

Temperate Highland Peat Swamps on Sandstone Monitoring and Management Plan LW 415 to 417

Annual Report

Springvale Mine

March 2019

TABLE OF CONTENTS

1. INTRODUCTION

Springvale Coal Pty Ltd (Springvale) is an underground longwall mine located 12km north west of Lithgow in NSW and 3 km south of the Centennial Angus Place Mine. The mine is a joint venture owned in equal share by Centennial Springvale Pty Ltd (a wholly owned subsidiary of Banpu Minerals Ltd) and Springvale SK Kores Pty Limited.

EPBC Approval 2011/5949 was issued to Springvale by the Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) on the 14th of March 2012. EPBC 2011/5949 is related to a controlled action area of the Springvale mine for mining of longwall panels (LW) 415 – 417 as shown in Figure 1.

On the 21st of October 2013 Springvale received approval from SEWPAC for the Temperate Highland Peat Swamps on Sandstone Monitoring and Management Plan (THPSS MMP) for Longwalls 415 to 417, as required under Condition 7 of the EPBC approval.

This Annual Report has been prepared to satisfy Condition 10 of the EPBC approval which states:

"A report detailing the results of actions carried out under the monitoring and management plan must be prepared and provided to the department annually on the anniversary date of this approval. The minister may request that the report be reviewed by an independent reviewer approved by the department".

The annual reporting period has been defined as the 1st of January 2018 to 31st of December 2018 to allow the compilation of data and input of specialist reports.

Figure 1 Controlled Action Area Longwalls 415 to 417

2. MONITORING SITES

2.1. Subsidence

Existing survey monitoring lines have already been installed in accordance with the approved *Springvale Subsidence Management and Reporting Plan for LW415 to 417 (September 2011)*. These lines include B, M, T, V, W, X and Y across Sunnyside East and Carne West THPSS. The survey lines installed to date have not been established in the THPSS to minimise impacts during the establishment of the lines and during monitoring.

Additional longitudinal centre lines have been installed at several key locations to provide early-warning and three dimensional (3-D) swamp subsidence data for trigger level review and corrective action management purposes should corrective action be required.

The location of the subsidence monitoring locations are shown in Figure 2.

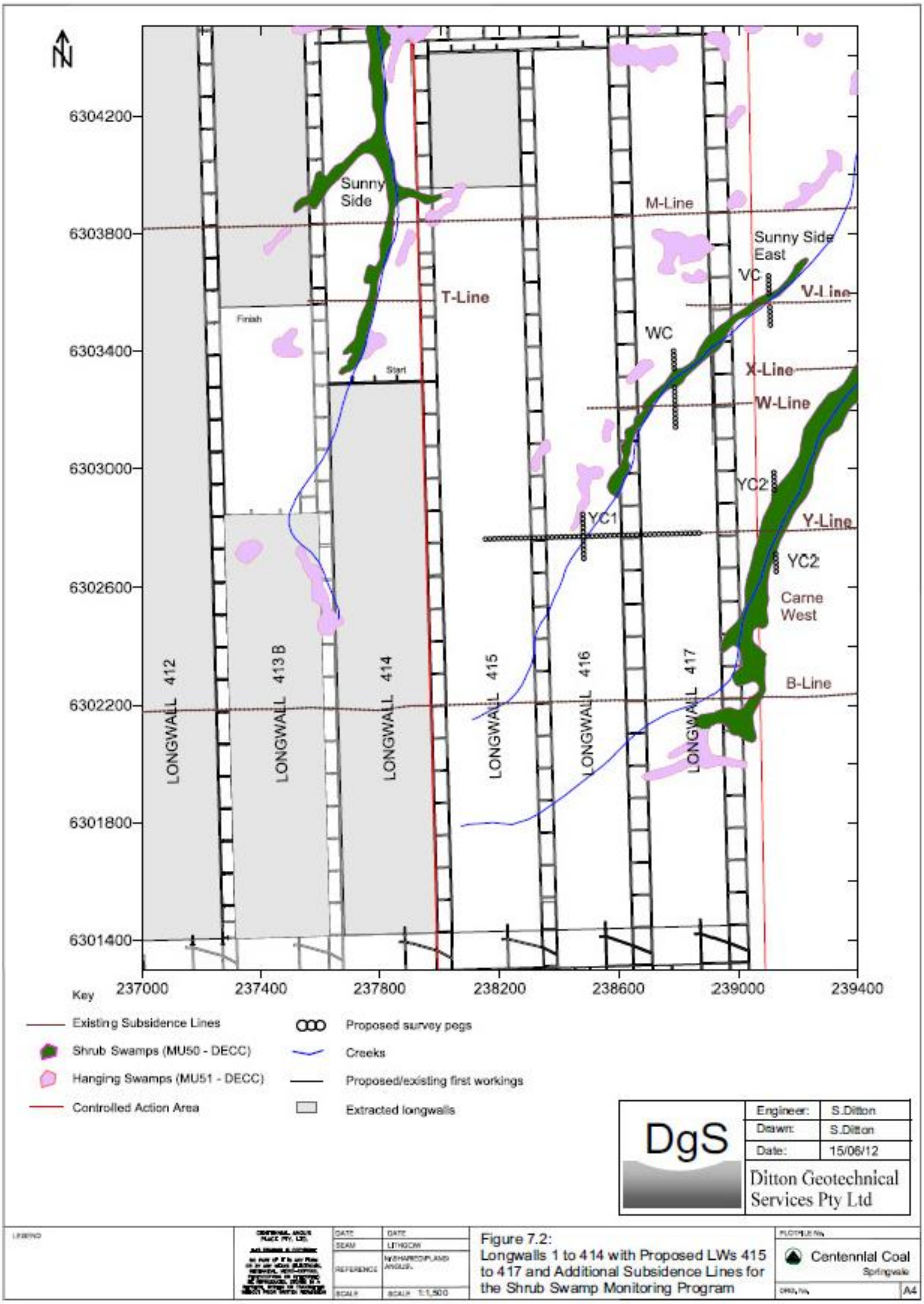

Figure 2 Subsidence Monitoring Locations

2.2. Flora

Centennial Coal has conducted flora monitoring of THPSS across the Newnes Plateau since 2003. Forty-six sites are now monitored which includes undermined swamps and swamps that have not been undermined. The data from these sites will be used as reference data where needed in combination with the specific sites that will be monitored as part of this THPSS MMP.

Table 1 provides details of the flora monitoring and reference sites which are part of the THPSS MMP while their locations are shown in Figure 3.

Table 1. Flora Monitoring Sites

Monitoring site name	Swamp	Easting (GDA94)	Northing (GDA94)	Description
Impact Sites				
WC01	Carne West Swamp	239461	6303219	Permanently wet, groundwater fed swamp. Dominated by *Gymnoschoenus sphaerocephalus*, *Lepidosperma limicola*, *Leptospermum grandifolium*, *Gleichenia dicarpa*, *Xyris gracilis ssp. gracilis* and Baeckea linifolia.
WC02	Carne West Swamp	239461	6303321	Permanently wet, groundwater fed swamp. Dominated by *Gymnoschoenus sphaerocephalus*, *Lepidosperma limicola*, *Leptospermum grandifolium*, *Gleichenia dicarpa*, *Xyris gracilis ssp. gracilis* and Baeckea linifolia.
WC03	Carne West Swamp	239195	6302908	Permanently wet, groundwater fed swamp. Dominated by *Gymnoschoenus sphaerocephalus*, *Lepidosperma limicola*, *Leptospermum grandifolium*, *Gleichenia dicarpa*, *Xyris gracilis ssp. gracilis* and Baeckea linifolia.
WC04	Carne West Swamp	239157	6302773	Permanently wet, groundwater fed swamp. Dominated by *Gymnoschoenus sphaerocephalus*, *Lepidosperma limicola*, *Leptospermum grandifolium*, *Gleichenia dicarpa*, *Xyris gracilis ssp. gracilis* and Baeckea linifolia.
SSE01	Sunnyside East	239022	6303531	Southern half is generally dry and channelized. Northern half likely permanently wet. Dominant species include *Gleichenia dicarpa, Leptospermum grandifolium*, *Baumea rubiginosa* and *Gahnia sieberiana*
Reference Sites				
TG01	Twin Gully	236565	6308755	Permanently wet, groundwater fed swamp. Dominant species include *Baeckea linifolia*, *Grevillea acanthifolia*, *Gleichenia dicarpa* and *Sphagnum cristatum.*
TG02	Twin Gully	236439	6308765	Permanently wet, groundwater fed swamp. Dominant species include *Baeckea linifolia*, *Grevillea acanthifolia*, *Gleichenia dicarpa* and *Sphagnum cristatum.*

Monitoring site name	Swamp	Easting (GDA94)	Northing (GDA94)	Description
TRI01	Tristar	236565	6308755	Permanently wet, groundwater fed swamp. Dominated by *Baeckea linifolia, Gleichenia dicarpa, Grevillea acanthifolia, Lepidosperma limicola, Leptospermum grandifolium*
TRI02	Tristar	236439	6308765	Permanently wet, groundwater fed swamp. Dominated by *Baeckea linifolia, Gleichenia dicarpa, Grevillea acanthifolia, Lepidosperma limicola, Leptospermum grandifolium*
LGG01	Lower Gang Gang Swamp	240148	6303040	Permanently wet, groundwater fed swamp, with channelised flows. Dominated by *Leptospermum grandifolium, Lepidosperma limicola, Boronia deanei and Gleichenia dicarpa.*
UGE01	Upper Gang Gang East Swamp	239928	6301878	Ephemeral, likely rainfall fed. Dominated by *Gleichenia dicarpa, Leptospermum grandifolium, Lepidosperma limicola, Gymnoschoenus sphaerocephalus and Xyris gracilis ssp. gracilis.*
BS01	Barrier Swamp	242111	6303738	Permanently wet, groundwater fed swamp. Dominated by *Gleichenia dicarpa, Leptospermum grandifolium, Lepidosperma limicola, Gymnoschoenus sphaerocephalus and Xyris gracilis ssp. gracilis.*
CCS01	Carne Central Swamp	241196	6302578	Ephemeral, likely rainfall fed. Dominated by *Lepidosperma limicola*, *Empodisma minus*, *Callistemon pityoides*, *Grevillea acanthifolia.*

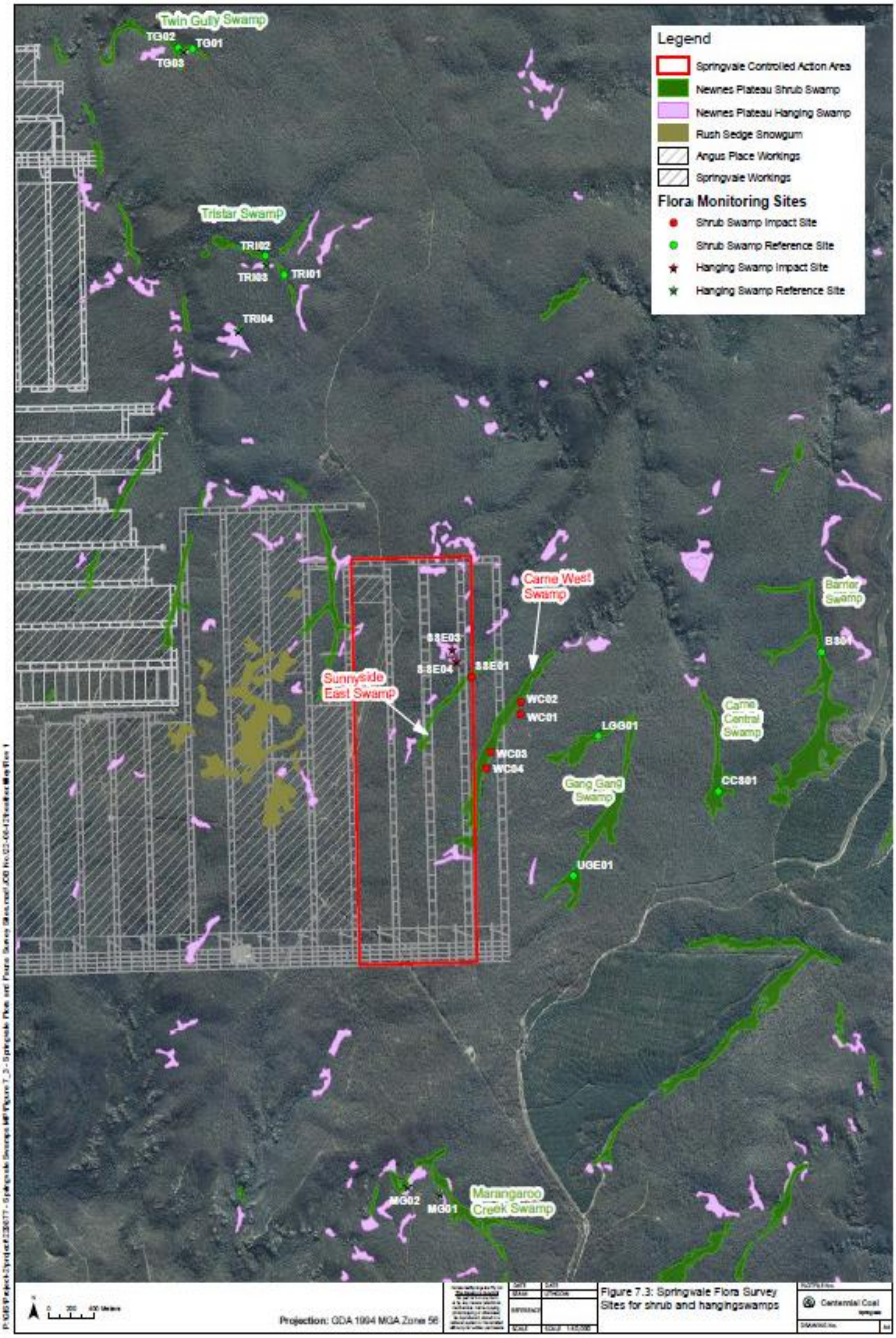

Figure 3 Flora Monitoring Locations

2.3. Groundwater

The THPSS baseline groundwater monitoring program commenced in May 2005 and has been gradually expanded to incorporate groundwater level and groundwater quality monitoring.

Piezometers have been installed in swamp systems and are referred to as swamp piezometers. These piezometers are hand augured to refusal and are shallow with a depth of up to 3 metres. These piezometers are used for direct measurement of swamp groundwater fluctuations.

Piezometers have also been installed outside of swamp systems and are referred to as aquifer piezometers. These piezometers often extend down through ridge lines and are deeper than the swamp piezometers extending to a depth of up to 30 metres. The aquifer piezometers are used to measure groundwater fluctuations outside of swamp systems.

Details of the groundwater monitoring program are presented below.

Groundwater monitoring locations are also shown on Figure 4.

2.3.1. Swamp Piezometers

The swamp piezometers are generally located on the edges of the swamps to minimise damage to swamp vegetation. The groundwater level measured at the swamp margin is representative of the groundwater level across the swamp.

Groundwater chemistry is monitored only in piezometers located in permanently waterlogged swamp conditions as sampling in periodically waterlogged conditions is often not possible due to the lack of groundwater in the piezometer.

Table 2 and 3 provides a summary of the groundwater monitoring undertaken at impact and reference swamps respectively.

Table 2. Groundwater Impact Monitoring Sites

Site name	Easting (GDA94)	Northing (GDA94)	Location	Mining Date (estimated)	Parameters monitored	
					Depth	Water Quality
Sunnyside East Swamp						
SSE1	238668	6303143	Over LW416/417	Undermined December 2013 / March 2015	✓	
SSE2	238831	6303352	Over LW 417	Undermined December 2014	✓	
SSE3	239064	6303558	Over LW 418	Undermined November 2015	✓	✓
Carne West Swamp						
CW1	239352	6303196	Over LW 419	Undermined November 2016	✓	✓
CW2	239382	6303247	Over LW 419	Undermined November 2016	✓	✓
CW3	238977	6302179	Over LW 417	Undermined April 2015	✓	
CW4	239070	6302377	Over LW 417	Undermined April 2015	✓	

Table 3. Groundwater Reference Monitoring Sites

Site name	Easting (GDA94)	Northing (GDA94)	Mining Area	Mining date (estimated)	Parameters monitored	
					Depth	Water Quality
Carne Central Swamp						
CC1	241193	6302693	East of LW 418	No approved mining to date	✓	✓
Marangaroo Swamp						
MS1	238860	6299169	East of LW 418	No approved mining to date	✓	✓
Tristar Swamp						
TS1	237559	6307289	Over Angus Place – NE Area	No approved mining to date	✓	
Twin Gully Swamp						
TG1	236438	6308766	Over Angus Place – NE Area	No approved mining to date	✓	

2.3.2. Aquifer Piezometers

Aquifer piezometers are located outside of swamp systems in the laterally extensive shallow aquifer to monitor groundwater fluctuations around the periphery of THPSS. The data collected from these piezometers provides a comparison with any fluctuations measured in the swamp piezometers to detect any mining related impacts.

Groundwater chemistry is not monitored in aquifer piezometers because these piezometers are located at a greater depth from the surface (i.e. on ridge lines) than swamp piezometers and the oxidation of analytes such as iron and managanese is unlikely due to a lack of freely available oxygen at this depth from surface.

Table 4 and 5 provides a summary of the groundwater monitoring undertaken at impact and reference swamps respectively.

Table 4. Aquifer Impact Monitoring Sites

Site Name	Easting (GDA94)	Northing (GDA94)	Location	Mining date (estimated)	Parameters monitored	
					Depth	Quality
RSS	238072	6303500	Over LW 415	September 2012	✓	
SPR1101	238484	6303627	Over LW 416	October 2013	✓	
RCW/ SPR1104	239746	6303184	Over LW 420	August 2017	✓	
SPR1107	239739	6302330	Over LW 420	November 2017	✓	
SPR1109	239186	6303314	Over LW 418	December 2015	✓	
SPR1110	238699	6302635	Over LW 416 / 417	January 2014 / March 2015	✓	

Table 5. Aquifer Reference Monitoring Sites

Site name	Easting (GDA94)	Northing (GDA94)	Location	Mining date (estimated)	Parameters monitored	
					Depth	Quality
SPR1108	239840	6301075	South of LW 420 Over LW427	To be undermined after 2025 if approved	✓	
SPR1111	240404	6303692	Nth of LW 422	Will not be undermined	✓	
SPR1113	240625	6302160	Over LW 423	Will not be undermined	✓	
AP5PR	236523	6308535	NE of Angus Place Mine	Will not be undermined in the foreseeable future	✓	

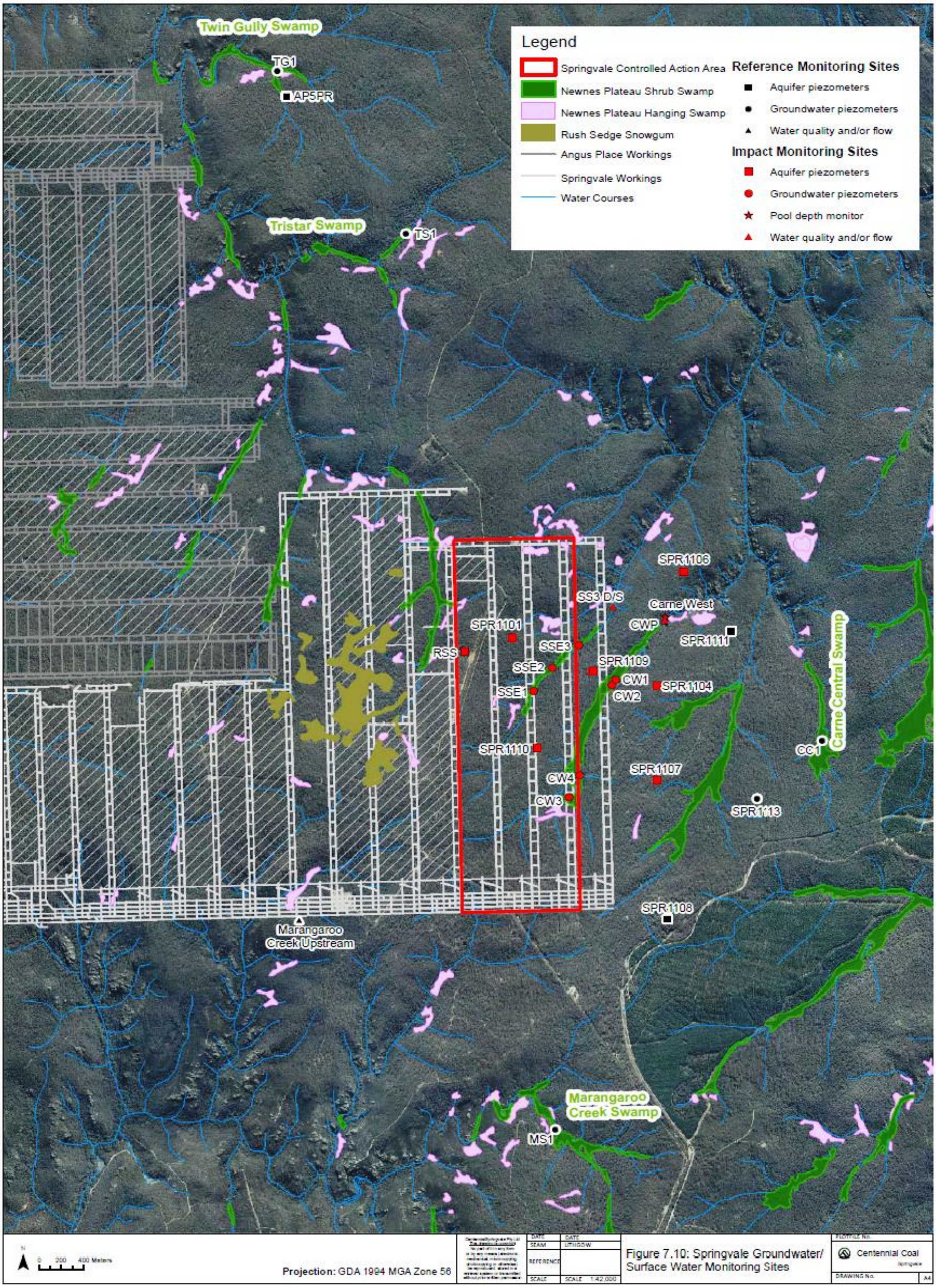

Figure 4 Groundwater and Surface Water Monitoring Locations

2.4. Surface Water

The most significant surface water flows in the Springvale controlled action area in the drainage lines that feed into the sub-permanently and permanently waterlogged swamps.

