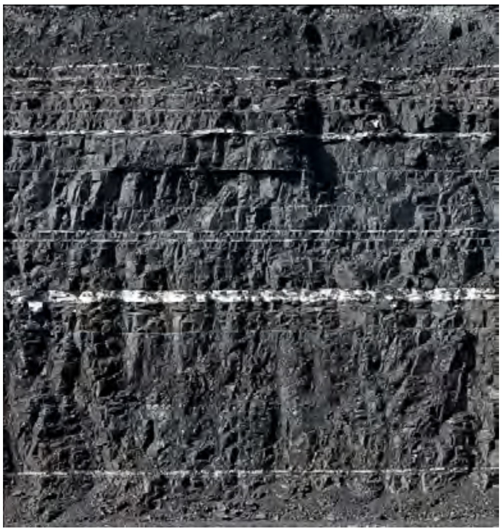
HUNTER VALLEY OPERATIONS



Annual Environmental Review

Hunter Valley Operations

March 2019

This page has been left blank intentionally

Version No.	Person Responsible	Document Status	Date
1.0	**Environment & Community Coordinator**	**Final**	**26/07/2019**

<table>
<tr><td>Name of Operations</td><td>Hunter Valley Operations</td></tr>
<tr><td>Name of Operator</td><td>HV Operations Pty Ltd</td></tr>
<tr><td>Development consent /project approval</td><td>DA 450-10-2003 / PA 06_0261</td></tr>
<tr><td>Name of holder of development consent/project approval</td><td>HV Operations Pty Ltd</td></tr>
<tr><td>Mining Lease Number</td><td>Contained within Section 3.1 of this report</td></tr>
<tr><td>Name of Mining Lease Holder</td><td>Contained within Section 3.1 of this report</td></tr>
<tr><td>Water Licence Number</td><td>Contained within Section 3.1 of this report</td></tr>
<tr><td>Name of Water Licence Holder</td><td>Contained within Section 3.1 of this report</td></tr>
<tr><td>MOP/RMP Start Date</td><td>HVO North – 26 February 2019
HVO South – 25 July 2018</td></tr>
<tr><td>MOP/RMP End Date</td><td>HVO North – 30 July 2020
HVO South – 30 July 2023</td></tr>
<tr><td>Annual Review Start Date</td><td>01/01/2018</td></tr>
<tr><td>Annual Review End Date</td><td>31/12/2018</td></tr>
<tr><td colspan="2">I, Tony Galvin, certify that this audit report is a true and accurate record of the compliance status of Hunter Valley Operations for the period 1st January 2018 to 31st December 2018 and that I am authorised to make this statement on behalf of Hunter Valley Operations.
Note.
a) The Annual Review is an 'environmental audit' for the purposes of section 122B(2) of the Environmental Planning and Assessment Act 1979. Section 122E provides that a person must not include false or misleading information (or provide information for inclusion in) an audit report produced to the Minister in connection with an environmental audit if the person knows the information is false or misleading in a material respect. The maximum penalty is, in the case of a corporation, $1 million and for an individual, $250, 000.
b) The Crimes Act 1900 contains other offences relating to the false and misleading information: section 192G (Intention to defraud by false or misleading statement- maximum penalty 5 years imprisonment); sections 307A, 307B and 307C (False or misleading applications/information/documents – maximum penalty 2 years imprisonment or $22,000, or both).</td></tr>
<tr><td>Name of Authorised Reporting Officer</td><td>Tony Galvin</td></tr>
<tr><td>Title of Authorised Reporting Officer</td><td>General Manager – Hunter Valley Operations</td></tr>
<tr><td>Signature of Authorised Reporting Officer</td><td></td></tr>
<tr><td>Date</td><td>28 March 2019</td></tr>
</table>

This page has been left blank intentionally

Version No.	Person Responsible	Document Status	Date
1.0	**Environment & Community Coordinator**	**Final**	**26/07/2019**

EXECUTIVE SUMMARY

This Annual Environmental Review (Annual Review) reports on the environmental performance of Hunter Valley Operations (HVO) during the 2018 calendar year and satisfies the requirements of HVO's Development Consents and Mining Leases. The structure of the 2018 Annual Review intends to align with the NSW Government *Post-approval requirements for State significant mining developments – Annual Review GUIDELINE (October 2015).*

HVO extracted 18.9 million tonnes of run-of-mine (ROM) coal during 2018 against an approved ROM extraction rate of 42 million tonnes per annum (mtpa). The Coal Handling Preparation Plants produced 12.9 million tonnes of saleable coal.

Noise

HVO manages noise to ensure compliance with permissible noise limits at nearby private residences. During the reporting period there were no non-compliances recorded against HVO's development consent limits. During 2018, 22 haul trucks were retrofitted with sound attenuation kits, making a total of 68 out of 81 trucks (83%) of the haul fleet are now sound attenuated. A total of 158 hours of equipment downtime was recorded due to proactive and reactive measures to minimise noise.

Blasting

During the reporting period 222 blast events were initiated at HVO. One blast exceeded the air-blast overpressure criteria of 120.0 dB at Moses Crossing and Jerrys Plains blast monitors and was reported to relevant agencies.

HVO employs a blast fume management protocol to mitigate generation of post blast fume emissions. Two blasts produced fume ranked as category 3 but remained onsite, there were no category 4 or 5 blast fume events.

A further non-compliance was recorded on 18 December when the Knodlers Lane Blast monitor failed to capture both overpressure and vibration results for the two blasts initiated in the Cheshunt Pit. This incident was reported to the Department of Planning & Environment.

Air Quality

Air quality monitoring is undertaken in accordance with the HVO Air Quality Monitoring Programme. An extensive network of monitoring equipment is utilised to assess performance against the relevant conditions of HVO's approvals. During 2018, HVO complied with all short term, long term and annual average air quality criteria. A total of 6,428 hours of equipment downtime was recorded due to proactive and reactive measures to minimise dust.

Heritage

Under the provisions of both the HVO South and HVO North Aboriginal Cultural Heritage Management Plans (ACHMP), an ACHMP Compliance Inspection was conducted within both ACHMP areas in December 2018. The inspections found that all sites have been managed in conformance with the ACHMP/HMP requirements. Additional sites were recorded and sites requiring maintenance and upgrades to site barricading and fencing were identified, with upgrade and maintenance work to be implemented in 2019.

The HVO JV became party to an Ancillary Agreement with the Plains Clan of the Wonnarua People (PCWP) which commenced on 3rd May 2018.

Water

HVO impounded minimal water from surface runoff in 2018 due to ongoing dry conditions. As a result HVO increased abstraction of water from the Hunter River to supplement its raw water requirements for coal washing and dust suppression.

One water related non-compliance was recorded during 2018 which involved the overflow of a firewater tank at Newdell Load Point, resulting in discharge of water to Bayswater Ck. HVO was issued two penalty notices from EPA totalling $30 000. A number of corrective and preventative actions were implemented to prevent a repeat incident.

An incident involving turbid water reporting to Farrells Creek from surface runoff ahead of active mining areas in West Pit also occurred. Heavy rainfall caused catchment runoff to overtop water management controls. Notifications were made to relevant authorities. Water management controls were modified and augmented to reduce potential for a repeat event.

A detailed groundwater investigation was triggered by elevated salinity in monitoring bore CFW55R located immediately downstream of the highwall of the North Void TSF, within the Hunter River alluvial floodplain. The investigation identified a seepage path from the North Void Tailings Storage Facility (TSF). HVO have notified this to relevant authorities and implemented a management plan to continue to manage and mitigate any potential impacts from this seepage path.

Rehabilitation and Land Management

A total of 100.9 ha of mined land was rehabilitated in 2018 and 140.2 ha of land was disturbed.

During 2018 HVO initiated corrective actions in accordance with the MOP Trigger Action Response Plan (TARP) in response to variations in rehabilitation outcomes identified by monitoring undertaken in 2017. A Section 240 Notice (improvement notice) was received from the Resources Regulator following the TARP trigger events and HVO has committed to management actions to address rehabilitation trajectory concerns and to undertake further rehabilitation monitoring. Other rehabilitation quality improvements in 2018 included ongoing development of undisturbed native pastures as seed harvesting areas to facilitate the use of locally sourced seed.

During 2018, 262 feral pigs were euthanised by control programmes undertaken by HVO and licensees on HVO owned non-mining land.

Two land related incidents were reported during the period. The first incident involved unauthorised clearing of 242 m^2 of land owned by HVO by a contractor working for Telstra. Activity ceased when HVO became aware of the issue and notified the Department of Planning and Environment.

The second incident involved part of an overburden dump in HVO's Glider Pit being approximately 10 m above the Obstacle Limitation Surface (OLS) for the Hunter Valley Gliding Club (HVGC) without their prior agreement. The HVGC and the Department of Planning and Environment were notified and the dump was promptly lowered below the OLS.

Biodiversity Management

Weed control, track and fence repairs and vertebrate pest management activities were conducted during 2018 in the Goulburn River Biodiversity Area.

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

1 STATEMENT OF COMPLIANCE

Table 1 is a Statement of compliance against the relevant approvals. Table 2 provides a brief summary of the non-compliances against development consents and a reference to where these are addressed within this Annual Review.

Table 1: Statement of compliance

Were all conditions of the relevant approval(s) complied with?	
PA 06_02161 (HVO South)	**No**
DA 450-10-2003 (HVO North)	**No**

Table 2: Non-compliances

Relevant approval	Condition number	Condition description (summary)	Compliance status[1]	Where addressed in Annual Review
DA 450-10-2003 (HVO North)	**Schedule 3 Condition 20.**	**Newdell mine water discharge**	**Non-Compliant (Medium)**	**11.2**
PA 06_02161 (HVO South)	**Schedule 3 Condition 7.**	**Overpressure exceedance**	**Non-Compliant (Low)**	**11.1**
PA 06_02161 (HVO South)	**Schedule 3 Condition 18**	**Monitoring Miscapture**	**Non-Compliant (Low)**	**11.1**
PA 06_02161 (HVO South)	**Schedule 3 Condition 48**	**Exceeding Obstacle Limitation Surface (HVGC)**	**Non-Compliant (Low)**	**11.4**
PA 06_02161 (HVO South)	**Schedule 5 Condition 2**	**Unauthorised clearing of land**	**Non-Compliant (Low)**	**11.3**

[1]Compliance status key for Table 2

Risk level	Colour Code	Description
High	**Non-compliant**	**Non-compliance with potential for significant environmental consequences, regardless of the likelihood of occurrence**
Medium	**Non-compliant**	**Non-compliance with:** **Potential for serious environmental consequences, but is unlikely to occur; or** **Potential for moderate environmental consequences, but is unlikely to occur**
Low	**Non-compliant**	**Non-compliance with:** **Potential for moderate environmental consequences, but is unlikely to occur; or** **Potential for low environmental consequences, but is unlikely to occur**
Administrative non-compliance	**Non-compliant**	**Only to be applied where the non-compliance does not result in any risk of environmental harm (e.g. submitting a report to government later than required under approval conditions)**

In the interest of disclosing all relevant information, during the reporting period HVO notified an incident to the Department of Planning and Environment and Resource Regulator against DA 450-10-2003 related to discharge of turbid water to Farrells Creek. Further detail is provided in Section 11.2.

2 INTRODUCTION

2.1 Document Purpose

This Annual Review is written to satisfy the requirements of the Hunter Valley Operations (HVO) Development Consents and conditions of mining leases for events which occurred during the 2018 calendar year. The Annual Review has been written in accordance with the NSW Government *Post-approval requirements for State significant mining developments – Annual Review Guideline* (October 2015).

This report is distributed to:

- NSW Department of Planning and Environment (DP&E);
- Resources Regulator in NSW;
- Natural Resource Access Regulator (NRAR);
- Singleton Council and Singleton Library;
- Muswellbrook Shire Council (MSC) and Muswellbrook Library; and
- HVO Community Consultative Committee (CCC).

2.2 Background

HVO is situated in the Upper Hunter Valley between Singleton and Muswellbrook, approximately 24 km northwest of Singleton, and approximately 100 km northwest of Newcastle. The Hunter River geographically divides HVO into HVO North and HVO South; however they are integrated operationally with personnel, equipment and materials utilised as required. This improves operational efficiency, rationalisation of infrastructure and resource utilisation.

HVO is a jointly controlled operation through a Joint Venture between Glencore (49%) and Yancoal (51%).

The regional context and layout of the HVO pits and facilities are shown in Figure 1 and Figure 2 respectively.

Please note that the aerial used in Figure 2 is a montage of imagery with various dates.

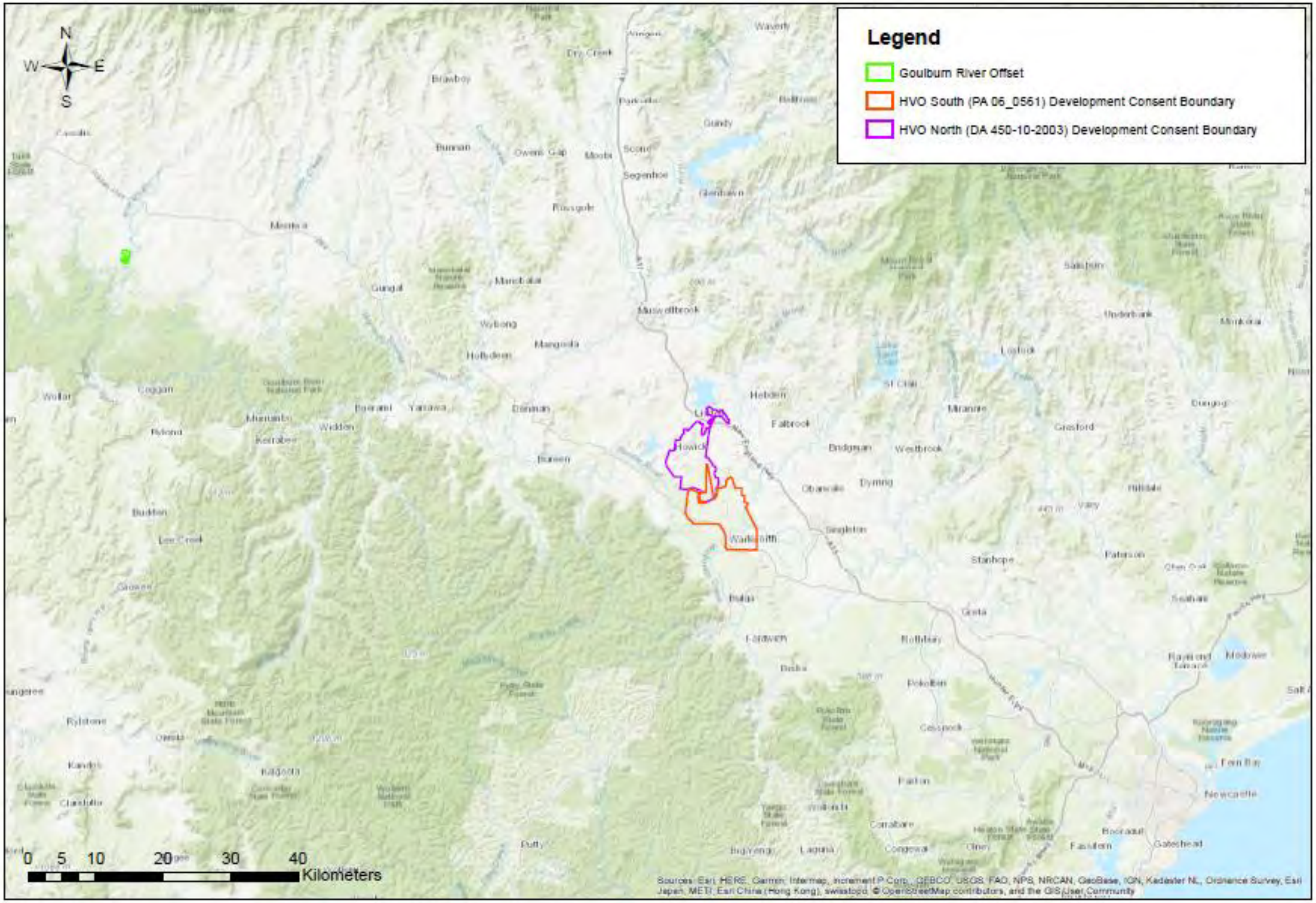


Figure 1: Regional Context

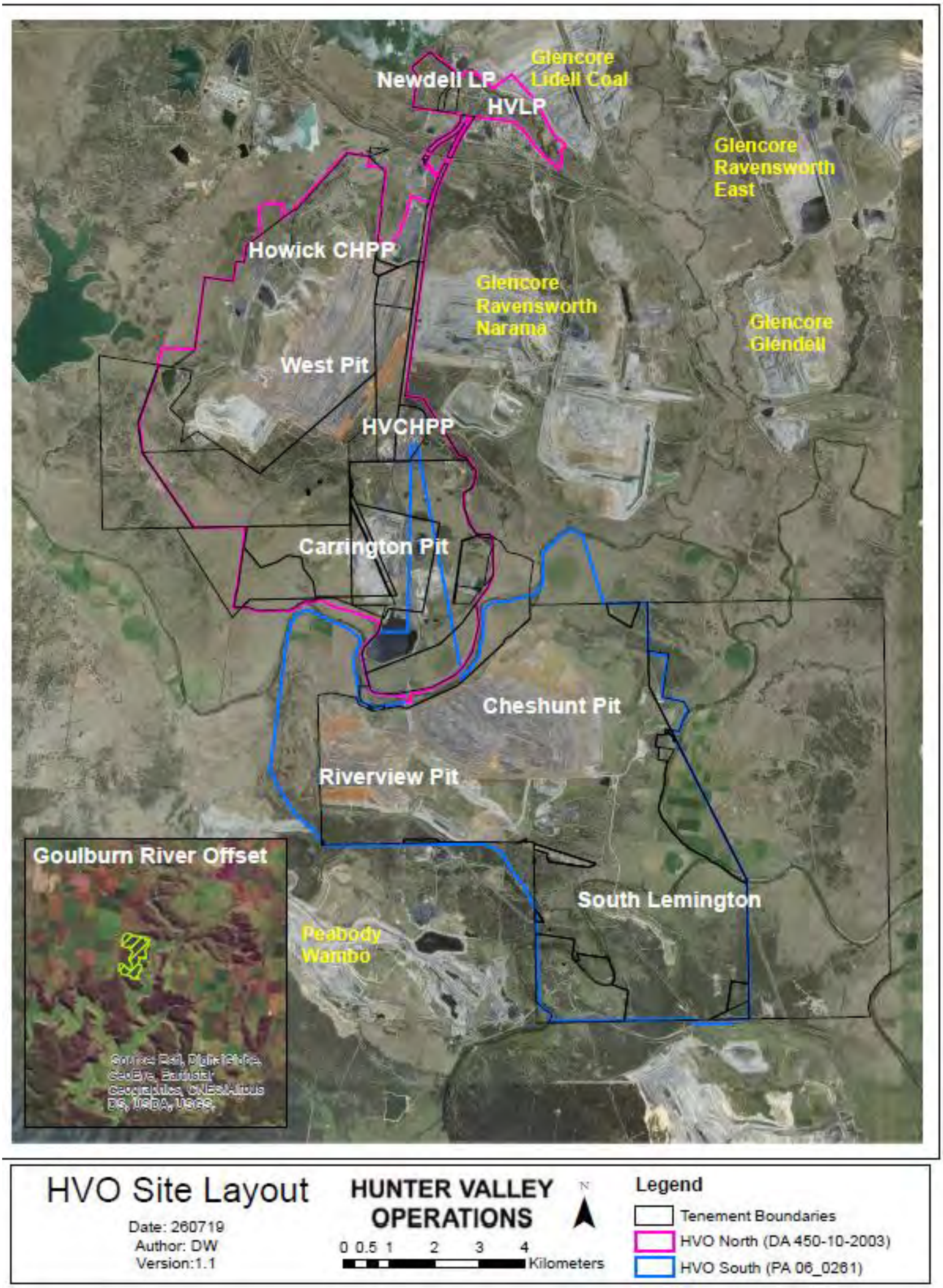


Figure 2: Hunter Valley Operations - Site Layout

2.3 Mine Contacts

Tony Galvin	**General Manager – HVO**
	Phone 02 6570 0228
	Email: tony.galvin@hvo.com.au
Andrew Speechly	**Manager – Environment & Community**
	Phone 02 6570 0497
	Email: andrew.speechly@hvo.com.au

3 APPROVALS

3.1 Approvals, Leases and Licenses

3.1.1 Current Approvals

The status of HVO development consents, licenses and relevant approvals are listed in the following tables:

Table 3: HVO Major Approvals;

Table 4: Summary of Mining Tenements;

Table 5: HVO Leases and Permits;

Table 6: Water Related Approvals; and

Table 7: Water Access Licence.

Table 3: HVO Major Approvals

Approval Number	Description	Issue Date	Expiry Date
HVO North DA 450-10-2003 MOD 7	HVO West Pit Extension & Minor Modifications (2003); and associated modifications. Covers West Pit (approved production limit of 12mtpa), Carrington Pit (approved production limit of 10mtpa), HVCHPP (approved processing limit of 20mtpa) and WCHPP (approved processing limit of 6mtpa).	12/06/2004	12/06/2025
HVO South PA 06_0261 MOD 5	Hunter Valley Operations – South Coal Project & associated modifications MOD 5 approved February 2018 The modification covere: - the progression of mining to the base of the Bayswater seam from Cheshunt Pit into Riverview Pit, and to the base of the Vaux seam in South Lemington Pit 2. - Increased overburden emplacement height in some areas to 240m AHD and incorporation of micro-relief - extraction rate increase from 16Mpta to 20Mtpa of ROM coal at peak production and increased processing rate from 16Mpta to 20Mtpa of ROM coal across HVO coal preparation plants. - The modification also involved changes to the Statement of Commitments.	28/02/2018	24/03/2030
EPBC 2016/7640	Hunter Valley Operations – State approved mining Hunter Valley NSW	10/10/2016	31/12/2030

Table 4: Summary of Mining Tenements

Title	Mining Tenement	Purpose	Grant Date	Expiry Date	Status
AUTH 72	Authorisation	Prospecting	08/03/1977	24/03/2018	Renewal Pending
EL 5291	Exploration Licence	Prospecting	28/04/1997	28/04/2018	Renewal Pending
EL 5292	Exploration Licence	Prospecting	28/04/1997	28/04/2020	Granted
EL 5417	Exploration Licence	Prospecting	23/12/1997	08/05/2018	Renewal Pending
EL 5418	Exploration Licence	Prospecting	23/12/1997	08/05/2017	Renewal Pending
EL 5606	Exploration Licence	Prospecting	11/08/1999	10/08/2019	Granted
EL 8175	Exploration Licence	Prospecting	23/09/2013	22/09/2018	Renewal Pending
(Part) CCL 708	Sub-Lease	Prospecting and Mining Coal	17/05/1990	29/12/2023	Granted
CCL 714	Consolidated Coal Lease	Prospecting and Mining Coal	23/05/1990	30/08/2030	Granted
CCL 755	Consolidated Coal Lease	Prospecting and Mining Coal	24/01/1990	05/03/2030	Granted
CL 327	Coal Lease	Prospecting and Mining Coal	06/03/1989	05/03/2031	Granted
CL 359	Coal Lease	Prospecting and Mining Coal	21/05/1990	20/05/2032	Granted
CL 360	Coal Lease	Prospecting and Mining Coal	29/05/1990	28/05/2032	Granted
CL 398	Coal Lease	Prospecting and Mining Coal	04/06/1992	03/06/2034	Granted
CL 584	Coal Lease	Prospecting and Mining Coal	01/01/1982	31/12/2023	Granted
CML 4	Consolidated Mining Lease	Prospecting and Mining Coal	02/03/1993	03/06/2033	Granted
ML 1324	Mining Lease	Prospecting and Mining Coal	19/08/1993	18/08/2014	Renewal Pending
ML 1337	Mining Lease	Prospecting and Mining Coal	01/02/1994	09/09/2014	Renewal Pending
ML 1359	Mining Lease	Prospecting and Mining Coal	01/11/1994	31/10/2015	Renewal Pending
ML 1406	Mining Lease	Prospecting and Mining Coal	27/02/1997	10/02/2027	Granted
ML 1428	Mining Lease	Prospecting and Mining Coal	15/04/1998	14/04/2019	Renewal Pending

Title	Mining Tenement	Purpose	Grant Date	Expiry Date	Status
ML 1465	Mining Lease	Prospecting and Mining Coal	21/02/2000	20/02/2021	Granted
ML 1474	Mining Lease	Prospecting and Mining Coal	24/11/2000	23/11/2021	Granted
ML 1482	Mining Lease	Prospecting and Mining Coal	19/03/2001	14/04/2019	Renewal Pending
ML 1500	Mining Lease	Prospecting and Mining Coal	21/12/2001	20/12/2022	Granted
ML 1526	Mining Lease	Prospecting and Mining Coal	03/12/2002	02/12/2023	Granted
ML 1560	Mining Lease	Prospecting and Mining Coal	28/01/2005	27/01/2026	Granted
ML 1589	Mining Lease	Prospecting and Mining Coal	02/11/2006	01/11/2027	Granted
ML 1622	Mining Lease	Prospecting and Mining Coal	22/10/2010	10/03/2027	Granted
ML 1634	Mining Lease	Prospecting and Mining Coal	31/07/2009	30/07/2030	Granted
ML 1682	Mining Lease	Prospecting and Mining Coal	16/12/2012	15/12/2033	Granted
ML 1704	Mining Lease	Mining Purposes	05/12/2014	04/12/2035	Granted
ML 1705	Mining Lease	Prospecting and Mining Coal	17/12/2014	16/12/2035	Granted
ML 1706	Mining Lease	Mining Purposes	09/12/2014	08/12/2035	Granted
ML 1707	Mining Lease	Prospecting and Mining Coal	09/12/2014	08/12/2035	Granted
ML 1710	Mining Lease	Prospecting and Mining Coal	22/12/2016	10/03/2027	Granted
ML 1732	Mining Lease	Mining Purposes	06/04/2016	05/04/2037	Granted
ML 1734	Mining Lease	Mining Purposes	06/04/2016	05/04/2037	Granted
ML 1748	Mining Lease	Mining Purposes	05/12/2016	04/12/2037	Granted
ML 1753	Mining Lease	Mining Purposes	19/04/2017	18/04/2038	Granted
ALA 52	Assessment Lease Application	Prospecting	Mining Lease Application lodged 10th September 2012		Offer of Grant – Pending Determination

Title	Mining Tenement	Purpose	Grant Date	Expiry Date	Status
ALA 58	Assessment Lease Application	Prospecting	Mining Lease Application lodged 1st December 2016		Application Pending
ALA 59	Assessment Lease Application	Prospecting	Mining Lease Application lodged 1st December 2016		Application Pending
ELA 5525	Exploration Licence Application	Prospecting	Exploration Licence Application lodged 3rd July 2017		Application Pending
ELA 5526	Exploration Licence Application	Prospecting	Exploration Licence Application lodged 3rd July 2017		Application Pending
ELA 5527	Exploration Licence Application	Prospecting	Exploration Licence Application lodged 3rd July 2017		Application Pending
MLA 489	Mining Lease Application	Mining Purposes	Mining Lease Application lodged 10th March 2015		Application Pending
MLA 495	Mining Lease Application	Mining Purposes	Mining Lease Application lodged 12th May 2015		Application Pending
MLA 496	Mining Lease Application	Mining Purposes	Mining Lease Application lodged 12th May 2015		Application Pending
MLA 520	Mining Lease Application	Mining Purposes	Mining Lease Application lodged 23rd December 2015		Application Pending
MLA 534	Mining Lease Application	Mining Purposes	Mining Lease Application lodged 28th October 2016		Application Pending
MLA 535	Mining Lease Application	Mining Purposes	Mining Lease Application lodged 28th October 2016		Application Pending
MLA 542	Mining Lease Application	Ancillary Mining Activities (Mining Purposes)	Mining Lease Application lodged 27th July 2017		Application Pending
MLA 543	Mining Lease Application	Ancillary Mining Activities (Mining Purposes)	Mining Lease Application lodged 27th July 2017		Application Pending

Table 5: HVO Leases and Permits

Licence No.	Description	Authority	Expiry Date
Environment Protection Licence			
EPL 640	Environment Protection Licence	EPA	N/A
Dangerous Goods / Explosives			
RR12709	Licence to Store	Workcover	06/7/2022
Radiation Licence			
RML5085293	Radiation Management Licence	EPA	14/11/2019
Aboriginal Heritage Permits			
C0001890	Care Agreement	OEH	3/06/2036
C0002193	Aboriginal Heritage impact Permit	OEH	6/12/2026
Road Closure Permits			
538338	Road Occupancy Licences– Golden Highway	RMS	28/06/2019
	Road Closure Approval Lemington Road	Singleton Council	30/06/2019

Table 6: Water Related Approvals

Licence Number	Type of License	Purpose	Legislation	Description	Renewal Date
20BL030566	Bore	Well	Part 5 Water Act 1912	East Open Cut	Perpetuity
20BL141584	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – Carrington Work Licence	Perpetuity
20BL166637	Bore	Monitoring Bore	Part 5 Water Act 1912	No Current Bores	Perpetuity
20BL167860	Bore	Excavation - Mining	Part 5 Water Act 1912	HVO North – Carrington Pit	11/05/2020
20BL168820	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – Bores: CGW39, CGW45a, CGW46,CGW47, CGW47a, CGW48, CGW49, P50/38.5, ,CGW56, 4036C, 4035P, 4032P, 4034P, 4033P, 4053P, 4052P, 4051C, 4040P, 4038C, 4037P Destroyed:CGW7,CGW50, CGW57, CGW58, CGW59, CGW60, CGW61, CGW62, CGW63	Perpetuity
20BL169241	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – Bores: DM1, HF3, HF7 Destroyed DM2	Perpetuity
20BL169641	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – Bores: CGW5, CGW51A, CGW52, CGW53, CGW54, CGW55A, CGW53A, CGW52A, CGW54A, CGW6, CFW55, CFW57, CFW57A, CFW59, and CFW55R. Destroyed CGW1, CGW2, CGW3, CGW5, CGW8,CGW9, CGW10, CGW12, CGW13, CGW14, CGW30, CGW33, CGW34, CGW35, CGW36, CGW37, CGW38, CGW40, CGW41, CGW42, CGW43, CGW44, CFW56, CFW56A, CFW58	Perpetuity

Licence Number	Type of License	Purpose	Legislation	Description	Renewal Date
20BL170496	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: BZ10 (CHPZ 2A), BZ11 (CHPZ 3A), BZ18 (CHPZ 10A), BZ20 (CHPZ 12A), BZ21 (CHPZ 13D) , BZ21A (CHPZ 13A), BZ20A (CHPZ 12D), BZ11A (CHPZ 3D) Destroyed AP50/47.5, AQ52, AV50/56.5, AS50/62.5, AR55, Bunc 3, BZ25 (Bunc 12) , BZ23 (Bunc 14), BZ24 (Bunc 13),	Perpetuity
20BL170497	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: BZ15 (CHPZ 7A), BZ16 (CHPZ 8D), BZ17 (CHPZ 9A), BZ19 (CHPZ 11A), BZ16A (CHPZ 8A), Bunc 46D Destroyed Bunc 39 (Shallow & Deep), Bunc 44D	Perpetuity
20BL170498	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: BZ12 (CHPZ 4A), BZ13 (CHPZ 5A), BZ14, BZ9 (CHPZ 1A), BC1, BC1a, BZ8-1, BZ8-2, BZ8-3, HG1, HG2, HG2a, HG3, S4, S6, BZ22 (CHPZ14D), BZ22A (CHPZ 14A), BZ5-1, BZ5-2 Destroyed S2, S3, S9, S11	Perpetuity
20BL171423	Bore	Monitoring Bore	Part 5 Water Act 1912	E1.5	Perpetuity
20BL171424	Bore	Monitoring Bore	Part 5 Water Act 1912	Destroyed GW9711	Perpetuity
20BL171425	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: GW9701, GW9710	Perpetuity
20BL171426	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: GW9702 Destroyed D2(WH236),	Perpetuity
20BL171427	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: C335, C630 (BFS)	Perpetuity
20BL171428	Bore	Monitoring Bore	Part 5 Water Act 1912	D807	Perpetuity
20BL171429	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: B925 (BFS), C122 (BFS), C122 (WDH)	Perpetuity

Licence Number	Type of License	Purpose	Legislation	Description	Renewal Date
20BL171430	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: C613 (BFS), C809 (GM/WDH)	Perpetuity
20BL171431	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: B631 (BFS), B631 (WDH)	Perpetuity
20BL171432	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: C130 (AFSH1), C130 (ALL), C130(BFS), C130 (WDH)	Perpetuity
20BL171433	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bore B334 (BFS)	Perpetuity
20BL171434	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: C317 (BFS), C317 (WDH)	Perpetuity
20BL171435	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: BZ3-1, BZ3-2, BZ3-3	Perpetuity
20BL171436	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: BZ4A(1), BZ4A(2), BZ4B	Perpetuity
20BL171437	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: WG1, WG2, WG3	Perpetuity
20BL171439	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: BRN, E012	Perpetuity
20BL171492	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: C1(WJ039), GW9704, North, GWAR981	Perpetuity
20BL171681	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: Bunc 45A, Bunc 45D	Perpetuity
20BL171725	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: B425 (WDH), BRS, C621 (BFS), C919 (ALL), D317 (BFS), D317(ALL), D317(WDH) Destroyed D420, D425, D621, PB02	Perpetuity
20BL171726	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: SR002, SR003, SR004, SR005, SR006, SR007	Perpetuity
20BL171727	Bore	Monitoring Bore	Part 5 Water Act 1912	SR001	Perpetuity
20BL171728	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: BZ2B, BZ1-1, BZ1-2, BZ1-3, BZ2-1, BZ2-2	Perpetuity
20BL171762	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: C817, D010 (BFS), D214 (BFS), D406 (BFS) (AFS), D510 (BFS), PB01 (ALL), D510 (AFS), D010 (GM), D010 (WDH), D406 (BFS) (AFS), D612 (AFS), D612 (BFS)	Perpetuity

Licence Number	Type of License	Purpose	Legislation	Description	Renewal Date
20BL171851	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North/South – Bores: HV2, PZ1CH200, PZ2CH400, PZ3CH800, 4118P, 4119P	Perpetuity
20BL171852	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – PZ4CH1380	Perpetuity
20BL171853	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – DM3	Perpetuity
20BL171854	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – Bores: DM5, PZ6CH2450	Perpetuity
20BL171855	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – PZ5CH1800	Perpetuity
20BL171856	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – Bores: HV6, HV3, DM6, HV2 (2), 4113P, 4114P. 4116P, 4117P	Perpetuity
20BL171857	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: HV4, HV4 (2) (GA3), GA3,	Perpetuity
20BL171858	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – DM4	Perpetuity
20BL171895	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO West – NPZ4	Perpetuity
20BL171896	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO West – NPZ2	Perpetuity
20BL171897	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO West – Bores: NPZ5, NPZ1	Perpetuity
20BL171898	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO West – NPZ3	Perpetuity
20BL173062	Bore	Monitoring Bore	Part 5 Water Act 1912	RC14	Perpetuity
20BL173065	Bore	Monitoring Bore	Part 5 Water Act 1912	HQ11	Perpetuity
20BL173063	Bore	Monitoring Bore	Part 5 Water Act 1912	RC07, RC08	Perpetuity
20BL173064	Bore	Monitoring Bore	Part 5 Water Act 1912	RC06	Perpetuity
20BL173069	Bore	Monitoring Bore	Part 5 Water Act 1912	RC11	Perpetuity
20CA201247	Works Approval	Pumping Plant	Water Management Act 2000	Associated with WAL965	Perpetuity
20CA212713	Works Approval	Pumping Plant	Water Management Act 2000	Associated with WAL36190	30/05/2025
20FW213280	Flood Work Approval	Levee	Water Management Act 2000	HVO North Carrington Levee 5	21/09/2021

Licence Number	Type of License	Purpose	Legislation	Description	Renewal Date
20FW213281 Formerly 20CW802613	Flood Work Approval	Levee	Water Management Act 2000	HVO South – Barry Levee	21/09/2027
20FW213277 Formerly 20CW802603	Flood Work Approval	Block Dam	Water Management Act 2000	HVO South – Hobden Gully Levee	21/09/2027
20FW213278 Formerly 20CW802604	Flood Work Approval	Levee	Water Management Act 2000	HVO North – North Pit Levee 3	21/09/2021
20WA210991 (see WAL 18307) Formerly 20SL050903	Stream Diversion	Stream Diversion	Water Management Act 2000	HVO West – Parnells Creek Dam	09/01/2023
20WA211427 Formerly 20SL061290	Stream Diversion	Cutting (Diversion Drain)	Section 10 Water Act 1912	Pikes Gully Creek Stream Diversion	07/09/2023
20WA210984 (see WAL 18327) 20SL042746	Diversion Works	Industrial	Water Management Act 2000	HV Loading Point Pump Bayswater Creek	08/09/2022
20WA211428 20SL061594	Stream Diversion	Cutting (Diversion Drain)	Water Management Act 2000	HVO North – Carrington Stream Diversion	31/7/2022
20WA201238 (see WAL 962)	Diversion Works	Pumping Plant	Water Management Act 2000	HVCPP River Pump	16/03/2018- Application for renewal pending
20WA201257 (see WAL 970)	Diversion Works	Pumping Plant	Water Management Act 2000	HVO South – LCPP River Pump	Perpetuity
20WA201338 (see WAL 1006)	Diversion Works	Pumping Plant	Water Management Act 2000	HVO South – LCPP River Pump	Perpetuity
20WA201501 (see WAL 1070)	Diversion Works	Pumping Plant	Water Management Act 2000	HVO South – LCPP River Pump	Perpetuity
20WA201685 (see WAL 13387)	Diversion Works	Pumping Plant	Water Management Act 2000	HVO West – "Lake Liddell" Licence	Perpetuity

Table 7: Water Access Licence

Licence Number	Description	Water Source	Water Sharing Plan	Water Source – Management Zone	Approved Extraction (ML)	Extraction 2017/18 Water Year (ML)
WAL962	HVO North – HVCPP River Pump – Water Access Licence	Hunter River	Hunter Regulated River WSP	Zone 1b (Hunter River From Goulburn River Junction To Glennies Creek Junction)	3,165	133 #
WAL969	HVO South – Former Riverview pump	Hunter River	Hunter Regulated River WSP	Zone 1b (Hunter River From Goulburn River Junction To Glennies Creek Junction)	39	0
WAL970	HVO South – LCPP River Pump – Water Access Licence	Hunter River	Hunter Regulated River WSP	Zone 2a (Hunter River From Glennies Creek Junction To Wollombi Brook Junction)	500	0
WAL1006	HVO South – LCPP River Pump – Water Access Licence	Hunter River	Hunter Regulated River WSP	Zone 2a (Hunter River From Glennies Creek Junction To Wollombi Brook Junction)	500	0
WAL1070	HVO South - LCPP River Pump – Water Access Licence	Hunter River	Hunter Regulated River WSP	Zone 2a (Hunter River From Glennies Creek Junction To Wollombi Brook Junction)	500	0
WAL13387	Macquarie Generation Hunter River Pump Station	Hunter River	Hunter Regulated River WSP	Zone 1b (Hunter River From Goulburn River Junction To Glennies Creek Junction)	20	0
WAL 13391	HVO North – Alluvial Rehabilitation Irrigation.	Hunter River	Hunter Regulated River WSP	Zone 1b (Hunter River From Goulburn River Junction To Glennies Creek Junction	420	364.1
WAL18127	Carrington BB1	Hunter River Alluvium	Hunter Unregulated and Alluvial Water Sources WSP	Hunter Regulated River Alluvial Water Source – Upstream Glennies Creek management zone	383	299#
WAL18158	Ollenberry	Hunter River Alluvium	Hunter Unregulated and Alluvial Water Sources WSP	Hunter Regulated River Alluvial Water Source – Upstream Glennies Creek management zone	65	51#
WAL18307	HVO West – Parnells Creek Dam (Diversion Works Bywash)	Unregulated River	Hunter Unregulated and Alluvial Water Sources WSP	Jerrys Water Source; Jerrys Management Zone	500	0
WAL18327	HV Loading Point Pump Bayswater Creek (Diversion Works)	Unregulated River	Hunter Unregulated and Alluvial Water Sources WSP	Jerrys Water Source; Jerrys Management Zone	150	0
WAL23889	Greenleek	Wollombi Brook	Hunter Unregulated and Alluvial Water Sources WSP	Lower Wollombi Brook Water Source	144	0
WAL36190	HVO North, old farm bore	Hunter River Alluvium	Hunter Unregulated and Alluvial Water Sources WSP	Hunter Regulated River Alluvial Water Source – Jerrys Management Zone	120	0

Licence Number	Description	Water Source	Water Sharing Plan	Water Source – Management Zone	Approved Extraction (ML)	Extraction 2017/18 Water Year (ML)
WAL39798	Lemington Underground (LUG) Bore	Permian Coal Seams	North Coast Fractured and Porous Rock Groundwater Sources WSP (commenced 1/7/16)	Permian Coal Seams	1,800	1127
WAL40462	HVO Pit Excavations / Alluvial Lands Bores (x4)	Permian Coal Seams	North Coast Fractured and Porous Rock Groundwater Sources WSP (commenced 1/7/16)	Permian Coal Seams	2,400	917#
WAL40463					180	
WAL40466					460	
TBA (20BL167860)	HVO North (Carrington Pit)	Permian Coal Seams	North Coast Fractured and Porous Rock Groundwater Sources WSP (commenced 1/7/16)	Permian Coal Seams	220	0
TBA (20BL170000)	HVO North – Pit Excavation	Permian Coal Seams	North Coast Fractured and Porous Rock Groundwater Sources WSP (commenced 1/7/16)	Permian Coal Seams	20	0

Passive take / groundwater inflows to pit.

3.1.2 Management Plans, Programmes and Strategies

Under the Project Approvals, HVO is required to develop and submit a range of environmental management plans for approval prior to implementation. Issued in 2009, the HVO South Coal Project Approval (PA06_0261) required submission of a number of monitoring programmes, strategies and some management plans, while the January 2013 modification to the HVO North Consent (DA 450-10-2003) contains a contemporary list of comprehensive management plan requirements. The approval of the modification to the HVO North Consent (Mod 6) in January 2017 and the Independent Environmental Audit triggered a review of all management plans. Updated plans were submitted to DP&E in 2017. Where possible, the HVO South conditions, commitments and obligations have been included in the Management Plans which have been submitted for HVO North, allowing for a single plan to detail management measures which will be employed across the site.

In addition to the triggered updates, all management plans were submitted for approval to DP&E in 2017 and 2018 with updated HVO branding. The management plans are made publically available on the HVO Insite website (https://insite.hvo.com.au/).

The status of these management plans is shown in Table 8 and Table 9.

Table 8: Management plans and Mining Operations Plans (MOPs) required for HVO North

Management Plan	Date Approved
HVO Water Management Plan	16/10/2018
HVO Bushfire Management Plan	23/06/2015
HVO Noise Management Plan	1902/2019
HVO Blast Management Plan	04/04/2014
HVO Air Quality and Greenhouse Gas Management Plan	12/02/2014
Hunter Valley Operations Environmental Management Strategy	08/01/2019
Rehabilitation Management Plan (addressed in MOP)	26/2/2019
Agricultural Lands Reinstatement Management Plan (addressed in MOP)*	19/02/2016
MOP - HVO North 2019-2021	26/2/2019
HVO River Red Gum Rehabilitation & Restoration Strategy	24/03/2010
HVO North Heritage Management Plan	12/02/2014
HVO Greenhouse and Energy Efficiency Plan (Addressed in HVO Air Quality and Greenhouse Gas Management Plan)	12/02/2014
Fine Reject Management Strategy	07/12/2018

*The Agricultural Lands Reinstatement Management Plan states that the agricultural reinstatement activities and monitoring results will be reported in the HVO Annual Environment Review. However work has not yet commenced hence no monitoring or reporting against the Management Plan specific to the Carrington West Wing project is provided in this report.

Table 9: Management Plans and MOPs required for HVO South

Management Plan	Date Approved
HVO River Red Gum Rehabilitation & Restoration Strategy	24/03/2010
HVO South Aboriginal Cultural Heritage Management Plan	24/04/2010
HVGC Amenity Management Plan	22/01/2013
HVO Water Management Plan	16/10/2018
HVO South Aboriginal Cultural Heritage Management Plan	24/04/2010
HVO Bushfire Management Plan	23/06/2015
HVO Noise Management Plan	19/02/2019
HVO Blast Management Plan	4/04/2014
HVO Air Quality and Greenhouse Gas Management Plan	12/02/2014
Hunter Valley Operations Environmental Management Strategy	08/01/2019
MOP - HVO South 2015-2018 **(Incorporates:** - **Landscape Management Plan** - **Rehabilitation and Biodiversity Management Plan** - **Mine Closure Plan** - **Final Voids Management Plan)**	30/11/2017
Rehabilitation and Biodiversity Management Plan (Offsets component)	26/06/2017- Goulburn River Biodiversity Area Management Plan
HVO Integrated Biodiversity Management Plan	2/8/2018
HVO Biodiversity Offset Strategy	23/10/2017

4 OPERATIONS SUMMARY

4.1 Mining

Areas to be mined are geologically modelled, a mine plan is formed and the relevant mining locations are surveyed prior to mining. Figure 3 illustrates the mining process. HVO have no active underground workings.

No changes were made to the mining method during the reporting period. Mining progress deviated slightly from the schedule of the MOPs as a result of normal variations in productivity and utilisation.

The mining equipment fleet employed to carry out mining operations at HVO in 2017 and 2018 is detailed in Table 10 along with the fleet forecast for 2019. Changes in the data appear in bold.

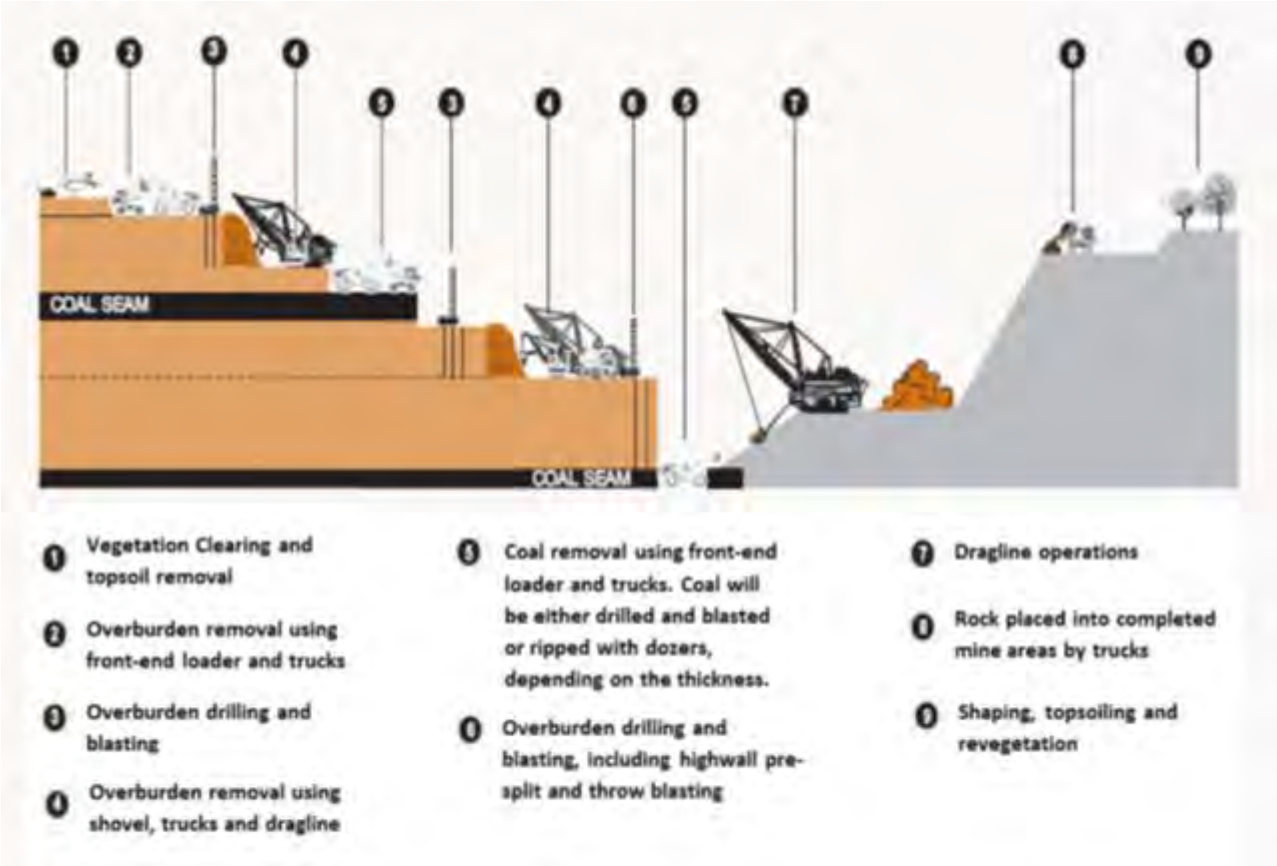


Figure 3: Open Cut Mining Schematic

Table 10: HVO Equipment Used 2017-2018

Equipment Type	Number Used in 2017	Number Used in 2018	Forecast numbers in 2019
Scrapers	2	2	2
Drills	8	8	8
Draglines	2	2	2
Shovels	3	3	3
Excavators	9	8	8
Trucks	105	**81**	86
Loaders	7	**6**	5
Service Trucks	5	5	5
Track Dozers	33	**29**	29
Rubber Tyre Dozers	5	5	5
Graders	11	11	11
Surface Miner*	0	0	0
Water Trucks	10	10	10
Floats	1	1	1
Cable Reeler	1	1	1
Cable Tractors	5	5	5
Total	**206**	**177**	**181**

4.1.1 Mineral Processing

Coal is transported to one of two CHPPs, where it is crushed to size and processed to remove impurities. Processing produces saleable coal, along with coarse and fine reject materials. Coarse rejects are disposed of in pit, and fine rejects are placed in a tailings dam, according to commitments outlined in the MOP. Each CHPP site has storage facilities for processed (saleable) and raw (unprocessed) coal. The capacity of each site is listed in Table 11. No changes or additions were made to process or facilities during the reporting period.

Table 11: Stockpile Capacities

Location	Raw stockpile(t)	Saleable stockpile (t)
Hunter Valley CHPP	176,000	330,000
West CHPP	15,000	30,000
Newdell CHPP	0	450,000

Processed, or product coal is transported to one of the two loading points via conveyor belt or road, detailed in Table 12. The coal from HVCHPP is transported to the Hunter Valley Load Point (HVLP) by means of overland conveyor whereas coal from West CHPP (Howick) is trucked to Newdell Load Point. After the coal has reached either HVLP or the Newdell Load Point, it is transported to Newcastle by rail.

Table 12: Methods of Coal Transportation

Category of Transport	Quantity (million tonnes)
Coal transported from the site via trains	12.9
Amount of coal received from Hunter Valley Operations South of the Hunter River	12.07
Amount of coal hauled by road to the Hunter Valley Loading Point	Nil
Coal hauled by road to the Newdell Load Point	1.6
Amount of coal hauled by road from the Newdell Loading Point to the Ravensworth Coal Terminal	Nil
Amount of coal hauled by road from the Hunter Valley Loading Point to the Ravensworth Coal Terminal	Nil
Number of coal haulage truck movements generated by the development. (includes -coal hauled to stockpile, coal hauled to bins, coal hauled from stockpile to bins)	40,085 (truck movements)

4.1.2 Production statistics

Project approvals allow for the extraction of up to 22 million ROM tonnes from operations north of the Hunter River and 20 million ROM tonnes from operations south of the Hunter River. A summary of production and waste at HVO during 2018 in comparison to previous years and approval limits is provided in Table 13.

Product coal includes low-ash, semi-soft and steaming coals.

Table 13: Production Statistics and Correlating Project Approval Limits

	Approved Limit (PA 06_0261 and DA 450-10-2003)	Reporting Period 2018	Reporting Period 2017	Forecast for 2019
Prime Waste (Mbcm)	-	100.4	97.3	106.3
ROM Coal (Mtpa) (mined)	42	18.99	19.48	19.5
- HVO South	*20*	11.9	*13.42*	11.3
- West Pit	*12*	5.4	*6.04*	8.2
- Carrington Pit	*10*	1.7	*0.01*	0
Coarse Reject (Mt)	-	3.0	3.2	3.1
Fine Reject- Tailings (Mt)	-	1.8	1.6	1.7
Product (Mtpa)	-	13.3	14.8	14.2
ROM Coal Processed	26	17.99	19.59	19.0
- Hunter Valley CHPP	20	15.6	16.25	15.6
- Howick CHPP	6	2.4	3.33	3.4

4.1.3 Summary of Changes (developments, equipment upgrades)

Similar levels of production and equipment were used throughout 2017 to 2018. Hire trucks were parked reducing overall truck numbers and a rope shovel was replaced.

Coal extraction in Carrington Pit was paused in 2018 with tailings emplacement to commence in the Carrington mining void in 2019.

Mining in the Carrington West Wing location has not yet commenced; at this time mining in this area will not commence in 2019.

5 ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW

The Resource Regulator (formerly DRG) provided feedback on the 2017 Annual Review on 3 July 2018. HVO addressed the feedback and resubmitted the 2017 Annual Review on 4 September 2018. The Resource Regulator provided acceptance of the 2017 Annual Review on 3 October 2018. Related to their review of 2017 performance the Regulator has issued separate correspondence (Section 240(1)(c) DI 0811 2018 and DI 0812 2018) relating to the rehabilitation of Hunter Valley Operations.

Following the Department of Planning & Environment's initial feedback on the 2017 Annual Review received by HVO on 24 May 2018, HVO revised the report to provide the additional detail requested. The 2017 Annual Review was resubmitted on 22 June 2018 addressing the Departments feedback. The Department provided final acceptance of the 2017 Annual Review of 12 December 2018 with no further feedback.

Details of actions required and status are provided in Table 14 below.

Table 14: Actions required following 2017 Annual Review

Action Required from previous Annual Review	Requested by	Action taken by the operator	Where discussed in previous Annual Review
Provide production figures for specific pits and coal preparation plants (CPPs)	DP&E	Updated production figures as required	Section 4.1.2
Provide date of aerial photograph used in Figure 2.	DP&E	Provided Date of Aerial Photograph	Section 2.2
Update Rehabilitation Figures 93, 94 and 95 to include extent of mining/rehabilitation activities, surface contours and rehabilitation vegetation types.	DP&E	Updated Figures 93, 94 and 95.	Section 8.8
Identify planned post-mined land uses on Figures 93, 94 and 95.	DP&E	Updated Figures 93, 94 and 95.	Section 8.8
Describe any renovation or removal of buildings during the reporting period.	DP&E	Included in Section 8.3	Section 8.3
Correct erroneous Table reference in Section 8.1.	DP&E	Reference Updated	Section 8.1
Include discussion on key limiting factors to successful rehabilitation.	DP&E	Provided Relevant discussion	Section 8.2
Provide update on status of completion of 2016 IEA actions	DP&E	Provided update on 2016 IEA actions	Section 10.
Detail the next scheduled IEA.	DP&E	Provided detail on next IEA.	Section 10.
Provide a summary of rehabilitation Monitoring	DP&E (Resource Regulator)	Provided Rehabilitation Monitoring Summary	Section 8.8
Include an assessment of the trajectory of rehabilitation completion criteria.	DP&E (Resource Regulator)	Provided trajectory assessment	Section 8.8.1
Provide a detailed description of all remedial works and management actions to be undertaken in 2018.	DP&E (Resource Regulator)	Provided details as required	Section 12.6

6 ENVIRONMENTAL PERFORMANCE

6.1 Meteorological Data

The collection of meteorological data is carried out to assist in day to day operational decisions, planning, environmental management and to maintain a historic record. The meteorological (weather) stations record wind speed, wind direction, temperature, humidity, solar radiation and rainfall. HVO operates two real time weather stations; the HVO Corporate Meteorological Station and the Cheshunt Meteorological Station. Data is publically available via the Monthly Environmental Reports published on the HVO Website (insite.hvo.com.au).

6.2 Noise

6.2.1 Management

Mining activities undertaken at HVO are managed to ensure adverse noise impacts are minimised, and to ensure compliance with permissible noise limits at nearby private residences. A combination of both proactive and reactive control mechanisms are employed to ensure effective management of noise as described in the HVO Noise Management Plan.

6.2.2 Sound Attenuation of Heavy Equipment

During 2018, 22 haul trucks were retrofitted with sound attenuation kits to achieve a sound power level of 115 dB(A). This is in addition to 28 trucks that have previously received Stage 1 noise attenuation, achieving a sound power level of 118 dB(A) and 18 trucks attenuated in 2017 115 dB(A) to making a total of 68 out of 81 trucks (83%) now sound attenuated.

During 2018, 12 haul trucks were sound power level tested following installation of sound attenuation equipment. HVO has developed a routine sound power level testing schedule which will continue to be implemented during 2019.

In 2019, HVO is scheduled to complete fitment of a further 13 sound attenuation kits haul trucks with all the haul fleet to be sound attenuated by the end of 2019.

6.2.3 Real Time Noise Management

HVO operates a network of directional real-time noise monitors to ensure noise emissions remain within compliance limits and to minimise community impact.

During 2018, the HVO Mine Monitoring and Control Team received and responded to 792[1] noise alarms, recording a total of 158 hours of equipment stoppage due to noise management.

The real-time system generates alarms when elevated noise is measured, triggering the implementation of reactive controls to reduce noise levels. The location of real time and attended noise monitoring locations are shown in Figure 4.

During 2018, HVO commissioned and implemented the use of the Environmental Noise Compass in Maison Dieu, to further improve the real-time noise monitoring system surrounding HVO.

An assessment of 2018 real time monitoring compared against attended compliance measurements taken at the same location indicated that the real time monitoring system generally aligned with values recorded during attended noise measurements. Where they didn't align, the majority of real time measurements were higher than attended noise measurements.

Details of this assessment is provided in Table 15.

[1] Noise alarm triggers are based on internally set noise criteria. Alarms received include noise exceedances from non-mine sources.

Table 15: Comparison of Attended and Real Time noise monitoring 2018

Monitoring Location	Number of attended noise measurements[1]		Real Time measurements that aligned[2] with attended measurements		Real Time measurements >3dB(A) of attended measurements		Real Time measurements <3dB(A) of attended measurements	
	South	North	South	North	South	North	South	North
Maison Dieu	12	NA	9	NA	1	NA	2	NA
Knodlers Lane	12	NA	9	NA	2	NA	1	NA
Long Point	12	NA	9	NA	0	NA	3	NA
Kilburnie South	12	12	2	8	8	1	2	3
Jerrys Plains[3]	15	17	3	10	12	5	0	1

Notes:

1. Includes measurements under all meteorological conditions

2. Aligned indicates measurements were within 3dB (A) of each other or measurement results <25dB indicated that source contribution was in audible or not measureable.

3. One data point not available for one of the attended monitoring events.

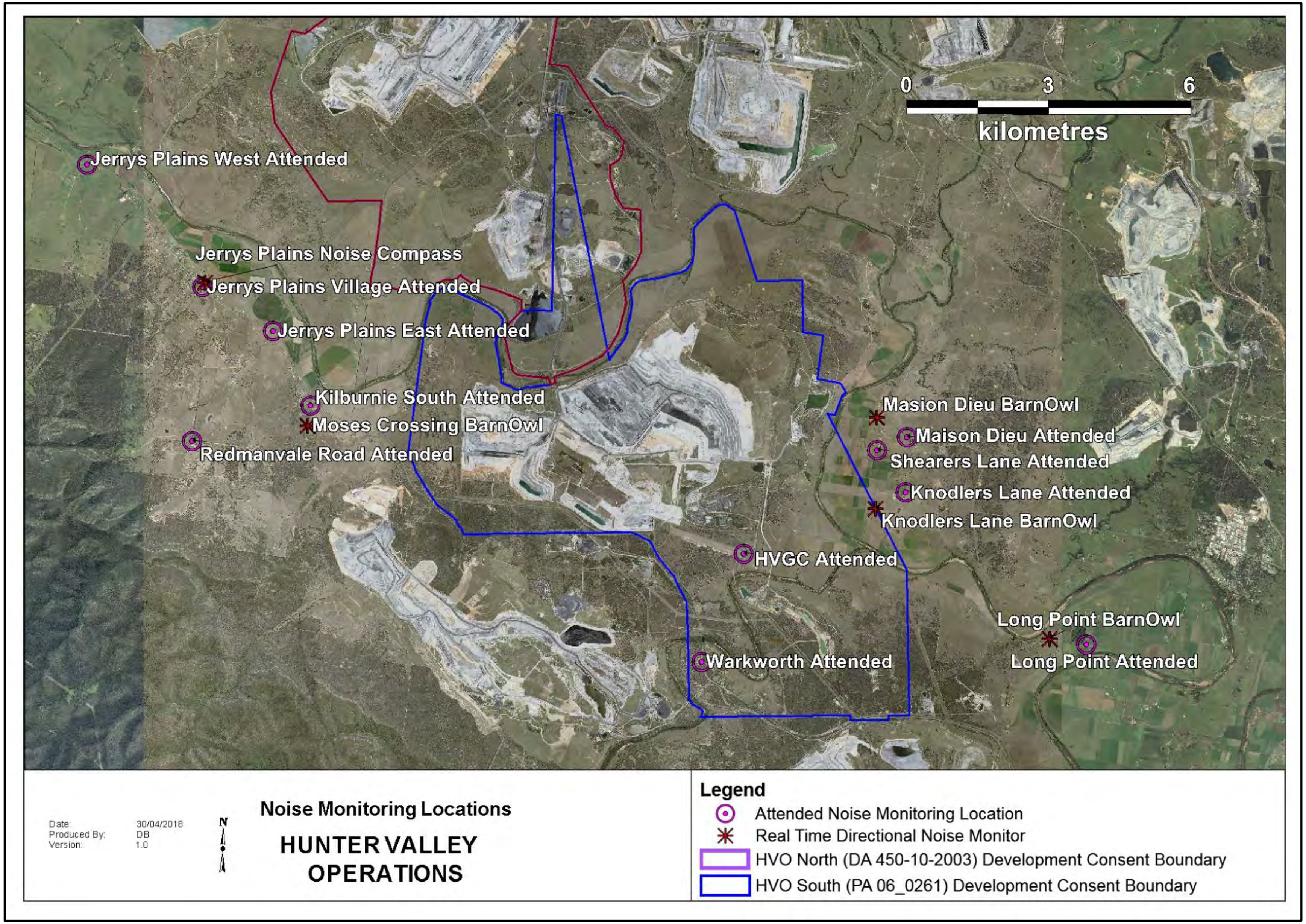


Figure 4: HVO Attended and Real-time Noise Monitoring Locations

6.2.4 Operational Noise Performance

To assess compliance with the relevant Project Approval noise criteria, HVO engages Global Acoustics to undertake routine compliance monitoring at nearby private residences, in accordance with the HVO Noise Management Plan. Monitoring is undertaken at a frequency of one night per month so as to ensure that noise impacts are adequately assessed under a range of meteorological conditions throughout the year.

A total of 105 measurements were taken during 2018. Each measurement involves an assessment of HVO mine noise against the various L_{Aeq} and $L_{A1\ 1min}$ noise criteria in place under the HVO North and South Approvals. Full details for all noise assessments completed can be found in the Hunter Valley Operations Monthly Environmental Monitoring Report, published on the HVO website (https://insite.hvo.com.au).

There were four noise exceedances during 2018. The August and September measurement's both exceeded criteria but did not constitute non-compliances as the noise was promptly addressed (within 75 minutes of detection, per approved Noise Management Plan).

During the original measurement at Kilburnie South 11 October 2018, a site-only LA1,1minute of 50 dB exceeded the relevant HVO South criterion of 45 dB. Dispatch was notifed by the acoustic consultant and five one minute re-measures were performed shortly after whereby LA1<1minute levels were all within the criterion of 45 dB.

During the measurement at Jerrys Plains Village on 17 December 2018 a site-only LAeq of 36 dB was measured. A 2 dB low-frequency modifying factor was triggered resulting in a site-only LAeq of 38 dB which exceeded the HVO North LAeq15minute criteria by 2 dB. A follow-up measurement was conducted at Jerrys Plains Village on 18 December 2018 with HVO North inaudible during the recording.

Noise measurements which exceeded criteria are presented in Table 16 below.

