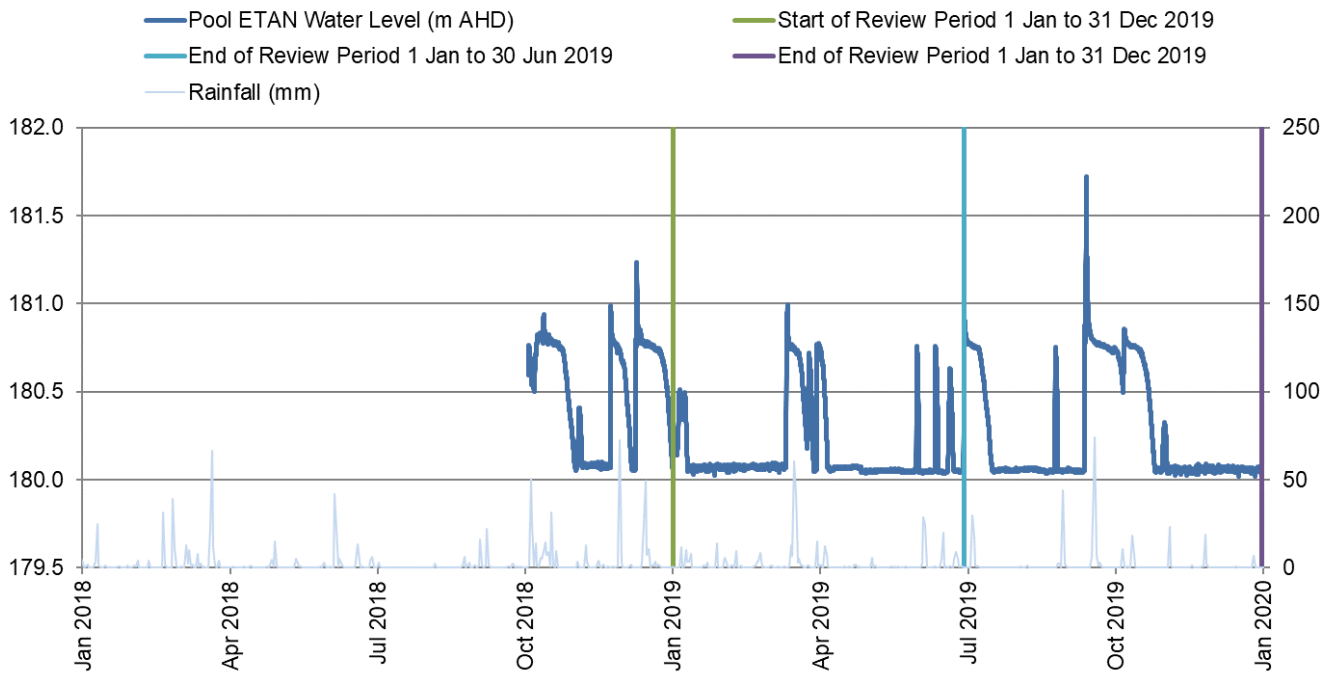

Chart A37 Pool ETAN

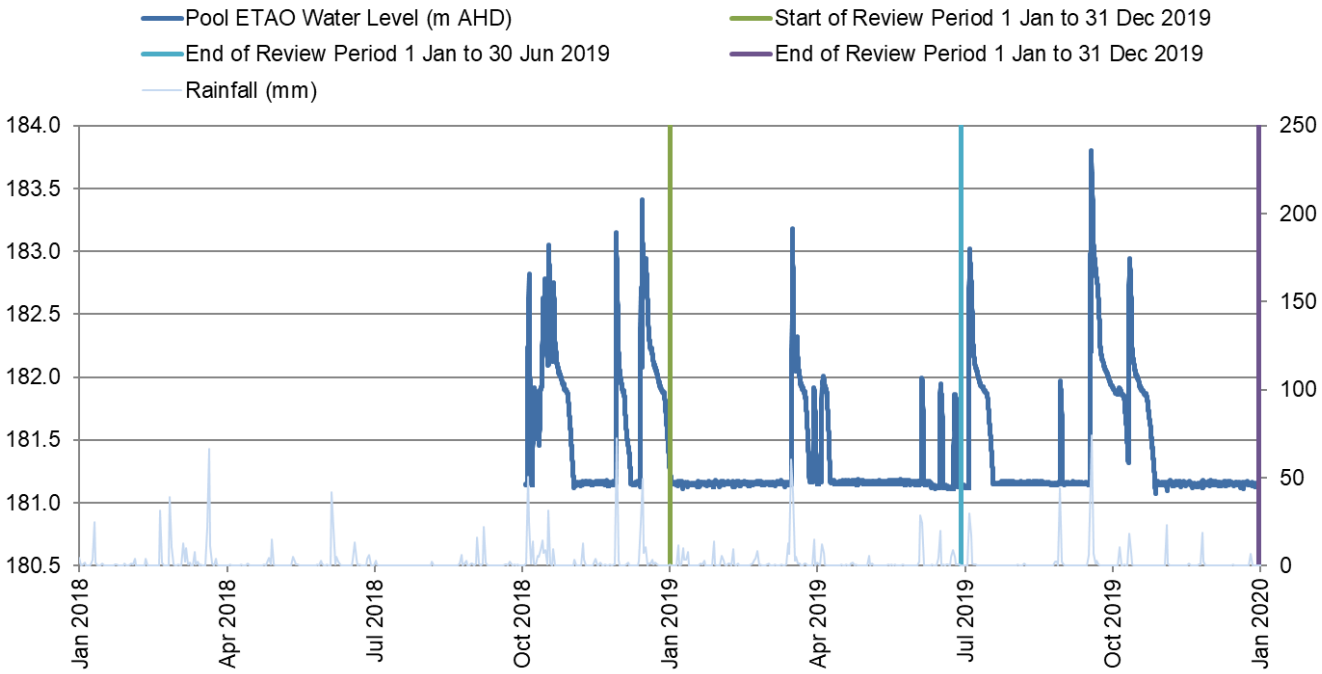

Chart A38 Pool ETAO

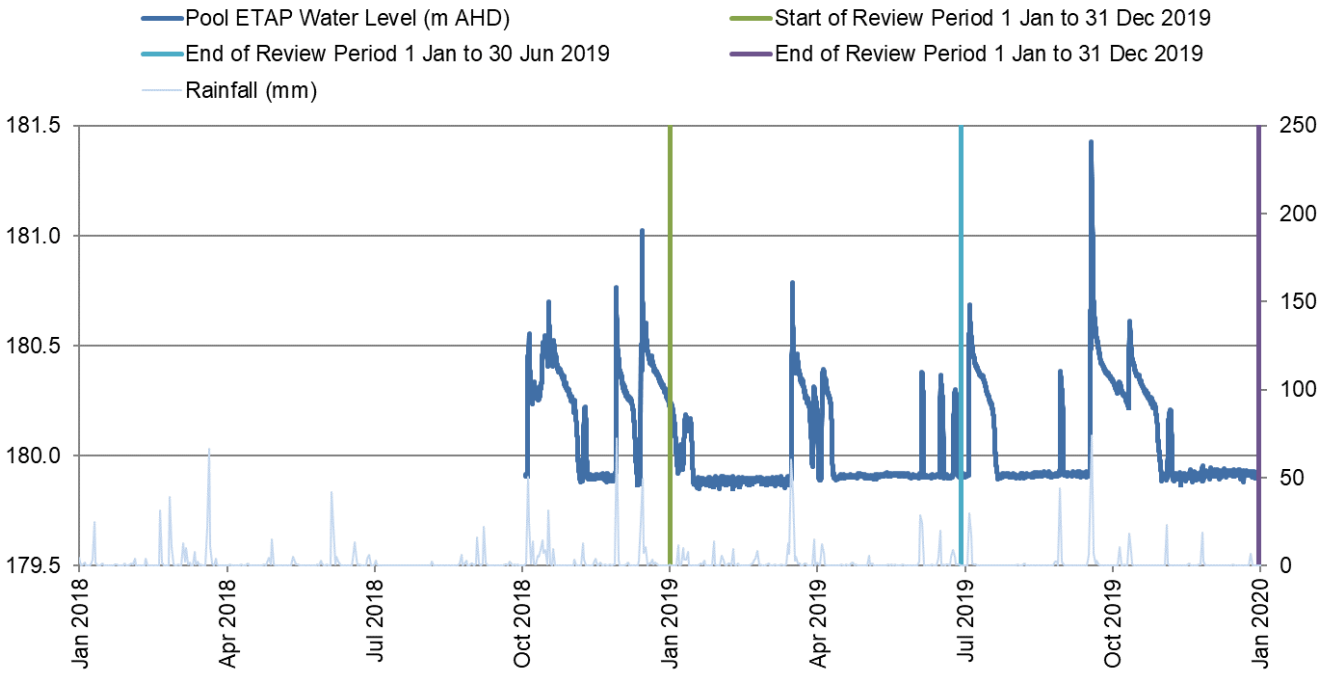

Chart A39 Pool ETAP

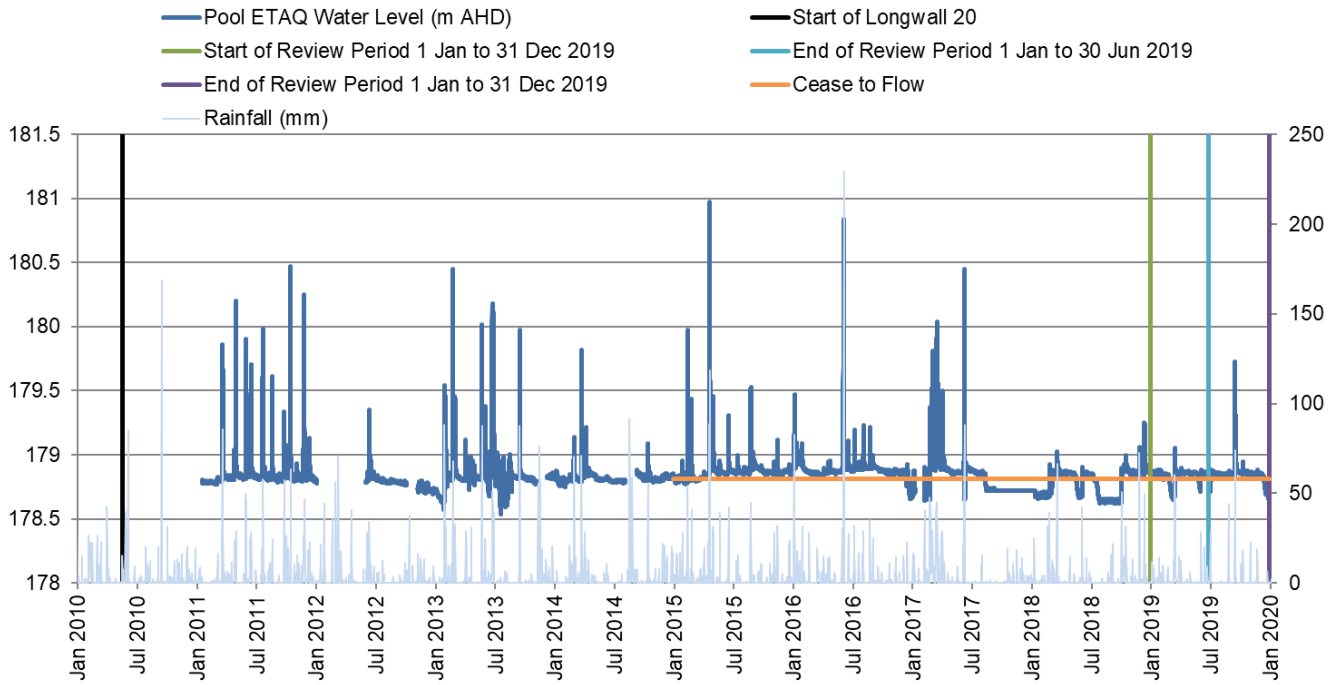

Chart A40 Pool ETAQ

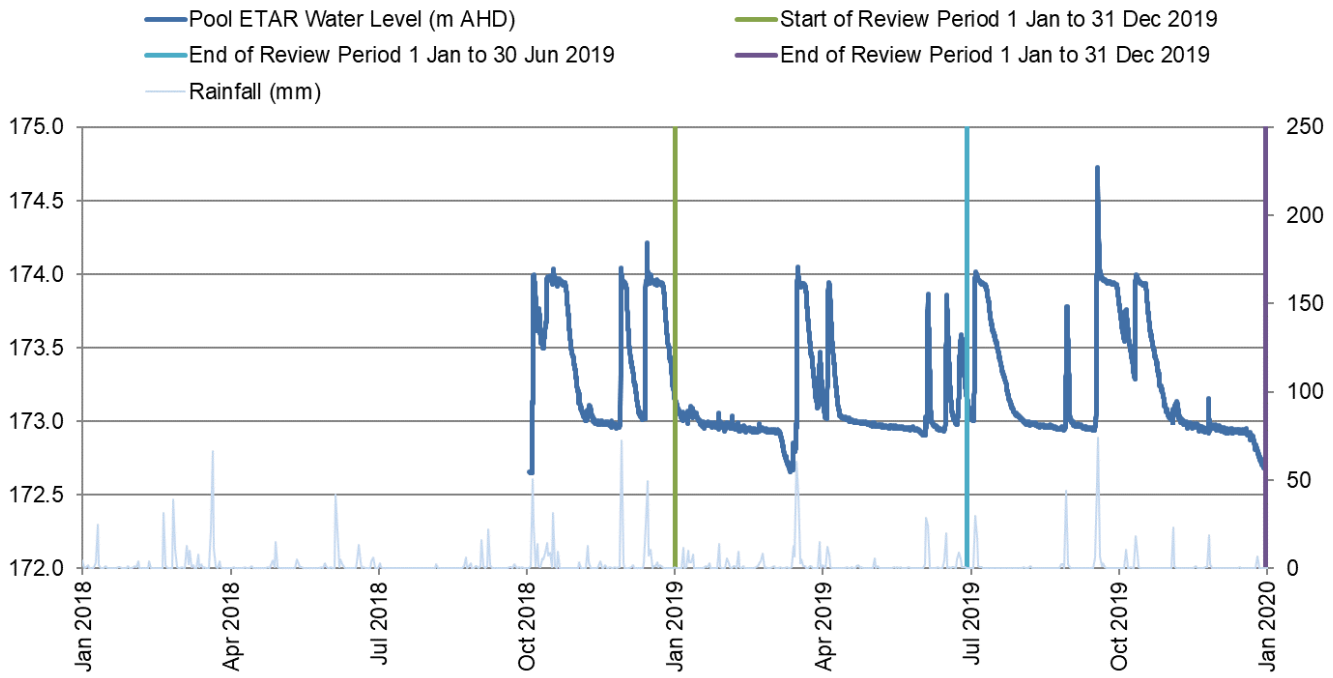

Chart A41 Pool ETAR

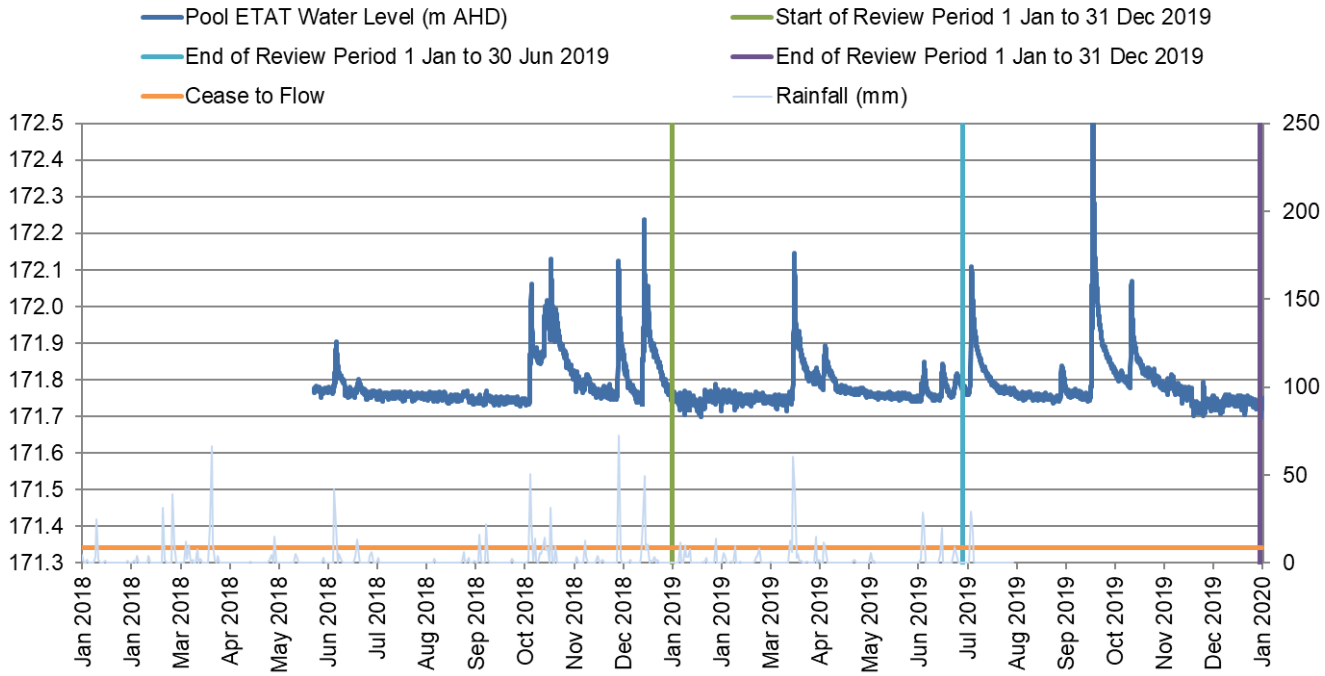

Chart A42 Pool ETAT

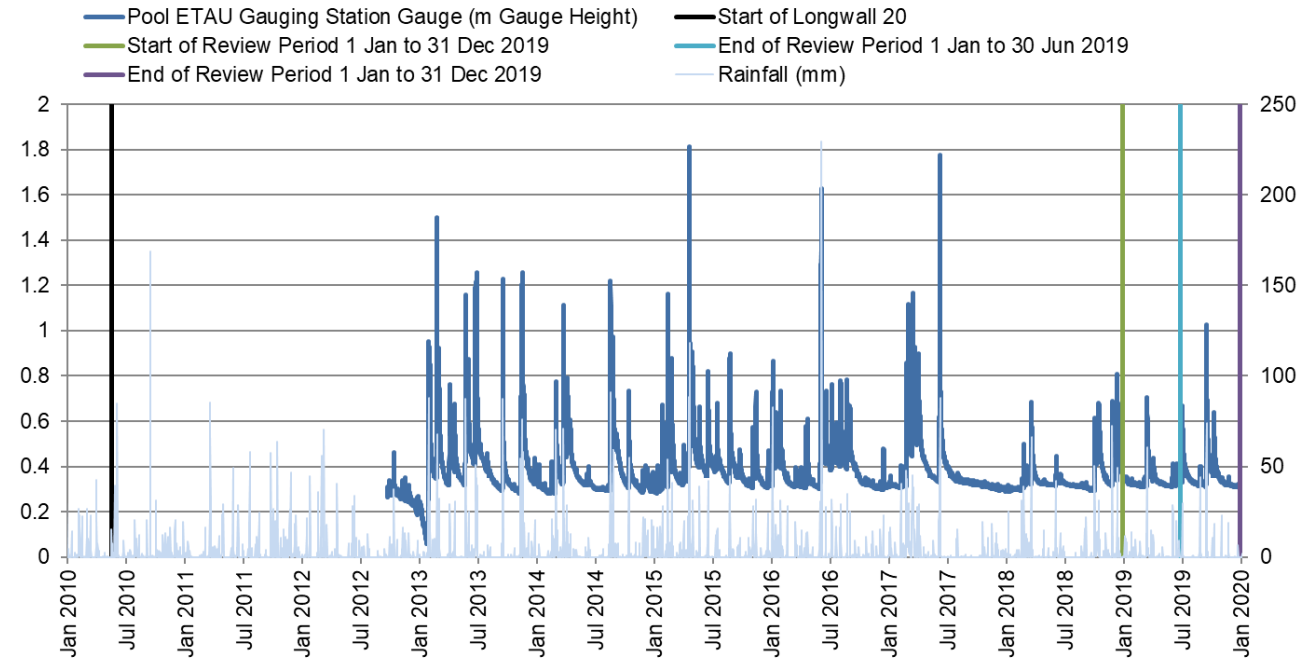

Chart A43 Pool ETAU (Stage data)

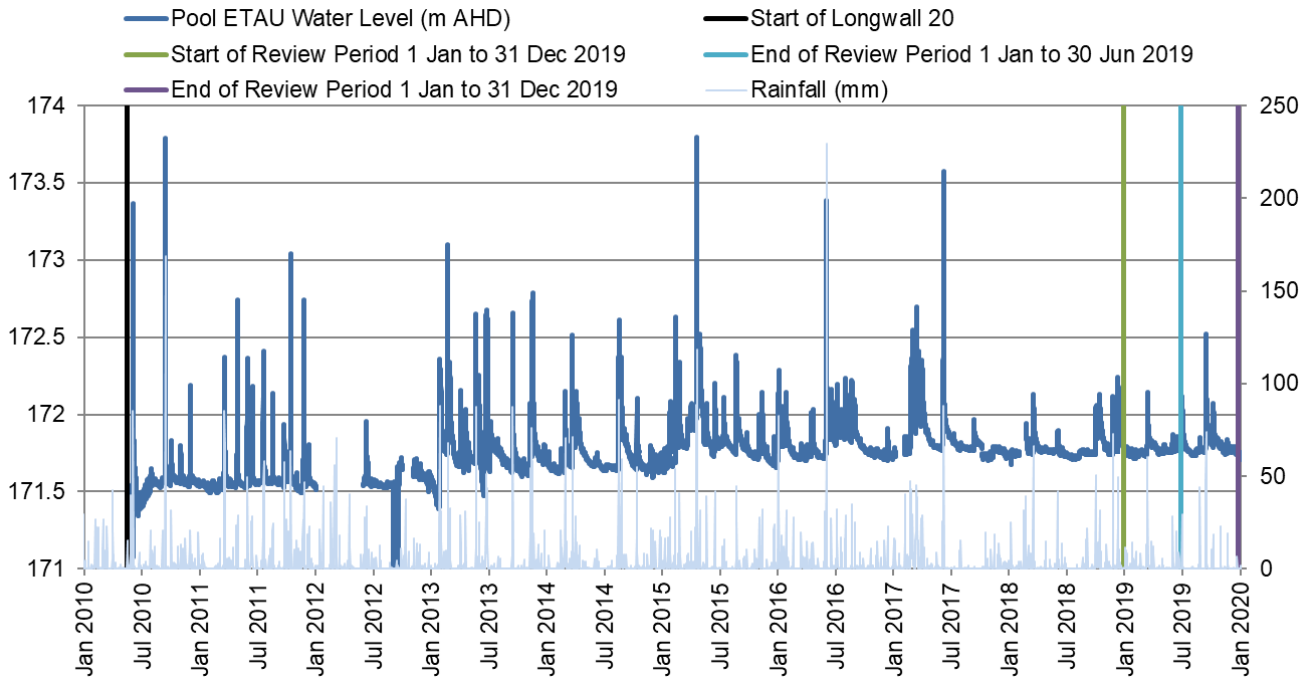

Chart A44 Pool ETAU

Pools on Tributary B/Reference Tributary

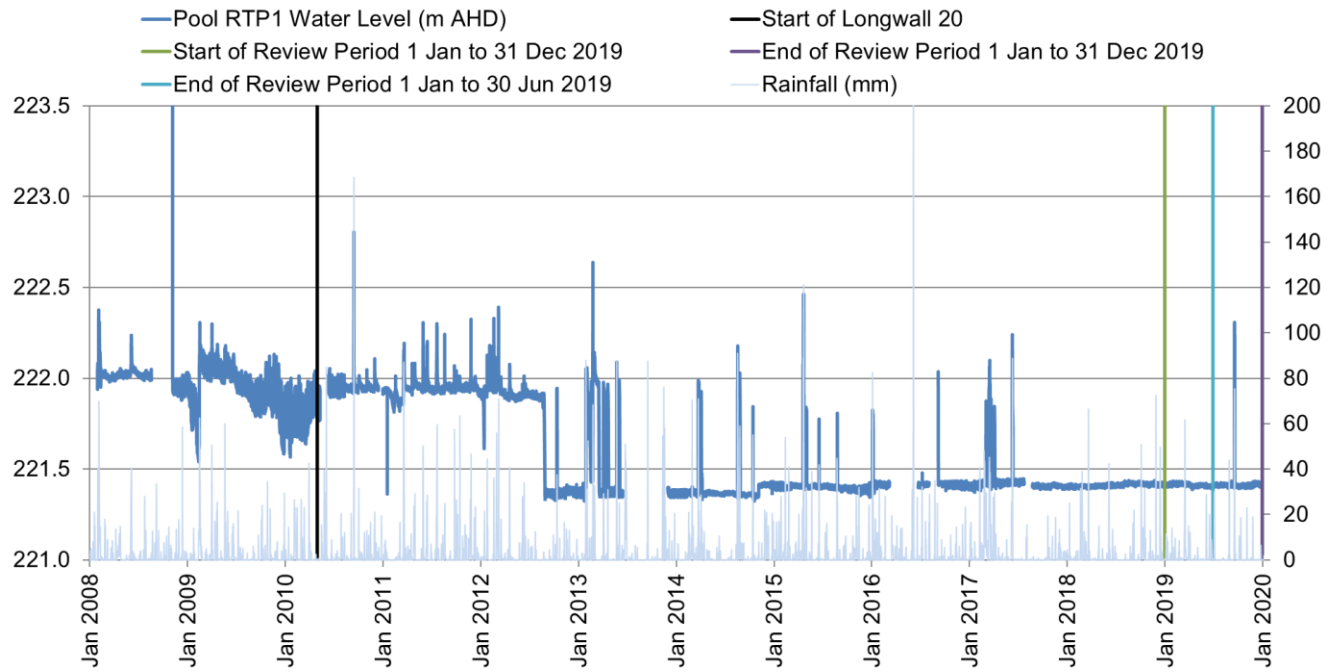

Chart A45 Pool RTP1[15]