Details of the surface water monitoring sites are given in Table 6.

Groundwater monitoring locations are also shown on Figure 4 in Section 2.3.

Table 6. Surface Water Monitoring Sites

Site Name	Easting (GDA94)	Northing (GDA94)	Location	Mining date	Parameters monitored		
					water depth	flow rate	water quality
Surface Water Quality - Impact Sites							
Carne West	239808	6303782	Nth end of Carne West Swamp	Swamp undermined December 2015 – March 2016 (LW418) and September – October 2016 (LW419)		✓	✓
CWP	239816	6303814	Nth end of Carne West Swamp		✓		
SS3 D/S	239363	6303908	Nth end of Sunnyside East Swamp	Swamp undermined December 2013 (LW416), December 2014 (LW417) and November 2015 (LW418).			✓
Surface Water Quality - Reference Site							
Marangaroo Creek Upstream	236633	6301063	Marangaroo Creek upstream	Will not be undermined		✓	✓

3. MINING ACTIVITY

During the 2018 reporting period, coal was extracted from longwalls 421 and 425.

Relevant to this report are longwalls 415 to 417 which were mined between 2012 and 2015. A summary of longwall start and finish dates are presented below.

Longwall 415	Commenced on the 15th of March 2012 and was completed on the 17th of September 2013.
Longwall 416	Commenced on the 25th of September 2014 and was completed on the 19th of August 2014.
Longwall 417	Commenced on the 11th of October 2014 and was completed on the 4th of July 2015
Longwall 418	Commenced on the 22nd of October 2015 and was completed on the 27th of May 2016.
Longwall 419	Commenced on the 2nd of August 2016 and was completed on the 18th March 2017 with a total chainage 2340m.
Longwall 420	Commenced on the 29th of April 2017 and was completed on the 9th of November 2017 with a total chainage of 2086m.
Longwall 421	LW421 started on the 19th of December 2017 and was completed on the 19thof June 2018 with a total chainage of 1698m.
Longwall 425	LW425 commenced on the 4th of August 2018 and the retreat chainage at 31st December 2018 was 1060m.

Reporting requirements for longwalls 418 - 421 are covered under approval EPBC 2013/6881.

Mining activity undertaken in 2018 is shown in Figure 5.

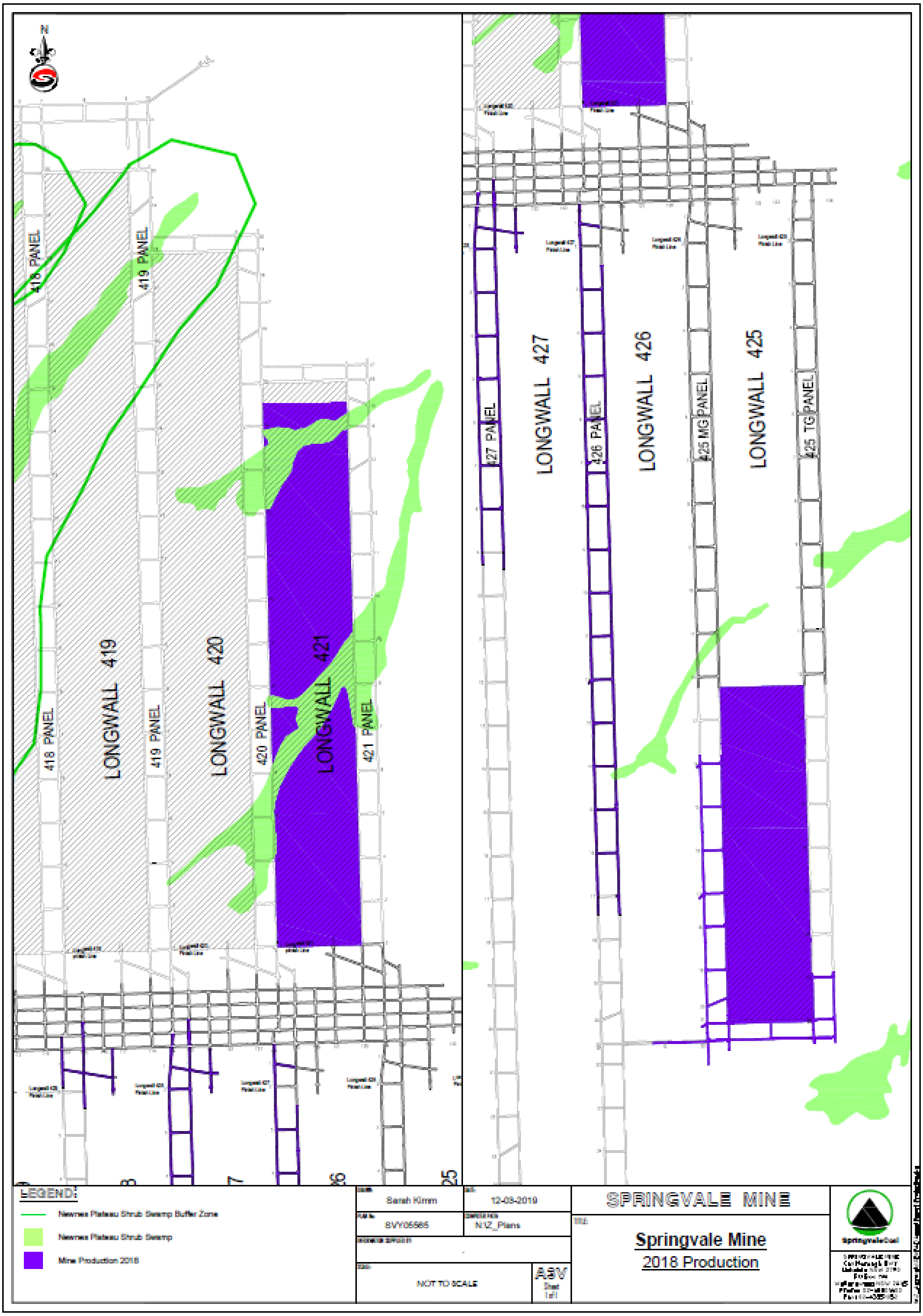

Figure 5 Mining Undertaken During 2018

4. METEROLOGICAL CONDITIONS

Daily rainfall is measured at the Bureau of Meteorology rain gauge at Maddox Lane, Lithgow (BoM Station No. 063132) and the Centennial Newnes Plateau Prison Farm Rain Gauge.

Annual rainfall in 2018 was recorded to be over 200mm less than the long-term average at Newnes Plateau. The Cumulative Rainfall Deficit (CRD) is presented on the monitoring hydrographs. The CRD continued the sharp declining trend of below average rainfall from the previous reporting period (January 2017 to December 2017), until August. Slightly above average rainfall recorded in September, October and November saw the CRD stabilising.

Monthly rainfall data is summarised in Table 7 and presented in Figure 6.

Table 7. Total Monthly Rainfall for 2018 and Long Term Average

	2018 Observed Rainfall (mm)		Long term Average Rainfall (mm)	
	Newnes Plateau	Lithgow Maddox Lane	Newnes Plateau	Lithgow Maddox Lane
January 2018	39.8	49.0	83.0	84.6
February 2018	92.6	65.2	122.0	76.8
March 2018	66.6	56.6	105.2	66.3
April 2018	16.0	13.6	61.2	43.1
May 2018	13.0	12.6	44.6	48.1
June 2018	49.2	34.6	69.8	50.3
July 2018	12.6	5.4	50.2	50.0
August 2018	38.4	38.0	58.5	63.2
September 2018	63.6	67.6	54.8	53.0
October 2018	117.2	79.8	83.8	68.0
November 2018	123.2	124.6	106.3	72.4
December 2018	73.6	80.6	89.9	73.9
Annual Total	**705.8**	**627.6**	**929.3**	**749.7**

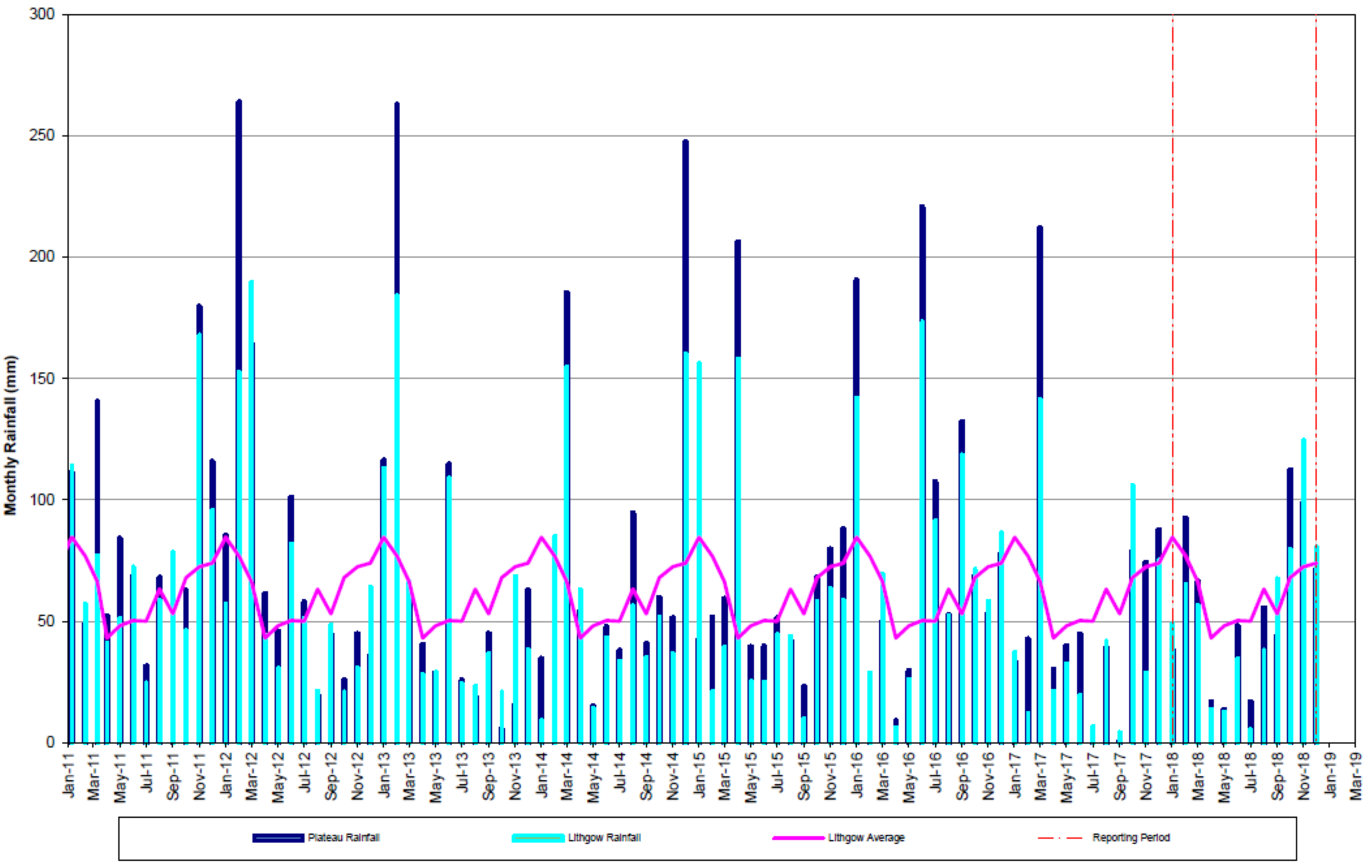

Figure 6 Monthly Rainfall – 2011 to 2019

5. MONITORING RESULTS

5.1. Subsidence

Subsidence monitoring has occurred in accordance with the Springvale Subsidence Management and Reporting Plan for Longwalls 415 to 417 (September 2011).

The following sections documents the maximum monitoring result for surveys undertaken for longwalls 415 - 417. Note no new resurveys of the subsidence marks affected by longwalls 415 to 417 were carried out during 2018.

No subsidence results during the reporting period required action under the THPSS MMP.

5.1.1. B Line Subsidence Monitoring

The following table summarises the results for the B Line. It is important to note that the B line uses the total station method which is known to be less accurate. Supplementary information may therefore be used to confirm results obtained in the event a trigger value is exceeded.

Table 8. B-Line Monitoring Results

	Subsidence (mm)		Tilt (mm/meter)		Tensile Strain (mm/meter)		Compressive Strain (mm/meter)	
	Max Result	**Trigger value**	**Max Result**	**Trigger value**	**Max Result**	**Trigger value**	**Max Result**	**Trigger value**
LW415	1290	1500	16.6	10	1.2	15	6.8	18
LW 416 to 418	999	1100	7.8	7	3.8	5	6.8	>6(plateaus) >14(valleys)

The exceedance of a subsidence trigger value occurred historically in the tilt category. Tilt occurs when two points vertically displace at different rates resulting in an increase to the slope of the surface.

The subsidence event has occurred at a distance of approximately 630m from the nearest Temperate Highland Peat Swamp on Sandstone Ecological Community located in Carne West Swamp. This distance is approximately 450m greater than the distance specified for an anomalous subsidence trigger level.

The Temperate Highland Peat Swamp on Sandstone Monitoring and Management Plan for Longwalls 415 - 417 states that the anomalous subsidence trigger level for tilt is a value greater than 10mm/m when occurring within 200 metres of a Temperate Highland Peat Swamp on Sandstone Ecological Community. The value surveyed, located well outside the Buffer Zone, is between survey marks B345 and B346 at 15.2mm/m.

5.1.2. M Line Subsidence Monitoring

The following table summarises the results for the M Line.

Table 9. M-Line Monitoring Results

	Subsidence (mm)		Tilt (mm/meter)		Tensile Strain (mm/meter)		Compressive Strain (mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW415	847	1500	7.3	10	3.2	15	2.5	18
LW 416 to 418	556	1100	1.6	7	0.6	5	1.5	>6(plateaus) >14(valleys)

The table above demonstrates compliance with the trigger values defined in the THPSSMP.

5.1.3. V and VC Line Subsidence Monitoring – Sunnyside East Swamp

The following table summarises the results for the V and VC Lines.

Table 10. V and VC Monitoring Results

	Subsidence (mm)		Tilt (mm/meter)		Tensile Strain (mm/meter)		Compressive Strain (mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW417 to LW418	625	1100	7.1*	7	0.7	5	4.8	14

* A result was recorded above the trigger value for tilt on VC line during a survey in 2016. In accordance with the THPSS MMP TARP, action is only required if anomalous subsidence is exceeded by >15%. The result of 7.1 did not exceed >15% if the trigger value of 7.

The table above demonstrates compliance with the trigger values defined in the THPSSMP.

5.1.4. W and WC Line Subsidence Monitoring – Sunnyside East Swamp

The following table summarises the results for the W and WC Lines.

Table 11. W and WC Monitoring Results

	Subsidence (mm)		Tilt (mm/meter)		Tensile Strain (mm/meter)		Compressive Strain (mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW416 to 418	815	1100	4.9	7	2.6	5	6.4	14

The table above demonstrates compliance with the trigger values defined in the THPSSMP.

5.1.5. Y and YC2 Line Subsidence Monitoring – Carne West Swamp

The following table summarises the results for the Y and YC2 Lines.

Table 12. Y and YC2 Monitoring Results

	Subsidence (mm)		Tilt (mm/meter)		Tensile Strain (mm/meter)		Compressive Strain (mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW416 to 418	406	1100	2.4	7	0.9	5	5.5	14

The table above demonstrates compliance with the trigger values defined in the THPSSMP.

5.1.6. LiDAR

A LiDAR campaign was undertaken in February and August 2018. Analysis of the data is still underway.

5.2. Flora

Springvale engages a specialist consultant to undertake monitoring and analyse the results of vegetation monitoring. Data analysis focuses on trends that have been observed that may relate to mining impacts between seasons in 2013 and 2014, in addition to assessing the extent of variation in vegetation composition and condition between monitoring surveys.

The following sections present a summary of the 2018 Spring monitoring report.

Table 13 shows impact and reference sites to assist in the interpretation of data.

Table 13. Flora Impact and Reference Sites

Impact Sites	Reference sites
SSE01	TG01
WC01	TG02
WC02	TRI01
WC03	LGG01
WC04	UGE01
	BS01
	CCS01

5.2.1. Native Species Diversity

A modified Braun-Blanquet scale was used to visually estimate cover abundance for species occurring within each site.

Total native plant species richness for impact and reference sites is shown in Table 14. Results from the quadrat (400 m^2) and four 20 m transects are tabulated for comparison between sampling methods and reference/impact sites.

Table 14. Total native plant species richness and Shannon Wiener Index with eveness

Site	Species Richness		Shannon-Wiener Index (point intercept method)	Evenness
	400m² Quadrat	Point Intercept Method		
Impact sites				
WC01	**11**	9	1.77	0.81
WC02	**12**	11	1.73	0.72
WC03	12	11	1.88	0.79
WC04	12	10	1.97	0.82
SSE01	**18**	11	1.97	0.82
Mean±SD	**10.8 ± 2.8**	**10.4 ± 0.9**	**1.9**	**0.8**
Reference sites				
TG01	20	14	2.08	0.79
TG02	21	15	2.15	0.79
TRI01	26	15	2.14	0.79
TRI02	22	16	2.00	0.72
BS01	23	15	2.15	0.79
Mean±SD	**22.4 ± 2.3**	**15 ± 0.7**	**2.10**	**0.78**
Reference sites excluded from analysis				
LGG01	31	19	2.02	0.69
UGE01	25	19	2.09	0.71
CCS01	22	18	2.14	0.74

Mean species richness using the point intercept method was lower at impact sites (10.4 ± 0.9) than reference sites (15.5 ± 1.4). A similar difference was found within 400m2 quadrats where species richness at impact sites (10.8 ± 2.8) was lower than reference sites (22.5 ± 2.2). A trigger for species richness is reported for WC01 and WC02 as shown in Table 14, and represents a repeat trigger within 12 months. A new trigger level observation was also recorded for impact site SSE01.

The species diversity index at the reference sites was slightly higher than the impact sites. Evenness scores are similar at the reference and impact sites, indicating relatively consistent species relative abundance.

5.2.2. Eucalypt Recruitment

Non-swamp eucalypt presence was estimated by summing incidence recorded in each 0.5 m x 0.5 m quadrat centred on sequential 1 metre intervals along each of the four parallel transects. This provided a total of approximately 80 quantitative measurements of eucalypt presence per monitoring quadrat.

Eucalypt recruitment over seasonal monitoring is shown in Table 15 below.

Table 15. Eucalypt Recruitment Over Time

Site	Seasons				
	Spring '17	Summer '17/'18	Autumn '18	Winter '18	Spring '18
Impact					
WC01	-	-	-	-	-
WC02	-	-	-	-	-
WC03	**2**	-	-	**2**	-
WC04	-	-	-	-	-
SSE01	**2**	-	**3**	**1**	-
Reference					
TG01	-	-	-	-	-
TG02	-	-	-	-	-
TRI01	-	-	-	-	-
TRI02	-	-	-	-	-
BS01	-	-	-	-	-
Reference sites excluded from analysis					
CCS01	-	-	-	-	-
LGG01	-	**2**	**1**	-	**3**
UGE01	-	-	-	-	-

Continued eucalypt recruitment above trigger thresholds was observed in LGGE01 (an excluded site). No new Eucalypt recruits were identified using the point intercept method in impact swamp SSE01, however the accumulated total still maintains a trigger level for the previous seasons.

5.2.3. Species Condition Scores

Four parallel transects were established to measure condition. The starting points of these transects were positioned randomly along a predetermined edge of the 400 m^2 permanent monitoring quadrat. A condition score was estimated for each plant species intersected every 0.5 m along the transect.

Mean species condition scores for impact and reference sites is shown in Table 16.

Table 16. Mean Species Condition Scores for the current and previous four monitoring rounds

Site	Mean Condition for all Species				
	Spring 2017	**Summer 2017/2018**	**Autumn 2018**	**Winter 2018**	**Spring 2018**
Impact					
WC01	2.3	3.3	3.3	3.0	2.0
WC02	2.6	3.4	3.2	2.8	2.1
WC03	2.3	2.8	3.0	2.7	2.1
WC04	2.0	2.5	3.2	2.5	1.9
SSE01	3.2	3.8	4.4	3.7	3.9
Mean condition	**2.5**	**3.2**	**3.4**	**2.9**	**2.4**
Reference					
TG01	3.4	3.9	4.0	3.7	3.9
TG02	3.6	3.8	4.1	3.8	3.5
TRI01	3.3	3.7	4.1	3.6	3.7
TRI02	3.2	4.1	4.0	3.7	4.1
BS01	3.3	3.6	3.8	3.4	3.3
CCS01	2.9	3.7	*	*	*
Mean condition	**3.3**	**3.8**	**4.0**	**3.6**	**3.1**
Reference sites excluded from analysis					
CCS01	*	*	3.7	3.4	3.2
LGG01	3.3	3.5	4.1	3.1	3.1
UGE01	2.7	3.2	4.1	3.4	2.7

*Central Carne Swamp removed from calculations for reference swamps from Autumn 2018.