Table 16: Noise measurements which exceeded noise criteria during 2018

Date/Time	Monitoring Location	Criteria	Criteria (dB)	Measured Noise (dB)	Criteria Exceeded by (dB)
9/8/2018 21:37	Jerrys Plains Village	HVO North $L_{Aeq\ 15min}$	36	39	3
5/9/2018 21:26	Jerrys Plains Village	HVO North $L_{Aeq\ 15min}$	36	39	3
11/10/2018 22:59	Kilburnie South	HVO South LA1	45	50	5
17/12/2018 21:53	Jerrys Plains Village	HVO North $L_{Aeq\ 15min}$	36	38	2

Table 17 and Table 18 show comparisons between the 2018 L_{Aeq} attended noise monitoring results (maximum HVO contribution levels measured under applicable meteorological conditions) and the predictions made in the HVO West Pit Extension and Minor Modifications EIS (2003) and the HVO South Modification 5 (2017)Environmental Assessment (2008).

Table 17: Comparison of 2018 noise monitoring results against previous years.

Year	Number of measurements	Number of measurements which exceeded allowable noise (under applicable meteorological conditions)	Number of non-compliances
2018	105	3	0
2017	100	1*	0
2016	109	2*	0
2015	107	3*	2
2014	75	2*	0

* The NSW Industrial Noise Policy (INP) allows for the measured result to be less than or equal to 2 dB above the applicable noise limit without constituting a non-compliance. Note: Where the measured result is greater than 2dB above the applicable noise limit, the site has 75 minutes to reduce noise levels below applicable noise limits before constituting a non-compliance. As of late October 2017, the NSW INP was superseded by the Noise Policy for Industry (NPfI), the requirements of this policy where implemented in late 2017.

Comparisons against the predicted noise levels in the HVO Carrington West Wing EA (2010) have not been made in this years' Annual Review, as this project has not commenced. Mining activity in the Carrington Pit area was limited to short term mining campaign prior to the proposed deposition of tailings material.

Comparisons against the predicted noise levels in the HVO West Pit Extension and Minor Modifications EIS (2003) have been made against the modelled scenario for Year 15 (indicative of activities carried out during 2018) of the development (Table 5.2 of Part J – Hunter Valley Operations West Pit Extension and Minor Modifications Technical Reports Part 3) are shown in Table 18.

Comparison of measured results against the modelled predictions for Year 15 in the HVO West Pit EIS (2003) demonstrates noise levels equal to or lower than predicted at all monitoring locations, with the exception of the Kilburnie South and Jerrys Plains monitoring location.

Table 18: Comparison of 2018 monitoring against HVO North (Year 15, West Pit EIS, 2003) - Night Period

Location	Units	EIS Prediction (INP)	2018 (max. measured $L_{Aeq\ 15min}$ under applicable met. conditions)
Knodlers Lane	dB(A)	27	Not measurable
Maison Dieu	dB(A)	26	Not measurable
Kilburnie South	dB(A)	34	<35
Jerrys Plains	dB(A)	<35	39
Jerrys Plains East	dB(A)	38	35

Comparisons against the predicted noise levels in the HVO South Modification 5 Environmental Assessment have been made against Stage 1 modelling scenario (indicative of activities carried out during 2018), (Table 6.1 of Appendix E– Hunter Valley Operations South Modification 5 Approval Environmental Assessment Report Volume 2).

Comparison of HVO South Pit area data measured through routine compliance assessment indicates noise lower than predicted levels for all receptors (Table 19).

Table 19: Comparison of 2018 monitoring against HVO South (Stage 1 HVO South Modification 5 EA-2017)

Location	Units	EIS Prediction	2018 (max. measured $L_{Aeq\ 15min}$ under applicable met. conditions)
Knodlers Lane	dB(A)	39	33
Maison Dieu	dB(A)	40	33
Shearers Lane (160)	dB(A)	41	40
Kilburnie South	dB(A)	39	36
Jerrys Plains	dB(A)	34	<30
Jerrys Plains East	dB(A)	35	32

6.3 Blasting

6.3.1 Blasting Management

The objective of blasting operations is to ensure that optimal fragmentation is obtained whilst minimising dust and fume generation, adhering to safety standards and conforming to approvals criteria for vibration and overpressure.

During 2018, HVO operated a blast monitoring network under Benchmark Monitoring's' Kaboom Blast Monitoring System. HVO achieved 100% blast data capture for all blast monitors with the exception of the Knodlers Lane monitoring station which achieved 98% for airblast overpressure and 99% for vibration during 2018. Monitors are located at or in close proximity to nearby privately owned residences and function as regulatory compliance monitors as shown in Figure 5. These monitors are located at:

- Jerrys Plains Village;
- Warkworth;
- Maison Dieu;
- Moses Crossing; and
- Knodlers Lane

Figure 5: Blast Monitoring Network

6.3.2 Blasting Performance

During the reporting period 222 blast events were initiated at HVO. HVO complied with all blasting related consent and licence conditions with the exception of one blast on 17 January 2018 in the HVO South area which exceeded the Airblast Overpressure criteria at Moses Crossing and Jerrys Plans. Details on the incident are provided in Section 11.1. Airblast Overpressure and Ground Vibration results for all blasts fired during the reporting period are displayed in Figure 6 to Figure 10.

There were a total of six blasts that recorded an initial overpressure reading greater than 115dB(L) during the reporting period. The resulting six readings over 115dB(L) limit have been assessed for comparison against the 5% of the total number of blasts over a 12 month period these results are shown in Table 20.

Table 20: HVO airblast overpressure allowable exceedance summary

Monitoring Location	Allowable Exceedance over 115dB(L) of time over 12 months (%)	Percentage of blasts over 115dB(L)
Moses Crossing	5	0.00
Jerrys Plains	5	0.00
Warkworth	5	0.45
Maison Dieu	5	2.53
Knodlers Lane	5	0.45

There were no exceedances of the 5 mm/s or 10 mm/s ground vibration criteria at any residence on privately-owned land.

During 2018, blasting occurred only between the hours of 7am and 6pm Monday to Saturday. No blasting was carried out on Sundays or Public Holidays. In addition, no more than 3 blasts were fired per day and the maximum number of blasts fired during any week was eight, less than the maximum weekly blasting frequencies as specified in DA 450-10-2003 and PA 06_0261.

No fume events were recorded leaving the site in accordance with protocols detailed in the HVO Blast Management Plan.

During the reporting period, HVO closed Lemington Road on 10 occasions and Golden Highway on 15 occasions with 15.5 minutes and 14 minutes being the average time that these respective roads were closed.

Coordination of blasting times with neighbouring mines, Ravensworth and Wambo, continued to occur by email notifications.

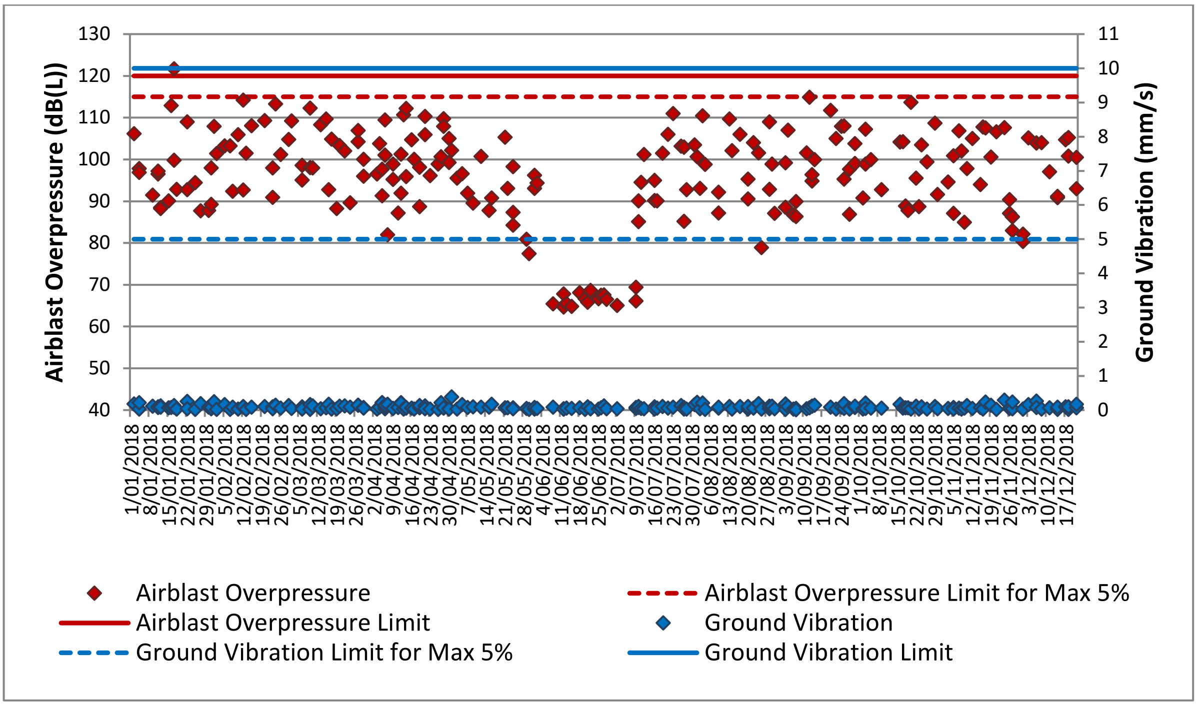


Figure 6: Jerrys Plains Blast Monitoring Results 2018

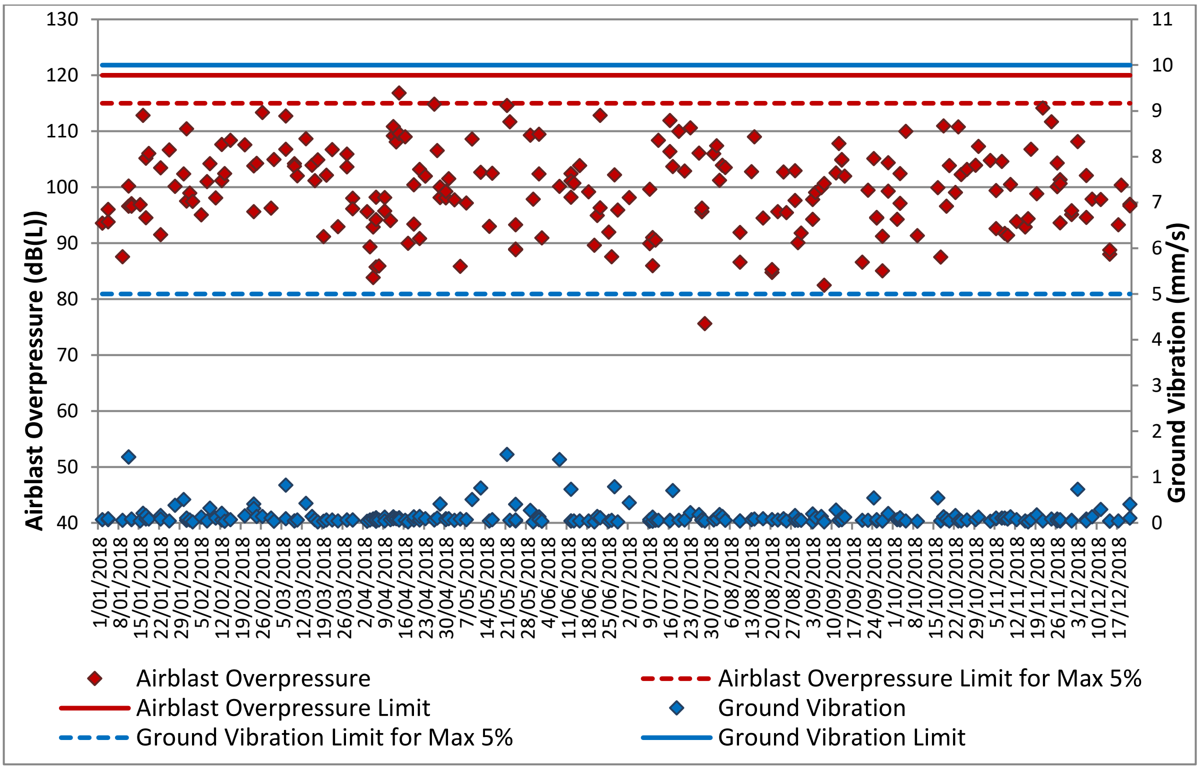


Figure 7: Knodlers Lane Blast Monitoring Results 2018

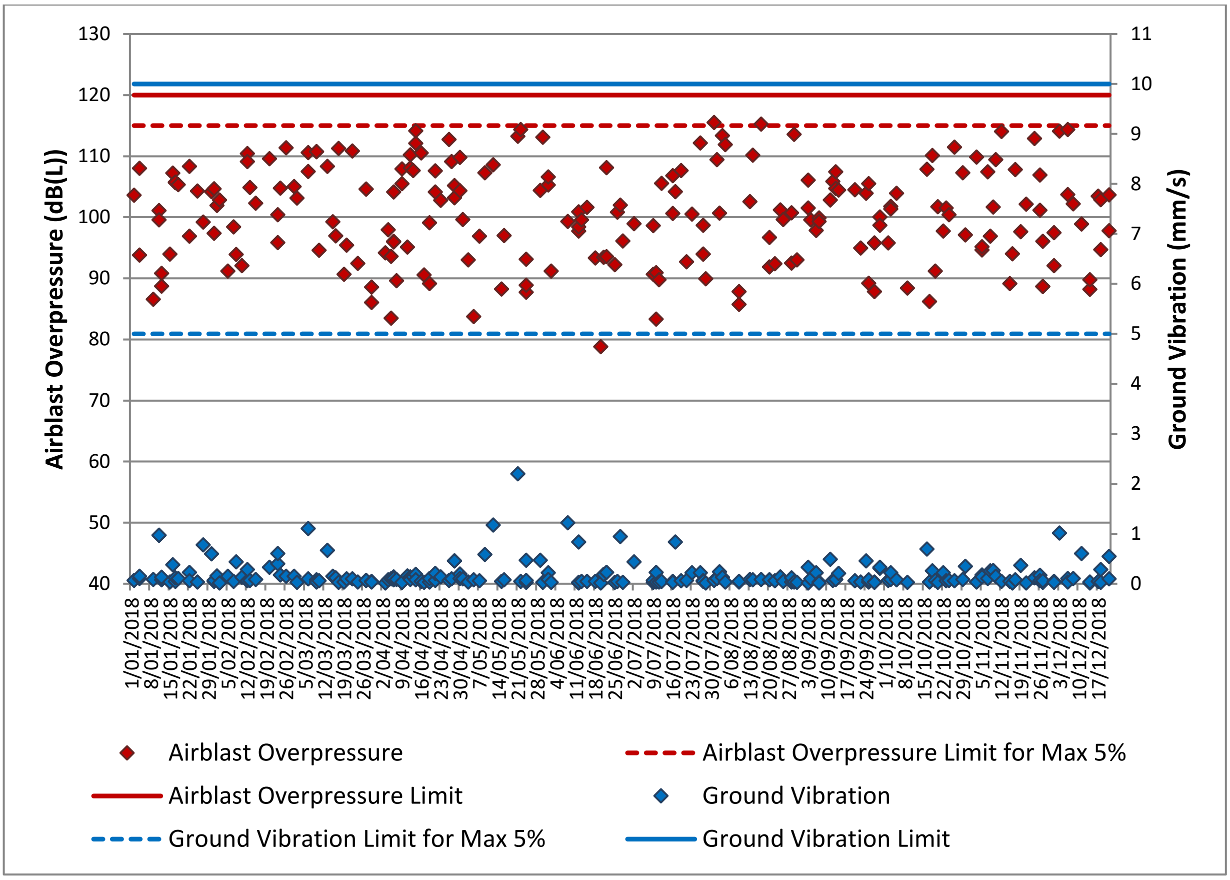


Figure 8: Maison Dieu Blast Monitoring Results 2018

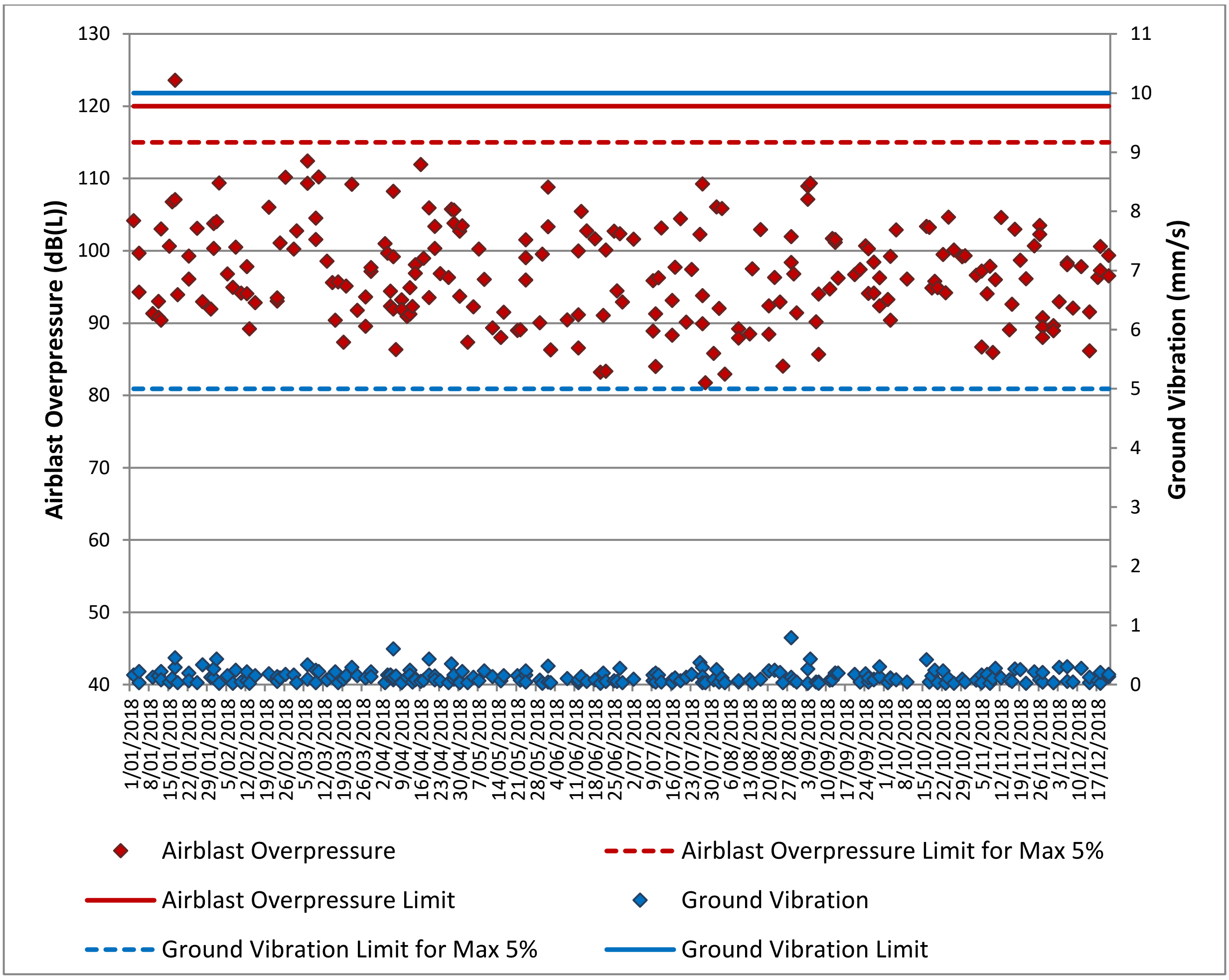


Figure 9: Moses Crossing Blast Monitoring Results 2018

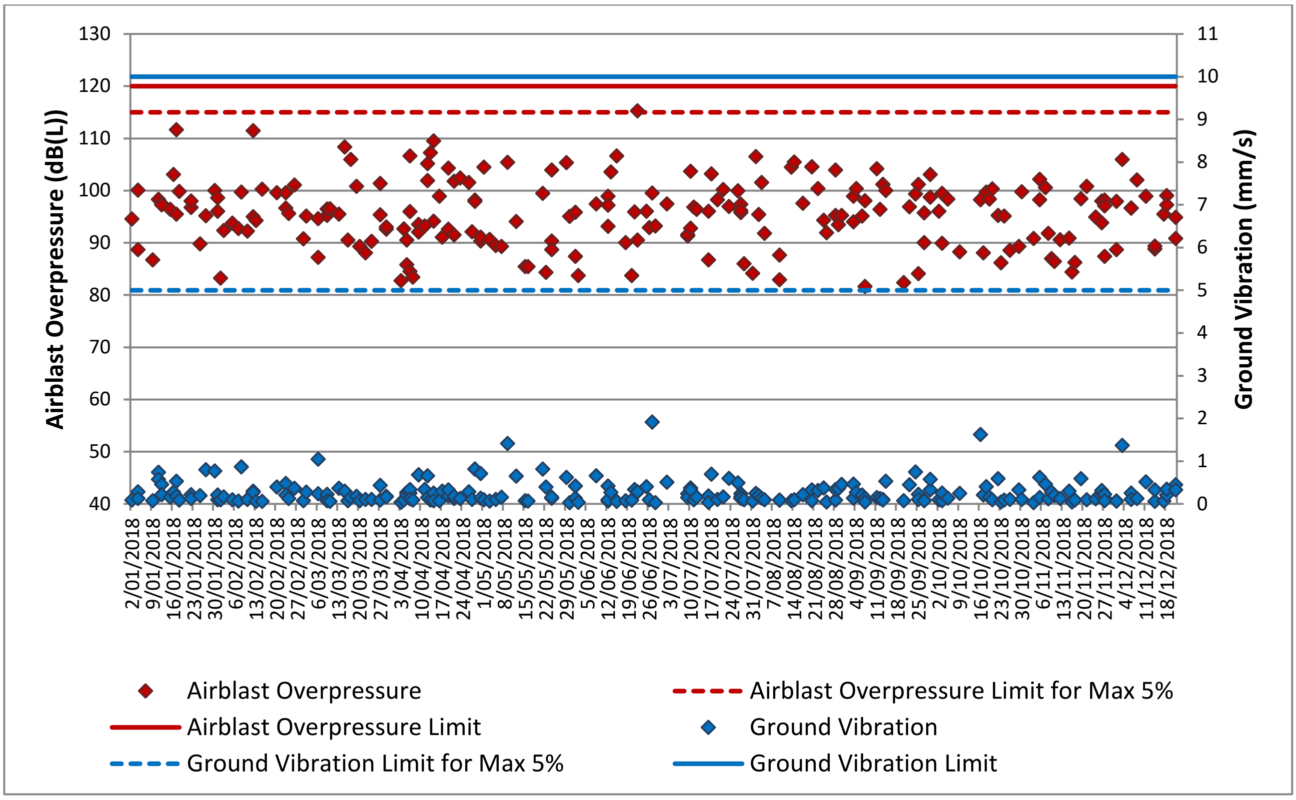


Figure 10: Warkworth Blast Monitoring Results 2018

6.3.3 Blast Fume Management

HVO operates a Post Blast Fume Generation Mitigation and Management Plan. This document outlines the practices to be utilised to reduce the risk of generation of post blast fume, and reduce potential offsite impact from any fume which may be produced. This includes specialised blasting design, appropriate product selection, on-bench water management, implementation of fume management zones and use existing blasting permissions to identify likely path of any fume which may be produced.

All blasts are observed for fume and any fume produced is ranked according to the Australian Explosive Industry & Safety Group (AEISG) Scale.

Fume rankings for shots fired during 2018 and comparison to previous years is provided in Table 21. Four blasts produced fume ranked as category 3 (AEISG scale) but did not leave the mine boundary. No fume ranked as category 4 or 5 occurred during 2018.

Table 21: Visible blast fume rankings according to the AEISG colour scale

AEISG Ranking	2018	2017	2016
0	214	272	275
1	19	39	49
2	16	11	13
3	4	2	1
4	0	0	0
5	0	0	0
Total*	**253**	**324**	**338**

* Where a number of individual blasts were fired as a blast event, fume was assessed for each individual blast pattern rather than for the event as a whole.

6.4 Air Quality

6.4.1 Air Quality Management

Air quality management initiatives are implemented at HVO to ensure that:

- Air quality impacts on surrounding residents are minimised;
- All statutory requirements are adhered to; and
- Local community and regulators are kept informed through prompt and effective response to issues and complaints.

Air quality control mechanisms employed at HVO are described in detail in the Hunter Valley Operations Air Quality and Greenhouse Gas Management Plan, publically available via the Hunter Valley Operations Website (https://insite.hvo.com.au/document-library/management-plans-hvo).

6.4.2 Air Quality Performance

6.4.2.1 Real Time Air Quality Management

HVO's real time air quality monitoring stations continuously log information and transmit data to a central database, generating alarms when particulate matter levels exceed internal trigger limits to guide the operational management.

A total of 1471 real time alarms for air quality and wind conditions were received and acknowledged during 2018 which is an increase from 750 alarms recorded during 2017. This increase is due to the implementation of several alarms relating to air quality during lifting of Cheshunt dump.

In response, 6428 hours of equipment downtime was recorded due to air quality management. A detailed breakdown of air quality related equipment stoppages (per month, per equipment type) presented in Figure 11.

Data availability from HVO's real time air quality monitoring stations is presented in Table 22.

Table 22: Real Time Air Quality Monitoring Data Availability 2018

Monitoring Location	2018 Data Availability
Warkworth	95.6%
Knodlers Lane	97.3%
Maison Dieu	99.7%
Howick	95.6%
HC1 Conveyor	93.4%
Wandewoi	96.4%
Golden Highway	92.3%

Note: Data availability calculated across 2018 based on availability of a 24hour average result.

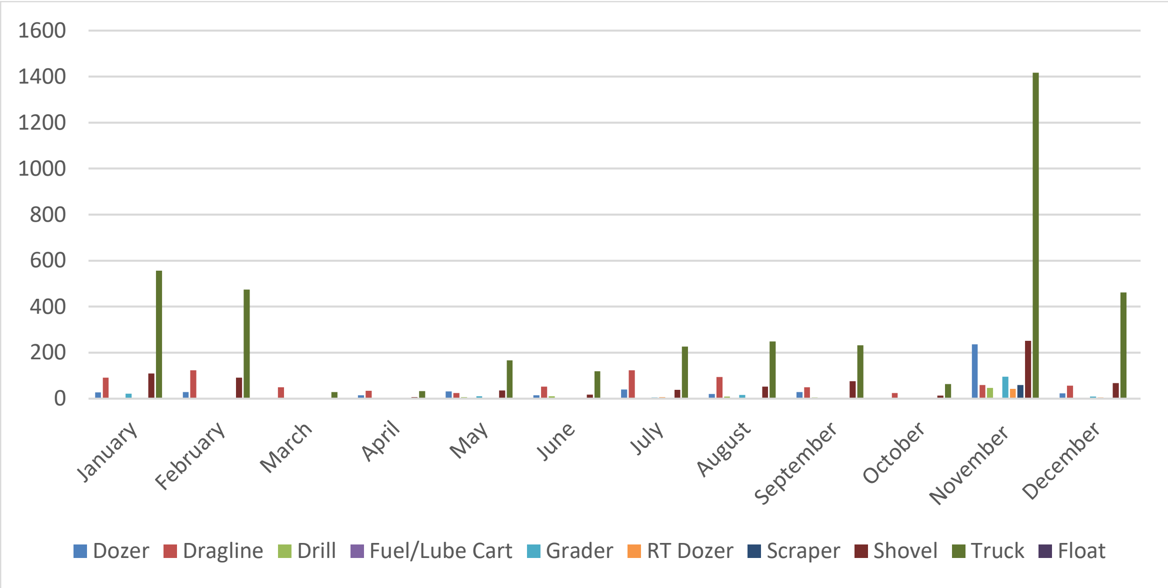


Figure 11: Equipment Downtime Hours for Air Quality Management 2018

All 24 hr average results recorded by HVO's surrounding network of TEOM monitors are presented on a quarterly basis in Figure 12 to Figure 15.

During 2018, 61 TEOM PM_{10} measurements exceeded the 24 hr short term impact assessment criteria. Each was investigated to determine the level of contribution from HVO activities to the elevated result (Table 23).

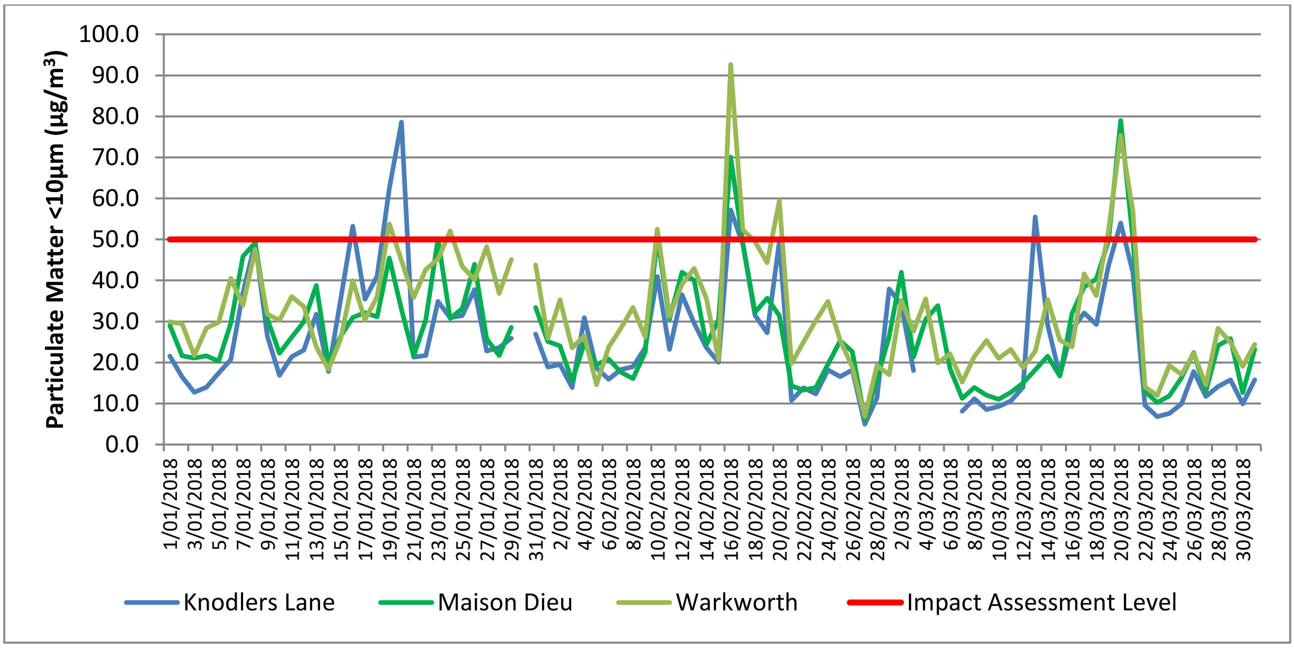


Figure 12: 24 hr average PM10 (real time monitors) – Quarter One 2018

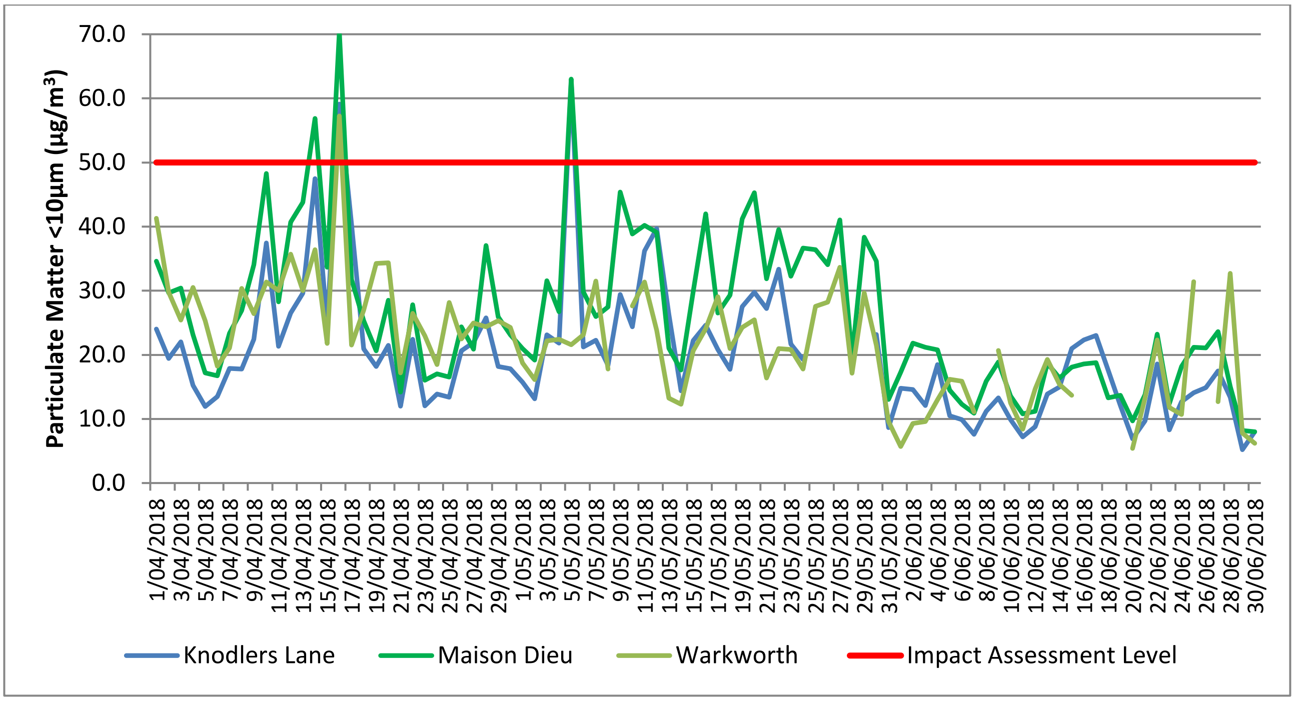


Figure 13: 24 hr average PM10 (real time monitors) - Quarter Two 2018

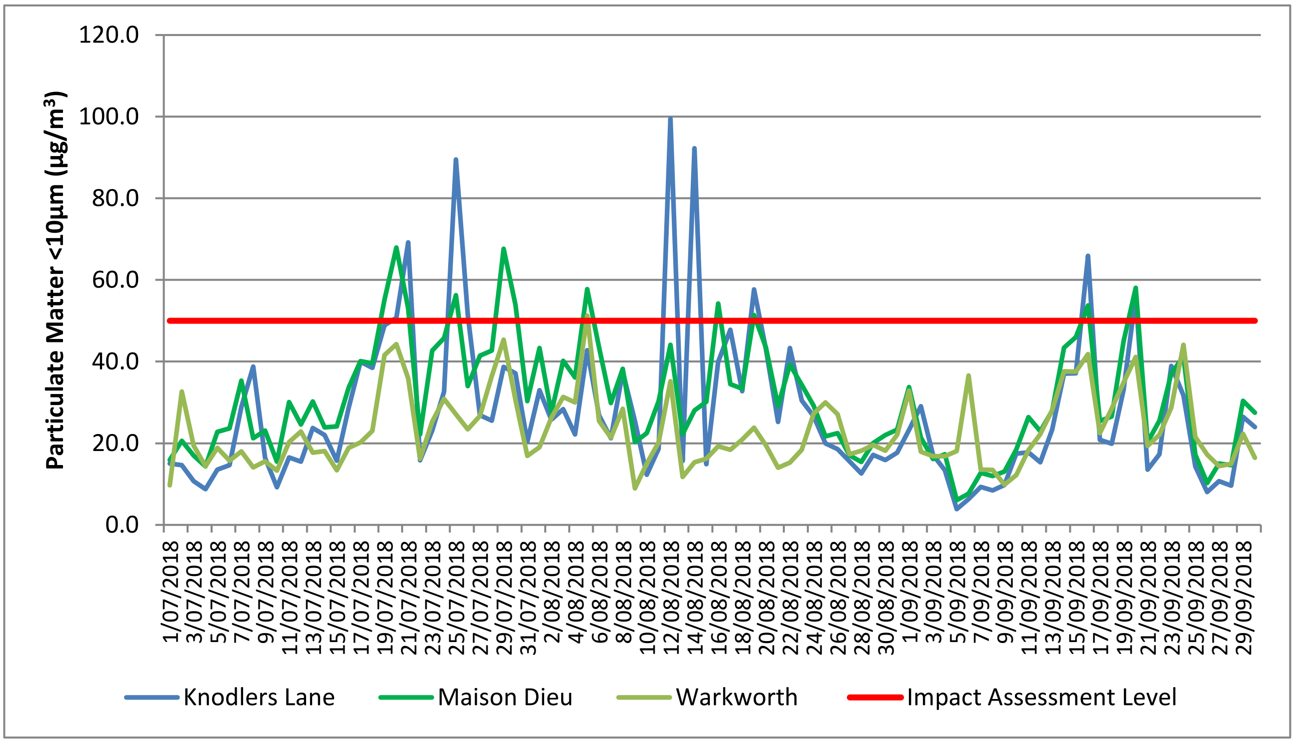


Figure 14: 24 hr average PM10 (real time monitors) - Quarter Three 2018

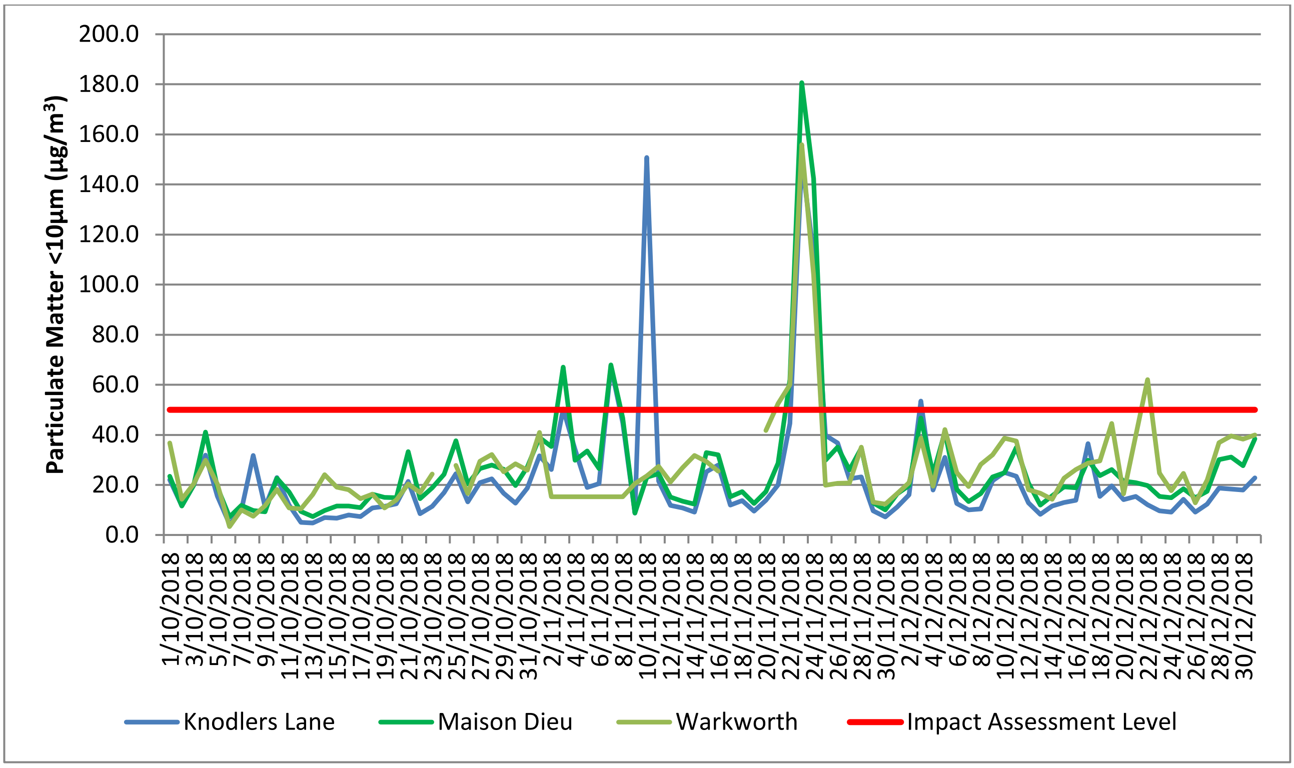


Figure 15: 24 hr average PM10 (real time monitors) - Quarter Four 2018

Table 23: 24 Hour Elevated Real Time PM10 Investigations

Date	Site	24hr result (µg/m^3)	Estimated max. contribution from HVO (µg/m^3)	Estimated max. Contribution (%)	Discussion
16/01/2018	Knodlers Lane PM10 TEOM	53.2	0	0	An internal investigation determined that HVO could not have contributed to the recorded value on this day as at no time was the wind from the direction of HVO.
19/01/2018	Warkworth PM10 TEOM	53.8	12.1	22.6	An internal investigation determined HVO maximum potential contribution to be in the order of 12.1ug/m3 or 22.6% of the total measured based on periods of time were wind blew from the direction of HVO to the monitor.
19/01/2018	Knodlers Lane PM10 TEOM	62.4	8.9	14.3	An internal investigation determined HVO maximum potential contribution to be in the order of 8.9ug/m3 or 14.3% of the total measured based on periods of time were wind blew from the direction of HVO to the monitor.
20/01/2018	Knodlers Lane PM10 TEOM	78.6	0	0	An internal investigation determined that HVO could not have contributed to the recorded value on this day as at no time was the wind from the direction of HVO.
23/01/2018	Maison Dieu PM10 TEOM	50.1	4.6	9.2	An internal investigation determined HVO maximum potential contribution to be in the order of 4.6ug/m3 or 9.2% of the total measured based on periods of time were wind blew from the direction of HVO to the monitor.
24/01/2018	Warkworth PM10 TEOM	52.0	0.2	0.4	An internal investigation determined HVO maximum potential contribution to be in the order of 0.2ug/m3 or 0.4% of the total measured based on periods of time were wind blew from the direction of HVO to the monitor.
9/02/2018	Warkworth PM10 TEOM	52.5	16.3	31	An internal investigation determined HVO maximum potential contribution to be in the order of 16.3ug/m3 or 31% of the total measured based on periods of time were wind blew from the direction of HVO to the monitor.
09/02/2018	Maison Dieu PM10 TEOM	50.5	6.2	12.3	An internal investigation determined HVO maximum potential contribution to be in the order of 6.2ug/m3 or 12.3% of the total measured based on periods of time were wind blew from the direction of HVO to the monitor.
15/02/2018	Knodlers Lane PM10 TEOM	57.2	1.7	3.0	An internal investigation determined HVO maximum potential contribution to be in the order of 1.7ug/m3 or 3.0% of the total measured based on prevailing wind conditions. Notes: Bushfires observed to the west of region
15/02/2018	Warkworth PM10 TEOM	92.6	3.2	3.5	An internal investigation determined HVO maximum potential contribution to be in the order of 3.2ug/m3 or 3.5% of the total measured based on prevailing wind conditions. Notes: Bushfires observed to the west of region

15/02/2018	Maison Dieu PM10 TEOM	70.1	1.8	2.6	An internal investigation determined HVO maximum potential contribution to be in the order of 1.8ug/m3 or 2.6% of the total measured based on prevailing wind conditions. Notes: Bushfires observed to the west of region
16/02/2018	Warkworth PM10 TEOM	52.4	21.1	40.3	An internal investigation determined HVO maximum potential contribution to be in the order of 21.1ug/m3 or 40.3% of the total measured based on periods of time were wind blew from the direction of HVO to the monitor.
19/02/2018	Warkworth PM10 TEOM	58.2	0.0	0.0	An internal investigation determined HVO maximum potential contribution to be in the order of 0 ug/m3 or 0 % of the total measured as wind did not blow from the direction of HVO to the monitor on this day. Notes: Significant bushfire activity was also present to the west of the region and would have had some contribution to the region.
12/03/2018	Knodlers Lane PM10 TEOM	55.5	0.6	1.0	An internal investigation determined HVO maximum potential contribution to be in the order of 0.6 ug/m3 or 1.0% of the total measured based on prevailing wind conditions and upwind monitoring results.
18/03/2018	Warkworth PM10 TEOM	52.1	22.5	43.1	An internal investigation determined HVO maximum potential contribution to be in the order of 22.5ug/m3 or 43.1% of the total measured based on prevailing wind conditions and upwind monitoring results.
19/03/2018	Knodlers Lane PM10 TEOM	54	16.5	30.6	An internal investigation determined HVO maximum potential contribution to be in the order of 16.5ug/m3 or 30.6% of the total measured based on prevailing wind conditions and upwind monitoring results.
19/03/2018	Maison Dieu PM10 TEOM	79	14.8	18.7	An internal investigation determined HVO maximum potential contribution to be in the order of 14.8ug/m3 or 18.7% of the total measured based on prevailing wind conditions and upwind monitoring results.
19/03/2018	Warkworth PM10 TEOM	75.4	16.7	22.1	An internal investigation determined HVO maximum potential contribution to be in the order of 16.7ug/m3 or 22.1% of the total measured based on prevailing wind conditions and upwind monitoring results.
20/03/2018	Warkworth PM10 TEOM	56.8	3.2	5.6	An internal investigation determined HVO maximum potential contribution to be in the order of 3.2ug/m3 or 5.6% of the total measured based on prevailing wind conditions and upwind monitoring results.
20/03/2018	Maison Dieu PM10 TEOM	50.1	1.6	3.2	An internal investigation determined HVO maximum potential contribution to be in the order of 1.6ug/m3 or 3.2% of the total measured based on prevailing wind conditions and upwind monitoring results.
13/04/2018	Maison Dieu PM10 TEOM	56.9	33.6	59.0	An internal investigation determined HVO maximum potential contribution to be in the order of 33.6ug/m3 or 59% of the total measured based on prevailing wind conditions and upwind monitoring results.

15/04/2018	Knodlers Lane PM10 TEOM	59.1	6.8	11.5	An internal investigation determined HVO maximum potential contribution to be in the order of 6.8g/m3 or 11.5% of the total measured based on prevailing wind conditions and upwind monitoring results.
15/04/2018	Maison Dieu PM10 TEOM	70.4	18.1	25.7	An internal investigation determined HVO maximum potential contribution to be in the order of 18.1g/m3 or 25.7% of the total measured based on prevailing wind conditions and upwind monitoring results.
15/04/2018	Warkworth OEH PM10 TEOM	57.3	5.0	1.6	An internal investigation determined HVO maximum potential contribution to be in the order of 5.0g/m3 or 1.6% of the total measured based on prevailing wind conditions and upwind monitoring results.
4/05/2018	Maison Dieu PM10 TEOM	63	30.3	48.2	An internal investigation determined HVO maximum potential contribution to be in the order of 30.5ug/m3 or 48.2% of the total measured based on prevailing wind conditions and upwind monitoring results.
4/05/2018	Knodlers Lane PM10 TEOM	62.6	29.9	47.8	An internal investigation determined HVO maximum potential contribution to be in the order of 29.9ug/m3 or 47.8% of the total measured based on prevailing wind conditions and upwind monitoring results.
18/07/2018	Maison Dieu PM10 TEOM	55.2	10	18	An internal investigation determined HVO maximum potential contribution to be in the order of 10.0ug/m3 or 18% of the total measured based on prevailing wind conditions and upwind monitoring results.
19/07/2018	Knodlers Lane PM10 TEOM	50.7	13.2	26	An internal investigation determined HVO maximum potential contribution to be in the order of 13.2ug/m3 or 26% of the total measured based on prevailing wind conditions and upwind monitoring results.
19/07/2018	Maison Dieu PM10 TEOM	67.9	30.4	44.8	An internal investigation determined HVO maximum potential contribution to be in the order of 30.4ug/m3 or 44.8% of the total measured based on prevailing wind conditions and upwind monitoring results.
20/07/2018	Knodlers Lane PM10 TEOM	69.2	37.3	53.9	An internal investigation determined HVO maximum potential contribution to be in the order of 37.3ug/m3 or 53.9% of the total measured based on prevailing wind conditions and upwind monitoring results.
20/07/2018	Maison Dieu PM10 TEOM	52.9	21.1	39.8	An internal investigation determined HVO maximum potential contribution to be in the order of 21.1ug/m3 or 39.8% of the total measured based on prevailing wind conditions and upwind monitoring results.

24/07/2018	Knodlers Lane PM10 TEOM	89.5	59.9	67	An internal investigation determined HVO maximum potential contribution to be in the order of 59.9ug/m3 or 67% of the total measured based on prevailing wind conditions and upwind monitoring results. An external investigation was also undertaking for compliance assessment of the co-located HVAS unit on this day. The investigation considered that local sources to the monitor would have contributed to the PM10 levels recorded at this location. It is also considered that the estimate contribution of all of HVO and that contributions from HVO South and North are represented in the estimate. In response to high winds of this day HVO recorded 23 hours of equipment delays.
24/07/2018	Maison Dieu PM10 TEOM	56.2	30.3	53.9	An internal investigation determined HVO maximum potential contribution to be in the order of 30.3ug/m3 or 53.9% of the total measured based on prevailing wind conditions and upwind monitoring results. In response to high winds of this day HVO recorded 23 hours of equipment delays.
25/07/2018	Knodlers Lane PM10 TEOM	51.5	30.7	59.7	An internal investigation determined HVO maximum potential contribution to be in the order of 30.7ug/m3 or 59.7% of the total measured based on prevailing wind conditions and upwind monitoring results.
28/07/2018	Maison Dieu PM10 TEOM	67.7	29.2	43.2	An internal investigation determined HVO maximum potential contribution to be in the order of 29.2ug/m3 or 43.2% of the total measured based on prevailing wind conditions and upwind monitoring results.
29/07/2018	Maison Dieu PM10 TEOM	53.9	34.9	64.7	An internal investigation determined HVO maximum potential contribution to be in the order of 34.9ug/m3 or 64.7% of the total measured based on prevailing wind conditions and upwind monitoring results.
04/08/2018	Warkworth PM10 TEOM	51.3	5.2	10.2	An internal investigation determined HVO maximum potential contribution to be in the order of 5.2/m3 or 10.2% of the total measured, based on prevailing wind conditions and upwind monitoring results.
04/08/2018	Maison Dieu PM10 TEOM	57.7	28.4	49.2	An internal investigation determined HVO maximum potential contribution to be in the order of 28.4ug/m3 or 49.2% of the total measured based on prevailing wind conditions and upwind monitoring results.
11/08/2018	Knodlers Lane PM10 TEOM	99.5	33.4	30.0	An internal investigation revealed that data from 330am to 8am appears erroneous. Data is not consistent with levels measured close by and in the same direction from HVO at Maison Dieu. Levels appear to be from local source. Wind speed was low, therefore, high peak unlikely to be caused by HVO.
13/08/2018	Knodlers Lane PM10 TEOM	92.3	19.3	5.2	An internal investigation revealed that data from 330am to 8am appears erroneous. Data is not consistent with levels measured close by and in the same direction from HVO at Maison Dieu. Levels appear to be from local source. Wind speed was low, therefore, high peak unlikely to be caused by HVO.

15/08/2018	Maison Dieu PM10 TEOM	54.3	36.6	67.5	An internal investigation determined HVO maximum potential contribution to be in the order of 36.6ug/m3 or 67.5% of the total measured based on prevailing wind conditions and upwind monitoring results.
18/08/2018	Knodlers Lane PM10 TEOM	57.6	37.7	65.4	An internal investigation determined HVO maximum potential contribution to be in the order of 37.7ug/m3 or 65.4% of the total measured based on prevailing wind conditions and upwind monitoring results.
18/08/2018	Maison Dieu PM10 TEOM	51.4	32.5	63.2	An internal investigation determined HVO maximum potential contribution to be in the order of 32.5ug/m3 or 63.2% of the total measured based on prevailing wind conditions and upwind monitoring results.
15/09/2018	Maison Dieu PM10 TEOM	53.8	17.3	32.2	An internal investigation determined HVO maximum potential contribution to be in the order of 17.3ug/m3 or 32.2% of the total measured based on prevailing wind conditions and upwind monitoring results.
15/09/2018	Knodlers Lane PM10 TEOM	65.9	29.5	44.8	An internal investigation determined HVO maximum potential contribution to be in the order of 29.5ug/m3 or 44.8% of the total measured based on prevailing wind conditions and upwind monitoring results.
19/09/2018	Maison Dieu PM10 TEOM	58.1	19	32.8	An internal investigation determined HVO maximum potential contribution to be in the order of 19ug/m3 or 32.8% of the total measured based on prevailing wind conditions and upwind monitoring results.
19/09/2018	Knodlers Lane PM10 TEOM	56.2	21.3	37.6	An internal investigation determined HVO maximum potential contribution to be in the order of 21.3ug/m3 or 37.6% of the total measured based on prevailing wind conditions and upwind monitoring results.
2/11/2018	Maison Dieu PM10 TEOM	67	26.2	39.1	An internal investigation determined HVO maximum potential contribution to be in the order of 26.2ug/m3 or 39.1% of the total measured based on prevailing wind conditions and upwind monitoring results.
2/11/2018	Knodlers Lane PM10 TEOM	50.3	9.4	18.7	An internal investigation determined HVO maximum potential contribution to be in the order of 9.4ug/m3 or 18.7% of the total measured based on prevailing wind conditions and upwind monitoring results.
6/11/2018	Maison Dieu PM10 TEOM	67.9	23.5	34.6	An internal investigation determined HVO maximum potential contribution to be in the order of 23.5ug/m3 or 34.6% of the total measured based on prevailing wind conditions and upwind monitoring results.
6/11/2018	Knodlers Lane PM10 TEOM	67.3	22.9	33.9	An internal investigation determined HVO maximum potential contribution to be in the order of 22.9ug/m3 or 34.6% of the total measured based on prevailing wind conditions and upwind monitoring results.
20/11/2018	Warkworth PM10 TEOM	52.4	17.7	33.7	An internal investigation determined HVO maximum potential contribution to be in the order of 17.7ug/m3 or 33.7% of the total measured based on prevailing wind conditions and upwind monitoring results.

21/11/2018	Maison Dieu PM10 TEOM	62.0	20.6	33.2	An internal investigation determined HVO maximum potential contribution to be in the order of 20.6ug/m3 or 33.2% of the total measured based on prevailing wind conditions and upwind monitoring results. Between 21 – 22 November 2018, the Hunter Valley experienced regional dust storms which contributed to elevated levels across this period.
21/11/2018	Warkworth PM10 TEOM	60.0	18.6	30.9	An internal investigation determined HVO maximum potential contribution to be in the order of 18.6ug/m3 or 30.9% of the total measured based on prevailing wind conditions and upwind monitoring results. Between 21 – 22 November 2018, the Hunter Valley experienced regional dust storms which contributed to elevated levels across this period.
22/11/2018	Knodlers Lane PM10 TEOM	149.6	38.3	25.6	An internal investigation determined HVO maximum potential contribution to be in the order of 38.3ug/m3 or 25.6% of the total measured based on prevailing wind conditions and upwind monitoring results. Between 21 – 22 November 2018, the Hunter Valley experienced regional dust storms which contributed to elevated levels across this period.
22/11/2018	Maison Dieu PM10 TEOM	180.7	69.4	38.4	An internal investigation determined HVO maximum potential contribution to be in the order of 69.4ug/m3 or 38.4% of the total measured based on prevailing wind conditions and upwind monitoring results. Between 21 – 22 November 2018, the Hunter Valley experienced regional dust storms which contributed to elevated levels across this period.
22/11/2018	Warkworth PM10 TEOM	155.9	44.6	28.6	An internal investigation determined HVO maximum potential contribution to be in the order of 44.6ug/m3 or 28.6% of the total measured based on prevailing wind conditions and upwind monitoring results. Between 21 – 22 November 2018, the Hunter Valley experienced regional dust storms which contributed to elevated levels across this period.
23/11/2018	Maison Dieu PM10 TEOM	142.3	71.4	50.1	An internal investigation determined HVO maximum potential contribution to be in the order of 71.4ug/m3 or 50.1% of the total measured based on prevailing wind conditions and upwind monitoring results.
23/11/2018	Knodlers Lane PM10 TEOM	112.2	41.3	36.9	An internal investigation determined HVO maximum potential contribution to be in the order of 41.3ug/m3 or 36.9% of the total measured based on prevailing wind conditions and upwind monitoring results.
23/11/2018	Warkworth PM10 TEOM	103.8	33.0	31.7	An internal investigation determined HVO maximum potential contribution to be in the order of 33.0ug/m3 or 31.7% of the total measured based on prevailing wind conditions and upwind monitoring results.

2/12/2018	Knodlers Lane PM10 TEOM	53.5	15.8	29.5	An internal investigation determined HVO maximum potential contribution to be in the order of 15.8ug/m3 or 29.5% of the total measured based on prevailing wind conditions and upwind monitoring results.

6.4.2.2 Temporary Stabilisation

Aerial Seeding was undertaken in July 2018 by a fixed wing aircraft to provide temporary cover to areas exposed to wind generated dust and erosion at HVO. Waste dumps and exposed areas were selected for seeding if they were not planned to be disturbed within six months. The 219 ha of area seeded included waste dumps ahead of mining disturbance (Figure 16 and Figure 17). All areas were seeded using an exotic pasture and legume mix suitable for autumn sowing. A starter fertiliser was mixed with the seed prior to loading to provide sufficient nutrients for plant growth.

Figure 16: Areas Aerial Seeded in 2018 – HVO West Pit

Figure 17: Areas Aerial Seeded in 2018 – HVO South Pit

6.4.2.3 Air Quality Monitoring

Air quality monitoring at HVO is undertaken in accordance with the HVO Air Quality Monitoring Programme. An extensive network of monitoring equipment is utilised to assess performance against the relevant conditions of HVO's approvals. Air quality monitoring locations are shown in Figure 18. During 2018, HVO complied with all short term and annual average air quality criteria; refer to Table 24 and Table 25, along with a summary of HVO's performance against the criteria. HVO currently operates under two separate Planning Approvals (DA450-10-2003 – HVO North, and PA 06-0261 – HVO South).

The following compliance assessment has been undertaken on a 'whole of HVO site' basis, rather than individually assessing the contribution of each approval area to the measured results. Air quality monitoring data is made publically available through the HVO Monthly Environmental Monitoring Report, which can be viewed on the Hunter Valley Operations Website (https://insite.hvo.com.au).

Table 24: Air quality impact assessment criteria and 2018 compliance assessment (HVO North DA 450-10-2003 and HVO South PA 06_0261)

Pollutant	Criterion	Averaging Period	Compliance
Deposited Dust	4 g/m^2/month	Maximum total deposited dust level	100%
	2 g/m^2/month	Maximum increase in deposited dust level	100%
Total Suspended Particulate matter (TSP)	90 $\mu g/m^3$	Long Term (Annual)	100%
Particulate matter <10µm (PM_{10})	30 $\mu g/m^3$	Long Term (Annual)	100%
	50 $\mu g/m^3$	Short Term (24 hour)	100%

Table 25: Air quality land acquisition criteria and 2018 compliance assessment (HVO North DA 450-10-2003 and HVO South PA 06_0261)

Pollutant	Criterion	Averaging Period	Compliance
Deposited Dust	4 g/m^2/month	Maximum total deposited dust level	100%
	2 g/m^2/month	Maximum increase in deposited dust level	100%
Total Suspended Particulate matter (TSP)	90 $\mu g/m^3$	Long Term (Annual)	100%
Particulate matter <10µm (PM_{10})	30 $\mu g/m^3$	Long Term (Annual)	100%
	150 $\mu g/m^3$ [a]	Short Term (24 hour)	100%
	50 $\mu g/m^3$ [b]	Short Term (24 hour)	100%

a – Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources);

b – Incremental impact (i.e. incremental increase in concentrations due to the development on its own)

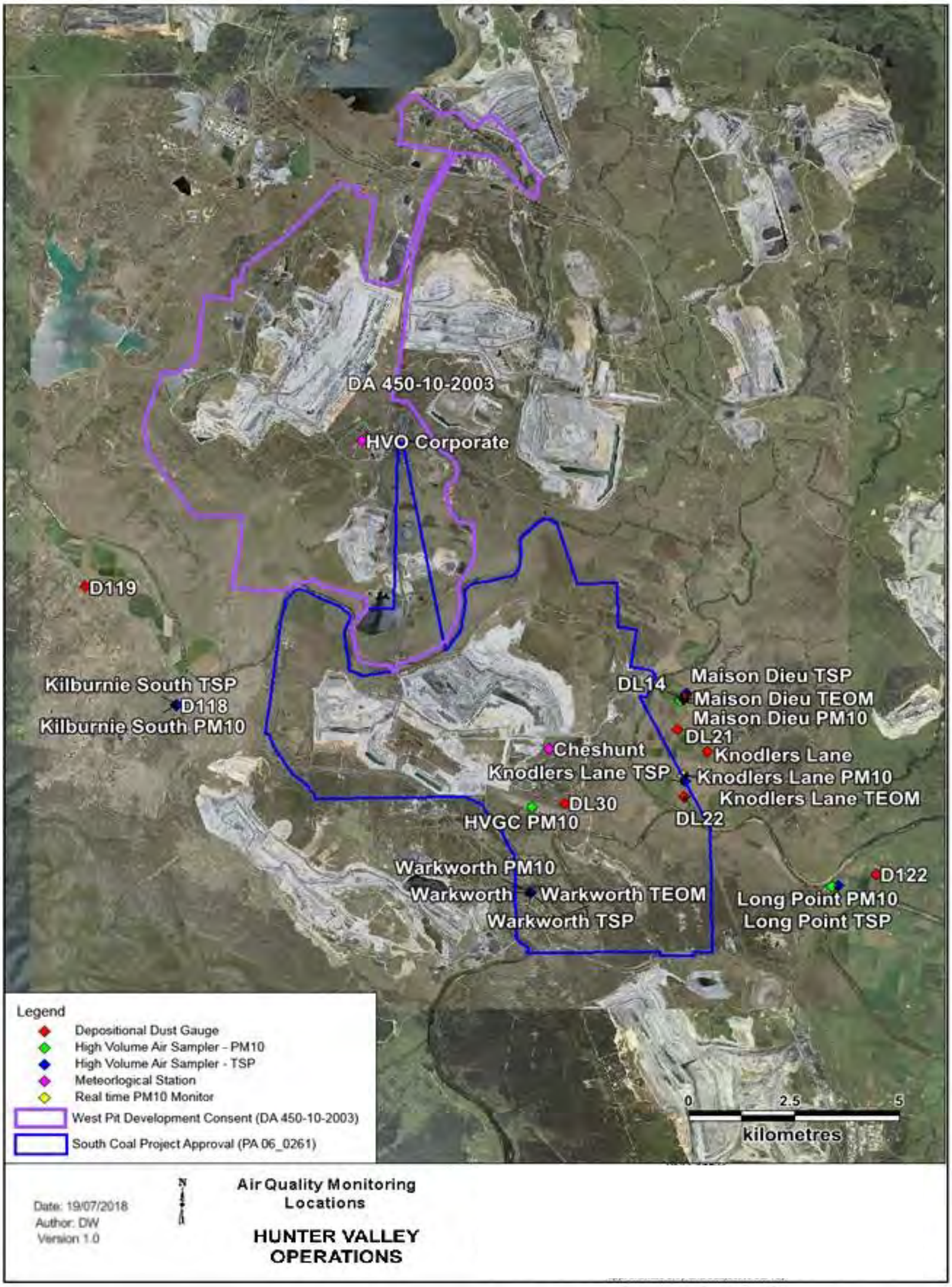


Figure 18: Air Quality Monitoring Locations

6.4.2.4 Deposited Dust

Deposited dust is monitored at nine locations on privately-owned land, in accordance with the HVO Air Quality Monitoring Programme. The annual average insoluble matter deposition rates in 2018 compared with the depositional dust impact assessment criterion and previous years' data are shown in Figure 19.

During 2018 all annual average insoluble matter deposition rates were compliant with the long-term impact assessment and land acquisition criteria. All monitoring locations demonstrated compliance with the maximum allowable insoluble solids increase criteria of 2 g/m^2/month (Figure 20).

There were two exceedances of the long term impact assessment criteria, for maximum total deposited dust level, recorded at DL30 and Warkworth monitoring locations. An external consultant was engaged to conduct an investigation which determined maximum HVO contribution to be 1.8 g/m^2/month, the total level of 4.2g/m^2/month at Warkworth and also not more than 2.3 g/m^2/month of the total level of 4.4 g/m^2/month at DL30. As per HVO's approved Air Quality Management Plan, this does not constitute non-compliance and no further action is required.

During 2018 monthly dust deposition rates equal to or greater than the long-term impact assessment criteria of 4 g/m^2/month were recorded at number of sites. Where field observations denote a sample as contaminated (typically with insects, bird droppings or vegetation), the results are excluded from Annual Average compliance assessment. Meteorological conditions and the results of nearby monitors for the sampling period are also considered when determining HVO's level of contribution to any elevated result. Details of excluded results are presented in the relevant HVO Monthly Environmental Monitoring Report.