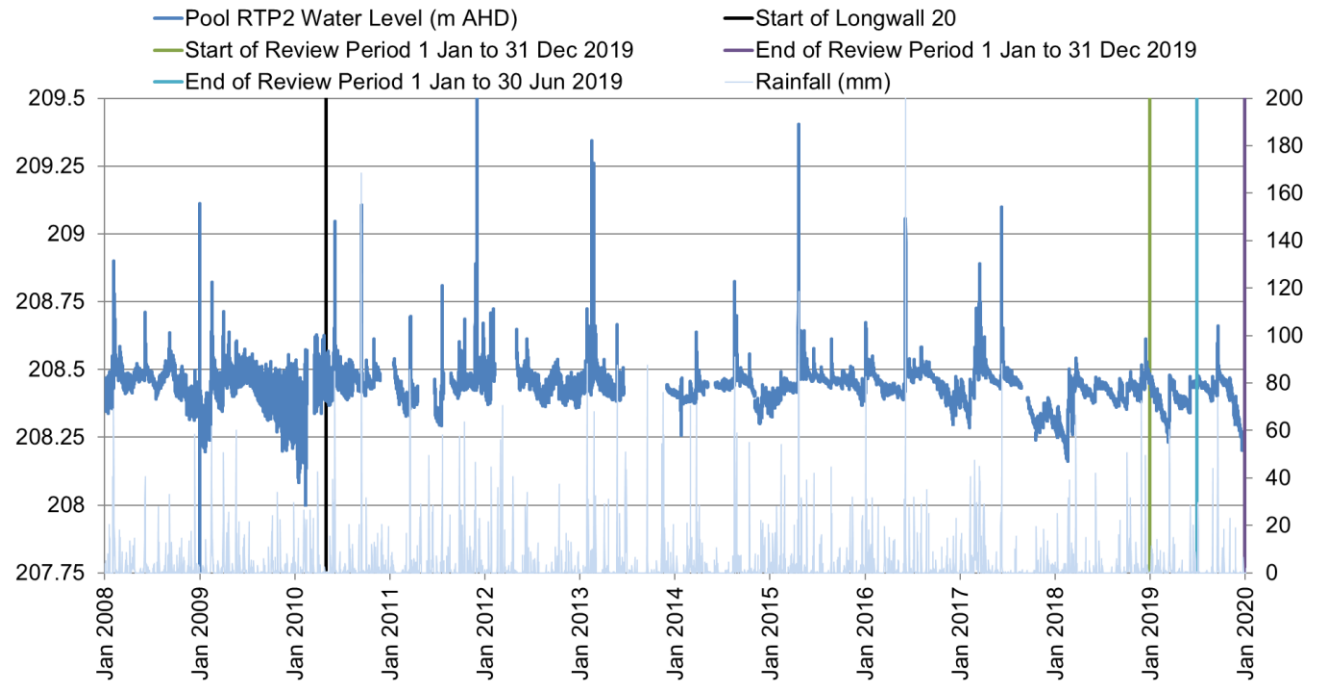

Chart A46 Pool RTP2

[15] Water levels have not been able to be reduced to AHD levels. The spikes are however indicative of water level rises associated with rainfall-runoff events and should be regarded as being indicative of relative pool water level changes.

Pools on Woronora River[16]

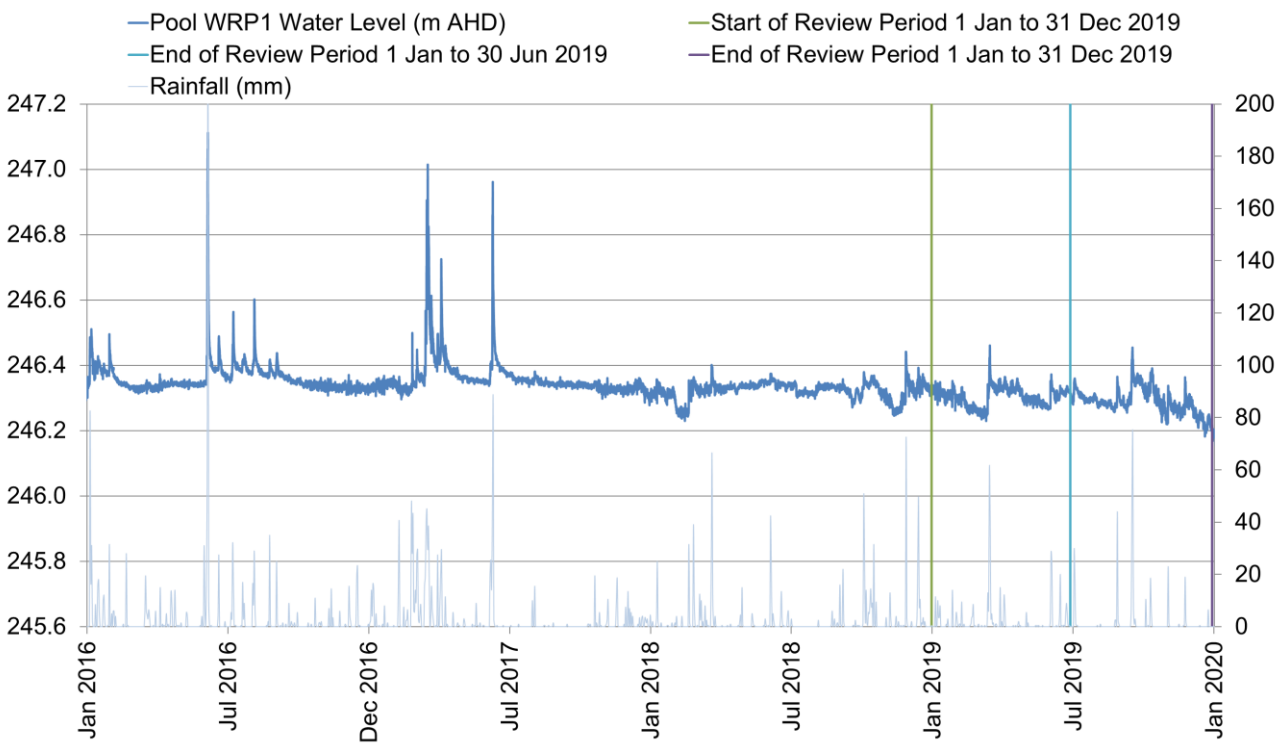

Chart A47 Pool WRP1

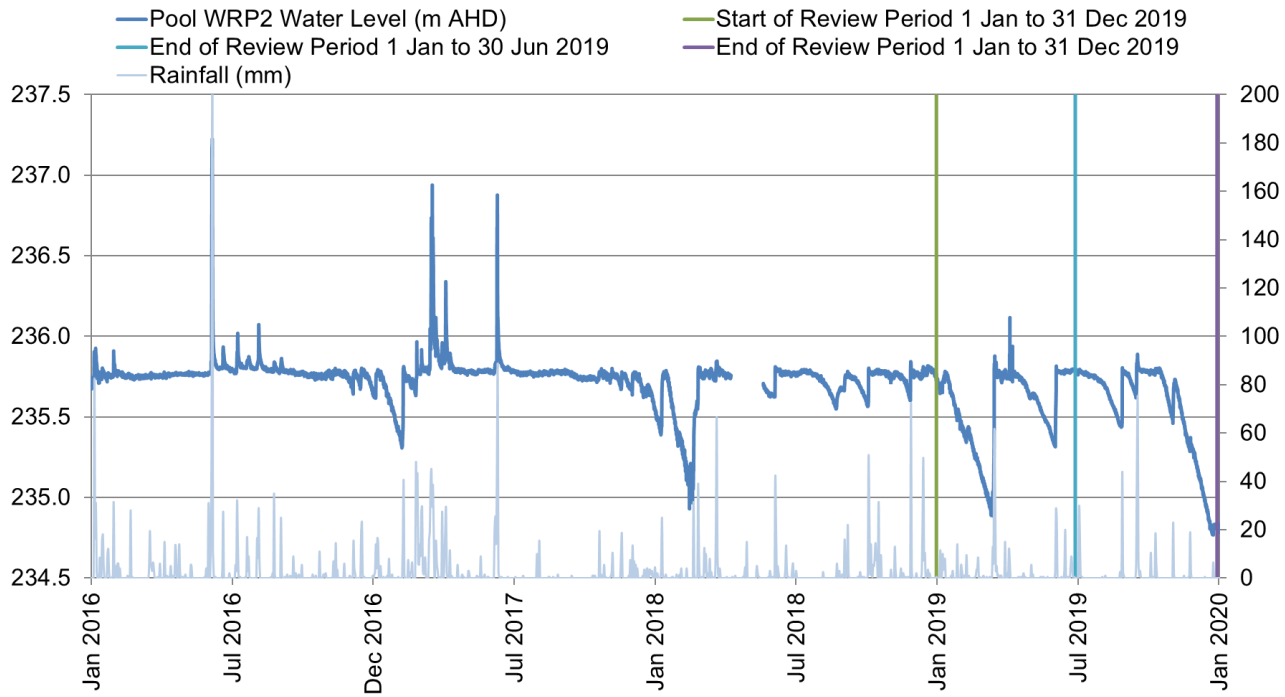

Chart A48 Pool WRP2

[16] Pool water level data for the Woronora River pools prior to January 2016 is considered to be largely erroneous as a result of water level sensor issues and is not shown.