‘All species’ mean condition score for impact sites was 2.3 (range 1.7 – 3.9) compared with 3.7 at reference sites (range 2.9 – 4.1). No impact sites were below the ‘all species’ condition threshold. However, four impact sites in West Carne (WC01, WC02, WC03 and WC04) were below the condition trigger threshold for the swamp species Gleichenia dicarpa and Baumea rubiginosa. Triggers have previously occurred within all the West Carne monitoring locations over the previous twelve months for these swamp species.

5.2.4. Non Live Ground Cover

Bare earth scoring was estimated at each of the 0.5 m intervals inspected for species condition

Percent of non-live ground cover was estimated using both the Braun-Blanquet cover abundance scale for the entire 400 m^2 quadrat and the point intercept method. Results are tabulated in Table 17.

Table 17. Non-live Ground Cover (cover abundance and point intercept methods)

Site	Non-live ground cover (%) Spring 2017	Non-live ground cover (%) Summer 2017/2018	Non-live ground cover (%) Autumn 2018	Non-live ground cover (%) Winter 2018	Non-live ground cover (%) Spring 2018	% Change between Spring 2017 and 2018**
Impact Sites						
WC01	1.875	0.625	7.5	8.75	1.875	0
WC02	0	1.875	6.875	7.5	2.5	2.5
WC03	8.75	15.625	12.5	4.375	4.375	-4.375
WC04	11.25	32.5	**17.5**	10	5.625	-5.625
SSE01	3.125	0.625	0	2.5	0	-3.125
Reference Sites						
TG01	0.625	1.875	1.25	0	1.25	0.625
TG02	0	3.75	4.375	0	6.875	6.875
TRI01	0	0	0.625	0	0.625	0.625
TRI02	3.75	0	0.625	0.6	1.25	-2.5
BS01	0	0	0	1.25	1.25	1.25
CCS01	5	0	*	*	*	*
Reference Sites excluded from analysis						
CCS01	*	*	0	0	0	-5
LGG01	1.25	1.875	3.125	1.875	1.25	0
UGE01	5	4.375	8.125	6.875	12.5	7.5

* Central Carne Swam removed from calculations for reference sites from Autumn 2018.

** Negative values denote a reduction in bare ground.

The non-live ground cover trigger criterion requires an increase of bare ground of more than 100 m2 over a three-year period. Consequently, the performance criterion for non-live ground cover was not triggered in the Spring 2018 monitoring period. One recurring trigger was recorded during the summer 2017-18 monitoring event; however, the trigger has not continued subsequently, and no further investigation has occurred. Due to the random nature of the sampling methodology, different sections of the 400 m2 quadrat are sampled in each monitoring event, giving rise to a previous trigger result that was not recorded in the Spring 2018 monitoring.

5.2.5. Establishment of Non-Native Weeds

Non-native weed presence was estimated by summing incidence recorded in each 0.5 m x 0.5 m quadrat centred on sequential 1 m intervals along each of the four parallel transects. Species name was recorded. This provided a total of approximately 80 quantitative measurements of weed presence per monitoring quadrat.

The results this monitoring event indicates a weed free status for all sites. This is consistent with results from each 2018 monitoring event.

5.2.6. Conclusions

Spring 2018 monitoring results were compared with the flora trigger levels specified in the THPSS MMP. The results of this comparison are provided in Table 18. During the reporting period, one new trigger was recorded for native species diversity at Sunnyside East Swamp (SSE01). The reason for this change in species diversity is unclear; however, may be related to the preceding near record dry and warm conditions. A trigger notification will be submitted per the approval requirments.

Repeat triggers identified have previously been reported to the Department.

Table 18. Monitoring Results and Flora Trigger Levels

Performance indicator	Parameter measured	Trigger level*	Spring 2018
Change in species assemblage	Change in diversity of native species	A change in the number of species of greater than 30 % for a given site within a three year period.	One new trigger exceedance for species richness was recorded at SSE01. Recurring trigger exceedances were observed at WC01 and WC02.
	Recruitment of eucalypt species	An increase in eucalypts in an impact site compared to reference sites of more than three individual plants within a one year period.	One impact site (SSE01) has sustained a repeat trigger for eucalypt recruitment. LGG01, which has been excluded from analysis, also exceeded trigger level this season.
Change in condition	Condition of key species	A decline in condition score at an impact site of more than 1.5 compared to the average condition score at reference sites within a one year period.	A recurring trigger level decrease in condition for *Gleichenia dicarpa* and *Baumea rubiginosa* was observed in WC01, WC02, WC03 and WC04.
	Non-live ground cover	An increase of bare ground of more than 100m^2 in a site within a three year period.	No sites triggered in spring 2018.
	Non-native weeds	An increase in non-native weed species of more than 4 in a monitoring site (each having a cover of greater than 5%) compared to the average number in reference sites within a one year period.	No impact sites showed an increase in weed species beyond the trigger level.

*Taken from THPSS MMP 415-417 and THPSS MMP 418. Data collection method used consistent with Erskine and Fletcher (2011).

5.3. Groundwater

A specialist consultant is engaged by Springvale to monitor and analyse groundwater data results. The following sections summarise the results of the monitoring undertaken.

5.3.1. Swamp Piezometer Results

Table 19 presents a comparison of the baseline defined in the THPSS MMP to the recalculated baseline based upon additional monitoring data presented prior to 200m from the piezometer location.

Table 19. Comparison of Swamp Piezometers 95th Percentile

Impact Site	95th Percentile 2005-2012	95thPercentile 2005 to 2014	95th Percentile: difference between 2005-2012 and 2005-2014
SSE1	2.12	2.16	0.04
SSE2	0.7	0.86	0.16
SSE3	0.17	1.71	1.54
CW1	0.25	0.91	0.66
CW2	0.24	0.36	0.12
CW3	1.01	1.07	0.06
CW4	1.20	1.34	0.14

Sunnyside East

The water level at Sunnyside East Swamp is monitored at piezometers SSE1, SSE2 and SSE3. All three piezometers were installed in March 2010.

Groundwater levels for SSE1, SSE2 and SSE3 are presented in Figure 7.

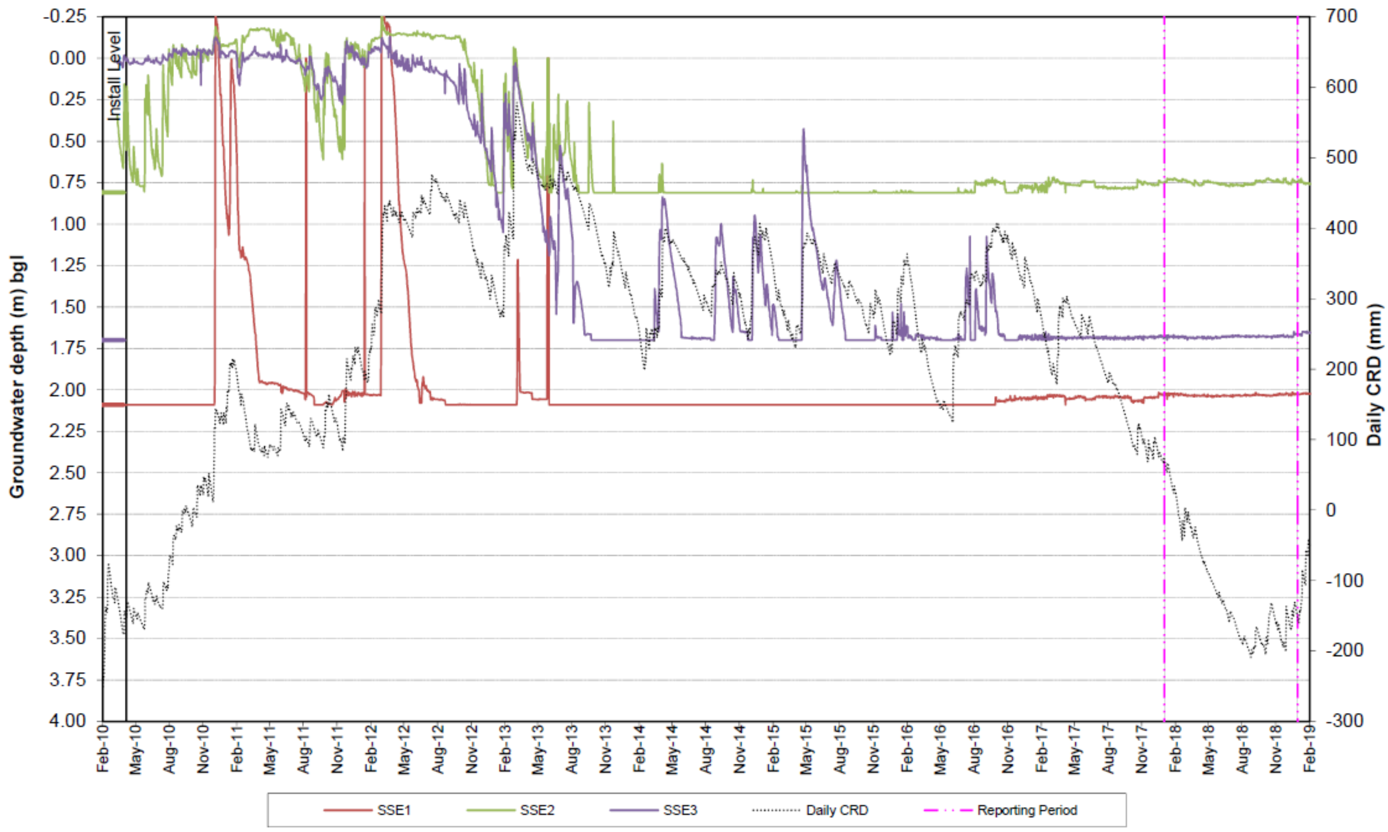

Figure 7 SSE1, SSE2 and SSE3 Piezometer Hydrograph - 2010 to 2018

SSE1

SSE1 is the deepest of the three piezometers installed at Sunnyside East and has shown water levels to be below the base of the piezometer throughout 2018. Historically this site has shown some strong responses to rainfall but only after prolonged rainfall and higher than average seasonal rainfall. No responses to rainfall were observed in SSE1 in 2018. This is not uncommon for this piezometer, as the water levels in the piezometer has remained unresponsive since mid 2013.

SSE1 had exceeded the short term trigger level to initiate an investigation during the passing of LW416. An Investigative Report was submitted in May 2014 in accordance with Springvale approvals. The water level remained beneath the trigger level throughout the extraction of LW418 and LW419.

SSE2

The water level in SSE2 has predominantly remained below the base of the piezometer since 2013 following a period of decline that started in March 2013. The onset of this decline coincides with a prolonged period of below average rainfall, which continued up to early 2014. Subsequent rainfall was generally around average with short intense periods of rainfall followed by a periods of lower than average rainfall of up to 12 months. 2017 onwards saw a period of extended below average rainfall with no periods of extended recharge events. The last quarter of 2018 saw rains returning resulting in a recovering CRD. Only minor water level fluctuations are observed in this piezometer over the review period, however they suggest that water is trapped within the base of the piezometer.

SSE2 exceeded the short term trigger level to initiate an investigation during the passing of LW416. An Investigative Report was submitted in May 2015 in accordance with Springvale approvals. The water level remained beneath the trigger level throughout the extraction of LW418 and LW419.

SSE3

SSE3 water levels have shown a very similar pattern to those in SSE2 with a decline from approximately ground level during the latter half of 2012 and commencing the current review period with the water level below the base of the piezometer at around 1.7mbgl. The onset of this decline in 2012 coincides with a prolonged period of below average rainfall, which continued up to March 2014. During 2016, SSE3 showed definitive responses to the two significant rainfall events – in January and the period July to September. Overall, during 2016 despite being below the base of the piezometer for considerable periods, the water levels showed a characteristic rainfall influenced trend only rising after prolonged and significant rainfall events. No significant responses were observed since water levels fell below the base of the piezometer in November 2016 remaining dry in throughout the review period.

SSE3 exceeded the short term trigger level to initiate an investigation during the passing of LW417. An Investigative Report was submitted in May 2015 in accordance with Springvale approvals.

Carne West

The water level at Carne West Swamp is monitored at piezometers CW1, CW2, CW3 and CW4. CW1 and CW2 were installed in May 2005, originally to provide background data on hydrogeological conditions in the swamp as well as comparative background data for other swamps. CW1 and CW2 provide an indication if standing water level changes occur in Carne West Swamp upstream of the monitoring sites. CW3 and CW4 were installed in October 2011 at the southern end of the swamp to provide monitoring coverage in the vicinity of LW417.

Groundwater levels for CW1, CW2, CW3 and CW4 are presented in Figure 8.

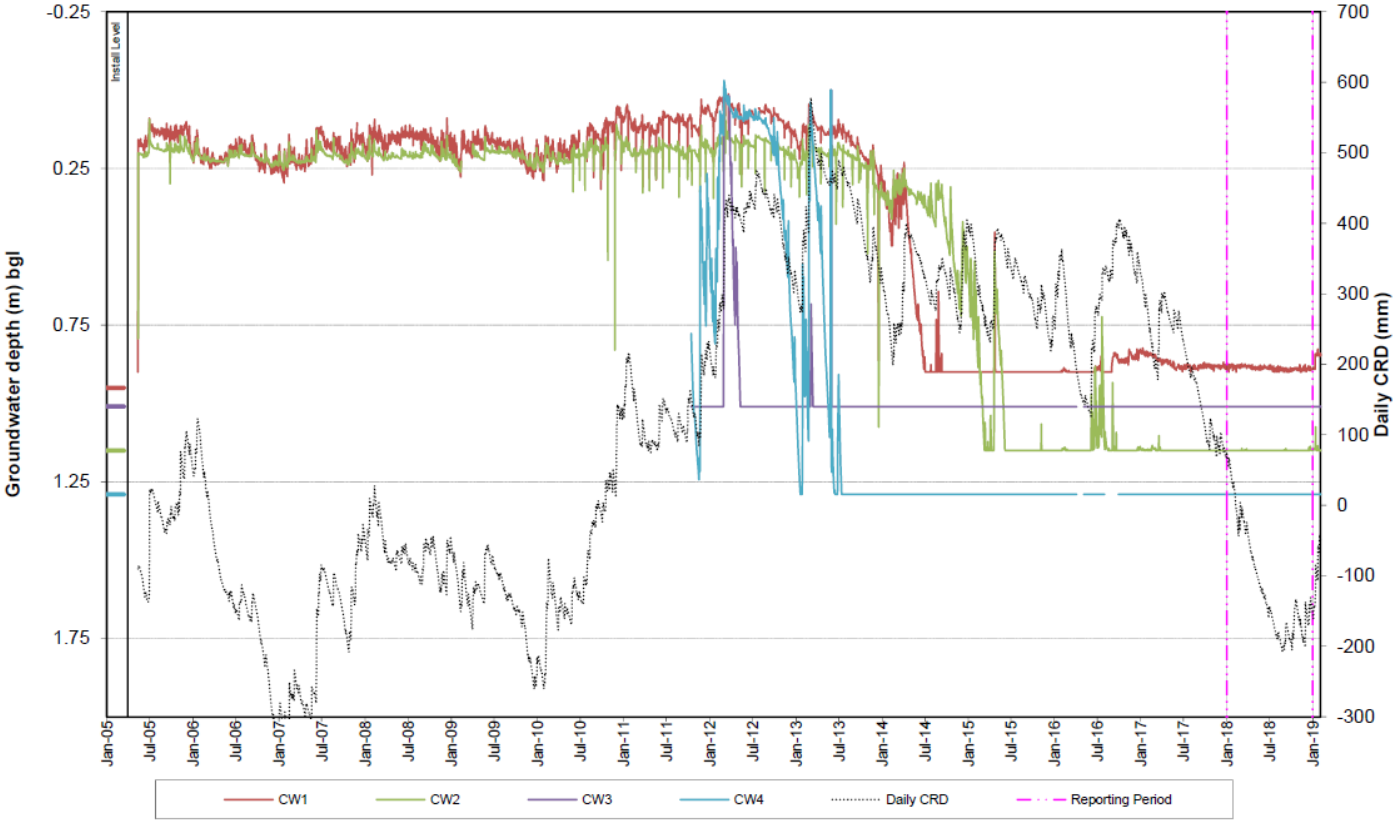

Figure 8 CW1 and Reference Sites Swamp Piezometer Hydrograph - 2005 to 2018

CW1

The water level observed in CW1 has shown a significant drop during 2014 and during the current review period remained below the base of the piezometer. This decline started in March 2013 and continued throughout 2014 until the water level reached the bottom of the piezometer (approximately 0.92mbgl) in mid-July. This level represents the lowest water level since monitoring began and has remained dry since then.

CW1 exceeded the short term trigger level to initiate an investigation during the passing of LW418. An Investigative Report was submitted in February 2016 in accordance with Springvale approvals.

CW2

The water level observed in CW2 has shown a decline in standing water level throughout 2014 with the water level dropping below the base of the piezometer in March 2015 where it remained until the middle of 2016. A series of short lived spikes in water level rainfall events occurred until September 2016 where the water level dropped below the base of the piezometer and has remained there until the end of the reporting period. CW2 historically showed similar fluctuation magnitudes to reference sites CC1, MS1 and the decline from 2014 is uncharacteristic and not consistent with responses observed at any of the reference swamps.

CW2 exceeded the short term trigger level to initiate an investigation during the passing of LW418. An Investigative Report was submitted in February 2016 in accordance with Springvale approvals.

CW3

The water level in CW3 remained below the base of the piezometer throughout the current review period. Since monitoring was initiated CW3 responded only to significant and prolonged rainfall events on two occasions, once in March 2012 and again in February 2013. The characteristic response for this piezometer comprises rapid rises and subsequent declines in water level to a depth below the base of the piezometer. The hydrograph indicates that the two above average rainfall periods in 2016 and one in 2017 did not result in observed water levels above the bottom of the piezometers in CW3.

CW3 exceeded the short term trigger level during the passing of LW417. An Investigative Report was submitted in September 2015 in accordance with Springvale approvals.

CW4

The water level in CW4 remained beneath the base of the piezometer throughout the review period. Since monitoring was initiated CW4 had been highly responsive to rainfall events and water levels corresponded closely with the Cumulative Rainfall Deficit (CRD) until the middle of 2013. Subsequent periods of above average rainfall from 2015 to 2016 have not led to water levels rising above the base of the piezometer.

CW4 exceeded the short term trigger level during the passing of LW417. An Investigative Report was submitted in September 2015 in accordance with Springvale approvals.

5.3.2. Aquifer Piezometer Results

A series of fifteen ridge piezometers have been established to monitor the groundwater level in the near-surface unconfined aquifers in the Burralow Formation and Banks Wall Sandstone at Springvale. Six of these have been chosen as impact sites including RSS, SPR1110, SPR1104, SPR1107, SPR1109, and SPR1110 due to their close proximity to the active longwalls. Ridge piezometers are equipped with water level data loggers.

As with the swamp piezometer results, Table 20 presents a comparison of the baseline defined in the THPSS MMP to the recalculated baseline based upon additional monitoring data presented prior being within 200m of the instruments.

Table 20. Comparison of Regional Aquifer Piezometers 95th Percentile

Impact Site	95th Percentile 2005-2012	95th Percentile 2005 to 2016	95th Percentile: difference between 2005-2012 and 2005-2014
RSS	29.52	29.80	0.28
SPR1101	36.08	N/A	N/A
SPR1104	25.28	29.07	1.57
SPR1107	22.50	31.84	2.00
SPR1109	36.19	41.50	5.31
SPR1110	58.78	65.26	6.48

RSS

RSS is located directly overlying LW415. Apart from a slight rise June to September 2016 due to the rising CRD, the water levels in this piezometer have maintained a steady declining trend extending into the reporting period.

Groundwater levels for RSS are presented in Figure 9.