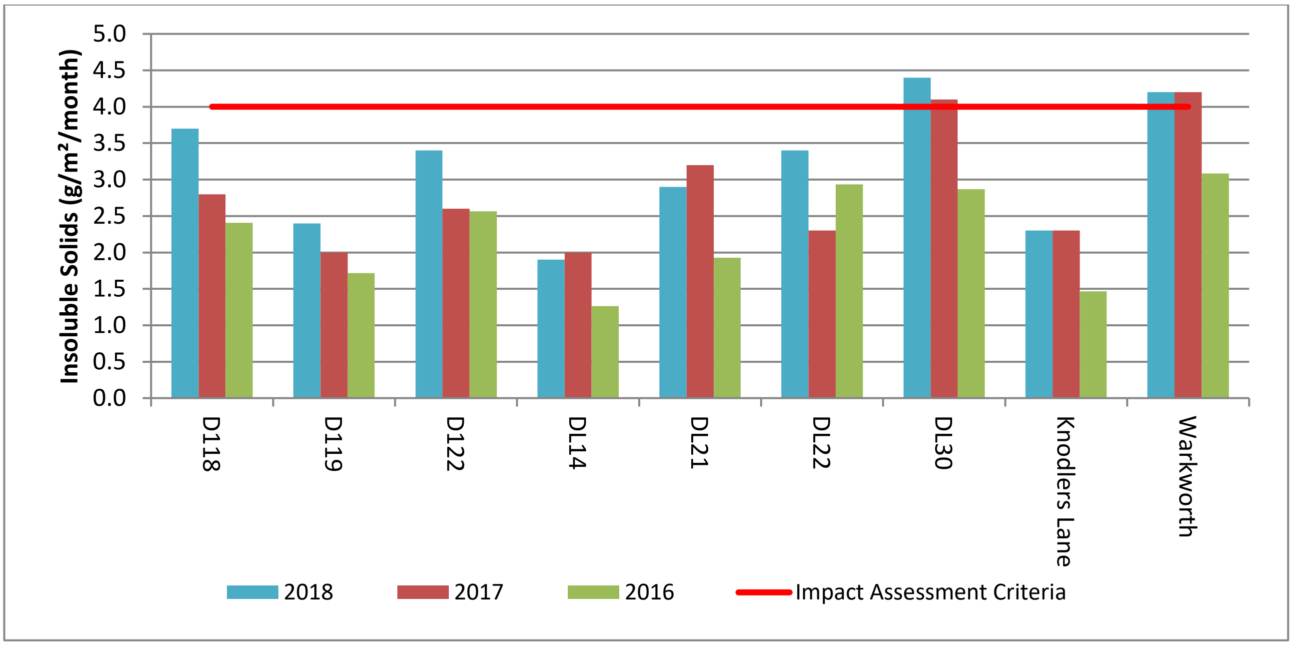


Figure 19: Annual average insoluble matter deposition rates 2016-2018

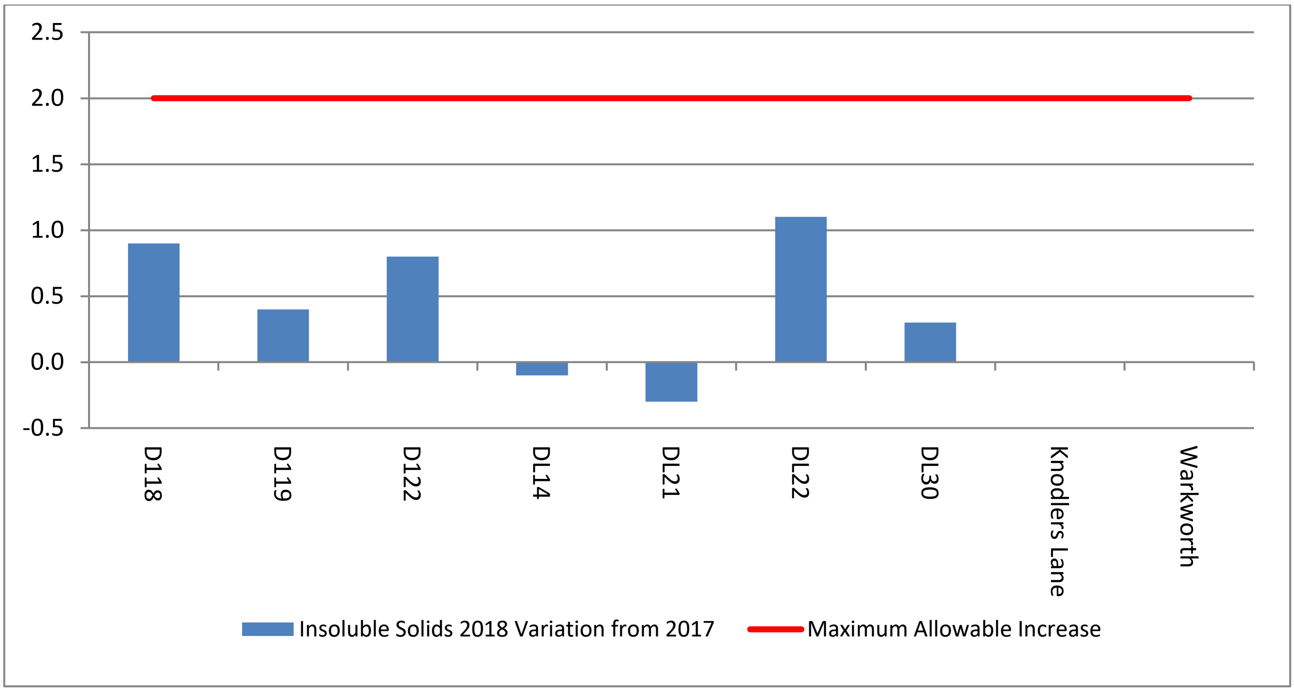


Figure 20: Annual average total insoluble solids variation, 2018 from 2017

6.4.2.5 Total Suspended Particulates (TSP)

Total Suspended Particulates (TSP) are monitored at five locations on privately owned land in accordance with the HVO Air Quality Monitoring Programme. Annual average TSP concentrations recorded in 2018 compared with the long term impact assessment criterion and previous years' data, are shown in Figure 21. The annual average TSP concentrations recorded in 2018 are higher than those recorded in previous years and is likely related to below average rainfall for the year.

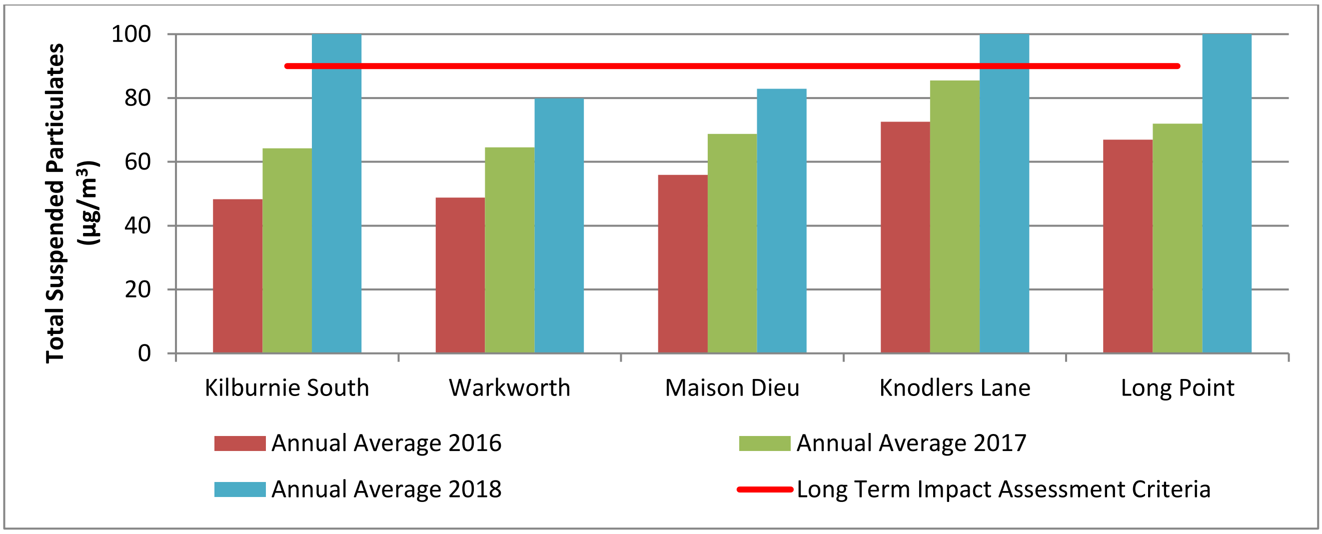


Figure 21: Annual average TSP concentrations 2016 to 2018

During 2018 three monitoring locations exceeded the impact assessment and land acquisition criteria at Kilburnie South, Knodlers Lane and Long Point.

The exceedances were investigated to determine the level of contribution from HVO activities in accordance with the compliance protocol outlined in the HVO Air Quality Management Plan. The recorded exceedance was determined to be compliant with the relevant criteria. An investigation was undertaken by external consultant's to determine the potential contribution of HVO to the 2018 annual average TSP levels recorded at Kilburnie South, Knodlers Lane and Long Point monitors. The contributions were estimated to be the 24 hour concentrations recorded by the respective monitors minus an estimated background level on the corresponding day. A summary of the investigation undertaken for the annual TSP exceedances are provided in Table 26.

Table 26: Annual TSP investigation - 2018

Date	Site	24 hour average TSP level ($\mu g/m^3$)	HVO's contribution to TSP level ($\mu g/m^3$)	Discussion
2018	Long Point HVAS TSP	106.3	42.8	An external consultant was engaged to investigate the exceedance, which determined that the result, excluding the influence of local dust sources , is below the criterion of 90µg/m3. As the measured result is not solely attributable to HVO, it does not constitute non-compliance, as per HVO's approved Air Quality Management Plan and so no further action is required.
2018	Kilburnie South HVAS TSP	111.9	40.4	An external consultant was engaged to investigate the exceedance, which determined that the result, is below the criterion of 90µg/m3. As the measured result is not solely attributable to HVO, it does not constitute non-compliance, as per HVO's approved Air Quality Management Plan and so no further action is required.
2018	Knodlers Lane HVAS TSP	104.5	32.4	An external consultant was engaged to investigate the exceedance, which determined that the result, is below the criterion of 90µg/m3. As the measured result is not solely attributable to HVO, it does not constitute non-compliance, as per HVO's approved Air Quality Management Plan and so no further action is required.

During the reporting period, 5 out of 305 TSP measurements were not able to be collected on the scheduled sampling date (based on a sampling frequency of every six days) due to power failures and technical issues with the monitors.

6.4.2.6 Particulate Matter <10µm (PM_{10})

Compliance assessment for Particulate Matter <10 µm (PM_{10}) is monitored at six locations on privately owned and mine owned land in accordance with the HVO Air Quality Monitoring Programme. During 2018 all short term and annual average results were compliant with the impact assessment and land acquisition criteria.

6.4.2.7 Short term PM_{10} impact assessment criteria

Monitoring results for 2018 PM_{10} (24 hr) collected by the High Volume Air Samplers are compared against the short term impact assessment criteria are shown in Figure 22. During 2018, 42 PM_{10} HVAS Samples exceeded the short term impact assessment criteria. Outcomes of Investigations into HVO's contribution to measured results that exceeded the short term criteria are provided in Table 27. HVO was compliant at all locations against the Short Term PM10 Impact Assessment Criteria.

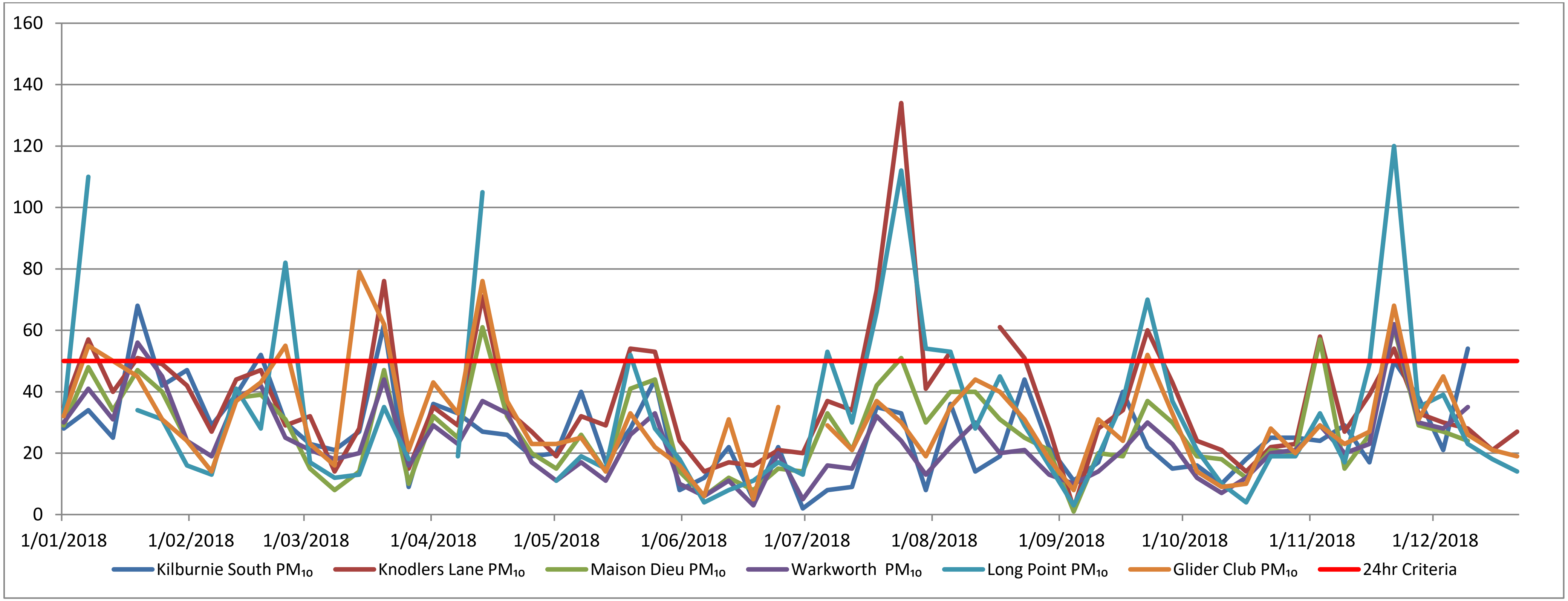


Figure 22: 2018 PM10 (24 hour) results (measured through HVAS network with HVO contribution)

Table 27: 24 hour PM10 High Volume Air Sampler Investigations – 2018

Date	Site	24hr result ($\mu g/m^3$)	Estimated max. contribution from HVO ($\mu g/m^3$)	Estimated max. Contribution (%)	Discussion
7/01/2018	Glider Club PM10 HVAS	55	17.5	31.8	An internal investigation determined HVO maximum potential contribution to be in the order of 17.5ug/m3 or 31.8% of the total measured based on prevailing wind conditions and upwind monitoring results.
7/01/2018	Knodlers Lane PM10 HVAS	57	19.5	35.5	An internal investigation determined HVO maximum potential contribution to be in the order of 19.5ug/m3 or 35.5% of the total measured based on prevailing wind conditions and upwind monitoring results.
07/01/2018	Long Point PM10 HVAS	110	<19.5	<17.7	An internal investigation determined HVO maximum potential contribution to be in the order of <19.5ug/m3 or <17.7% of the total measured based on prevailing wind conditions and upwind monitoring results.
19/01/2018	Warkworth PM10 HVAS	56	0.7	0	HVO could not have been a significant contributor to the 24 hour average recorded on this day given winds from the direction of HVO was only ~25% of the time, furthermore if the average of upwind monitors is used to conservatively calculate a contribution from HVO the resulting contribution is <0ug/m3. When looking at the Warkworth OEH TEOM data from the period of time that wind blew from the direction of HVO, this data set only contributed an additional 0.7ug/m3 to overall average
19/01/2018	Knodlers Lane PM10 HVAS	51	6	13.3	An internal investigation determined HVO maximum potential contribution to be in the order of 6ug/m3 or 13.3% of the total measured based on prevailing wind conditions and upwind monitoring results.
19/01/2018	Kilburnie South PM10 HVAS	68	23	51.1	An internal investigation determined HVO maximum potential contribution to be in the order of 23ug/m3 or 51.1% of the total measured based on prevailing wind conditions and upwind monitoring results.
18/02/2018	Kilburnie South PM10 HVAS	52	14.3	33.3	An internal investigation determined HVO maximum potential contribution to be in the order of 14.3 ug/m3 or 33.3% of the total measured as a conservative estimation as there was insignificant periods of when wind blowing from the direction of HVO (9% of the time).
24/02/2018	Glider Club PM10 HVAS	55	29.0	52.7	An internal investigation determined HVO maximum potential contribution to be in the order of 29.0ug/m3 or 52.7% of the total measured based on prevailing wind conditions and upwind monitoring results.
24/02/2018	Long Point PM10 HVAS	82	<29.0	<35.4	An internal investigation determined HVO maximum potential contribution to be in the order of 29.0ug/m3 or 35.4% of the total measured based on prevailing wind conditions and upwind monitoring results. Indicating that a source local to the monitor was likely a significant contributor on this day.
14/03/2018	Glider Club PM10 HVAS	79	NA	NA	An internal investigation determined HVO maximum potential contribution to be in the order of 0 ug/m3 or 0 % of the total measured as wind did not blow from the direction of HVO to the monitor on this day.

20/03/2018	Knodlers Lane PM10 HVAS	76	31.5	50.8	An internal investigation determined HVO maximum potential contribution to be in the order of 31.5ug/m3 or 50.8% of the total measured based on prevailing wind conditions and upwind monitoring results.
20/03/2018	Glider Club PM10 HVAS	62	3	4.8	An internal investigation determined HVO maximum potential contribution to be in the order of 3ug/m3 or 4.8% of the total measured based on prevailing wind conditions and upwind monitoring results.
20/03/2018	Kilburnie South PM10 HVAS	62	7	11	An internal investigation determined HVO maximum potential contribution to be in the order of 7ug/m3 or 11% of the total measured based on prevailing wind conditions and upwind monitoring results.
13/04/2018	Maison Dieu PM10 HVAS	61	34.0	55.7	An internal investigation determined HVO maximum potential contribution to be in the order of 34.0ug/m3 or 55.7% of the total measured based on prevailing wind conditions and upwind monitoring results.
13/04/2018	Knodlers Lane PM10 HVAS	71	44.0	62.0	An internal investigation determined HVO maximum potential contribution to be in the order of 44.0ug/m3 or 62% of the total measured based on prevailing wind conditions and upwind monitoring results.
13/04/2018	Glider Club PM10 HVAS	76	49.0	64.5	An internal investigation determined HVO maximum potential contribution to be in the order of 49.0ug/m3 or 64.5% of the total measured based on prevailing wind conditions and upwind monitoring results.
13/04/2018	Long Point PM10 HVAS	105	<49.0	<46.7	An internal investigation determined HVO maximum potential contribution to be in the order of 49.0ug/m3 or 46.7% of the total measured based on prevailing wind conditions and upwind monitoring results.
19/05/2018	Long Point PM10 HVAS	52	24	46.2	An internal investigation determined that winds were generally not from the direction of HVO on this day (4% of the day). As such a conservative maximum contribution was calculated to be in the order of 24.0ug/m3 or 46.2% of the total measured based on prevailing wind conditions and upwind monitoring results.
19/05/2018	Knodlers Lane PM10 HVAS	54	27	50	An internal investigation determined HVO maximum potential contribution to be in the order of 27ug/m3 or 50% of the total measured based on prevailing wind conditions and upwind monitoring results.
25/05/2018	Knodlers Lane PM10 HVAS	53	11.5	21.7	An internal investigation determined HVO maximum potential contribution to be in the order of 11.5ug/m3 or 21.7% of the total measured based on prevailing wind conditions and upwind monitoring results.
06/07/2018	Long Point PM10 HVAS	53	31.5	59.4	An internal investigation determined HVO maximum potential contribution to be in the order of 31.5ug/m3 or 59.4% of the total measured based on prevailing wind conditions and upwind monitoring results.
18/07/2018	Knodlers Lane PM10 HVAS	73	41.0	56.2	An internal investigation determined HVO maximum potential contribution to be in the order of 41ug/m3 or 56.2% of the total measured based on prevailing wind conditions and upwind monitoring results.

18/07/2018	Long Point PM10 HVAS	66	34.0	51.5	An internal investigation determined HVO maximum potential contribution to be in the order of 34ug/m3 or 51.5% of the total measured based on prevailing wind conditions and upwind monitoring results.
24/07/2018	Knodlers Lane PM10 HVAS	134	<87.8	<65	An external investigation was undertaken and found that HVO's estimated maximum contribution to PM10 levels was estimated to be less than 87.8µg/m3 or 65% of the total level of 134µg/m3. The investigation considered that local sources to the monitor would have contributed to the PM10 levels recorded at this location specifically at the HVAS unit as the co-located TEOM unit recorded lower PM10 levels. It is also considered that the estimate contribution of all of HVO and that contributions from HVO South and North are represented in the estimate. In response to high winds of this day HVO recorded 23 hours of equipment delays.
24/07/2018	Long Point PM10 HVAS	112	<44	<39	An external investigation was undertaken and found that HVO's estimated maximum contribution to PM10 levels was estimated to be less than 44µg/m3 or 39% of the total level of 112µg/m3. The investigation considered that dust raised from wind erosion of local sources would have contributed to the PM10 levels recorded at this location. In response to high winds of this day HVO recorded 23 hours of equipment delays.
24/07/2018	Maison Dieu PM10 HVAS	51	27.0	52.9	An internal investigation determined HVO maximum potential contribution to be in the order of 27ug/m3 or 52.9% of the total measured based on prevailing wind conditions and upwind monitoring results. In response to high winds of this day HVO recorded 23 hours of equipment delays.
30/07/2018	Long Point PM10 HVAS	54	32.5	60.2	An internal investigation determined HVO maximum potential contribution to be in the order of 32.5ug/m3 or 60.2% of the total measured based on prevailing wind conditions and upwind monitoring result
5/08/2018	Knodlers Lane PM10 HVAS	53	18	34	An internal investigation determined HVO maximum potential contribution to be in the order of 18ug/m3 or 34.0% of the total measured based on prevailing wind conditions and upwind monitoring results.
5/08/2018	Long Point PM10 HVAS	53	18	34	An internal investigation determined HVO maximum potential contribution to be in the order of 18ug/m3 or 34.0% of the total measured based on prevailing wind conditions and upwind monitoring results.
17/08/2018	Knodlers Lane PM10 HVAS	61	32	52	An external investigation determined HVO maximum potential contribution to be in the order of 32ug/m3 or 52% of the total measured based on prevailing wind conditions and upwind monitoring results.
23/08/2018	Knodlers Lane PM10 HVAS	51	15.5	30.4	An internal investigation determined HVO maximum potential contribution to be in the order of 15.5ug/m3 or 30.4% of the total measured based on prevailing wind conditions and upwind monitoring results.
22/09/2018	Long Point PM10 HVAS	70	38.8	54.3	An internal investigation determined HVO maximum potential contribution to be in the order of 38.8ug/m3 or 54.3% of the total measured based on prevailing wind conditions and upwind monitoring results.
22/09/2018	Knodlers Lane PM10 HVAS	60	38	63.3	An internal investigation determined HVO maximum potential contribution to be in the order of 38ug/m3 or 63.3% of the total measured based on prevailing wind conditions and upwind monitoring results.

22/09/2018	Glider Club PM10 HVAS	52	31	51.7	An internal investigation determined HVO maximum potential contribution to be in the order of 31ug/m3 or 51.7% of the total measured based on prevailing wind conditions and upwind monitoring results.
3/11/2018	Knodlers Lane PM10 HVAS	58	33	56.9	An internal investigation determined HVO maximum potential contribution to be in the order of 33ug/m3 or 56.9% of the total measured based on prevailing wind conditions and upwind monitoring results.
3/11/2018	Long Point PM10 HVAS	57	32	56.1	An internal investigation determined HVO maximum potential contribution to be in the order of 32ug/m3 or 56.1% of the total measured based on prevailing wind conditions and upwind monitoring results.
21/11/2018	Glider Club PM10 HVAS	68	18.5	34.3	An internal investigation determined HVO maximum potential contribution to be in the order of 18.5ug/m3 or 34.3% of the total measured based on prevailing wind conditions and upwind monitoring results. Between 21 – 22 November 2018, the Hunter Valley experienced regional dust storms which contributed to elevated levels across this period.
21/11/2018	Knodlers Lane PM10 HVAS	54	4.5	8.3	An internal investigation determined HVO maximum potential contribution to be in the order of 4.5ug/m3 or 8.3% of the total measured based on prevailing wind conditions and upwind monitoring results. Between 21 – 22 November 2018, the Hunter Valley experienced regional dust storms which contributed to elevated levels across this period.
21/11/2018	Long Point PM10 HVAS	120	<4.5	<3.8%	An internal investigation determined HVO maximum potential contribution to be in the order of <4.5ug/m3 or <3.8% of the total measured based on prevailing wind conditions and upwind monitoring results. Between 21 – 22 November 2018, the Hunter Valley experienced regional dust storms which contributed to elevated levels across this period.
21/11/2018	Maison Dieu PM10 HVAS	61	11.5	18.9	An internal investigation determined HVO maximum potential contribution to be in the order of 11.5ug/m3 or 18.9% of the total measured based on prevailing wind conditions and upwind monitoring results. Between 21 – 22 November 2018, the Hunter Valley experienced regional dust storms which contributed to elevated levels across this period.
21/11/2018	Warkworth PM10 HVAS	62	12.5	23.1	An internal investigation determined HVO maximum potential contribution to be in the order of 12.5ug/m3 or 23.1% of the total measured based on prevailing wind conditions and upwind monitoring results. Between 21 – 22 November 2018, the Hunter Valley experienced regional dust storms which contributed to elevated levels across this period.
9/12/2018	Kilburnie South PM10 HVAS	54	28.8	53.2	An internal investigation determined HVO maximum potential contribution to be in the order of 28.7ug/m3 or 53.2% of the total measured based on prevailing wind conditions and upwind monitoring results.

6.4.2.8 Long term PM_{10} impact assessment criteria

Annual average PM_{10} concentrations recorded at the six monitoring locations in 2018, compared with the long term PM10 impact assessment criterion and previous years' data, are shown on Figure 23.

During 2018, three monitoring locations exceeded the annual average PM_{10} impact assessment criteria. The results were investigated to determine the level of contribution from HVO activities in accordance with the compliance protocol outlined in the HVO Air Quality Management Plan. The exceedances were determined to be compliant with the relevant criterion. A summary of the investigations undertaken for the annual PM_{10} exceedances are provided in Table 28.

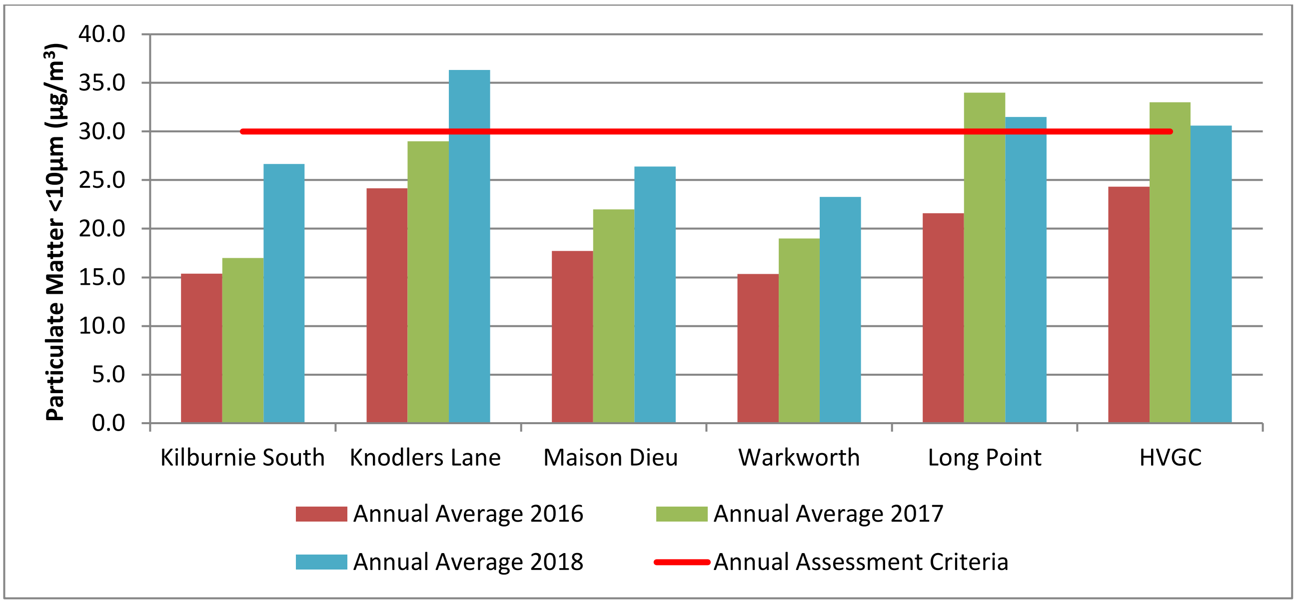


Figure 23: Annual average HVAS PM10 results 2016 to 2018

Table 28: Assessment of Annual Average PM10 -2018

Monitoring Location	Measured PM_{10} Annual Average µg/m³	Maximum Calculated PM_{10} Solely due to HVO µg/m³	Discussion
Knodlers Lane	36.9	28.7	Internal and external investigations into 24 hour PM10 exceedances through the year, based on prevailing winds and upwinds monitoring results has determined that the maximum HVO contribution to the annual average PM10 result to be less than the criterion of 30µg/m³. As measured results are not solely attributable to HVO, these do no constitute non-compliance as per HVO's approved Air Quality Management Plan and so no further action is required.
Long Point	33.3	23.6	
Hunter Valley Gliding Club	31.1	26.2	

6.4.3 Comparison of 2016 Air Quality data against EA predictions

Table 29 to Table 31 show a comparison between 2018 air quality data and the Stage 2 predictions made in the HVO South Modification 5 Environmental Assessment 2017 (EA). Comparisons have been made against the predictions listed in the EA for the nearest private residence to each monitoring location.

Annual average PM_{10} measurements in 2018 are generally consistent or slightly above predicted levels for all monitoring locations. Comparison of 2018 maximum 24 hr PM_{10} values against the predicted maximum values returned results generally above the predicted Stage 2 for all monitoring locations. Refer to Table 29 for estimates of HVO contribution to measured exceedances of 24 hr PM_{10} criteria during 2018.

TSP Annual Averages exceeded modelled predictions in 2018 at all monitoring locations, it's considered that this is a result of dry conditions that persisted through 2018 and reflects regional air quality trends.

Table 29: 2018 PM10 annual average results (HVAS) compared against cumulative predictions for Stage 2 (HVO South Mod 5 Environmental Assessment)

Site (EA receptor)	Short Term (24hr) criteria		Long Term (annual average) criteria	
	Predicted maximum 24hr PM_{10} due to HVO South alone (µg/m^3) Stage 2	2018 maximum 24hr PM_{10} result (µg/m^3)	Predicted PM_{10} annual averages (µg/m^3) Stage 2	2018 PM_{10} annual average (µg/m^3)*
Maison Dieu (256)	36	48	21	25
Warkworth (90)	95	45	46	22
Kilburnie South (307)	31	50	27	24
Knodlers Lane (117)	59	87	28	29
Long Point (137)	36	70	20	25
HVGC**	>50	50	>30	26

*measured value captures external background sources.

** The HVGC has entered into an Amenity Management Plan with Hunter Valley Operations.

Table 30: 2018 TSP annual average results (HVAS) compared against cumulative predictions for Stage 2 (HVO South Mod 5 Environmental Assessment)

Site (EA receptor)	Long Term (annual average) TSP Criteria	
	Stage 2 prediction (µg/m^3)	2018 annual average (µg/m^3)
Maison Dieu (256)	60	82.8
Warkworth (90)	106	79.8
Kilburnie South (307)	76	111.9
Knodlers Lane (117)	75	104.5
Long Point (137)	61	106.3

Table 31: 2018 Depositional Dust annual average results (HVAS) compared against cumulative predictions for Stage 2 (HVO South Mod 5 Environmental Assessment)

Site (representative receptor ID)	Units (Insoluble Solids)	Assessment Criteria	Stage 2 EA Predictions Annual Averages	2018 Actual Annual Average
D118 (Kilburnie Sth) (307)	g/m^2/month	4	2.9	3.7
D119 (Jerry's Plains) (421)	g/m^2/month	4	2.0	2.4
DL14 (Maison Dieu) (256)	g/m^2/month	4	2.0	1.9
DL21 (261)	g/m^2/month	4	2.2	2.9
DL22 (118)	g/m^2/month	4	2.9	3.4
Knodlers Lane (120)	g/m^2/month	4	2.4	2.3
Warkworth (90)	g/m^2/month	4	3.4	4.2

Table 32 and Table 33 detail comparisons between 2018 air quality monitoring results and the modelled predictions from the 2010 HVO North Carrington West Wing Air Quality Impact Assessment. Predictions have been sourced from modelled scenarios of Year One of the Carrington West Wing development. It should be noted that while Approval has been granted for the commencement of that project, works have not yet commenced.

Table 32: 2018 PM10 annual average results (HVAS) compared against cumulative predictions for Year One (CWW) - HVO North Environmental Assessment

Site (EA receptor)	Long Term (annual average) criteria	
	Predicted PM_{10} annual average ($\mu g/m^3$)	2018 PM_{10} annual average ($\mu g/m^3$)
Maison Dieu (6)	19.1	25.2
Warkworth (39)	20.8	21.9
Kilburnie South (4)	19.7	24.3

*no modelled predictions for the Long Point area

Table 33: 2018 TSP Annual Average results compared against cumulative predictions for Year One (CWW) - HVO North Environmental Assessment

Site (EA receptor)	Long Term (annual average) criteria	
	Predicted TSP annual average ($\mu g/m^3$)	2018 TSP annual average ($\mu g/m^3$)
Maison Dieu (6)	44.7	82.8
Warkworth (39)	46.6	79.9
Kilburnie South (4)	45.2	112.0

*no modelled predictions for the Long Point area

Comparison of measured PM_{10} and TSP with modelled predictions demonstrates above average values for all monitoring locations. Given that the TSP fraction settles out of suspension faster than PM_{10} (and thus much closer to the operation), it is not reasonable to suggest that nearby private residences are being impacted by mine-generated TSP to a greater degree than by PM_{10}, on the basis of measured data exceeding the predictions. Rather, the data suggests the assumptions in the model relating to extraneous dust sources are under predicting total TSP levels which are experienced at receptors. It is considered that above average results are also attributable to dry conditions that persisted through 2018 and reflects regional air quality trends.

6.4.3.1 Recycling

HVO has continued to have a focus on training and reinforcing the principles of a good waste management across the site including recycling. In 2018 23 per cent of non-mineral waste material generated at HVO was disposed to licensed offsite landfill facilities.

The overall recycling percentage has increased from 69% in 2017 to 77% in 2018.

HVO will explore further opportunities to continue to improve recycling rates in 2019.

6.4.3.2 Sewage Treatment/Disposal

The sewage treatment and disposal facilities at HVO consist of sewage treatment plants which treat, disinfect and re-use the treated effluent on-site. The remaining effluent from some septic systems that can't be treated on site is sent to approved facilities for disposal.

HVO currently has 5 main grouped on-site sewerage management systems, these are interconnected from multiple systems forming the 5 main systems. These facilities are located at Howick, HVO North, HVO South and two in-pit locations.

6.4.3.3 Hydrocarbons

During 2018, 1061 kL of waste oil was taken offsite to be refined into a base oil for reuse in new oil products. Other hydrocarbons recycled via a licensed waste hydrocarbon disposal company include approximately 27 tonnes of waste grease.

6.4.3.4 Contaminated Soil

Management of hydrocarbon contaminated soil employs the use of bioremediation areas that are maintained and operated in accordance with HVO procedures.

Contaminated soil is taken to one of the bioremediation areas and placed in cells based on the time of contamination. To maximise air circulation, contaminated soil is spread out in beds of no more than approximately 300 mm in height and approximately a grader width at the base. Beds are oriented north south where possible to achieve maximum exposure to sunlight. The beds are turned by a grader or equivalent on regular intervals in order to provide aeration for beneficial microbial activity.

Soil in the treatment area is sampled and tested on a regular basis until total hydrocarbon levels are below relevant guidelines. Soil meeting these criteria is then removed and disposed of in the spoil dump.

Waste and Hazard Management Non-compliances during reporting period

There were no externally reportable incidents related to waste or hazard management during the reporting period.

6.5 Heritage Summary

6.5.1 Management and Community Consultation

Aboriginal cultural heritage is managed under the provisions of separate Aboriginal Cultural Heritage Management Plans (ACHMP) approved for these development consents. At HVO North, where mining or associated development activities may impact Aboriginal cultural heritage sites, an Aboriginal Heritage Impact Permit (AHIP) must also be sought from the OEH under Part 6 of the National Parks and Wildlife Act 1974 (NPW Act), on the basis of the management requirements established through the ACHMP process. The HVO South ACHMP area was approved as a State Significant Development which excludes the requirement for obtaining AHIPs prior to implementing cultural heritage management measures authorised under the provisions of the ACHMP.

Hunter Valley Operations consults jointly with the Upper Hunter Valley Aboriginal Cultural Heritage Working Group (CHWG) and the Plains Clan of the Wonnarua Peoples (PCWP). The CHWG is comprised of representatives from HVO and Registered Aboriginal Parties (RAPs) from Upper Hunter Valley aboriginal community groups, corporations and individuals. The CHWG met and discussed cultural heritage management matters associated with HVO on the 23rd August 2018.

Separate to the ACHMP, the HVO JV is party to an Ancillary Agreement with the Plains Clan of the Wonnarua People (PCWP). This is an Ancillary Agreement to a Deed under section 31(1)(b) of the *Native Title Act 1993 (Cth)* regarding the grant of Assessment Lease Application 59 and also an agreement for the grant of Mining Lease Application 534. The agreement commenced on the 3rd May 2018.

Aboriginal cultural heritage at HVO is managed; in consultation with the RAPs associated with the CHWG and the PCWP, in accordance with the ACHMPs, development consent conditions, and the Ancillary Agreement to protect, manage and mitigate cultural heritage at HVO. Management measures include:

- Ongoing consultation and involvement of the local Aboriginal community in all matters pertaining to Aboriginal cultural heritage management;
- Compliance with existing ACHMP's and Development Consent conditions;
- A cultural heritage Geographic Information System (GIS) and Cultural Heritage Zone Plan (CHZP) incorporating cultural heritage spatial and spatial data (site location, description, assessments, date recorded, associated reports, management provisions and various other details to assist with the management of sites);
- A Ground Disturbance Permit (GDP) system for the assessment and approval of ground disturbing activities to ensure these activities do not disturb cultural heritage places;
- Limit of Disturbance Boundary (LODB) procedures to demarcate approved disturbance areas and delineate areas not to be disturbed;
- Ongoing cultural heritage site inspections, monitoring and auditing along with regular compliance inspections of development works;
- Protective management measures such as fencing/barricading sites to avoid disturbance, protective buffer zones, cultural heritage off-set areas; and
- Communicating cultural heritage issues and site awareness to personnel via internal electronic and face to face processes.

In consultation with the CHWG and OEH, a Cultural Heritage Storage Facility (CHSF) was established at Hunter Valley Services. The CHSF is a storage shed, with an adjacent sea container, fitted out to allow safe and secure storage of cultural materials, such as stone artefacts. It is a central repository for all materials collected during community collection and salvage activities on all lands related to HVO (including offset properties).

6.5.2 Aboriginal Archaeological and Cultural Heritage Investigations

In January 2018 a two day field work program was conducted at the Wandewoi Biodiversity Area, HVO North by Tocomwall Pty Ltd (a commercial and professional services entity of the PCWP). Field work reviewed the distribution of sites recorded in February and March 2017 and identified any potential archaeological deposits (PADs) in proximity to artefact scatters. During this program 5 PADs were identified.

In June 2018 a one day field work program was conducted at 'Glider Pit' HVO South in the form of a salvage collection of a single cultural heritage site.

These works were conducted in accordance with the relevant AHIPs, the HVO North HMP, the HVO South HMP and the OEH Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales (2010).

6.5.3 Audits and Incidents

Under the provisions of the HVO South ACHMP and the HVO North HMP, a Compliance Inspection was conducted within both areas during 2018. The purpose of the compliance inspection is to provide the RAPs with:

- The opportunity to visit mine operations and mine areas to inspect operational compliance with ACHMP/HMP provisions and GDP procedures;
- To inspect and monitor the condition and management of sites; and
- To review the effectiveness and performance of the ACHMP/HMP provisions in the management of cultural heritage at the mine.

This compliance inspection was conducted by RAP representatives of the CHWG and RAP representatives of the PCWP with the assistance of a qualified archaeologist and HVO personnel.

The 2018 HVO North compliance inspection was conducted over two days on the 5^{th} and 6^{th} December by RAP representatives of the Plains Clan of the Wonnarua Peoples. The key aboriginal cultural heritage sites inspected included CM CD1 and sites at the 'Riverview', 'Parnells' and 'Wandewoi' properties.

The 2018 HVO South compliance inspection was conducted over one day on the 7^{th} December by RAP representatives of the CHWG. The key aboriginal sites inspected were in proximity to the 'Glider Pit' and 'South Lemington Pit 1'.

The inspections found that all sites have been managed in conformance with the ACHMP/HMP requirements. Additional sites were recorded and sites requiring maintenance and upgrades to site barricading and fencing were identified, with upgrade and maintenance work to be implemented in 2019.

During the reporting period there were 25 GDPs assessed for cultural heritage management considerations at HVO. There were no incidents nor any unauthorised disturbance caused to cultural heritage sites at HVO during 2018.

6.5.4 Historic Heritage - Management and Community Consultation

In 2018 community consultation was conducted at the Hunter Valley Operations Community Consultative Meetings held on the 2^{nd} February, 5^{th} May, 8^{th} August and 21^{st} November 2018, no matters were raised pertaining to management of historic (non-Indigenous) heritage located on HVO property at these meetings.

In 2018, the HVO Community Grants Program awarded a $1,800 grant to the Singleton Historical Society and Museum for their 'Newspaper Microfilm' project.

7 WATER MANAGEMENT

7.1 Water Balance

7.1.1 Water Management

HVO manages surface and ground water according to three main objectives:

- Fresh water usage is minimised;
- Impacts on the environment and HVO neighbours are minimised; and
- Interference to mining production is minimal.

This is achieved by:

- Minimising freshwater use from the Hunter River;
- Preferentially using mine water for coal preparation and dust suppression;
- An emphasis on control of water quality and quantity at the source;
- Segregating waters of different quality where practical;
- Recycling on-site water;
- Ongoing maintenance and review of the system; and
- Disposing of water to the environment in accordance with statutes and regulations.

Plans showing the layout of all water management structures and key pipelines are shown in Figure 24 to Figure 26. The HVO Water Management Plan contains further detail on management practices and is available on HVO website.

Figure 24: West Pit water management infrastructure

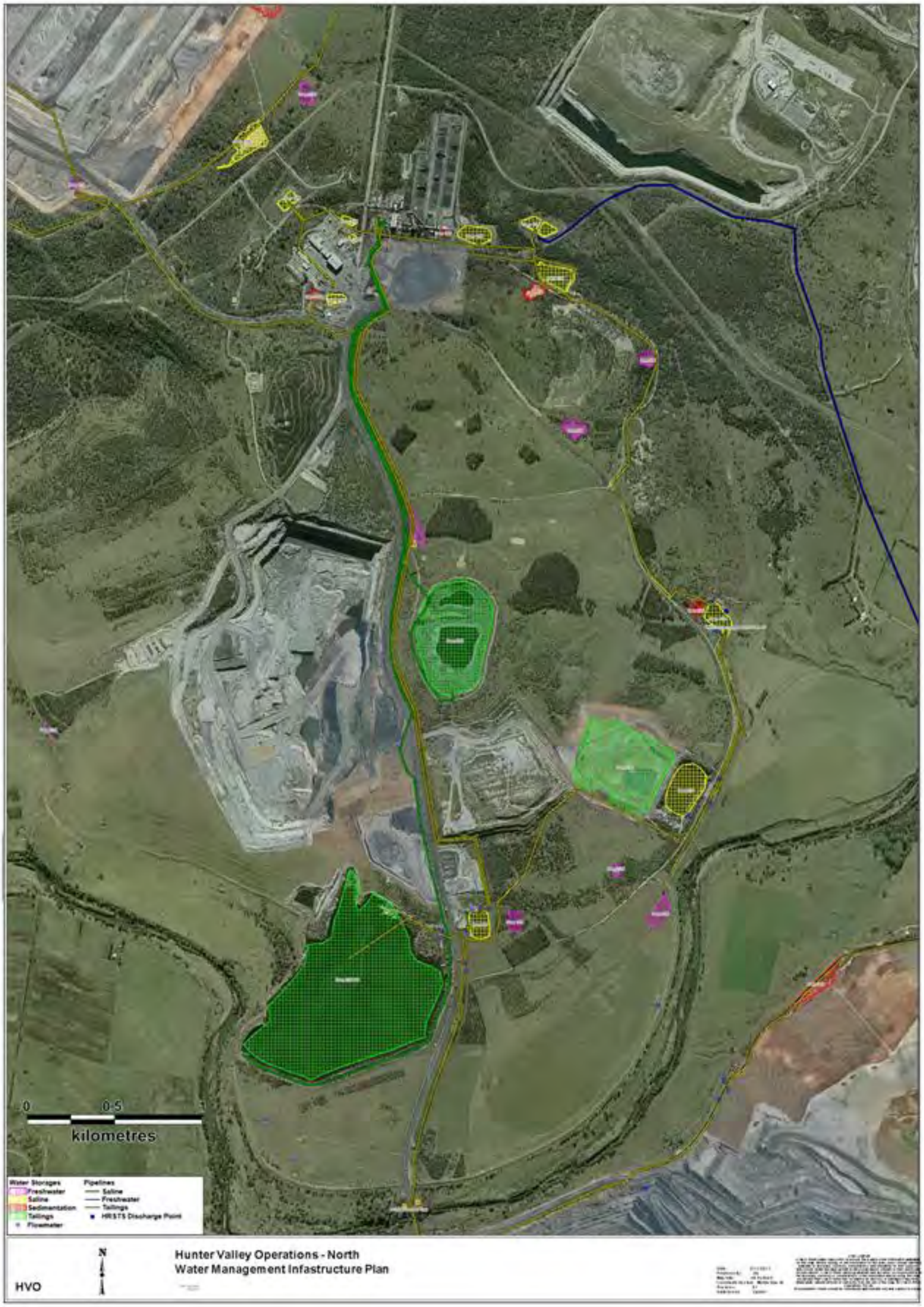


Figure 25: North Pit water management infrastructure

Figure 26: South Pit water management infrastructure

7.1.2 Water Performance

7.1.2.1 Water Balance

The 2018 static water balance for HVO is presented in **Table 34**.

Table 34

Table 34: 2018 HVO Water Balance

Water Stream	Volume (ML)
Inputs	
Fresh Water (potable)	45 (0.5%)
Fresh Water (Hunter River extraction)	1,866 (22.3%)
Groundwater	1,354 (16.2%)
Rainfall Runoff	2,909 (34.8%)
Recycled to CHPP from Tails & Storage (not included in total)	2,659
Imported (Liddell/Ravensworth (via Cumnock))	838 (10%)
Water from ROM Coal	1,350 (16.1%)
Total Inputs	**8,362**
Outputs	
Dust Suppression	2,539 (31.4%)
Evaporation - Mine Water & Tailings Dams	1,579 (19.5%)
Entrained in Process Waste	1,402 (17.3%)
Discharged (HRSTS)	0 (0%)
Vehicle Wash-down	310 (3.8%)
Sent to Third Party	0 (0%)
Miscellaneous Industrial Use	350 (4.3%)
Water in Coarse Reject	626 (7.7%)
Water in Product Coal	1,280 (15.8%)
Total Outputs	**8,086**
Change in Pit Storage	**276 (Increase)**

7.1.2.2 Water Inputs

A total of 477 mm of rainfall was recorded at HVO in 2018 producing an estimated 2,909 ML of runoff. Water falling on undisturbed clean water catchments is diverted off site into natural systems where possible.

Groundwater inflows to the pits are calculated via numerical groundwater modelling methods; these are given in

Table 34Groundwater inflows were estimated to have contributed 1,354 ML to the site during 2018. 1,866 ML of fresh water was pumped from the Hunter River during the reporting period.

7.1.2.3 Water Outputs

The main outputs were water use for dust suppression (2,539 ML), evaporation from dams (1,579 ML), water entrained in process waste (1,402 ML) and water in product coal (1,280 ML).

HVO participates in the Hunter River Salinity Trading Scheme (HRSTS) allowing it to discharge from licensed discharge points during declared discharge events, associated with increased flow in the Hunter River. HVO maintains three licensed discharge monitoring locations:

- Dam 11N, located at HVO North, which discharges to Farrell's Creek
- Lake James, located at HVO South, which discharges to the Hunter River; and
- Parnell's Dam, located at HVO West, which discharges to Parnell's Creek.

During 2018 Hunter Valley Operations discharged no water under the Hunter River Salinity Trading Scheme and Environment Protection Licence 640.

7.2 Surface Water

Surface water monitoring activities continued in 2018 in accordance with the HVO Water Management Plan and HVO Surface Water Monitoring Programme. HVO maintains a network of surface water monitoring sites located on mine site dams, discharge points and surrounding natural watercourses (Figure 27). Water quality monitoring is undertaken to verify the effectiveness of the water management system onsite, and to identify the emergence of potentially adverse effects on surrounding watercourses. A number of mine water dams are monitored routinely to verify the quality of mine water, used in coal processing, dust suppression, and other day to day activities around the mine.

Surface water monitoring data is reviewed on a quarterly basis. The review involves a comparison of measured pH, Electrical Conductivity (EC) and Total Suspended Solids (TSS) results against internal trigger values which have been derived from the historical data set. The response to measured excursions outside the trigger limits is detailed in the HVO Water Management Plan.

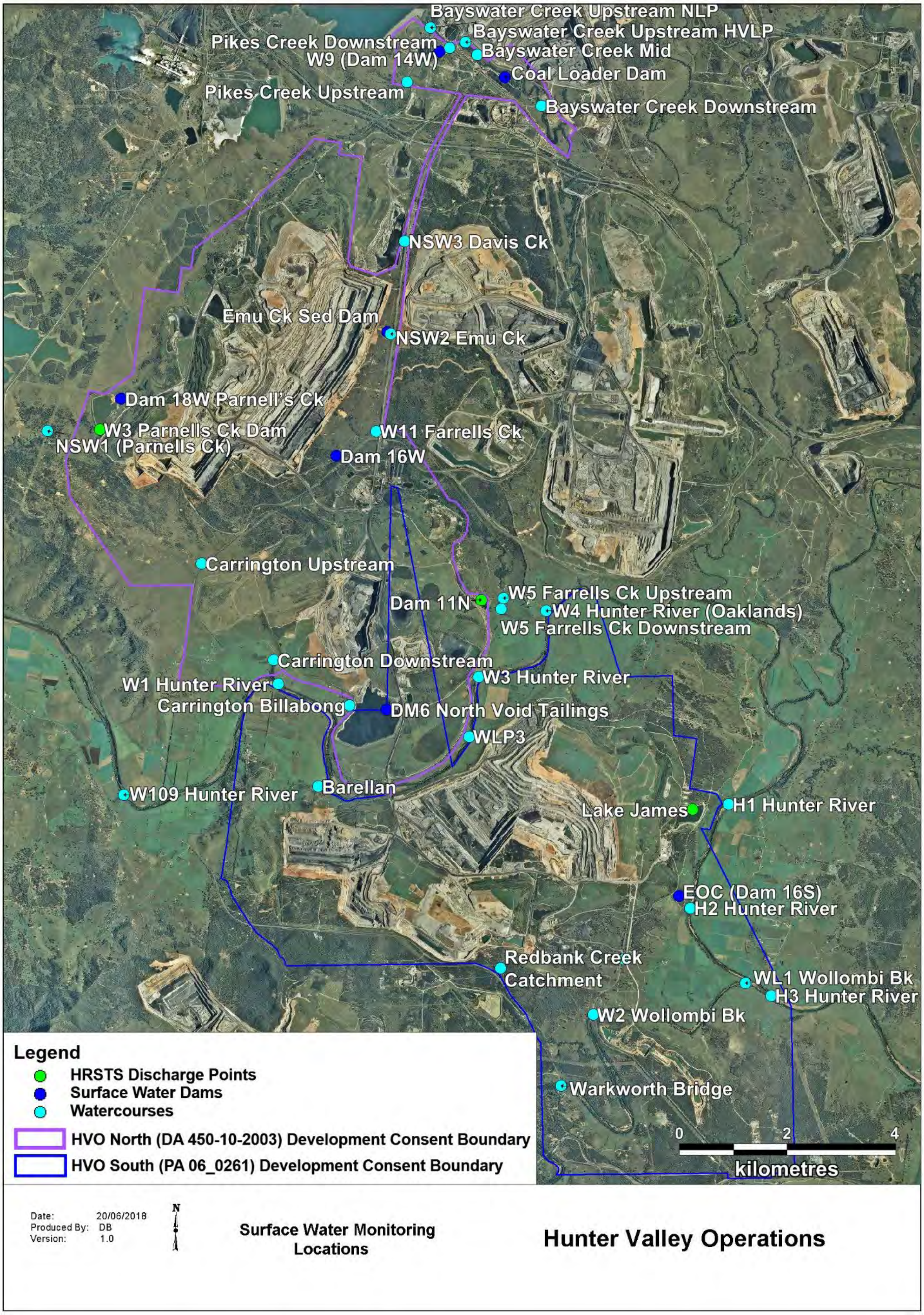


Figure 27: Surface Monitoring Locations

7.2.1 Surface Water Monitoring

Routine surface water monitoring was undertaken in accordance with the Surface Water Monitoring Programme.. All analysis of surface water was carried out in accordance with approved methods by a NATA accredited laboratory.

Water quality is evaluated through the parameters of pH, EC and TSS. Pertinent surface water sites were also sampled for comprehensive analysis annually. Long term water quality trends for the Hunter River, Wollombi Brook, other surrounding tributaries and site dams are presented in this section. The sampling frequency for ephemeral water sites was modified in 2016, from quarterly to a rain-event trigger system, in an effort to ensure samples taken were more representative of typical water quality for those streams (up to eight sampling events per annum can now be taken under the revised sampling protocol). Due to dry conditions during the reporting period resulted in fewer rain event sampling runs being completed in 2018. All required sampling and analysis was undertaken, except as detailed in Table 35. ANZECC criteria are shown in the figures for comparative purposes.

Table 35: HVO Water Monitoring Data Recovery for 2018 (by exception)

Location	Data Recovery (%)	Comments
Barellan	0%	Site recorded as dry during all 2018 monitoring events.
Carrington Billabong	0%	Site recorded as dry during all 2018 monitoring events.
Carrington Upstream	0%	Site recorded as dry during all 2018 monitoring events.
NSW1 (Parnell's Ck)	66%	Site was unable to be accessed safely during 2018 monitoring events
Pikes Creek Downstream	0%	Site recorded as dry during all 2018 monitoring events.
Pikes Creek Upstream	0%	Site recorded as dry during all 2018 monitoring events.
Redbank Creek Catchment	66%	Site recorded as dry during October and November monitoring events.

7.2.1.1 Hunter River

The Hunter River was sampled on 40 occasions from eight monitoring locations during 2018. Long term trends for pH, EC and TSS are shown in Figure 28 to Figure 30. Results for water quality were consistent with historical trends; EC was seasonally variable and controlled by flow volumes through the catchment. Trigger tracking results are detailed in Table 36.

Table 36: Hunter River Internal Trigger Tracking Results

Location	Date	Trigger limit	Action taken in response
H2	13/12/2018	pH – 5^{th} percentile (ANZECC criteria)	First exceedance. Watching brief

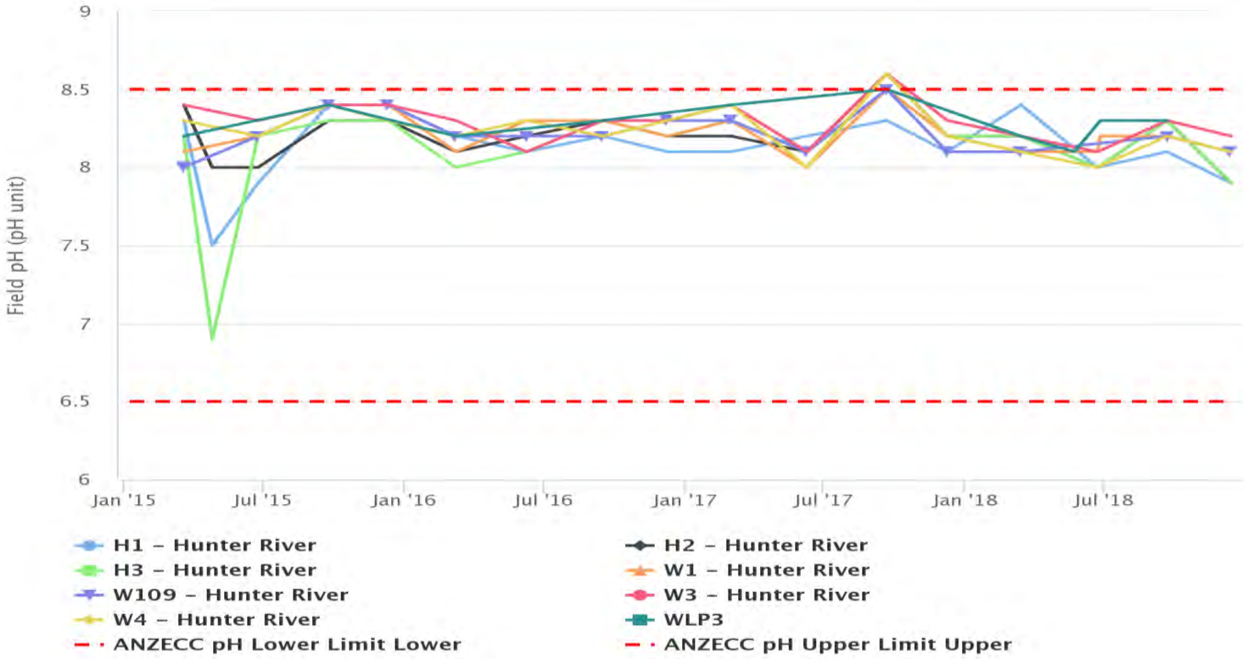


Figure 28: Hunter River pH Trends 2015 – 2018

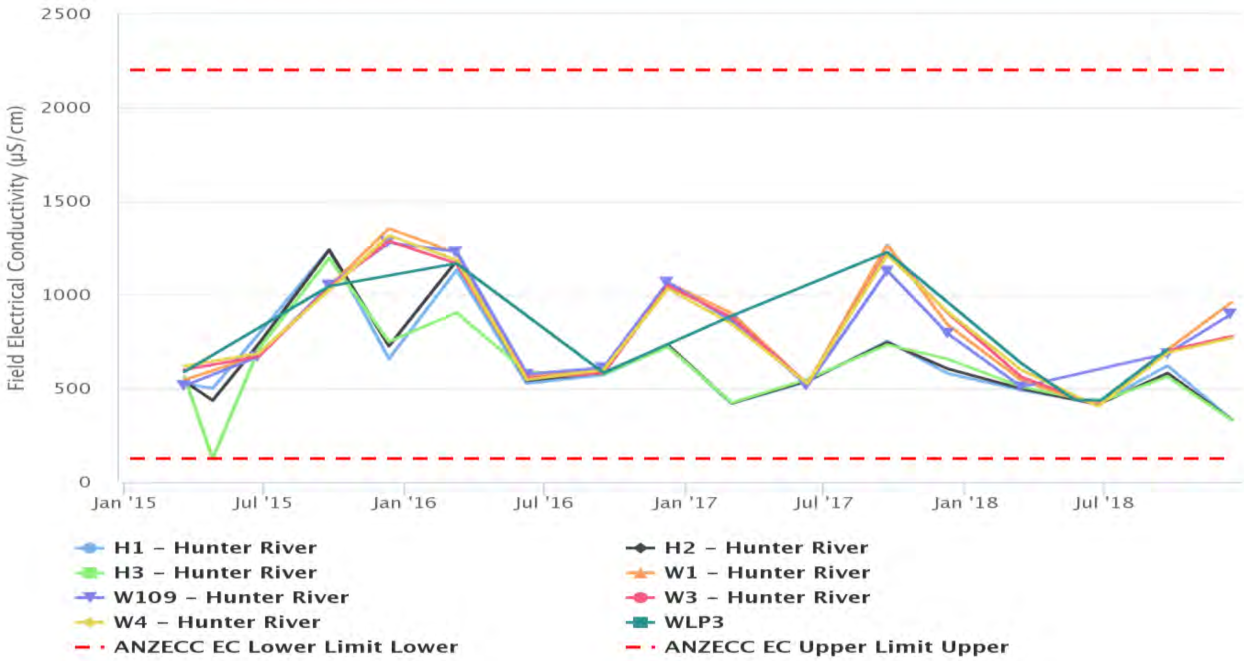


Figure 29: Hunter River EC Trends 2015 - 2018

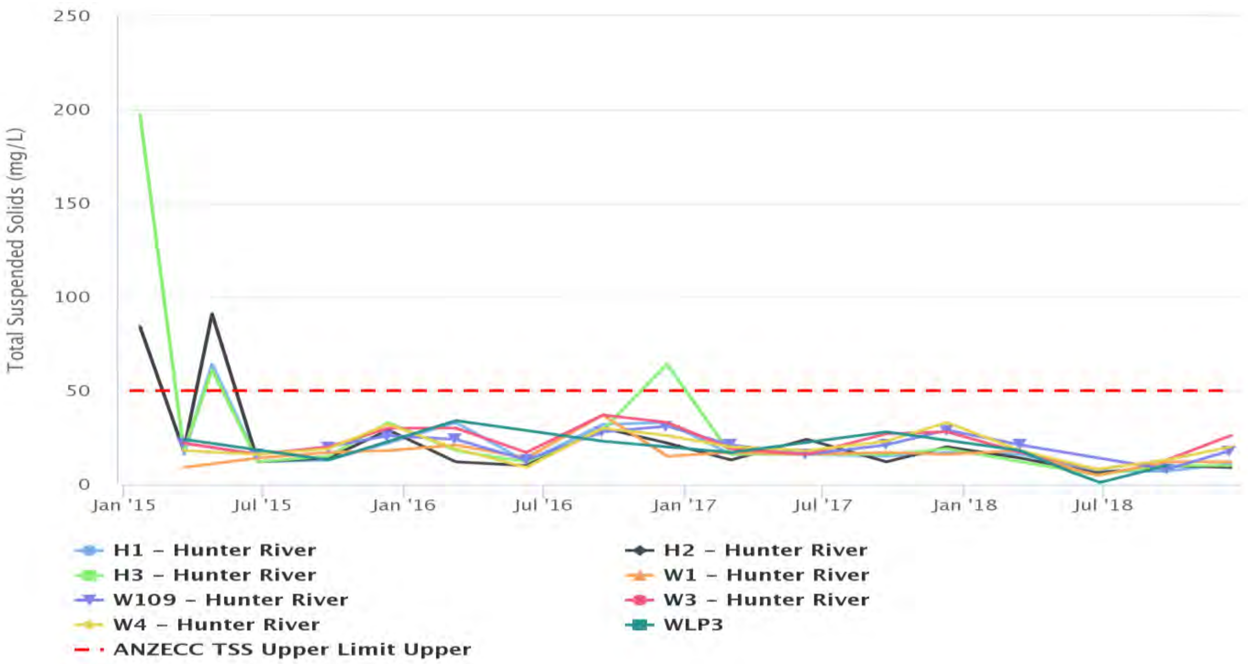


Figure 30: Hunter River TSS Trends 2015 – 2018

7.2.1.2 Wollombi Brook

Wollombi Brook was sampled on 12 occasions from three monitoring locations during 2018. Long term trends for pH, EC and TSS from Wollombi Brook are shown in Figure 31 to Figure 33. Results were generally consistent with historical trends and acceptable ranges. EC was variable and recorded an increasing trend at the W2 location due to drying conditions in the Wollombi Brook. Trigger tracking results are detailed in Table 37.