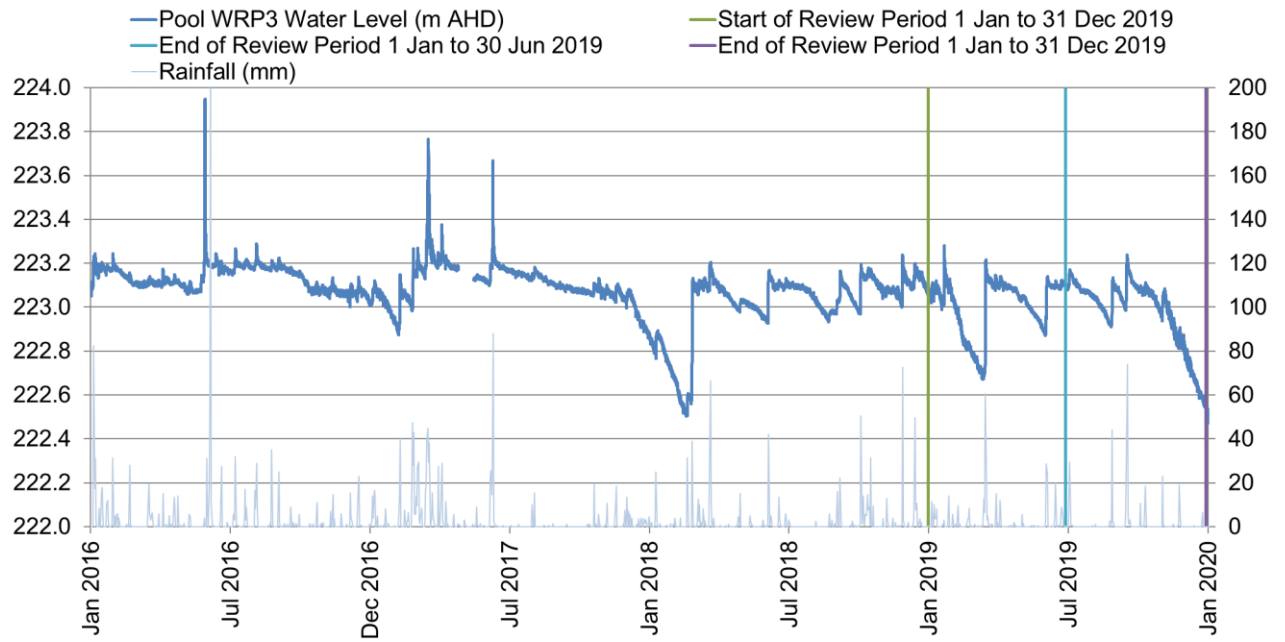

Chart A49 Pool WRP3

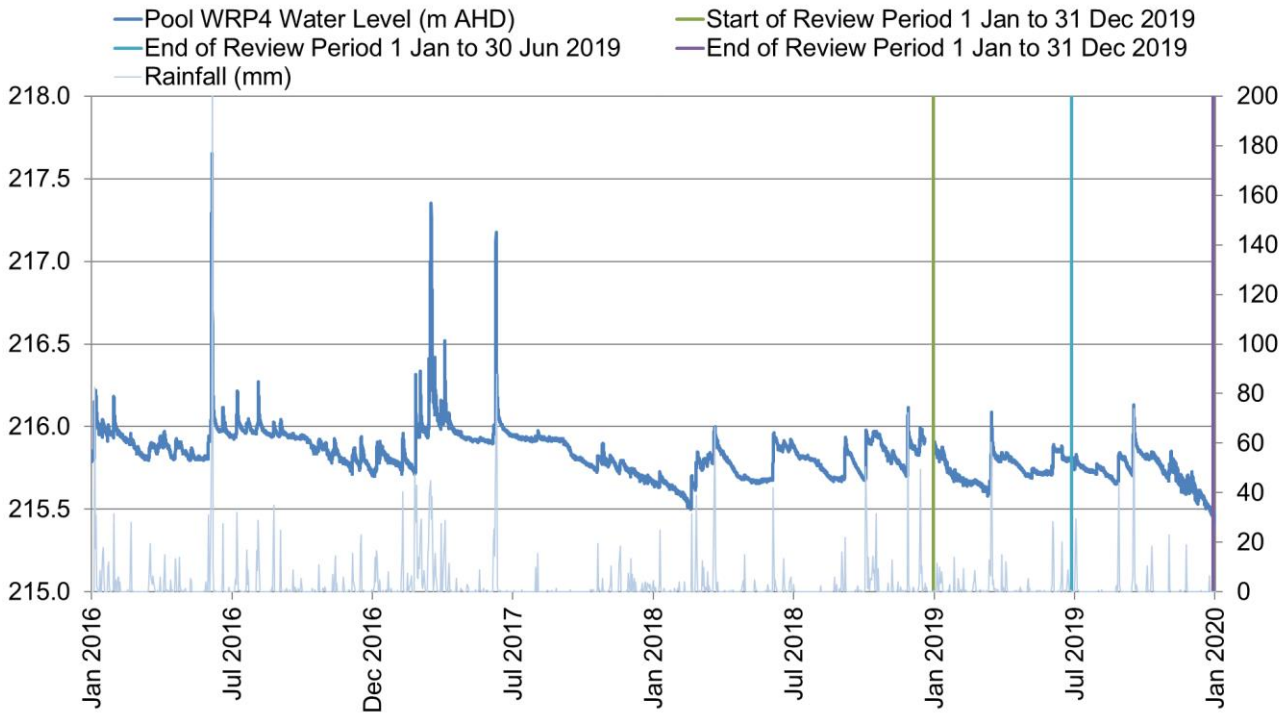

Chart A50 Pool WRP4[17]

[17] Pool water level data for WRP4 was erroneous from 20 December 2018 to 1 January 2019 and removed from the dataset. The erroneous data was a result of a logger positioning error.

Appendix B
Surface Water Quality Monitoring Results for Select Sites – pH, Electrical Conductivity, Dissolved Iron, Dissolved Manganese and Dissolved Aluminium

Waratah Rivulet

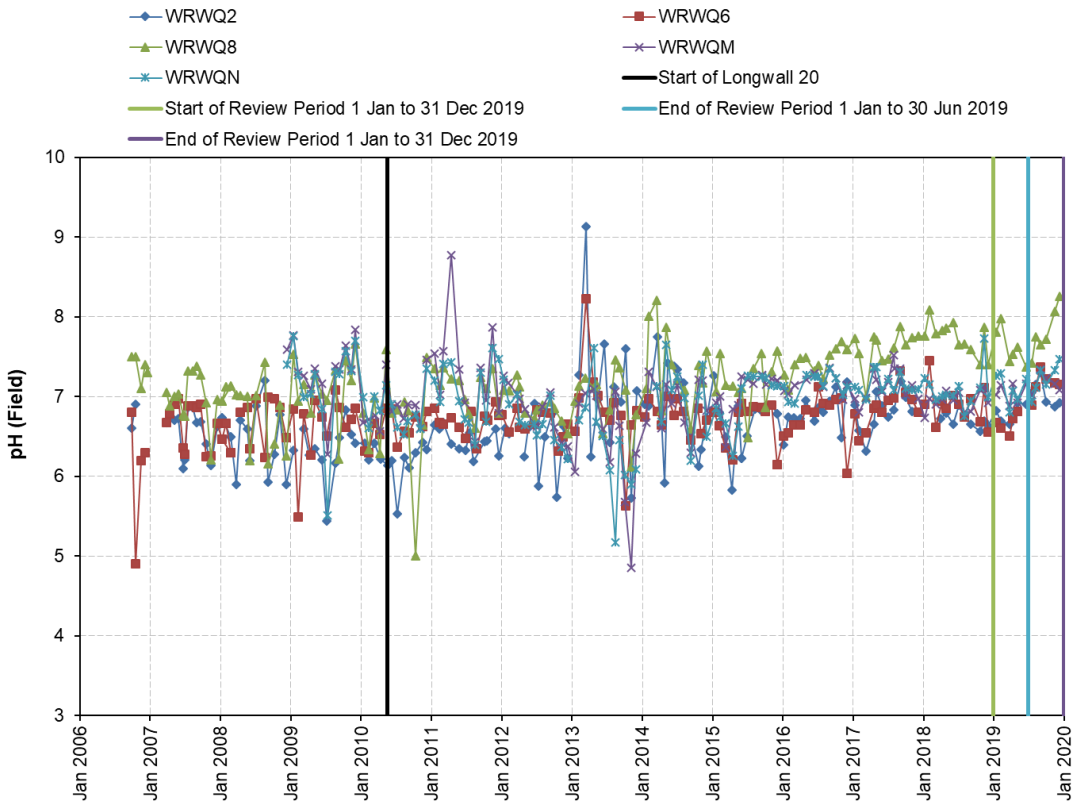

Chart B1 pH Levels Waratah Rivulet – Upper to Middle Reach Sites

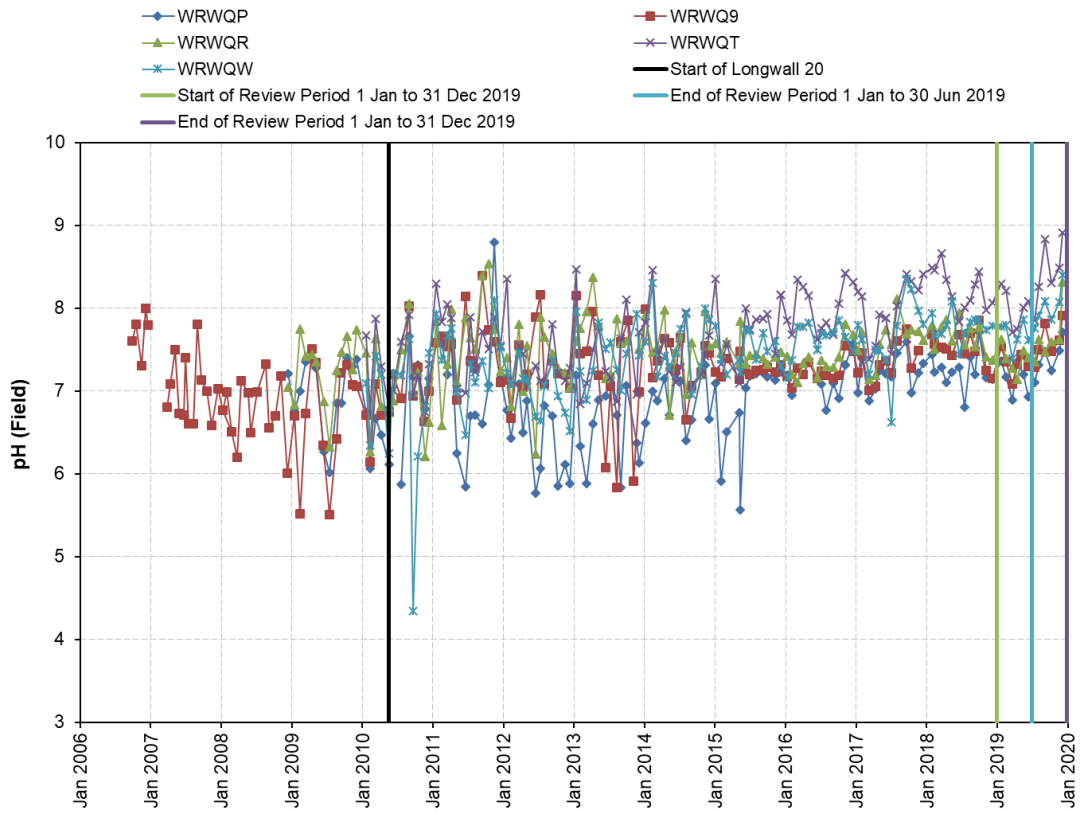

Chart B2 pH Levels Waratah Rivulet – Lower Reach Sites

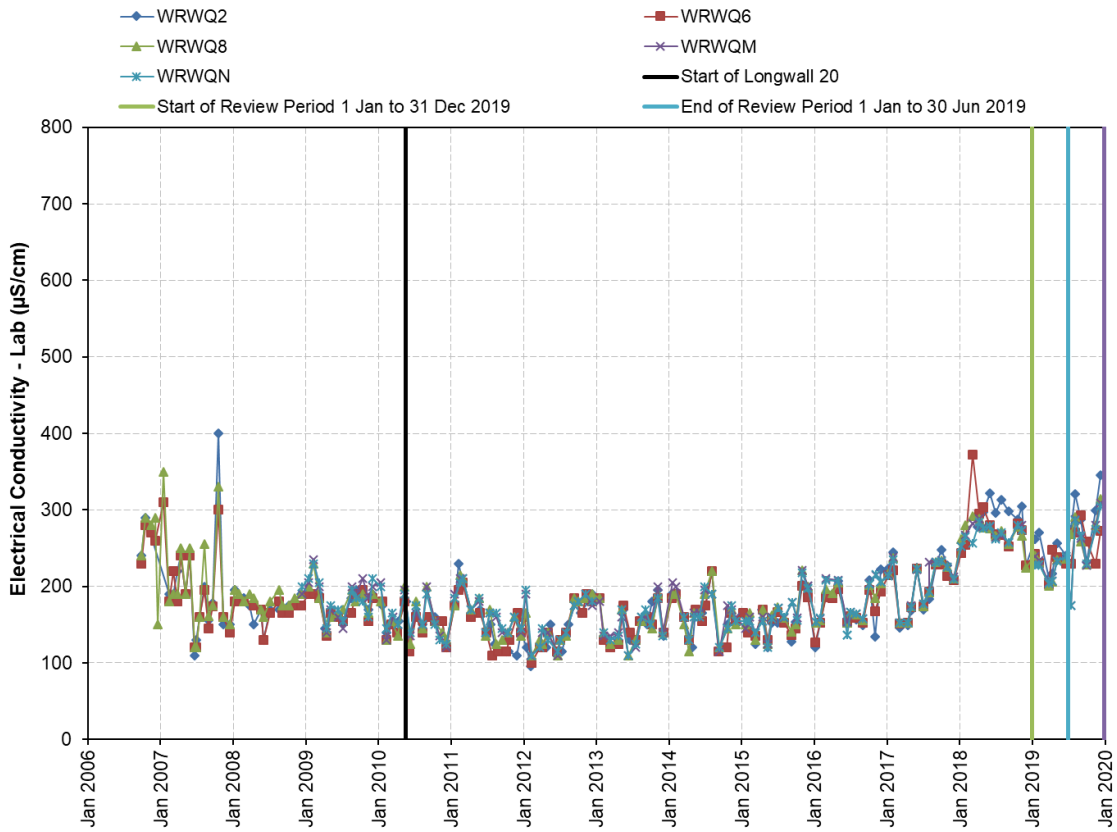

Chart B3 Electrical Conductivity (EC) Waratah Rivulet – Upper to Middle Reach Sites[18]

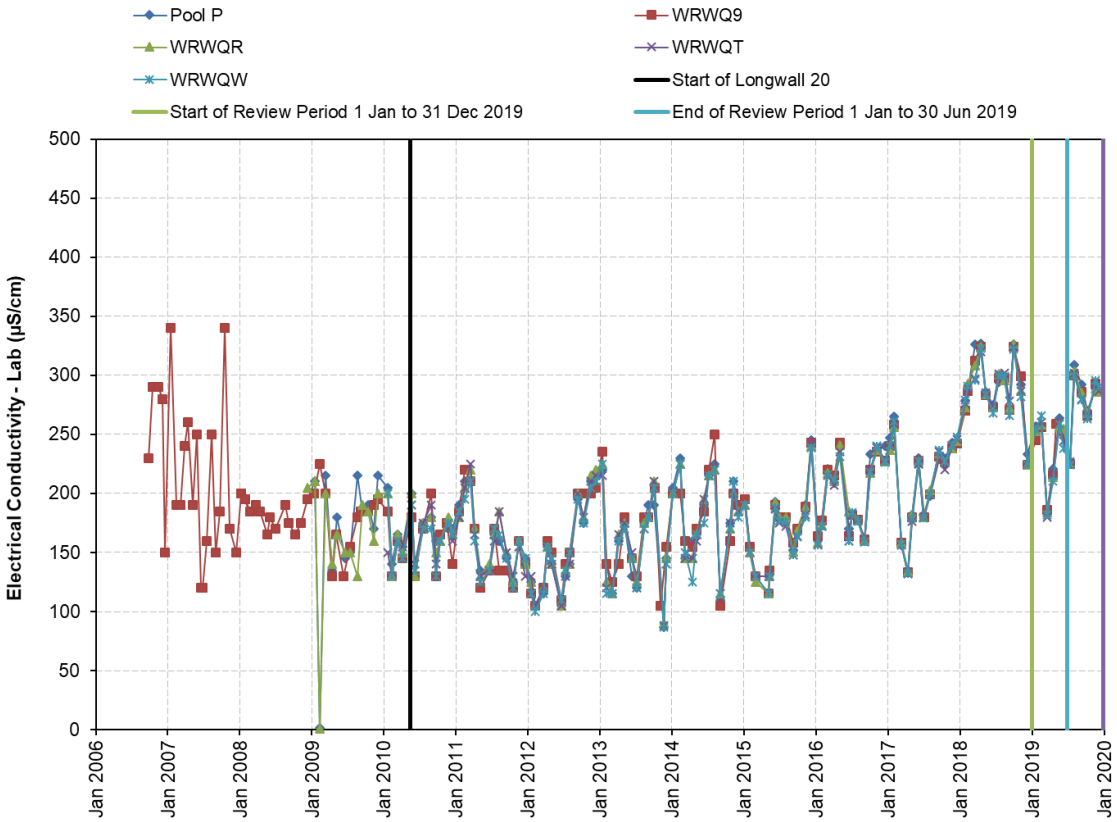

Chart B4 Electrical Conductivity (EC) Waratah Rivulet – Lower Reach Sites[17]

[18] The water quality meter was calibrated to a much lower temperature of water than that recorded in the Waratah Rivulet during the review period and, as such, the field recorded electrical conductivity values were found to be inaccurate. Consequently, the laboratory values for electrical conductivity have been presented for this review period rather than field recorded electrical conductivity values.