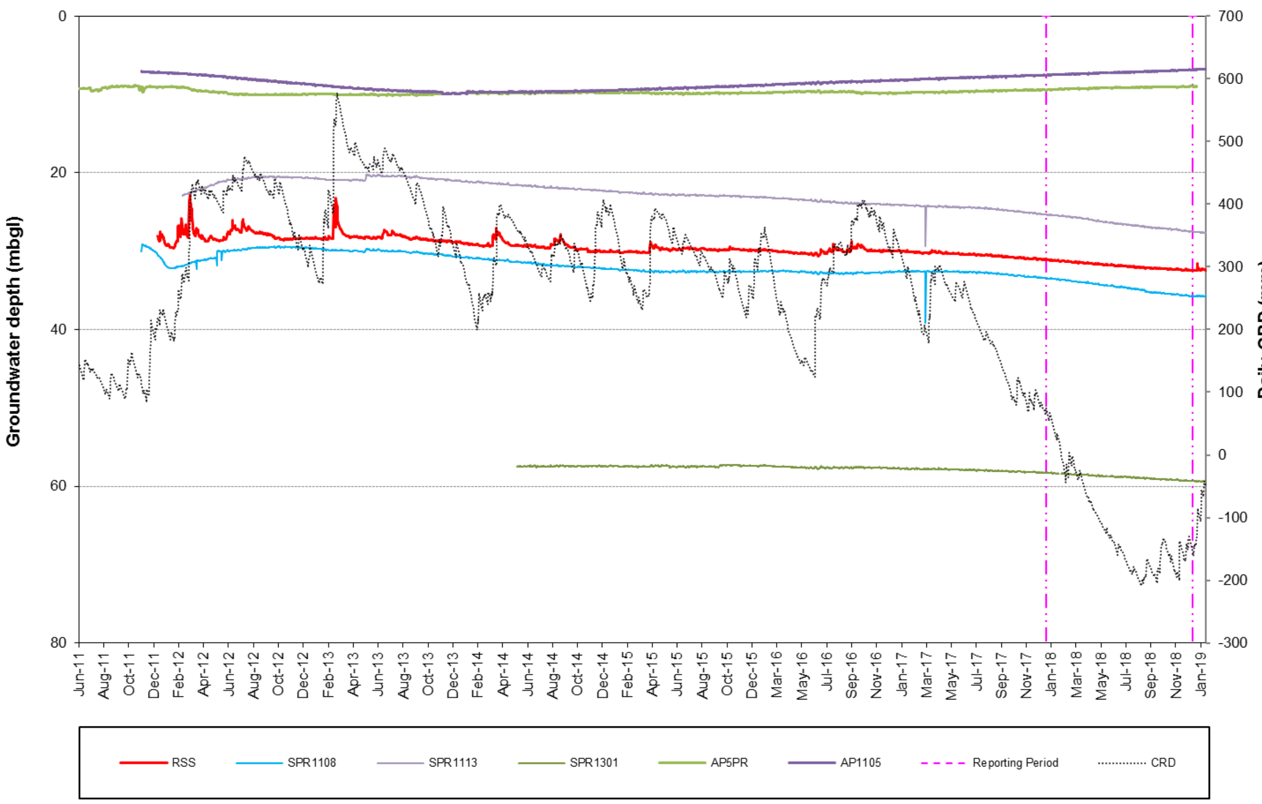

Figure 9 RSS and Reference Ridge Piezometer Hydrograph - 2011 to 2018

SPR1101

The water level in this borehole has typically remained relatively stable at 35mbgl until the water level began to decline on 3 December 2013 to 42.29mbgl on 22 December 2013. This represents a drop of 6.99m to a level below the bottom of the piezometer as the piezometer is dry. This period also corresponds to the time when LW416 was passing underneath. An investigation into the reason for the rapid drop in the water level in this monitoring point has been conducted. The investigation found that the piezometer hole was previously used as an exploration borehole and was drilled to a depth which intersected strata where bed separation effects and increased storage occurred, and while the water level has declined, it does not represent any net loss of water from the aquifer.

The replacement of SPR1101 with a deeper piezometer to intercept the reduced water level has been completed (SPR1401). A groundwater level logger was installed in this piezometer on the 20th November 2014. The water level in SPR1401 declined to around 35mbgl in mid-2015 and then stabilised. The stabilisation confirms the decline to be due to bed separation effects.

Groundwater levels for SPR1101 are presented in Figure 10.

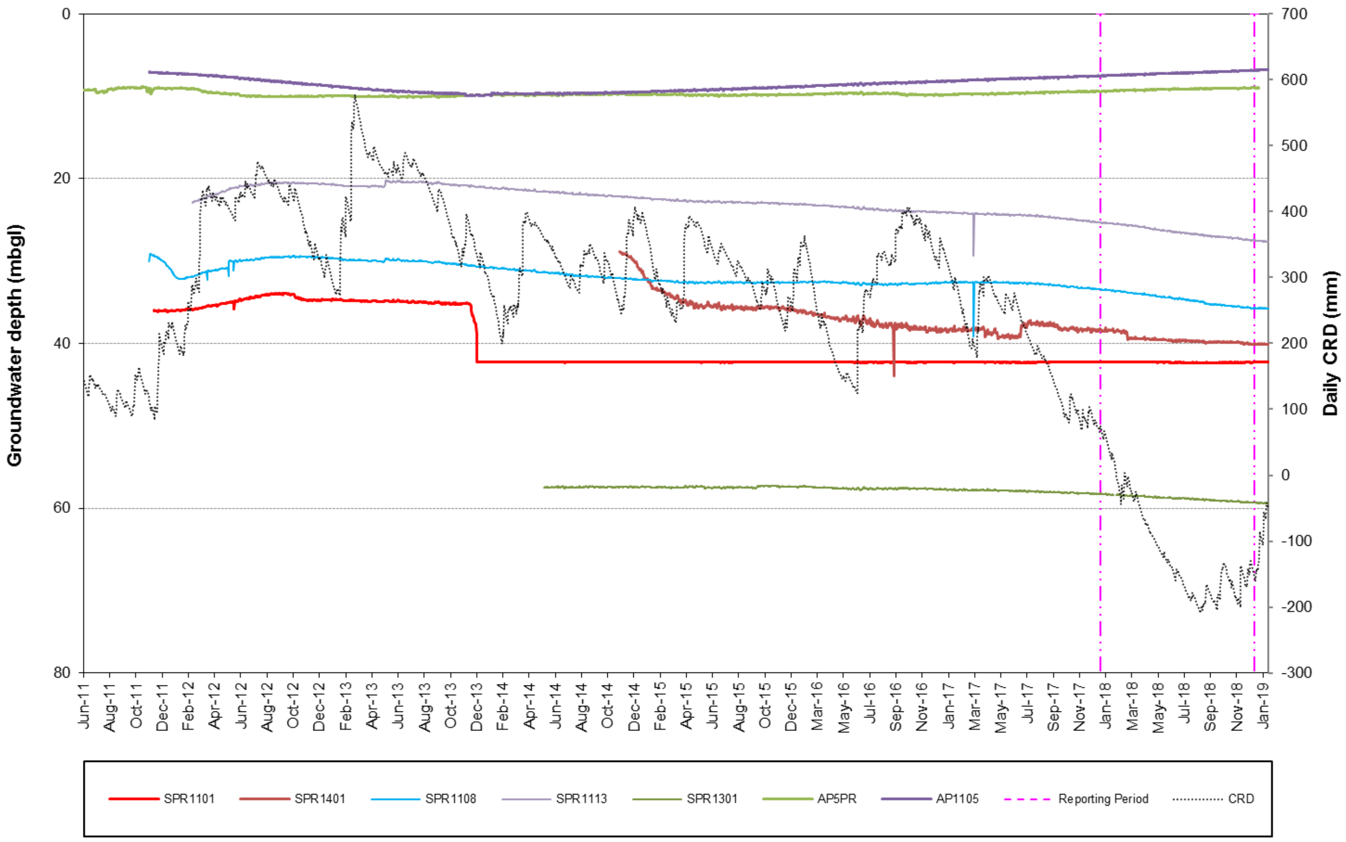

Figure 10 SPR1101 and Reference Ridge Piezometer Hydrograph - 2011 to 2018

SPR1104

SPR1104 showed an almost identical groundwater level response to the reference piezometers SPR1113, SPR1108 and SPR1111, throughout the monitoring history until October 2016 when the water level dropped before stabilising in December 2016. A sudden drop of water levels, falling below the base of the piezometer also occurred during June 2017. A similar response was also observed at SPR1111 in February 2017. This has been inferred to be in response to LW419 mining leading to bed separation effects as noted historically in SPR1101. SPR1104 dropped below the short term trigger (pre-mining 5th percentile) on the 2nd of August 2016 immediately upon entering the 600m trigger investigation area associated with LW419. Water levels at SPR1104 has not recovered falling below the base of the piezometer in July 2017 and remained below the base through the review period.

An Investigative Report was submitted in February 2017 in accordance with Springvale approvals.

Groundwater levels for SPR1104 are presented in Figure 11.

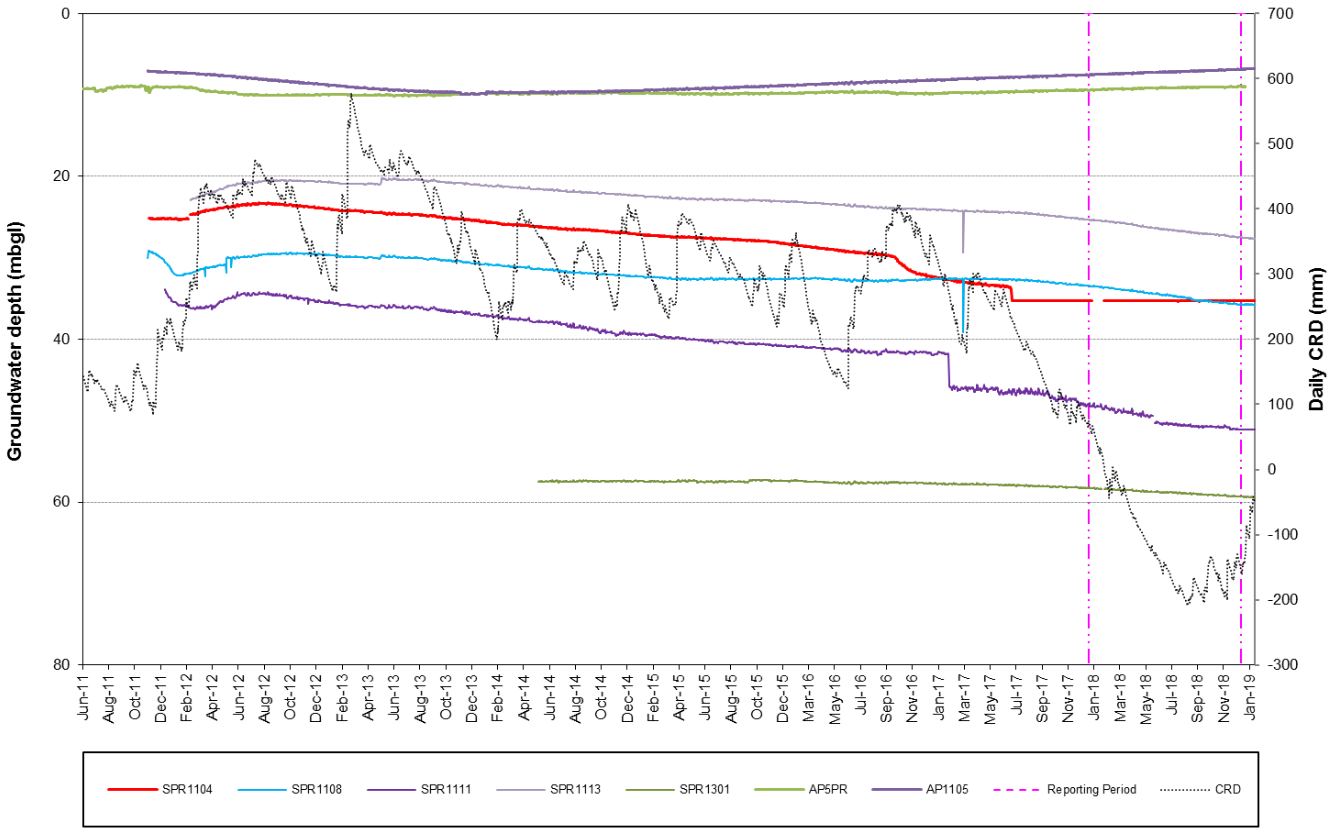

Figure 11 SPR1104 and Reference Ridge Piezometer Hydrograph - 2011 to 2018

SPR1107

SPR1107 showed similar groundwater level response to the reference piezometers SPR1113, SPR1108 and SPR1111 historically, however, over recent years the declining trend at SPR1107 has become more rapid. SPR1107 dropped below the short term trigger (pre-mining 5th percentile) on the 4th of November 2016 immediately upon entering the trigger investigation area associated with LW419. The decline continued and the water level dropped below the logger, shown by the data gap from January to September 2017. SPR1107 was undermined by LW420 and the rate of water level decline stablised once LW420 had passed, however the overall declining trend has continued to the end of the reporting period.

An Investigative Report was submitted in February 2017 in accordance with Springvale approvals.

Groundwater levels for SPR1107 are presented in Figure 12.

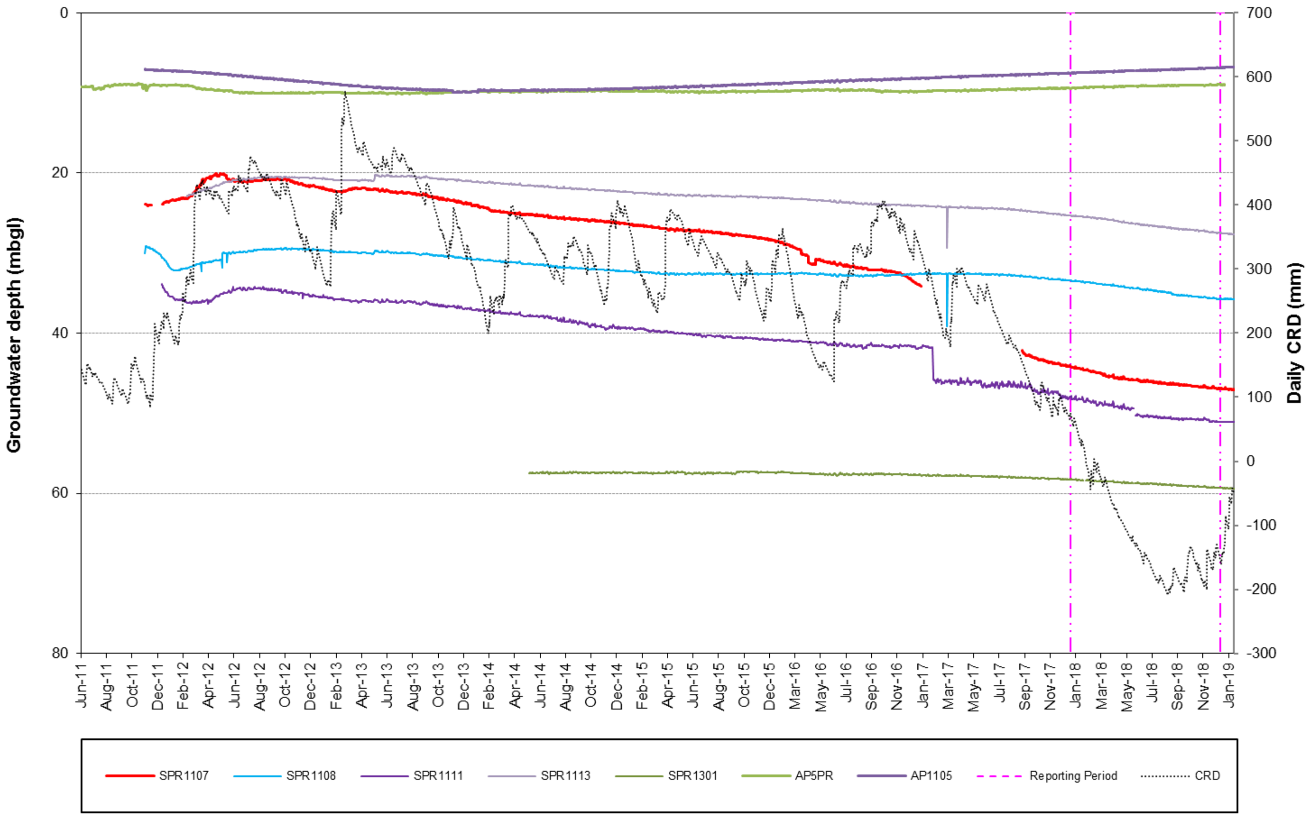

Figure 12 SPR1107 and Reference Ridge Piezometer Hydrograph - 2011 to 2018

SPR1109

SPR1109 shows similar groundwater level response to the reference swamps SPR1113, SPR1108 and SPR1111 up to the end of 2015. In series of stepped drops can be seen during the early part of 2016 which has been inferred to be due to mining induced bed separation effects and increased storage occurring, this is confirmed by the stabilization of water levels in the second half of 2016. From March to May 2017 the water level appears to have dropped below the logger before subsequent water level measurements show the overall declining trend to continue through the reporting period.

SPR1109 had exceeded the short term trigger level during the mining of LW418 in 2015. An Investigative Report was submitted in February 2016 in accordance with Springvale approvals.

Groundwater levels for SPR1109 are presented in Figure 13.

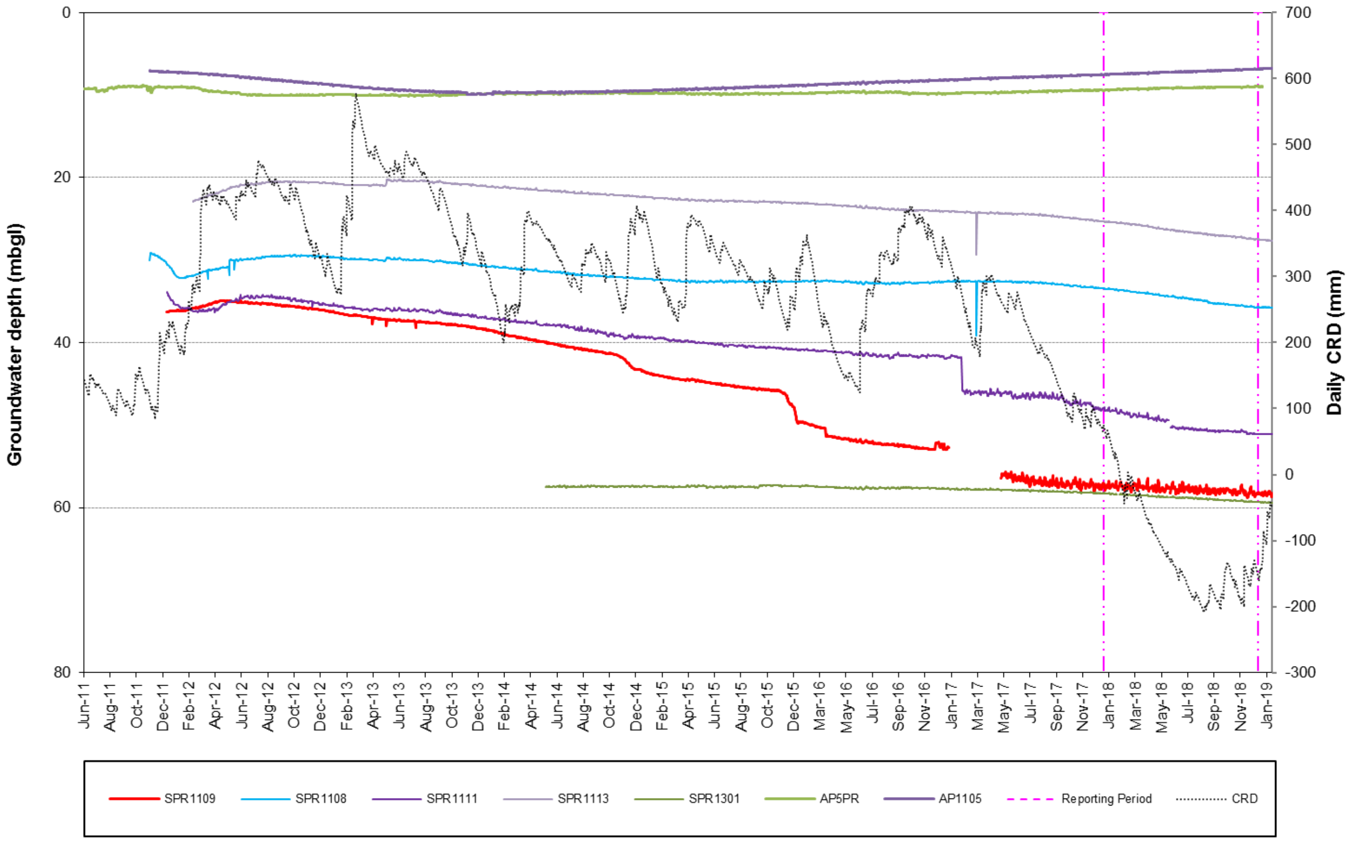

Figure 13 SPR1109 and Reference Ridge Piezometer Hydrograph - 2011 to 2018

SPR1110

SPR1110 is located above LW417 panel. A declining trend is observed in this piezometer during January 2013 with water levels declining to below the base of the piezometer where it has remained. It is possible that SPR1110 is responding to longer term climatic trends, however no response is observed to individual rainfall events and the decline may also be due to bed separation effects following LW416 extraction.

Groundwater levels for SPR1110 are presented in Figure 14.