Table 37: Hunter River Internal Trigger Tracking Results

Location	Date	Trigger limit	Action taken in response
W2 -Wollombi Brook	14/03/2018	EC -95th Percentile	1st exceedance. Maintain watching Brief
W2 -Wollombi Brook	14/03/2018	pH -95th Percentile	1st exceedance. Maintain Watching Brief
W2 -Wollombi Brook	22/06/2018	EC- - 95th Percentile	2nd consecutive exceedance. Maintain watching Brief
W2 -Wollombi Brook	21/09/2018	EC -95th Percentile	3rd exceedance of 95th percentile. Field notes indicate sample was taken from a pool of water in the brook with no flow observed. Upstream – Warkworth Bridge 1172ug/m3 Downstream – WL1 – 594ug/m3 Watching brief issued. Unlikely mining related impact, EC increase likely due to pooling of water and significantly low rainfall recorded during 2018
W2 -Wollombi Brook	13/12/2018	EC - 95th Percentile	Fourth consecutive exceedance of EC trigger (2440µs/cm) Investigation identified that sample was collected from turbid pooling water in the Wollombi Brook as there was no flow. Samples taken downstream in the Wollombi Brook recorded EC level at 526µs/cm. Maintain watching brief.
Warkworth Bridge	14/03/2018	EC -95th Percentile	2nd consecutive exceedance. Maintain watching Brief
Warkworth Bridge	14/03/2018	pH -95th Percentile	1st exceedance. Maintain Watching Brief
Warkworth Bridge	14/03/2018	TSS - 50mg/L (ANZECC Guideline)	Field notes indicate the sample was taken from a pool of water in the Brook which was very turbid and orange in colour. Furthermore samples taken in the Brook downstream at W2 and WL1 recorded TSS levels at 4 and 6mg/L respectively. Based on this it can be assumed that the sample taken was not representative of water flows in the Brook and that there is no downstream impact to suggest mining influence.

Warkworth Bridge	22/06/2018	EC - 95th Percentile	3rd consecutive exceedance of 95th EC Percentile. Field notes indicate the sample was taken from a pool of water in the Brook which was very turbid and orange in colour. Furthermore samples taken in the Brook downstream at WL1 (next downstream sampling location where the brook was flowing) recorded an EC of 501us/cm .Based on this it can be assumed that the sample taken was not representative of water flows in the Brook and that there is no downstream impact to suggest mining influence.
Warkworth Bridge	22/06/2018	TSS - 50mg/L (ANZECC Guideline)	Second consecutive occurrence of >50mg/L; Field notes indicate the sample was taken from a pool of water in the Brook which was very turbid and orange in colour. Furthermore samples taken in the Brook downstream at W2 and WL1 recorded TSS levels at 6 and 14mg/L respectively. Based on this assume that the sample taken was not representative of water flows in the Brook and that there is no downstream impact to suggest mining influence.
Warkworth Bridge	21/09/2018	EC -95th Percentile	4th consecutive exceedance of 95th EC Percentile. Field notes indicate the sample was taken from a pool of water in the Brook which was not flowing. Furthermore samples taken in the Brook downstream at WL1 (next downstream sampling location where the brook was flowing) recorded an EC of 594us/cm Based on this it can be assumed that the sample taken was not representative of water flows in the Brook and that there is no downstream impact to suggest mining influence.
Warkworth Bridge	13/12/2018	EC - 95th Percentile	Fifth consecutive exceedance of EC trigger (1268µs/cm). Investigation identified that sample was collected from pooling water in the Wollombi Brook as there was no flow. Samples taken downstream in the Wollombi Brook recorded EC level at 526µs/cm. Maintain watching brief.

Figure 31: Wollombi Brook pH Trends 2015 – 2018

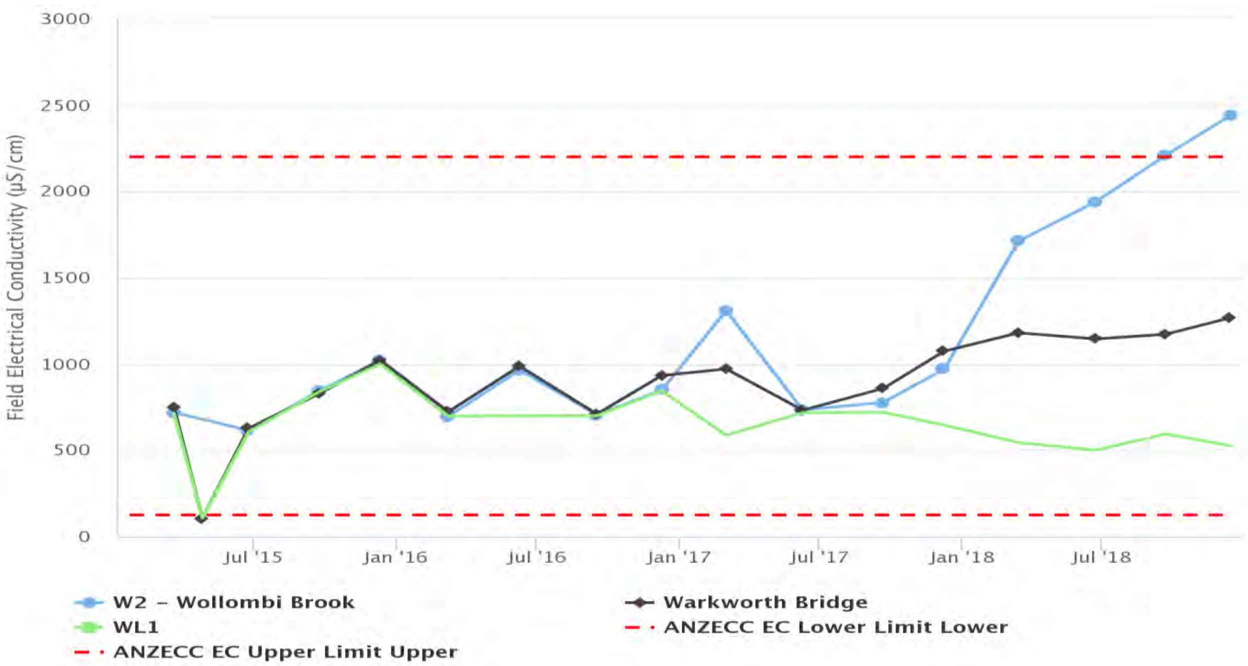


Figure 32: Wollombi Brook EC Trends 2015 – 2018

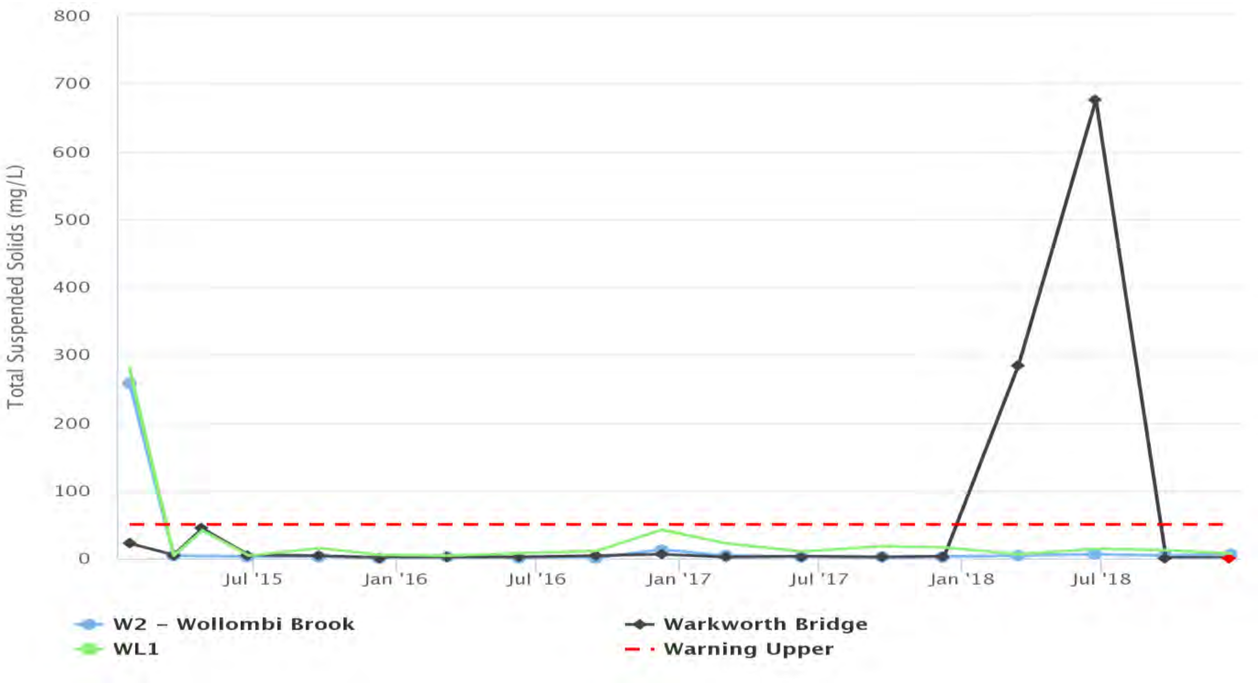


Figure 33: Wollombi Brook TSS Trends 2015 – 2018

7.2.1.3 Other Surrounding Tributaries

Event-based monitoring of natural tributaries surrounding HVO continued during 2018, three rain event sampling rounds were triggered on 26 February, 5 October and 29 November 2018. Monitoring during these rain event's occurred on the following water courses:

- Comleroi Creek;
- Emu Creek;
- Farrells Creek;
- Pikes Creek;
- Redbank Creek (dry during October and November rain events);
- Davis Creek (dry during February rain event);
- Bayswater Creek; and
- Parnells Creek.

Long term trends for pH, EC and TSS are shown Figure 34 to Figure 36. On occasion, some sampling sites recorded results outside of the internal trigger levels however, results for water quality remained generally within historical trends and acceptable ranges. The surface water monitoring programme will be reviewed in 2019. The ephemeral nature of these monitoring locations is the primary reason for the considerable variation in physical water quality. Trigger tracking results are detailed in Table 38.

Table 38: Other Tributaries Internal Trigger Tracking Results

Location	Date	Trigger limit	Action taken in response
Bayswater Creek Midstream	26/02/2018	pH -5th Percentile	Watching Brief
Bayswater Creek Midstream	26/02/2018	TSS - 50mg/L (ANZECC Guideline)	Elevated TSS associated with rainfall event (35mm 25 - 26/02/2018). Observations indicate that the sample was taken from pooling water in the creek line and no flow was observed. Downstream location was observed dry. No further action required.
Bayswater Creek Upstream HVLP	26/02/2018	TSS - 50mg/L (ANZECC Guideline)	Elevated TSS associated with rainfall event (35mm 25 - 26/02/2018). Observations indicate that there was no flow in the creek and that samples were taken from pooling water in the Creek.tDownstream location was observed dry suggesting that the sample taken was not representative of water quality when the creekis flowing and that there is no cause to suggest mining influence.
Comleroi Creek	26/02/2018	pH -5th Percentile	1st exceedance. Watching Brief
Emu Creek NSW2	26/02/2018	TSS - 50mg/L (ANZECC Guideline)	Elevated TSS associated with rainfall event (35mm 25 - 26/02/2018). Observations indicate that the sample was taken from pooling water in the creek line and no flow was observed. Mining has removed catchment upstream of downstream of the NSW2 sampling site. No further action required.
Bayswater Creek Downstream	5/10/2018	TSS - 50mg/L (ANZECC Guideline)	1st exceedance. Elevated TSS associated with rainfall event (76mm 4-5/10/2018). Site typically dry in 12 months prior. Field notes indicate that the sample was taken from a turbid pool of water in the creek. Monitoring results upstream indicated there was no flow in the creek Based on this it can be assumed that the sample taken was not representative of water quality when the creek is flowing and that there is no cause to suggest mining influence.
NSW2 Emu Creek	5/10/2018	TSS - 50mg/L (ANZECC Guideline)	Elevated TSS associated with rainfall event (76mm 4-5/10/2018). Observations indicate that sample was taken from a slow flow of water through the creek line. No further downstream catchment exists due to neighbouring mining operations intersecting Emu Creek. No further action required.
NSW2 Emu Creek	29/11/2018	TSS - 50mg/L (ANZECC Guideline)	Elevated TSS associated with rainfall event (52.4mm 28/11/2018). Observations indicate that sample was taken from a pool of water through the creek line. No further downstream catchment exists due to neighbouring mining operations intersecting Emu Creek. No further action required.
NSW3 Davis Creek	5/10/2018	TSS - 50mg/L (ANZECC Guideline)	Elevated TSS associated with rainfall event (76mm 4-5/10/2018). Site is typically dry. Observations indicate that sample was taken from a pool of water through the creek line as there was no flow. EC (261µs/cm) and pH (7.0) monitoring parameters also suggest no mining influence. Maintain watching brief.

Location	Date	Trigger limit	Action taken in response
NSW3 Davis Creek	29/11/2018	TSS - 50mg/L (ANZECC Guideline)	Elevated TSS associated with rainfall event (52.4mm 28/11/2018). Site is typically dry. Observations indicate that sample was taken from a pool of water through the creek line as there was no flow. EC (244µs/cm) and pH (7.1) monitoring parameters also suggest no mining influence. Maintain watching brief.
Comleroi Creek	29/11/2018	TSS - 50mg/L (ANZECC Guideline)	Elevated TSS associated with rainfall event (52.4mm 28/11/2018). Observations indicate that sample was taken from a pool of water through the creek line as there was no flow. Other monitoring parameters also suggest no mining influence. Maintain watching brief.
W11	5/10/2018	pH- 5th Percentile.	Watching brief. Sampling event following this indicated pH within trigger range.
Bayswater Creek Downstream	29/11/2018	pH - 5th percentile	First Exceedance. Watching Brief

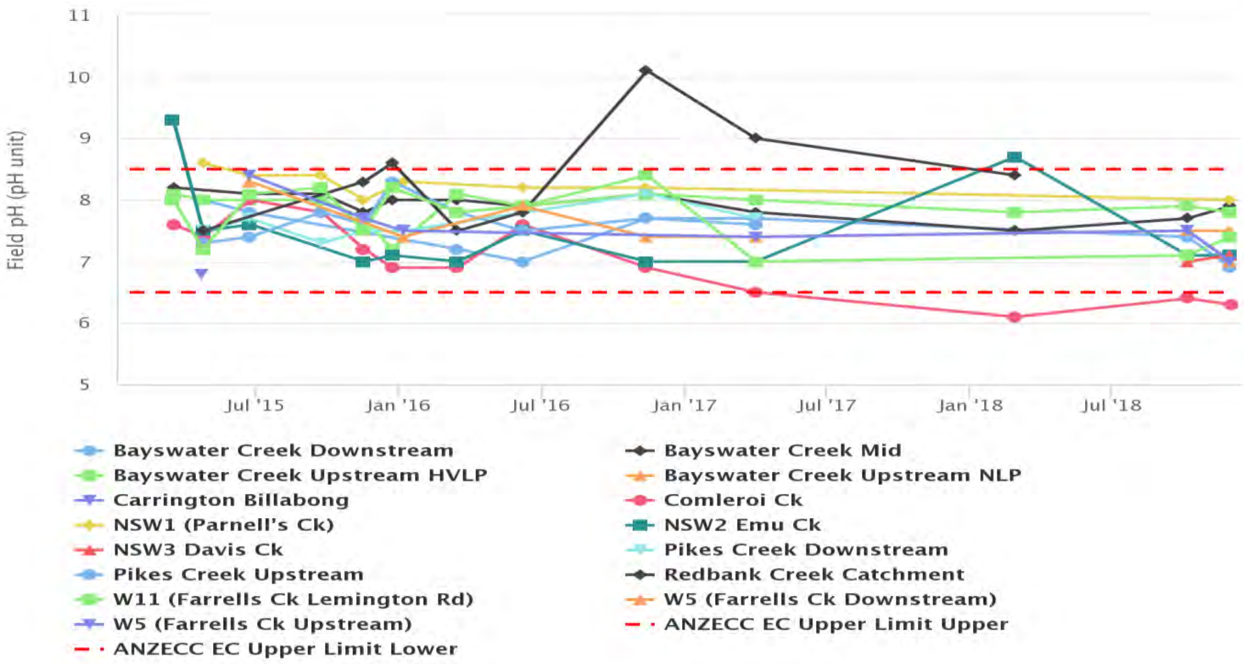


Figure 34: Other Tributaries pH Trends 2015 – 2018

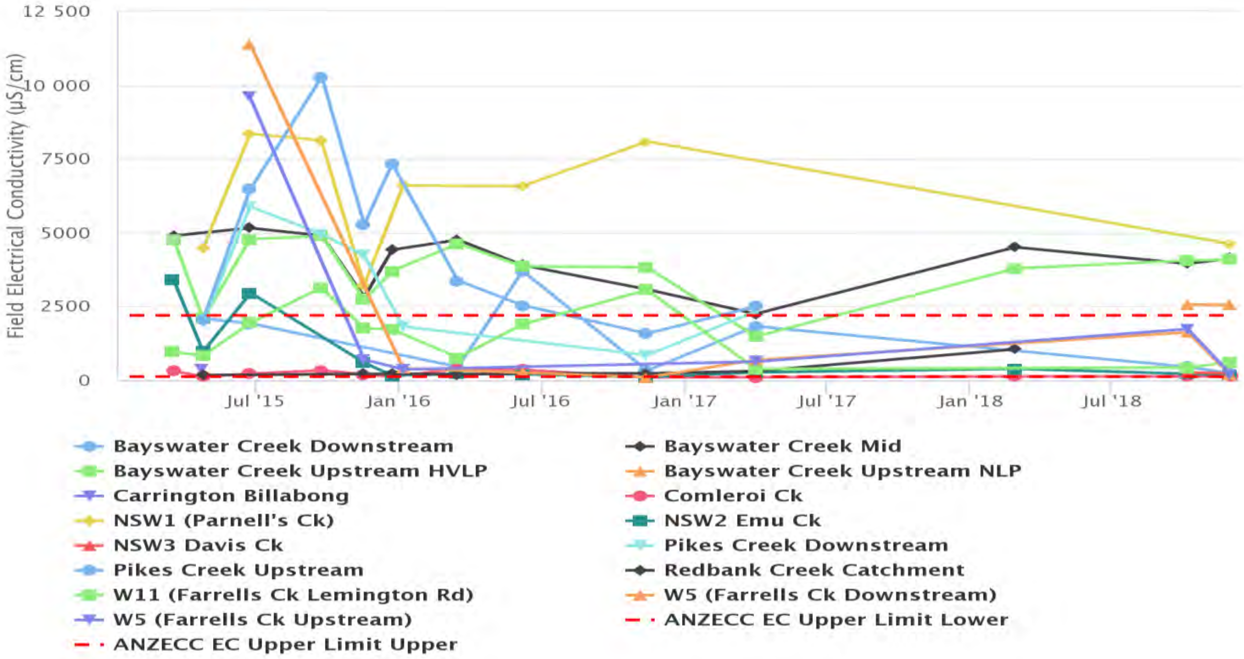


Figure 35: Other Tributaries EC Trends 2015 – 2018

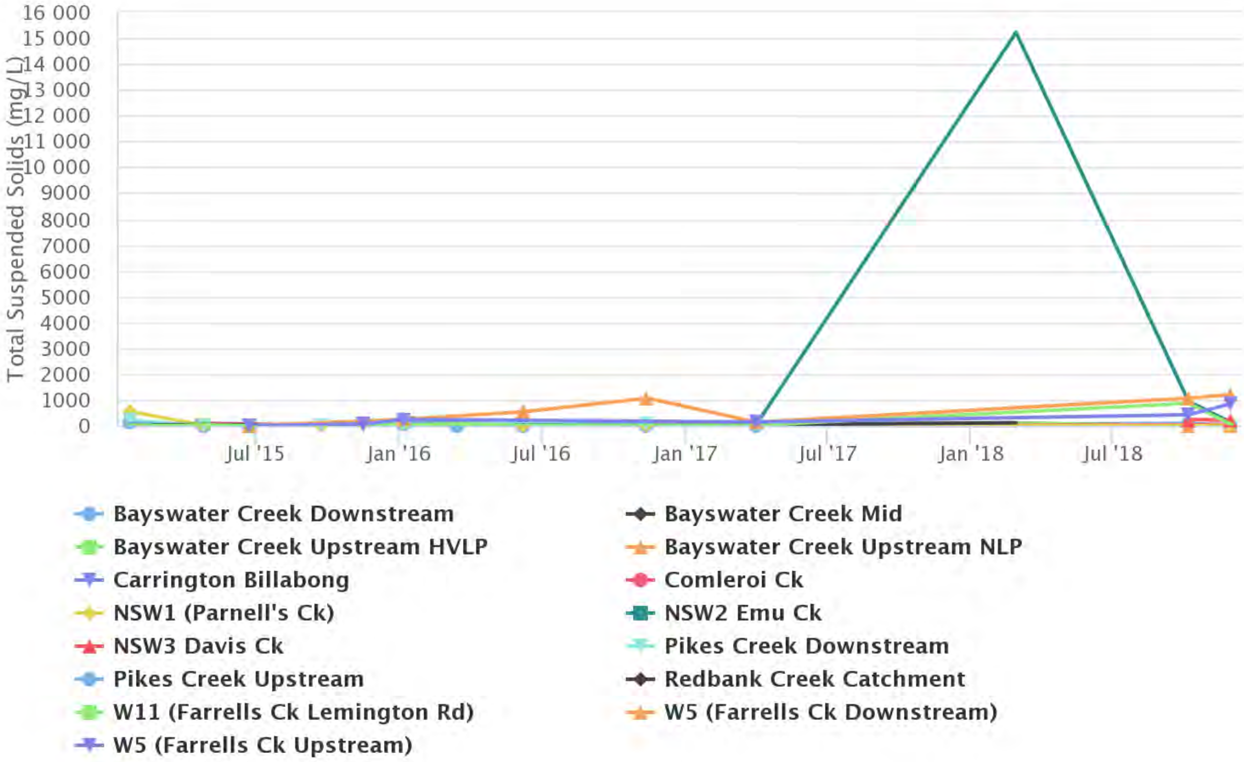


Figure 36: Other Tributaries TSS Trends 2015 – 2018

7.2.1.4 HVO Site Dams

During 2018, 68 samples were collected across 10 on site dams. Long term trends for pH, EC and TSS are shown in Figure 37 to Figure 39. EC results show a varying trend during the reporting period, as a result of drier weather conditions reducing rainfall runoff inflows to the mine water management system. DM6 North Void tailings dam recorded a single spike in TSS on 1 August 2018, this was due to very low water level at the sampling location during the sampling event.

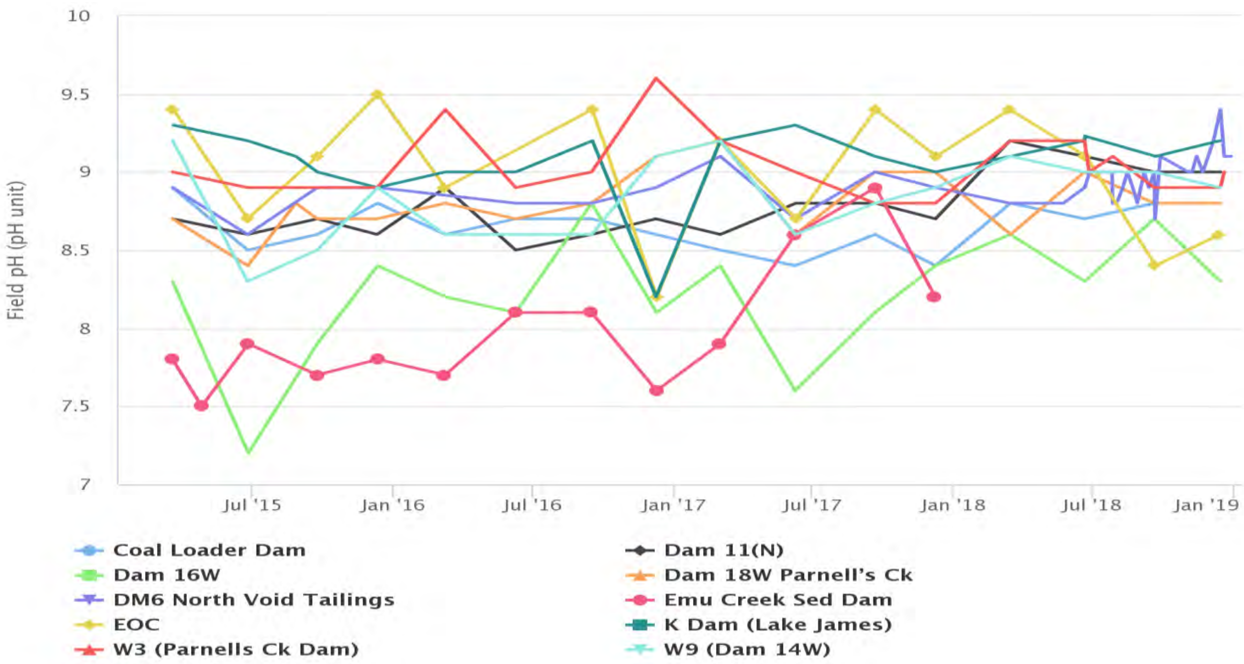


Figure 37: HVO Site Dams pH Trends 2015 – 2018

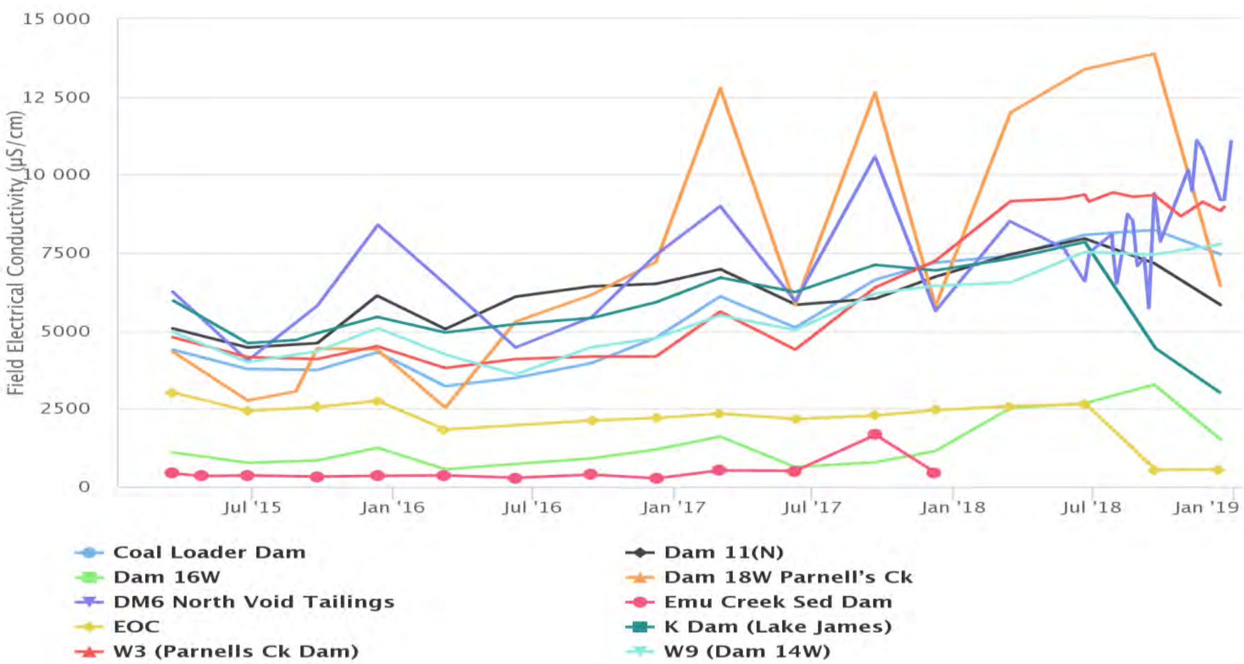


Figure 38: HVO Site Dams EC Trends 2015 – 2018

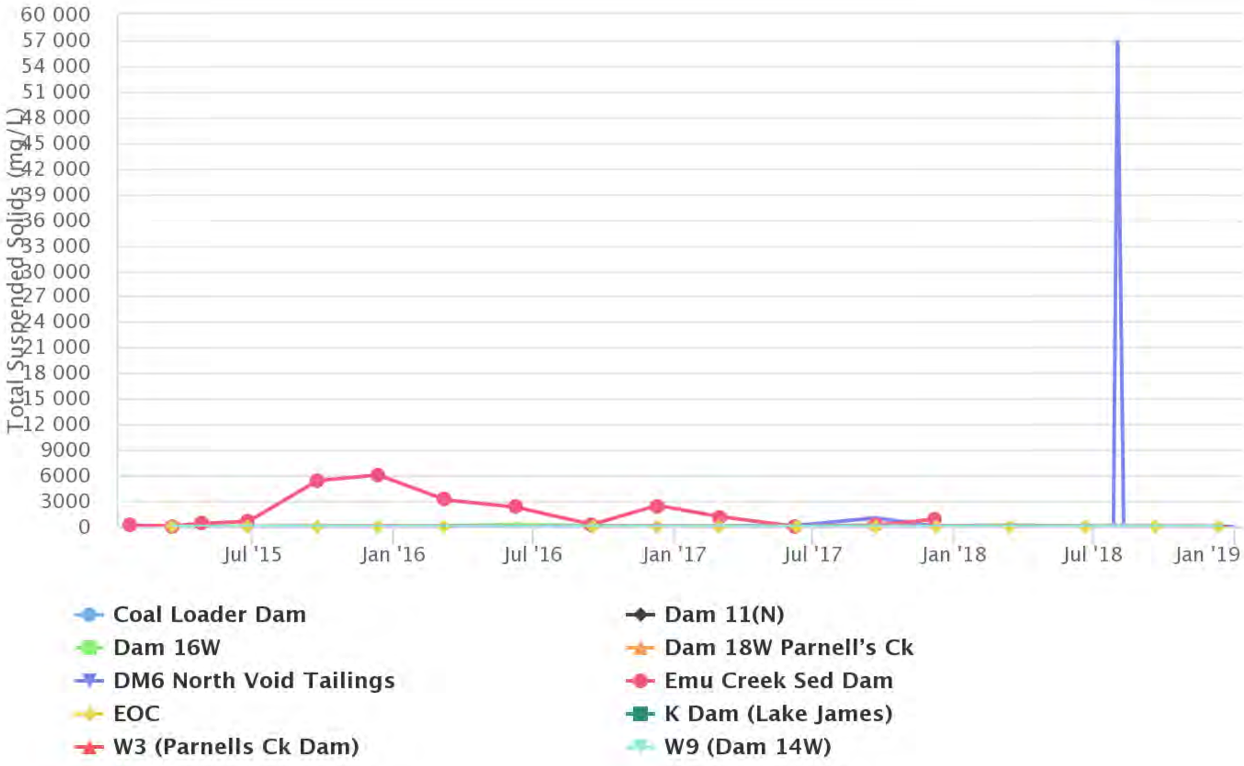


Figure 39: HVO Site Dams TSS Trends 2015 – 2018

7.3 Comparison of 2018 Water Quality Data with EIS Predictions

7.3.1 South Pit EIS Predictions

The South Pit EIS estimated an ‘instantaneous’ water quality for Electrical Conductivity of 5,700 µS/cm as an upper limit. Instantaneous water quality is a simple estimate obtained by dividing the total salt available by the maximum amount of possible void water. Electrical Conductivity measurements at Lake James averaged 5,650 µS/cm during 2018, in line with predicted EC levels.

The South Pit EIS estimated average runoff water quality from undisturbed catchments to be 400 mg/L for TSS and 615 µS/cm for EC. Comleroi Creek, South of Cheshunt Pit was sampled three times during a rain events in 2018 resulting in a TSS of 38 mg/L and EC of 129 µS/cm, demonstrating that runoff water from undisturbed catchments in the HVO South area is of better quality than that which was predicted in the EIS.

7.3.2 Carrington Pit EIS Predictions

The long term mine water quality for Carrington is discussed in the Carrington Mine Environmental Impact Statement (ERM 1999). The EIS estimated an “instantaneous” water quality for Electrical Conductivity of 7,050 µS/cm.

Dewatering from Carrington is a mixture of surface runoff from overburden emplacements, coal mining areas and seepage from the coal seams and alluvium. Water is directed to Dam 9N and into Dam 11N. The average EC and TSS in Dam 11N during 2018 was 7,095 µS/cm and 12 mg/L respectively, and is considered broadly representative of mine water quality for Carrington.

The Carrington EIS states that runoff from undisturbed catchments within the Carrington Pit will be directed around the mine via contour banks or surface drains to discharge where possible into natural creeks. The salinity of the runoff water was predicted to be approximately 615 µS/cm. Runoff from rehabilitated lands was initially predicted to have higher TSS, with levels approaching pre-mining conditions after several years. Carrington Billabong (where such water quality would be measured for this comparison) was reported as dry during the rain event monitoring rounds in 2018 with no samples collected.

7.3.3 West Pit EIS Predictions

The West Pit EIS included the data in Table 39 as representative of water quality in the local catchment area. The pH at Emu Creek (NSW2) averaged 7.6 during the review period, which is within EIS predictions and also recorded an average 262 µS/cm for Electrical conductivity indicating fresher than predicted EC results. . The pH and EC at Farrells Creek (combined upstream and downstream monitoring sites) averaged 7.3 and 971 µS/cm respectively during the review period, were within EIS predictions. The pH and EC at Davis Creek averaged 7.1 and 252 µS/cm respectively during the review period, slightly lower than EIS predictions Parnell’s Dam (W3) measured an average EC of 9,160 µS/cm in 2018, this is outside of the predicted range however correlates to drying conditions and decreasing water level in the dam across 2018.

Table 39: Representative Water Quality for West Pit

Watercourse	pH (pH Units)	EC (µS/cm)
Davis Creek	7.7 to 8.4	767 to +8,000
Emu Creek	7.5 to 8.8	365 to +1,000
Farrells Creek	7.0 to 9.2	195 to +12,000
Mine Water (Parnell’s Dam)	-	2,400 to 6,300

7.4 Performance relating to HRSTS Discharges

HVO participates in the Hunter River Salinity Trading Scheme (HRSTS), allowing it to discharge to the Hunter River via three licensed discharge points, including Dam 11N, Dam 15S (Lake James) and Dam 9W (Parnells Dam). Discharges can only take place subject to the schemes regulations.

As required by the EPL, HVO submitted a discharge report for the 2017/18 financial year. No water was discharged off site during 2018 via the Hunter River Salinity Trading Scheme (HRSTS).

7.5 Groundwater

7.5.1 Groundwater Management

Groundwater monitoring activities were undertaken in 2018 in accordance with the HVO Water Management Plan and Groundwater Monitoring Programme. The monitoring results are used to establish and monitor trends in physical and geochemical parameters of surrounding groundwater potentially influenced by mining.

The groundwater monitoring programme at HVO measures the quality of groundwater against background data, EIS predictions and historical trends. Ground water quality is evaluated through the parameters of pH, EC, and Standing Water Level (SWL) (measured as elevation in metres with respect to the Australian Height Datum, mAHD). On a periodic basis (nominally once per annum) a comprehensive suite of analytes are measured, including major anions, cations and metals. Prior to sampling for comprehensive analysis, bore purging is undertaken to ensure a representative sample is collected.

Groundwater monitoring data is reviewed on a quarterly basis. The review involves a comparison of measured pH and EC results against internal trigger values which have been derived from the historical data set. Trigger limits are calculated as the 95th percentile maximum value (EC and pH) and the 5th percentile minimum value (pH only) from data collected since 2011. Trigger levels have been set on the basis of geographical proximity and target stratigraphy. Bores that record as dry and bores of unknown seam have not been included in calculation of the trigger limits. The response to measured excursions outside the trigger limits is detailed in the HVO Water Management Plan. Where investigations and subsequent actions have been undertaken following review of monitoring data, these are detailed in this section. Monitoring locations are shown in Figure 40. The Annual Groundwater Review is provided in Appendix 1.

7.5.2 Groundwater Performance

Sampling of ground waters was carried out in accordance with the HVO Groundwater Monitoring Programme. Where laboratory analysis was undertaken, this was performed by a NATA accredited laboratory. Sites with a data capture rate of less than 100 per cent are outlined in Table 40.

During 2018, a review of environmental monitoring data and published reports was undertaken which identified that three groundwater monitoring locations identified in the approved water monitoring program had not previously been reported in monthly or annual reports as described by the water management plan. These monitoring locations included GW_100, GW_101 & D010(GM). Data from these monitoring locations has since been included in monthly monitoring reports and this Annual Review. An internal process has been developed to prevent reoccurrence.

Table 40: HVO Groundwater Monitoring Data Recovery for 2018

Location	Data Recovery (%)	Comments
4036C	0%	Insufficient water during 2018 monitoring events.
4051C	0%	Bore unable to be sampled in 2018 due to obstruction (potential bore collapse).
4113P	0%	Bore unable to be sampled in 2018 due to obstruction (potential bore collapse).
B425(WDH)	0%	Insufficient water to sample during 2018 monitoring events
BC1	0%	Insufficient water during 2018 monitoring events.
BZ1-2	0%	Insufficient water during 2018 monitoring events.
BZ4A(2)	75%	Insufficient water during August monitoring event
C122(BFS)	0%	Insufficient water during 2018 monitoring events.
C919 (ALL)	25%	Insufficient water during August and November monitoring events
CFW56	0%	Insufficient water during 2018 monitoring events.
CFW57	96%	Sample not collected on 30 November as no safe access due to rain event
CGW45	0%	Bore unable to be sampled in 2018 due to obstruction (potential bore collapse).
CGW45a	0%	No sample collected for 2018 monitoring events
CGW46a	0%	No sample collected for 2018 monitoring events
CGW47	0%	Insufficient water during 2018 monitoring events.
CGW47	50%	Insufficient water during September and December monitoring events.
CHPZ8A	0%	Insufficient water during 2018 monitoring events.
D317(ALL)	0%	Insufficient water during 2018 monitoring events.
DM2	0%	Insufficient water during 2018 monitoring events
DM7	0%	Insufficient water during 2018 monitoring events
DM8	0%	Unable to be sampled due to pump fitment on bore.
DM9	0%	Unable to be sampled due to pump fitment on bore.
GW-101	0%	Insufficient water during 2018 monitoring events
GW-107	0%	Insufficient water during 2018 monitoring events
GW-108	0%	Insufficient water during 2018 monitoring events
GW-121	0%	Insufficient water during 2018 monitoring events
GW-122	88%	Sample not collected in November as no safe access due to rain event
GW-124	88%	Sample not collected in November as no safe access due to rain event
GW-126	88%	Sample not collected in November as no safe access due to rain event
GW-128	88%	Sample not collected in November as no safe access due to rain event
GW-129	88%	Sample not collected in November as no safe access due to rain event
S4	0%	Insufficient water during 2018 monitoring events

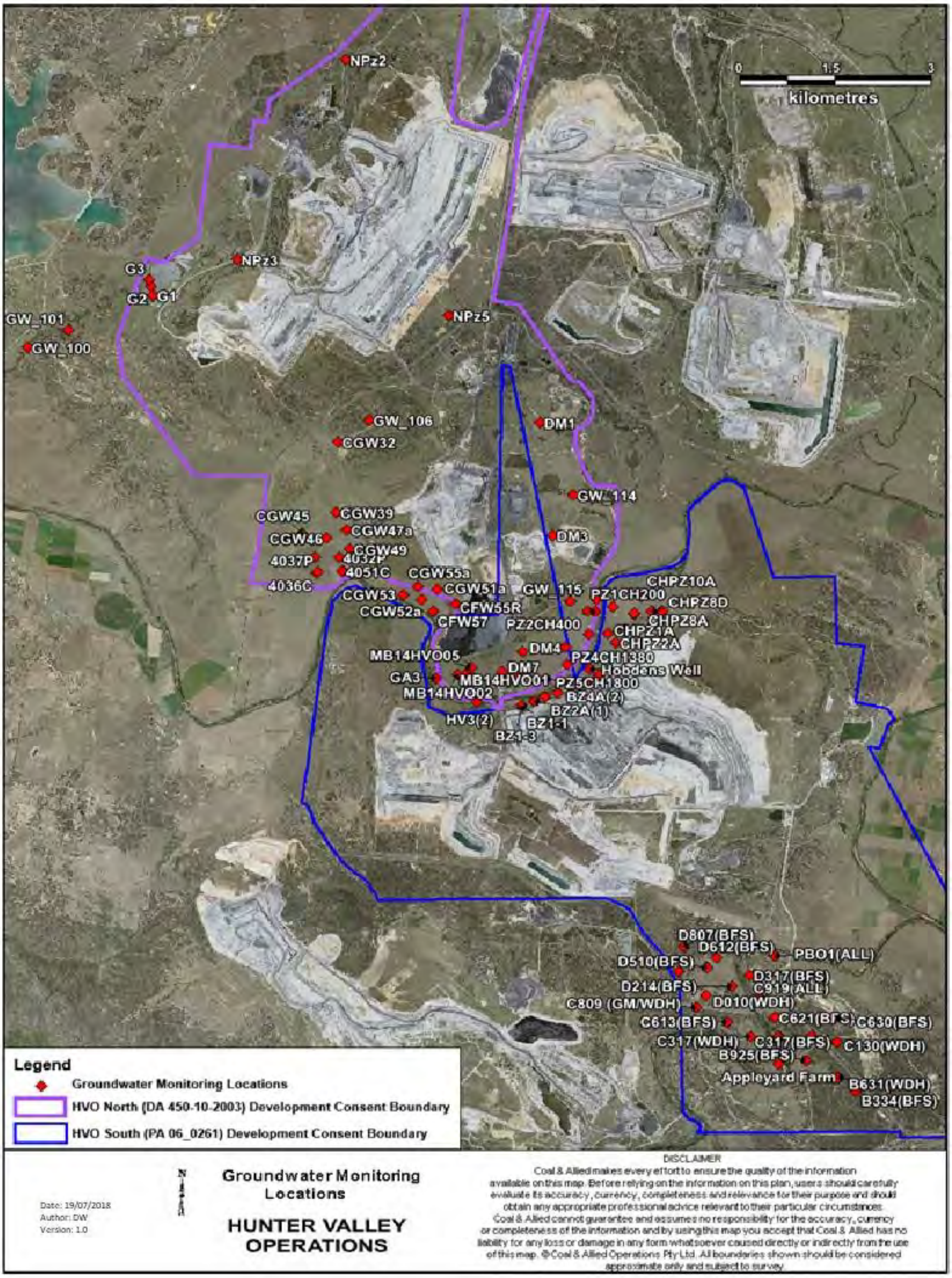


Figure 40: Groundwater Monitoring Network at HVO – 2018

7.5.3 Groundwater Monitoring Summary

The following section presents groundwater monitoring data in relation to the geographic locations and target stratigraphy for groundwater monitoring bores. Results are given for the following locations:

- Carrington Broonie;
- Carrington Alluvium;
- Carrington Interburden;
- Carrington West Wing Alluvium;
- Carrington West Wing LBL;
- Carrington West Wing Flood Plain;
- Cheshunt / North Pit Alluvium;
- Cheshunt Interburden;
- Cheshunt Mt Arthur;
- Cheshunt Piercefield;
- Lemington South Alluvium;
- Lemington South Arrowfield;
- Lemington South Bowfield;
- Lemington South Interburden;
- Lemington South Woodlands Hill;
- North Pit Spoil;
- West Pit Alluvium; and
- West Pit Sandstone / Siltstone.

Each location is discussed below, and a summary of monitoring data presented. Where monitoring results required further investigation following the recording of three consecutive measurements outside the internal statistical limits, these results are summarised in tables for each location.

7.5.3.1 Carrington Broonie

Carrington Groundwater was sampled on 8 occasions during 2018 from two monitoring locations. The EC, pH and SWL trends for 2015 to 2018 for Carrington Broonie Seam groundwater bores are shown in Figure 41 to Figure 43 respectively. Data was generally consistent with historical ranges with some minor variation noted with pH results. Trigger tracking results are listed in Table 41.

Table 41: HVO Carrington Broonie Groundwater 2018 Monitoring Internal Trigger Tracking

Location	Sample Date	Trigger limit	Action taken in response
CGW53	8/03/2018	PH - 5th percentile	Watching Brief. Returned to normal range.
CGW53	22/06/2018	PH - 5th percentile	1st Exceedance
CGW52	26/09/2018	pH - 5th Percentile	1st exceedance. Returned to normal range.

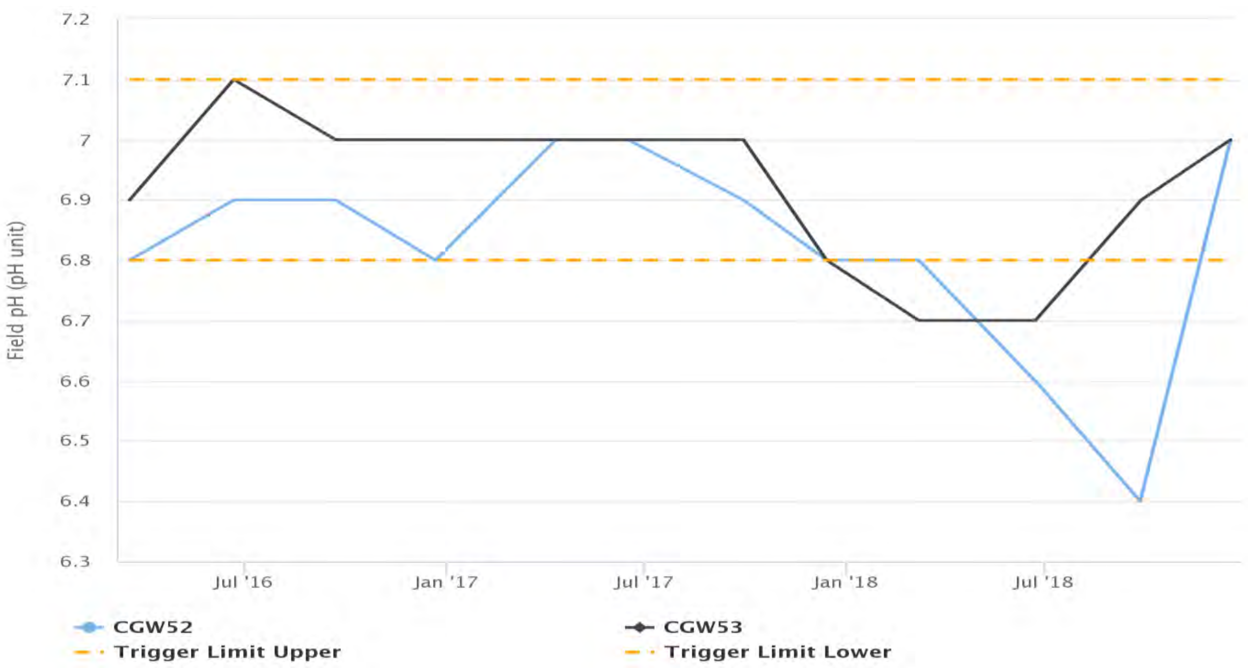


Figure 41: Carrington Broonie Groundwater pH Trends 2015 – 2018

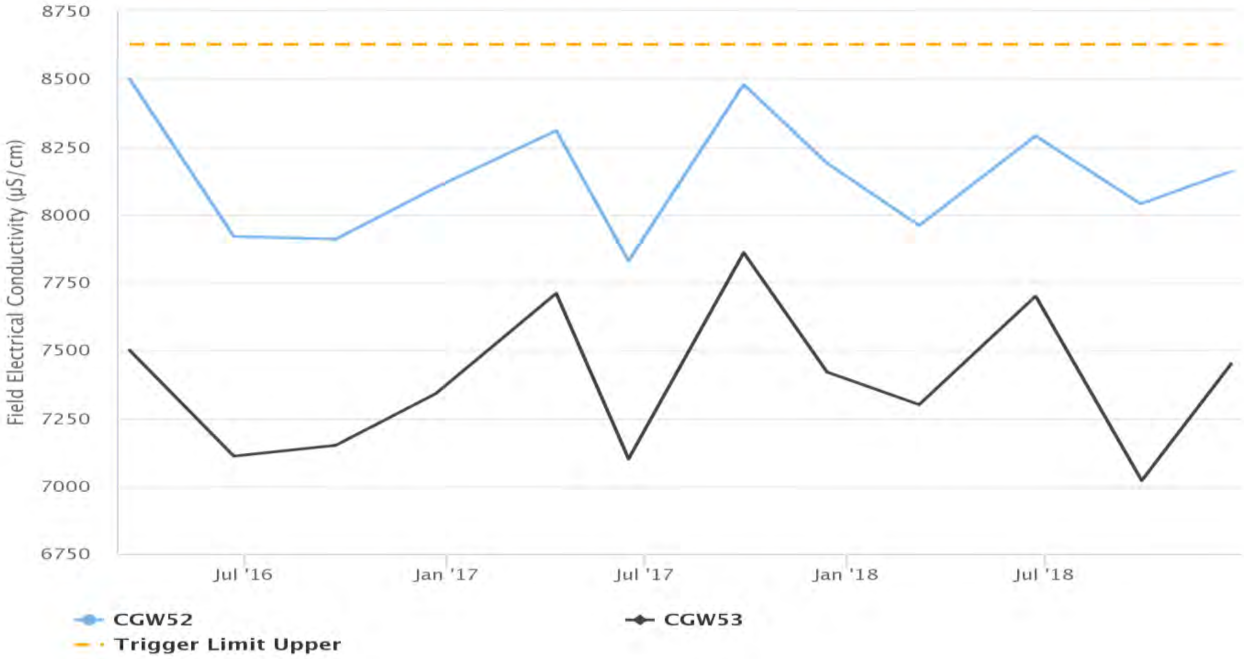


Figure 42: Carrington Broonie Groundwater EC Trends 2015 – 2018

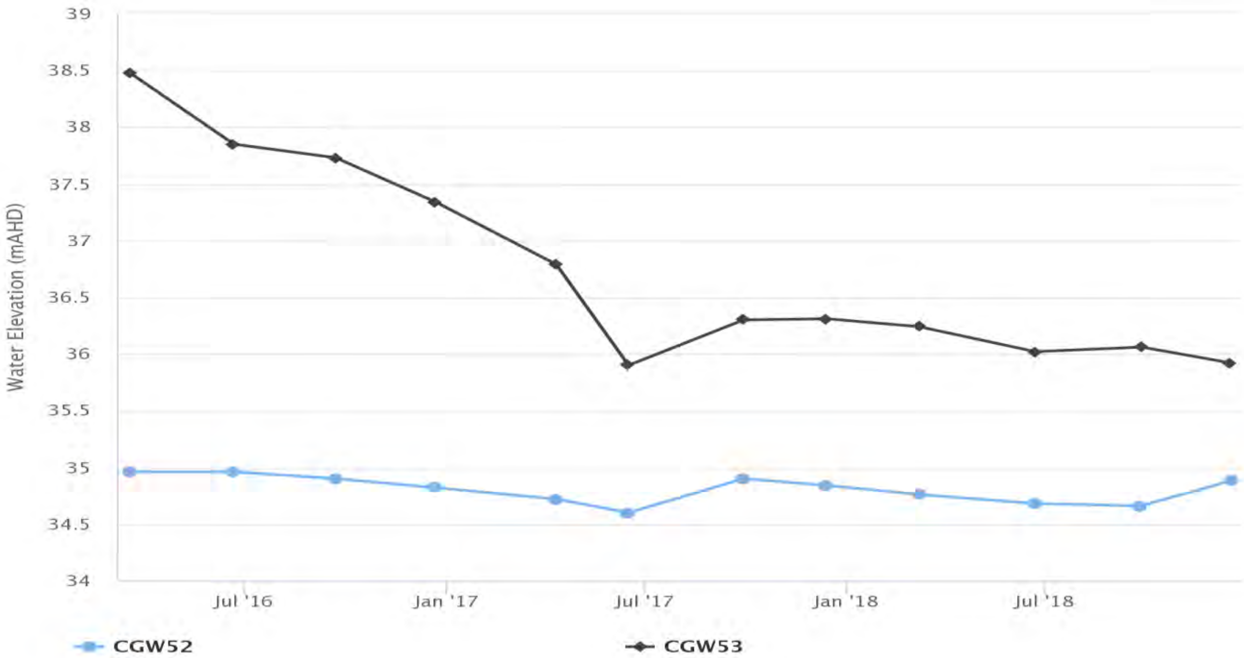


Figure 43: Carrington Broonie Groundwater SWL Trends 2015 – 2018

7.5.3.2 Carrington Alluvium

Groundwater monitoring in the Carrington Alluvium area was undertaken at five sites during 2018, with 116 samples collected during the reporting period. The EC, pH and SWL trends for 2015 to 2018 for Carrington Alluvium groundwater bores are shown in Figure 44 to Figure 46. Trigger tracking results are listed in Table 42.

Multiple exceedances of trigger limits for CFW55R near Carrington triggered a detailed investigation. Water samples were above the EC trigger of 6,324 µS/cm and pH under the trigger level of 7.0. In May 2018 a site investigation was undertaken to assess the bore condition. CFW55R is constructed with 50 mm PVC casing to a total depth of 15.4 m below ground level (mbgl), with a screened interval of 10.4 to 15.4 mbgl, within alluvium. Based on the site visit and review of available data, it was identified that North Void may intersect palaeochannel alluvium sediments at the north-western end of North Void Tailings Storage Facility (North Void TSF). These sediments had the potential to form a groundwater flow pathway between North Void TSF, through spoil and into the alluvial sediments around bore CFW55R.

As a result of the trigger exceedance investigation for bore CFW55R it was decided to drill a series of additional monitoring bores. From 3rd October 2018 to 25th October 2018 a total of ten new monitoring bores were drilled and constructed (GW_120 to GW_129); eight intersecting alluvium, one intersecting weathered sandstone and one intersecting waste rock material. Each of the monitoring bores were constructed with 50 mm or 125 mm diameter PVC casing and completed with a lockable steel monument cover and concrete base. A review of results from the augmented monitoring programme identified a likely seepage pathway from the North Void TSF to the alluvial sediment.

A management plan was prepared to manage potential impacts from the identified seepage pathway. The primary aim of the plan was to limit the potential for seepage by reducing available water in the TSF and lowering the permeability of the tailings. This was achieved by installing additional deposition points to beach tailings against the area likely to be the seepage pathway and force water away. Secondary flocculation was also introduced to increase tailings consolidation which also reduces tailings permeability. In January 2019, HVO ceased tailings deposition into the North Void TSF to allow the tailings to dry and consolidate. Further work will continue in 2019 to assess the effectiveness of current controls and identify feasible engineering measures if current controls are found to be ineffective.

Monitoring of the area continues at an increased frequency including data collection from continuous groundwater loggers measuring water level and quality installed in October 2018. Electrical conductivity and pH have stabilised in CFW55R and in the last quarter standing water level has declined, this is an initial indication that current controls are being effective.

HVO has consulted with regulatory authorities regarding the trigger exceedances, monitoring programme and management actions. The EPA are modifying HVO's Environmental Protection Licence to add conditions which reflect the key elements of the management plan prepared by HVO.

Table 42: HVO Carrington Alluvium Groundwater 2018 Monitoring Internal Trigger Tracking

Location	Sample Date	Trigger limit	Action taken in response
CFW55R	29/03/2018 19/04/2018 21/05/2018 27/06/2018 25/07/2018 1/08/2018 9/08/2018 15/8/2018 5/9/2018 27/9/2018 25/10/2018 1/11/2018 7/11/2018 13/11/2018 22/11/2018 30/11/2018 11/12/2018 19/12/2018 27/12/2018	PH - 5^{th} percentile	Detailed investigation undertaken and management plan implemented.
CFW55R	29/03/2018 19/04/2018 21/05/2018 27/06/2018 25/07/2018 1/08/2018 9/08/2018 15/8/2018 22/8/2018 28/8/2018 5/9/2018 13/9/2018 19/9/2019 27/9/2018 25/10/2018 1/11/2018 7/11/2018 13/11/2018 22/11/2018 30/11/2018 4/12/2018 11/12/2018 19/12/2018 27/12/2018	EC – 95^{th} percentile	Detailed investigation undertaken and management plan implemented.

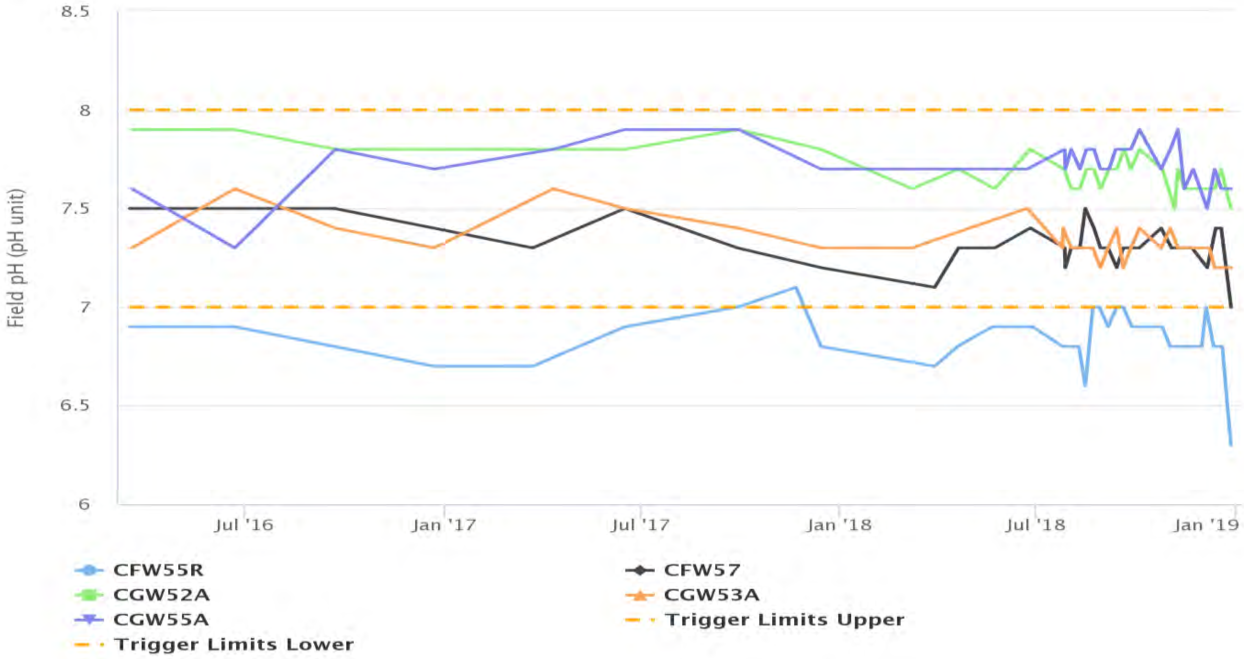


Figure 44: Carrington Alluvium Groundwater pH Trends 2015 – 2018

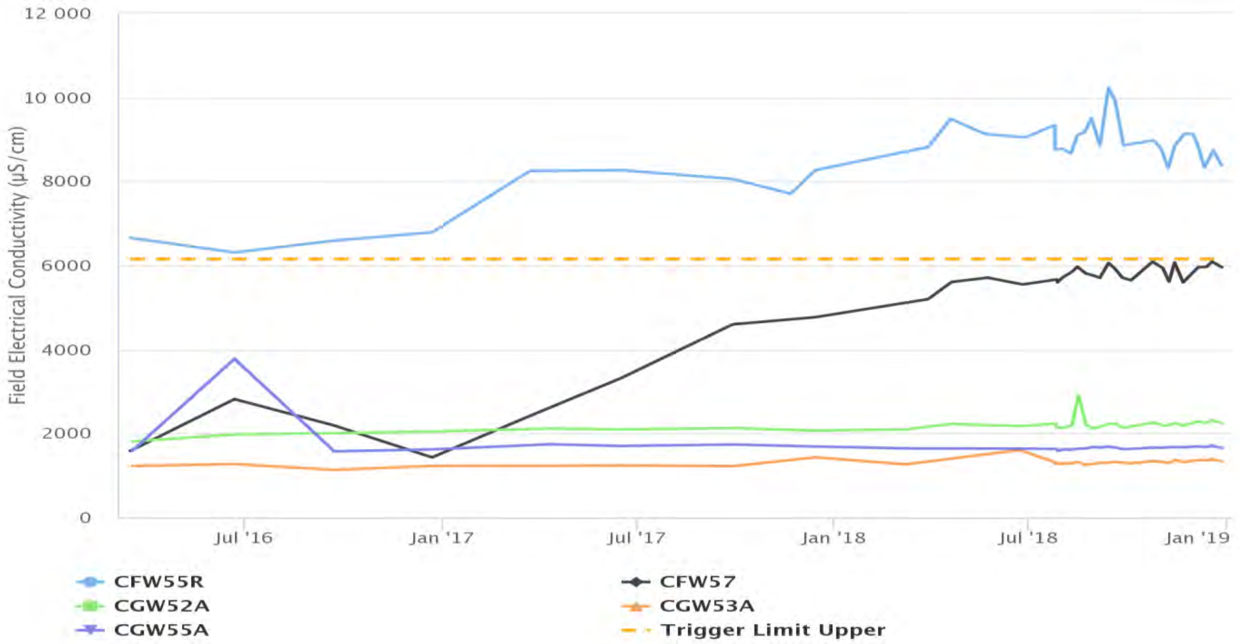


Figure 45 – Carrington Alluvium Groundwater EC Trends 2018 - 2018

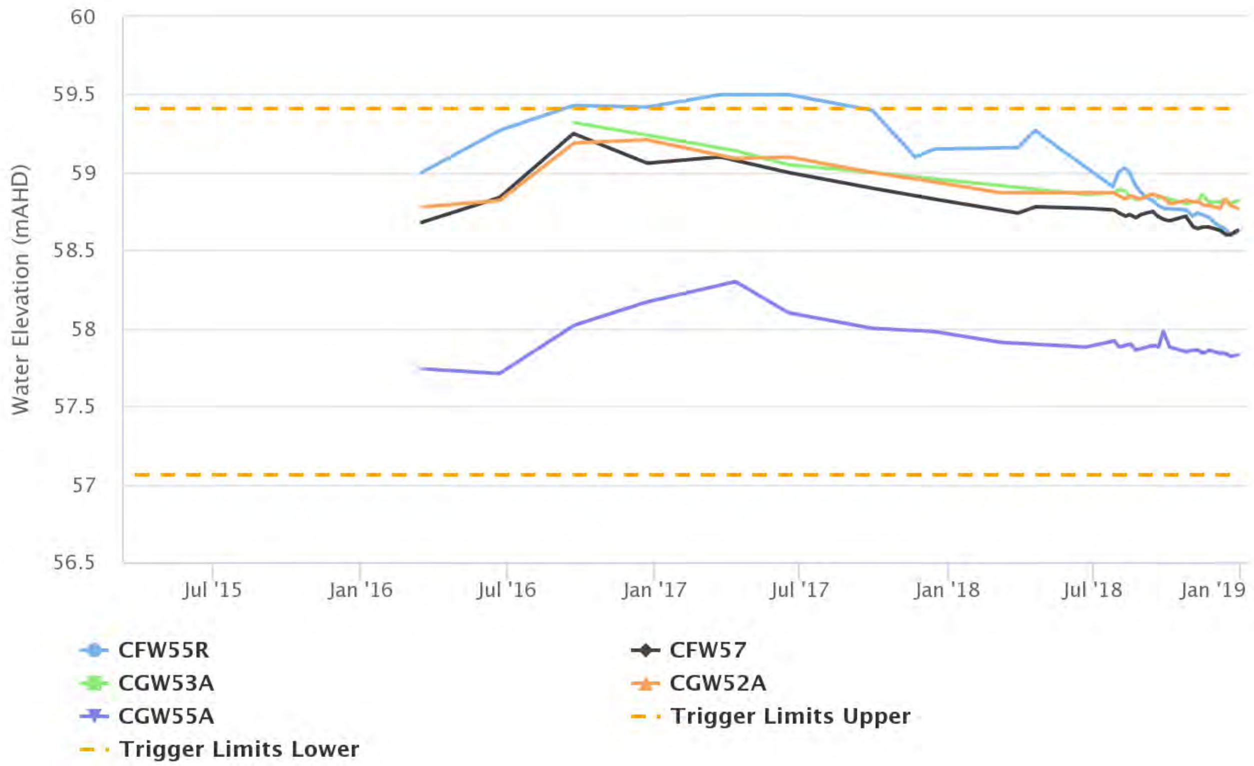


Figure 46:Carrington Alluvium Groundwater SWL trends 2015 – 2018

7.5.3.3 Carrington Interburden

Groundwater monitoring in the Carrington Interburden was undertaken at one site during 2018, with 23 samples collected for field analysis during the reporting period. The EC, pH and SWL trends for 2015 to 2018 for groundwater bores in the Carrington Interburden are shown in Figure 47 to Figure 49 respectively. Results were generally consistent with historical trends. 4036C and 4051C bores contained insufficient water for accurate PH and EC analysis throughout 2018.

Sampling frequency for several bores in this area had been increased during 2018 in response to an ongoing groundwater investigation initiated by exceedances of trigger limits.

Trigger tracking results are listed in Table 43.