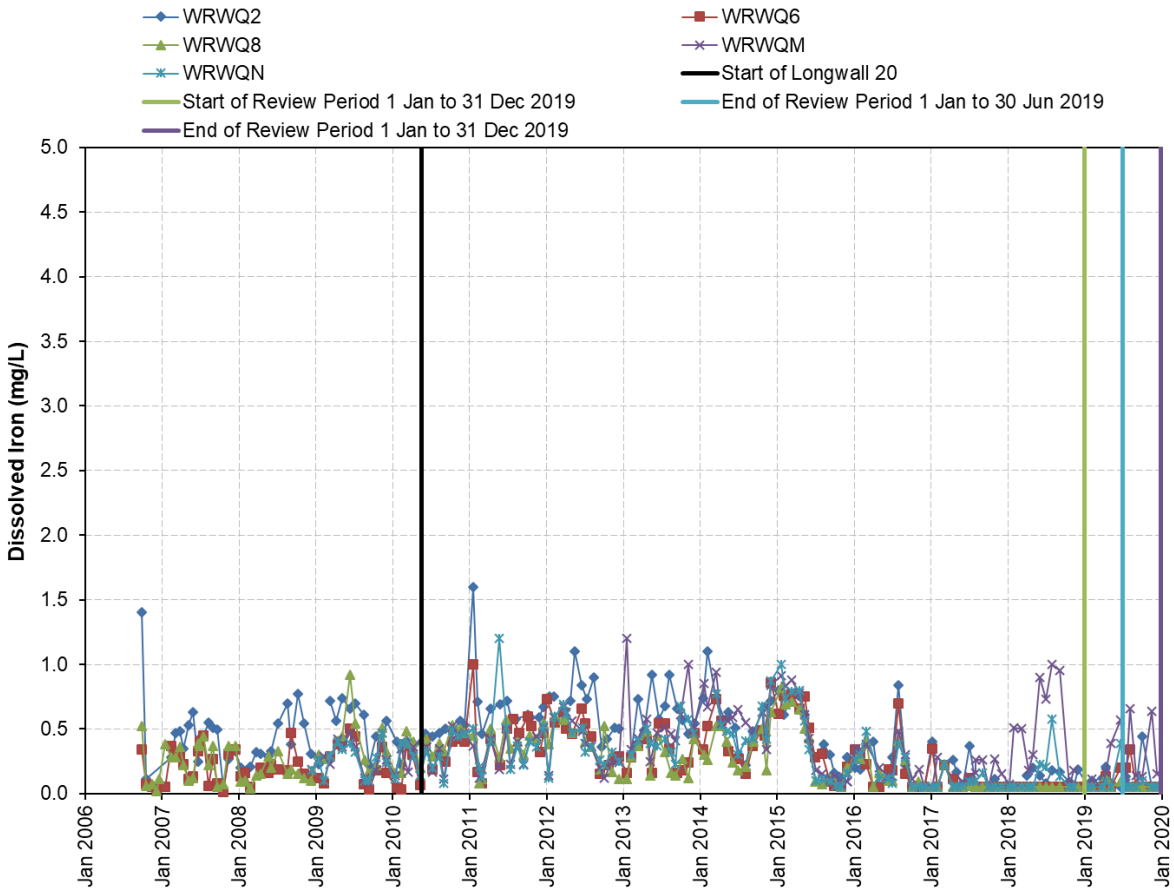

Chart B5 Dissolved Iron Waratah Rivulet – Upper and Middle Reach Sites

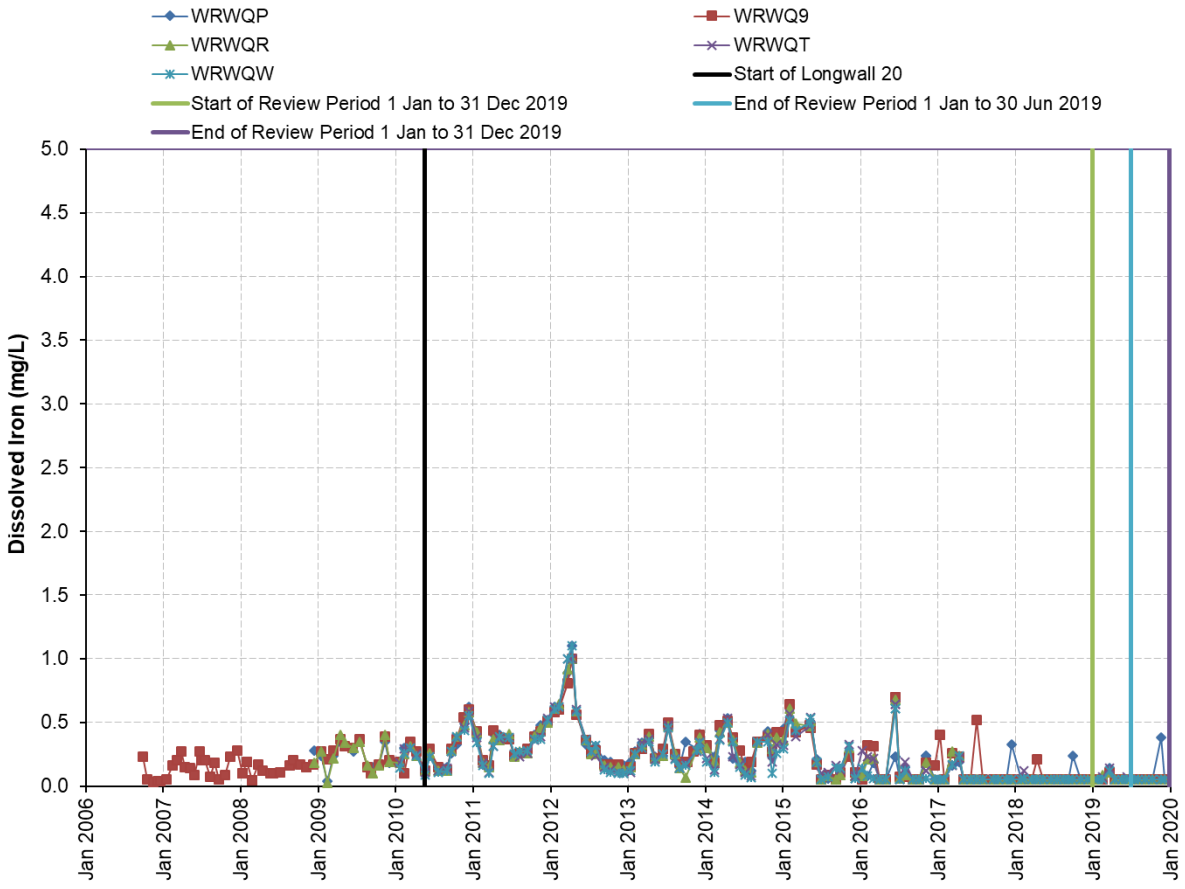

Chart B6 Dissolved Iron Waratah Rivulet – Lower Reach Sites

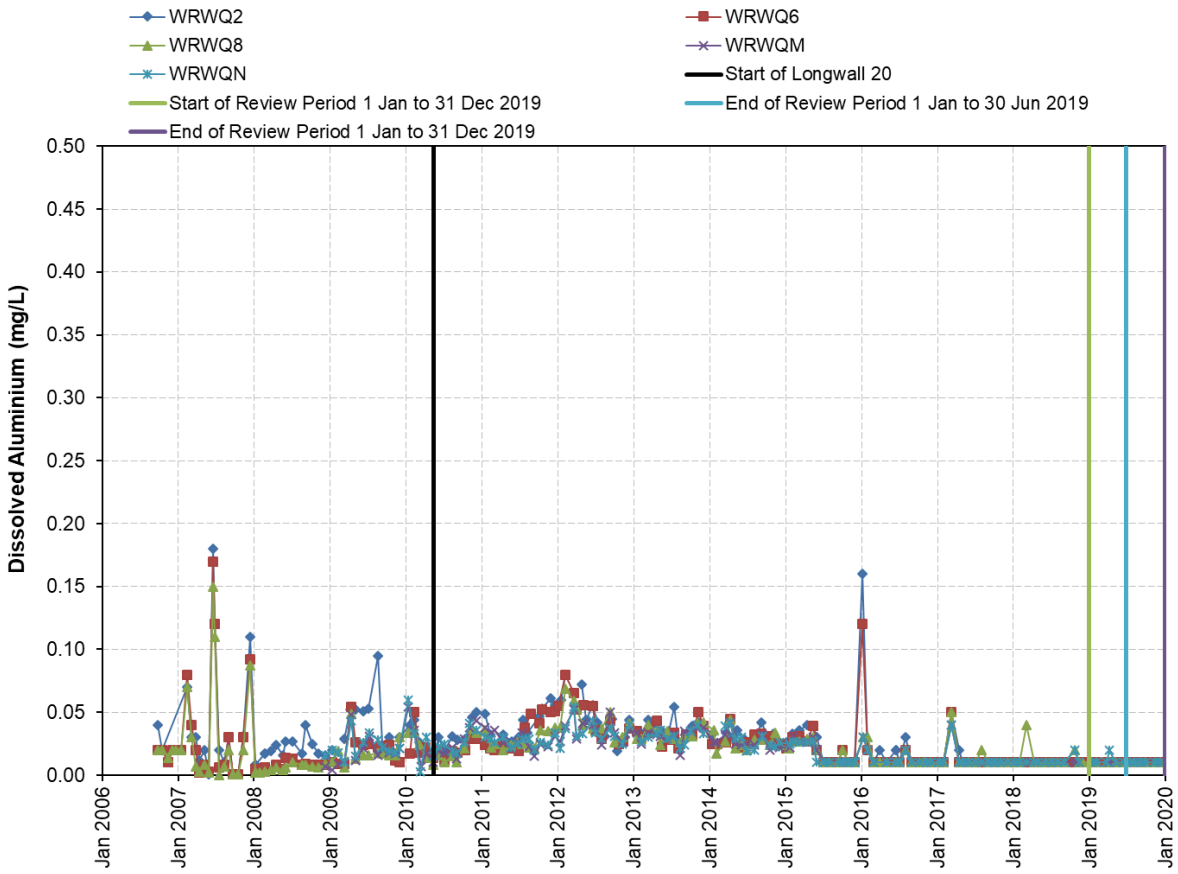

Chart B7 Dissolved Aluminium Waratah Rivulet – Upper to Middle Reach Sites

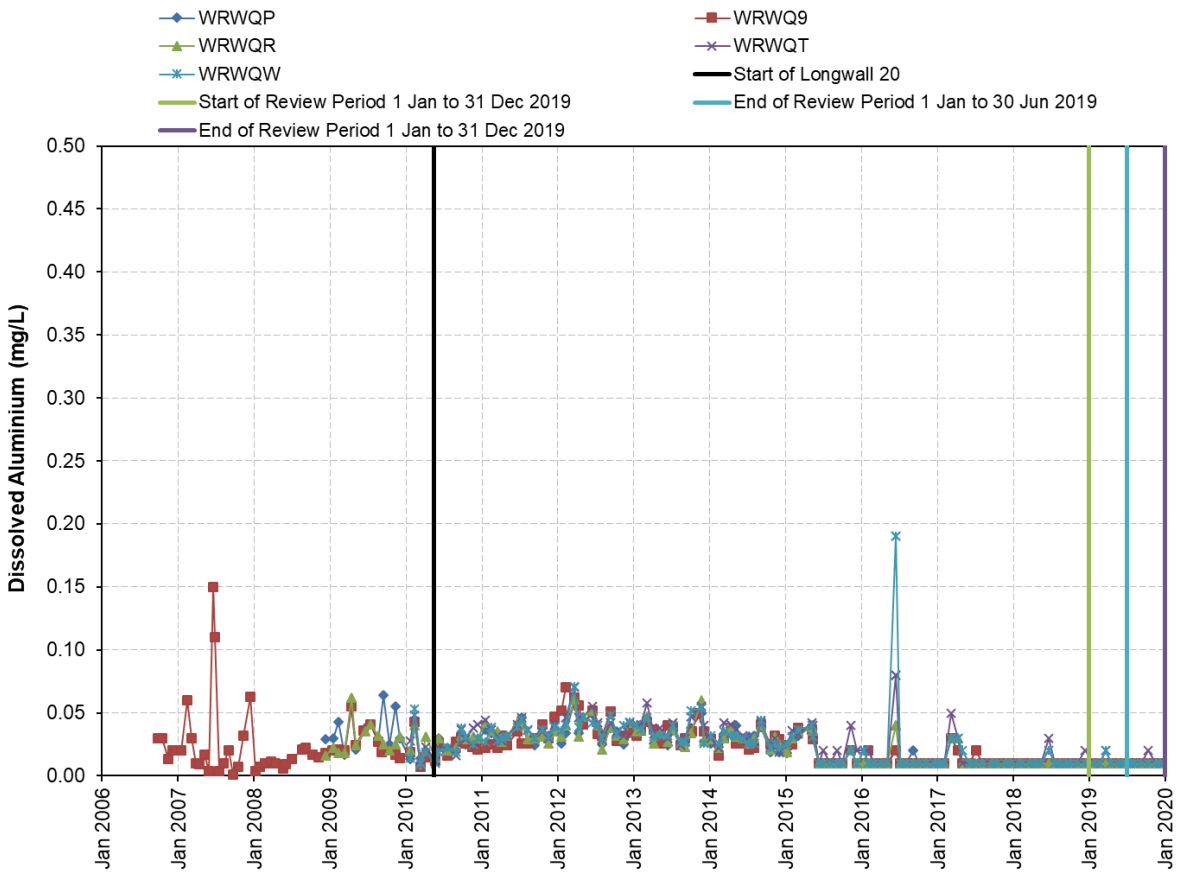

Chart B8 Dissolved Aluminium Waratah Rivulet – Lower Reach Sites

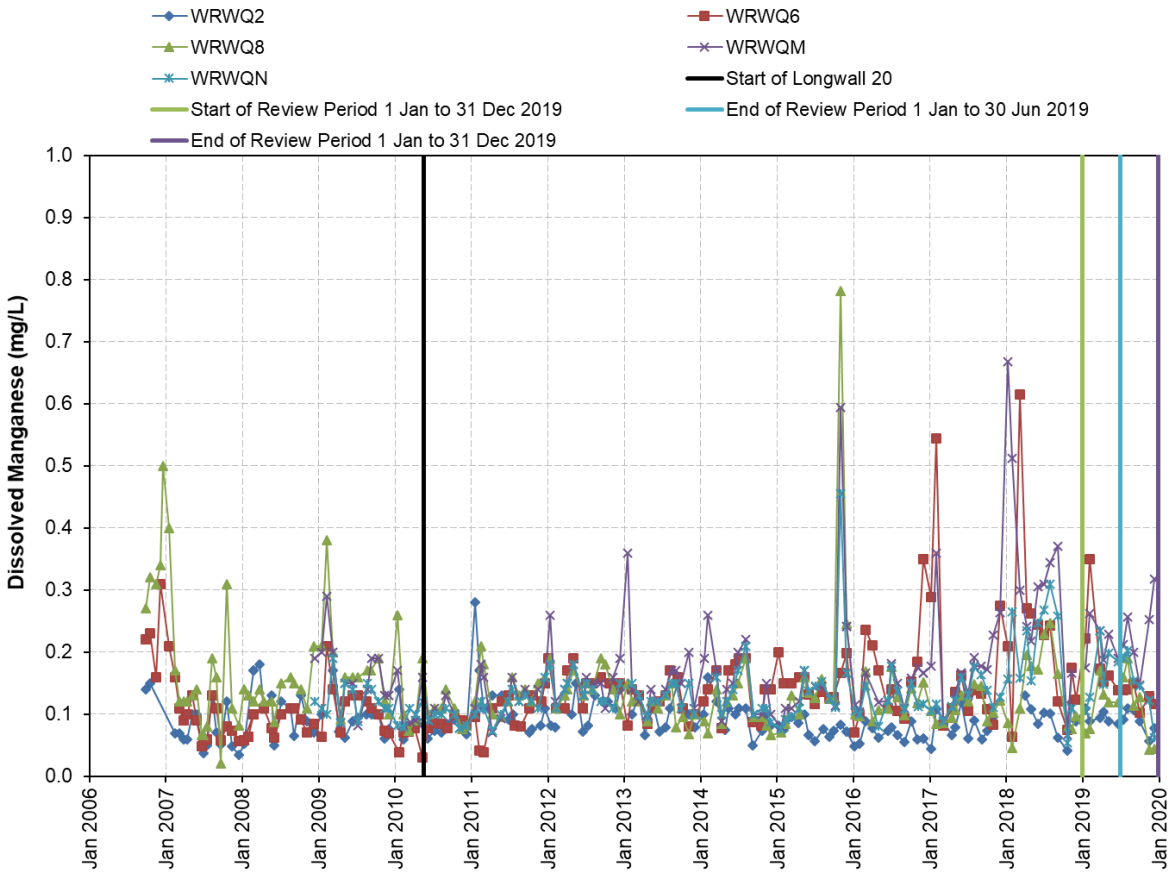