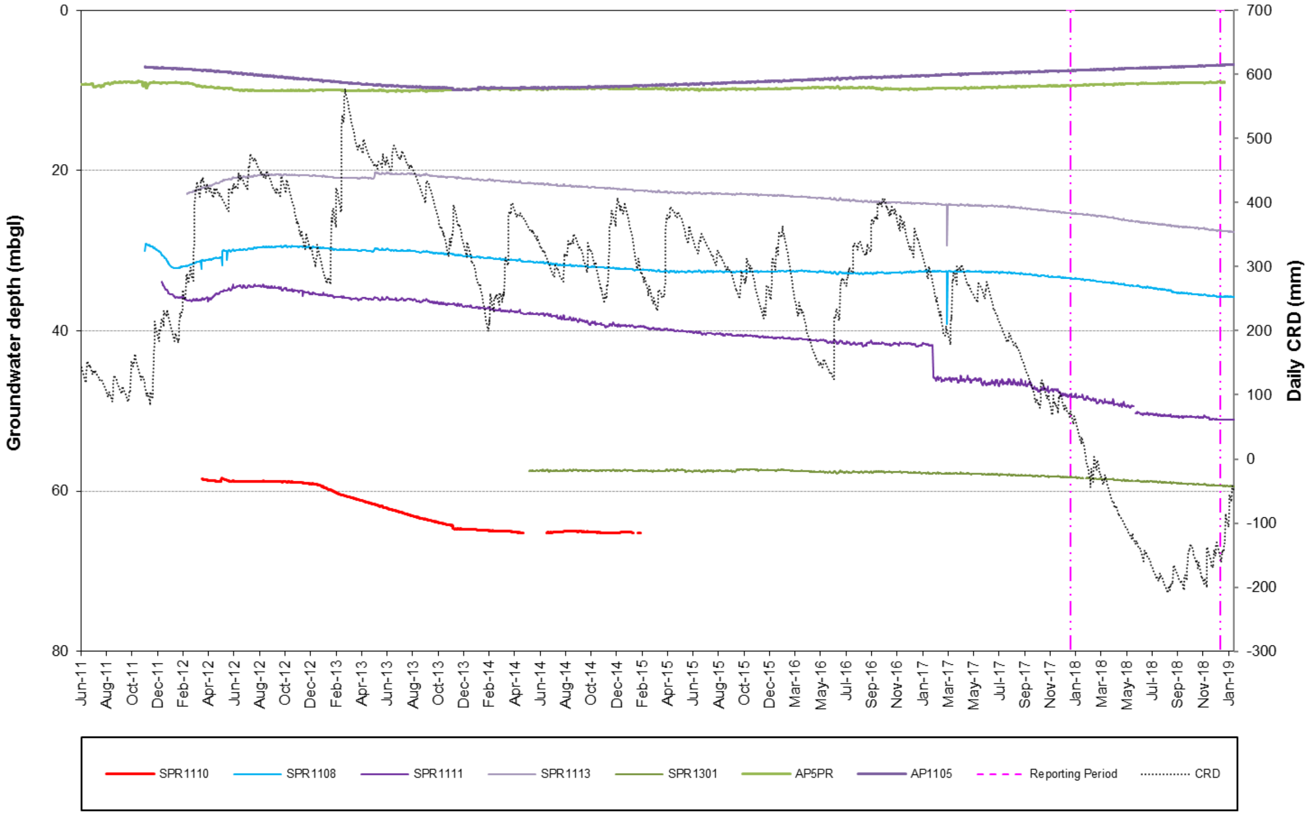

Figure 14 SPR1110 and Reference Ridge Piezometer Hydrograph - 2011 to 2018

5.3.3. Groundwater Quality

Groundwater monitoring samples are collected opportunistically based upon groundwater level which is presented in Section 5.3.1.

Carne West

CW1 and CW2

Water quality data for CW1 is available until May 2014, after this date the piezometer was largely dry and unable to be sampled. No samples were able to be obtained from CW1 throughout 2017. Historic results are presented for reference.

Water quality data for CW2 is available until May 2015, after this date the piezometer has been dry and unable to be sampled.

Figure 15 presents pH results for CW1 and CW2.

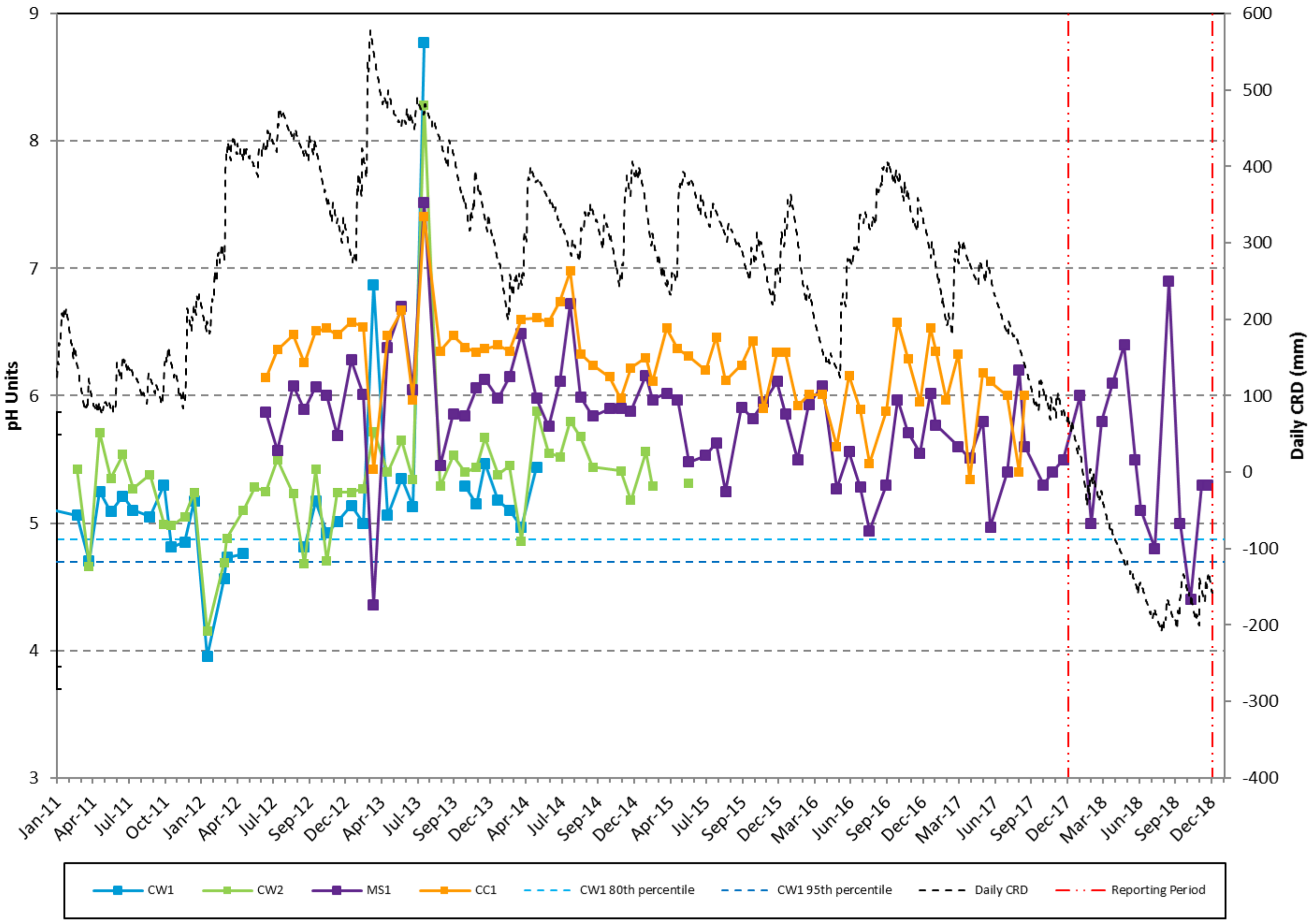

Figure 15 CW1 and CW2 Monitoring Data – pH - 2011 to 2018

Figure 16 presents Electrical Conductivity (EC) results for CW1 and CW2.

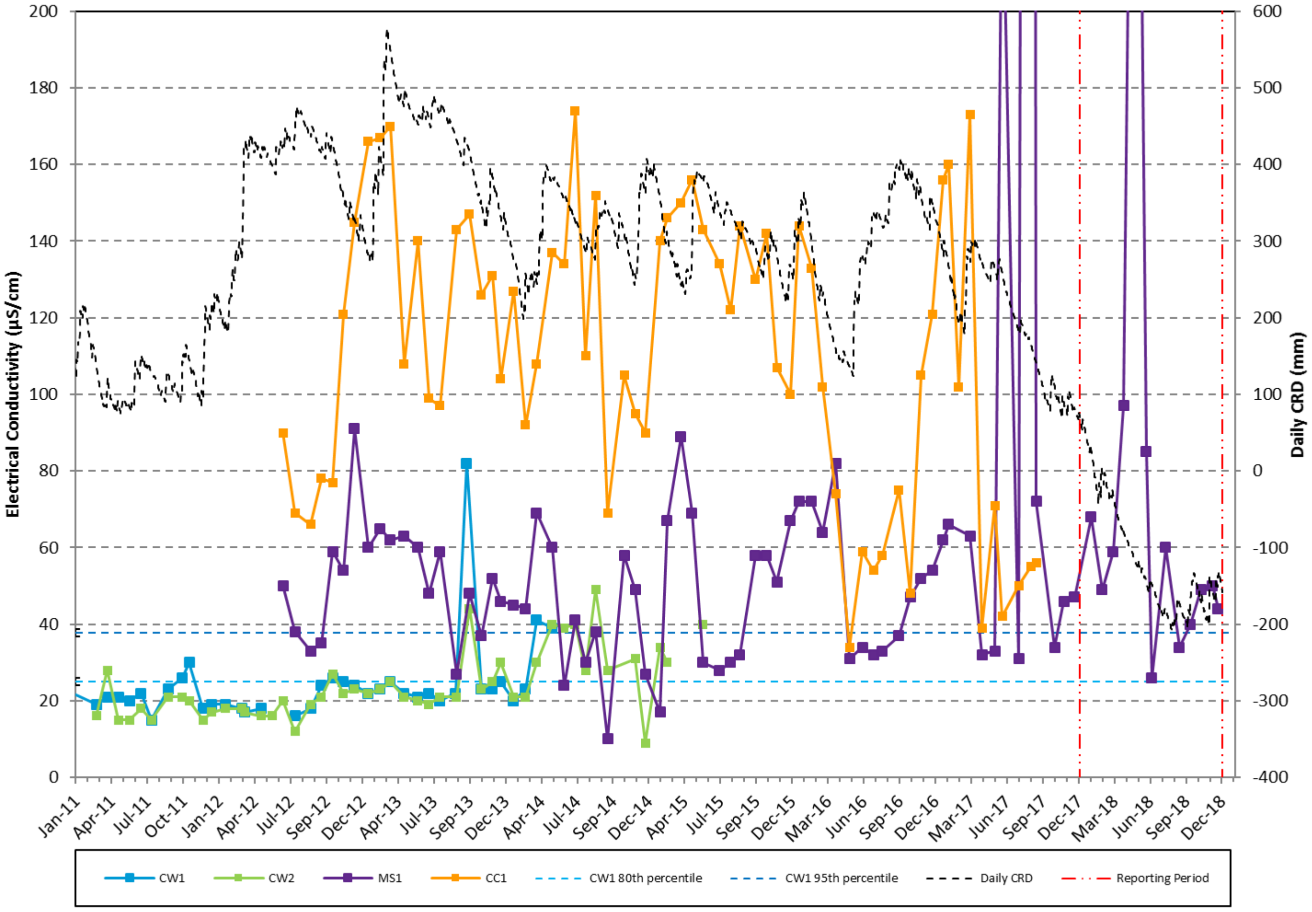

Figure 16 CW1 and CW2 Monitoring Data – EC - 2011 to 2018

Figure 17 presents filterable iron results for CW1 and CW2.

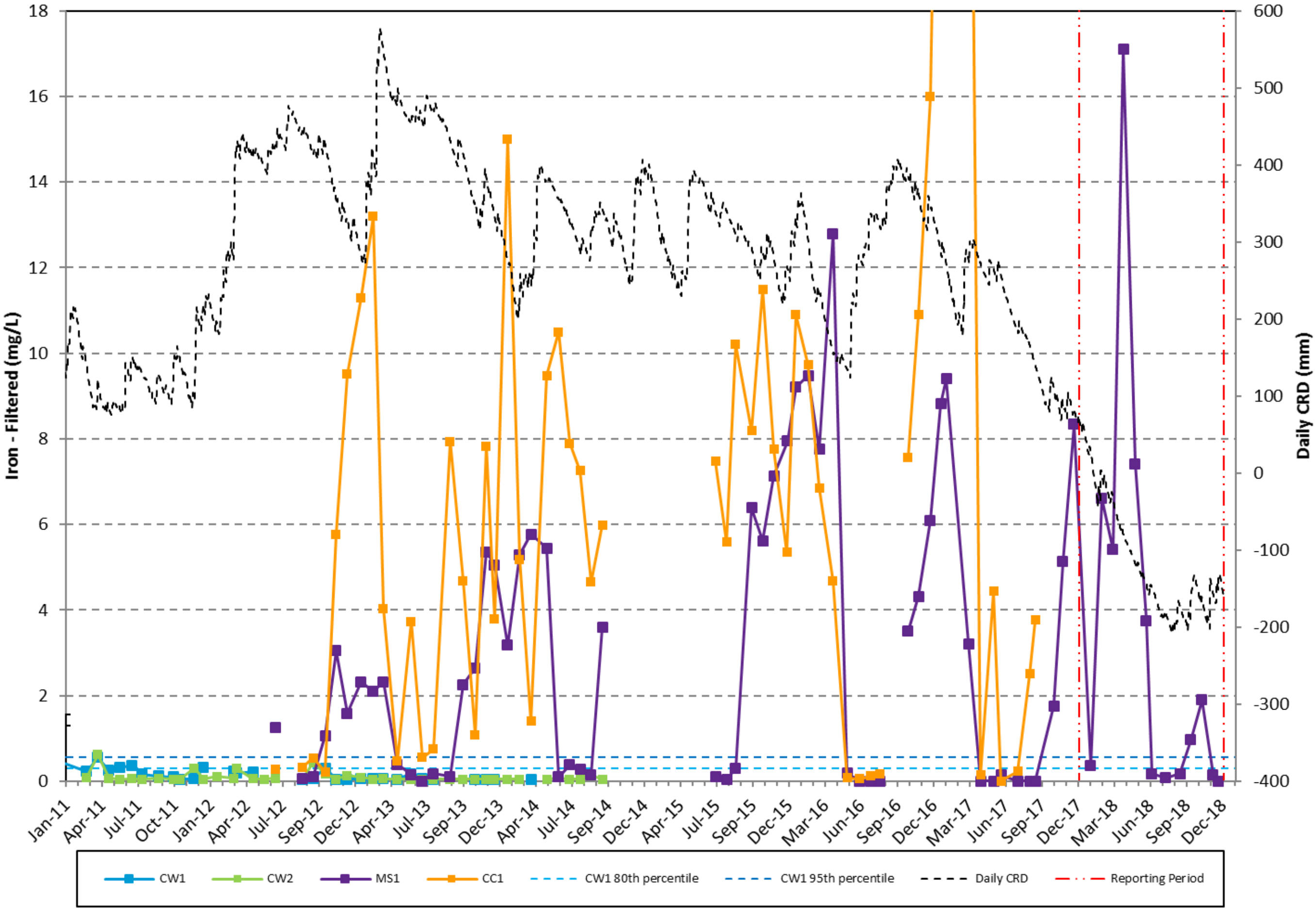

Figure 17 CW1 and CW2 Monitoring Data – Fe - 2011 to 2018

SSE3

A decline in water levels at SSE3 has meant that only limited sampling has been possible since 2014. Sampling has not been possible during the current reporting period.

pH

The pH at SSE3 has historically fluctuated between 5.2 and 6.3 pH units. These fluctuations are considered natural and are consistent with the reference swamps.

Figure 18 presents pH results for SSE3.

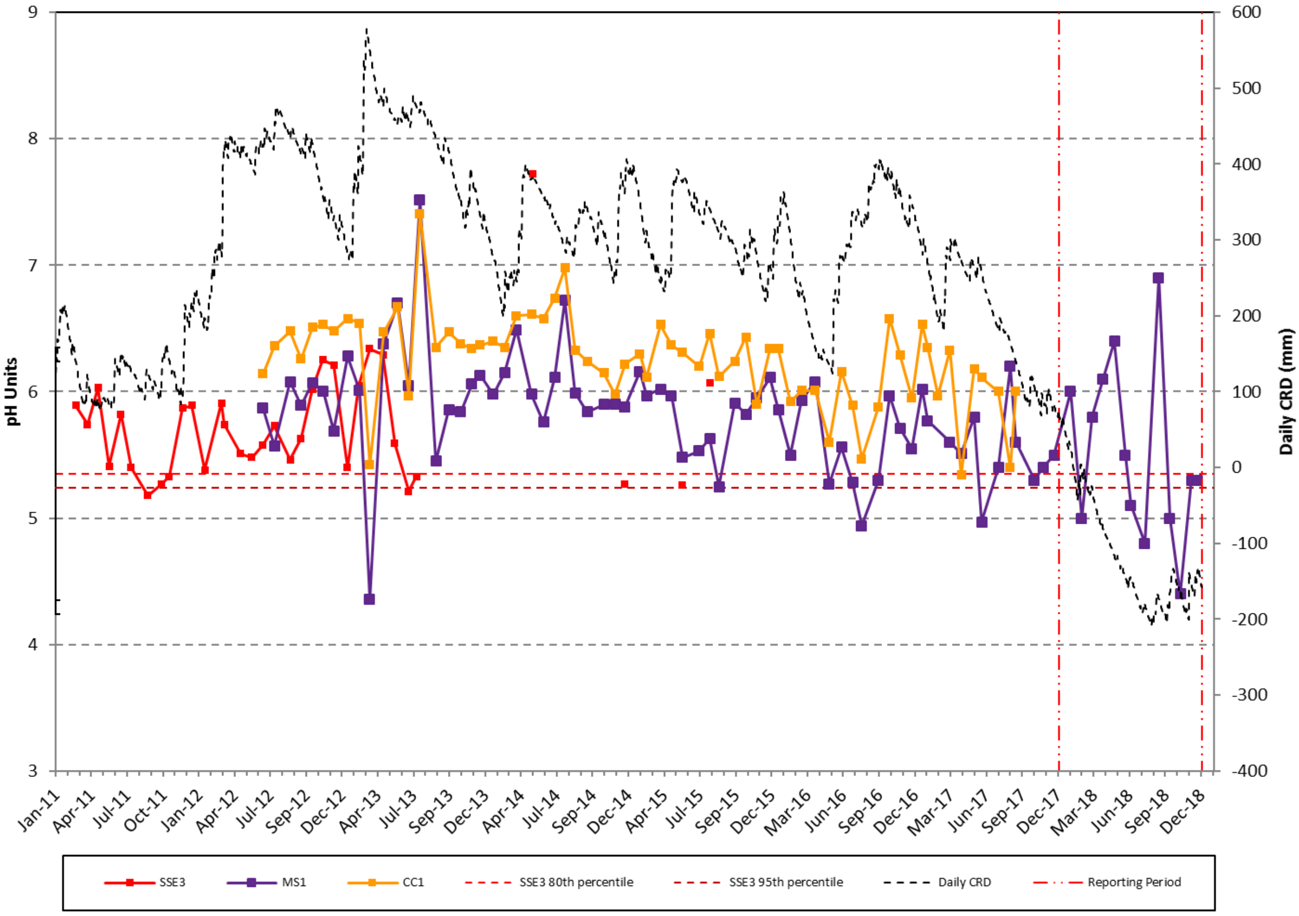

Figure 18 SSE3 Swamp Piezometers – pH - 2011 to 2018

Electrical Conductivity

EC at SSE3 is generally very fresh, historically ranging between 20 and 100µS/cm. This is similar to the MS1 reference site and less than the CC1 reference site. A decline in water levels at SSE3 has meant no water samples could be taken during the review period. An extended duration of below average rainfalls during the 2018 review period had caused EC at reference site MS1 to spike.

Figure 19 presents EC results for SSE3.

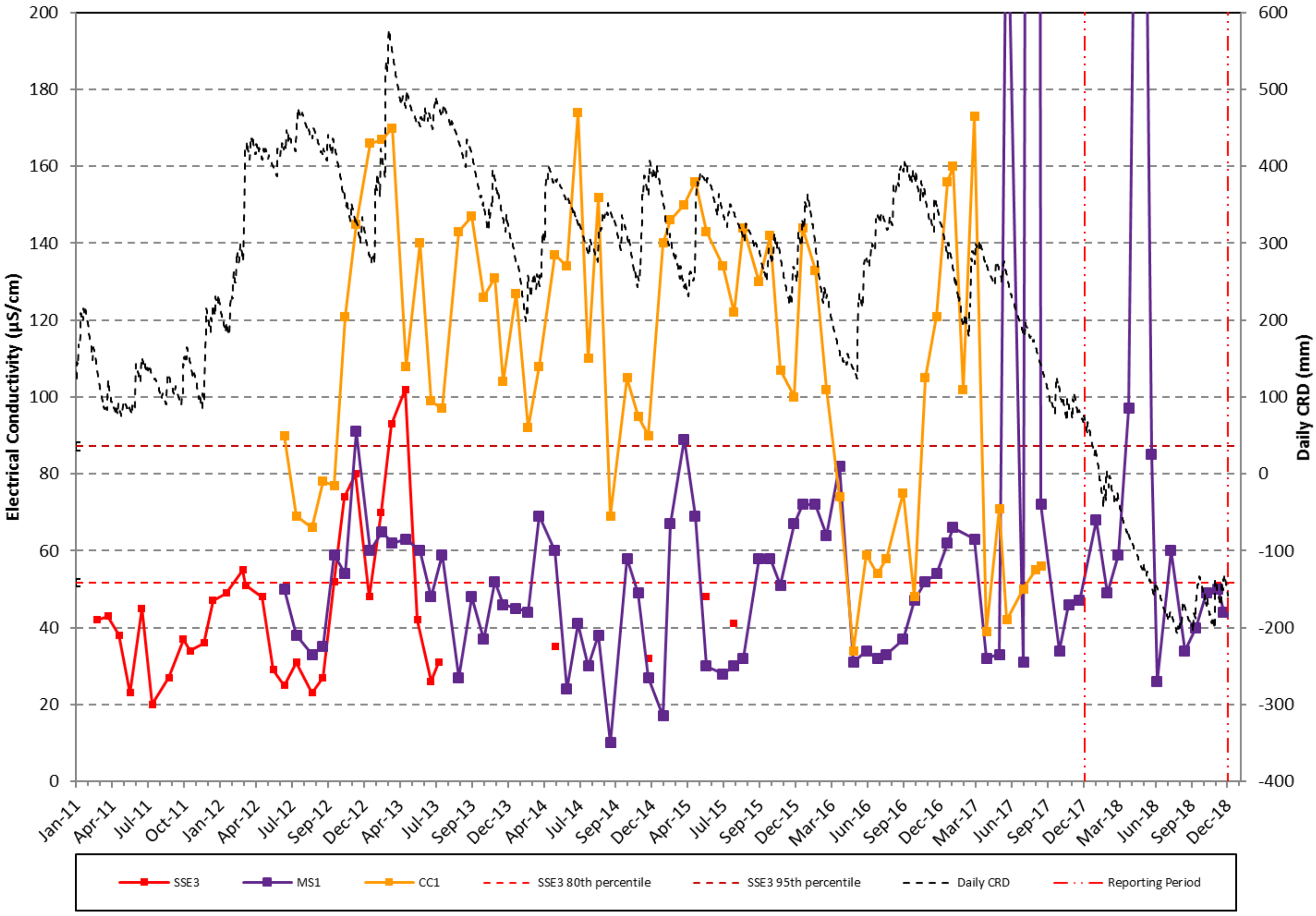

Figure 19 SSE3 Swamp Piezometers – EC - 2011 to 2018

Iron

The concentration of filtered iron at SSE3 has historically ranged between 0.18 and 14.4mg/L with elevated values correlating reasonably well with periods of above average rainfall. During the review period no samples were taken due to low water levels.