Table 43: HVO Carrington Interburden Groundwater 2018 Monitoring Internal Trigger Tracking

Location	Sample Date	Trigger limit	Action taken in response
CGW51a	27/12/2018	PH - 5^{th} percentile	Watching Brief

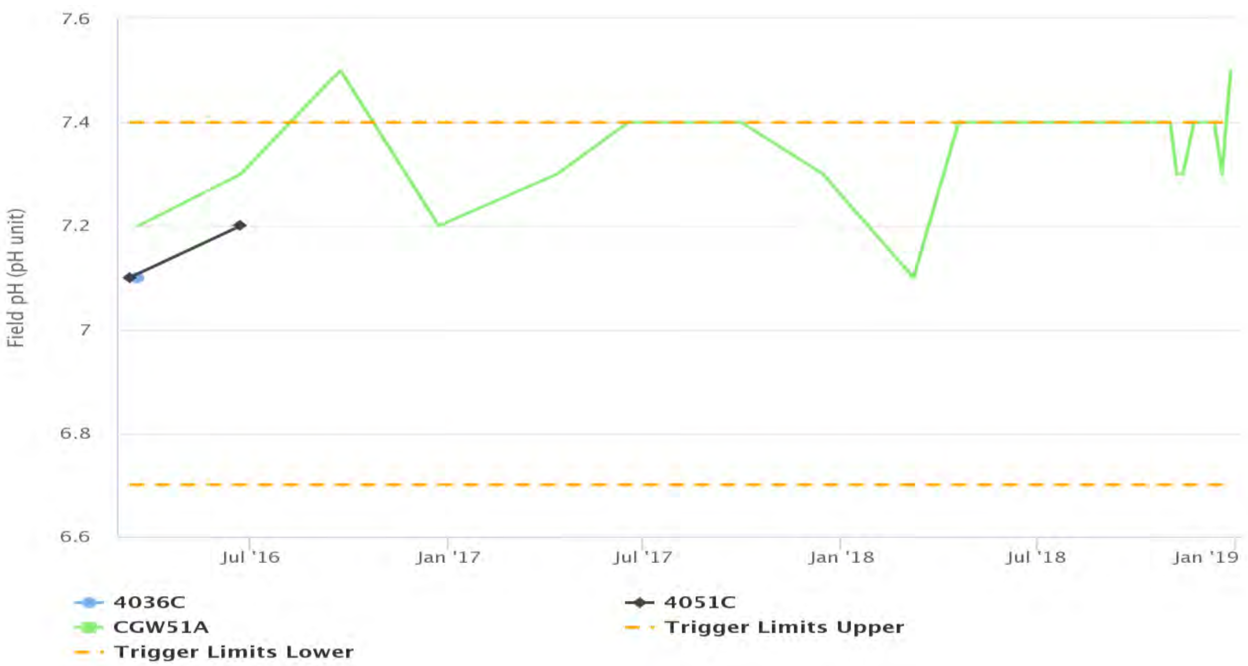


Figure 47: Carrington Interburden Groundwater pH Trends 2015 – 2018

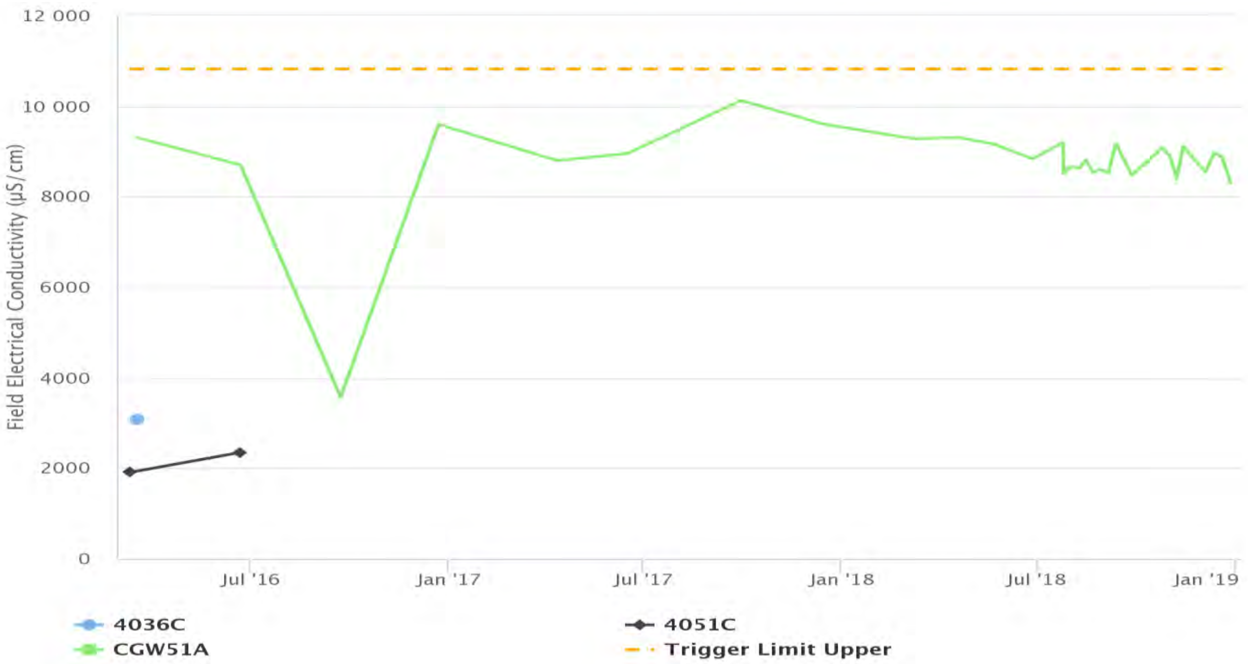


Figure 48: Carrington Interburden Groundwater EC Trends 2015 – 2018

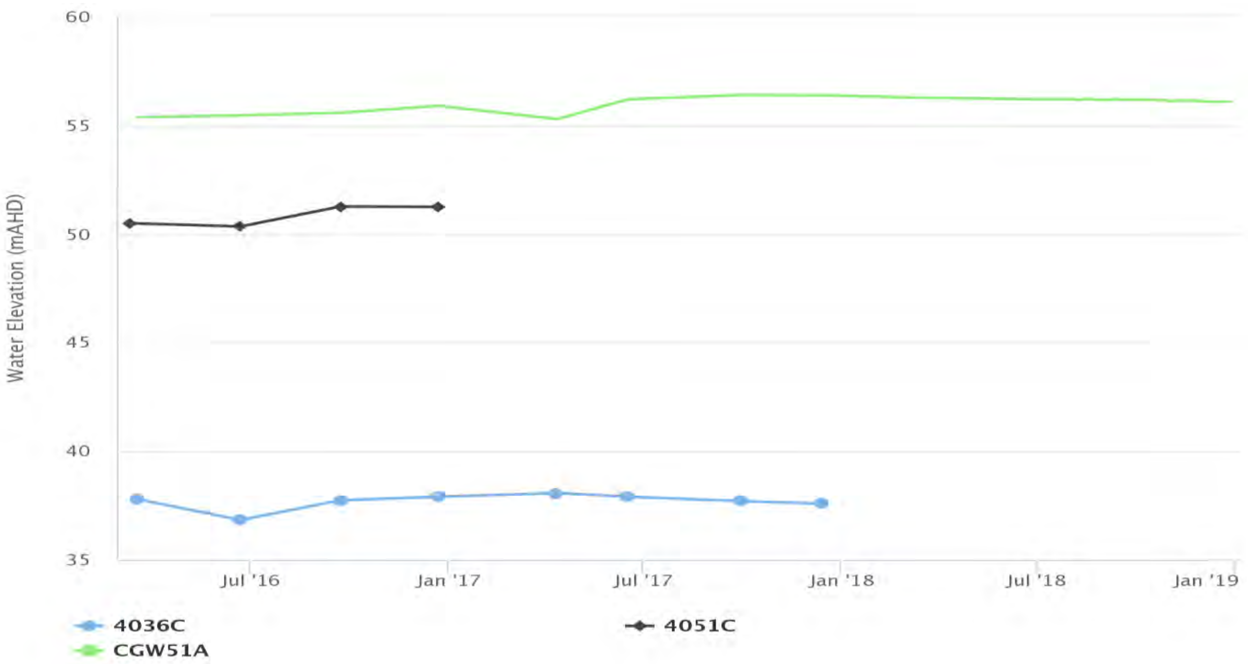


Figure 49: Carrington Interburden Groundwater SWL Trends 2015 – 2018

7.5.3.4 Carrington West Wing Alluvium

Groundwater monitoring in the Carrington West Wing Alluvium was undertaken at five sites in 2018 with 20 samples collected for field analysis during the reporting period. Results are shown in Figure 50 to Figure 52. Results during 2018 were generally consistent with historical trends.

Trigger tracking results are listed in Table 44.

Table 44: HVO Carrington West Wing Alluvium Groundwater 2018 Monitoring Internal Trigger Tracking

Location	Sample Date	Trigger limit	Action taken in response
CGW49	22/06/2018	EC - 95th percentile	1st Exceedance

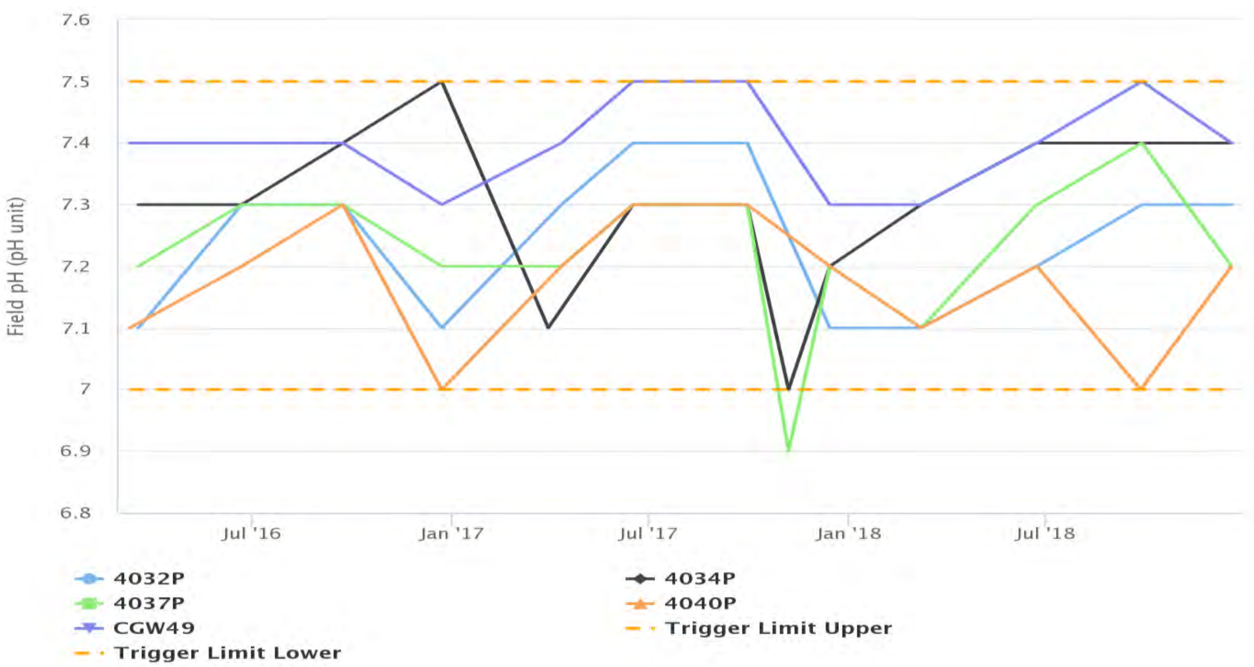


Figure 50: Carrington West Wing Alluvium Groundwater pH Trends 2015-2018

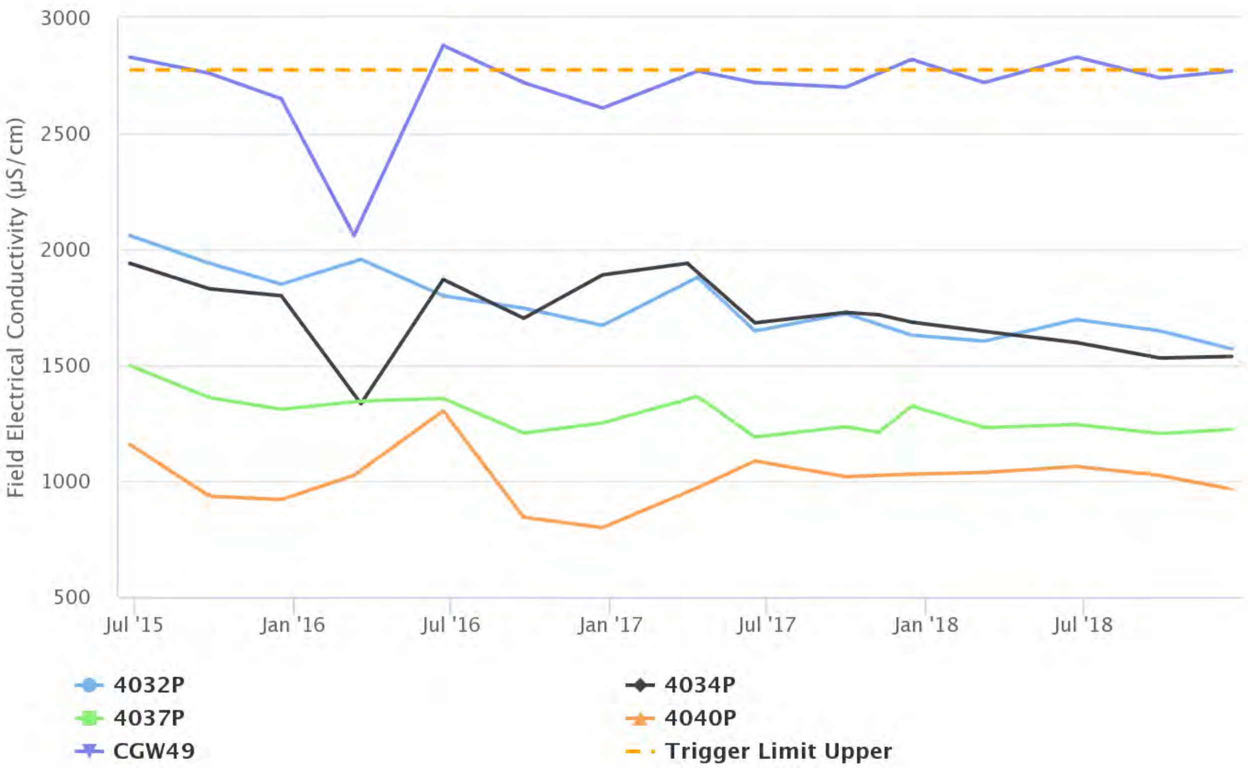


Figure 51: Carrington West Wing Alluvium Groundwater EC Trends 2015 – 2018

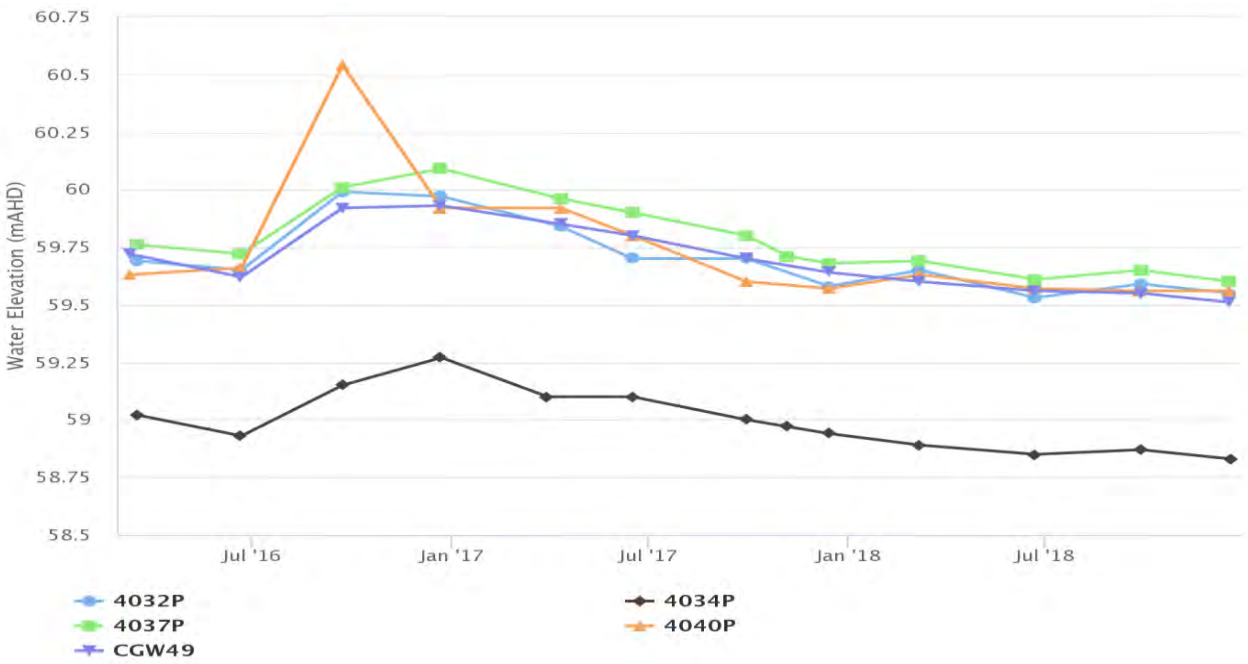


Figure 52: Carrington West Wing Alluvium Groundwater SWL Trends 2015 - 2018

7.5.3.5 Carrington West Wing Flood Plain

Groundwater monitoring in the Carrington West Wing Flood Plain was undertaken at four sites in 2018 with 14 samples collected for field analysis during the reporting period. Results are shown in Figure 53 to Figure 55. Groundwater levels declined within the bores over 2018, which appears to correlate with climate and stream flow trends. CGW47a was reported as dry in Q3 and Q4. Trigger tracking results are listed in Table 45.

Table 45: Carrington West Wing Floodplain Groundwater 2018 Monitoring Internal Trigger Tracking

Location	Sample Date	Trigger limit	Action taken in response
GW-106	29/03/2018	EC – 5^{th} percentile	Watching Brief *

* = 1st/2nd trigger. Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

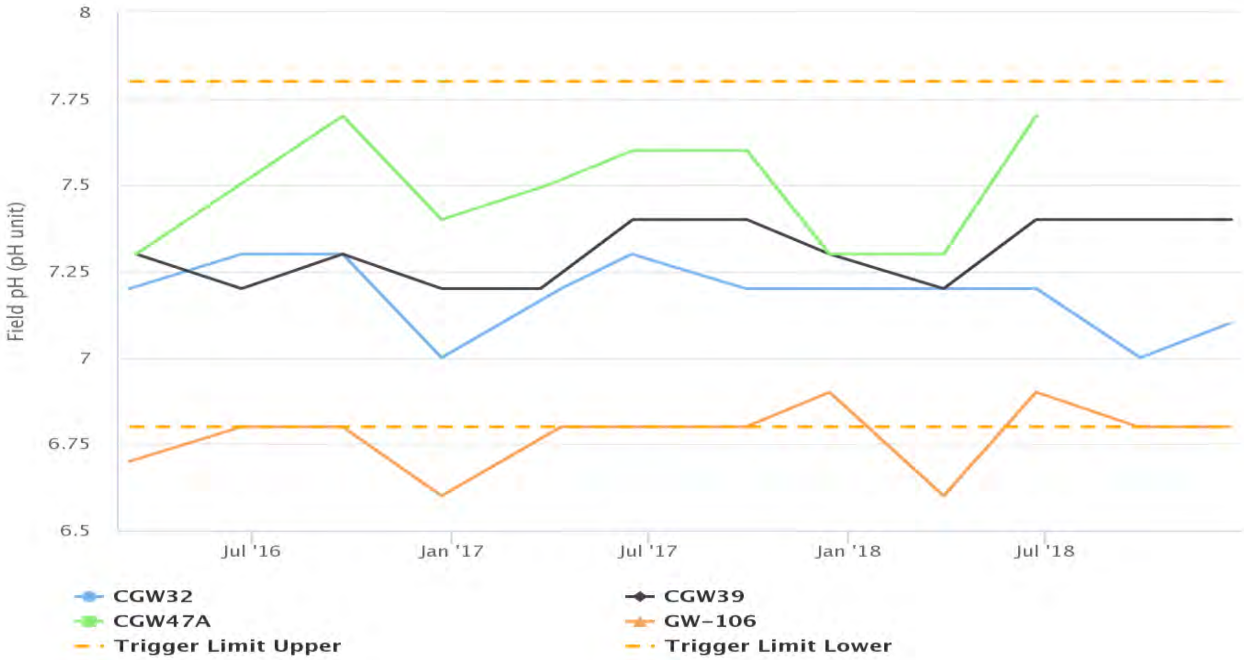


Figure 53: Carrington West Wing Flood Plain Groundwater pH Trends 2015 - 2018

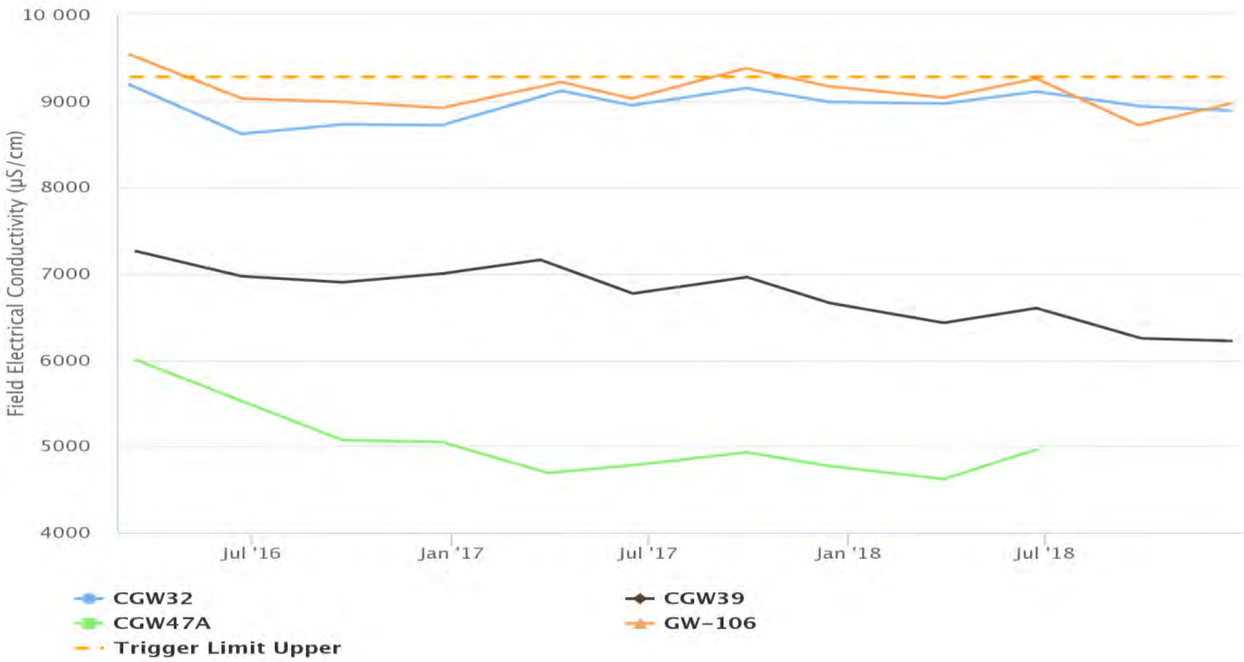


Figure 54: Carrington West Wing Flood Plain Groundwater EC Trends 2015 - 2018

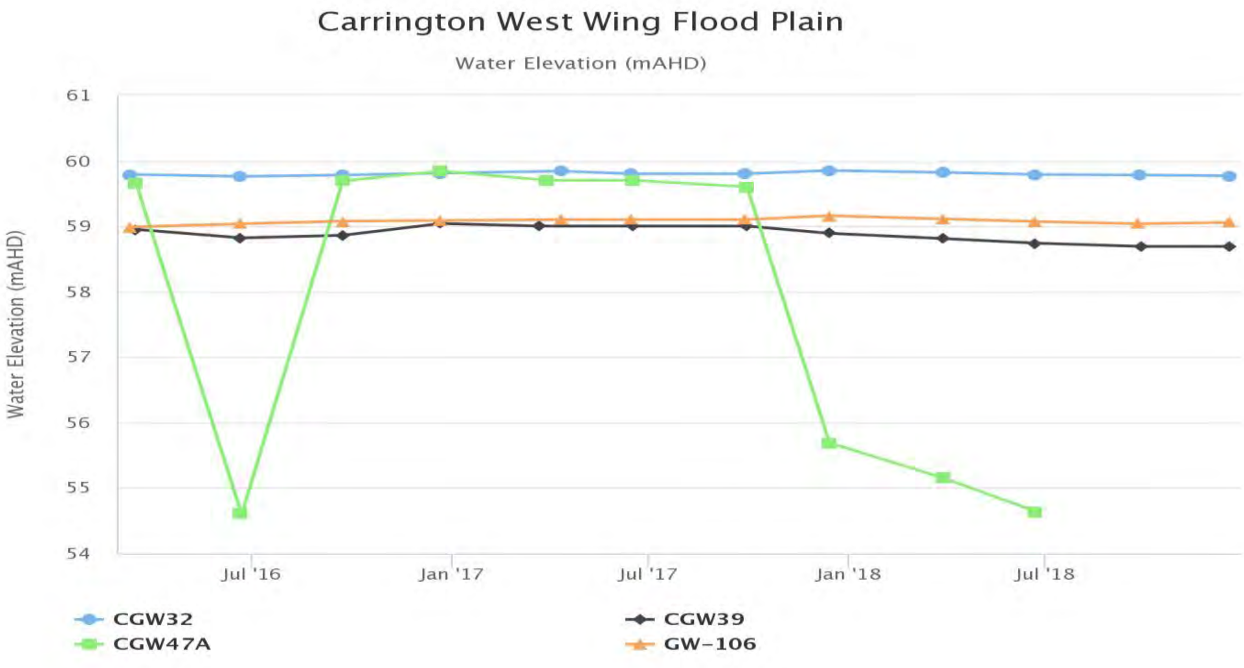


Figure 55: Carrington West Wing Flood Plain Groundwater SWL Trends 2015- 2018

7.5.3.6 Cheshunt / North Pit Alluvium

Groundwater monitoring in the Cheshunt / North Pit area was undertaken at 17 sites during 2018, with 64 samples collected during routine monitoring. Electrical Conductivity, pH and SWL trends for 2015 to 2018 are shown in Figure 56 to Figure 58. Trigger tracking results are listed in Table 46. Water level in piezometer PZ2CH400 increased by 5.36 m in the last sample of 2018. This does not appear to be mining related (when compared to water levels within the north pit spoil) and an investigation will be undertaken to assess competency of the piezometer.

Table 46: Cheshunt/North Pit Alluvium Groundwater 2018 Monitoring Internal Trigger Tracking

Location	Sample Date	Trigger limit	Action taken in response
Hobdens Well	25/05/2018	pH- 95th Percentile	1st exceedance
BZ1-1	9/11/2018	pH – 95th Percentile	1st exceedance. Watching Brief*
Hobdens Well	2/11/2018	pH – 95th Percentile	1st exceedance. Watching Brief*
GA3	17/12/2018	pH – 5th Percentile	1st exceedance. Watching Brief*

* = 1st/2nd trigger. Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

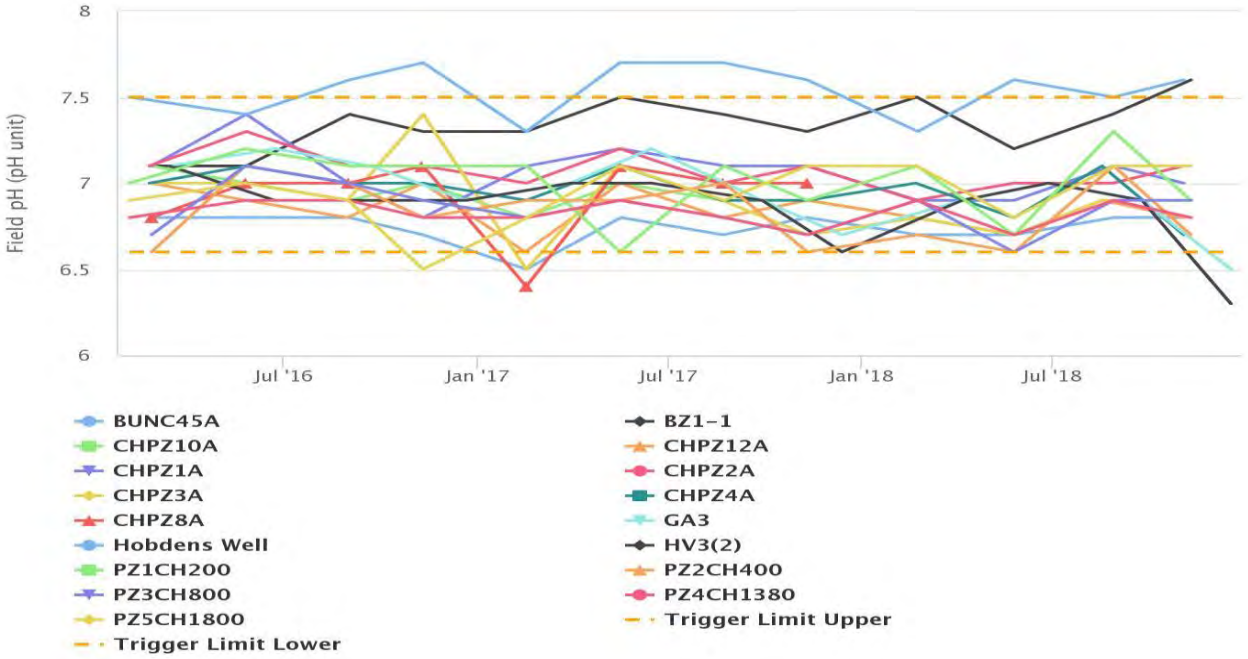


Figure 56: Cheshunt/North Pit Alluvium Groundwater pH trends 2015 – 2018

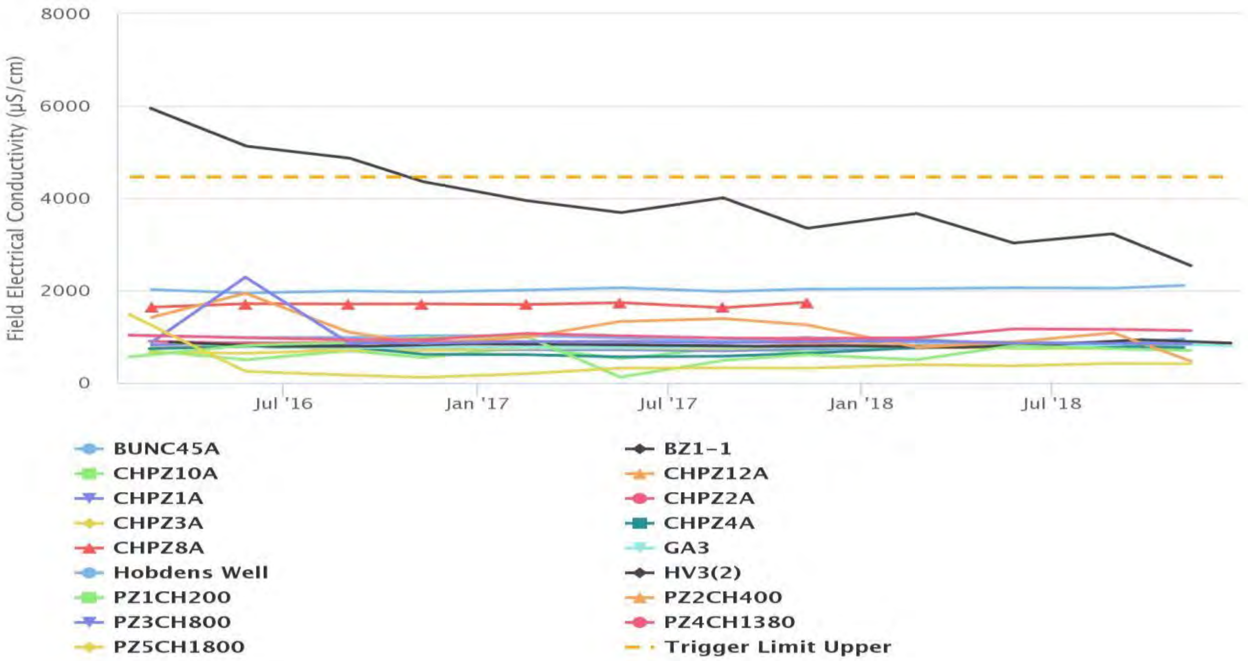


Figure 57: Cheshunt/North Pit Alluvium Groundwater EC Trends 2015 - 2018

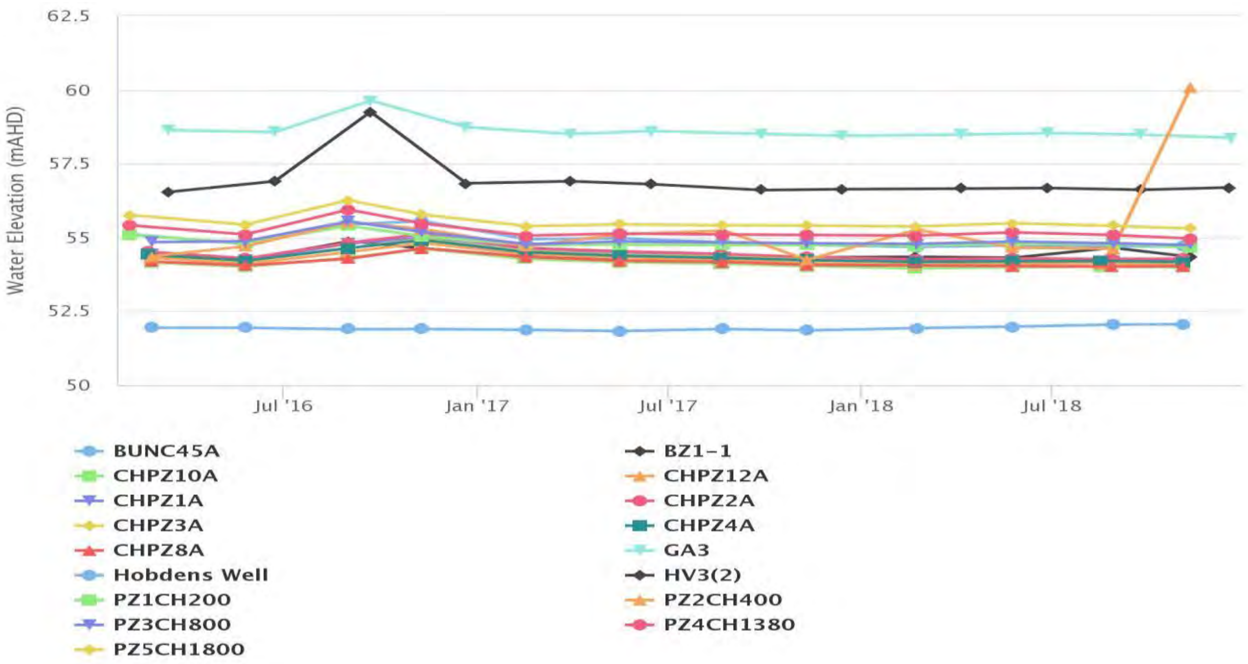


Figure 58: Cheshunt/North Pit Alluvium Groundwater SWL trends 2015 - 2018

7.5.3.7 Cheshunt Interburden

Groundwater monitoring in the Cheshunt Interburden area was undertaken at three sites during 2018, with 12 samples collected during the reporting period. The EC, pH and SWL trends for 2015 to 2018 are shown in Figure 59 to Figure 61. Trigger tracking results are listed in Table 47.

Table 47: Cheshunt Interburden Groundwater 2018 Monitoring Internal Trigger Tracking

Location	Sample Date	Trigger limit	Action taken in response
HG2	23/02/2018	pH - 5th Percentile	Watching Brief
BZ8-2	25/05/2018	pH - 5th Percentile	1st exceedance
HG2	25/05/2018	pH - 5th Percentile	3rd consecutive exceedance. Historical pH readings since 2004 show regular fluctuations of between 6.3 and 7.8. The 2018 readings are considered consistent with historical recorded concentrations, with no adverse impacts identified
BZ3-3	9/11/2018	pH – 5th Percentile	1st exceedance. Watching Brief*
BZ8-2	9/11/2018	pH – 5th Percentile	1st exceedance. Watching Brief*
HG2	9/11/2018	pH – 5th Percentile	1st exceedance. Watching Brief*

* = 1st/2nd trigger. Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

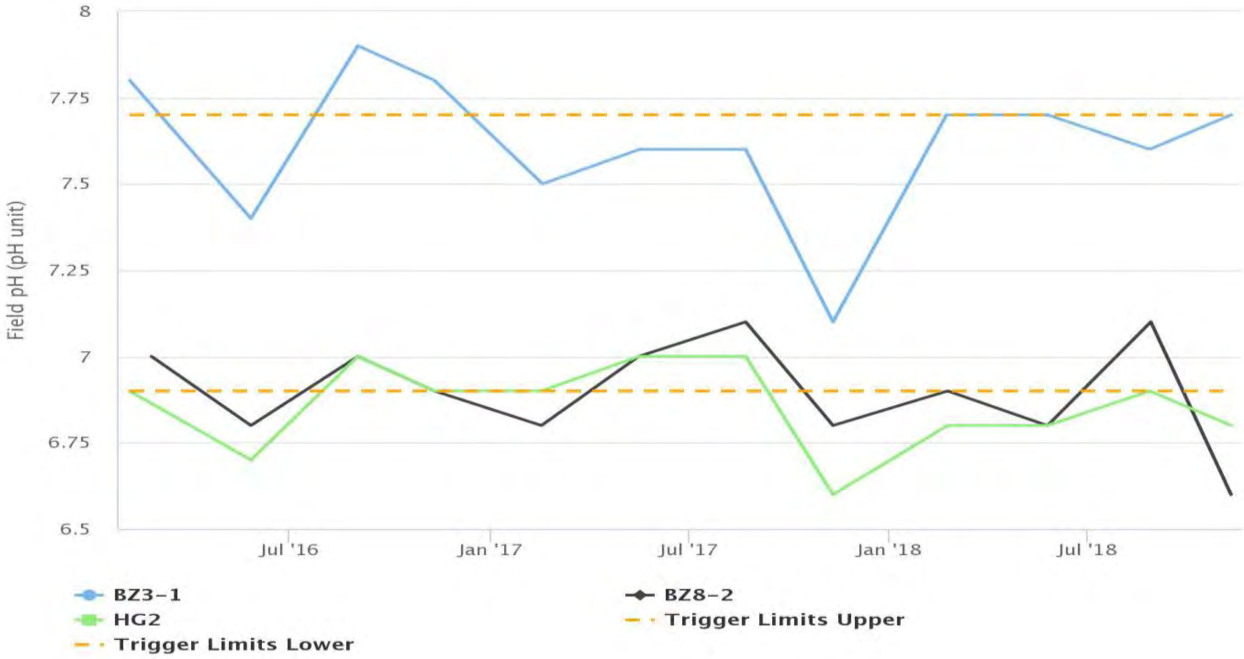


Figure 59: Cheshunt Interburden Groundwater pH Trends 2015 – 2018

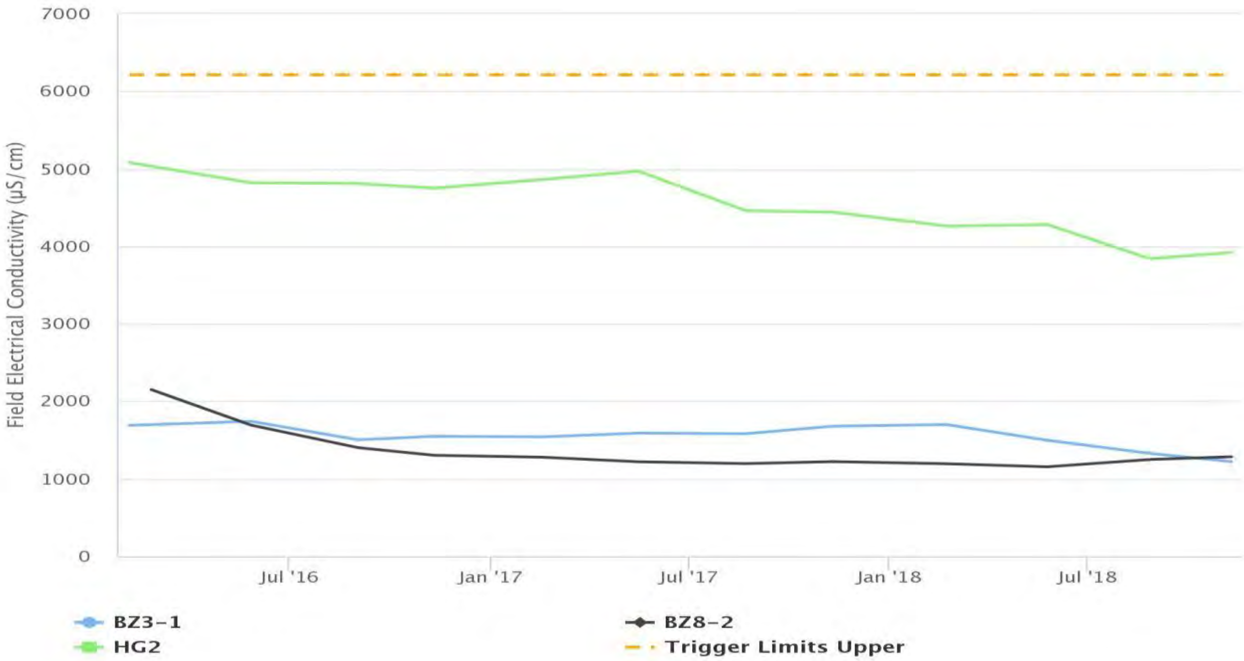


Figure 60: Cheshunt Interburden Groundwater EC Trends 2015 – 2018

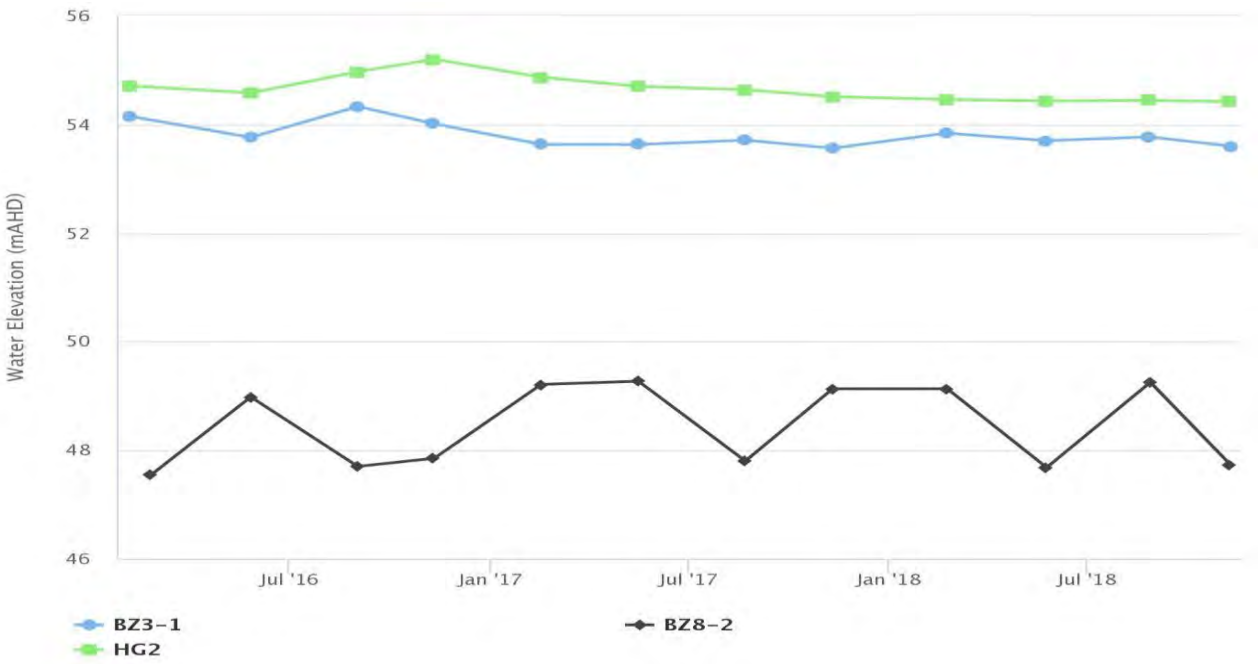


Figure 61: Cheshunt Interburden Groundwater SWL Trends 2015- 2018

7.5.3.8 Cheshunt Mt Arthur

Groundwater monitoring in the Cheshunt Mt Arthur area was undertaken at seven sites during 2018. A total of 24 samples were collected during the reporting period. The pH, EC and SWL trends for 2015 to 2018 are shown in Figure 62 to Figure 64. Monitoring results were generally consistent with historical trends. Trigger tracking results are listed in Table 48.

Table 48: Cheshunt Mt Arthur Groundwater 2018 Monitoring Internal Trigger Tracking

Location	Sample Date	Trigger limit	Action taken in response
BZ4A(2)	22/02/2018	pH - 5th Percentile	Watching Brief
BZ3-3	9/11/2018	pH – 5th Percentile	1st exceedance. Watching Brief*

* = 1st/2nd trigger. Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

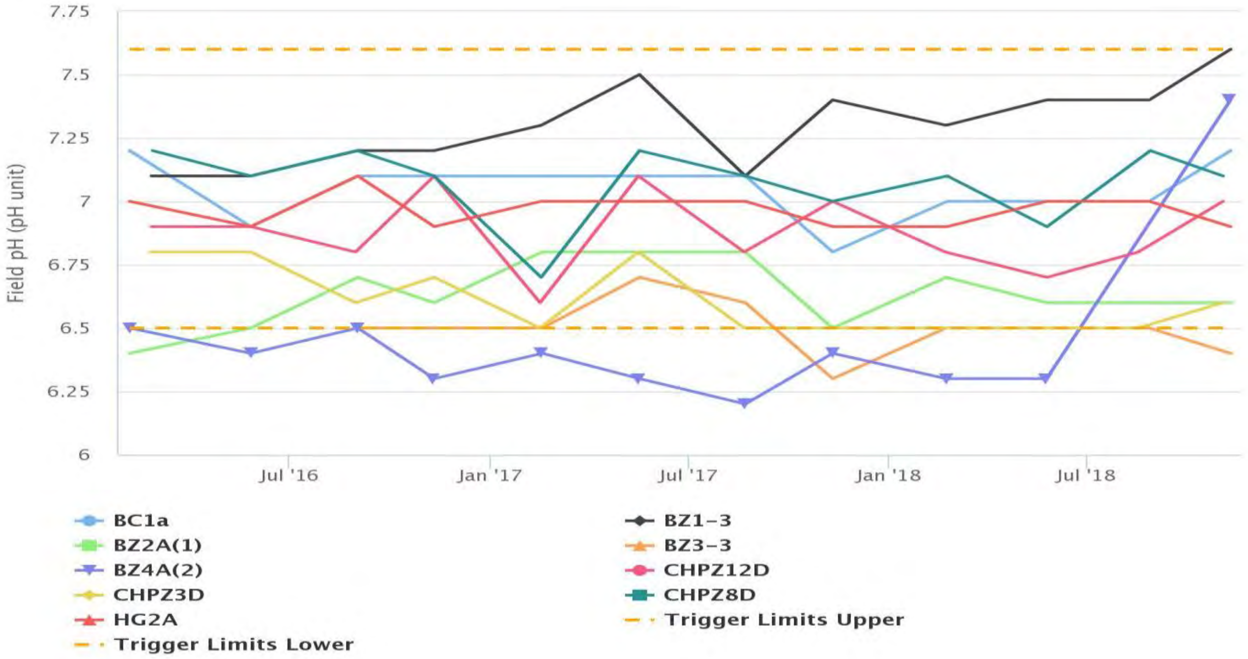


Figure 62: Cheshunt Mt Arthur Groundwater pH Trends 2015 – 2018

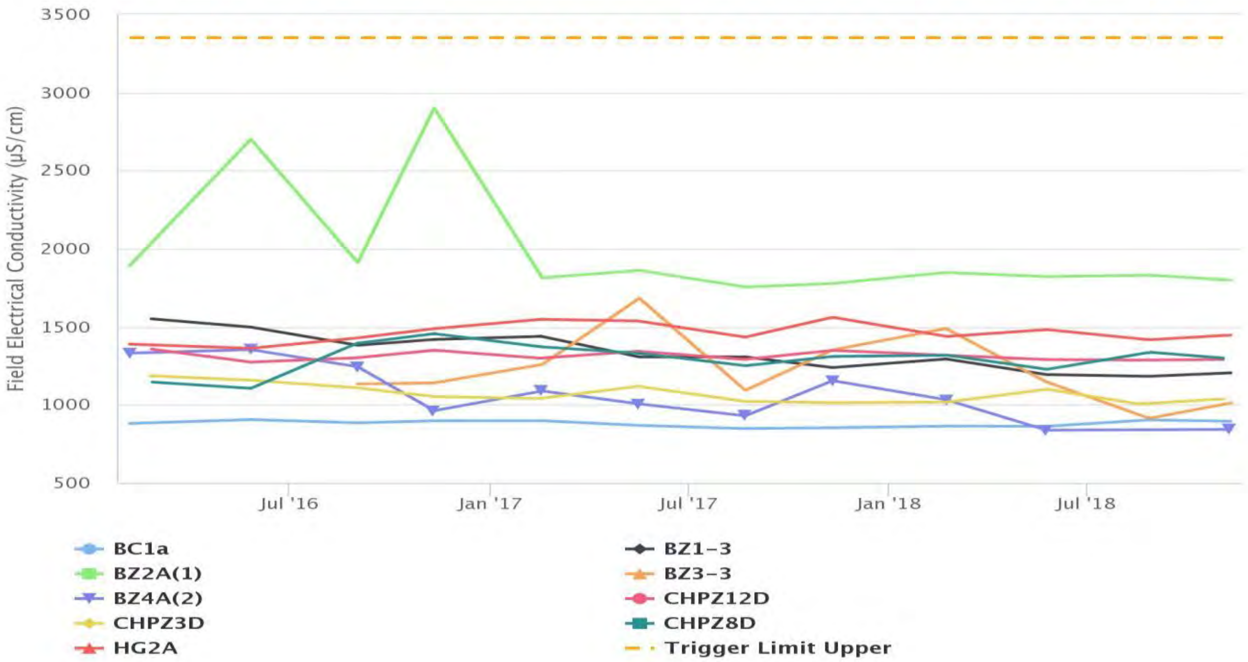


Figure 63: Cheshunt Mt Arthur Groundwater EC Trends 2015 – 2018

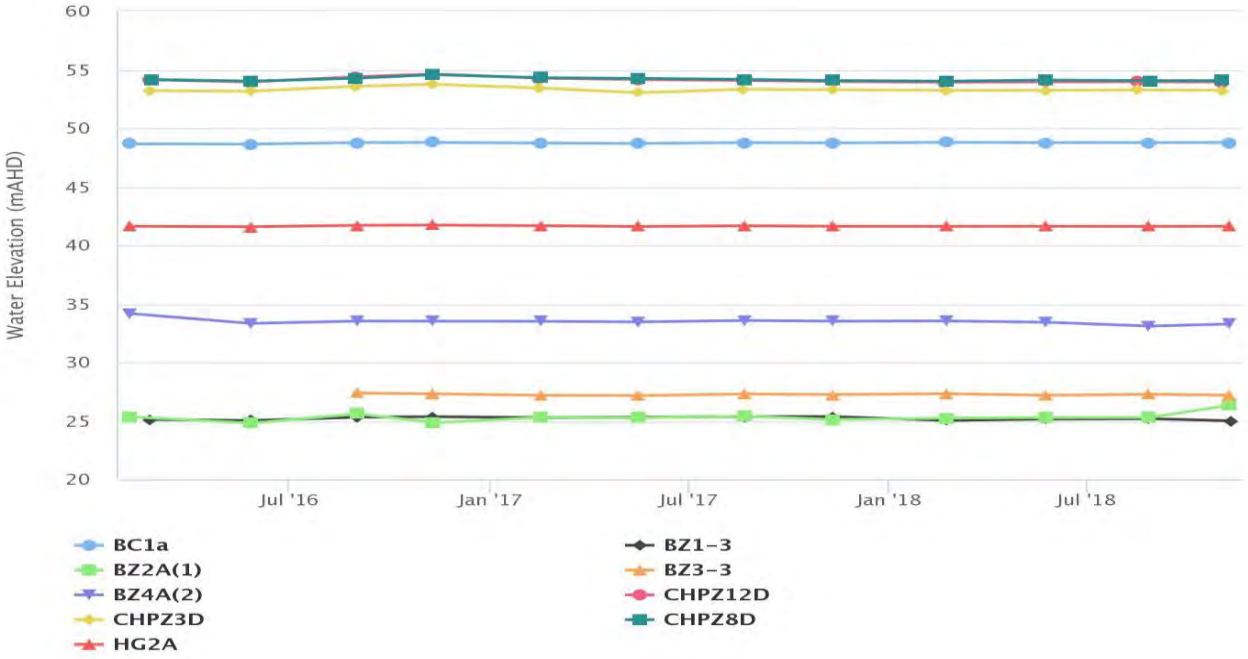


Figure 64: Cheshunt Mt Arthur Groundwater SWL Trends 2015 – 2018

7.5.3.9 Cheshunt Piercefield

Groundwater monitoring in the Cheshunt Piercefield area was undertaken from one site during 2018; a total of four samples were collected. The pH, EC and SWL trends for 2015 to 2018 are shown in Figure 65 to Figure 67.

Water quality results were generally consistent with historical trends;

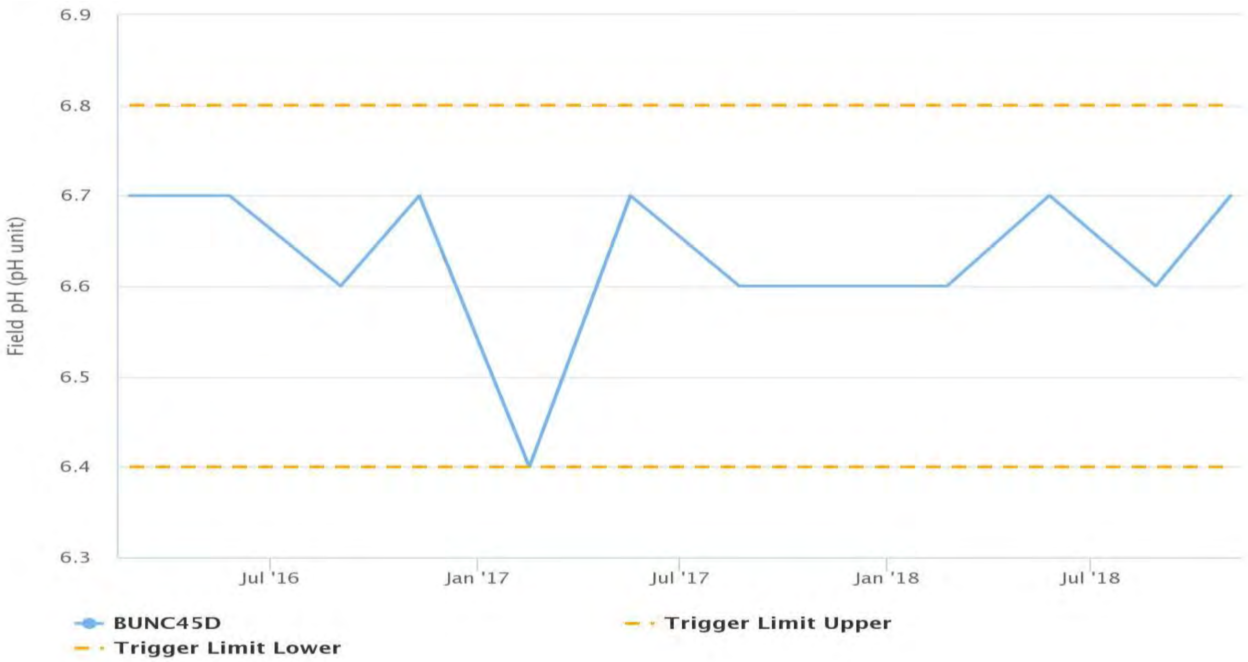


Figure 65: Cheshunt Piercefield Groundwater pH Trends 2015 - 2018

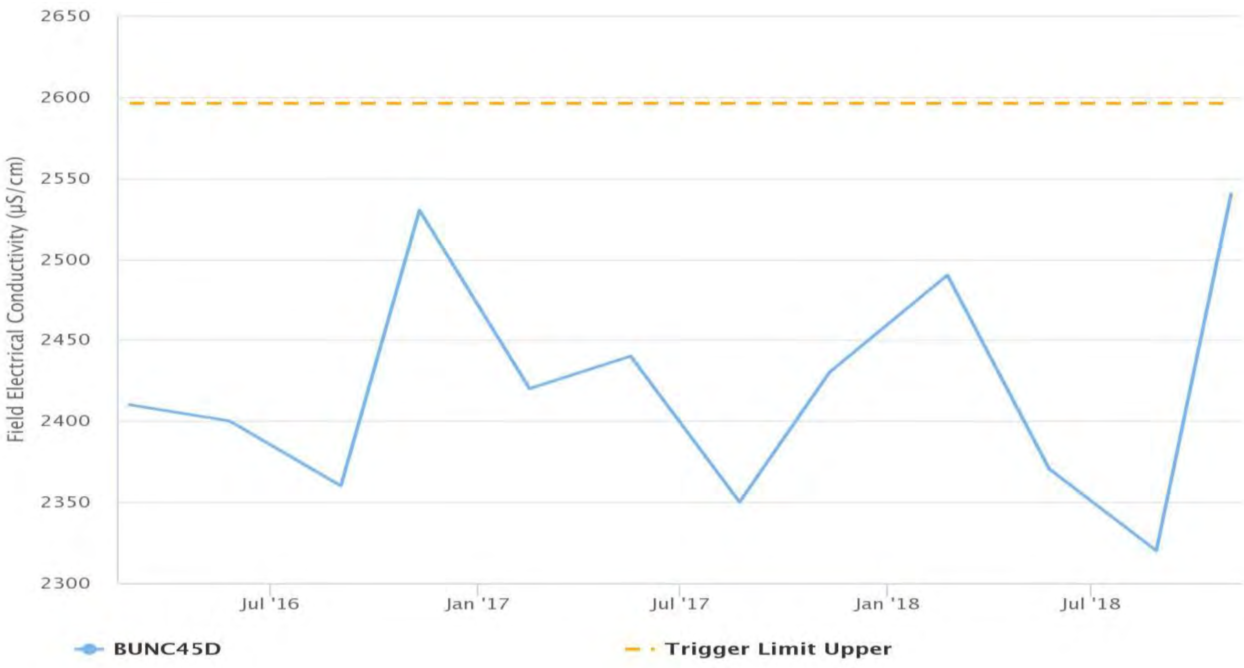


Figure 66: Cheshunt Piercefield Groundwater EC Trends 2015 – 2018

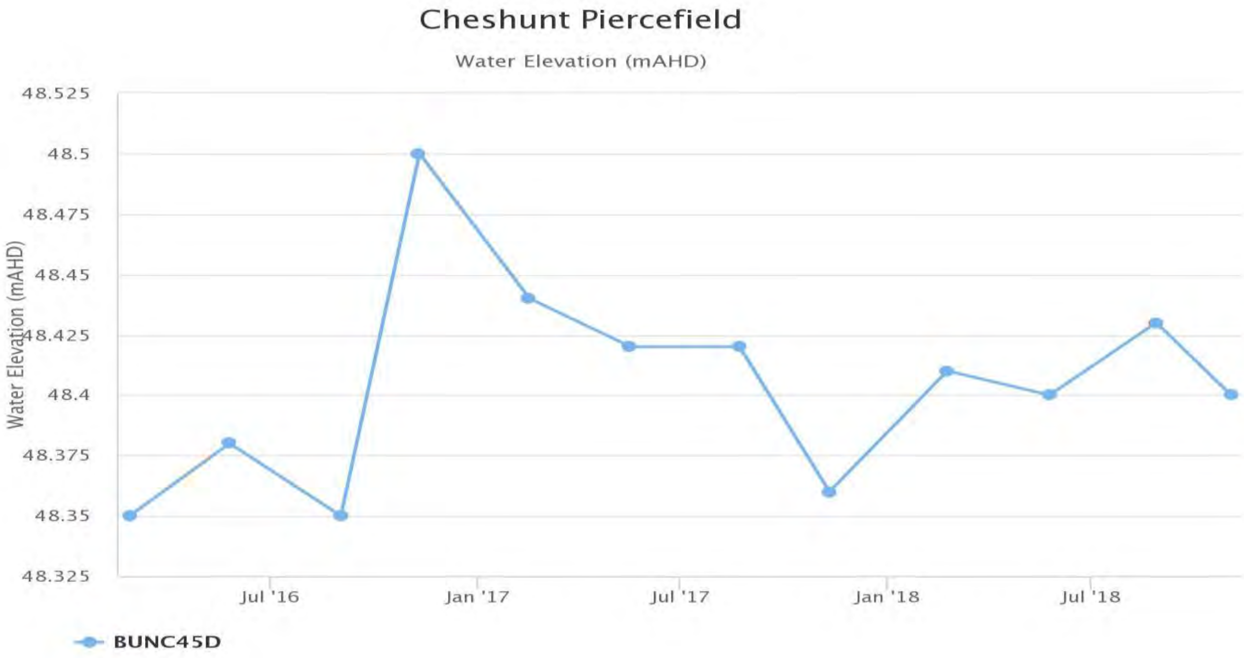


Figure 67: Cheshunt Piercefield Groundwater SWL Trends 2015 – 2018

7.5.3.10 Lemington South Alluvium

Groundwater monitoring in the Lemington South Alluvium area was undertaken at three sites during 2018. A total of eight samples were collected during the reporting period with water level measured on a monthly basis. The pH, EC and SWL trends for 2015 to 2018 are shown in Figure 68 to Figure 70. Trigger limits as listed in Table 49.