Chart B9 Dissolved Manganese Waratah Rivulet – Upper to Middle Reach Sites

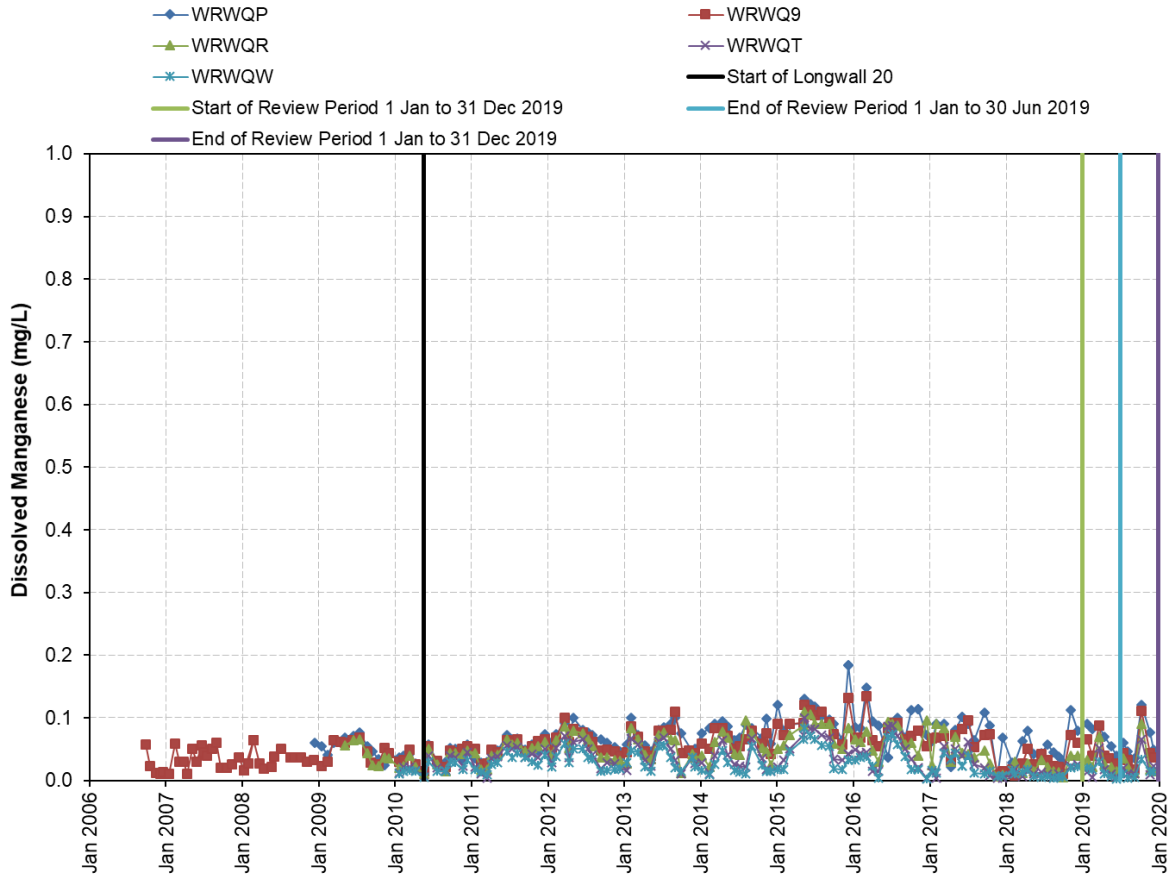

Chart B10 Dissolved Manganese Waratah Rivulet – Lower Reach Sites

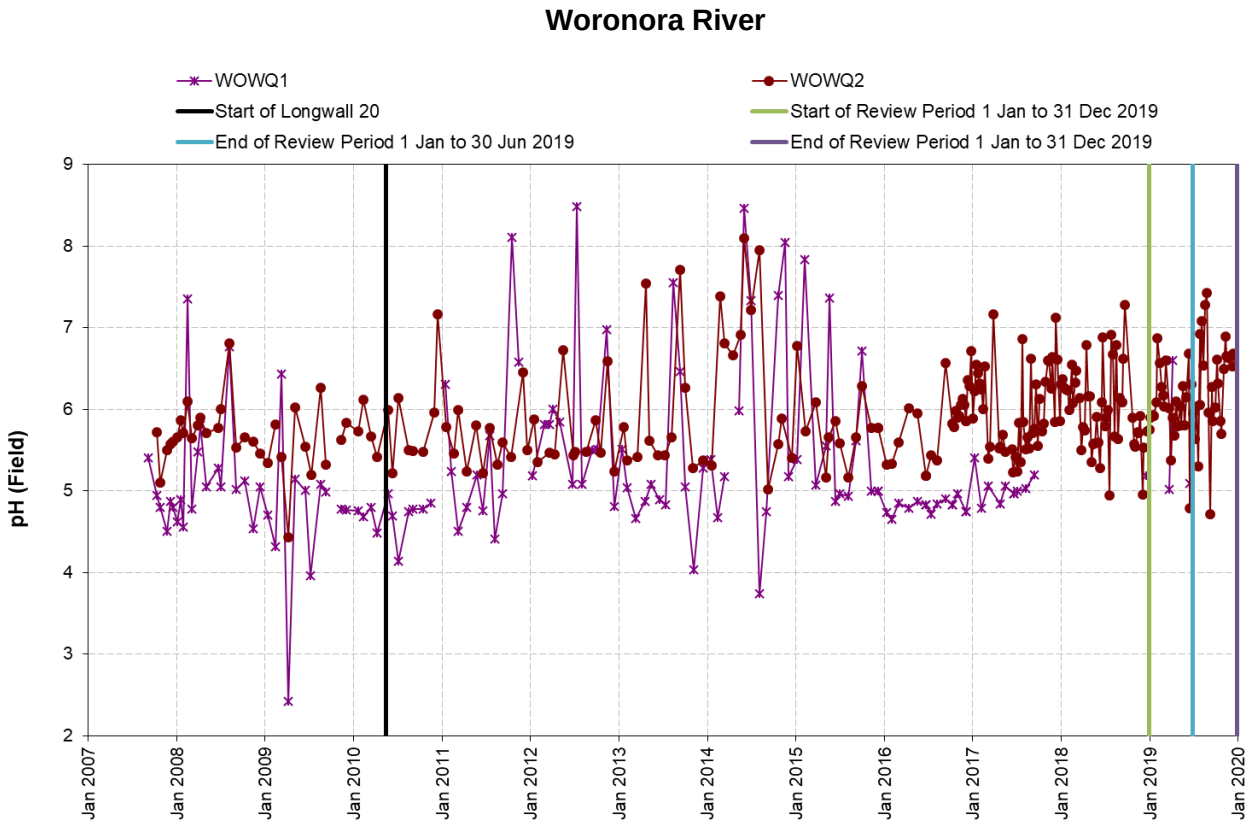

Chart B11 pH Levels Woronora River[19]

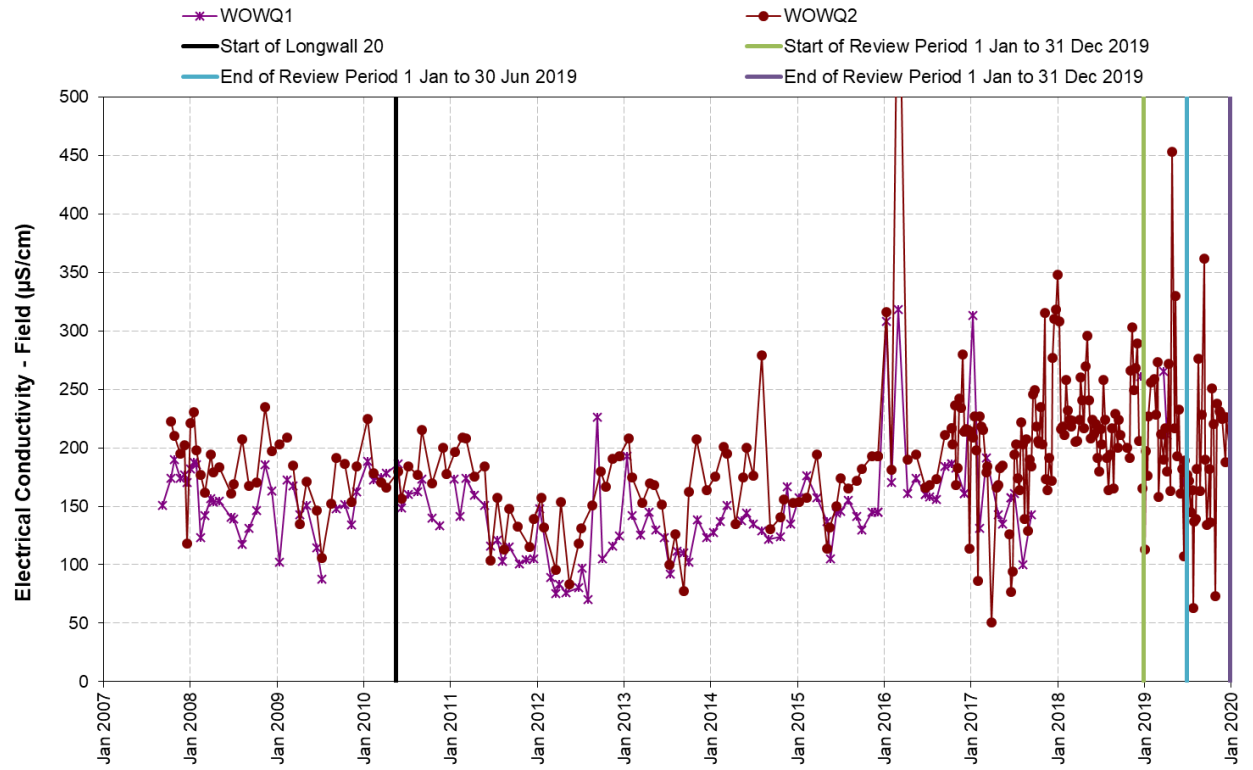

Chart B12 Electrical Conductivity (EC) Woronora River

[19] WOWQ1 was dry between 23 October 2017 and 20 December 2018, in May 2019 and between 3 July 2019 and 12 December 2019 and hence no water quality samples were collected.