Figure 20 presents filterable iron results for SSE3.

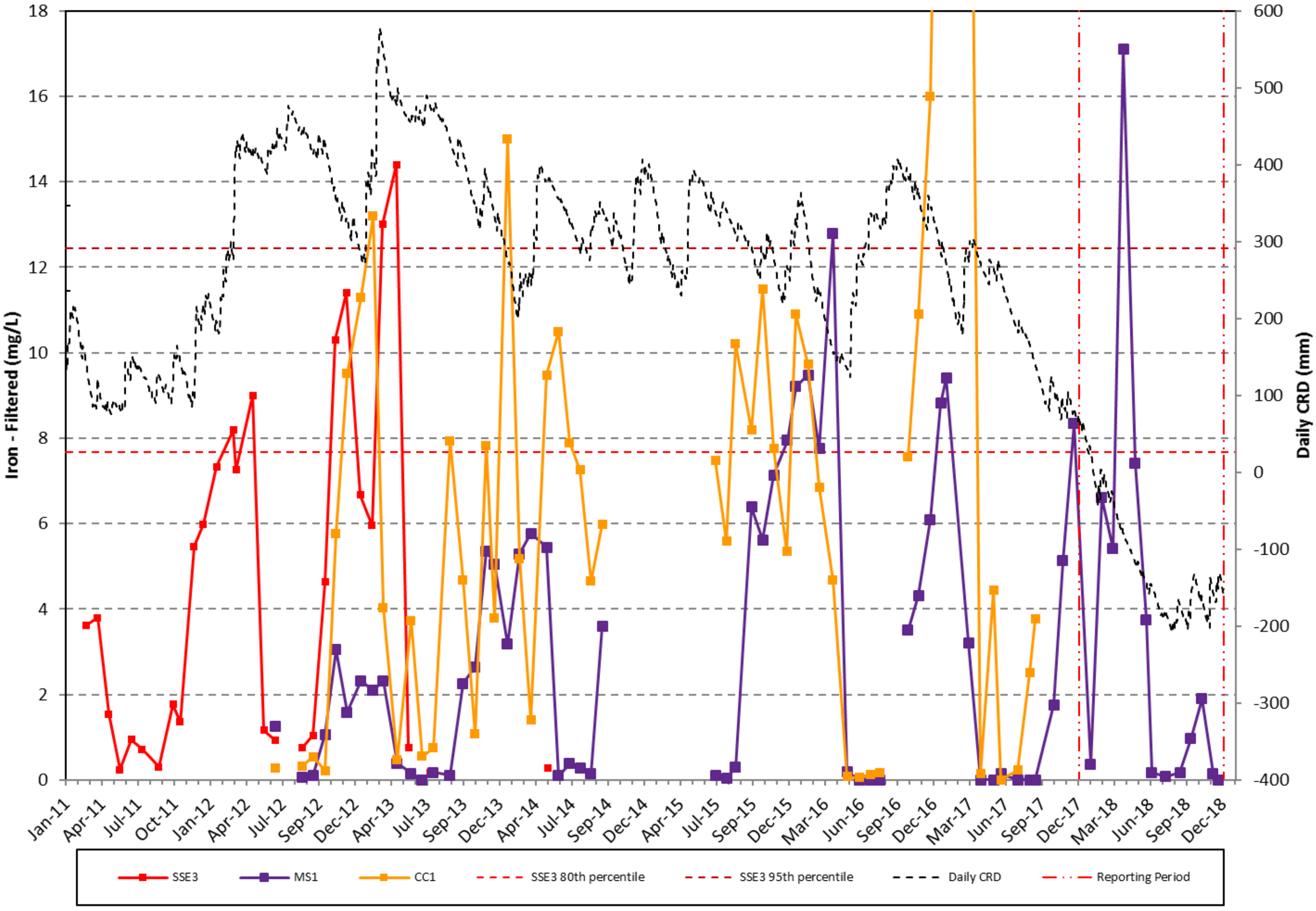

Figure 20 SSE3 Swamp Piezometers – Fe - 2011 to 2018

5.4. Surface Water

Surface water monitoring samples are collected opportunistically based upon water level and flow rates.

5.4.1. Carne West

Flow Rate

Flows in Carne West historically showed a close correlation with the CRD, increasing during periods of above average rainfall and spiking with large rainfall events until mid 2014, after which, little or no flows have been recorded. The change in flow regime is likely in part due to an extended dry period from 2014 through to mid 2018 when moderate rainfall has been observed, reversing the negative CRD trend. Rainfall levels continued to fluctuate and it is considered that rainfall has not been sufficient as only transient flows occured during the reporting period in Carne West, some of which may have occurred between sampling rounds.

Figure 21 presents flow rate monitoring results for Carne West.

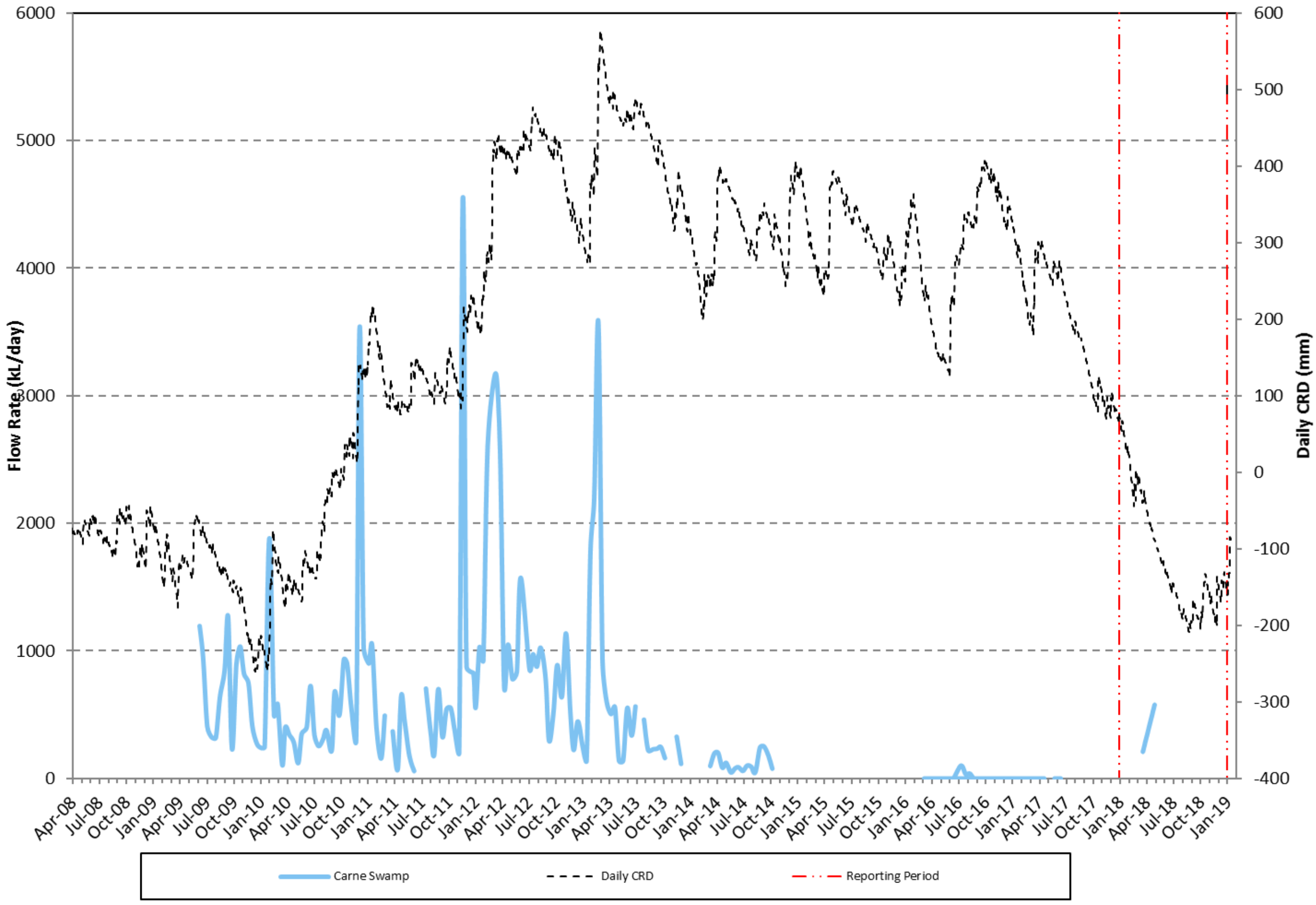

Figure 21 Carne West Flow Monitoring Results June 2009 to 2018

Water Quality

pH

The pH at Carne West has historically fluctuated between 4 and 8 pH units. These fluctuations are considered natural given that the pH at Marrangaroo Creek fluctuates between similar levels. Only one pH sample was taken at Carne West during the review period because of dry conditions and it was within historical limits.

Figure 22 presents pH results at Carne West.

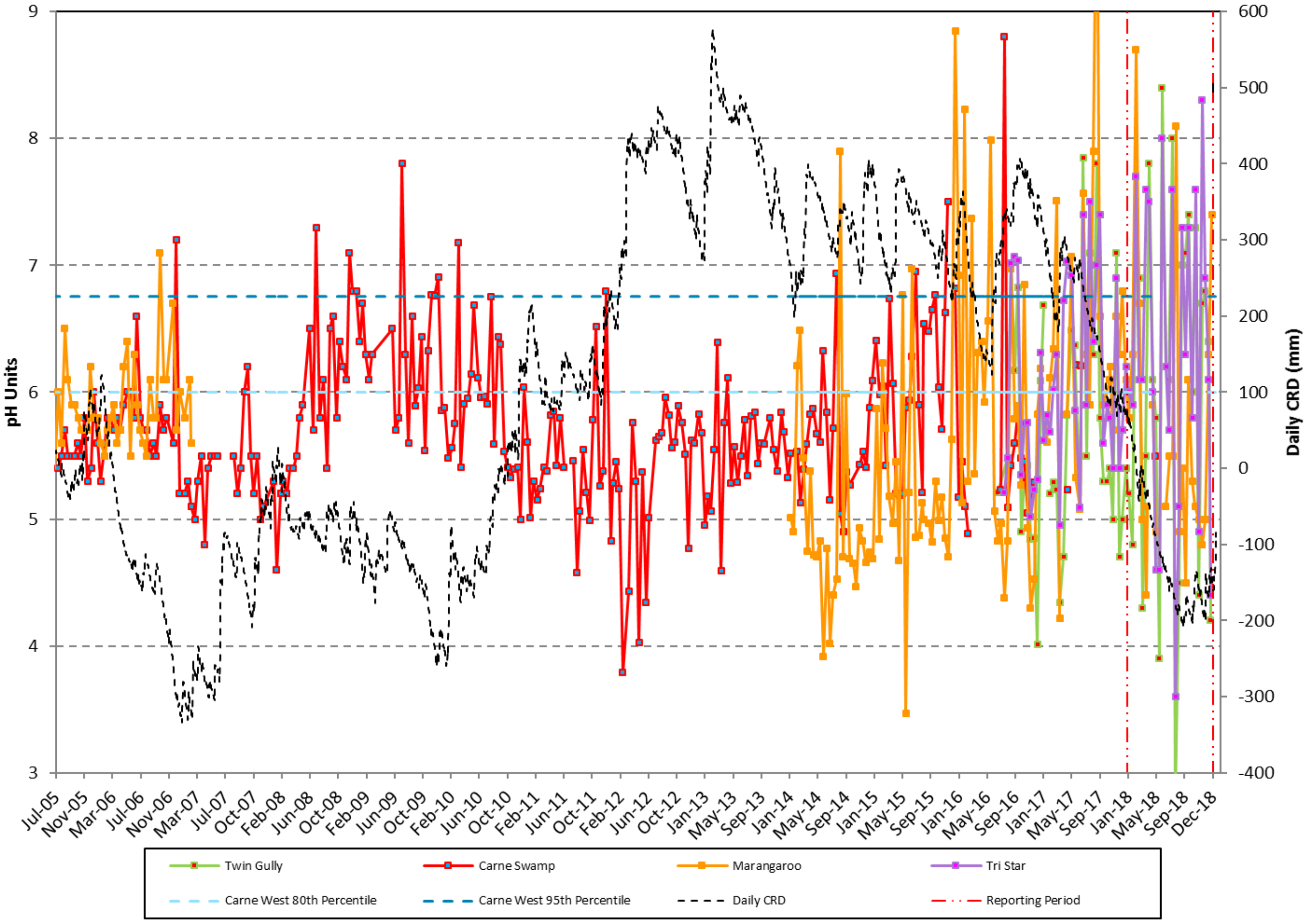

Figure 22 Carne West Monitoring Data – pH - 2005 to 2018

Electrical Conductivity

The EC at Carne West is extremely fresh ranging historically between 10 and 40µS/cm, which is close to the EC of rain water. Marrangaroo Creek has historically fluctuated between 10 and 70µS/cm, which is also considered fresh. Carne West generally remained dry during the review period, only one sample was able to be taken in April, the EC reading remained beneath the 80th percentile within historical limits.

Figure 23 presents EC results at Carne West.

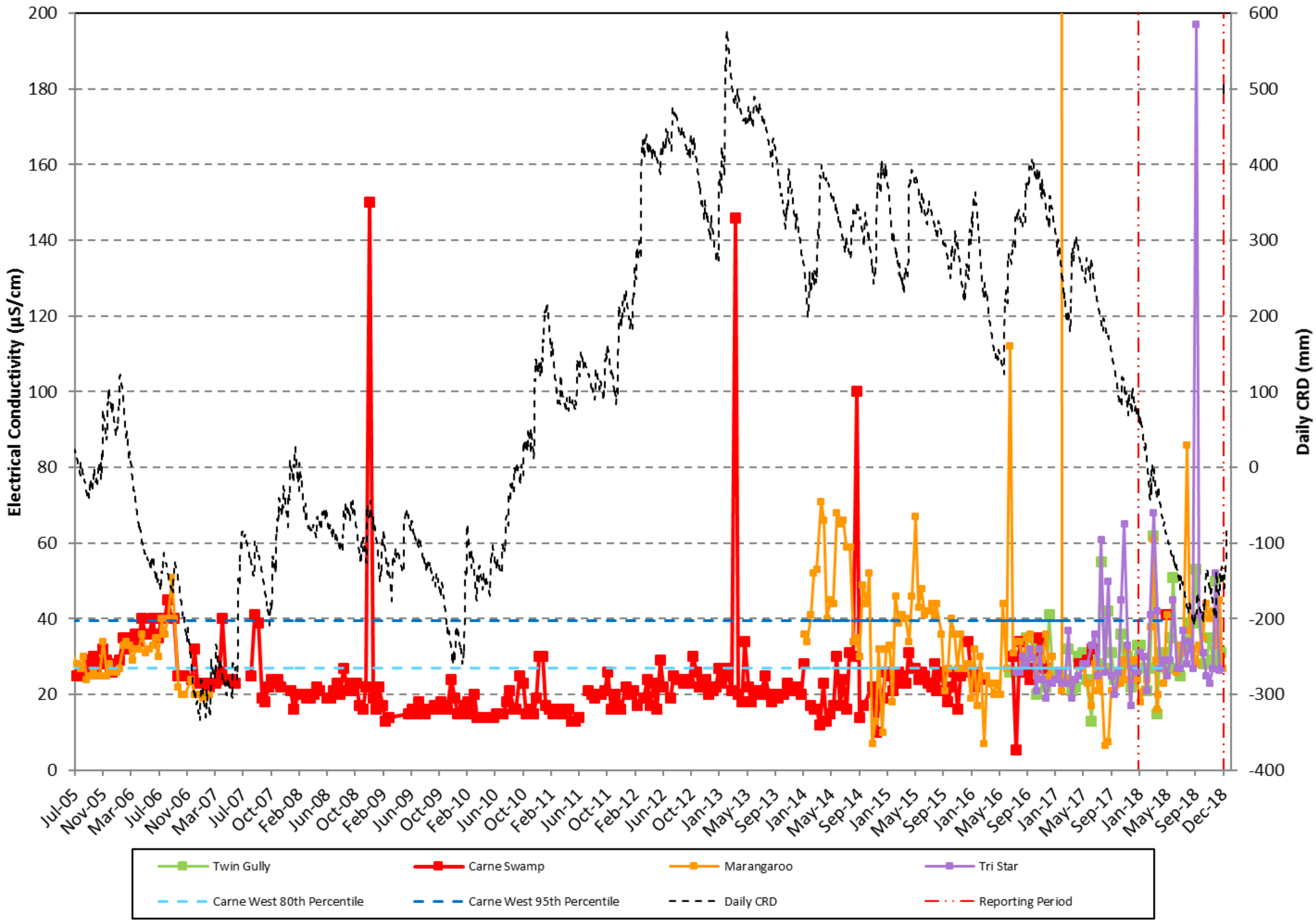

Figure 23 Carne West Monitoring Data – EC - 2005 to 2018

Manganese

The concentration of filtered manganese at Carne West historically fluctuates between 0 and 0.05mg/L with occasional spikes recorded during periods of increased rainfall. These results are similar to those recorded at Marrangaroo Creek. During the reporting period, no data was collected on manganese due to dry conditions.

Figure 24 presents Manganese results at Carne West.

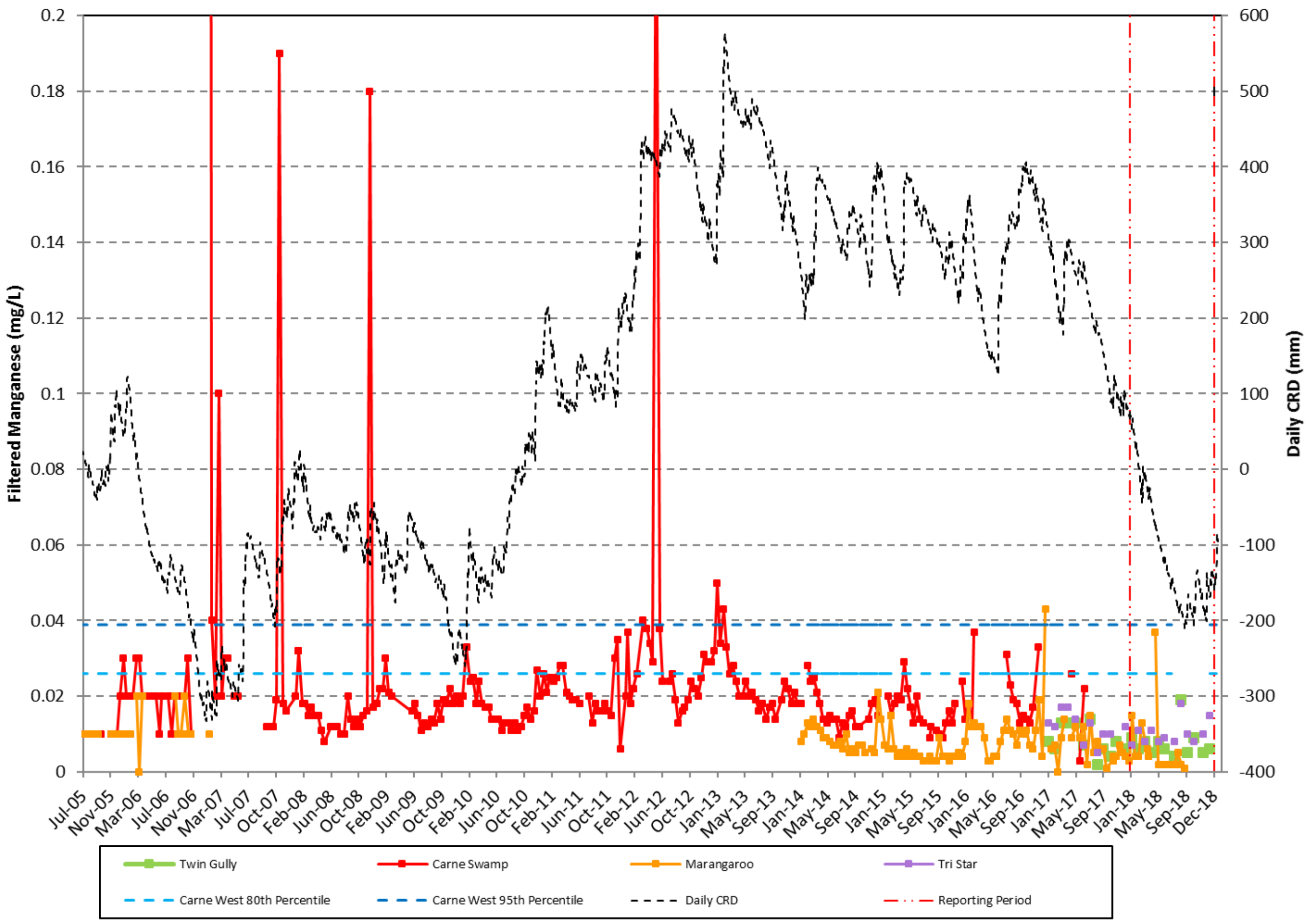

Figure 24 Carne West Monitoring Data – Mn - 2005 to 2018

Iron

The concentration of filtered iron at Carne West historically fluctuates between 0.1 and 1.0mg/L with occasional spikes recorded during periods of increased rainfall. These results are similar to those recorded at Marrangaroo Creek. Iron was not sampled during the reporting period due to dry conditions.