Table 49: Lemington South Alluvium Groundwater 2018 Monitoring Internal Trigger Tracking

Location	Sample Date	Trigger limit	Action taken in response
PB01(ALL)	16/02/2018	EC -95th Percentile	Watching Brief*
PB01(ALL)	24/05/2018	EC -95th Percentile	3rd consecutive exceedance
PB01(ALL)	30/11/2018	EC – 95th Percentile	Investigatied. PB01(ALL) records large fluctuations in EC, however there appears to be a slight trend of rising EC over time up to 4,830 µS/cm in 2018. This coincides with a slight decline in groundwater levels. Groundwater trends for PB01(ALL) generally correlate to streamflow within Wollombi Brook which has been declining. Bore PB01(ALL) is located on the northern banks of the Wollombi Brook, in an area with no active mining or land clearance. The results indicate the spikes in EC may relate to natural fluctuations and adverse impacts due to mining have been identified

* = 1st/2nd trigger. Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

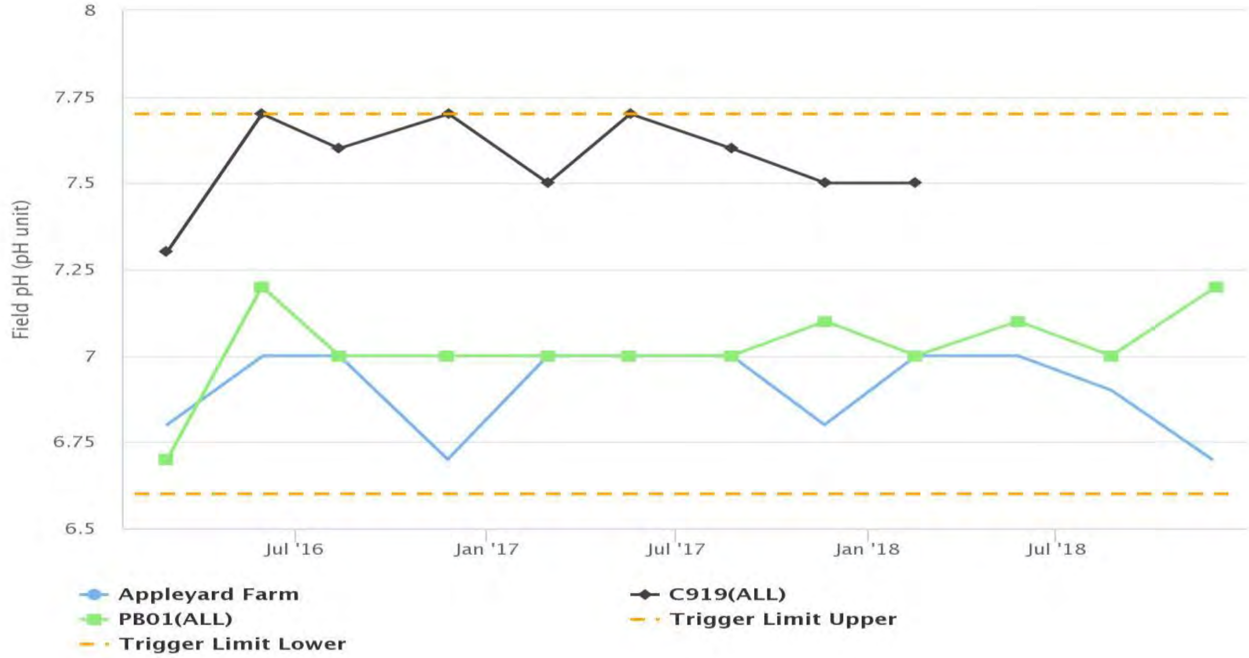


Figure 68: Lemington South Alluvium Groundwater pH Trends 2015 – 2018

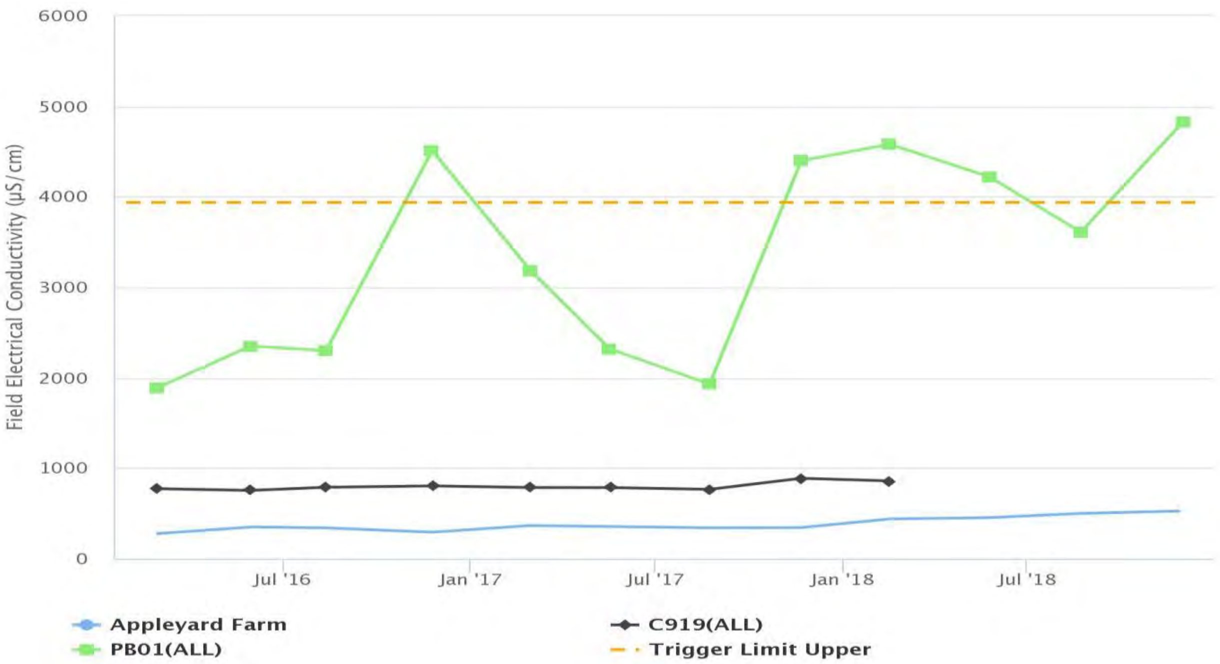


Figure 69: Lemington South Alluvium Groundwater EC Trends 2015 – 2018

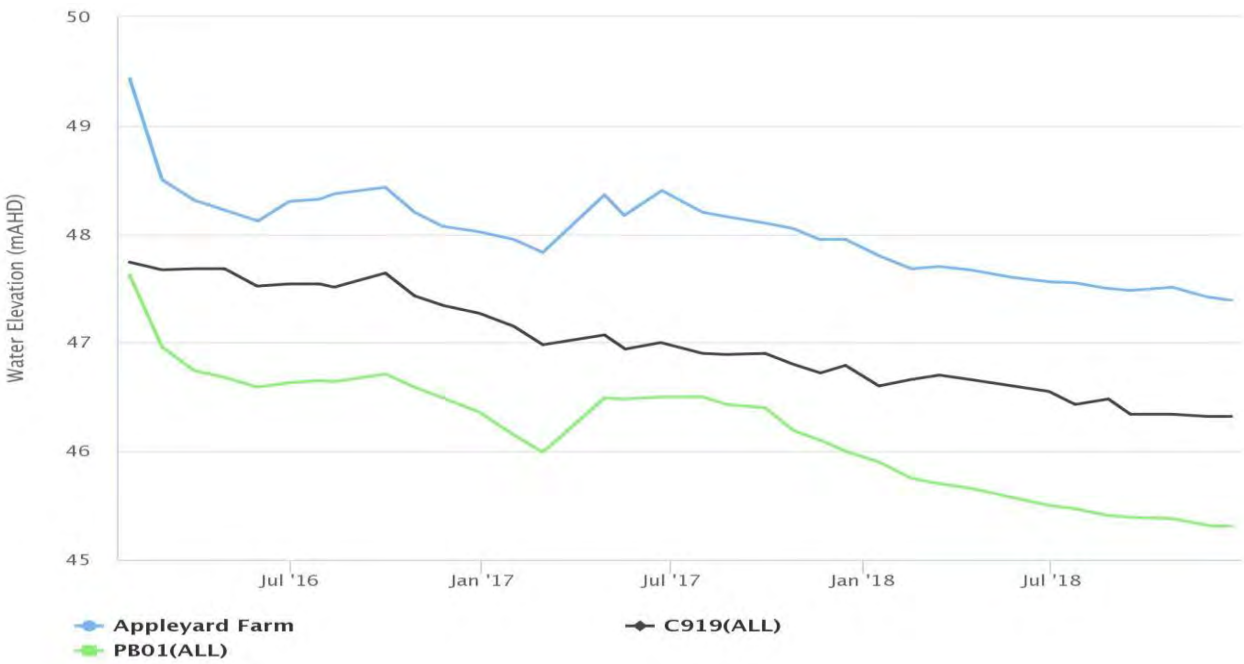


Figure 70: Lemington South Alluvium Groundwater SWL Trends 2015 - 2018

7.5.3.11 Lemington South Arrowfield

Groundwater monitoring in the Lemington South Arrowfield area was undertaken at four sites during 2018. A total of 4 samples were collected during the reporting period. The pH, EC and SWL trends for 2015 to 2018 are shown in Figure 71 to Figure 73. Results were generally consistent with historical trends with the exception of an exceedance of internal EC trigger for D612(AFS) as listed in Table 50.

Table 50: HVO Lemington South Arrowfield Seam Groundwater 2018 Monitoring Internal Trigger Tracking

Location	Date	Trigger limit	Action taken in response
D612(AFS)	24/05/2018	EC -95th Percentile	Investigated. Bore D612(AFS) is located between Lemington South Pit and LUG Bore and intersects the Arrowfield Seam (AFS). Historical readings since 2008 show regular fluctuations of between 11,000 µS/cm and 15,890 µS/cm The 2018 readings are therefore considered consistent with historical concentrations.
D612(AFS)	30/11/2018	EC -95th Percentile	Investigated

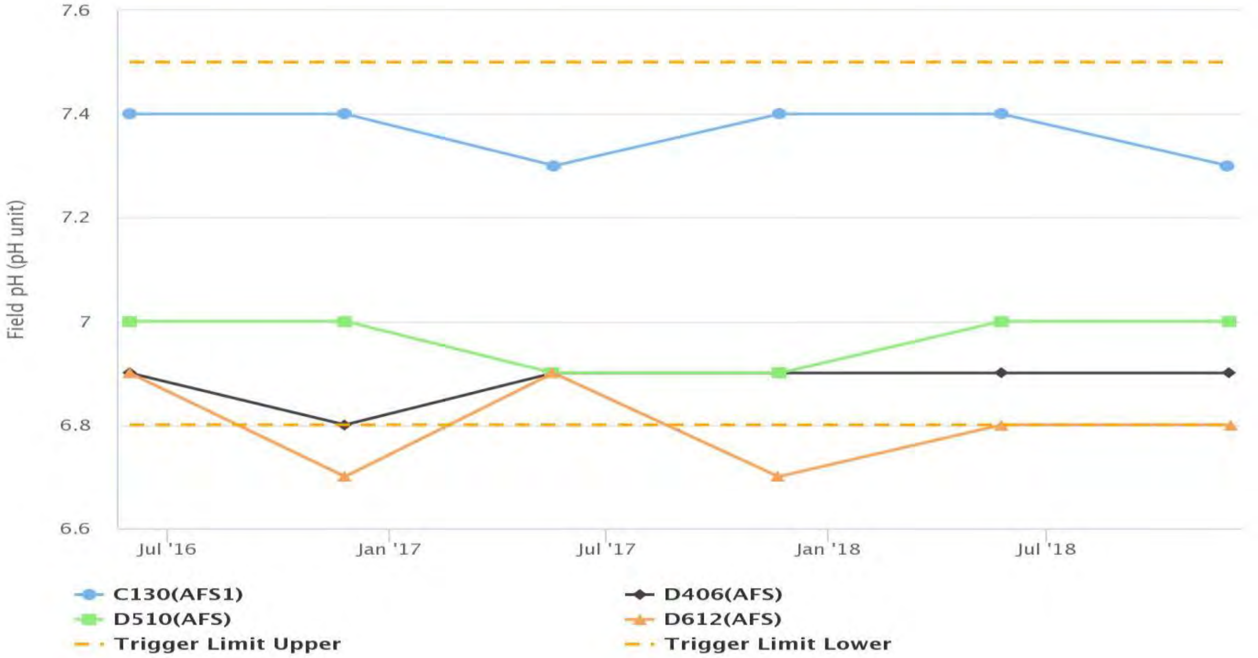


Figure 71: Lemington South Arrowfield Groundwater pH Trends 2015 - 2018

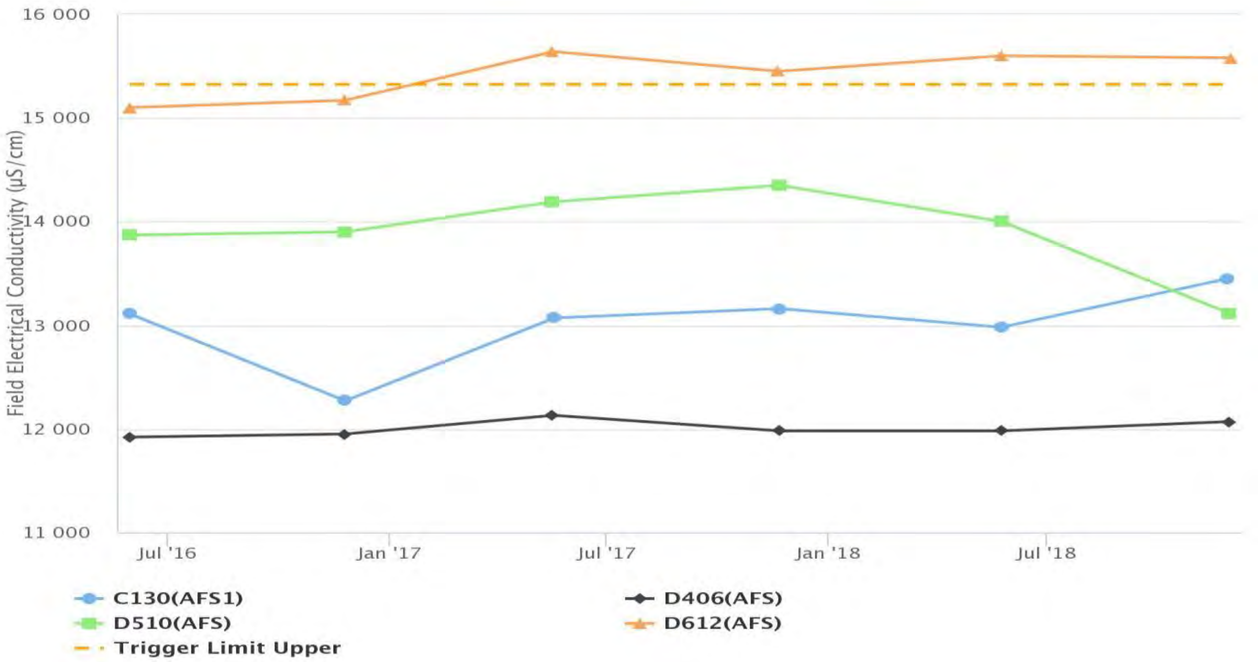


Figure 72: Lemington South Arrowfield Groundwater EC Trends 2015 -2018

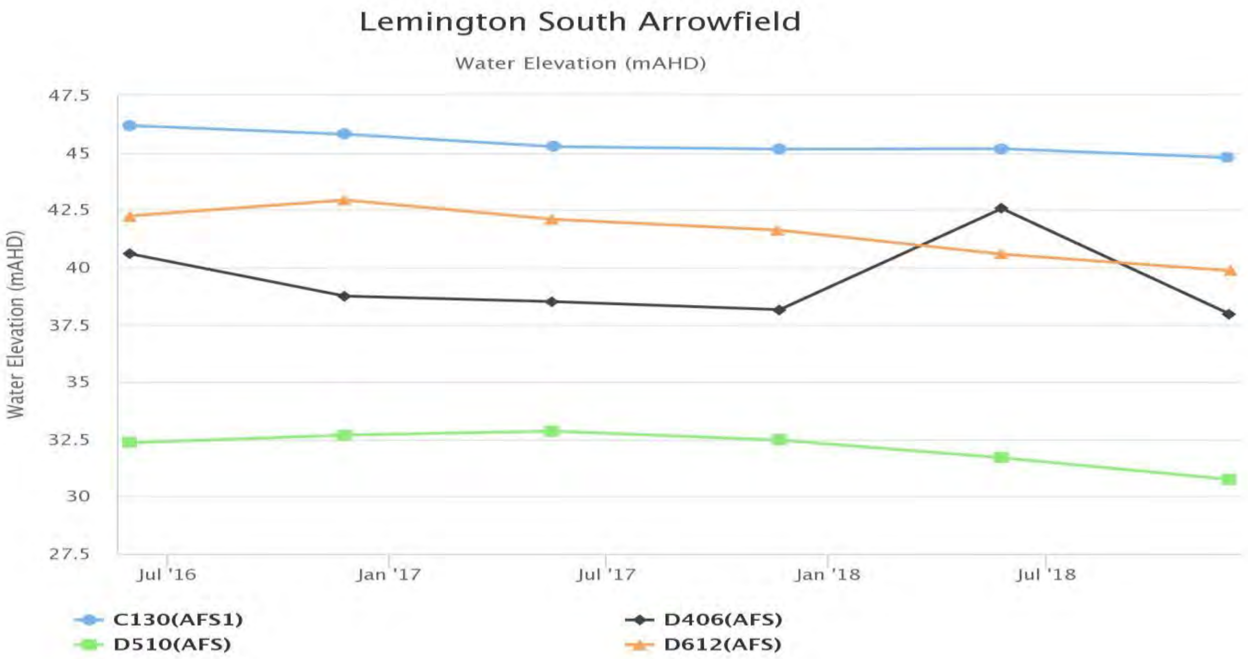


Figure 73: Lemington South Arrowfield Groundwater SWL Trends 2015 – 2018

7.5.3.12 Lemington South Bowfield

Groundwater monitoring in the Lemington South Bowfield area was undertaken at 16 sites during 2018. A total of 24 samples were collected during the reporting period. The pH, EC and SWL trends for 2015 to 2018 are shown in Figure 74 to Figure 76. Results were generally considered to be consistent with historical trends with the exception of B631(BFS) which exceeded internal triggers as listed in Table 51.

Table 51: HVO Lemington South Bowfield Seam Groundwater 2018 Monitoring Internal Trigger Tracking

Location	Sample Date	Trigger limit	Action taken in response
B631 (BFS)	28/11/2018	EC - 95th percentile	1st exceedance. Watching Brief*

* = 1st/2nd trigger. Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

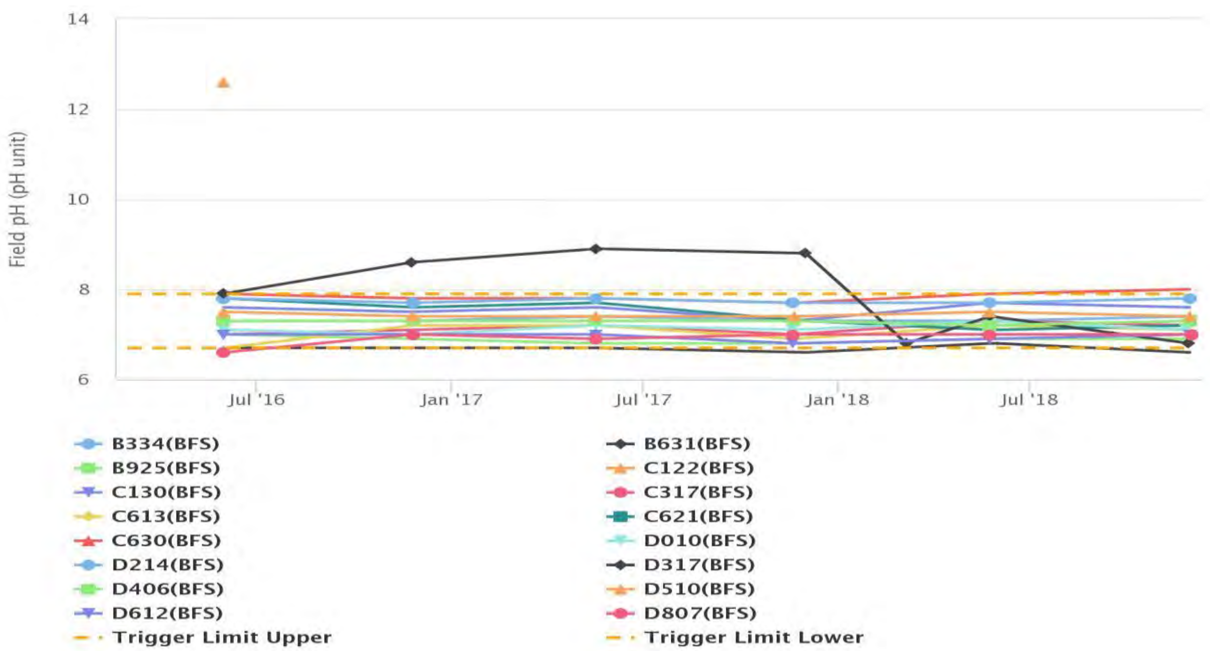


Figure 74: Lemington South Bowfield Groundwater pH Trends 2015 – 2018

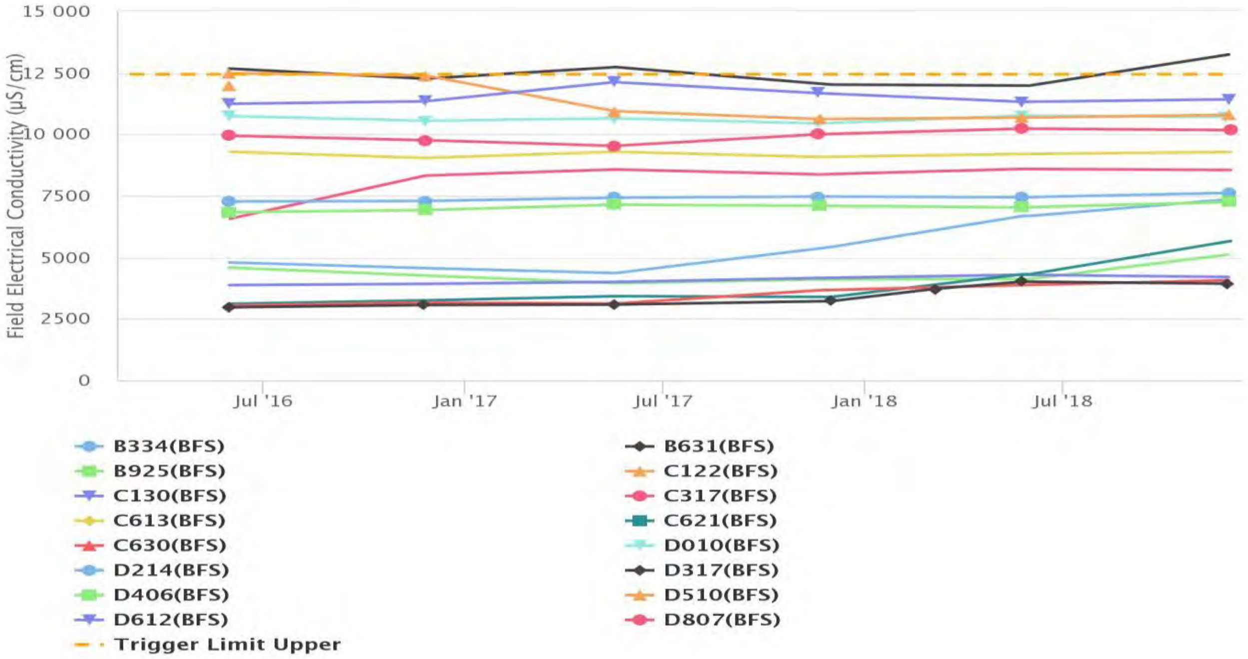


Figure 75: Lemington South Bowfield Groundwater EC Trends 2015 – 2018

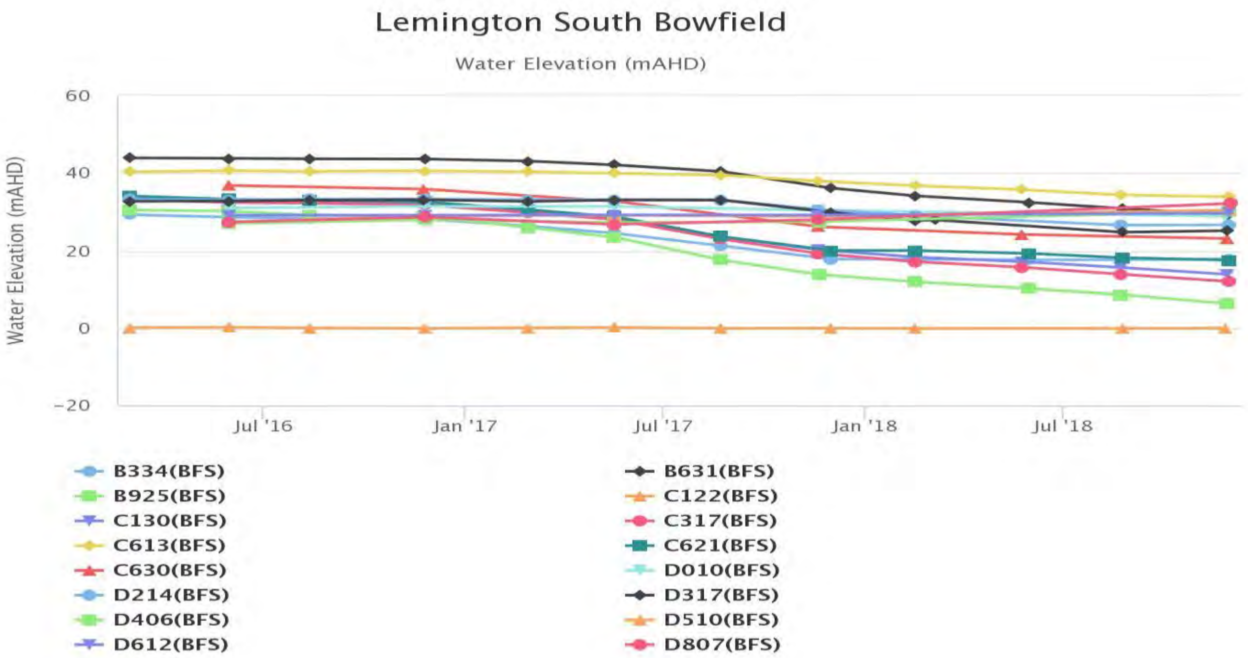


Figure 76: Lemington South Bowfield Groundwater SWL Trends 2015 – 2018

7.5.3.13 Lemington South Interburden

Groundwater monitoring in the Lemington South Interburden area was undertaken at one site during 2018; a total of four samples were collected. The pH, EC and SWL trends for 2015 to 2018 are shown in Figure 77 to Figure 79. Internal triggers as listed in Table 52.

Table 52: HVO Lemington South Interburden Seam Groundwater 2018 Monitoring Internal Trigger Tracking

Location	Sample Date	Trigger limit	Action taken in response
C130(ALL)	16/02/2018	EC -95th Percentile	Watching Brief
C130(ALL)	24/05/2018	EC -95th Percentile	2nd consecutive exceedance
C130(ALL)	28/11/2018	EC – 95th Percentile	1st exceedance. Watching Brief*

* = 1st/2nd trigger. Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

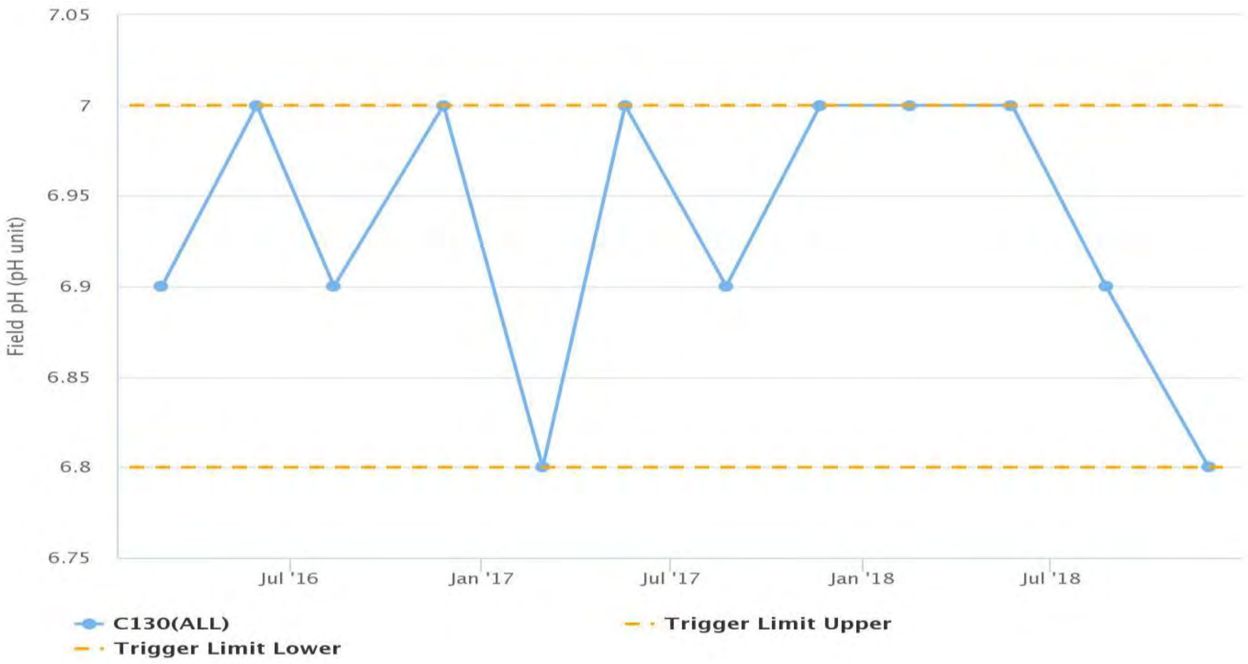


Figure 77: Lemington South Interburden pH Trends 2015 – 2018

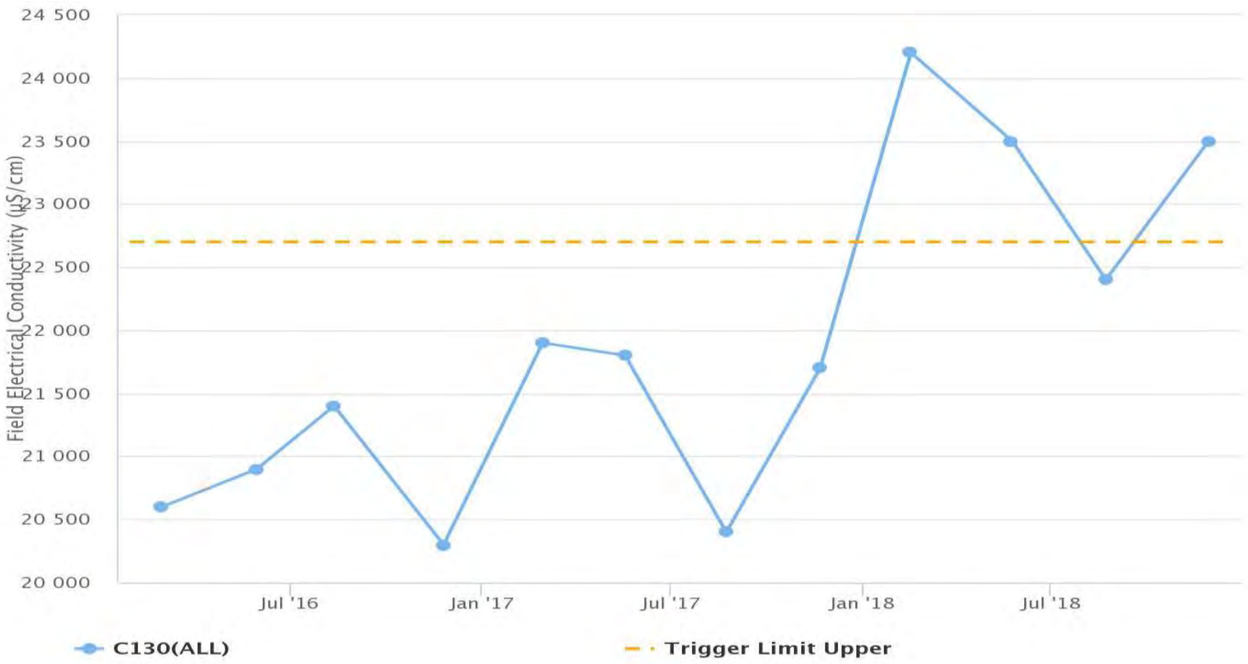


Figure 78: Lemington South Interburden EC Trends 2015 – 2018

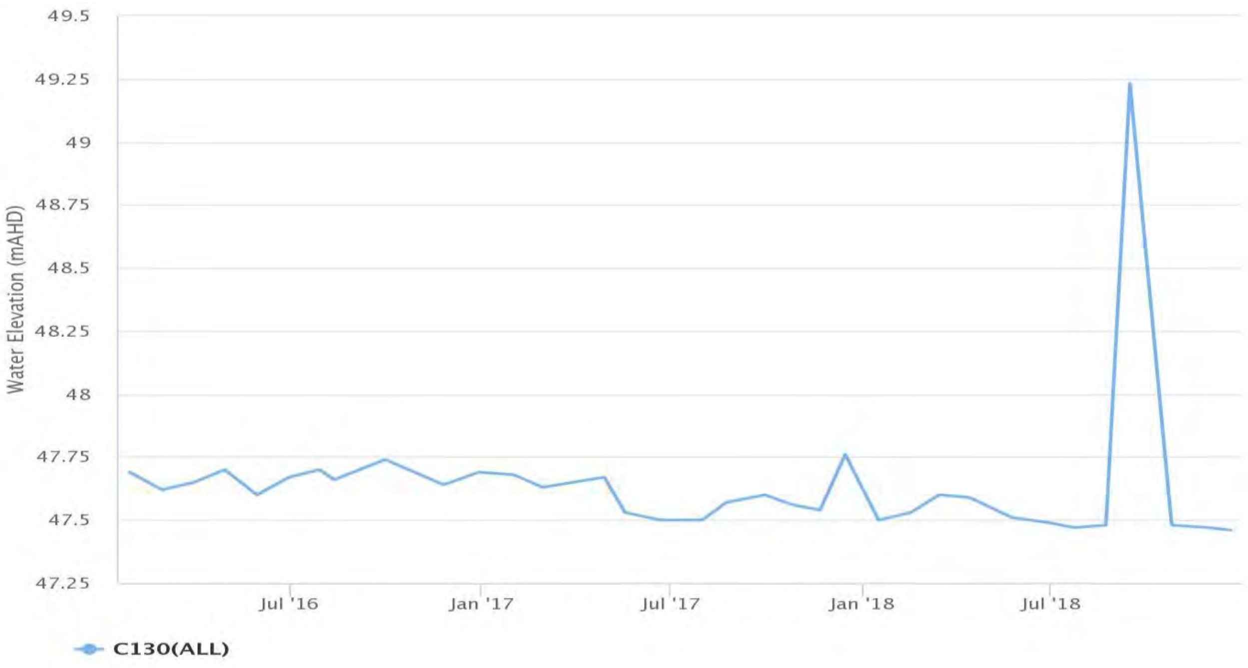


Figure 79: Lemington South Interburden SWL Trend 2015 – 2018

7.5.3.14 Lemington South Woodlands Hill

Groundwater monitoring in the Lemington South Woodlands Hill seam was undertaken at seven sites during 2018. A total of 10 samples were collected during the reporting period. The pH, EC and SWL trends for 2015 to 2018 are shown in Figure 80 to Figure 82. Results were stable and consistent with historical trends with the exception of exceedances of internal trigger limits as listed in Table 53.

Table 53: HVO Lemington South Woodlands Hill Seam Groundwater 2018 Monitoring Internal Trigger Tracking

Location	Sample Date	Trigger limit	Action taken in response
C130(WDH)	24/05/2018	EC -95th Percentile	3rd consecutive exceedance
C130(WDH)	28/11/2018	EC – 95th Percentile	Investigated. Bore C130(WDH) is located between Lemington South Pit and LUG Bore and intersects the Woodlands Hill Seam (WDH). Historical readings since 2000 show regular fluctuations of EC between 18,210 µS/cm and 21,000 µS/cm. The 2018 readings for pH are therefore considered consistent with historical concentrations.

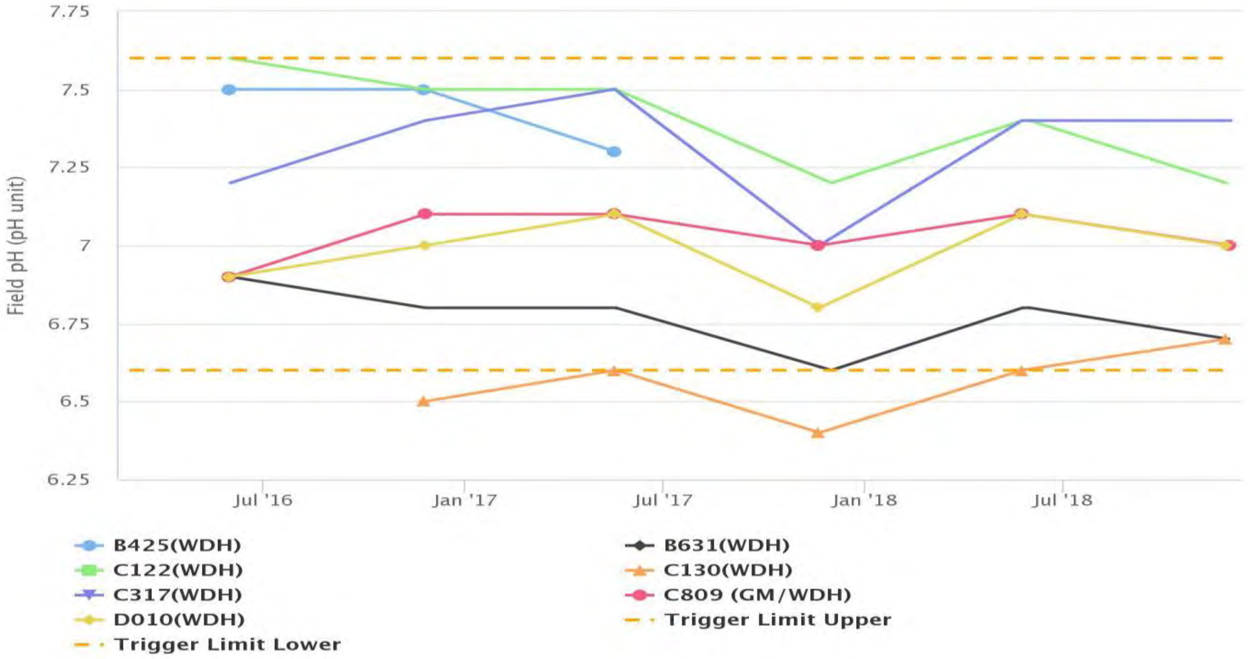


Figure 80: Lemington South Woodlands Hill Groundwater pH Trends 2015 – 2018

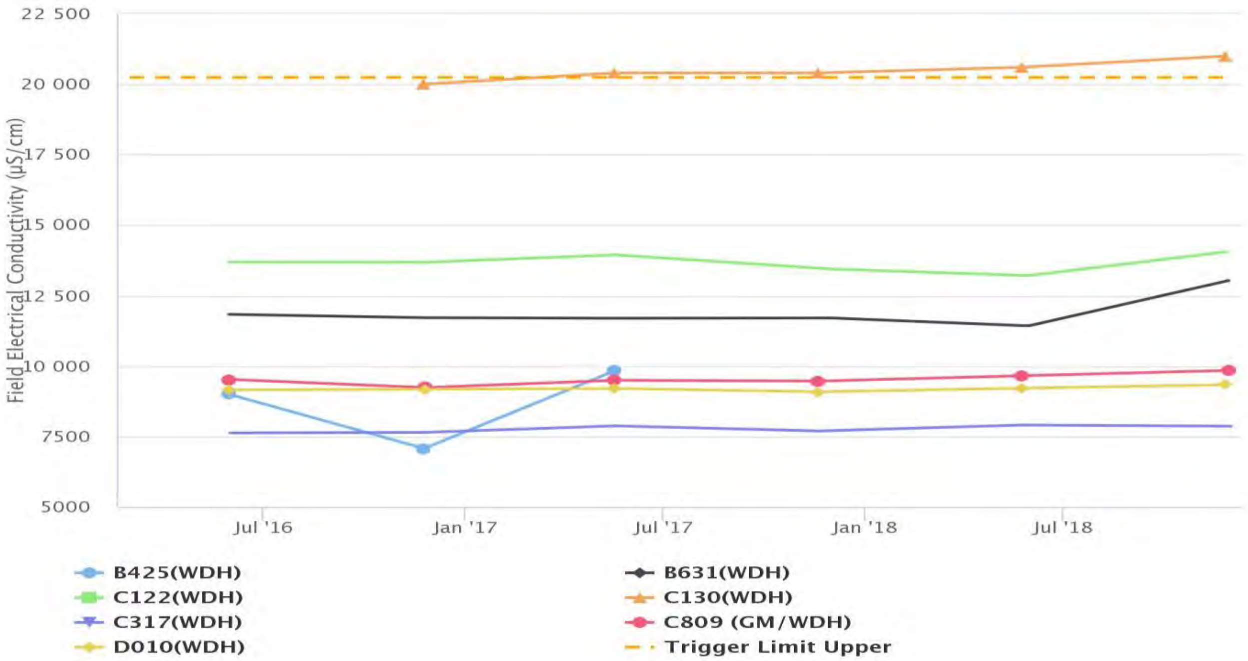


Figure 81: Lemington South Woodlands Hill Groundwater EC Trends 2015 – 2018

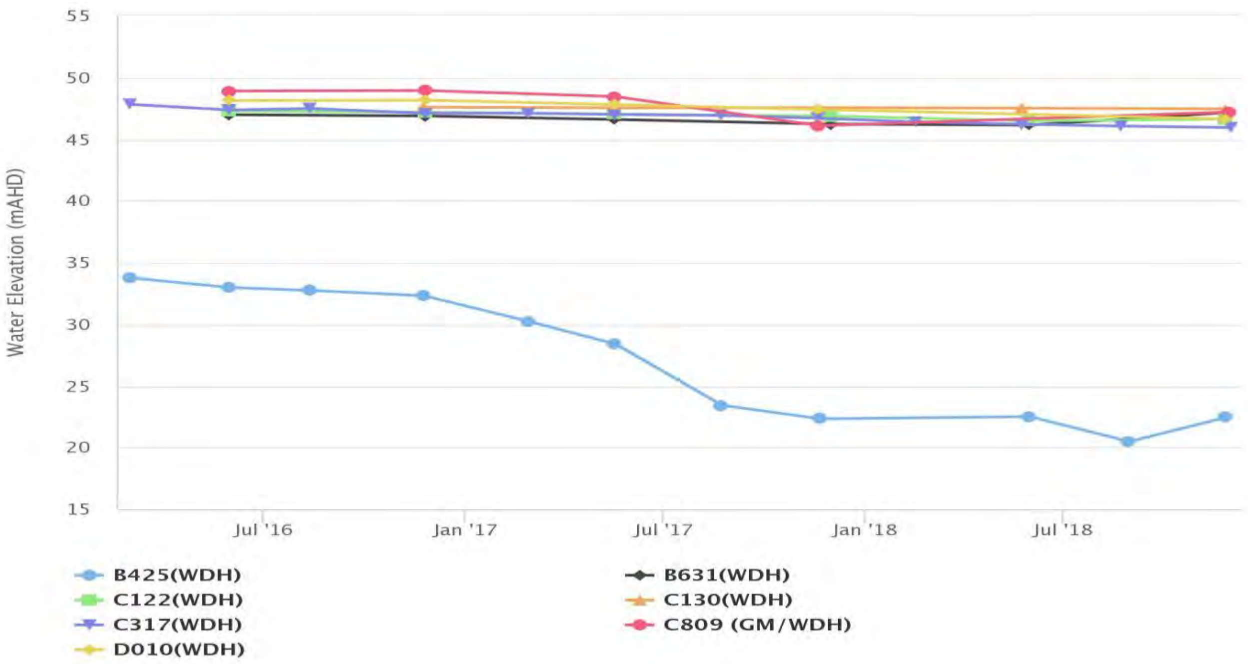


Figure 82: Lemington South Woodlands Hill Groundwater SWL Trends 2015 - 2018

7.5.3.15 North Pit Spoil

Groundwater monitoring in the North Pit Spoil area was undertaken at 13 sites during 2018. A total of 48 samples were collected during the reporting period. The pH, EC and SWL trends for 2015 to 2018 are shown in Figure 83 to Figure 85. Water quality and levels were generally stable and consistent with historical trends with the exception of exceedances of internal triggers as listed in Table 54.

Table 54: North Pit Spoil Groundwater 2018 Monitoring Internal Trigger Tracking

Location	Sample Date	Trigger limit	Action taken in response
4116P	6/04/2018	EC -95th Percentile	External Investigation in progress
MB14HVO05	6/04/2018	pH - 5th Percentile	1st exceedance
4116P	27/06/2018	EC -95th Percentile	External Investigation in progress
4116P	21/09/2018	EC -95th Percentile	5th Consecutive exceedance. Investigation in progress
MB14HVO05	21/09/2018	pH - 5th Percentile	2nd consecutive exceedance
4116P	17/12/2018	EC – 95th Percentile	Investigated. The bore is currently dry and there is potential that historical readings may not have been based on representative groundwater samples. The condition of bore 4116P will be reviewed, including a check of the total depth and potential presence of sediments within the base of the bore.

* = 1st/2nd trigger. Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

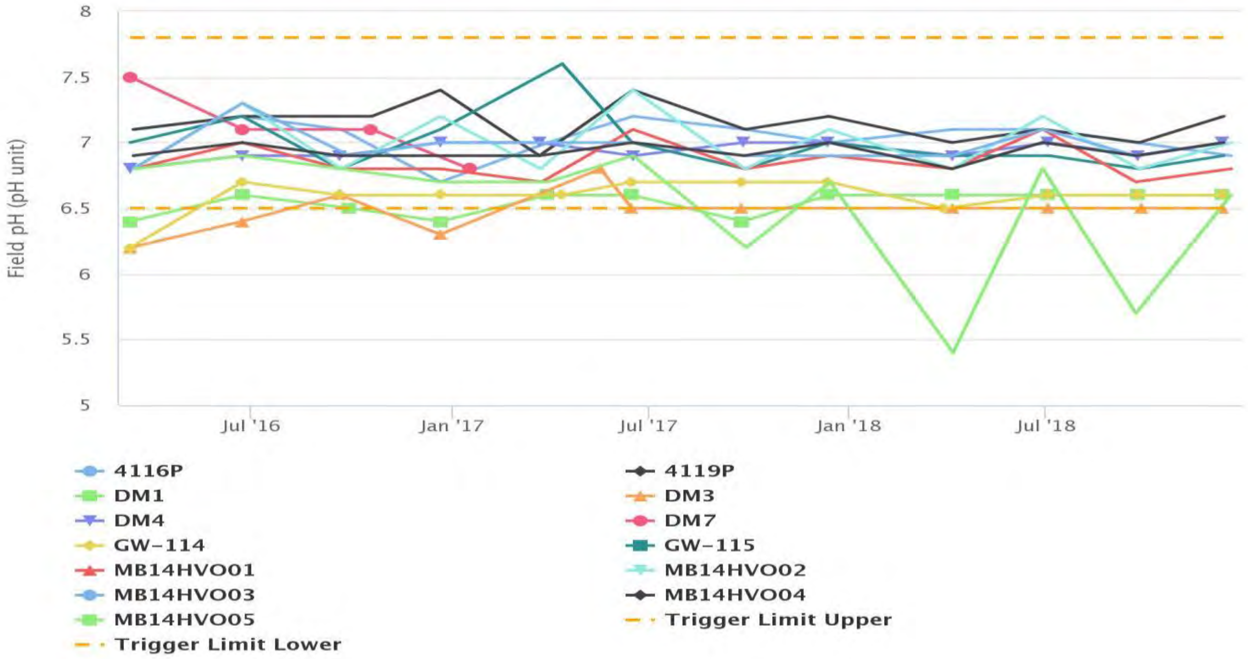


Figure 83: North Pit Spoil Groundwater pH Trends 2015 – 2018

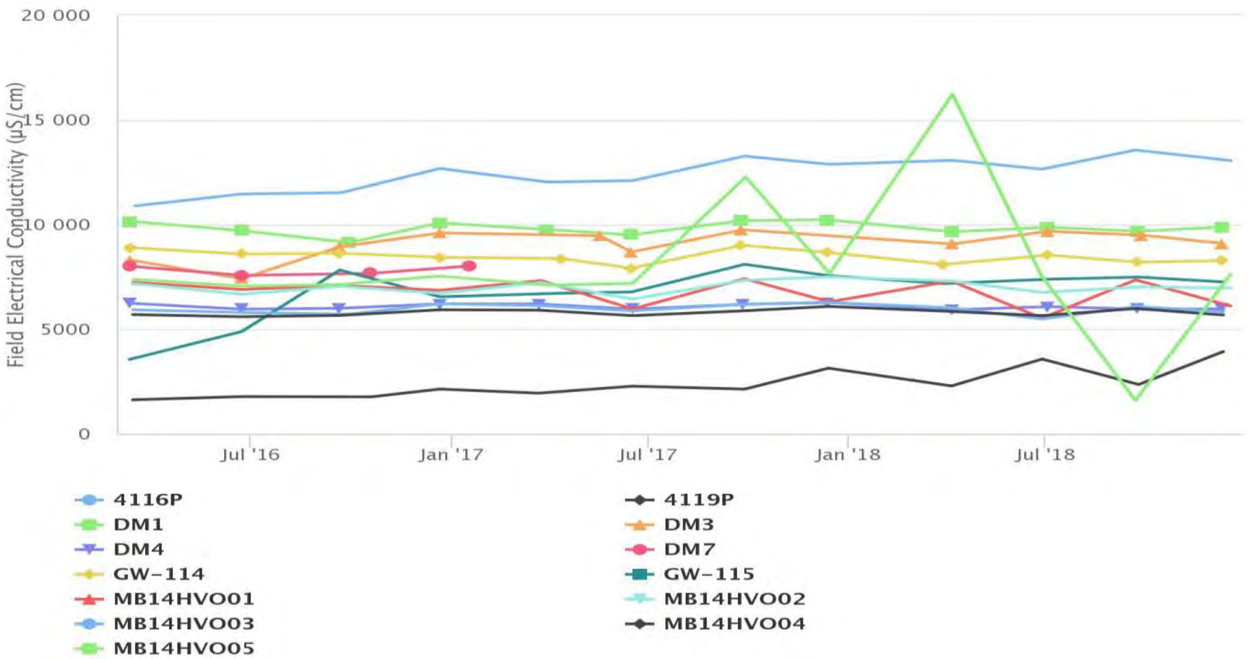


Figure 84: North Pit Spoil Groundwater EC Trends 2015 – 2018

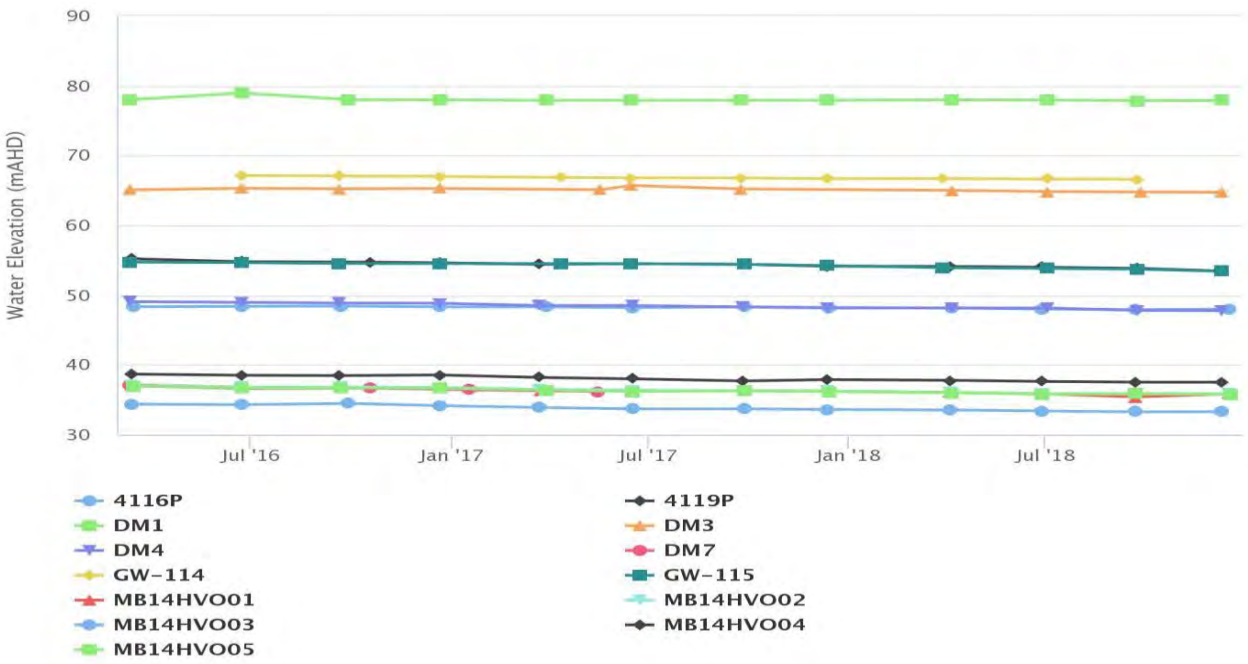


Figure 85: North Pit Spoil Groundwater SWL Trends 2015 – 2018

7.5.3.16 West Pit Alluvium

Groundwater monitoring in the West Pit Alluvium area was undertaken at three sites during 2018. A total of 30 samples were collected during the reporting period. The pH, EC and SWL trends for 2015 to 2018 are shown in Figure 86 to Figure 88. Results were consistent with historical trends with the exception of exceedances of internal triggers as listed in Table 55.

Table 55: West Pit Alluvium Groundwater 2018 Monitoring Internal Trigger Tracking

Location	Date	Trigger limit	Action taken in response
G2	13/03/2018	pH - 95th percentile	Watching Brief*

* = 1st/2nd trigger. Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

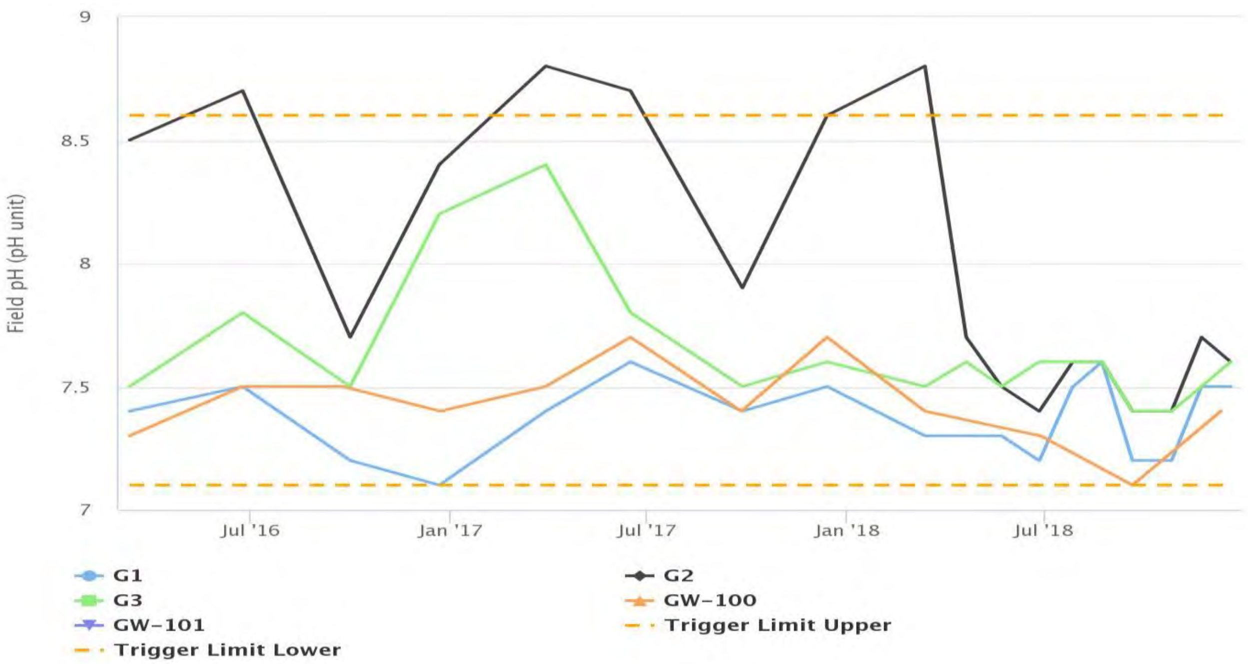


Figure 86: West Pit Alluvium Groundwater pH Trends 2015 – 2018

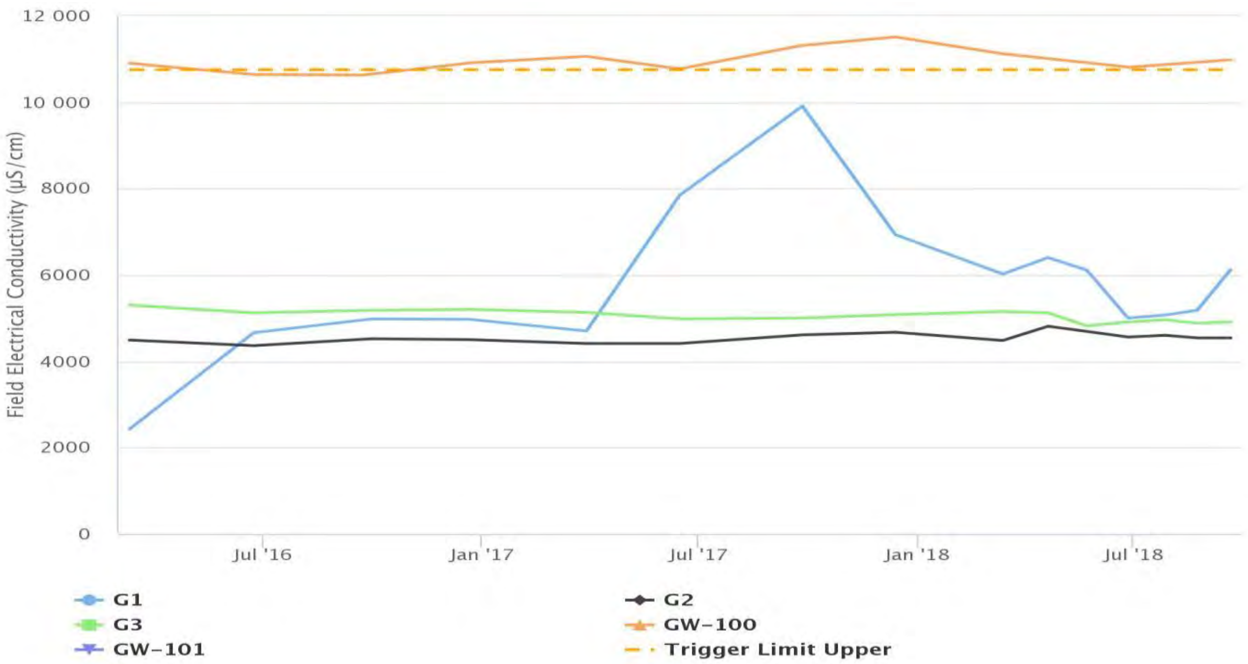


Figure 87: West Pit Alluvium Groundwater EC Trends 2015 – 2018

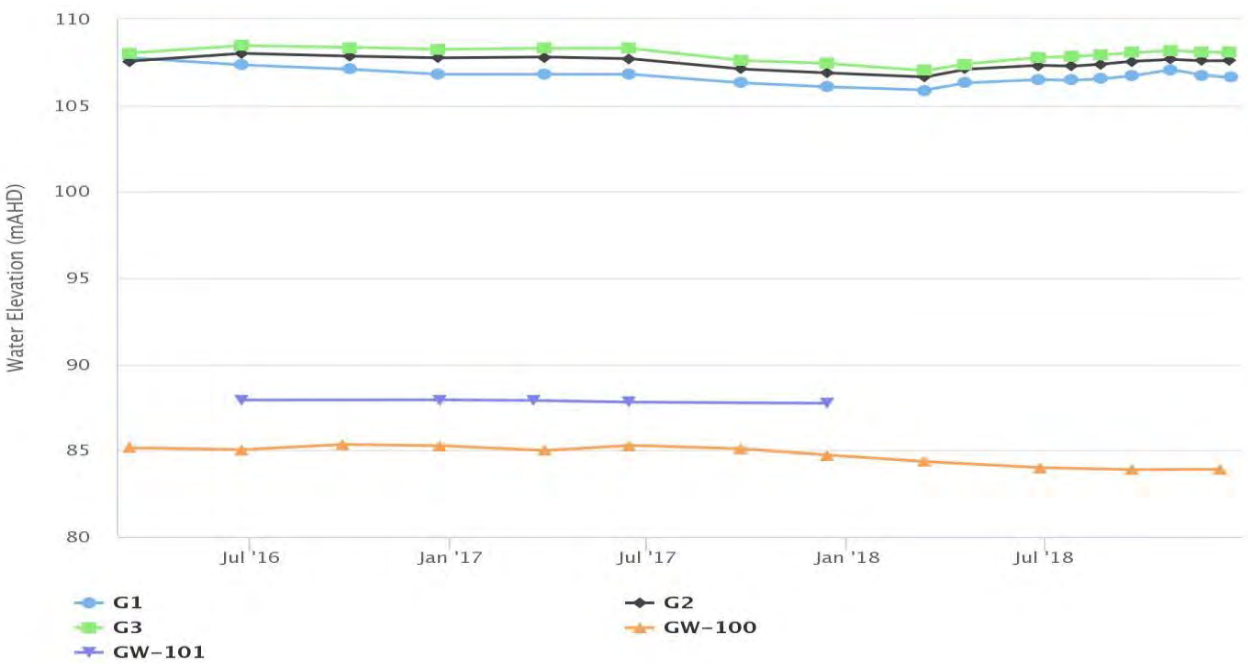


Figure 88: West Pit Alluvium Groundwater SWL Trends 2015 – 2018

7.5.3.17 West Pit Sandstone/ Siltstone

Groundwater monitoring in the West Pit Sandstone/ Siltstone area was undertaken at three sites during 2018. A total of 12 samples were collected during the reporting period. The pH, EC and SWL trends for 2015 to 2018 are shown in Figure 89 to Figure 91. Results were generally consistent with historical trends with the exception of internal trigger exceedances listed in Table 56.

Table 56: West Pit Sandstone/Siltstone Groundwater 2018 Monitoring Internal Trigger Tracking

Location	Date	Trigger limit	Action taken in response
NPZ2	13/03/2018	EC -95th Percentile	3rd consecutive exceedance
NPZ3	13/03/2018	pH - 95th Percentile	Watching Brief
NPZ2	24/09/2018	EC -95th Percentile	Investigated. Historical EC readings for NPz2 since 2008 show regular fluctuations of between 12,590 µS/cm and 19,400 µS/cm at the site. The 2018 readings of 12,900 µS/cm and 14,800 µS/cm are therefore considered consistent with historical concentrations. Based on available information, the cause for the changes in EC at NPz2 do not appear to correlate to mine activities conducted at West Pit.
NPZ3	24/09/2018	pH - 95th Percentile	1st exceedance
NPz5	18/12/2018	pH – 5th Percentile	1st exceedance. Watching Brief*

* = 1st/2nd trigger. Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

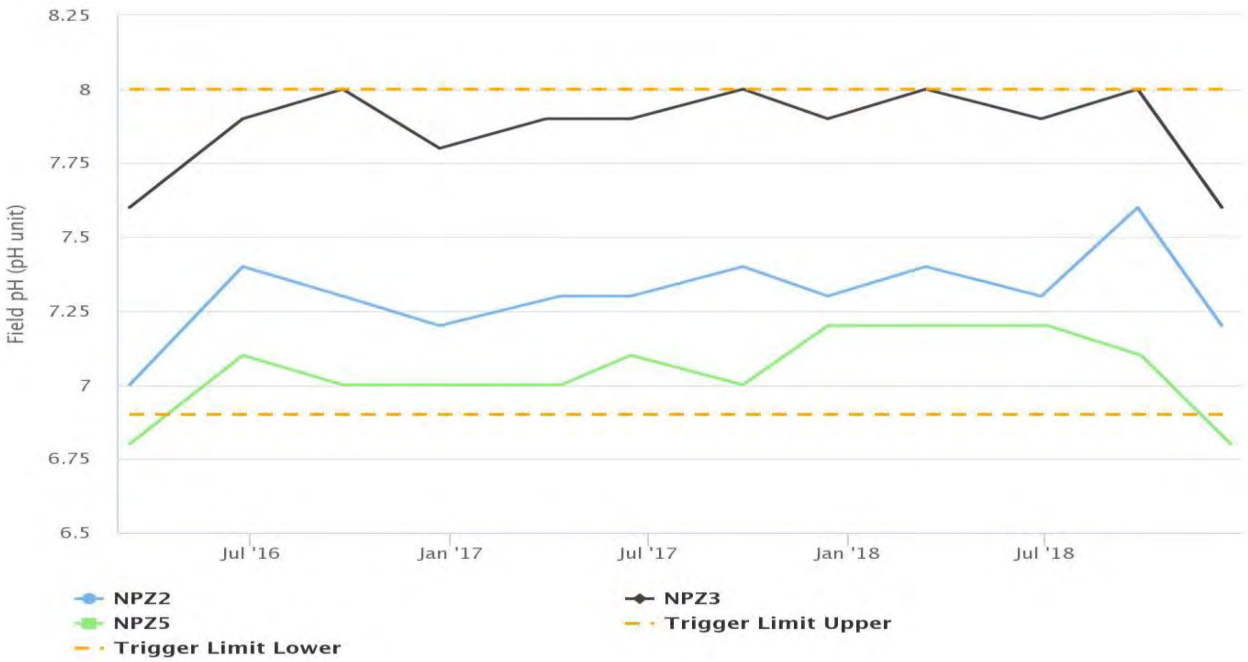


Figure 89: West Pit Sandstone/ Siltstone Groundwater pH Trends 2015 – 2018

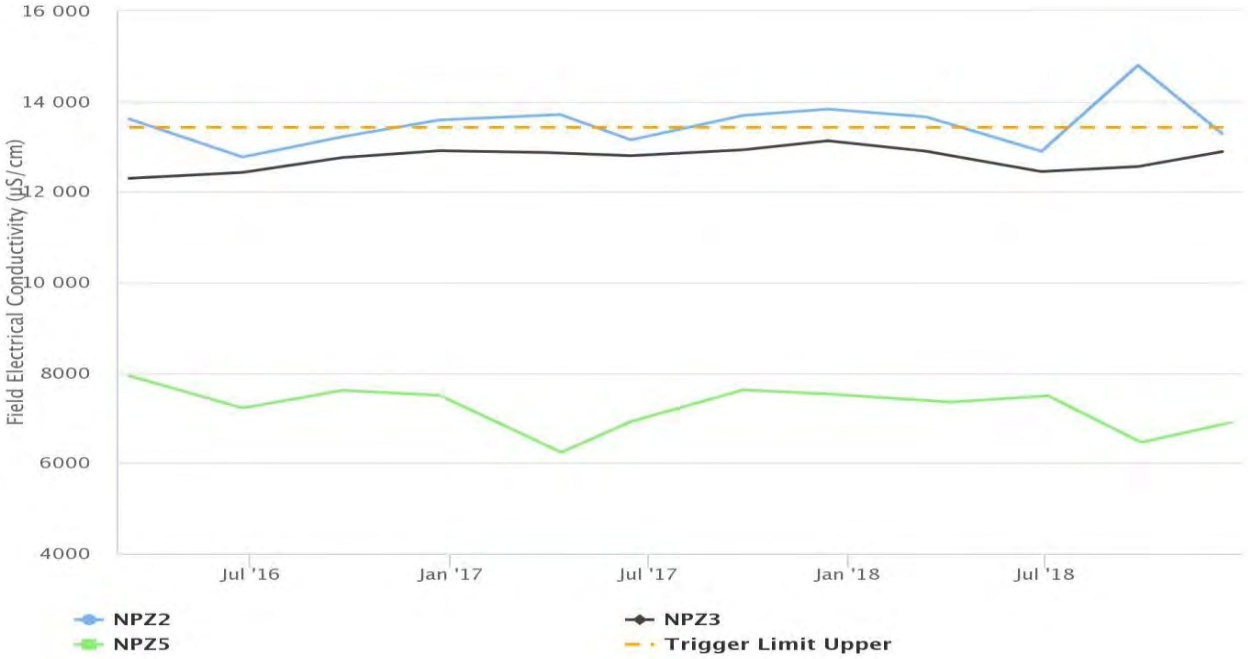


Figure 90: West Pit Sandstone/ Siltstone Groundwater EC Trends 2015 – 2018

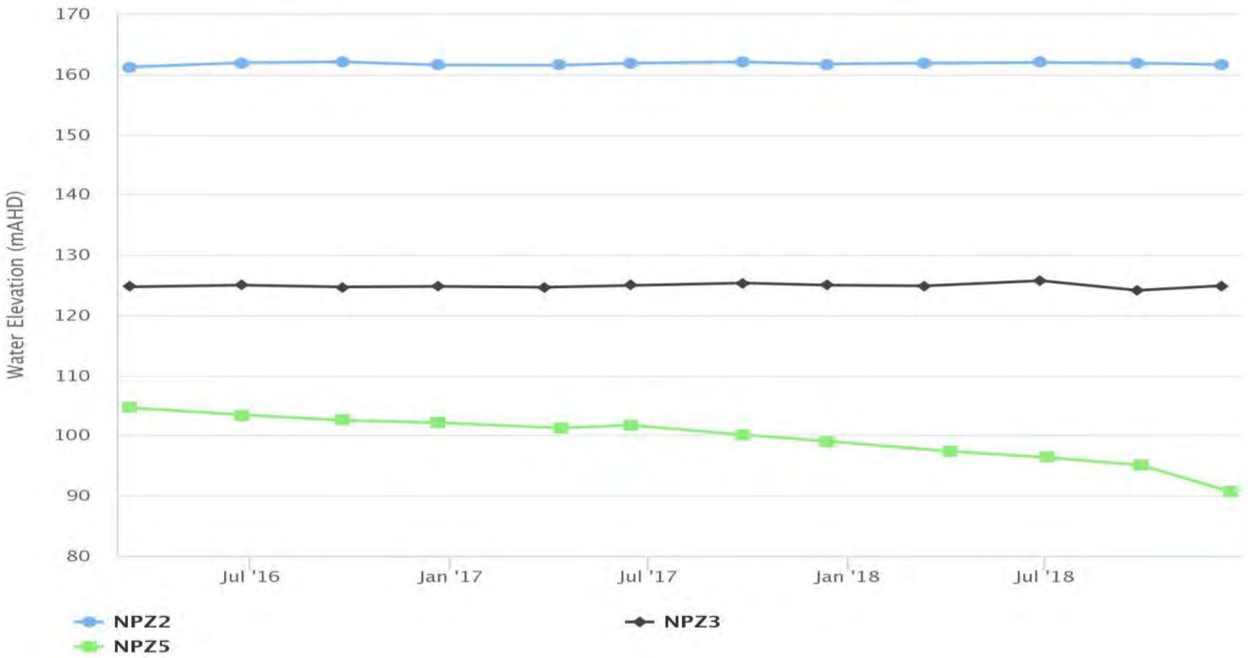


Figure 91: West Pit Sandstone/ Siltstone Groundwater SWL Trends 2015 – 2018

7.6 Compensatory Water Supply

During 2018 HVO did not provide compensatory water supply or alternate compensation in lieu of compensatory water supply under any new or existing agreements, and circumstances which may trigger a requirement to provide a compensatory water supply were not identified.