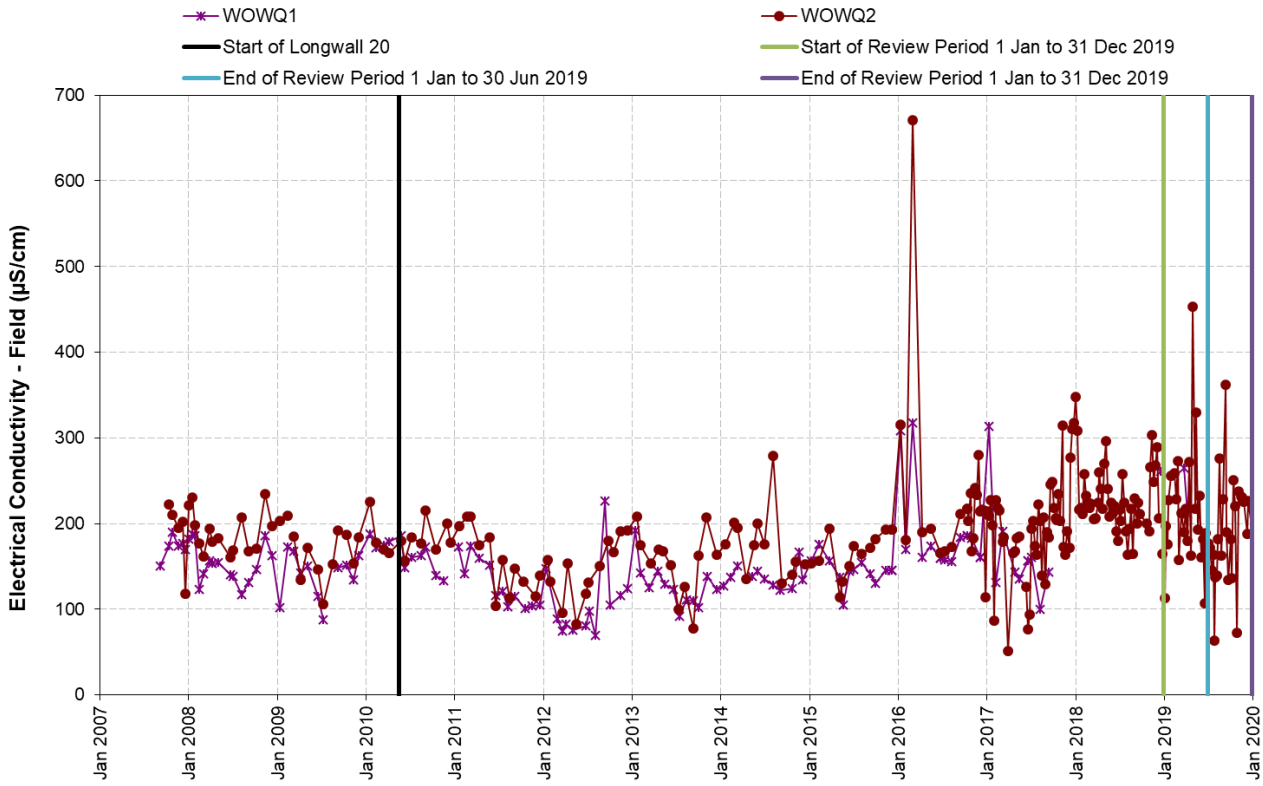

Chart B12a Electrical Conductivity (EC) Woronora River

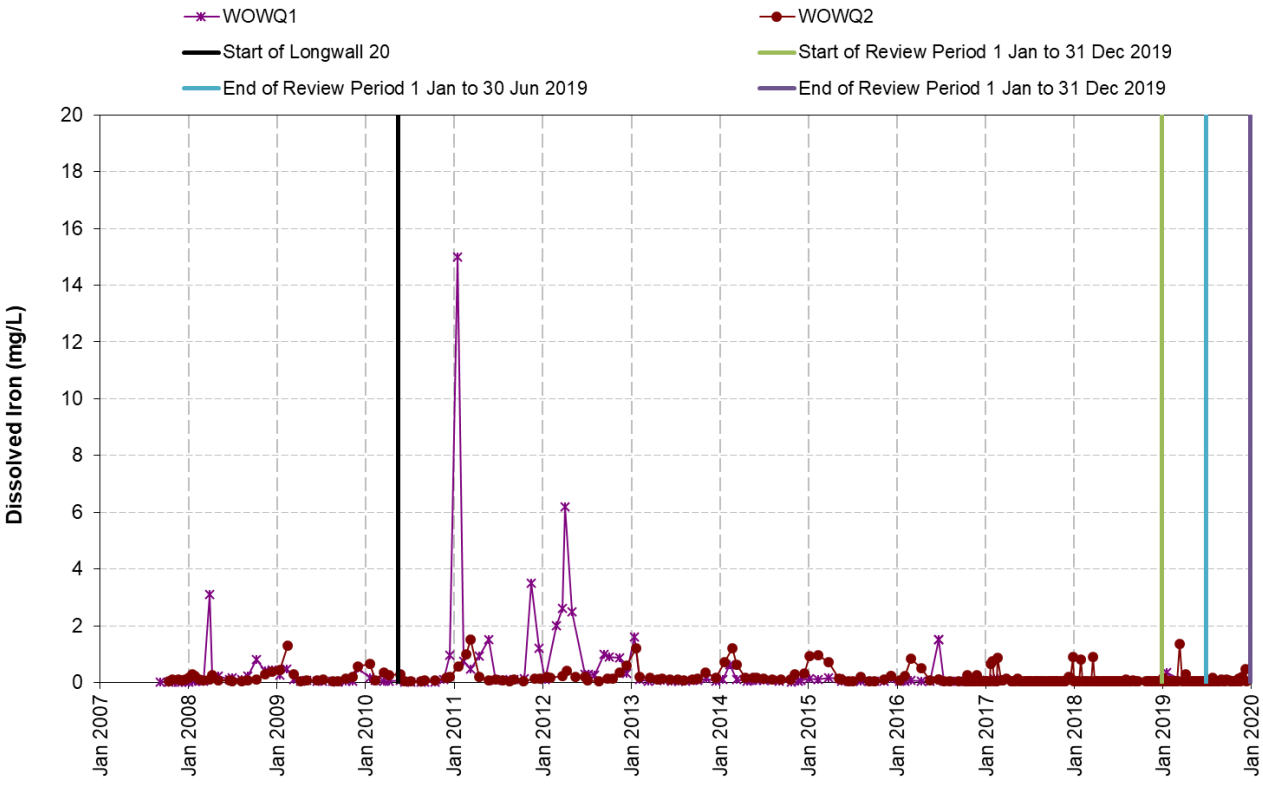

Chart B13 Dissolved Iron Woronora River

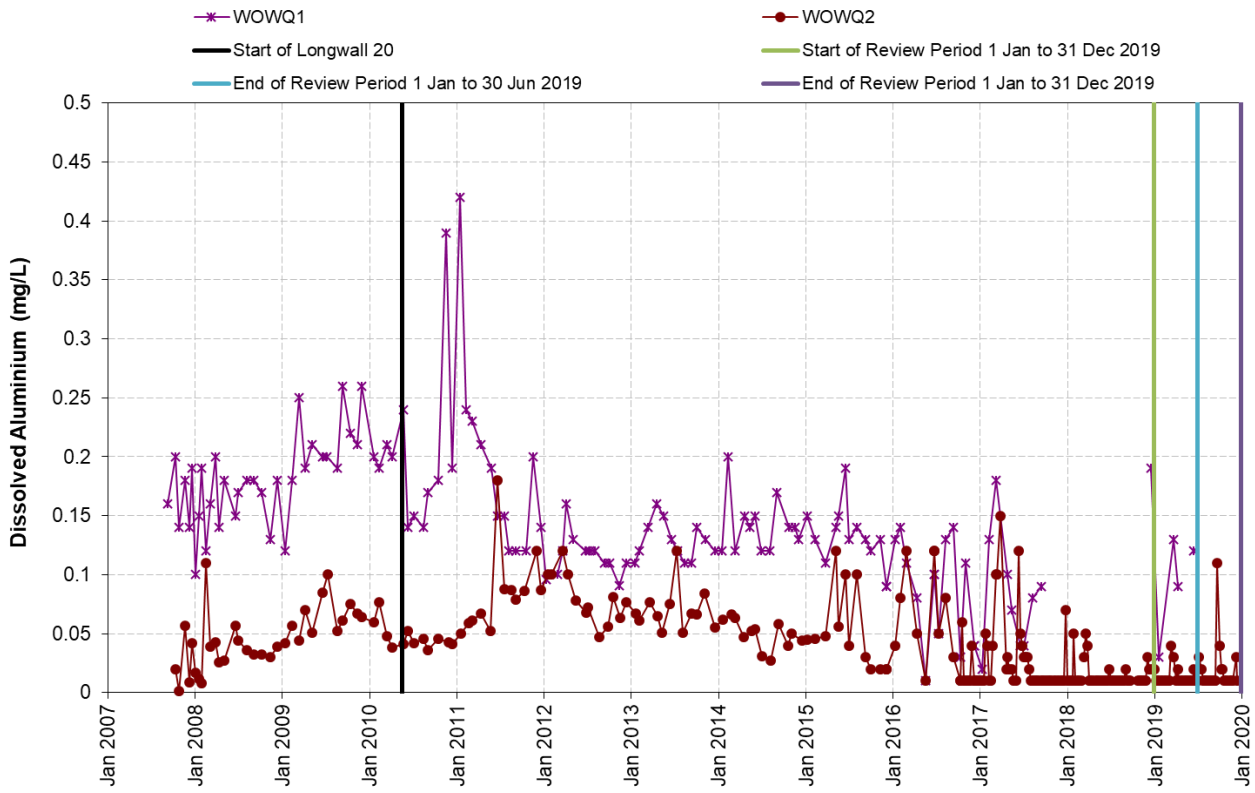

Chart B14 Dissolved Aluminium Woronora River

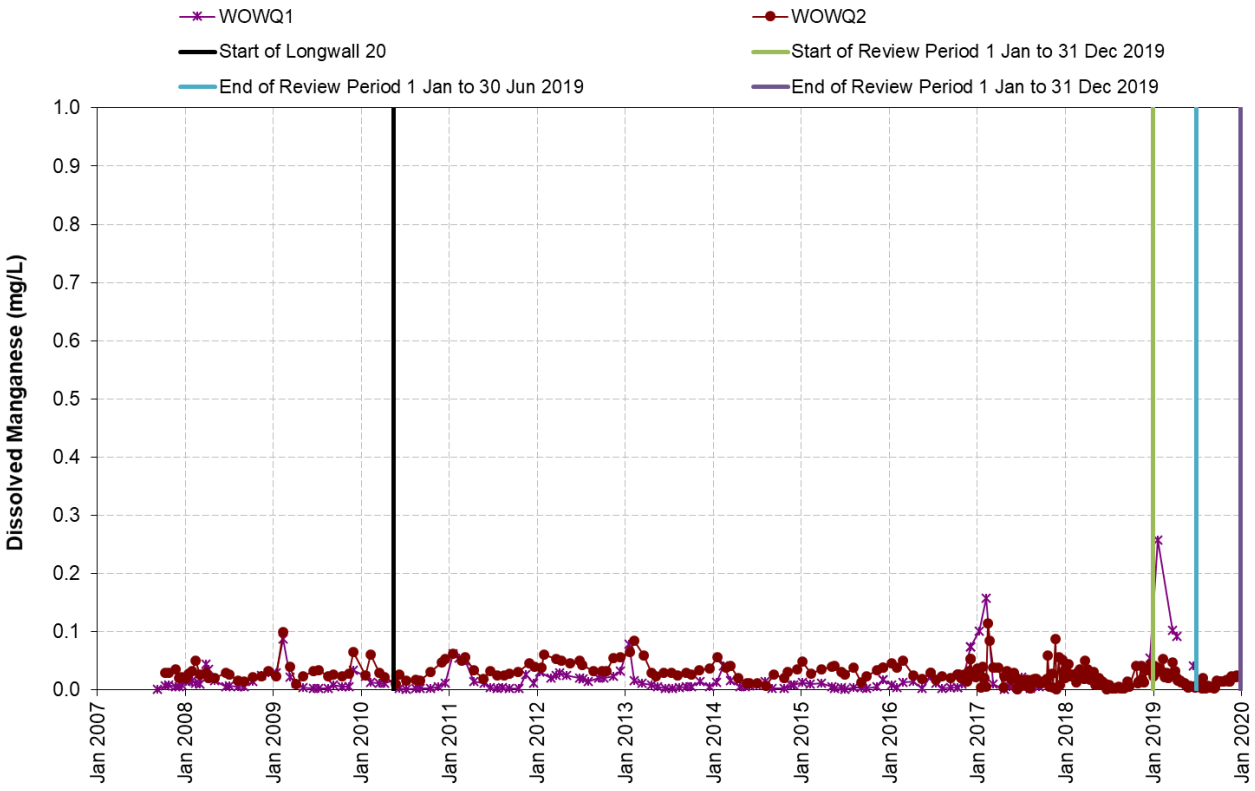

Chart B15 Dissolved Manganese Woronora River

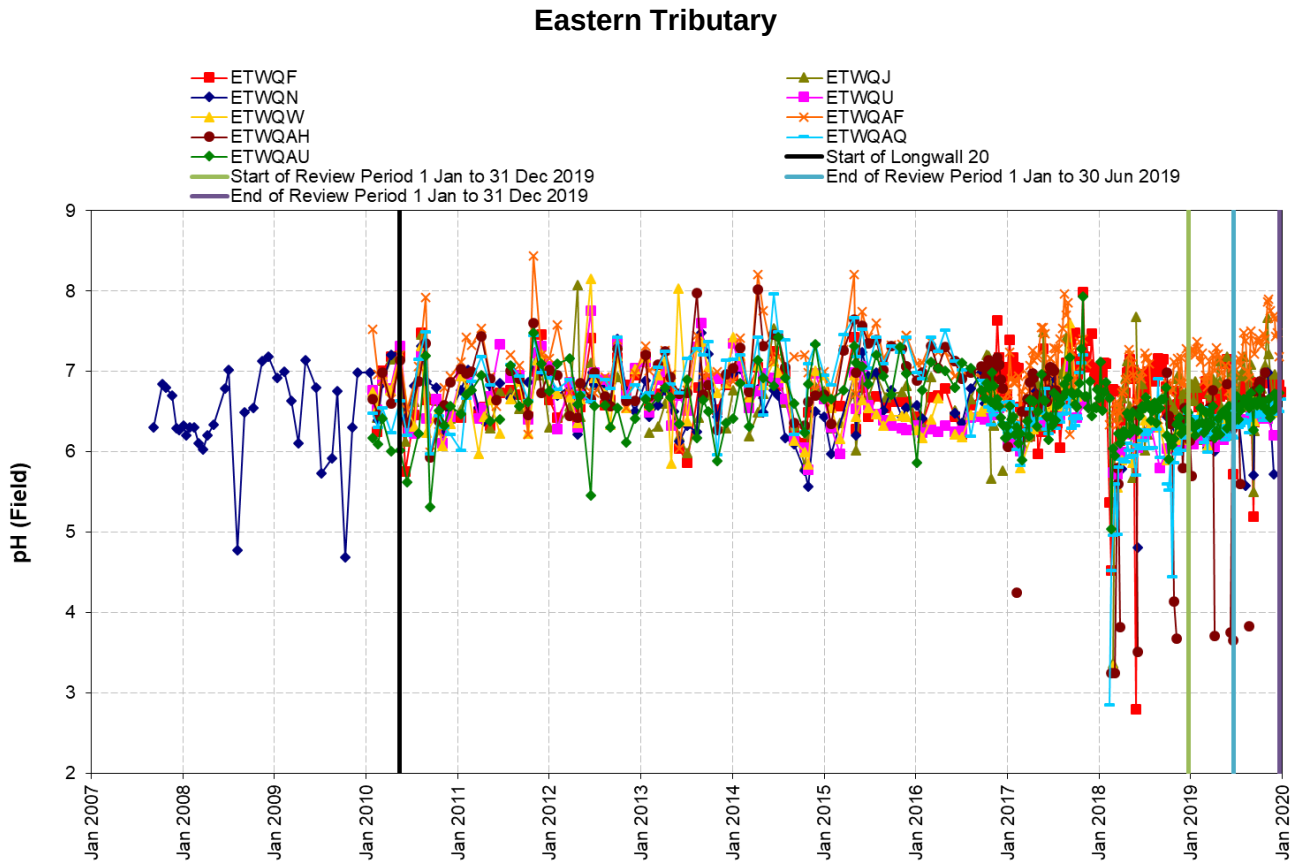

Chart B16 pH Levels Eastern Tributary

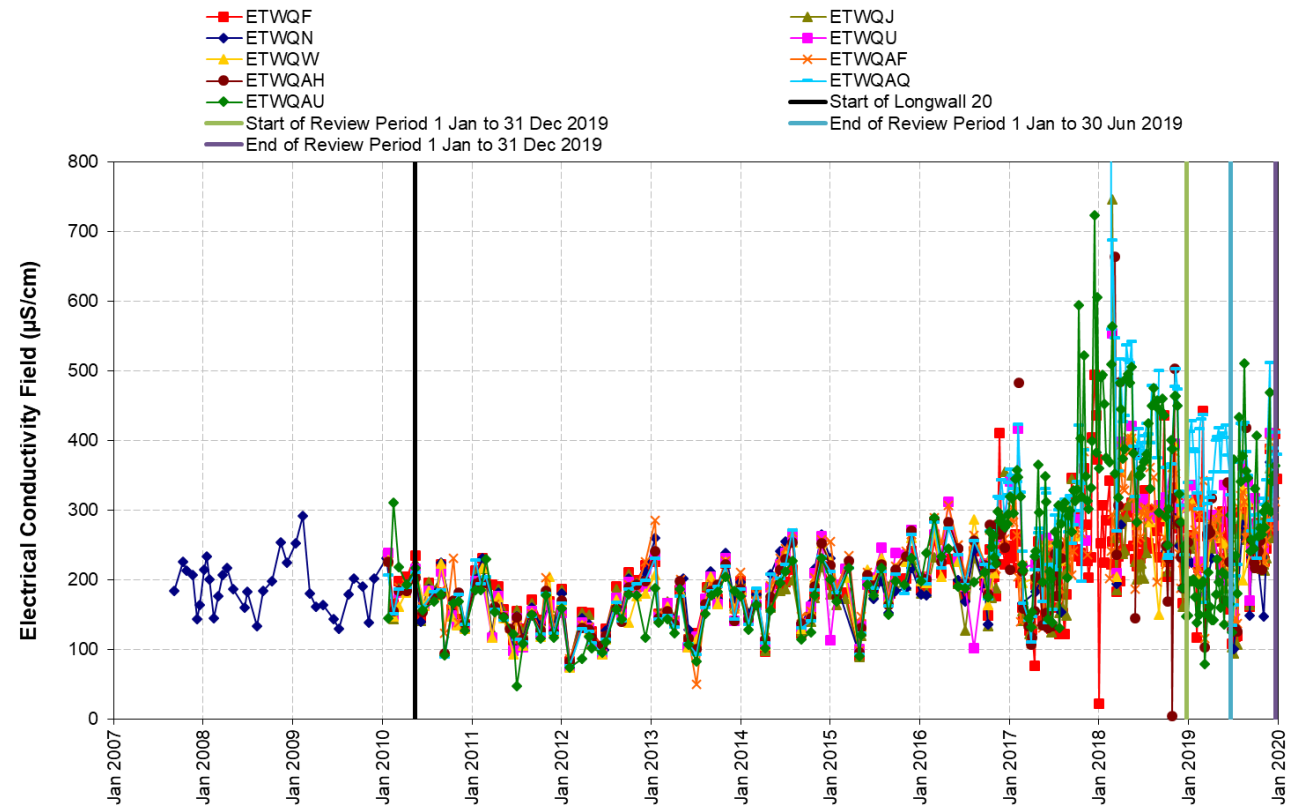

Chart B17 Electrical Conductivity (EC) Eastern Tributary

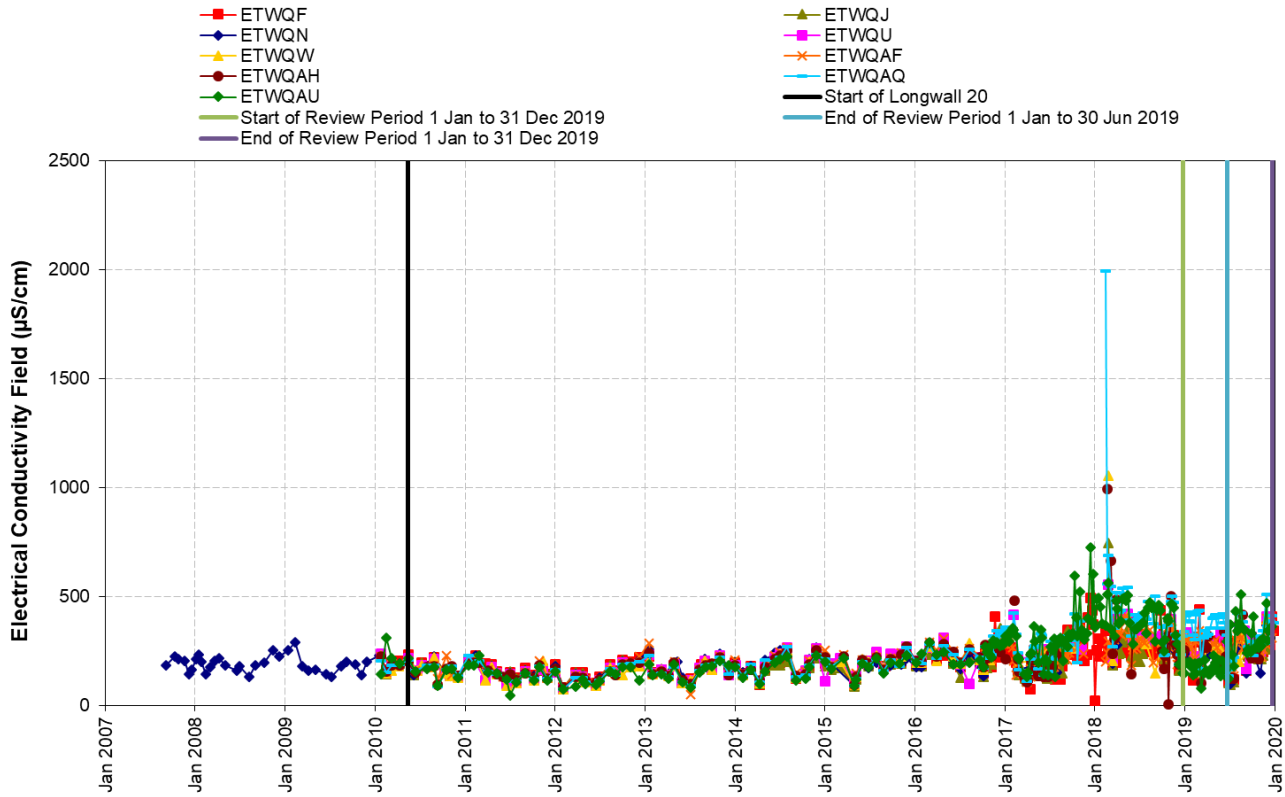

Chart B17a Electrical Conductivity (EC) Eastern Tributary

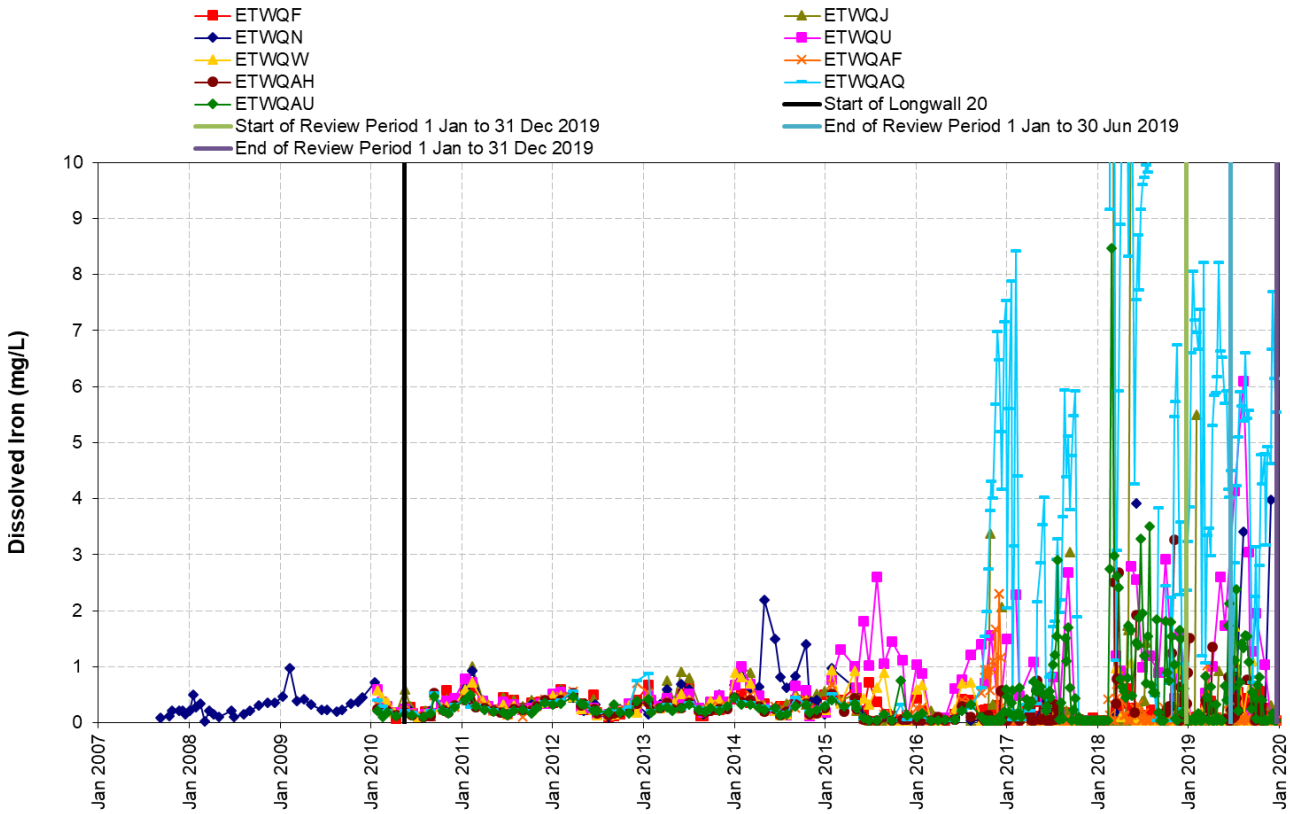