Figure 25 presents Iron results at Carne West.

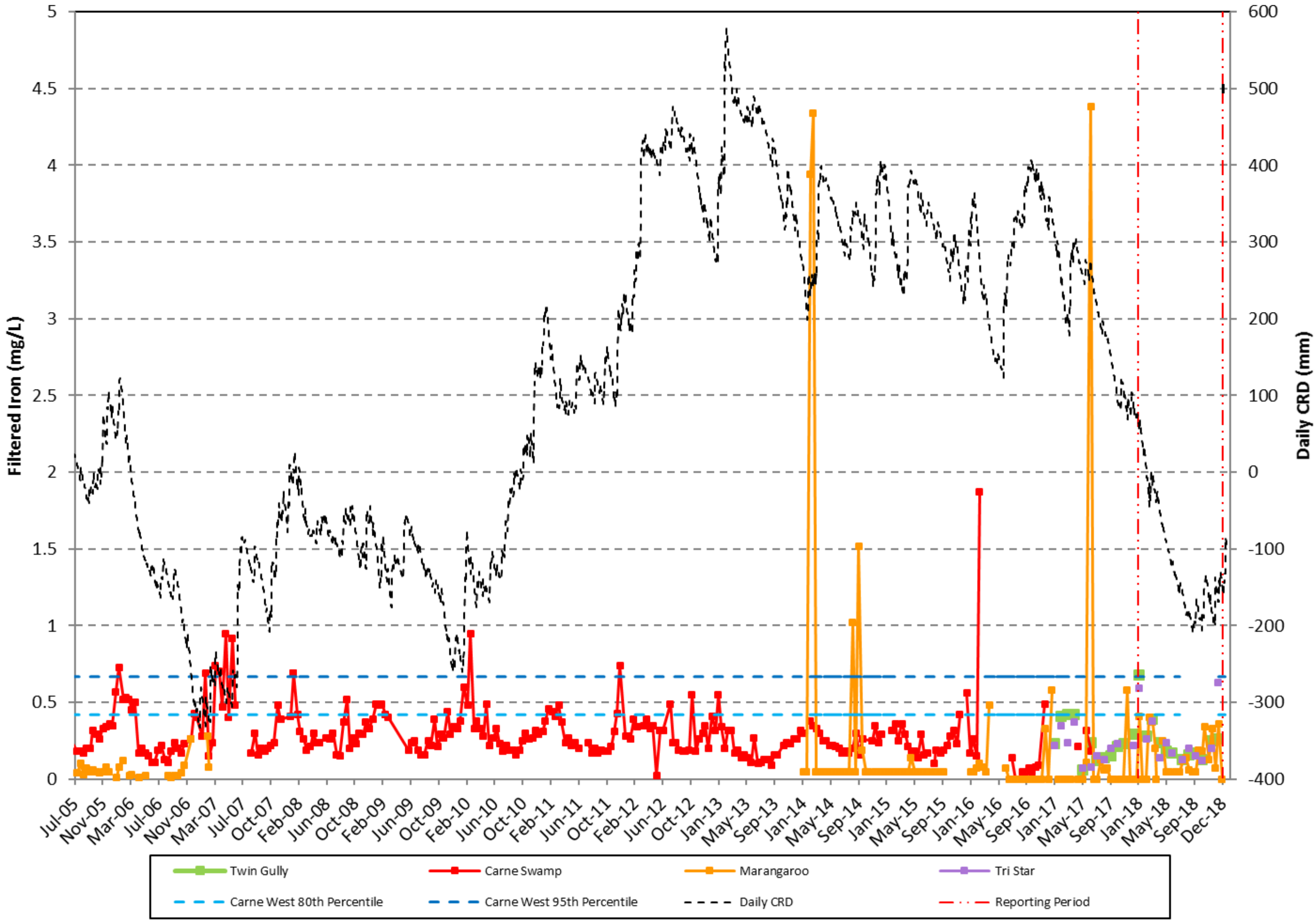

Figure 25 Carne West Monitoring Data – Fe - 2005 to 2018

5.4.2. Carne West Pool (CWP)

Water Depth

Pool data depths historically show characteristic spikes which correspond to rainfall. Carne West Pool was dry during the review period. Monitoring at Carne West Pool began during a extended wetting period and it has gone dry in the past during periods of low rainfall. The observed response is considered to be within historical variability and can be explained by the extended dry climatic conditons during the reporting period.

Spikes in pool depth do not always have a clear immediate relationship with rainfall events. Progressive increases in pool depth during periods of below average rainfall indicate that there is considerable storage retained in the swamp alluvium/peat, and a delayed release of this water to the stream is occurring.

Carne West Pool water depth data is presented in Figure 26.

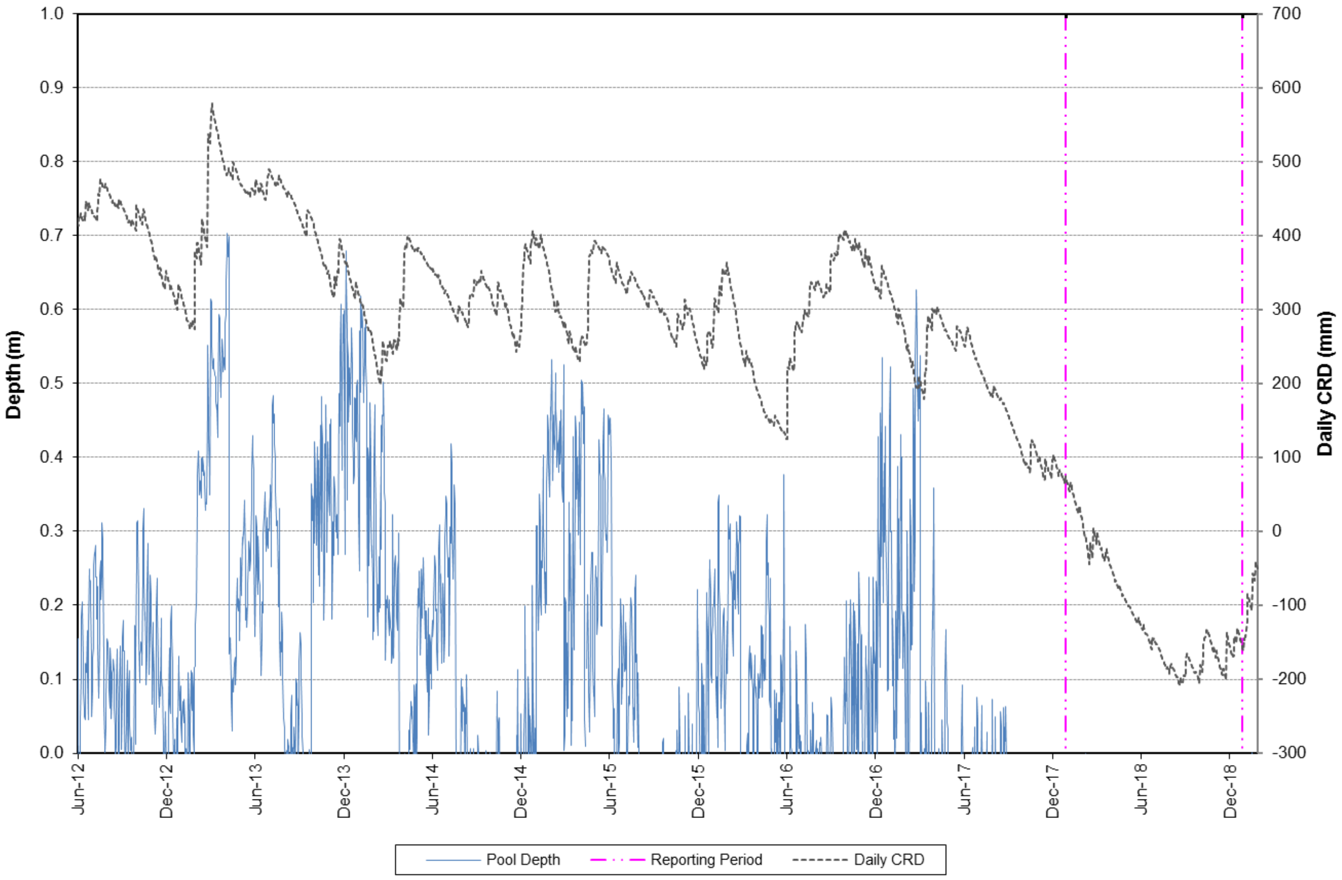

Figure 26 Carne West Pool Monitoring Data 2012 to 2018

5.4.3. SS3 Downstream

Water Quality

pH

The pH at SSE3 Downstream has historically fluctuated between 4.5 and 7.5 pH units. These fluctuations are considered natural given that the pH at reference sites fluctuates between similar levels.

The surface water level in SSE3 Downstream was too shallow to sample throughout 2018.

Figure 27 presents pH results for SS3 Downstream.

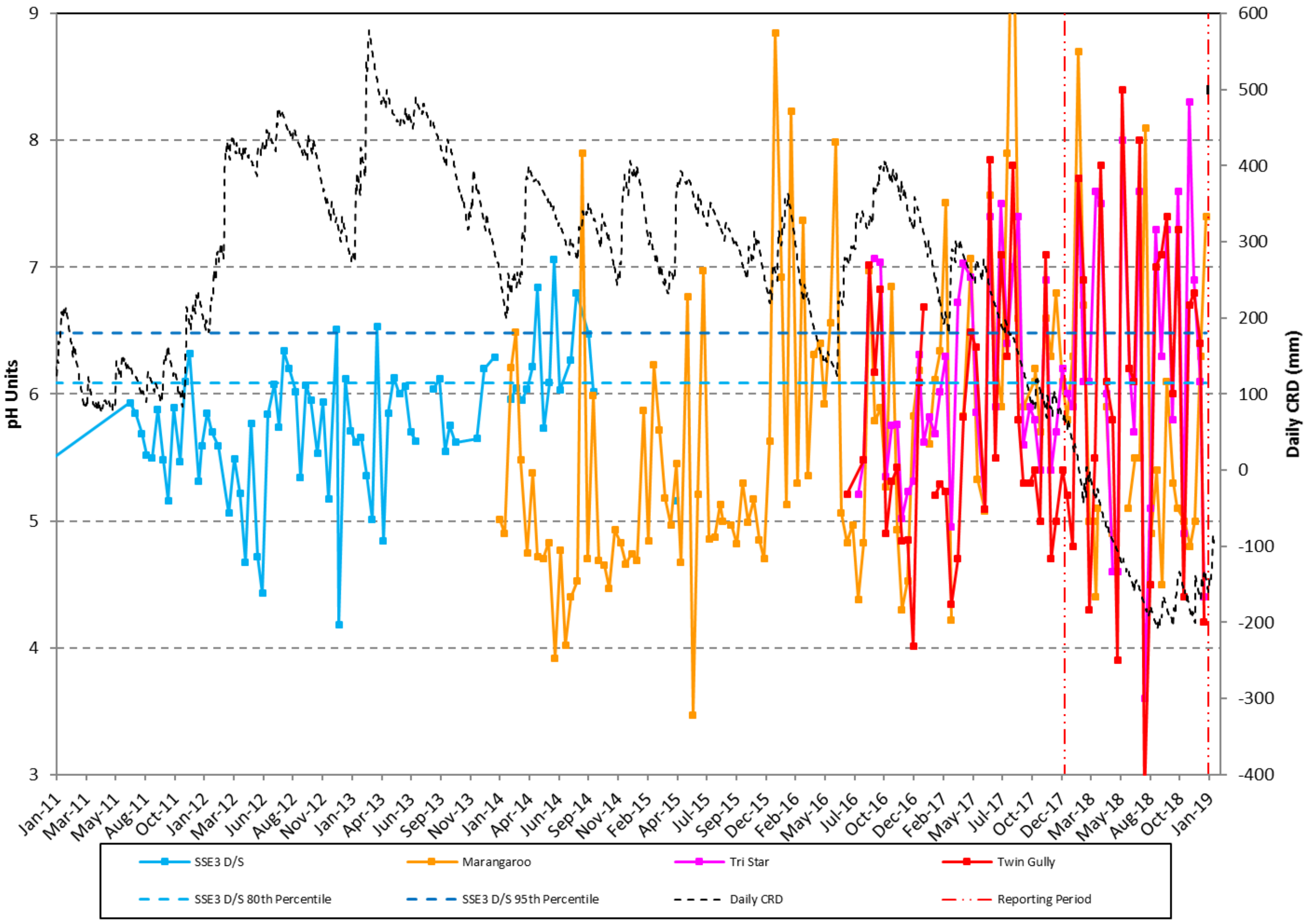

Figure 27 SS3 D/S Monitoring Results – pH - 2010 to 2018

Electrical Conductivity

The EC at SSE3 Downstream is extremely fresh ranging historically between 10 and 40µS/cm. which is close to the EC of rain water. Marrangaroo Creek has historically fluctuated between 10 and 70µS/cm, which is also considered fresh. No samples have been collected during the reporting period due to the sampling site being dry.

Figure 28 presents electrical conductivity results SS3 Downstream.

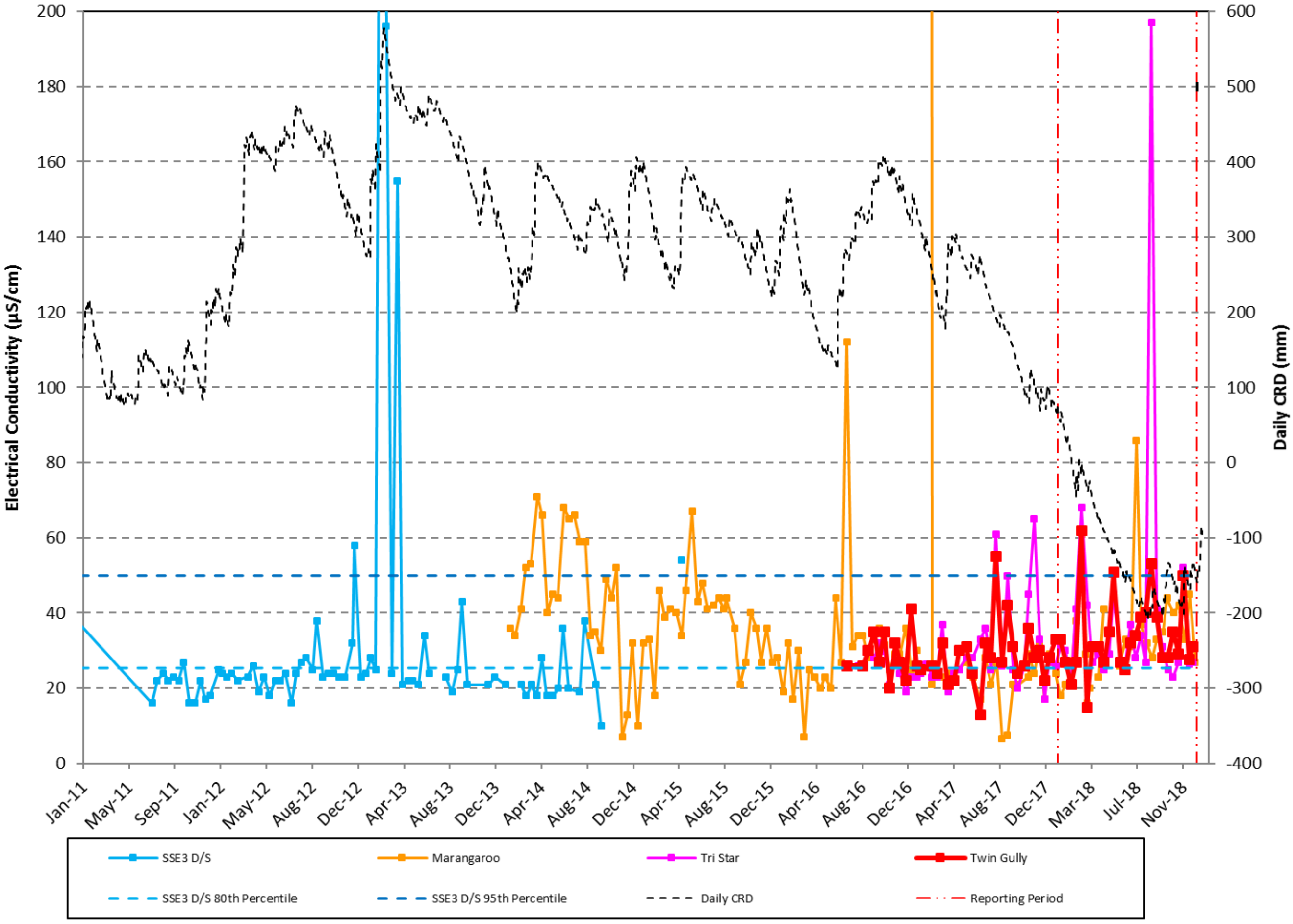

Figure 28 SS3 D/S Monitoring Results – EC - 2010 to 2018

Managanese

The concentration of Filtered Manganese at SSE3 Downstream historically fluctuates between 0.01 and 0.05mg/L with occasional spikes recorded during periods of increased rainfall. These results are similar to those recorded at Marrangaroo Creek. No sample could be collected during the reporting period due to the sampling site being dry.

Figure 29 presents filterable manganese results for SS3 Downstream.

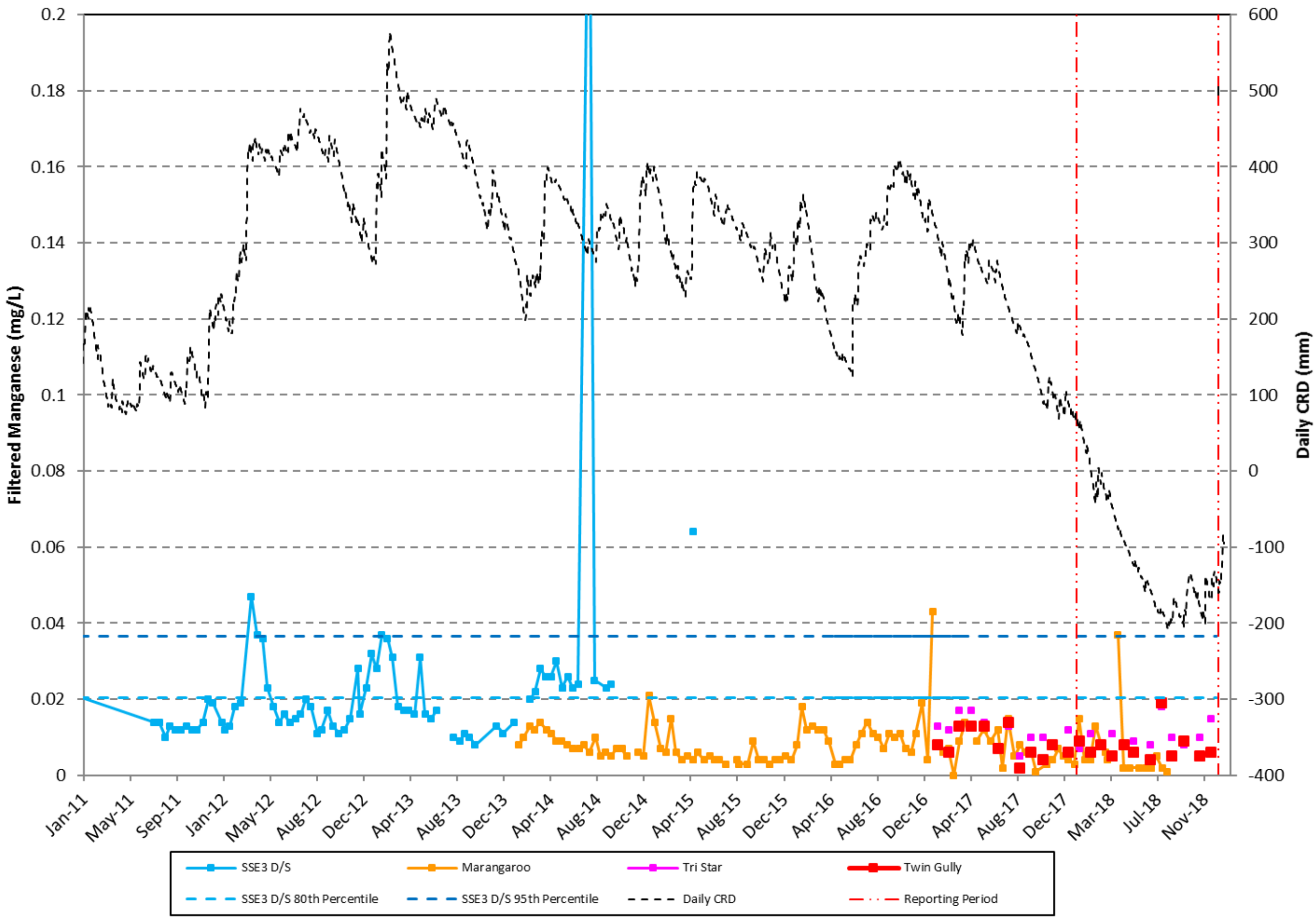

Figure 29 SS3 D/S Monitoring Results – Mn – 2011 to 2018

Iron

The concentration of Filtered Iron at SSE3 Downstream historically fluctuates between 0.1 and 0.5mg/L with occasional spikes recorded during periods of increased rainfall. These results are similar to those recorded at Marrangaroo Creek. No samples could be collected during the reporting period due to the site being dry.