8 REHABILITATION AND LAND MANAGEMENT

8.1 Summary of Rehabilitation

Rehabilitation at HVO is undertaken in accordance with commitments made in the various Mining Operations Plans (MOPs) covering the site: Hunter Valley Operations North MOP (includes Newdell CHPP and Hunter Valley Load Point) and Hunter Valley Operations South MOP.

A summary of the key rehabilitation performance indicators is shown in Table 57.

Table 57: Key Rehabilitation Performance Indicators

Mine Area Type	Previous Reporting Period (Actual) Year 2018-1 (ha)	This Reporting Period (Actual) Year 2018 (ha)	Next Reporting Period (Forecast) Year 2018+1 (ha)
A. Total mine footprint[2]	6,443.4	6539.0	6588.4
B. Total Active Disturbance[3]	3,527.5	3599.2	3590.4
C. Land being prepared for rehabilitation[4]	39.6	212.3*	140.5
D. Land under active rehabilitation[5]	2,876.3	2727.5*	2857.5
E. Completed rehabilitation[6]	0	0	0

*Increase in land being prepared for rehabilitation is due to reclassification of areas previously reported as under active rehabilitation which require remedial actions prior to being re-sown to final vegetation.

8.2 Rehabilitation Overview

A summary of rehabilitation completed in 2018 is shown in Table 58.

Table 58: Summary of new rehabilitation completed in 2018

Rehabilitation Site Name	Seed Mix	Area (ha)	Summary
Barrys 155 topsoil	Cereal cover crop	7.7	Interim landform sown to initial cover crop. Topsoil used in lieu of compost following MWOO ban.
Barrys 155 spoil compost	HVO Pasture Light Woody Mix	19.5	Interim landform sown with native seed.
Barrys 155 slope	HVO Woodland Mix	5.9	Final landform sown with final cover.
Glider 125	HVO Pasture Light Woody Mix	11.1	Final landform sown with final cover.
Glider 155	HVO Woodland Mix	2.2	Interim landform sown with native seed.
Riv North cover	Cereal cover crop	7.2	Interim landform sown with native seed.
Riv North natives	HVO Woodland Mix	41.9	Interim landform sown with native seed.
West South 230	HVO Woodland Mix	5.4	Final landform sown with native seed.

---

[2] **Total mine footprint** includes all areas within a mining lease that either have at some point in time or continue to pose a rehabilitation liability due to mining and associated activities. As such it is the sum of total active disturbance, decommissioning, landform establishment, growth medium development, ecosystem establishment, ecosystem development and relinquished lands (as defined in DRE MOP/RMP Guidelines). Please note that subsidence remediation areas are excluded.

[3] **Total active disturbance** includes all areas ultimately requiring rehabilitation such as: on-lease exploration areas, stripped areas ahead of mining, infrastructure areas, water management infrastructure, sewage treatment facilities, topsoil stockpiles areas, access tracks and haul road, active mining areas, waste emplacements (active/unshaped/in or out-of-pit), and tailings dams (active/unshaped/uncapped).

[4] **Land being prepared for rehabilitation** – includes the sum of mine disturbed land that is under the following rehabilitation phases – decommissioning, landform establishment and growth medium development (as defined in DRE MOP/RMP Guidelines).

[5] **Land under active rehabilitation** – includes areas under rehabilitation and being managed to achieve relinquishment – includes the following rehabilitation phases as described in the DRE MOP/RMP Guidelines – “ecosystem and land use sustainability” (revegetation assessed as showing signs of trending towards relinquishment OR infrastructure development).

[6] **Completed rehabilitation** – requires formal sign off by DRE that the area has successfully met the rehabilitation land use objectives and completion criteria.

8.3 Rehabilitation Performance

A total of 100.9 ha rehabilitation was undertaken during 2018. Details of the rehabilitation areas including areas completed during 2018, the extent of mining, surface contours and rehabilitation vegetation types are provided in Figure 92.

Table 59 details the amount of rehabilitation and disturbance completed during the reporting period compared with proposed area in the respective MOP's.

Table 59: Summary of rehabilitation and disturbance completed in 2018

MOP	2018 Totals (ha)		Cumulative Totals During Current MOP Period (ha)*	
	Actual	**Proposed MOP**	**Actual**	**Proposed MOP**
Rehabilitation				
HVO North	5.4	78.7	146.3	255
HVO South	95.5	85.4	95.5	85.4
HVO Total	**100.9**	**164.1**	**n/a****	**n/a**
Rehabilitation Disturbance				
HVO North	2.6	0	101.7	272.4
HVO South	75.0	110.7	75.0	110.7
HVO Total	**77.6**	**110.7**	**n/a**	**n/a**
New Disturbance				
HVO North	36.9	119.3	121.8	416.1
HVO South	25.6	24.1	25.6	24.1
HVO Total	**62.5**	**143.4**	**n/a**	**n/a**
Net Rehabilitation (Rehabilitation minus Rehabilitation Disturbance)				
HVO North	2.8	78.7	44.6	-17.4
HVO South	20.5	-25.3	20.5	-25.3
HVO Total	**23.3**	**53.4**	**n/a**	**n/a**

Comparison with HVO North MOP Amendment C 2015 to 2018 approved 24 October 2018 and HVO South MOP Amendment C 2018 to 2022 (approved 25 July 2018);

*Cumulative North MOP figures for period 2015-2018 (4yrs) Cumulative South MOP figures for period 2018 only.

**Whole of site cumulative total across MOP period not provided due to offset MOP periods.

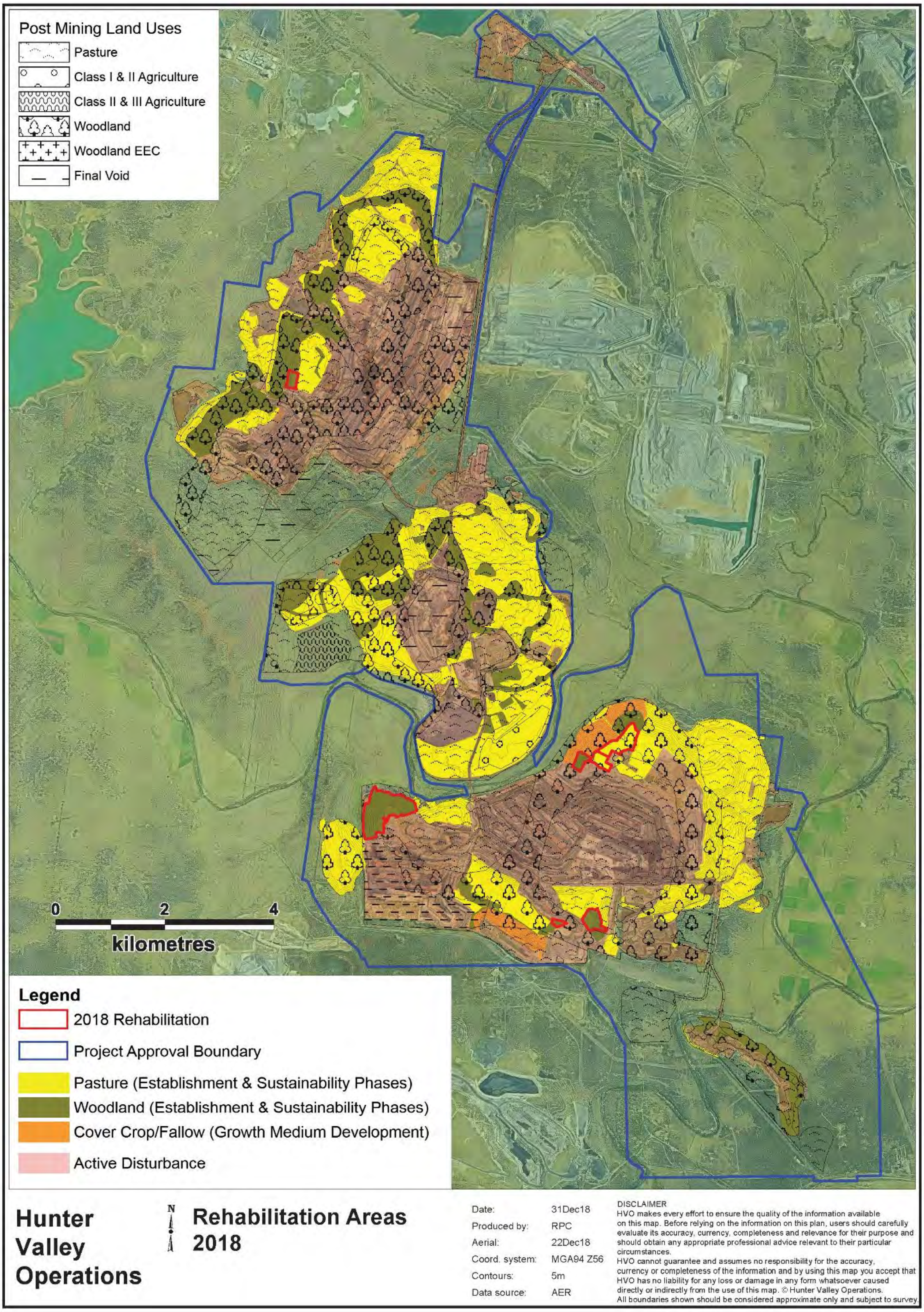


Figure 92: HVO Rehabilitation Areas as at 2018

Following commencement of a new MOP for HVO South MOP in July 2018 the rehabilitation to end of 2018 exceeded the MOP projection for the reporting period by 10.1 hectares.

The area of rehabilitation sown in HVO North during the reporting period was 73.3 hectares below the MOP commitment (5.4 ha completed vs 78.8 ha commitment). This resulted in the cumulative rehabilitation total across the full MOP period (2015 to 2018) being 108.7 hectares below the MOP projection (146.3 ha completed vs 255 ha commitment). Reduced rehabilitation at HVO North is offset by reduced rehabilitation disturbance over the period of the MOP. During the MOP period HVO disturbed 101.7 ha of rehabilitation compared to a MOP projection of 272.4 ha, or 170.7 ha below full projection. In terms of net rehabilitation, HVO North is therefore in front of the MOP projections by 62 ha.

A comparison of rehabilitation progression against predictions in the *HVO West Pit Extension and Minor Modifications Environmental Impact Statement (EIS) (October 2003)* and subsequent modifications to the HVO North approval (DA 450-10-2003) indicate that rehabilitation progression is generally consistent with EIS predictions. Planning approval modifications that changed the rate of rehabilitation progression at HVO North include: Carrington East Extension (Modification 2 - 2006); Carrington Out-of-Pit TSF (modification 4 - 2014); and Carrington In-Pit TSF (Modification 6 - 2014). When the modifications listed above are taken into account the EIS projection for rehabilitation area at the end of 2018 was 1766.9 ha. Actual HVO North rehabilitation area at the end of 2018 totalled 1,799.6 ha which is generally consistent with the EIS projection.

As at the end of 2018, rehabilitation progress for HVO South is consistent with the predictions in the HVO South Coal Project Environmental Assessment Report (January 2008). Rehabilitation progression at the end of 2019 (Stage 1) shows 1047.6 ha of rehabilitation completed. The actual rehabilitation area at the end of 2018 was 927.9 ha, with new rehabilitation totalling 77.9ha planned for 2019 in association with progression of 30ha from the growth medium development phase. Projected total rehabilitation at end 2019 is therefore 1035.8ha and consistent with progression to the end of Stage 1.

8.4 Rehabilitation Programme Variations

The variations to the rehabilitation programme are summarised in Table 60.

Table 60: Variations to the Rehabilitation Programme

Has rehabilitation work proceeded generally in accordance with the conditions of an accepted Mining Operations Plan	**HVO North - No** **HVO South – Yes**
If not please cite any approval granted for variations, or briefly describe the seasonal conditions or other reasons for any changes and the nature of any changes which have been made.	

Actual rehabilitation completed in HVO North during the period 2015 to 2018 = 146.3 ha
MOP target for rehabilitation completion in HVO North during the period 2015 to 2018 = 255 ha
Therefore, HVO North completed 108.7 ha less rehabilitation than projected across the period 2015 to 2018.

Delayed rehabilitation progression against the MOP projections has occurred primarily because of:

- Slower dump progress in West Pit compared with the MOP forecast (as initially reported in 2016 AEMR) due to lower waste generation (production) in West Pit;
- Slower progress in rehabilitating South-East TSF due to the risk controls associated with the work;
- Planned rehabilitation of Centre TSF not commencing as South-East TSF capping has not been completed; and
- Planned rehabilitation in Carrington West Wing (CWW) not occurring as development of CWW has not commenced,

New disturbance in HVO North during the period 2015 to 2018 = 121.8 ha
MOP projected new disturbance in HVO North during the period 2015 to 2018 = 416.1 ha
Therefore, HVO North has progressed 294.3 ha less new disturbance than projected across the period 2018 to 2018.

Reduced new disturbance against the MOP projections has occurred because:

- Carrington West Wing has not commenced
- Mitchell Pit has not commenced
- Mine advance in West Pit has not been as rapid as projected.

Actual Net Rehabilitation completed in HVO North during period 2015 to 2018 = +44.6 ha
(Net Rehabilitation = Rehabilitation Completed minus Rehabilitation Disturbance)
MOP target for Net Rehabilitation in HVO North during period 2015 to 2018 = -17.4 ha
Therefore, HVO North Net Rehabilitation progress for the period 2015 to 2018 is 62 ha ahead of the MOP projection.

HVO North net rehabilitation is advanced relative to the MOP due to not commencing the Carrington West Wing and Mitchell Pit developments which had significant disturbance footprints across the period of the MOP.

Notification to Resources Regulator has not occurred separately for each variation however the key elements have been addressed in previous annual reporting. No actions in relation to the variations have been canvassed by HVO or Resources Regulator. HVO sought and received extension of the MOP period from 30 November 2018 until 30 March 2019 to allow preparation and submission of a new MOP reflective of current operations inclusive of these variations..

8.5 Rehabilitation Trials

No rehabilitation trials, research projects or other initiatives were commenced during the reporting period. Reporting associated with the Upper Hunter Mining Dialogue Grazing Study (ACARP Project No. C23053) was completed during the reporting period. The Grazing Study was undertaken between 2014 and 2017 and compared grazing of pasture rehabilitation areas at HVO with grazing of nearby paddocks that had never been mined to determine whether rehabilitated mine land can sustainably support productive and profitable grazing in the Upper Hunter. The study found that cattle fattened appropriately on rehabilitated pastures, did not demonstrate heavy metal toxicities, and that normal indicators of sustainability used in grazing enterprises can and should be applied to rehabilitated pastures. Full details of the study are available from the UHMD and ACARP websites.

8.6 Key issues that may affect rehabilitation

The key issues that may affect rehabilitation are:

- **Vegetation Establishment** impacts due to competition from problematic weed species, uncontrolled or inappropriate vehicle or livestock impacts, or resulting in low resilience to bushfire impact; and atypical species diversities, structural densities, growth rates, productivity and recruitment levels when compared with analogue sites.

- **Growth Medium Suitability** issues due to soil nutrient and chemical properties impacting vegetation establishment; or establishment of inadequate soil depth during the Growth Medium Establishment phase.

- **Landform Stability** including the stability of water management structures, internal and external batter slopes and final void batters, and settlement and ponding on final landform surfaces of tailings storage facilities;

- **Spontaneous Combustion** occurring from placement of high risk materials on or near the final surface, or from exposed coal seams;

- **Fauna Recolonisation** impacts due to competition and predation by vertebrate pest species; and

- **Ecosystem Function** issues such that key Landscape Function Analysis (LFA) values for stability, infiltration, nutrient cycling or landscape organisation are trending away from analogue site values.

During 2018 a previously unidentified risk emerged when regulatory changes halted use of Mixed Waste Organic Outputs (MWOO) which is used as a cost effective soil ameliorant during the rehabilitation process. At the end of October 2018, the EPA advised that it was ceasing the use of MWOO material for mine rehabilitation until a review of use was undertaken and further controls considered. At the end of the reporting period application of MWOO material to land at mine sites remained unlawful. Investigations are ongoing to identify alternate products and it is anticipated that soil amelioration will occur on a needs basis rather than as a standard process until the issue is resolved.

A Trigger Action Response Plan (TARP) is included in the MOPs and identifies the proposed contingency strategies in the event of variations or impacts to rehabilitation outcomes. Weed management continues to be a key issue to manage in order to meet rehabilitation objectives. Management activities for both native and pasture vegetation types are described below.

Native Vegetation Rehabilitation

Since 2011, HVO has increased its focus on re-establishing a diverse native understorey within native vegetation rehabilitation. Experience over this period has shown that weed competition, which includes exotic grasses in the context of native vegetation establishment, is the main limiting factor to the successful establishment of a native understorey. The weed seed source is coming from both historically disturbed areas that are being stripped ahead of mining; and from the cover species on topsoil stockpiles.

HVO has implemented a range of programs to minimise the impact of weeds in rehabilitation, including:

- Prioritising the use of topsoils from good quality native vegetation areas on rehabilitation that is being returned to native vegetation;
- Managing new and old topsoil stockpiles to clean up exotic grass/weed cover and establish a cover of native vegetation;
- Use of spoils and subsoils ameliorated with compost and gypsum as the growth medium for areas being returned to native vegetation. This method avoids the use of "weedy" topsoils and allows native vegetation to become established in the absence of competitive weed species (continuation pending clarification of regulatory approval as noted above);
- Use of a staged approach to rehabilitation where early sowing of sacrificial cover crops provide opportunities for weed control prior to sowing the native seed mixes;
- Use of a weed wiper and spot spraying to target exotic grasses and weeds in areas that have already been sown with native seed mixes;
- Development of native seed production areas to supply local provenance native grasses for use in rehabilitation and topsoil stockpile maintenance.

Pasture Rehabilitation

HVO has been trialling the use of native grass species in pasture rehabilitation. Where native grass species are being used the limiting factor is weed competition; this is discussed in the section above. In pasture rehabilitation, where exotic pasture species are being used, the desired pasture species are less susceptible to weed competition. The main limiting factor for rehabilitation success in exotic pastures is a lack of diversity which can lead to declining feed quality during the winter periods.

The diversity of exotic pastures in rehabilitation are initially high due to the range of grass and legume species in the seed mixes. However, in the absence of the introduction and management of grazing these sites can become dominated by competitive summer growing species (i.e. Rhodes Grass and Green Panic). During winter these long rank grasses have poor feed quality and tend to shade out the winter growing legumes that would provide good quality feed over this period.

Therefore, to maintain pasture diversity and quality, implementation of grazing management to pasture rehabilitation areas in a timely manner is necessary. Where operational restrictions prevent the introduction of grazing other techniques, such as slashing, can be used to replicate the effect of grazing. HVO has been expanding the areas of pasture rehabilitation that are exposed to grazing through licence agreements over the last couple of years and this is planned to continue.

8.7 Rehabilitation Monitoring

Performance criteria for each rehabilitation phase have been detailed in the Mining Operations Plan (MOP) for both HVO North and HVO South. These criteria have been developed so that the rehabilitation success can be quantitatively tracked as it progresses through the phases outlined below:

- Stage 1 – Decommissioning
- Stage 2 – Landform Establishment
- Stage 3 – Growing Media Development
- Stage 4 – Ecosystem and Land use Establishment
- Stage 5 – Ecosystem and Land use Sustainability
- Stage 6 – Rehabilitation Complete

The performance criteria are objective target levels or values that can be measured to quantitatively demonstrate the progress and ultimate success of a biophysical process. A monitoring methodology has been developed to measure the performance criteria utilising a combination of tool to assess changes occurring over time.

The target levels or values have been based on monitoring results from reference sites. Continued refinement of the criteria in association with key regulatory stakeholders remains ongoing in association with an adaptive management approach.

The monitoring programme for rehabilitated land returned to native vegetation was commenced during 2015. Further monitoring was conducted in early and mid-2017. A number of results from the 2017 monitoring event initiated TARP triggers in relation to native weed presence and the trajectory of native vegetation establishment. This was reported in the 2017 Annual Environmental Review.

In October 2018 in response to TARP triggers and observations during annual inspections, the DP&E – Resources Regulator issued HVO with notice under Section 240(1)(c) of the Mining Act (1992) (Section 240 Improvement Notice).

As detailed by the TARP triggers, and in accordance with this Section 240 notice, HVO initiated review of 12 areas of concern by suitably qualified specialists using an abridged monitoring methodology so as to understand in more detail current site conditions and trajectory, and support intervention decision making. An overview of the outcomes of this monitoring program is presented in Table 61 and Figure 93.

Table 61 – Summary of 2018 rehabilitation monitoring inspections

Site Name	Trajectory Ranking	Key Issues	Recommendations
HVOWES201601	Failing	• Soil issues. • Poor plant health and growth. • Threatening weeds present in significant density.	• Repeat monitoring and assessment. • Investigate soil issues and ameliorate as necessary. • Control Galenia (spot spraying). Aerate to prepare a seed bed and stimulate germination of natives. • Seeding options include: • If significant germination/reshooting of natives, consider: • Oversow with native seed mix. • Sow only chenopods, trees and shrubs to enable treatment of grass weeds with selective herbicide, then following 1-2 seasons of weed control sow grasses. • If there is no evidence of improvement in native cover: • Spray out entire block, prepare seedbed and resow either entire suite of natives or staged native sowing such as grasses and herbs only, followed by trees and shrubs as required.
HVOWES201604	Stable but needs work to improve	• Stable native vegetation with good grass cover, low shrub and tree diversity and low stem density. • Some threat from weeds.	• Following soil analysis, build on existing native vegetation to increase diversity and cover. • Control weed threats. • Selective seeding, if required.
HVOCAR200902	Failing	• Well established canopy but stem density too high for continued success. • Under storey and ground layer have low diversity dominated by threatening weeds (Green Panic). • Contour banks and swales without significant native cover.	• Thin Eucalypts using mechanical means or fire. • Control weed threats. • Increase shrub layer diversity (fire would stimulate Acacia germination). • Increase shrub and ground layer diversity with soil disturbance and sowing.
HVOCHE201201	Failing	• Very poor native cover or diversity apart from some saltbushes. • Significant densities of threatening weeds. • Evidence of ongoing soil or subsoil problems – poor plant growth and health. Even normally vigorous weeds show signs of drought stress and nutrition problems when compared to other HVO sites.	• Investigate soil issues and ameliorate as necessary. • Develop and implement a re-establishment plan.

Site Name	Trajectory Ranking	Key Issues	Recommendations
HVOLEM201601	Stable but needs work to improve	• Good shrub diversity and density. Ground layer dominated by Couch. Threat from *Acacia saligna* colonising from adjacent vegetation. • Contour banks and swales have low native cover and diversity. • Soil appears to be Warkworth Sands Woodland type so species sown may not have been appropriate to this soil type.	• Manage weed threats. • Investigate initially sown species mix. • Sow ground layer species appropriate for this soil type, if required.
HVORIV201401	Stable but needs work to improve	• Good native species diversity but relatively low native groundcover layer (higher percentage of bare ground). • Heavily infested with threatening weeds, especially Rhodes Grass. • Evidence of soil issues in some areas.	• Manage exotic grasses threat to avoid contamination of adjacent areas. This should involve a combination of targeted slashing/brush cutting, blanket spraying of larger areas of exotic grasses and spot spraying of isolated plants. • Following control of exotic grasses increase native ground cover by re-sowing native grasses and Saltbushes.
HVORIV201402	Stable but needs work to improve	• Generally good native grass diversity and cover, apart from one area which appears to have a different topsoil type. • Good shrub layer cover and some Eucalypts, although stem density is low. • Threat of invasion and spread of Rhodes Grass and Green Panic.	• Treat threatening weeds. • Augment native ground and shrub layer in areas with lower stem density, if required.
HVORIV201403	Stable but needs work to improve	• Good but patchy native diversity and cover in ground layer. • Evidence of soil issues. • Significant weed threats (in particular Rhodes Grass).	• Investigate soil issues and ameliorate as necessary. • Manage weed threats. • Re-sow restricted suite of natives (only sow proven successful species), if required.
HVORIV201404	Failing	• Patchy native vegetation cover. • Majority of the site is dominated by threatening weeds. • Soil issues appear to be causing poor native establishment.	• Investigate soil issues and ameliorate as necessary. • Manage any weeds which pose a threat to adjacent rehab areas (Rhodes Grass and Green Panic pose highest risk of quickly invading areas dues to windblown seed). • Consider re-sowing with limited native seed mix (only sow proven successful species).
HVORIV201405	Failed	• Evidence of serious soil problems. • Site is almost entirely dominated by annual plants (both native and exotic) suggesting a serious issue with subsoil and/or topsoil.	• Investigate soil issues and ameliorate as necessary. • Spray out and resow with limited native seed mix (only sow proven successful species).
HVORIV201501	Tracking towards success but needs work	• Good native cover and diversity in ground layer. • Shrub and canopy layer has low stem density (particularly Eucalypts).	• Manage weed threats. • Selective seeding, if required.

Site Name	Trajectory Ranking	Key Issues	Recommendations
HVORIV201503	Tracking towards success but needs work	• Good native cover and diversity across the majority of the site. • Two small zones within the site have lower tree and shrub stem density.	• Manage weed threats. • Selective seeding, if required.

8.8 Overview of rehabilitation trajectory

Due to the abridged monitoring methodology used during 2018, direct assessment of these results against completion criteria is not valid. Inspected sites were placed on a four point scale using quantitative data and qualitative professional judgement and ranked as either:

- Tracking towards success but needs work;
- Stable but needs work to improve;
- Failing; or
- Failed.

Of the 12 sites inspected, one site was found to be 'failed', four to be 'failing', five to be 'stable but needing work', and two 'tracking towards success'. Based on this, the majority of sites are on a trajectory for success provided appropriate and timely management interventions occur.

Of note, the site identified as failed was a previous subsoil trial block which suggests that this block may have been at elevated risk of challenge from the start.

When considered in the context of the full 29 sites comprising the 2017 monitoring event, the data indicates that 24 of the 29 sites, or approximately 80 percent of the sample, are tracking favourably. Ongoing targeted TARP style monitoring during 2019 will further develop the current understanding of the status of HVO's wider rehabilitation footprint and inform appropriately targeted interventions and ongoing adaptive management to continue to maintain a trajectory towards success.

Additionally, HVO has committed to a detailed work plan in response to the TARP triggers, Section 240 notice, and the information provided by subsequent inspections. An overview of the plan is provided in Appendix 2.

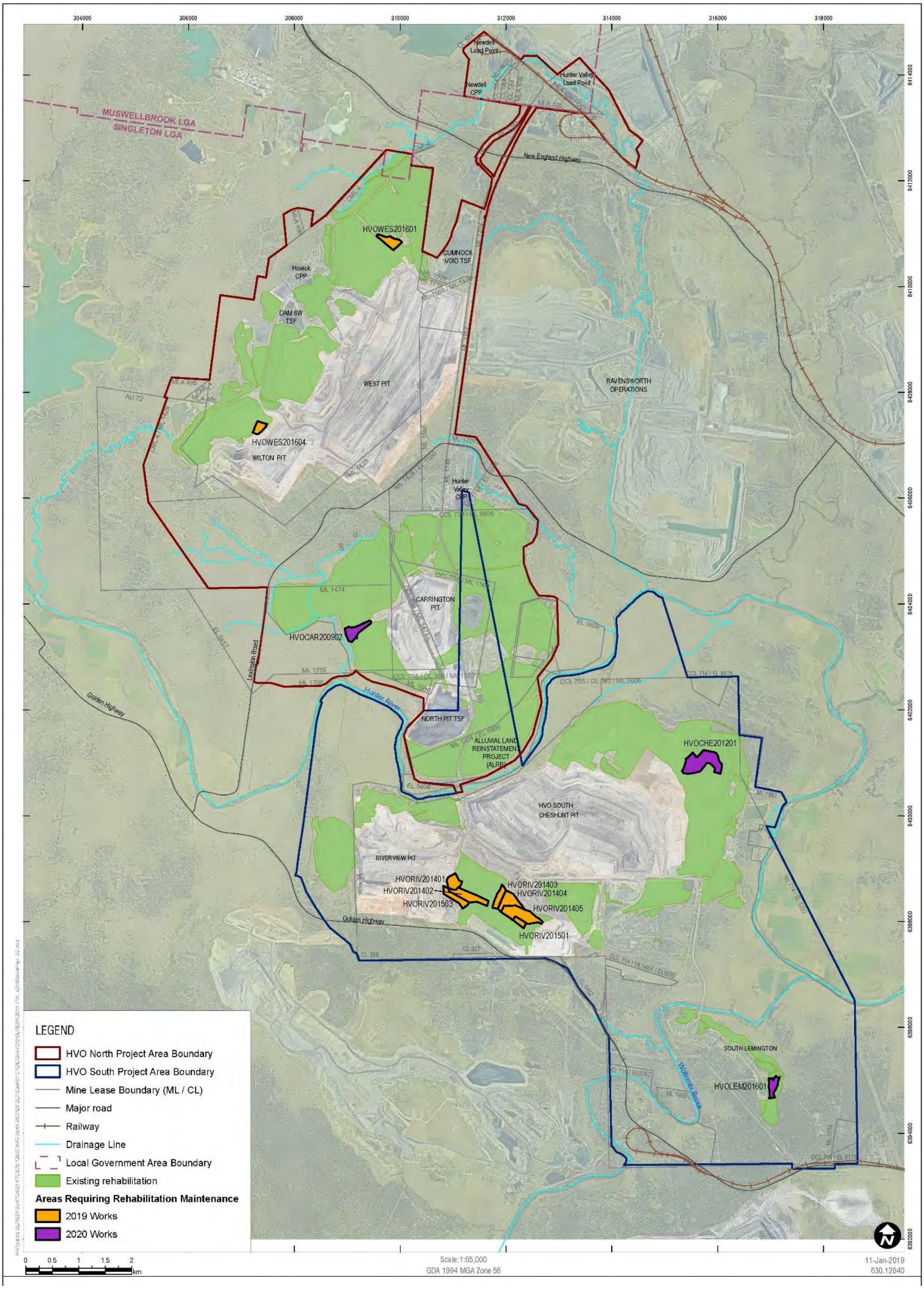


Figure 93 - Overview of 2018 rehabilitation monitoring inspections and future work plan

8.9 Rehabilitation Maintenance

Management of Rehabilitated Areas is undertaken proactively to assist in initial establishment and when issues are identified through monitoring, auditing or inspections.

An overview of key rehabilitation maintenance activities is shown in Figure 94 and detailed below.

Broadacre maintenance

Broadacre weed treatment within rehabilitation areas is undertaken using agricultural methods comprising boom sprays and wick wipers. In existing rehabilitation areas boom spraying is primarily used to manage cover crop and fallow areas prior to sowing to final native seed mixes. Pre-emergent application of herbicide is used when appropriate necessary to control emerging weeds in the period between sowing and germination of the desired species. Wick wiping targets rapidly growing exotic grasses and other erect growing weeds in the period following native germination but while desirable species remain below the wiper target zone. During 2018 areas totalling 291 ha were boom sprayed, 102 ha received wick wipe treatment of existing rehabilitation received boom and/or wick wiper treatment (Figure 94). Native seed mixes are sown as part of the maintenance program where areas have been sown to an initial cover crop or where areas previously sown to native have not established successfully. During 2018 52.2ha of maintenance native seeding was completed, in addition to re-establishment of 17 ha of cover crop on an area not sufficiently prepared for progression to final natives.

Ground based interventions

Hand spraying and manual removal of weeds is undertaken in rehabilitation areas with early stage and establishing native vegetation that would be likely to be damaged or destroyed should broadacre methods be used. During 2018 103 ha of rehabilitation areas at various stages of establishment were treated by ground crews in this manner.

Grazing of Rehabilitation Areas

Grazing of rehabilitation areas is utilised to encourage and maintain pasture diversity, encourage nutrient cycling, and assist in fuel load management. A licence agreement is in place for grazing 719 ha of HVO North rehabilitation area, with temporary fuel load licences across a further 212 ha of rehabilitated land around HVO North. Opportunities to integrate grazing to assist rehabilitation progression continue to be assessed.

Figure 94: Rehabilitation Maintenance – post-rehabilitation weed control

8.10 Vertebrate Pest Management

As part of HVO's Vertebrate Pest Action Plan a number of baiting programmes are carried out on a seasonal basis. These programmes are conducted at a level of frequency designed to disrupt pest species breeding/colonisation cycles and employ a variety of methodologies including baiting, trapping and ground based shooting

Wild Dog and Fox Baiting Programmes

Three 1080 ground baiting program targeting wild dogs and foxes were implemented across operational and biodiversity areas. These were undertaken during summer, winter and spring. Each program consisted of approximately 60 bait sites utilising meat baits and ejector baits. Baits were checked over a three week period and replaced each week when taken.

A wild dog and fox soft-jaw trapping and shooting program was carried out in autumn in 2018. Results included 3 dogs trapped and euthanised and 1 dog shot.

Pig Baiting & Trapping

A trial synchronised 1080 pig baiting program was conducted by HVO, The Singleton Local Land Services (branch) and several adjoining corporate landholders in September 2018. The bait station at the Wandewoi Biodiversity Area accounted for an estimated 15 pigs and two traps at the Archerfield property accounted for a further 16 pigs.

In addition there are several pig traps permanently located and maintained at Archerfield Farm, Carrington Stud and North Pit. These traps accounted for 139 pigs in 2018.

Ground Based Shooting

HVO has two shooters attending the site on a regular basis opportunistically controlling feral pest species. Feral species controlled include pigs, wild dogs, foxes, hares /rabbits, cats and a deer.

Table 62 summarises the results from the programmes carried out at HVO during 2018 with baiting locations and results for the programmes illustrated in Figure 95 to Figure 97.

Table 62: Summary of Vertebrate Pest Management 2018

Season	1080 Baiting				Trapping		Shooting			
	Total Lethal Baits Laid	Takes by Wild Dog	Takes by Fox	Takes by Feral Pig	Wild Dog	Feral Pig	Feral Pig	Wild Dog	Feral Cat	Hares & Rabbits
Summer	120	69	6			47	54		1	47
Autumn -Winter	120	77	5		3	76	54	1		10
Spring	122	73	10	15		16				
TOTAL	362	219	21	15	3	139	108	1	1	57

Vertebrate pest management programmes will continue to be carried out during 2019 to limit feral pest impacts on landholdings and surrounding neighbours.

Site: Hunter Valley Operations
Client: Yancoal Hunter Valley Operations
Project: Vertebrate Pest Management 2018
MGA Zone 56 (GDA94)

N

Program Results: Summer - Autumn
(22 February - 6 March 2018)
No. of Bait Stations: 60
Poison Used: 1080 baits (including 5 ejector baits)

Rural & Environmental

Figure 95: HVO Vertebrate Pest Management Bait Locations – Summer 2018

Figure 96: HVO Vertebrate Pest Management Bait Locations – Autumn 2018

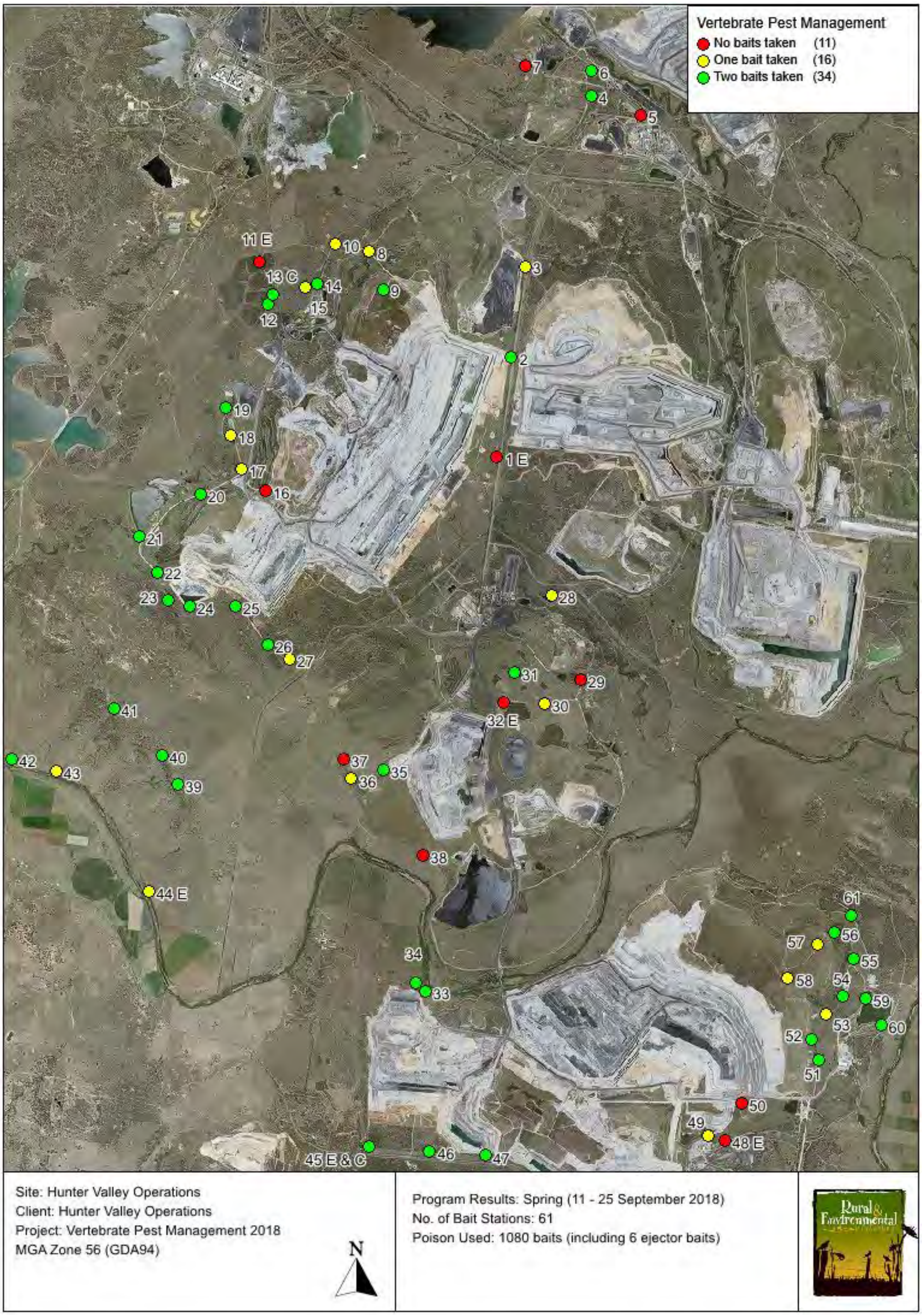


Figure 97: HVO Vertebrate Pest Management Bait Locations – Spring 2018

8.11 Supplementary Weed Treatment

In addition to weed occurrence in rehabilitation areas, weeds identified at HVO occur primarily in areas that have been disturbed such as previous civil works areas, soil stockpiles, water management structure surrounds, and general areas of minor ground disturbance. A total of 88 days of weed control work was undertaken on site at HVO during 2018, with 118 ha of land treated, including River Red Gum areas and maintenance of 102 environmental monitoring points. The weeds targeted during the 2018 weed management programme were based on the results of the 2017 weed survey. Figure 98 to Figure 100 illustrates the target species and weed treatment areas across HVO.

The dominant weed species that were targeted during 2018 included:

- African boxthorn (*Lycium ferocissimum*)
- African olive *(Olea europea)*
- Balloon vine (*Cardiospermum grandiflorum*)
- Bathurst burr (*Xanthium spinosum*)
- Blackberry (*Rubus fruticosus)*
- Castor oil plant (*Ricinus communis*)
- Galenia (*Galenia pubescens)*
- Green cestrum (*Cestrum parqui)*
- *Opuntia* (Pear) species (Tiger, Prickly and Creeping pear)
- Various thistles: Scotch thistle (*Onopordum acanthium*), saffron thistle(*Carthamus lanatus*) and variegated thistle (*Silybum marianum*)
- Farmers friends (*Bidens pilosa*)
- Stinging nettle (*Urtica dioica*)
- Mallow (*Malva parviflora*)
- Mustard weed (*Sisymbrium officinale*)
- Narrow leaf cotton bush (*Gomphocarpus fructicosis*)

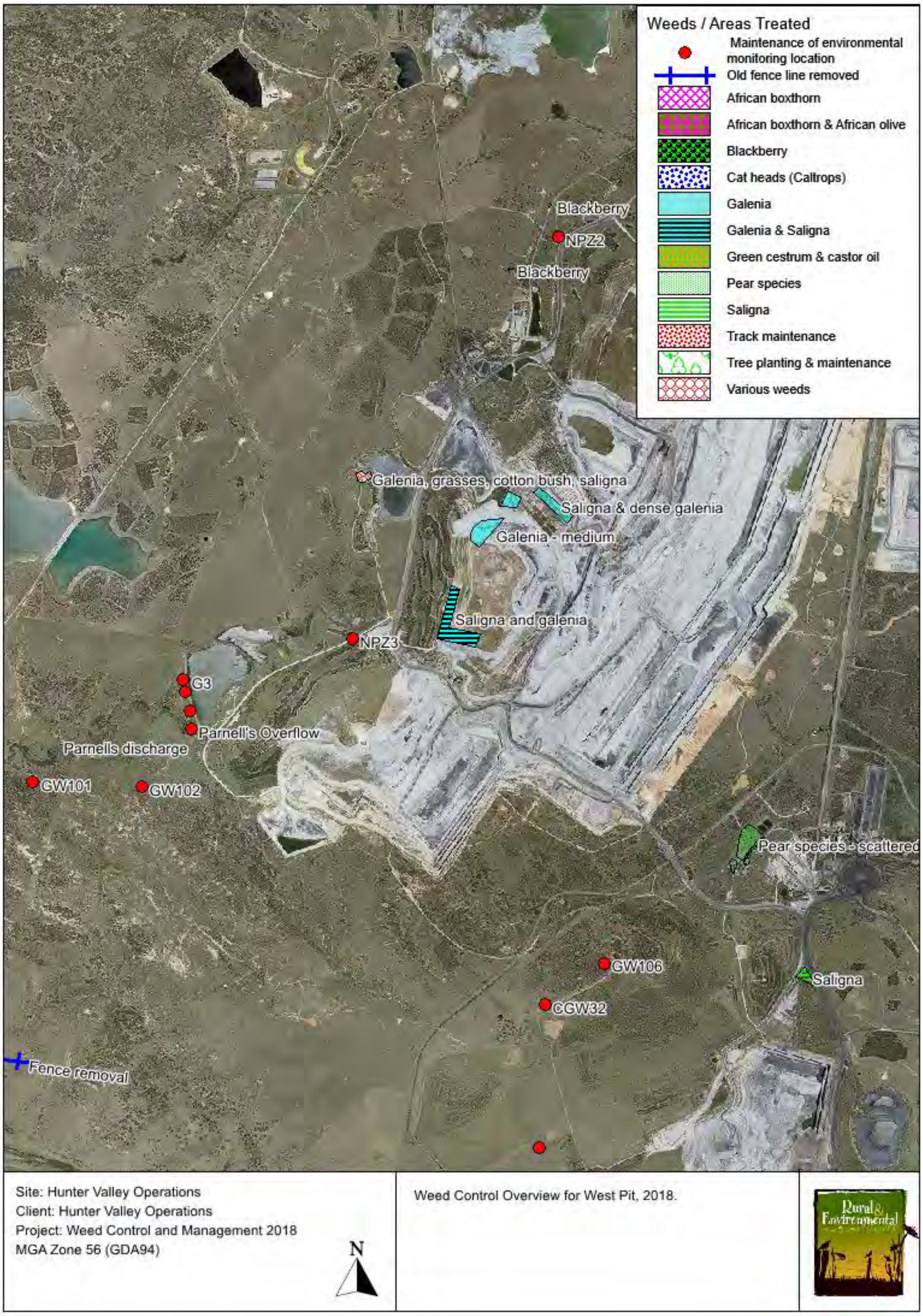
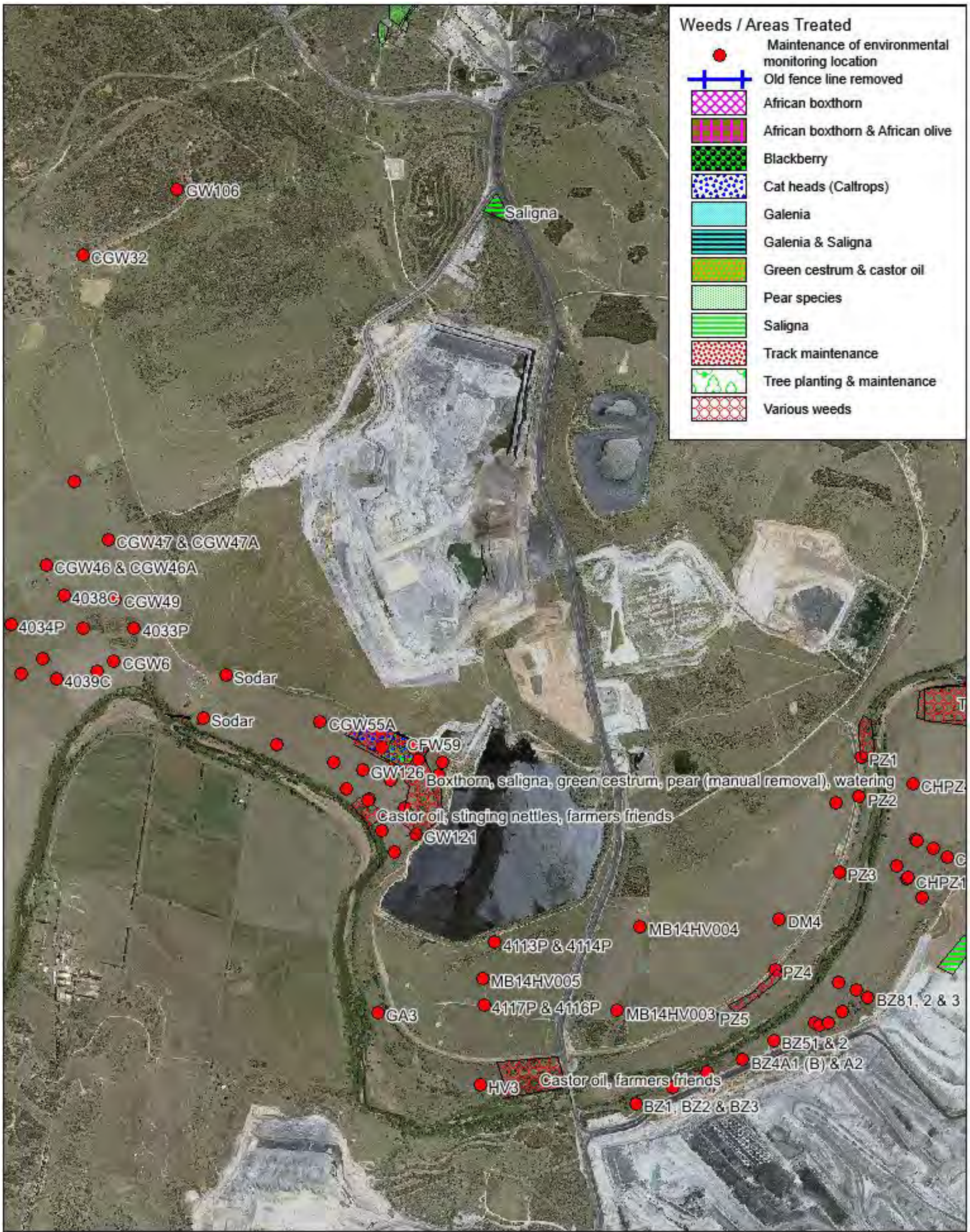


Figure 98: Weed Control Overview for West Pit – 2018



Site: Hunter Valley Operations
Client: Hunter Valley Operations
Project: Weed Control and Management 2018
MGA Zone 56 (GDA94)

Weed Control Overview for Carrington Pit, 2018.

Figure 99: Weed Control Overview for Carrington Pit - 2018

Site: Hunter Valley Operations
Client: Hunter Valley Operations
Project: Weed Control and Management 2018
MGA Zone 56 (GDA94)

N

Weed Control Overview for Cheshunt and Riverview Pits 2018.

Figure 100: Weed Control Overview for Cheshunt and Riverview Pit - 2018

8.12 Renovations

No renovations or removals to report.

8.13 Top Soil Management

Topsoil is managed according to the HVO Ground Disturbance Permit system and land management procedures. Table 63 outlines the topsoil used and stockpiled during 2018. There were 71.7 ha of rehabilitation top soiled during 2018, using soil resources from ahead of mining pre-strip and rehabilitation disturbance activities.

Table 63: Soil Management

Soil Used This Period (m^3)	Soil Prestripped This Period (m^3)	Soil Stockpiled to Date (m^3)	Soil Stockpiled Last Report (m^3)
71,650	140,200	1,931,663	1,875,213

8.14 Tailings Management

A Fine Rejects Management Strategy for HVO has been developed in accordance with the planning approval for HVO North (Clause 28A of DA 450-10-2003 Mod 4). A revised strategy was submitted on 28 September 2018 to reflect approval to deposit tailings in Carrington Pit. The strategy outlines tailings management for the time horizon spanned by current approvals.

Key Tailings Management Activities in 2018, include:

- Recommenced capping of the Southeast TSF late in 2018, ongoing.
- Construction of the Carrington secondary flocculation plant and commencement of pipe-head flocculation of tailings into the North Void TSF.
- Preparation of the Carrington In-Pit TSF for commencement of tailings deposition in January 2019
- Implementation of a Management Plan for the North Void TSF to manage and mitigate any potential impacts from an identified seepage pathway as detailed in Section 7.5.

Table 64 below outlines the current state of Tailings Storage Facilities across HVO that are still active or pending decommissioning.

Table 64: HVO Tailings Storage Facilities

Facility	Status	Decant System
North Void	Active (temporarily ceased deposition January 2019)	Decant pumps in place, regular pumping.
Dam 6W	Active	Decant pump in place, regular pumping.
Cumnock Void	Active (only deposited tailings for part of the year)	Decant pump in place, regular pumping when deposition occuring
Bob’s Dump	Inactive	Solar pump in place, pumping as required.
Southeast TSF	Inactive - capping commenced	Solar pump in place, pumping as required.
Central TSF	Inactive	No pumps required due to drying after rainfall (small catchment reporting to TSF).

8.15 River Red Gum Restoration and Rehabilitation

There are a number of River Red Gum sites (endangered population) across HVO South and North. These are managed under the River Red Gum Restoration and Rehabilitation Strategy. In April 2018, the Department of Planning granted HVO conditional approval of the current HVO River Red Gum Rehabilitation and Restoration Strategy subject to preparation of an updated strategy following its 10 year review. The sites have been categorised into a high level of management at the Carrington Billabong, intermediate level at the priority sites and low level at the low priority sites.

Management activities have included fencing and the removal of cattle grazing to reduce the impact on native vegetation at high priority sites. Weed management activities were implemented in accordance with the Weed Management Plan across all priority sites in 2018 targeting; African Boxthorn (*Lycium ferossimum*), African Olive (*Olea Europea subsp cuspidate*),Bathurst Burr(*Xanthium spinosum*) Galenia (*Galenia pubescens*), Tiger Pear (*Opuntia aurantiaca*), Prickly Pear (*Opuntia stricta*), Castor Oil (*Ricinus communis*), Farmer's Friend (*Bidens pilosa*), *Acacia saligna*, Green Cestrum (*Censtrum parqui*) and various Thistles (*Onopordum acanthium*), (*Carthamus lanatus*), (*Silybum mariamum*).

Planting programmes to increase the understory diversity of the Carrington Billabong were undertaken in spring 2015 and autumn 2017. Figure 101 shows native tube stock planting at Carrington Billabong. A total of 1,000 plants were planted during each programme and these were broken down into 500 grasses, 250 shrubs and 250 small trees. Additional native understorey planting was undertaken in spring 2018, including 440 long stem river red gums and approximately 200 understory native grasses and shrubs. Weed control was conducted on three occasions at high and intermediate priority sites along with follow up watering for recently established plantings.

Figure 101: Native tube stock planting at Carrington Billabong (photo taken in 2017)

8.16 Biodiversity Offsets

8.16.1 Management

The Hunter Valley Operation Mine's impacts on biodiversity values are offset through the protection and management of Biodiversity Areas (BAs). The BA that relate to HVO PA 06_0261 is the Goulburn River which has an offset area of 140 hectares.

HVO manage a number of other offsets including Wandewoi, Condon View and Mitchel Hill however these are managed under EPBC approval 2016/7640 and are subject to compliance reporting under that approval and are not subject to further discussion in this review.

8.16.2 Biodiversity Area Management Activities

The following are the key actions completed throughout 2018.

8.16.3 Weed Control

Weed control activities were conducted at the Goulburn River Biodiversity Areas in autumn and summer targeting;

- Blackberry;
- Green Cestrum;
- Pear Scotch Thistle;
- Variegated Thistle and;
- Willow.

8.16.3.1 Infrastructure Management and Improvement

The monthly property infrastructure inspections were undertaken at Goulburn River Biodiversity Area in 2018.

8.16.3.2 Fire Management

Bushfire management consultants LRM were appointed to review the Goulburn River Biodiversity Area, Bushfire Management plan and prepare an updated individual biodiversity Area Bushfire Management Plan in 2019.

8.16.3.3 Strategic Grazing

All livestock have been removed from Goulburn River Biodiversity Area in line with the management plan procedures. Strategic grazing activities did not take place during the 2018 reporting period.

8.16.3.4 Vertebrate Pest Management

The 1080 ground baiting programmes were undertaken in autumn and spring at Goulburn River BA targeting wild dogs and foxes. Baits were checked over a three week period and replaced each week when taken.

Vertebrate pest management programmes will continue to be implemented during 2019 to limit feral pest impacts on landholdings and surrounding neighbours.

9 COMMUNITY

9.1 Complaints

A total of 26 complaints were received by HVO during 2018 (Figure 102). This represents a decrease of 13 community complaints from the previous year. Complaints were received in relation to noise, dust and blasting, air quality and flora and fauna

HVO provides a 24 hour Community Complaints Hotline (telephone: 1800 888 733) for community members to comment on concerns relating to its operations. All complaint details are recorded in accordance with Condition M4.2 of Environmental Protection Licence 640.

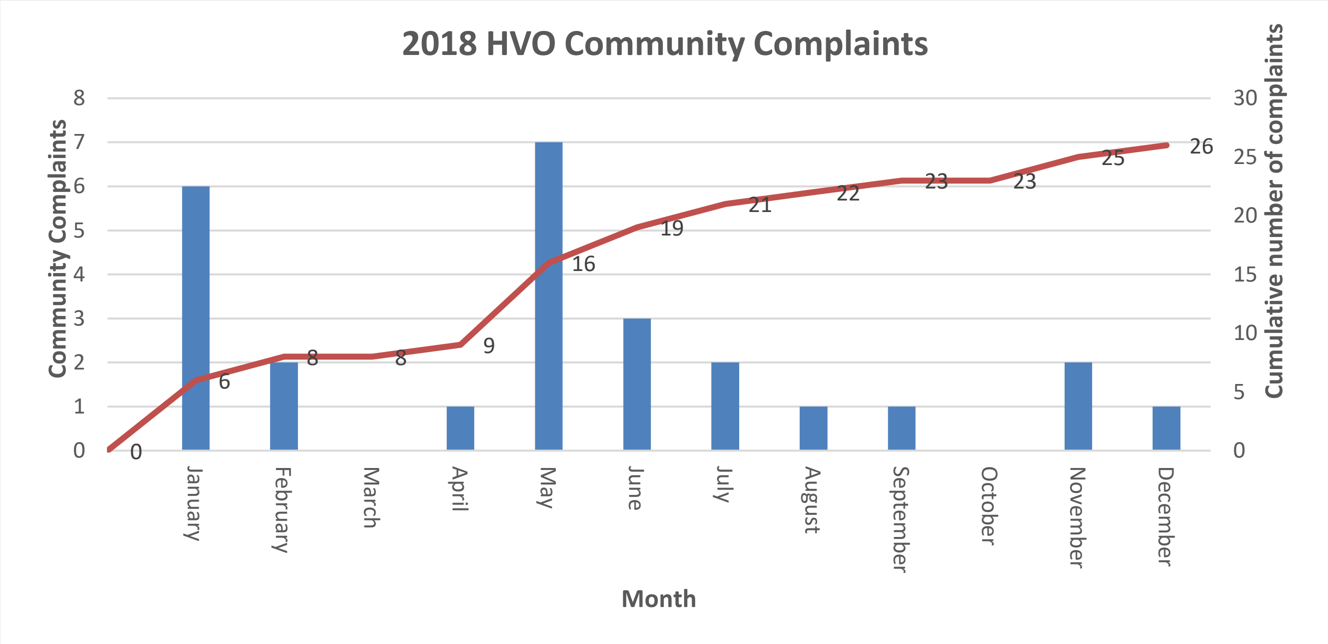


Figure 102 Community Complaints in 2018

9.1.1 Noise complaints

Eight noise complaints were received in 2018 compared to 18 in 2017. Seven of these complaints were from Jerrys Plains (from the same household) and one was from Long Point. Additional activities to mitigate noise impacts in 2018 include additional attended monitoring spot checks, continued truck sound attenuation and restricting night time dumping on Cheshunt dump. These activities will have contributed to a reduction in noise received by near neighbours.

9.1.2 Blasting complaints

HVO received eleven complaints regarding blasting activities in 2018 compared to 13 in 2017. The complaints related to overpressure/vibration and dust, a small proportion related to odour. Five complaints originated from Jerrys Plains, four from Long Point, 1 from Maison Dieu and 1 anonymous complaint was received. The majority of these complaints were received in January related to the blast overpressure exceedance incident which also produced a dust plume.

9.1.3 Dust complaints

Five dust complaints were received during 2018 compared to four in 2017 with four complaints from Maison Dieu and one from Jerrys Plains. Additional operational controls were employed to mitigate dust to neighbours in 2018 including dumping restrictions on Cheshunt dump, additional equipment downtime and commencement of a chemical dust suppressant in West Pit.

9.1.4 Flora and Fauna complaints

Two complaints were received during 2018 in regards to sightings of feral pigs and came from residents in Apple Tree Flat and Jerrys Plains. HVO's feral animal management programme has been effective in 2018 with additional culling being undertaken in response to community concerns raised.

9.2 Review of Community Engagement

9.2.1 Communication

Regular letters were sent to HVO's near neighbours to provide an overview of current and future mining operations and other relevant activities, as well as inform residents about how impacts are being managed. In addition, HVO issues correspondence to specific near neighbours who may be affected by certain changes, to inform of upcoming consultation activities and as a feedback mechanism. In 2018, this included communication relating to:

- Operational updates;
- Environmental activities such as aerial seeding activities, feral pest management programme;
- Community initiatives such as near neighbour first aid training, donation and sponsorship programme;
- HVO Community Consultative Committee meeting updates; and
- Communication tools – InSite, environmental monitoring public reporting website and the blast notification SMS alert system.

In August, HVO hosted a community information session for near neighbours at Maison Dieu aimed at providing community members with an opportunity to speak with HVO representatives about current operations and future plans, The session was attended by residents from Maison Dieu, as well as HVO staff members.

A range of consultation and engagement activities were also completed, including:

- Proactive near neighbour visits for residents living in the HVO area to discuss current operations and future plans for near neighbour engagement, as well as consultation to provide project updates at key project milestones and activities, and to respond to concerns/queries raised by individual near neighbours;
- Business Chamber briefings;
- Participation in the Upper Hunter Mining Dialogue - a programme coordinated by the NSW Minerals Council to engage the community across the Hunter Valley;
- Hosted mine tours;
- School engagement - including Singleton High School roundtable interviews and support of Jerrys Plains Primary School pre-school programme; and
- Participation in various community events and committees.

HVO continued to encourage the community to contact the company in a way that suits the individual community members.

9.2.2 Community Consultation Committee (CCC)

The HVO CCC meetings were held in February, May, August and November 2018. The HVO CCC meet to discuss operations, projects and mine activities. The Committee is comprised of HVO representatives, community members and other key external stakeholders, including Council. The HVO CCC minutes are available on the HVO website (https://insite.hvo.com.au/document-library/ccc). The community is invited to visit the website(s) to learn more about the HVO CCC.