Chart B18 Dissolved Iron Eastern Tributary

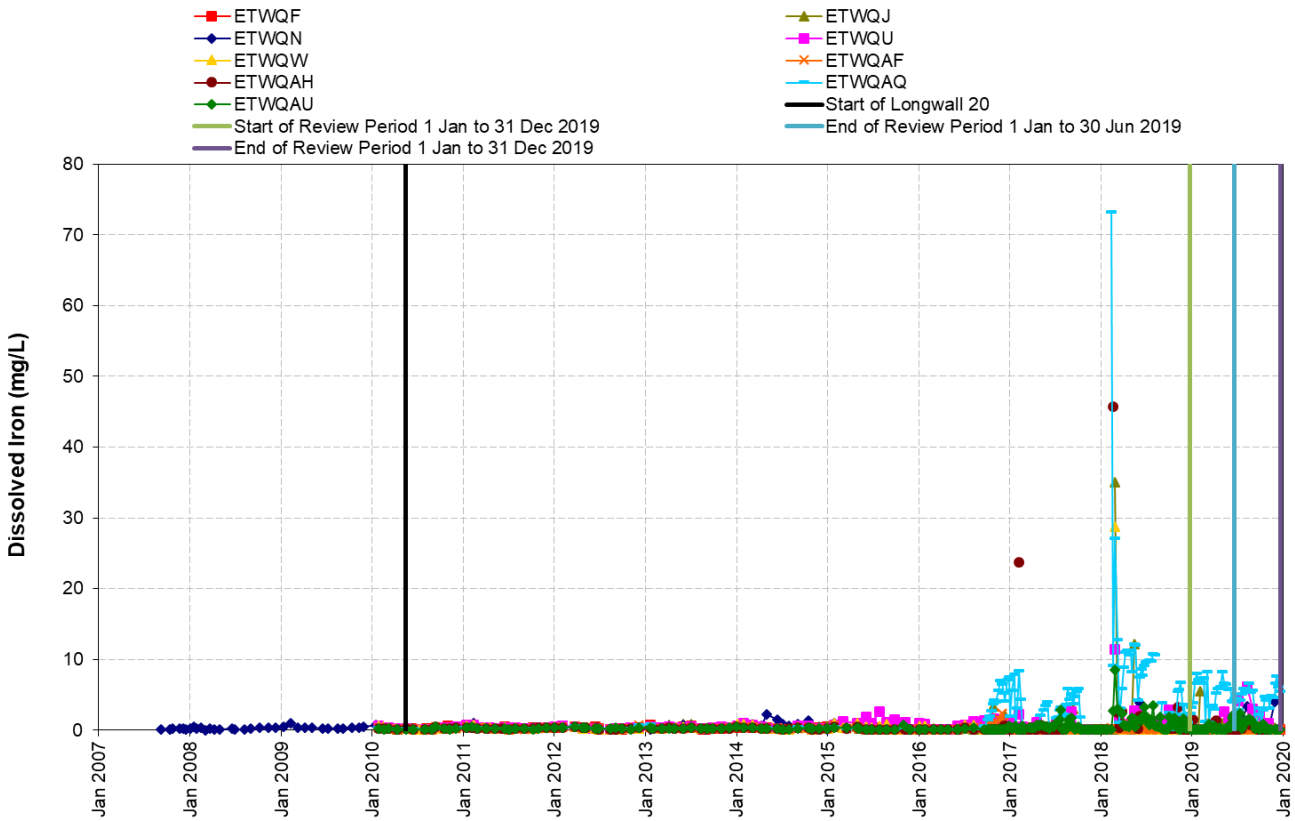

Chart B18a Dissolved Iron Eastern Tributary

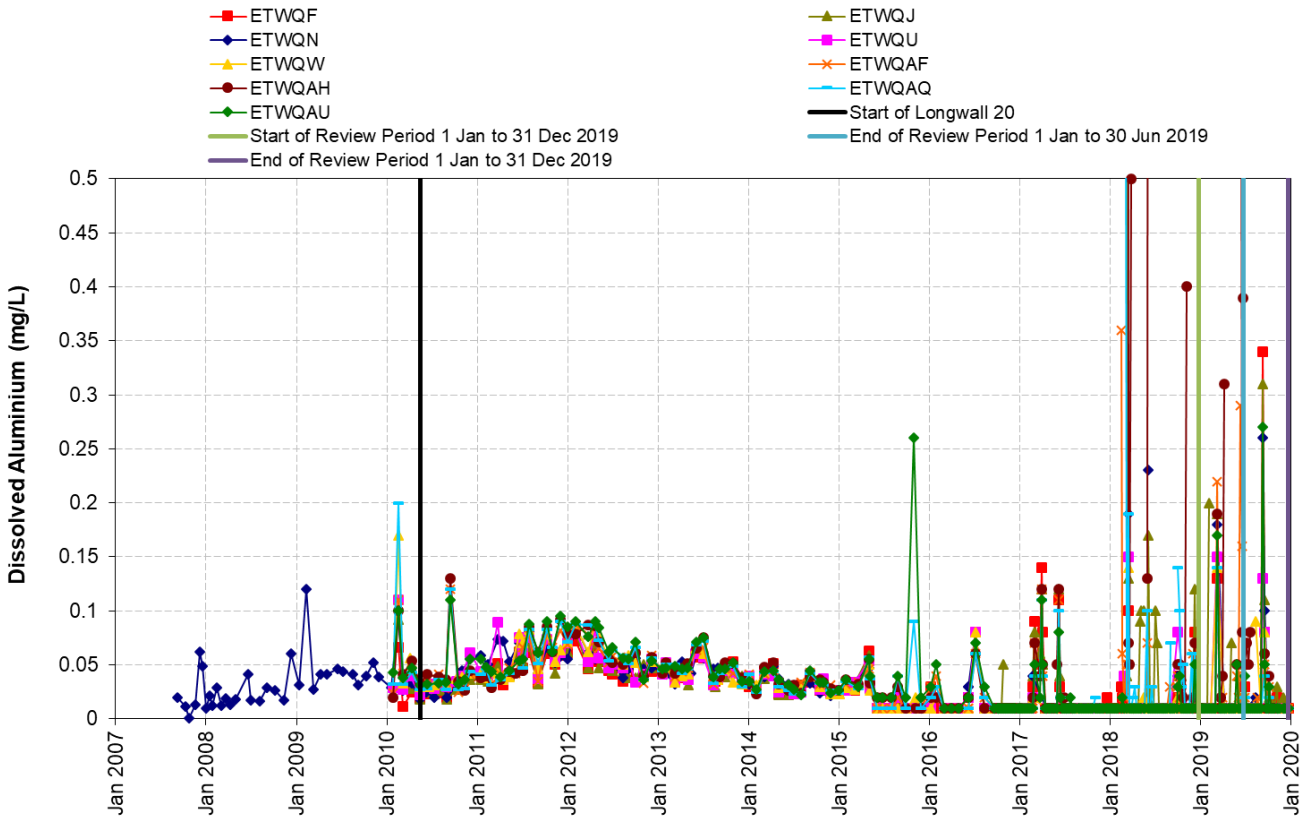

Chart B19 Dissolved Aluminium Eastern Tributary

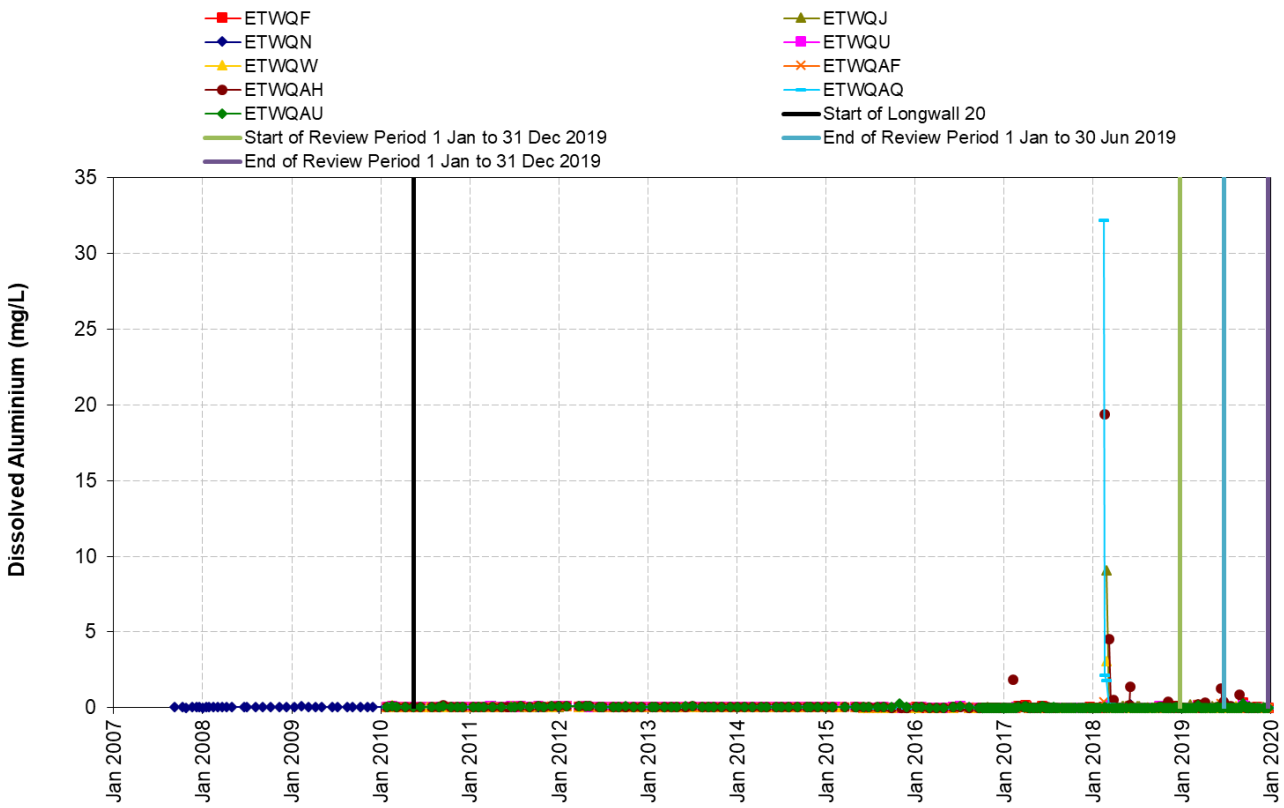

Chart B19a Dissolved Aluminium Eastern Tributary

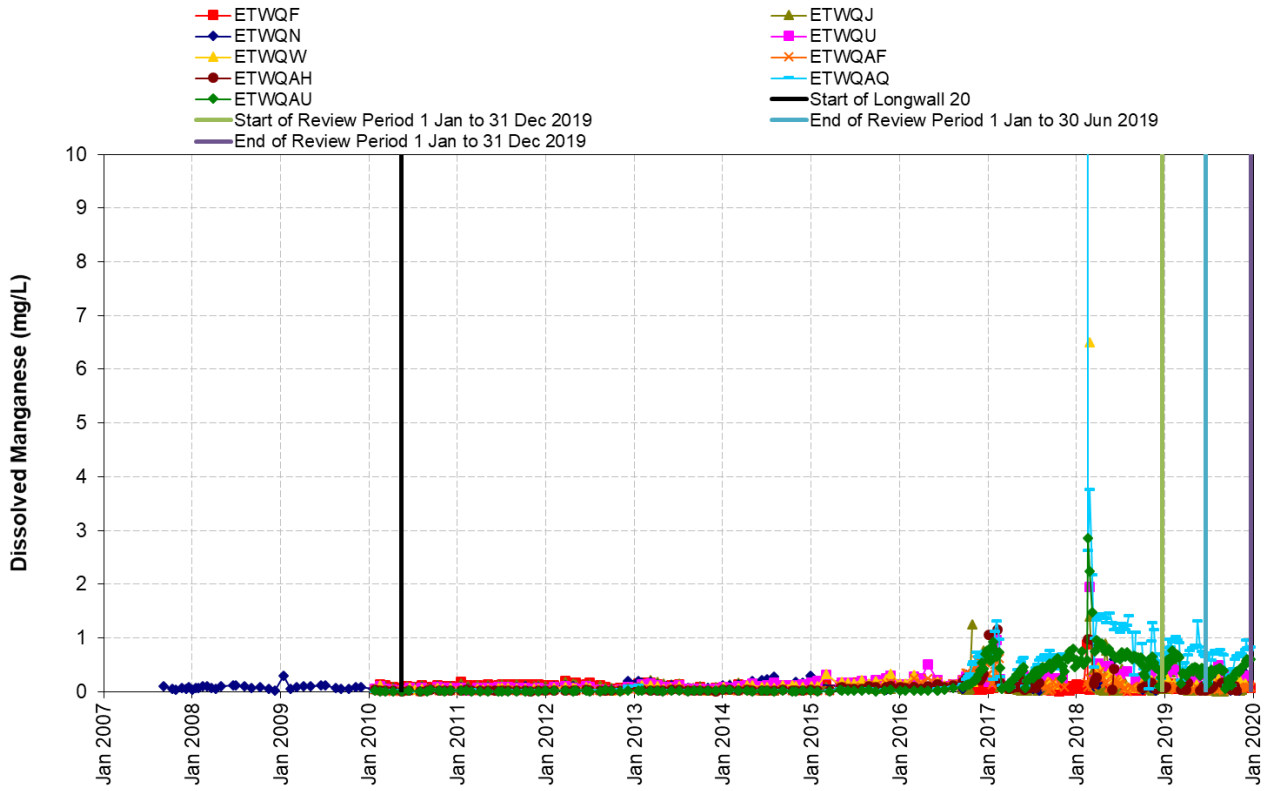

Chart B20 Dissolved Manganese Eastern Tributary

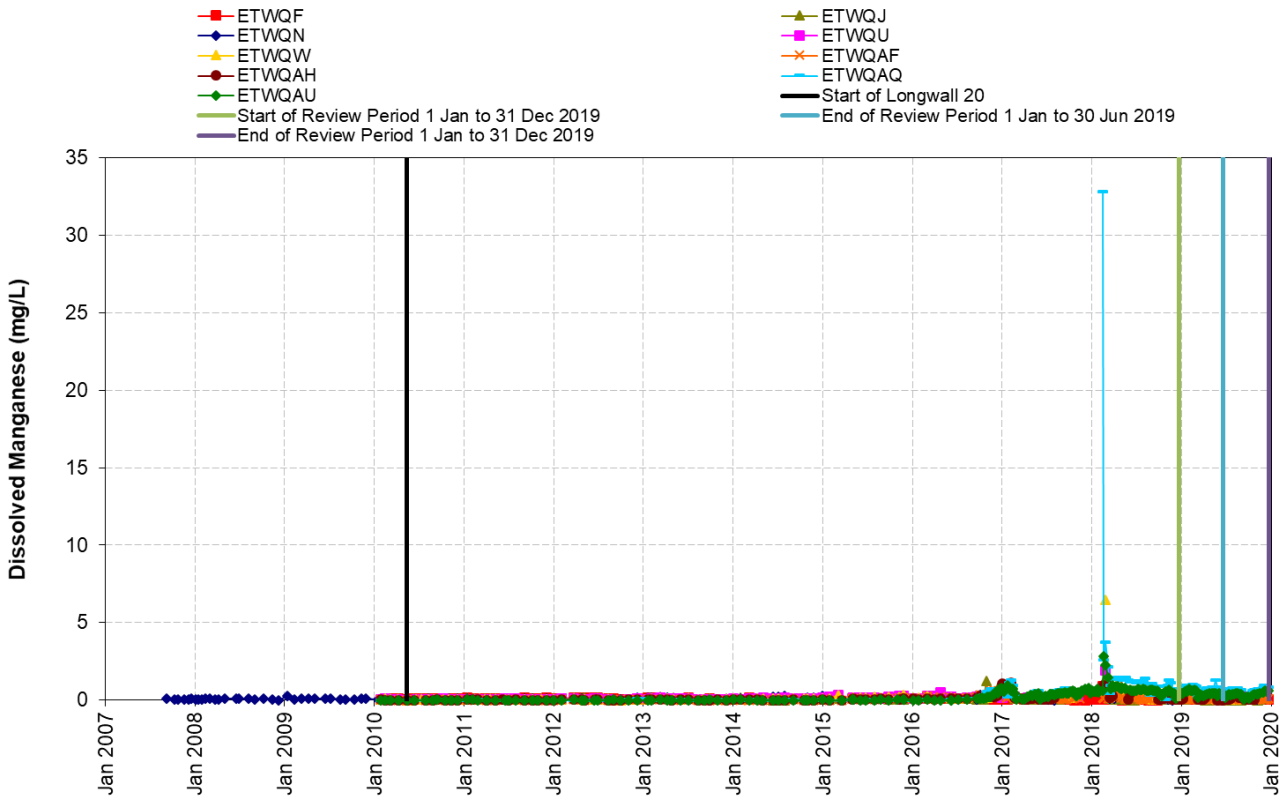

Chart B20a Dissolved Manganese Eastern Tributary

Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

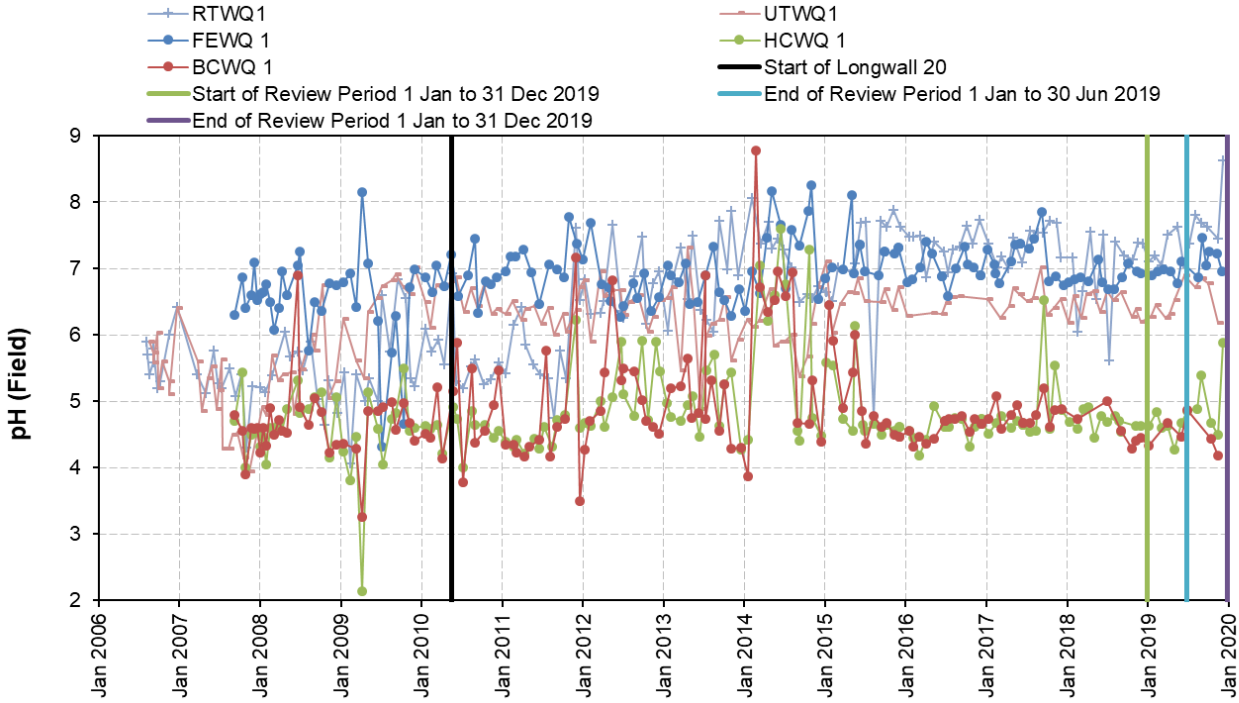

Chart B21 pH Levels Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