Figure 30 presents filterable iron results for SS3 Downstream.

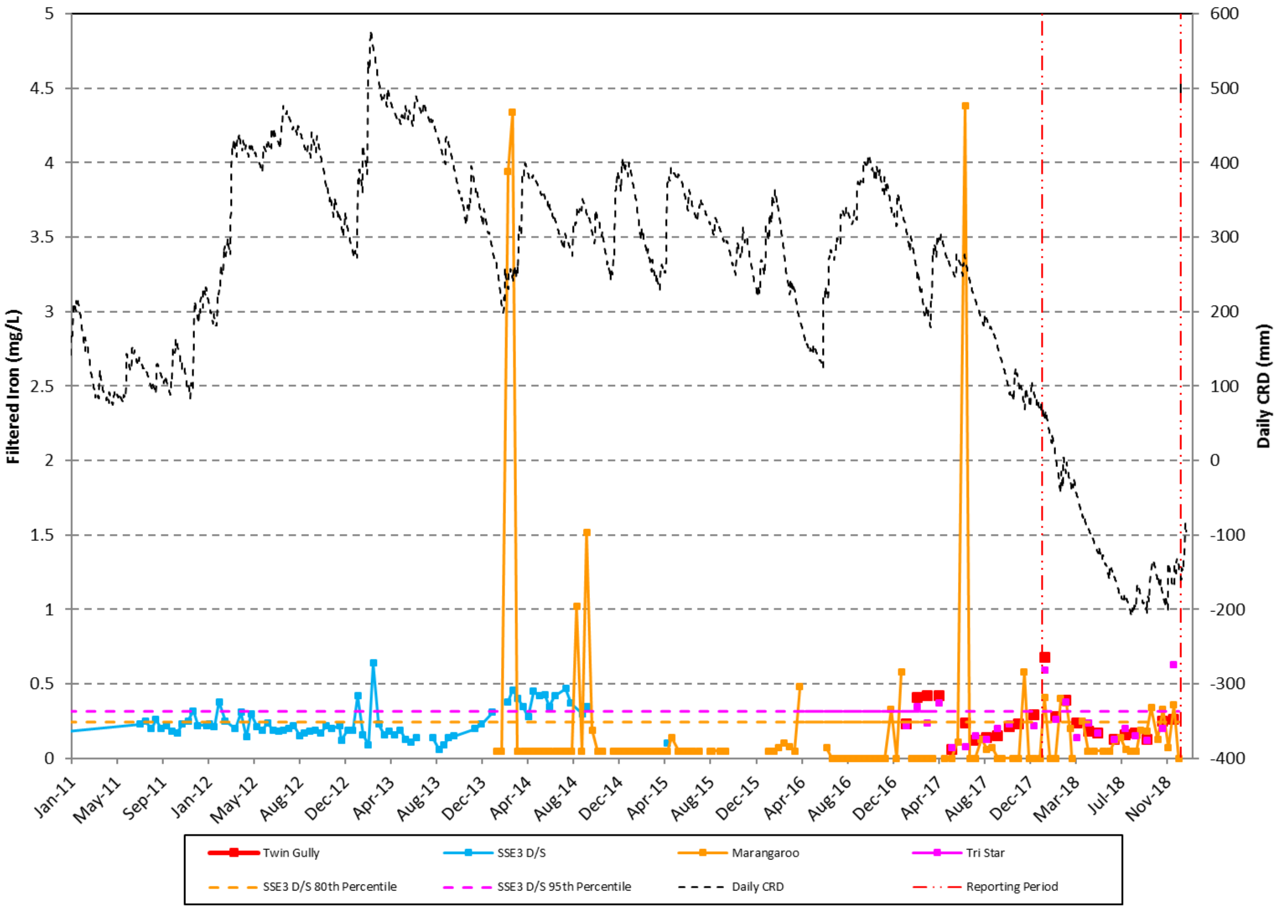

Figure 30 SS3 D/S Monitoring Results – Fe - 2010 to 2018

6. TRIGGER LEVELS AND EXCEEDANCES

6.1. Subsidence

Triggers for subsidence have been developed following modelled predictions for subsidence above longwall panels 415, 416 and 417. The modelling is based on previous monitoring data as well as subsidence theory.

Anomalous subsidence is defined in the Springvale Coal EPBC approval 2011/5949 and in the THPSS MMP for longwalls 415-417. The subsidence trigger levels from the THPSS MMP are presented in Table 21.

Table 21. Subsidence Trigger Levels

Location	Survey Sites	Performance Trigger Levels	
		Anomalous Subsidence	
LW415 **(W=315 metres)**	B and M lines	Subsidence	>1.5 metres
		Tilt	> 10 mm/metres
		Tensile Strain	> 15 mm/metres
		Compressive Strain	>18 mm/metres
LW416 and 417 **(W=260 metres)**	B and M lines	Subsidence	> 1.1 metres
		Tilt	> 7 mm/metres
		Tensile Strain	> 5 mm/m
		Compressive Strain	> 6 mm/m (plateaus) > 14 mm/m (valleys)
Sunnyside East Swamp	*V-VC and W-WC Lines* *LiDAR*	Subsidence	>1.1 metres
		Tilt	> 7 mm/metre
		Tensile Strain	> 5 mm/metre
		Compressive Strain	>14 mm/metre
Carne West Swamp	Y-YC1, YC2 and B Lines LiDAR	Subsidence	>1.1 metres
		Tilt	> 7 mm/metre
		Tensile Strain	> 5 mm/metre
		Compressive Strain	>14 mm/metre

During the reporting period there was no anomalous subsidence within 200 metres of a Temperate Highland Peat Swamp on Sandstone Ecological Community associated with longwalls 415 – 417.

6.2. Flora

Triggers for flora have been developed using data collected from reference site monitoring carried out since 2003. The triggers have been developed based on an analysis of natural variance in vegetation communities which has been determined following an analysis of reference site data.

Details of trigger levels for flora are set out in Table 22. Each trigger has a defined level of change and a defined timescale in which this change is to be observed to determine whether an impact has occurred.

Spring 2018 Report Results

As identified in Setion 5.2, one new trigger was identified in the Spring 2018 monitoring report. The trigger recorded was for species richness at monitoring site SSE01.

In accordance with approvals, notification will be provided to the Department and an Investigative Report prepared and submitted. Further information on the trigger and investigation outcomes will be provided in subsequent reports.

Details of the triggers are reproduced from Section 5.2.6 in Table 22 below against Spring 2018 results.

Autumn 2018 Report Results

Upon recipt of the Autumn 2018 monitoring report, continuing flora triggers were identified under the THPSS MMP for longwalls 411 – 418. Continuing triggers were detected within Sunnyside Swamp (eucalpyt recruitment) and Carne West Swamp (specieis richness and condition species).

Having already completed a trigger notificiation and targeted flora investigative report in accordance with the THPSS MMP TARP Chart, Springvale are continuing monitoring and broader investigation work around THPSS for the purpose of a broader report to be provided to the Department.

Table 22. Flora Trigger Levels

Performance Indicator	Parameter Measured	Trigger Level*	Summer 2017/18	Autumn 2018	Winter 2018	Spring 2018
Change in species assemblage	Change in diversity of native species	A change in the number of species of greater than 30 % for a given site within a three year period.	One impact site (WC02) showed a repeat trigger for species richness. Two reference sites have also triggered (TRI01 & TRI02)	One impact site (WC02) showed a repeat trigger for species richness. One reference site has also triggered (TRI01).	One impact site (WC01) showed a trigger for species richness. One reference site has also triggered (TRI01).	One new trigger exceedance for species richness was recorded at SSE01. Recurring trigger exceedances were observed at WC01 and WC02.
	Recruitment of eucalypt species	An increase in eucalypts in an impact site compared to reference sites of more than three individual plants within a one year period.	One impact site (SSE01) maintained an increase in eucalypt recruitment beyond the trigger level.	One impact site (SSE01) maintained an increase in eucalypt recruitment beyond the trigger level.	One impact site (SSE01) maintained an increase in eucalypt recruitment beyond the trigger level.	One impact site (SSE01) has sustained a repeat trigger for eucalypt recruitment. LGG01, which has been excluded from analysis, also exceeded trigger level this season.
Change in condition	Condition of key species	A decline in condition score at an impact site of more than 1.5 compared to the average condition score at un-impacted sites within a one year period.	Four impact sites showed a decrease in condition beyond the trigger level for Gleichenia dicarpa and Baumea rubiginosa (WC01, WC02 , WC03 and WC04).	Two impact sites showed a decrease in condition beyond the trigger level for Gleichenia dicarpa and Baumea rubiginosa (WC01 and WC04).	Four impact sites showed a decrease in condition beyond the trigger level for Baumea rubiginosa (WC01, WC02, WC03 and WC04).	A recurring trigger level decrease in condition for *Gleichenia dicarpa* and *Baumea rubiginosa* was observed in WC01, WC02, WC03 and WC04.
	Non-live ground cover	An increase of bare ground of more than $100m^2$ in a site within a three year period.	One impact site (WC04) has showed a repeat trigger for non-live ground cover	No impact sites showed a trigger for non-live ground cover.	No impact sites showed a trigger for non-live ground cover.	No sites triggered in spring 2018.
	Non-native weeds	An increase in non-native weed species of more than	No impact sites showed an increase in weed	No impact sites showed an increase in weed	No impact sites showed an increase in weed	No impact sites showed an increase in

Performance Indicator	Parameter Measured	Trigger Level*	Summer 2017/18	Autumn 2018	Winter 2018	Spring 2018
		4 in a monitoring site (each having a cover of greater than 5%) compared to the average number in reference sites within a one year period.	species beyond the trigger level.	species beyond the trigger level.	species beyond the trigger level.	weed species beyond the trigger level.

*Taken from THPSS MMP 415-417 and THPSS MMP 418. Data collection method used consistent with Erskine and Fletcher (2011).

6.3. Groundwater Depth

The methodology for developing groundwater level triggers to determine whether anomalous impacts have occurred is based on statistical analysis and the development of percentile based triggers.

Short-term significant changes in groundwater level are considered to occur at the 95th percentile level. However, exceedance of this level, by definition, will occur five percent of the time under natural conditions. This has led to the development of long term triggers that complement the short term triggers. Any mining-induced changes in groundwater levels will be inferred based on a set of trigger values for the groundwater depths in swamp piezometers and the groundwater elevations at ridge top aquifer piezometers installed beneath the ridges between swamps.

Table 23 details the short and long term change description for swamp and aquifer groundwater level.

Table 23. Short and Long Term Change Descriptions as Relevant to Swamp and Aquifer Groundwater Level

Type of Change	Description
Swamp groundwater depth (from ground surface)	
Short-term changes	Trigger level is exceeded if the groundwater depth in any piezometer > 95th percentile pre-mining groundwater depth for more than 7 consecutive days
Long-term changes	Trigger level is exceeded if the post-mining 50th percentile groundwater depth for any piezometer > 80th percentile pre-mining level
Aquifer groundwater level	
Short-term changes	Trigger level is exceeded if the groundwater level > baseline 95th percentile or < baseline 5th percentile pre-mining groundwater level for more than one month
Long-term changes	Trigger level is exceeded if the post-mining 50th percentile groundwater level for any bore is > baseline 80th percentile or < baseline 20th percentile pre-mining level

Due to the relatively short time period since undermining long term changes to groundwater depth cannot yet be determined.

The trigger levels are based on the monitoring records from 1 January 2005 up to 31 December 2011 at the swamp piezometers and up to 30 April 2012 for aquifer piezometers. Groundwater triggers for swamp piezometer water are presented in Table 24 while aquifer piezometer trigger levels are presented in Table 25. Baseline data collection is however considered up to the time until mining is within 200m of the piezometer.

Table 24. Groundwater Trigger Levels for Swamp Piezometers

Location	LW 415-417 THPSS MMP Short-term Change 7-day moving average greater than the Pre-mining 95th Percentile for 7 days (metres below ground level)	Recalculated Pre-Mining Trigger Short-term Change 7-day moving average greater than the Pre-mining 95th Percentile for 7 days (metres below ground level	LW 415-417 THPSS MMP Long-term Change Post-mining median greater than the Pre-mining 80th Percentile (metres below ground level)	Recalculated Pre-Mining Trigger Long-term Change Post-mining median greater than the Pre-mining 80th Percentile (metres below ground level)	Pre-mining calculated cut-off date
Permanently Waterlogged					
CW1	0.25	0.93	0.21	0.26	LW418 - 05/12/2015
CW2	0.24	1.16	0.22	0.28	LW418 - 03/12/2015
SSE3	0.17	1.71	0.04	1.48	LW417 – 12/11/2014
Periodically Waterlogged					
CW3	1.01	1.07	1.01	1.06	LW417 – 19/03/2015
CW4	1.21	1.34	1.13	1.33	LW417 – 05/03/2015
SSE1	2.12	2.16	2.11	2.15	LW416 – 10/01/2014
SSE2	0.70	0.83	0.41	0.61	LW416 – 16/12/2013

Table 25. Groundwater Trigger Levels for Aquifer Piezometers

Location	LW415-417 THPSS MMP: Short-term Change (7-day moving average less than the Pre-mining 5th Percentile for 1 month)	LW415-417 THPSS MMP: Short-term Change (7-day moving average greater than the Pre-mining 95th Percentile for 1 month)	Recalculated Pre-Mining Trigger Short-term Change (7-day moving average greater than the Pre-mining 95th Percentile for 1 month)	LW415-417 THPSS MMP: Long-term Change (Post-mining median less than the Pre-mining 20th Percentile)	LW415-417 THPSS MMP: Long-term Change (Post-mining median greater than the Pre-mining 80th Percentile)	Recalculated Pre-Mining Trigger Short-term Change (7-day moving average greater than the Pre-mining 95th Percentile for 1 month)	Pre-mining calculated cut-off date
RSS	1125.6	1131.4	1128.16	1127.9	1129.8	1128.86	LW415 - 20/09/2012
SPR1101	1089.9	1090.8	1089.93	1090.0	1090.6	1090.03	LW415 – 18/09/2012
SPR1104	1070.1	1073.1	1069.2	1071.8	1072.8	1067.97[1]	LW419 – 01/08/2016
SPR1107	1090.0	1093.7	1086.2	1090.5	1093.2	1080.66[2]	LW419 – 03/11/2016
SPR1109	1077.0	1078.3	1067.7	1077.1	1078.0	1069.3	LW418 – 25/11/2015
SPR1110	1089.8	1090.1	1083.4	1089.8	1090.0	1083.6	LW416 – 18/09/2014

[1]Pre-mining trigger recalculated from 1069.8 at cut-off date 31/12/2015.

[2]Pre-mining trigger recalculated from 1087.3 at cut-off date 31/12/2015.

No groundwater triggers were activated in aquifer piezometers during the reporting period. SPR1113 and SPR1211 triggers were activated during the reporting period, however were reported under the EPBC2013/6881 (for both triggers) and Extraction Plan for longwalls 420 – 422 and longwalls 424 – 427 respectively. These triggers have not been reported in this Annual Report as neither site were impact sites under the Longwall 415 – 417 THPSS MMP. The triggers will be further reported on in the Springvale Annual Review and EPBC2013/6881 Compliance Report.

6.4. Groundwater Quality

Triggers for groundwater quality have been developed using data collected from reference sites. This data has been assessed using the ANZECC (2000) Water Quality Guidelines for the Protection of Aquatic Life (95% species protection levels) to calculate the triggers. Groundwater quality triggers were developed using the ANZECC (2000) guidelines procedure for setting local guidelines when the water quality does not meet the default ANZECC (2000) guideline values because of local conditions. The 80th percentile value of background water quality is used as the local water quality value in the case where the background concentrations are higher than the ANZECC (2000) guidelines. The default is used if the 80th percentile is lower than the default trigger value. This approach has been used to develop the water quality triggers for groundwater.

Trigger levels for groundwater quality are presented in Table 26.

Table 26. Groundwater Quality Trigger Levels

Element	Short-term Minor Change (1)	Short-term Major Change (2)	80th Percentile Baseline
CW1			
pH	4.6 – 5.3	4.1 – 5.8	4.8 – 5.0
EC (uS/cm)	30	30	22
Fe (Filterable Mg/L)	0.57	1.69	0.37
CW2			
pH	4.5 – 5.6	4.0 – 6.2	4.8 – 5.4
EC (uS/cm)	23.1	27.1	20.2
Fe (Filterable Mg/L)	0.48	0.67	0.30
SSE3			
pH	5.2 – 5.9	4.8 – 6.5	5.3 – 6.1

Element	Short-term Minor Change (1)	Short-term Major Change (2)	80^{th} Percentile Baseline
EC (uS/cm)	52	69	48
Fe (Filterable Mg/L)	8.43	13.51	7.27

6.5. Surface Water Quality

Surface water quality triggers have been developed using the ANZECC (2000) water quality guidelines for protection of aquatic life (95% species protection levels). Minor and major variation / impacts will be assessed by using the ANZECC protocols of comparing the pre-mining 80^{th} and 95^{th} percentile baseline with the 50^{th} percentile of the post-mining data and allowing for the effects of short-term spikes due to rainfall runoff events.

Table 27 provides a description short term and long term changes in reference to minor or major variations. The surface water triggers levels are presented in Table 28.

Table 27. Short and Long Term Change Descriptions as Relevant to Minor and Major Changes in Surface Water

Type of change	Description
Minor Changes	
Long-term minor changes	For each analyte, if the post-mining 50th percentile ≤ baseline 80^{th} percentile, the changes are considered minor and would not have an unacceptable impact on aquatic life (i.e. provided the long-term increase in concentrations is such that the 50^{th} percentile does not exceed the baseline 80^{th} percentile, the increase is considered to be minor)
Short-term minor changes –	For each analyte, if any measured parameter > baseline 80^{th} percentile, but ≤ baseline 95^{th} percentile (5^{th} percentile for pH) trigger value for ≤ two months, the changes are considered minor and would not have an unacceptable impact on aquatic life. It should be noted that about 20% of observations will exceed the 80^{th} percentile and these are usually short-term spikes in concentrations, which are often due to rainfall runoff events. These short-term spikes generally occur for less than two consecutive months.
Major Changes	
Long-term major changes	For each analyte, if the post-mining 50^{th} percentile > baseline 80^{th} percentile, the changes are considered major.

Type of change	Description
Short-term major changes	For each analyte, if any measured parameter > baseline 80th percentile by two standard deviations for more than two months, the changes are considered major

Table 28. Surface Water Quality Triggers

Element	Short-term Minor Change (1)	Short-term Major Change (2)	80th Percentile Baseline
Carne Swamp			
pH	4.80 – 6.8	4.1 – 7.3	5.3 – 6.1
EC (uS/cm)	40	51	27
Mn (Filterable Mg/L)	0.036	0.174	0.022
Fe (Filterable Mg/L)	0.69	0.77	0.44
Sunnyside East Swamp			
pH	5.0 – 6.5	4.5 – 6.5	5.5 – 6.0
EC (uS/cm)	27	33	24
Mn (Filterable mg/L)	0.037	0.037	0.019
Fe (Filterable Mg/L)	0.313	0.363	0.260
Marrangaroo Creek Upstream (Reference Site)			
pH	5.2 – 6.7	4.5 – 7.1	5.5 – 6.1
EC (uS/cm)	40	47	33
Mn (Filterable Mg/L)	0.02	0.11	0.01
Fe (Filterable Mg/L)	0.10	0.26	0.08

Surface water flows and water chemistry show trends that are consistent with historical monitoring and that observed in previous years monitoring.

7. SUMMARY

Springvale received conditional approval to mine longwalls 415 to 417 which are beneath Temperate Highland Peat Swamps on Sandstone (THPSS). A THPSS Management Plan (THPSS MMP) was developed and implemented in accordance with the conditions of approval. This includes an extensive monitoring program which covers both the controlled action and the surrounding environment to assist in identifying any potential impact from mining.

Extraction commenced from longwall 415 in March 2012 and the extraction of longwall 417 was completed in July 2015.

During 2018 coal was mined from longwalls 421 and 425. These longwalls are covered under EPBC 2013/6881 and the respective Extractions Plans for longwalls 420-422 and longwall 424-427. Reporting of environmental results relevant to these approvals is completed separately to this report.

Subsidence monitoring has been undertaken in accordance with the Springvale Subsidence Management and Reporting Plan for Longwalls 415 to 417. Subsidence, tilt, tensile strain and compressive strain results demonstrates compliance with the trigger values defined in the THPSSMP.

Annual rainfall in 2018 was recorded to be over 200mm less than the long-term average at Newnes Plateau. The CRD continued the sharp declining trend of below average rainfall from the previous reporting period until August. Slightly above average rainfall recorded in September, October and November saw the CRD stabilising.

No groundwater trigger levels relevant to longwalls 415 – 417 approvals were exceeded during the reporting period.

One new flora performance indicator trigger was exceeded at Sunnyside Swamp (SSE01) during the reporting period. Springvale will complete a trigger notification and investigative report in accordance with site approvals.

Surface water flows and water chemistry show trends that are consistent with historical monitoring and that observed in previous years monitoring.

Springvale Coal
PO Box 198
Wallerawang NSW 2845
www.centennialcoal.com.au