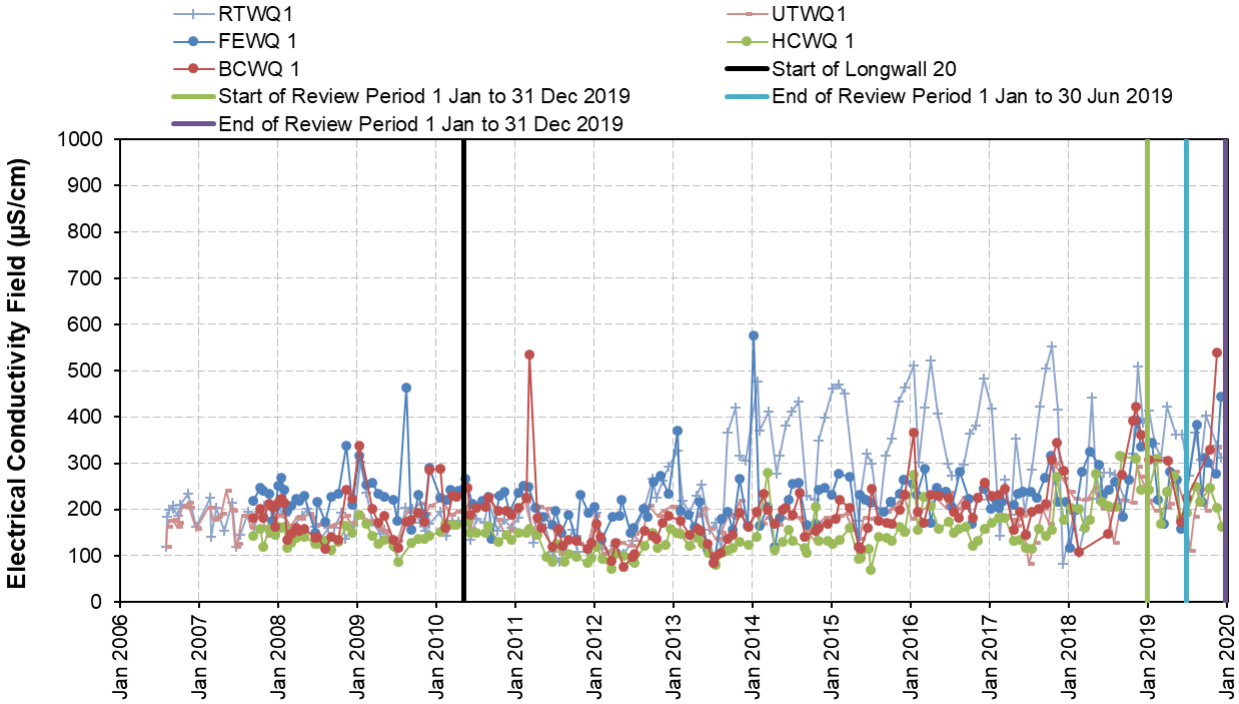

Chart B22 Electrical Conductivity (EC) Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

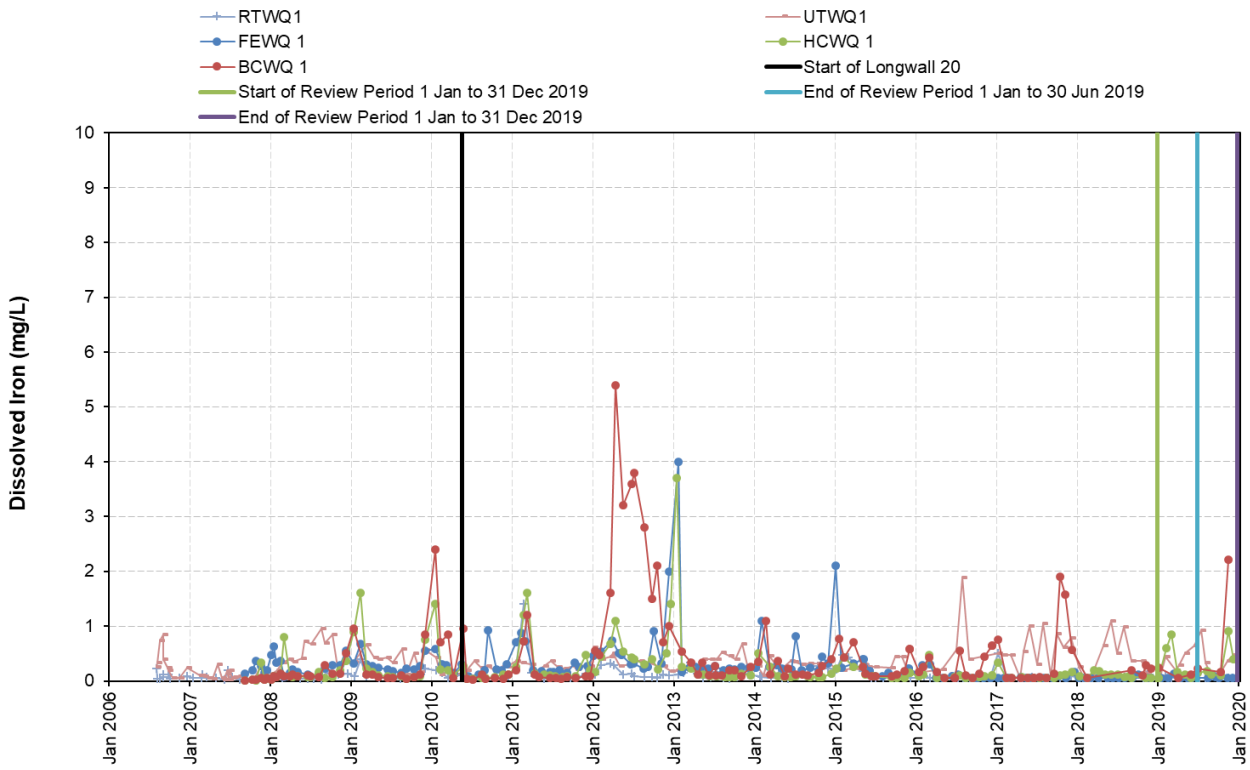

Chart B23 Dissolved Iron Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

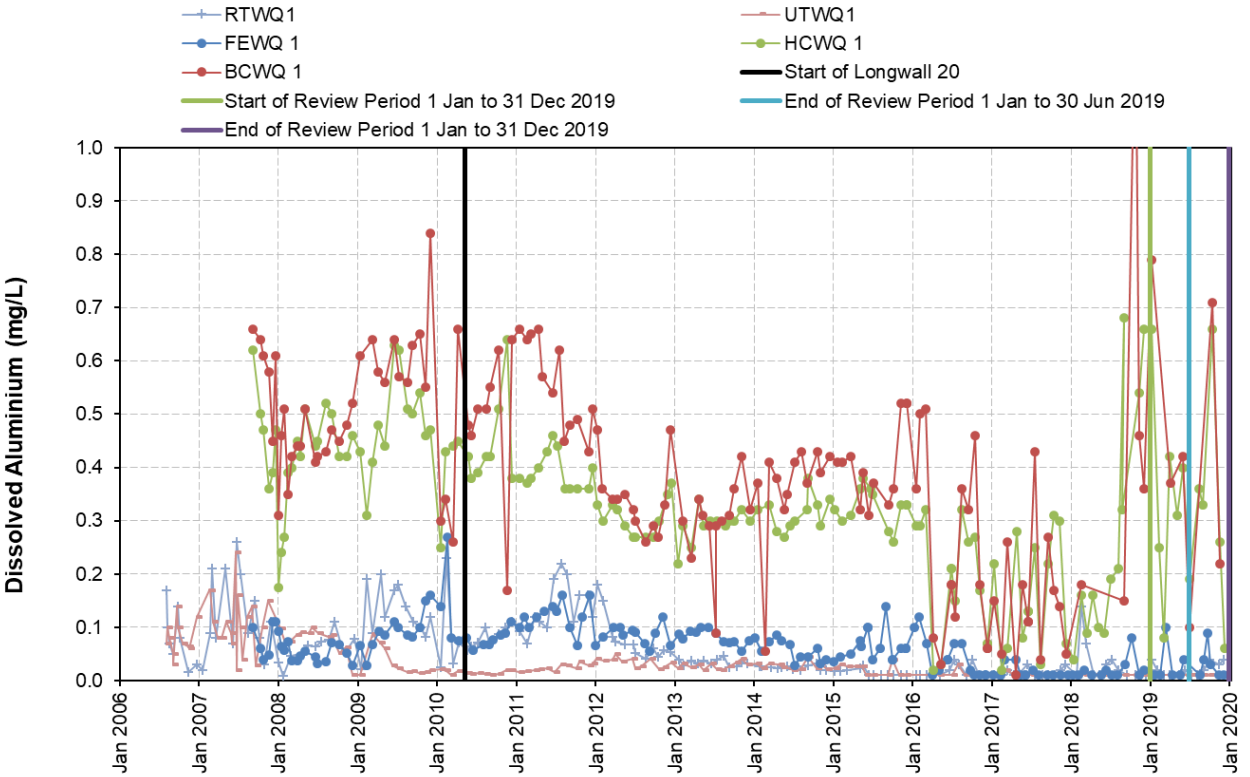

Chart B24 Dissolved Aluminium Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

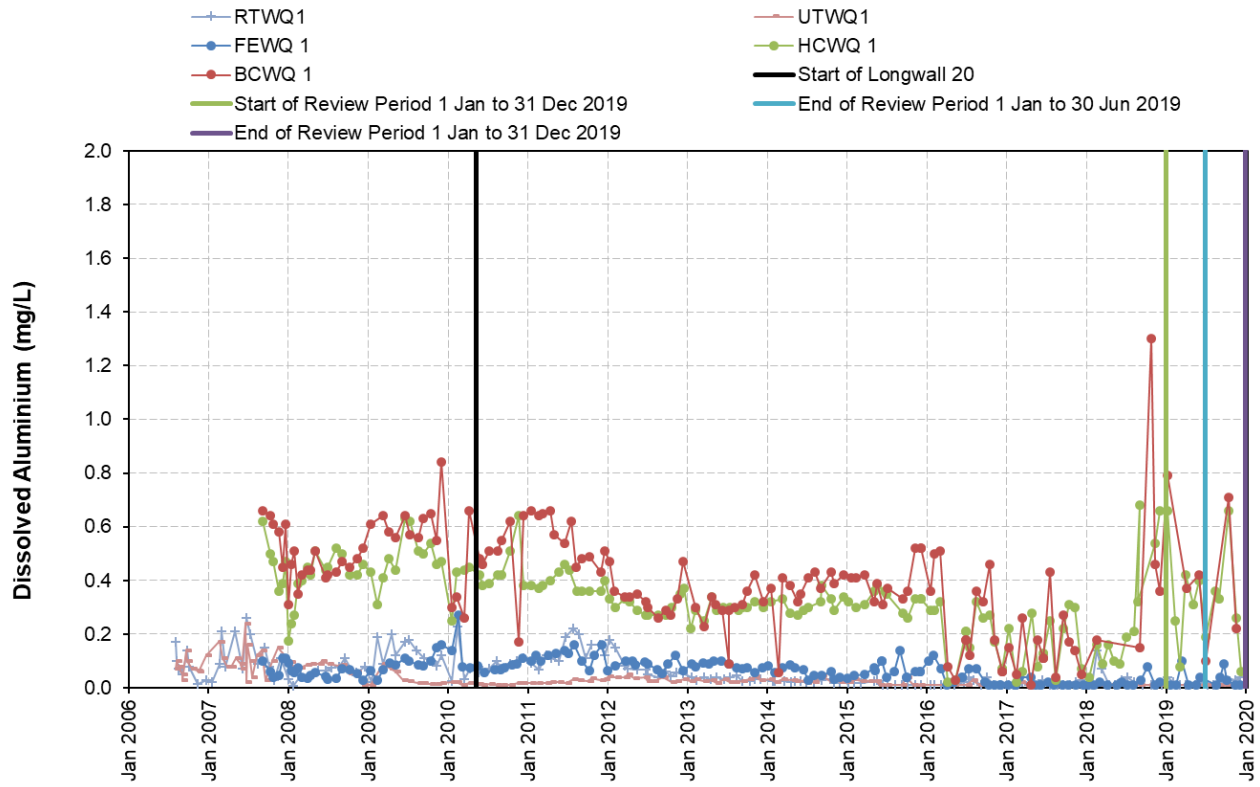

Chart B24a Dissolved Aluminium Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek

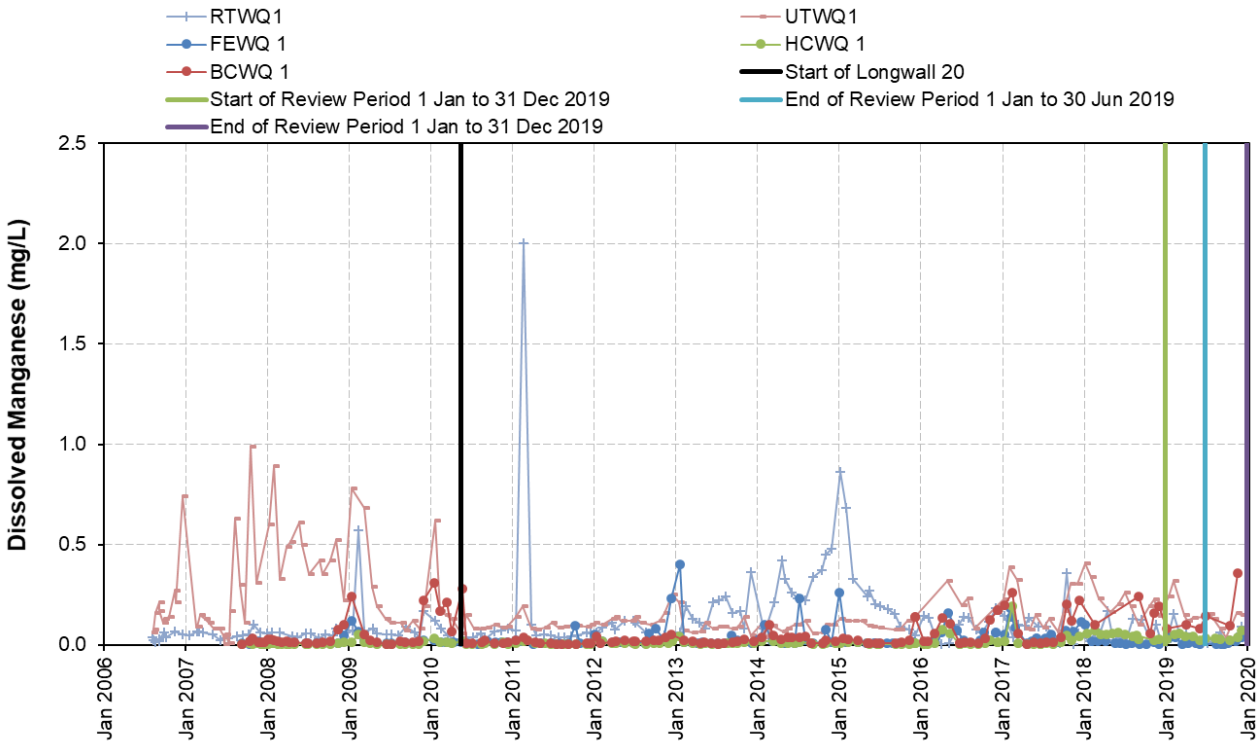

Chart B25 Dissolved Manganese Tributary B, Tributary D, Far Eastern Tributary, Bee Creek and Honeysuckle Creek