Following CCC meetings a letter is mailed to HVO near neighbours to provide an update on matters which were discussed at the meeting and any additional information about HVO's plans and activities. In 2018 CCC members included:

- Dr Colin Gellatly (Independent chairperson);
- Cr Hollee Jenkins;
- Dr Neville Hodkinson;
- Mr Charlie Shearer (Janelle Wenham as Mr Shearer's alternative);
- Mr David Love;
- Mr Brian Atfield;
- Mrs Di Gee;
- Mr Todd Mills;
- Mr Michael Wellard;
- Mrs Jeanie Hayes;
- Mrs Sarah Purser (minute taker);
- HVO General Manager – Mr Jason McCallum (up to May 2018); and Mr Tony Galvin (from May 2018)
- Manager Environment & Community – Mr Andrew Speechly.

9.2.3 Community Grants

HVO supports applications for local donations and sponsorships that have a clear community benefit. In 2018, HVO provided $57,464 to 16 local projects and initiatives, including:

1. Wildlife Aid Inc – Wildlife Warriors
2. Singleton Council – International Day People with Disability Bush Dance
3. Cancer Council NSW – Transport to Cancer Treatment Singleton
4. Singleton Heights Pre-School Inc – Physical Acknowledgement of Country
5. Singleton fire brigade social club - Singleton Christmas lolly run
6. Singleton Heights Public School - Reaching for the Heights
7. Singleton Historical Society & Museum - Newspaper Microfilm
8. Australian Stock Horse Society Eastern Branch - Eastern Branch ASHS Championships and Performance Weekend
9. Singleton Scout Group - Lighting and Heating
10. Singleton Council - Pass Your Hat - Charity Drought Fundraiser

11. Singleton Neighbourhood Centre Inc - Paving of Outside Area

12. Singleton Council - Blast - Youth Adventure Festival (Colour run)

13. Penguins Garden Group - Penguins Garden Group

14. Salvation Army Singleton - Children's Christmas Party

15. Jerrys Plains Community Hall – donation towards installation of split system air conditioning

16. Hunter Valley Annual Campdraft

HVO also continued its partnership with Jerrys Plains Public School providing funding for their pre-school programme.

10 INDEPENDENT AUDIT

The most recent independent compliance audit was undertaken in October 2016. Outcomes of the audit including subsequent action plan was submitted to the Department in December 2016 with Department Approval of the audit and action plan received in February 2017. During 2018 HVO worked to complete the status of subsequent actions. The next audit is due in 2019.

11 INCIDENTS AND NON-COMPLIANCES

11.1 Blasting

During 2018 there were two non-compliance’s related to blasting summarised below.

11.1.1 Incident 17 January 2018

A blast fired in HVO South’s Riverview pit exceeded the air-blast overpressure criteria of 120.0 dB. Maximum overpressure recorded at Moses Crossing and Jerrys Plains Village was 123.6 and 121.7 dBL respectively. Blasting was undertaken in accordance with internal blasting permissions and the HVO Blast Management Plan. Investigations revealed that a previously unidentified geological weakness in strata on the blast pattern was the most likely cause of a face burst and a top ejection shortly after initiation. This was determined to be the most likely cause of the overpressure exceedance. The incident was reported to the Department of Planning and Environment and the Environment Protection Authority. The EPA issued HVO with a Penalty Infringement Notice of $15,000 for this exceedance. Corrective and preventative actions identified to prevent re-occurrence included:

- Use of a balloon to see wind direction before shots are fired.
- Review permissions page and adjust firing permissions towards Jerry’s Plains.
- Recalibrate air blast model factors to ensure a similar blast does not pass the overpressure test in the blast model.

11.1.2 Incident 18 December 2018

Knodlers Lane blast monitor failed to capture complete blast monitoring results for two blasts initiated in the Cheshunt Pit. Both overpressure and vibration results were not captured for the shot at 13:19 and vibration data was not captured for the shot at 13:18. This miscapture was reported to the Department of Planning & Environment. An investigation into the cause of the miscapture was undertaken, indicating that the malfunction of the unit is suspected to have been caused by water ingress or lightening / power surges, over the week preceding the blast. A second monitor closer to the mine recorded blasting results below criteria which would indicate that the Knodlers lane blast monitor would not have recorded an exceedance.

The ground unit was exchanged for a calibrated ground unit on 19 December and following examination of the subsequent data captured, the control unit was also determined to have been affected which was exchanged on the 20 December.

Subsequently, software has been installed on all blast monitors that assist with rapid fault detection in order to prevent a re-occurrence of this incident.

11.2 Water

During 2018 there were two incidents related to water as summarised below.

11.2.1 Incident 11 May 2018

The Newdell fire water tank was found to be overflowing as the water supply (pumped from Dam 14W) continued to supply the tank despite reaching its full cut off level. The overflow water reported via a drainage line to Sump 060. The float operated pump on 060 failed to contain the volume of water in the sump which has then flowed to a culvert under the rail loop and into Bayswater Creek. The Creek was, at the time of the Incident, not flowing. Accordingly, the portion of the mine water that was discharged from the Sump did not commingle with the water contained in the Creek to a greater extent than 1,100m from the culvert to which the Sump was discharging. Any environmental impact to the Creek is likely to be very minor, with no evidence of harm to the flora and fauna of the Creek nor any apparent levels of pollutants likely to cause any such ongoing harm. This is particularly the case given the normally elevated salinity of Bayswater Creek, which has an electrical conductivity around 3500 uS/cm.

Once identified, the supply to the fire water tank was stopped and investigation commenced to determine extent and pathway of flow of water. A small pump was installed to stop the flow of water from the culvert, once contained recovery of the water in the creek commenced. Sampling was undertaken to determine water quality at the source and downstream of the flow.

Notifications were made to relevant authorities in accordance with HVO’s Pollution Incident Response Management Plan, EPL, Development Consent and Mining Lease.

An incident investigation was undertaken and deemed the cause of the overflow to be due to computer control logic (which controls pumps) not turning off the pump to the Firewater tank when it was full.

HVO undertook the following immediate actions in response to the incident:

- Ceased operation of pump N023 which caused the overflow of the Firewater tank;
- Enacted the Pollution Incident Response Management Plan (PIRMP) and notified the incident to all relevant agencies (in addition to EPA);
- Undertook water sampling at the source as well as at up and downstream locations;
- Disabled the PLC logic that had allowed pump N023 to be initiated by the Newdell truck wash tank;
- Installed a portable pump in culvert below Sump 060 to recover discharged water;
- Relocated the portable pump from the culvert once all water was recovered in the drainage line to Bayswater Creek to recover the remaining water;
- Recovered up to 4.3ML of water from Bayswater Creek. HVO then liaised with the EPA to cease water recovery.

A number of preventative actions have since been implemented, including:

- Re-programming the computer logic (PLC);
- Update of the Newdell water management procedure and training of Operators;
- Lowered set points for high level alarms on the Firewater tank;
- Implemented audible alarms;
- Removal of manual switches which could over-ride the computer logic.

HVO was issued two Penalty Infringement Notices from the EPA, totalling $30 000.

11.2.2 Incident 5 October 2018

An inspection following approximately 75mm of overnight rainfall identified turbid water flowing offsite and in to Farrell's Creek. Observations indicate that rainfall on disturbed areas in the upper pre-strip catchment had overtopped surface water management controls and flowed to lower catchment dams prior to reporting offsite with runoff generated from undisturbed catchment areas.

The rainfall recorded on 4 October 2018 significantly exceeded the design rainfall depth for the sediment dams. The total rainfall recorded on 4 October was 74.8 mm. This corresponds to a 33% Annual Exceedance Probability (AEP) 24 hour duration design rainfall total. The majority of the rainfall (70.0 mm) was recorded in a 6 hour period. This corresponds to a 6% AEP 6 hour duration design rainfall total. The 5 day 85th percentile design rainfall for sizing of the sediment dams (Type F soils) in accordance with the Blue Book is 27.7 mm.

HVO undertook the following immediate actions in response to the incident:

- The area was inspected following rainfall;
- Installation of additional windrows on disturbed surface within the W1 catchment to reduce the catchment size reporting to W1 (5/10/18);
- Dewatered Dam W1 (5/10/18), Farm Dam 1 (6/10/18), and Farm Dam 2 (7/10/18) and commenced pumping from Farrells Creek Dam (8/10/18);
- Investigated flow paths and extent;
- Installed sediment curtain in Farrells Creek Dam to lower turbidity of water from any further overflow;
- Conducted water sampling;
- Commenced maintenance work on existing surface water management controls to restore capacity. Identified work includes:
- Desilting of contours in the system (7/10/18, complete)
- Construction of an additional contour in the catchment above Farm Dam 1 and Dam W1 (8/10/18, complete)

Subsequent to the immediate controls, HVO undertook a review of the area and augmented the erosion and sediment controls to increase capacity to contain runoff water.

Notifications were made to relevant authorities in accordance with HVO’s Pollution Incident Response Management Plan, EPL and Development Consent on 5 October 2018.

11.3 Unauthorised Land Clearing

11.3.1 Incident 19 June 2018

HVO identified that approximately 242 m2 vegetation had been cleared on mine owned land subject to PA 06_0261. The clearing was identified to have been undertaken by a Telstra contractor for the purpose of upgrading their facility adjacent to the clearing. HVO did not provide authorisation for Telstra or any of its contractors to access this land or clear vegetation. As soon as property ownership was confirmed, HVO directed the contractor to cease all activities on its land, until they could demonstrate appropriate approvals and agreements were in place to permit the activity.

The incident was notified to the DP&E on Thursday 12 April 2018.

The area cleared was rehabilitated by the Telstra contractor.

11.4 Land Rehabilitation

11.4.1 Incident 19 June 2018

HVO identified that part of an overburden dump in the Glider Pit was approximately 10 m above the Obstacle Limitation Surface (OLS) for the Hunter Valley Gliding Club (HVGC). HVO subsequently reviewed weekly survey data and identified that an exceedance of the OLS first occurred between the 22 and 28 April 2018.

Schedule 4, Condition 48 of the project approval states that HVO must not conduct any activity associated with the project above the OLS unless agreed with HVGC. The dump plan was designed by the HVO Technical Services team in August 2017 and accompanied with a documented risk assessment identifying the need to notify the HVGC of the planned exceedance of the OLS and to obtain the agreement of HVGC prior to constructing the dump in this manner. This requirement was communicated internally but, regrettably, was not actioned.

HVO notified HVGC and the Department of Planning and Environment on Thursday 21 June 2018 as soon as HVO determined that HVGC had not indicated its agreement prior to HVO exceeding the OLS. In addition,

HVO acted promptly to lower the dump below OLS, with bulk push commencing on the week of 25 June 2018 and on 21 July 2018, confirmed that the reshaping of the landform in respect of the OLS had been completed.

In order to prevent a reoccurrence of this incident, HVO Technical Services Team has implemented an action tracking system within the mine planning process to ensure that actions pertaining to HVGC and the need to obtain its prior agreement in relation to any exceedances of the OLS are assigned to the correct people, are carried out and can be tracked and monitored.

12 ACTIVITIES TO BE COMPLETED IN 2019

12.1 Noise

Noise management improvements identified for implementation in 2019 include:

- Noise attenuation of up to 12 rear dump trucks; and
- Revision of the HVO Noise Management Plan.

12.2 Blasting

Blasting management improvements identified for implementation in 2019 include:

- Revision of the HVO Blast Management Plan; and
- Review internal blasting permission process.

12.3 Air Quality

Air Quality management improvements identified for implementation in 2019 include:

- Revision of the HVO Air Quality & Greenhouse Gas Management Plan;
- Aerial seeding of overburden that is temporarily unavailable for rehabilitation; and
- Continue to implement internal dust improvement programme including continuation of the chemical dust suppressant trial in West Pit.

12.4 Historic Heritage

The Hunter Valley Operations Joint Venture (HVOJV) will continue to consult with the neighbouring Liddell Coal Operations on any future mining plans that may interact with the Chain of Ponds Inn complex to ensure appropriate protective management measures are implemented where required.

12.5 Water

Improvements to mine water management in 2019 include:

- Implement pipeline and water infrastructure management projects to reduce potential for unauthorised water discharges;
- Review safe access to surface water monitoring location NSW1;
- Upgrading water transfer infrastructure including pumping from the Hunter River;
- Review of the groundwater monitoring network including monitoring locations and trigger levels; and
- Three yearly independent review of the HVO North groundwater model.

12.6 Rehabilitation

During the next reporting period key focus areas for HVO will be:

- Completion of 86ha of new rehabilitation;
- Continued progression of historic cover crop / weed management areas to final cover;
- Continuation of rehabilitation TARP characterisation inspections;
- Implementation of the TARP Intervention Work Plan following 2017 triggers and follow-up inspections and monitoring, and regulator commitments;

- Developing and sustaining improvements in site topsoil handling and management practices;
- Site preparations to enable initial construction of a micro-relief drainage landform; and
- Further develop opportunities for grazing access to suitable rehabilitation areas.

12.7 Tailing Storage Facility Capping

- Capping activities on Southeast TSF will continue during 2018 to progress rehabilitation of the remaining surface.
- Implementation of the Management Plan for North Void TSF, including groundwater modelling to assess effectiveness of current controls
- Commencement of deposition into Carrington In-Pit TSF and temporary cessation of deposition into North Void TSF

12.8 Community Development

Priority areas for community development in 2018 included education, economic development, community health, environment and land management. HVO currently support numerous programmes and sponsorships in relation to these priority areas with continuation and commencement of these into 2019.

12.9 Timeline for implementation of improvement projects

A proposed timeline for the improvement projects mentioned in Section 12 is shown below in Figure 103.

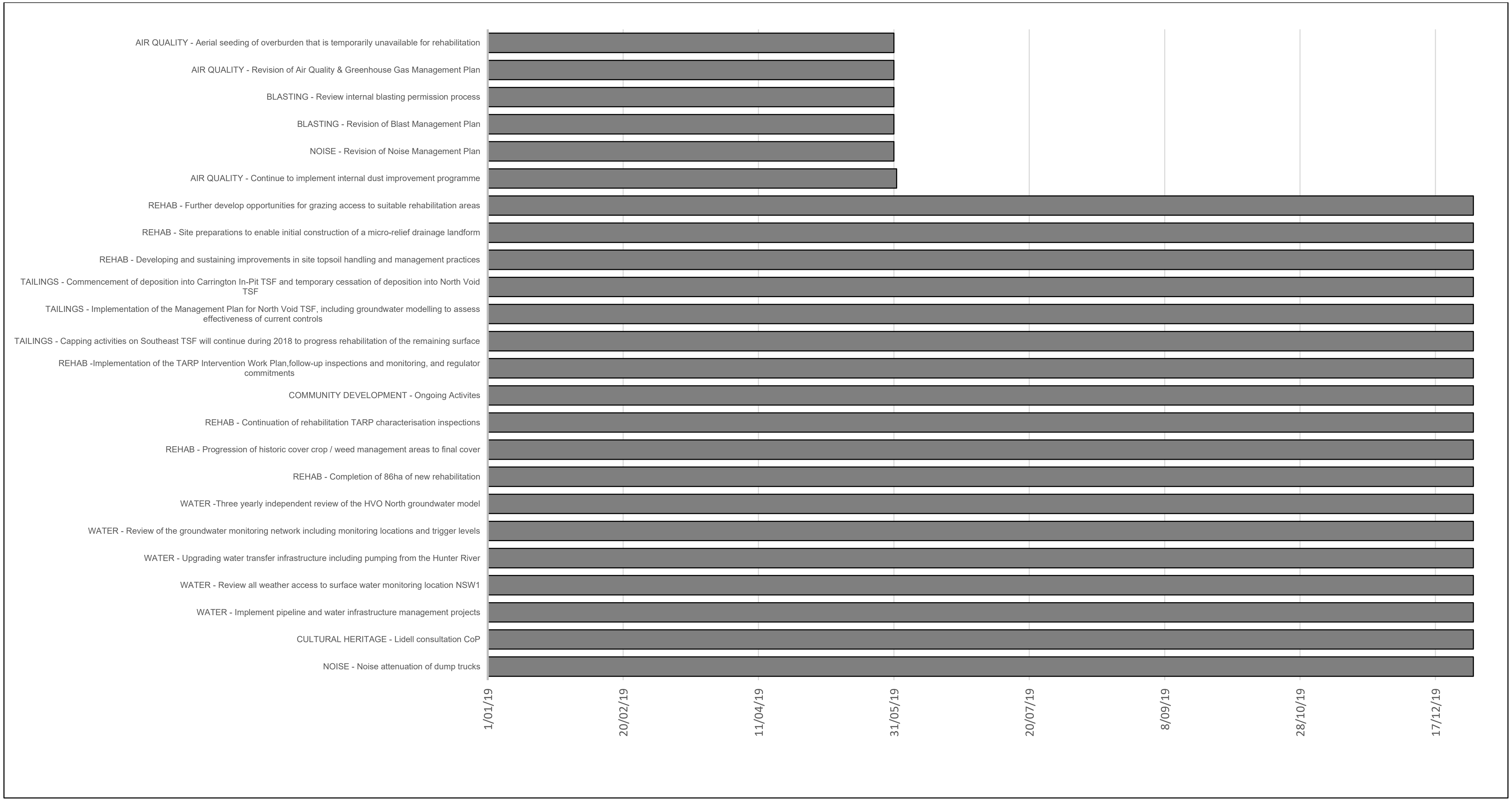


Figure 103: Proposed Timeline for Implementation of 2019 Improvement Projects

APPENDIX 1: ANNUAL GROUND WATER REVIEW 2018

HUNTER VALLEY OPERATIONS

Prepared for:

Hunter Valley Operations Pty Ltd
Singleton NSW

SLR Ref: 620.12182-R11
Version No: v3.0
July 2019

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Level 2, 15 Astor Terrace
Spring Hill QLD 4000 Australia
(PO Box 26 Spring Hill QLD 4004 Australia)
T: +61 7 3858 4800   F: +61 7 3858 4801
E: brisbane@slrconsulting.com   www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Hunter Valley Operations Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
620.12182-R11-v3.0	11 July 2019	Kirsty Cooksey	Claire Stephenson Andrew Speechly	Claire Stephenson
620.12182-R11-v2.0	27 March 2019	Kirsty Cooksey	Claire Stephenson Andrew Speechly	Claire Stephenson
620.12182-R11-v1.0	11 March 2019	Kirsty Cooksey	Claire Stephenson	Claire Stephenson

CONTENTS

CONTENTS

CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

CONTENTS

APPENDICES

1 Introduction

1.1 Overview

The Hunter Valley Operations (HVO) mining complex is located approximately 20 km north-west of Singleton, NSW. As part of compliance with mine approval conditions, routine groundwater monitoring is conducted across HVO, and the data reviewed and analysed on an annual basis. The annual groundwater review is required for:

- HVO North in accordance with Condition 27 of Development Consent (DA 450 10 2003) and individual bore license conditions (20BL173587-89 and 20BL173847).
- HVO South in accordance with Condition 28 of the Project Approval (PA 06 0261 24) and licence conditions for Lemington Underground (LUG) Bore (20BL173392).
- Individual bore license conditions (20BL173587-89, 20BL173847 and 20BL173392).

This report presents the annual groundwater review for HVO, developed in accordance with the approval conditions and requirements outlined within the Water Management Plan (WMP).

1.2 Scope

The scope of work for this review included analysis of monitoring data and reporting. This report presents:

- Site background:
  - Legislative requirements and conditions relevant to groundwater;
  - Mine activities over reporting period;
  - Hydrogeological regime; and
  - Groundwater monitoring network and program.
- Data review:
  - Review and illustration (i.e. hydrographs) of groundwater level trends;
  - Review and illustration (i.e. hydrographs) of groundwater quality trends; and
  - Comparison of water level and quality trends to relevant trigger levels and natural trends (i.e. surface water levels and rainfall);
- Discussion of groundwater impacts and compliance over the reporting period and provision of recommendations (where required).

2 HVO Complex

The following section provides a description of the HVO Complex of relevance to this annual groundwater review. The general site layout is presented in **Figure 2-1**.

2.1 Mine operations

Table 2-1 presents a summary of mine areas across HVO, approved mining timeframes and activities conducted over 2018. Overall, mining was active at West Pit, Cheshunt Pit, and Riverview Pit over 2018, with rehabilitation of Glider Pit also in 2018.

Table 2-1 Summary of HVO Activities

Mine Area	Seam Mined To	Approved Life of Mining	2018 Activities
West Pit	Bayswater to Hebden seams	1949 to 2025	Mining active
North Pit	Vaux Seam	1979 to 2003	Inactive – fully rehabilitated
Alluvial Lands	Vaux Seam	1993 to 2003	Inactive – fully rehabilitated
Carrington Pit	Bayswater Seam	2000 to 2021	Inactive – not rehabilitated (open pit)
Carrington West Wing	Bayswater Seam	Not commenced	Not commenced
Cheshunt Pit	Vaux & Bayswater seams	2002 to 2030	Mining active – down to the Bayswater Seam
Riverview Pit	Vaux & Bayswater seams	1997 to 2030	Mining active – down to the Vaux Seam
Glider Pit	Vaux Seam	2016 – 2017	Mining completed in 2017 and fully backfilled.
Lemington South Pit 1	Bowfield Seam Warkworth Seam	1998 to 2006 2019 to 2030	Inactive – rehabilitated with final void/pit lake present. Used for water storage from LUG Bore abstraction

As of the 28th February 2018 the Planning Assessment Commission granted consent for the HVO South Modification 5. These approved operations are reflected in **Table 2-1**, which includes mining of the Riverview Pit down to the Bayswater seam.

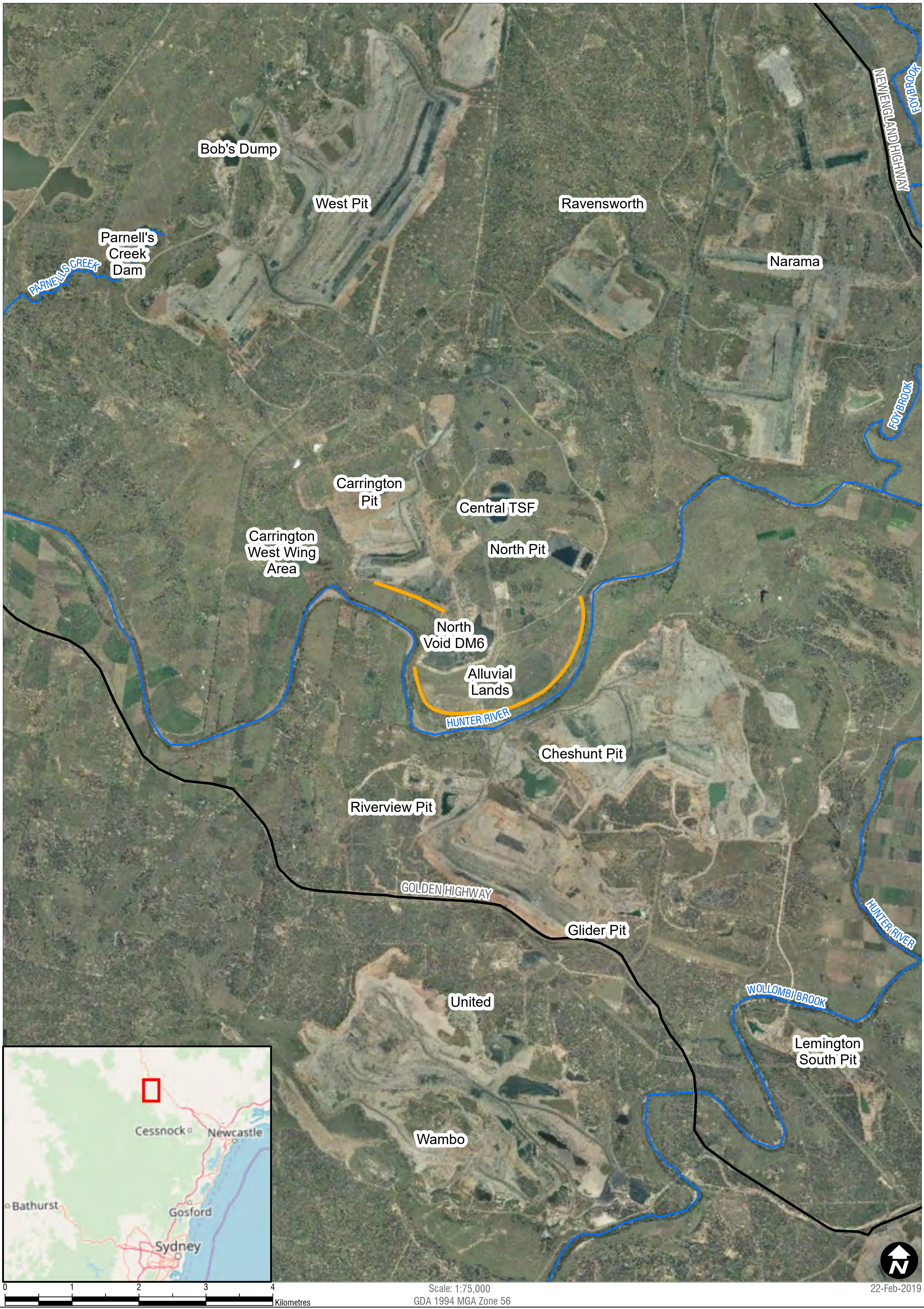
A range of tailings storage facilities (TSF) are present across HVO, as summarised in **Table 2-2**. The TSF's are managed in accordance with the site Fine Rejects Management Strategy, which includes decant requirements to enable better consolidation of the material.

Table 2-2 Summary of approved tailings storage facilitates at HVO

Mine Area	Location	Status
Dam 6W	West Pit	Active over 2018
Bob's Dump (20W)	West Pit	Inactive over 2018
North Void (DM6)	North Pit	Active over 2018
Southeast TSF (27N)	North Pit	Inactive – capping commenced 2016
Central TSF (28N)	North Pit	Inactive over 2018
Carrington Out of Pit Fine Reject Emplacement (COOP FRE)	Carrington area – out of pit emplacement.	Approved, not yet constructed
Carrington In Pit Fine Reject Emplacement	Carrington area – in pit emplacement	Void area over 2018, to commence emplacement in 2019

Over 2018 only two areas were actively used for tailings storage, Dam 6W at West Pit and North Void (DM6) at North Pit.

Groundwater was also abstracted from the Lemington Underground Bore (LUG) during 2018. LUG Bore is a production bore constructed into the historical Lemington Underground beneath HVO that mined the Mt Arthur Seam of the Whittingham Coal Measures, with this mine having been inactive since 1999.



H:\Projects-SLR\620-BNE\620-BNE\620.12182 HVO Groundwater Compliance\06 SLR Data\01 GIS\01 ArcGIS\SLR62012182_F02_Locality_001.mxd

Sheet Size : A4

SLR

www.slrconsulting.com.au

Hunter Valley Operations
2018 Groundwater Level and Quality Review
Locality Map

Figure 2.1

2.2 Groundwater Impacts

Groundwater impacts associated with the approved operations at HVO have been progressively assessed for each mining area, including:

- Alluvial Lands Project Groundwater Assessment (MMA 1992);
- Carrington Pit Groundwater Assessment (MER 1998);
- West Pit Extension Groundwater Assessment (MER 2003);
- Carrington Pit Extended Groundwater Assessment (MER 2005);
- Carrington West Wing Groundwater Assessment (MER 2010);
- HVO South Groundwater Assessment (ERM 2008);
- HVO North Modification 4 Groundwater Assessment – Carrington Out of Pit Fine Reject Emplacement (AGE 2013b);
- HVO North Modification 6 Groundwater Assessment – Carrington In Pit Fine Reject Emplacement (AGE 2016); and
- HVO South Modification 5 Groundwater Assessment (AGE 2017).

The most recent groundwater assessment that captures operations across HVO North and HVO South was the HVO South Modification 5, which was granted consent by the Planning Assessment Commission on 28th February 2018. The groundwater assessment for Modification 5 was completed by AGE (2017), and included development of a numerical groundwater model to represent groundwater response to approved mine activities and the proposed modification. AGE (2017) reported on predicted impacts associated with approved operations over 2017 (model Year 2). The approved operations included mining at Cheshunt Pit, Riverview Pit, Glider Pit and West Pit, as well as surrounding non-HVO mining operations (i.e. Ravensworth, Mt Thorley Warkworth etc) and abstraction from the LUG Bore. Existing (2015) groundwater conditions and groundwater response to approved mining, as reported by AGE (2017), indicated:

- Groundwater within the hard rock units (i.e. Whittingham Coal Measures) is directly intercepted by approved operations at HVO;
- Groundwater within the confined to semi-confined Permian coal measures became depressurised around the area of active mining. Groundwater drawdown responses were observed around 2 km to 6 km from active mine areas within the Permian coal measures;
- There is no direct interception of groundwater within alluvium for active mine operations at HVO. However, historically the South Lemington Pit 1 footprint did directly intercept alluvium and barrier walls were established at Alluvial Lands and Carrington Pit to separate mine areas from alluvium; and
- With depressurisation of the coal measures, the model predicted a reduction in upward seepage to the alluvium that was referred to as ‘indirect take’.

These findings largely aligned with historical groundwater assessments conducted for the approved operations across HVO. Groundwater licenses have been obtained for the approved operations, as discussed in **Section 2.3**. Management and monitoring requirements of potential groundwater related impacts from approved operations are captured within the development consent conditions.

- Condition 27 of Development Consent (DA 450 10 2003) for HVO North, last updated January 2017 for Modification 6 and again in July 2017 (no changes to groundwater conditions in July); and
- Condition 28 of the Project Approval (PA 06 0261 24) for HVO South, last updated October 2012.

These conditions are addressed within the site Water Management Plan (WMP). Further discussion on the monitoring and management requirements is included within **Section 2.4**.

2.3 Groundwater Licensing

Under the *Water Act 1912* and *Water Management Act 2000*, adequate water licences are required for approval of the mine developments. Groundwater licenses held for HVO are outlined in **Table 2-3**.

Table 2-3 HVO Groundwater Licenses

License Number	Description	WSP	Water Source - Management Zone	Approved Extraction (ML)
WAL 40462	HVO Pit Excavations – Alluvial Lands Bores	North Coast Fractured and Porous Rock	Permian Coal Seams	2,400
WAL 40463				180
WAL 40466				460
WAL41527	HVO North – Carrington Pit			700
WAL41533	HVO North Pit Excavation			20
WAL39798	Lemington Underground (LUG) Bore			1,800
WAL18127	Carrington BB1	Hunter Unregulated and Alluvial Water Sources	Hunter Regulated River Alluvial Water Source – Upstream Glennies Creek Management zone	383
WAL18158	Ollenberry			65
WAL18307	HVO West – Parnells Creek Dam (Diversion Works Bywash)		Jerrys Management Zone Jerrys Management Zone	500
WAL18327	HV Loading Point Pump Bayswater Creek (Diversion Works)			150
WAL36190	HVO North, old farm bore			120
WAL23889	Greenleek		Lower Wollombi Brook Water Source	144
WAL962 (20AL201237)	Surface water access – West Pit area	Hunter Regulated River Water Source	Hunter River (Zone 1b) between Goulburn River junction and Glennies Creek junction.	3,165

License Number	Description	WSP	Water Source - Management Zone	Approved Extraction (ML)
WAL970, WAL1006 & WAL1070 (20AL201256, 20AL201337 & 20AL201500)	Surface water access – HVO North and HVO South areas		Hunter River (Zone 2a) between Glennies Creek junction and Wollombi Brook junction.	1,500 (500 each)

2.4 Groundwater Conditions

In accordance with the development consent approval conditions, HVO are required to prepare and implement a Water Management Plan (WMP) to the satisfaction of the Director-General. **Table 2-4** presents a summary of the relevant groundwater conditions from the development consent and WMP. The table identifies where the conditions relating to routine groundwater monitoring for 2018 have been addressed.

Table 2-4 Groundwater Conditions within WMP

Approval Condition	Condition	Where Addressed
Sch. 3, Cond. 27(c) (PA 06_0261)	A groundwater monitoring program that includes:	
	• Additional baseline data of groundwater levels yield and quality in the region, and privately-owned groundwater bores, which could be affected by the project;	See WMP No private bores predicted to be impacted for current approved operations and no monitoring of private bores.
	• Groundwater impact assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts of the project; and	See **Section 4.3** for criteria and **Section 5** for comparison to triggers
	• *A program to monitor:* o *Groundwater inflows to the open cut mining operations; and*	See WMP
	o *Impacts of the project on the region's aquifers, any groundwater bores, and surrounding watercourses, and in particular, the Hunter River and Wollombi Brook and adjacent alluvium; and*	See **Section 5**
Sch. 4, Cond. 27(c) (DA450-10-2003)	*A Groundwater Management Plan, which includes:*	
	• *Detailed baseline data on groundwater levels, yield and quality in the region, and privately- owned groundwater bores, that could be affected by the development;*	See WMP

Approval Condition	Condition	Where Addressed
	• *Groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts;*	See **Section 4.3** for criteria and **Section 5** for comparison to triggers
	• *A program to monitor:*	
	o *Groundwater inflows to the open cut mining operations;*	See WMP
	o *the impacts of the development on:* ▪ *The alluvial aquifers, including additional groundwater monitoring bores as required by NOW;*	See **Section 5**
	▪ *The effectiveness of the low permeability barrier;*	See **Section 5**
	o *Base flows to the Hunter River;*	Groundwater trends reviewed in **Section 5**
	o *Any groundwater bores on privately-owned land that could be affected by the development; and*	No private bores predicted to be impacted for current approved operations and no monitoring of private bores.
	o *Groundwater dependent ecosystems, including the River Red Gum Floodplain Woodland EEC located in the Hunter River alluvium;*	See WMP
	o *The seepage/leachate from water storages, backfilled voids and the final void;*	See **Section 5** – including discussion on groundwater trends within North Pit spoil.
Sch. 4, Cond. 27(c) (DA450-10-2003)	• *A program to validate and recalibrate (if necessary) the groundwater model for the development, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions;*	See **Section 5.5**
HVO SOUTH, Appendix 3 to HVO South Approval	*In addition to the mitigation measures undertaken at HVO for groundwater management, the following controls specific to the proposal will be implemented:* • *Groundwater Flow To and From Rivers:* o *development of protocols for monitoring and reporting of NOW stream gauge results to clearly record any reductions in flows that are attributed to mining. This will*	See Surface Water Review

Approval Condition	Condition	Where Addressed
	include monitoring Hunter River flows immediately up gradient and down gradient of the site. In addition, consideration will be given to tying in specific CNA water level recordings with current NOW gauging locations;	
	o *monitoring of groundwater elevations within alluvium between the Hunter River and the Cheshunt Pit; and*	See **Section 5**
	o *measured groundwater elevations and river flow will be assessed against predictions to determine whether application of additional management measures is required; and*	See **Section 5**
	o *offset seepage to pits in accordance with regulatory requirements.*	See WMP

Additional conditions are in place for the approved Carrington West Wing; however, mining has not commenced here and there are no current plans to commence these operations in the near future.

Groundwater monitoring is conducted in accordance with the Groundwater Monitoring Program outlined within **Appendix A** of the WMP. The program outlines groundwater monitoring frequency, parameters to be tested and groundwater triggers for electrical conductivity (EC) and pH. The WMP was updated in October 2018, including updates to the monitoring network and trigger levels. This annual review is based upon the monitoring and reporting requirements documented within the October 2018 version of the WMP. Further discussion on the groundwater monitoring program and triggers is included in **Section 4**.

3 Hydrogeological Setting

This section presents a brief summary of the hydrogeological setting for HVO. This includes discussion on climate, terrain, drainage, geology and groundwater bearing units.

3.1 Climate, Terrain and Drainage

3.1.1 Climate

The climate of the HVO region can be classed as temperate and is characterised by hot summers and mild dry winters. Rainfall data is available from Bureau of Meteorology (BoM) Station 61086 (Jerrys Plains) from 1900 to 2014, Station 61191 (Bulga South) from 1959 to present and Station 61397 from 1900 to present. **Table 3-1** provides the average monthly rainfall data, as well as the 2018 monthly data.

Table 3-1 Long Term Average and 2018 Climate Data

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average Historical	73	71	60	47	39	46	40	35	39	50	60	68	**627**
2018 Rainfall	5	55	63	14	8	29	2	21	24	74	49	51	**450**

A cumulative deviation from mean (CDM) rainfall plot is provided as **Figure 3-1** to illustrate long term climate trends in the HVO area, based on the average rainfall across the three BoM stations. The CRD graphically shows trends in recorded rainfall compared to long-term averages and provides a historical record of relatively wet and dry periods. A rising trend in slope in the CRD graph indicates periods of above average rainfall, whilst a declining slope indicates periods when rainfall is below average. A level slope indicates average rainfall conditions. As shown in **Figure 3-1** below, the region has generally experienced below average rainfall from 2016.

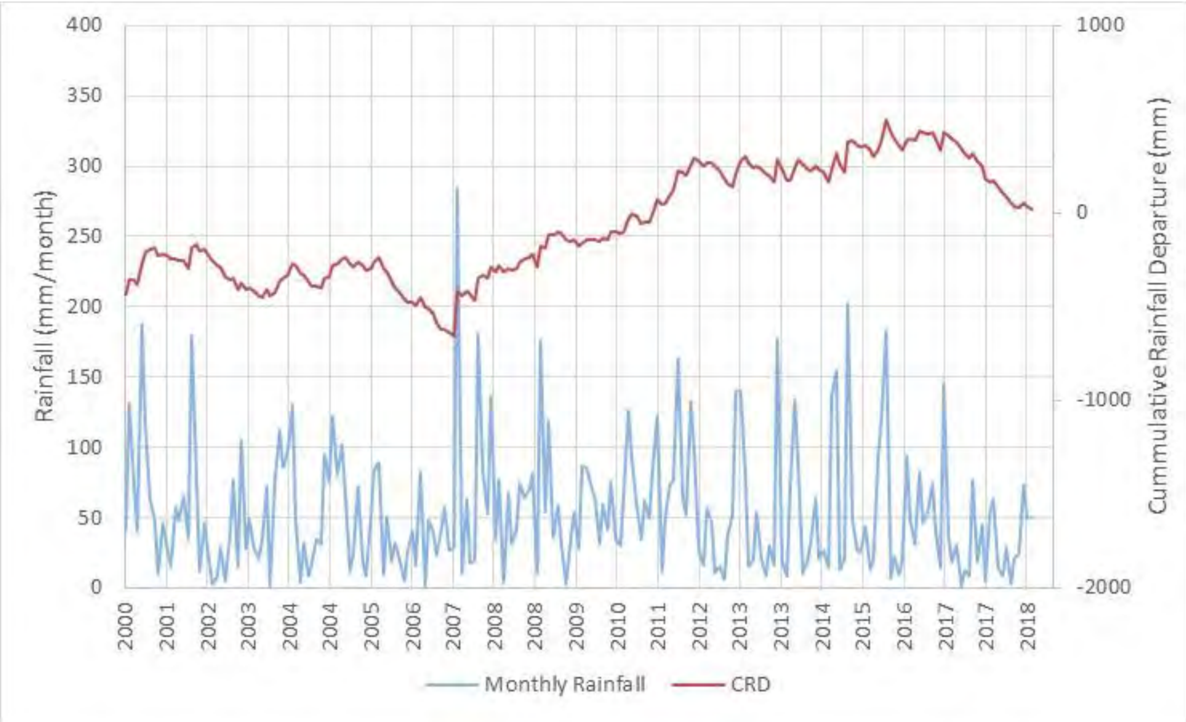


Figure 3-1 Cumulative Rainfall Departure and Monthly Rainfall

3.1.2 Terrain and Drainage

The HVO site terrain and surface drainage is dominated by the easterly flowing Hunter River which dissects the complex in a general east-west direction. Ground elevations range between 60 m Australian Height Datum (mAHD) along the Hunter River alluvial plains to 180 mAHD in the northern parts of HVO North and in the western parts of HVO South. Minor ephemeral drainage features are also present around HVO North (i.e. Parnells Creek, Farrells Creek and Bayswater Creek) and HVO South (Wollombi Brook), draining into the Hunter River.

Real time stream flow data is monitored along the Hunter River and Wollombi Brook at DPI Water gauging stations via the Hunter Integrated Telemetry System (HITS). Time series river water elevations (mean level above zero gauge elevation) is presented in **Figure 3-2** for three HITS stations (Hunter River @ Liddell, Hunter River @ U/S Foy Brook and Wollombi Brook @ Warkworth) as well as four locations monitored monthly at HVO (WL03, WL05, WL10 and WL14).

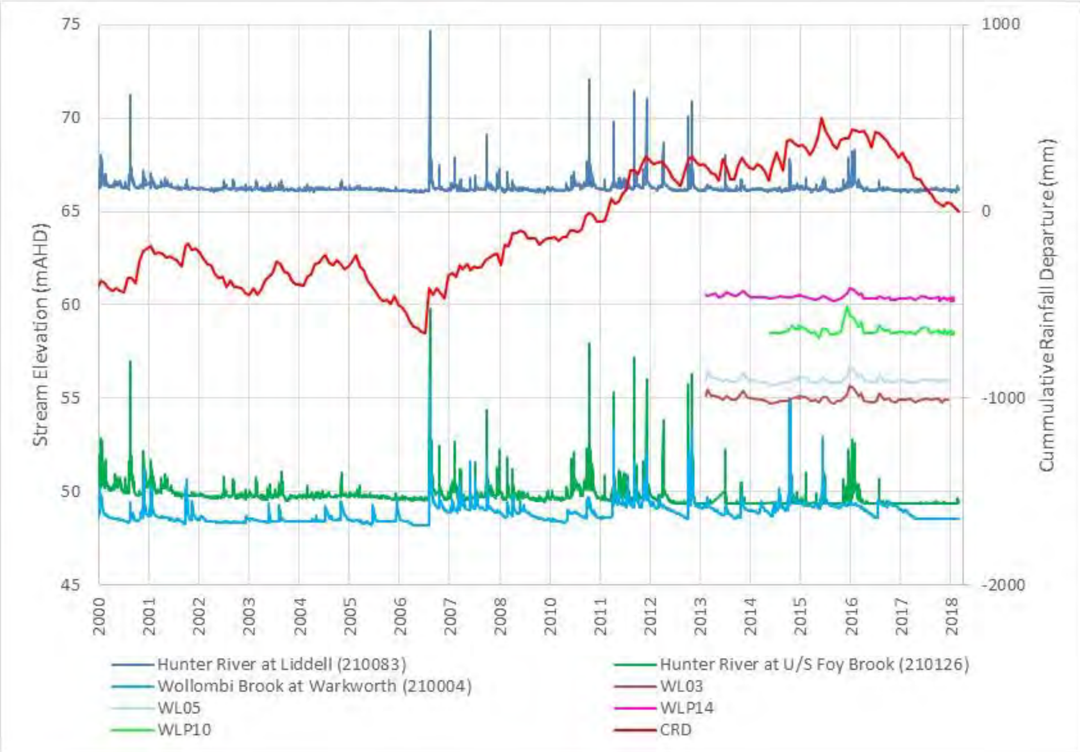


Figure 3-2 Surface Water Levels

As shown in **Figure 3-2**, over 2018 stream elevations within the Hunter River ranged from 66 mAHD upstream at Liddell, down to 49 mAHD at Foy Brook. Over 2018, stream elevations within Wollombi Brook remained fairly static, ranging between 48.5 mAHD and 48.6 mAHD.

3.2 Geology

HVO lies within the Hunter Coalfields, which are dominated by the Permian aged Whittingham Coal Measures of the Sydney Basin. The Whittingham Coal Measures are made up of the Jerrys Plains Sub-group and Van Sub-group. These units comprise economic coal seams along with overburden and interburden consisting of sandstone, siltstone, tuffaceous mudstone and conglomerate. The Whittingham Coal Measures are truncated to the east by the Hunter-Mooki Thrust Fault and occur at HVO as stratified (layered) sequences that dip at a shallow angle (2^0 to 5^0) to the south-west. The coal seams subcrop to the north and east of HVO.

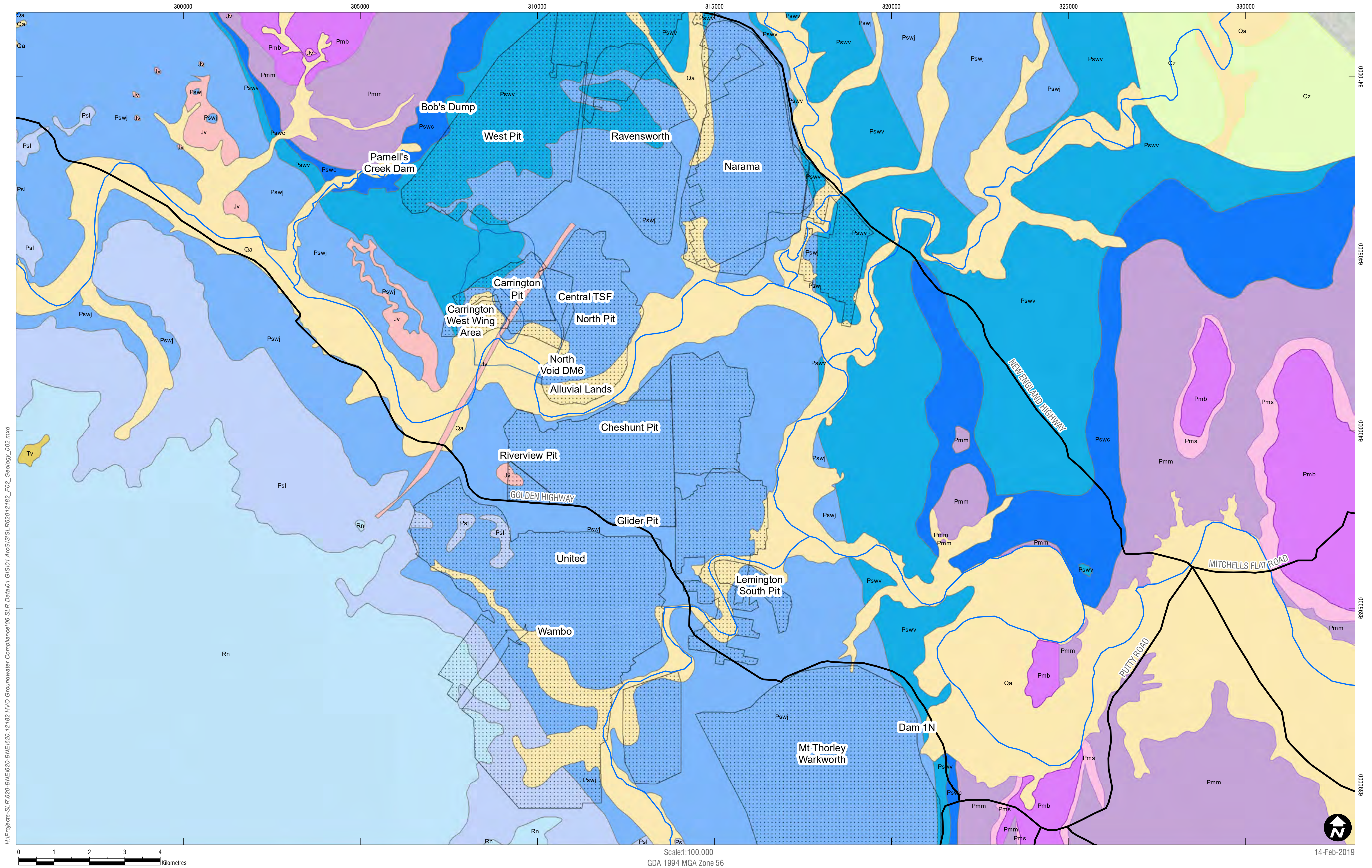
At HVO North the Whittingham Coal Measures are incised by a palaeochannel of the Hunter River (**Figure 3-3**). The properties and extent of the palaeochannel were assessed and mapped by MER (2008). The palaeochannel comprises heterogeneous distribution of silts, sands and gravels.

Along the Hunter River and Wollombi Brook thin Quaternary alluvial deposits unconformably overlie the Permian strata. The alluvial deposits comprise surficial fine grained sediments (i.e. silts and clays). Along major watercourses (i.e. Hunter River and Wollombi Brook) the surficial sediments overly basal sands and gravels that are between 7 m to 20 m thick.

Table 3-2 presents a summary of site geology and **Figure 3-3** presents a map of the geology of the HVO site and surrounds.

Table 3-2 HVO Generalized Stratigraphy

Age	Stratigraphic Unit		Description
Cainozoic	Quaternary sediments - alluvium (Qa)	Surficial alluvium (Qhb)	Shallow sequences of clay, silty sand and sand.
		Productive basal sands/gravel (Qha)	Basal sands and gravels along major watercourses (i.e. Hunter River).
	Silicified weathering profile (Czas)		Silcrete
	Alluvial terraces (Cza)		Silt, sand and gravel
Jurassic	Volcanics (Jv)		Flows, sills and dykes
Permian	Whittingham Coal Measures	Jerrys Plains Sub-group (Pswj)	Coal bearing sequences interbedded with sandstone and siltstone. Coal seams (youngest to oldest) include Whybrow Seam, Redbank Creek Seam, Wambo Seam, Whynot Seam, Blakefield Seam, Glen Munro Seam, Woodlands Hill Seam, Arrowfield Seam, Bowfield Seam, Warkworth Seam, Mt Arthur Seam, Piercefield Seam, Vaux Seam, Broonie Seam and Bayswater Seam.
		Archerfield Sandstone	Lithic sandstone marker bed.
		Vane Sub-group (Pswv)	Coal bearing sequences interbedded with sandstone and siltstone. Coal seams (youngest to oldest) include Lemington Seam, Pikes Gully Seam, Arties Seam, Liddell Seam, Barrett Seam and Hebden Seam.



Mine Areas
Palaeochannel (MER)

Hunter Coalfields 100k Geology

Qa - Quaternary Alluvium
Tv - Tertiary Basalt
Jv - Jurassic Volcanics
Rn - Narrabean Group
Psl - Newcastle Coal Measures
Pswj - Jerrys Plains Subgroup
Pms - Muree Sandstone
Pgr _ Rowan Formation
Pswv - Archerfield Ss. Vane Subgroup
Pswc - Saltwater Creek Formation
Pmm - Mulbring Siltstone
Pmb - Branxton Formation
Cz - Carboniferous tuff and ignimbrite

Sheet Size : A3

SLR
www.slrconsultingaustralia.com.au

Hunter Valley Operations
2018 Annual Groundwater Review
Surface Geology

Figure 3-3

3.2.1 Groundwater Units

The principal groundwater units at HVO and its immediate surrounds are the productive alluvium associated with the Hunter River and Wollombi Brook, and the Permian coal seams of the Whittingham Coal Measures. Description of the groundwater units was derived from historical groundwater assessment reports, discussed in **Section 2.2**.

3.2.2 Alluvium

The Quaternary alluvium is an unconfined groundwater system that is recharged by rainfall infiltration, streamflow and upward leakage from the underlying stratigraphy, particularly in undisturbed areas (i.e. away from active mining). The potentiometric surface and flow direction within the alluvium is a subdued reflection of topography. Groundwater within the Hunter River alluvium flows in an easterly direction, while water within the Wollombi Brook alluvium flows in a north to north-easterly direction towards the Hunter River.

Regionally, the Hunter River and Wollombi Brook are predominantly gaining water from the surrounding alluvium, as well as from rainfall and regulated flow (i.e. dam releases). However, there are also areas where the rivers recharge the underlying alluvium. These losing conditions can occur around areas of active mining, where the hydraulic gradient is increased due to depressurisation of the underlying coal measures. Losing conditions also occur within the more topographically elevated tributaries of the main water courses, where the water table is deeper and not connected directly to the streams.

While “less productive” groundwater within the surficial alluvium does not meet the ANZECC (2000) water quality guidelines for stock water supply, the “highly productive” alluvium (basal sands and gravels) is considered suitable for stock water supply from a water quality perspective. However, most agricultural producers (crop and cattle) utilise surface water resources (Hunter River and Wollombi Brook) in preference to alluvial groundwater.

The alluvial aquifer of the Hunter River supports Carrington Billabong, an ephemeral freshwater wetland located south of Carrington Pit that is considered a Groundwater Dependant Ecosystem (GDE). Alluvial groundwater levels around Carrington Billabong have remained relatively stable during active mining at Carrington Pit. This is due to installation of a barrier wall through the unconsolidated alluvial sediments, which separates the Billabong from Carrington Pit. The stable alluvial groundwater levels in this area are also taken to indicate limited hydraulic connection between the nearby palaeochannel alluvium and the underlying depressurised coal measures.

3.2.3 Permian Coal Measures

The Whittingham Coal Measures outcrop across the north to east of HVO. The coal measures form unconfined groundwater systems at outcrop, becoming semi-confined to confined as they dip towards the south-west.

Recharge occurs from direct rainfall to the ground surface, infiltrating into the formations through the thin soil cover and weathered profile. The coal measures also occur at subcrop in localised zones beneath alluvium associated with the Hunter River and Wollombi Brook, where the unit is recharged by downward seepage where gradients promote this flow.

The coal seams are typically moderately to slightly permeable, whilst the hydraulic conductivity of the interburden material is generally less than coal seams but is more variable, depending on the predominance of fractures in the rock mass. The hydraulic conductivity of the coal seams generally decreases with depth due to the closure of the cleats with increasing stratigraphic pressure.

The direction of groundwater flow for the Whittingham Coal Measures is influenced by the local geomorphology and structural geology, as well as the long history of mining within the region which has significantly altered groundwater flow paths within the Permian units. Groundwater flow in the Permian aquifers on a regional scale follows the regional topography, flowing in a north-easterly direction. However, on a local scale groundwater levels show drawdown impacts associated with the extensive active mining areas. Groundwater discharge from the Whittingham Coal Measures currently occurs as discharge to active mining and abstraction bores, as well as upward seepage to the Quaternary alluvium where hydraulic gradients promote this flow.

There is no significant usage of groundwater from the Permian coal measures, likely due to the poor quality that generally exceeds ANZECC (2000) water quality guidelines for stock supply, and presence of perennial surface water flows (Hunter River and Wollombi Brook) and the more productive alluvial aquifer.

4 Groundwater Monitoring

4.1 Groundwater Monitoring Programme

Groundwater monitoring is conducted at HVO in accordance with the HVO WMP, specifically the Groundwater Management Plan and Groundwater Monitoring Programme. The monitoring results are used to establish and monitor trends in physical and geochemical parameters of surrounding groundwater potentially influenced by mining.

The monitoring programme at HVO measures the Standing Water Level (SWL) in monitoring bores, reported as elevation (mAHD). The data is compared against background data, EIS predictions and historical trends as a means of assessing any HVO related impacts to the quantity of groundwater in the various aquifers.

The monitoring programme at HVO also assesses the quality of groundwater against background data and historical trends. Groundwater quality is evaluated through the parameters of pH and electrical conductivity (EC). On a periodic basis (nominally once per annum) a comprehensive suite of analytes is measured, including major anions, cations and metals. Prior to sampling for comprehensive analysis, bore purging is undertaken to ensure a representative sample is collected.

Groundwater quality monitoring data is reviewed on a quarterly basis. The review involves a comparison of measured pH and EC results against internal trigger values which have been derived from the historical data set. Trigger limits are calculated as the 95th percentile maximum value (EC and pH) and the 5th percentile minimum value (pH only) from data collected since 2011. Trigger levels have been set based on geographical proximity and target stratigraphy.

The groundwater monitoring network at HVO comprises a total of 104 bores that require routine monitoring in accordance with the WMP, with an additional 33 bores monitored across the site. The bores are installed into a number of geologic units. As outlined within the WMP, bores are grouped into one of eight Locations, as summarised below:

- West Pit (HVO North)
- North Pit (HVO North – historical mine area fully rehabilitated)
- Carrington (HVO North – historical mine area)
- Carrington West Wing - CWW (HVO North – approved mine area but not yet commenced)
- Cheshunt/North Pit (HVO North and HVO South - bores located between North Pit and Cheshunt Pit)
- Cheshunt (HVO South – south of Hunter River)
- Lemington South – Lemington (HVO South – near Wollombi Brook)
- Southern (HVO South – unmined area east of Lemington South Pit 1)

The details of each of the HVO monitoring bores as well as each bores respective monitoring program are provided in **Appendix A** and the location of the bores are presented in **Figure 4-1** to **Figure 4-3**. Of the 137 bores in the network, 104 bores have trigger levels set.

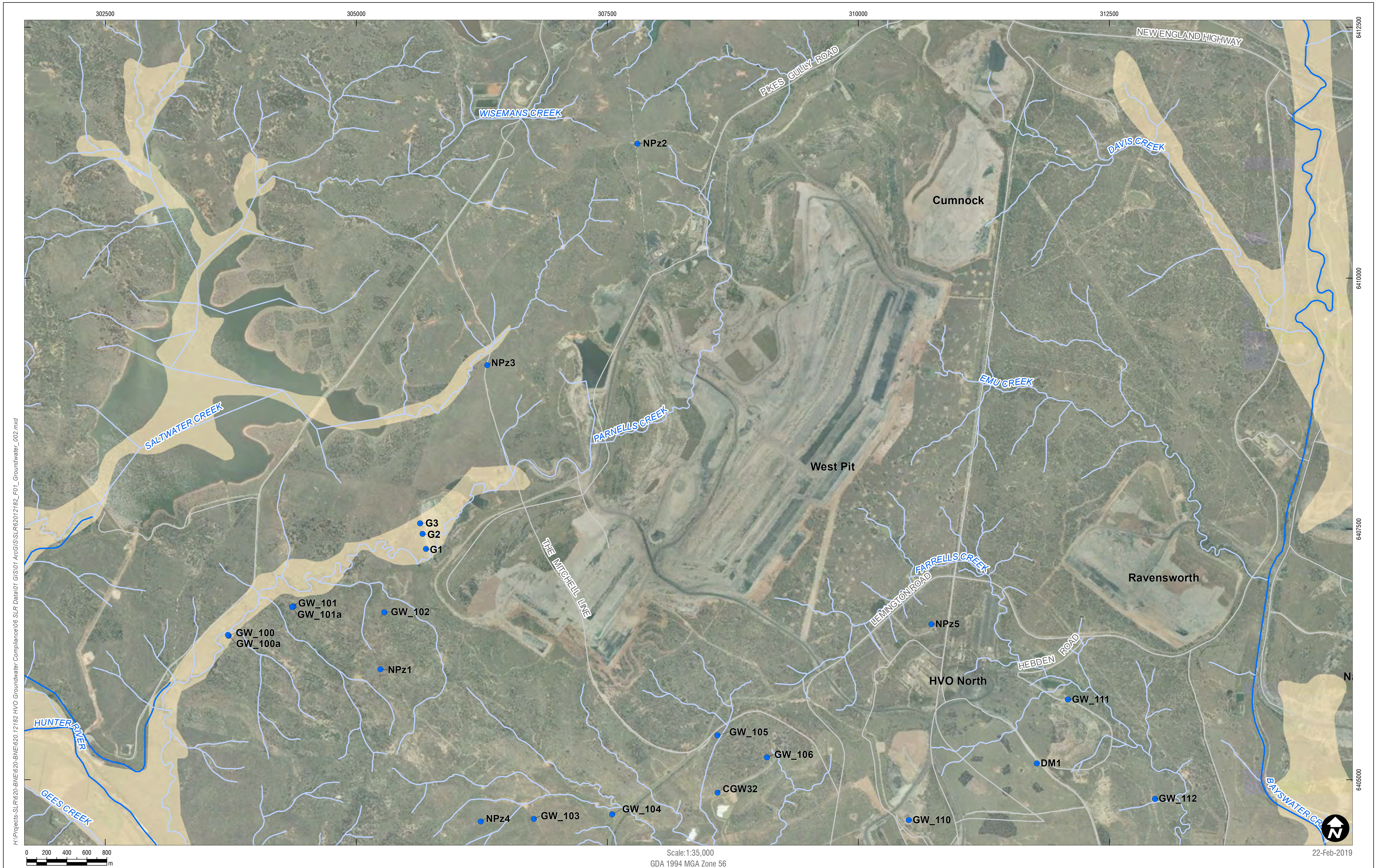
As outlined in **Appendix A**, full laboratory water quality analysis is required to be conducted for 65 of the 137 bores, either 6-monthly (27 bores) or annually (38 bores). There are also two different laboratory analytical suites used, as follows:

Comprehensive analysis 1

- TDS;
- Major Ions (Ca, Cl, K, Na, SO_4 (or S), CO_3);
- Total Alkalinity, Bicarbonate Alkalinity, Carbonate Alkalinity, Hydroxide Alkalinity; and
- Metals (Al, As, B, Cd, Cu, Hg, Mg, Ni, Pb, Se, and Zn).

Comprehensive analysis 2

- TDS;
- Major ions (Ca, Cl, K, Na, SO_4 (or S), CO_3);
- SiO_2;
- Total Alkalinity, Bicarbonate Alkalinity, Carbonate Alkalinity, Hydroxide Alkalinity;
- Metals (Al, As, B, Be, Cd, Co, Cu, F, Fe, Hg, Mg, Mn, Pb, Rb, Sb, Se, Sr, Zn); and
- Nutrients (Ni, NH3, NO2, NO3 and P).



Sheet Size : A3

SLR

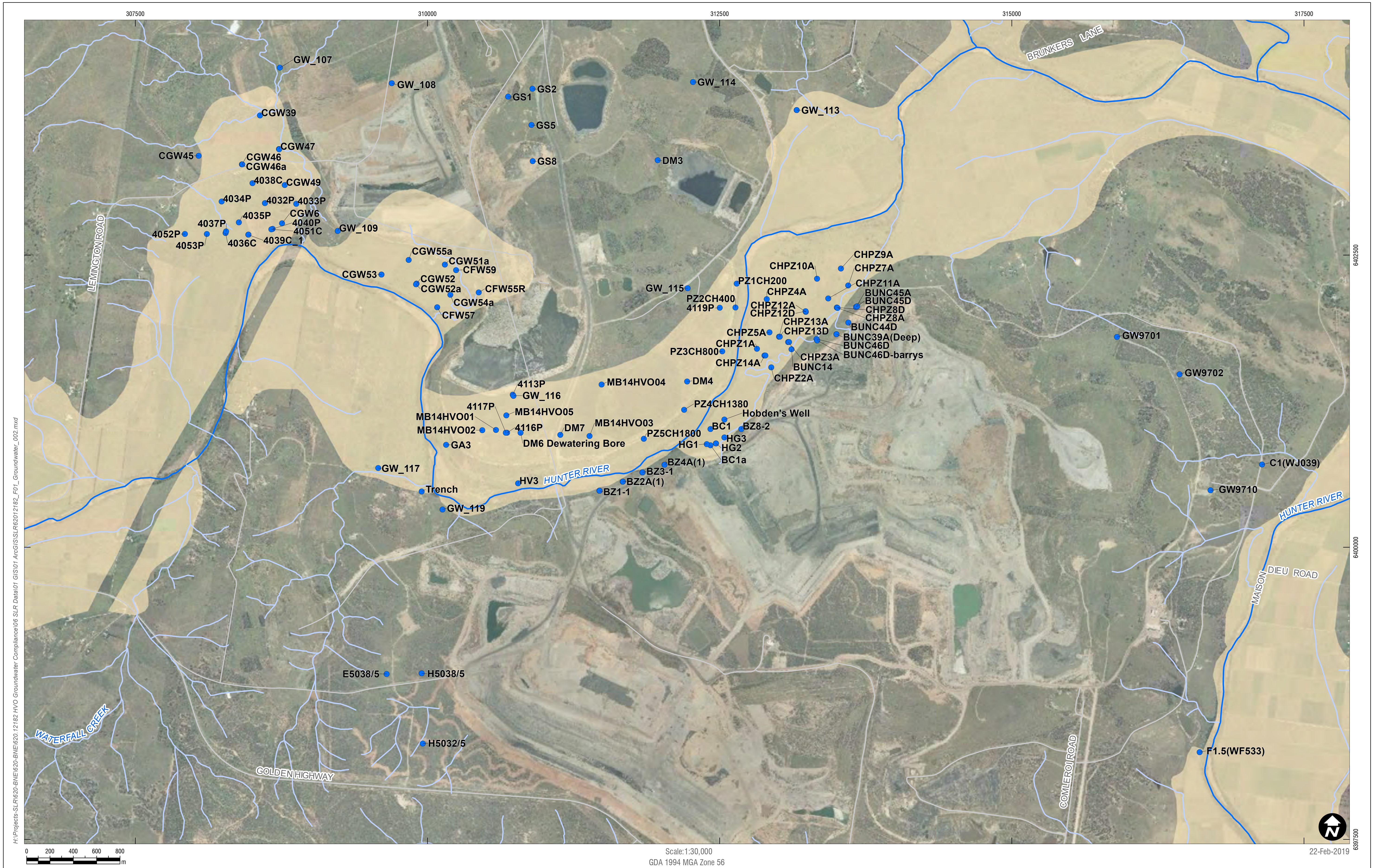
www.slrconsultingaustralia.com.au

1
2
3

- Monitoring point
- Quaternary alluvium (1:100k)
- Dual Carriageway
- Standard Road
- Major watercourse
- Minor watercourse

Hunter Valley Operations
2018 Groundwater Level and Quality Review
Groundwater Monitoring Network – West Pit

Figure 4-1



Sheet Size : A3

SLR

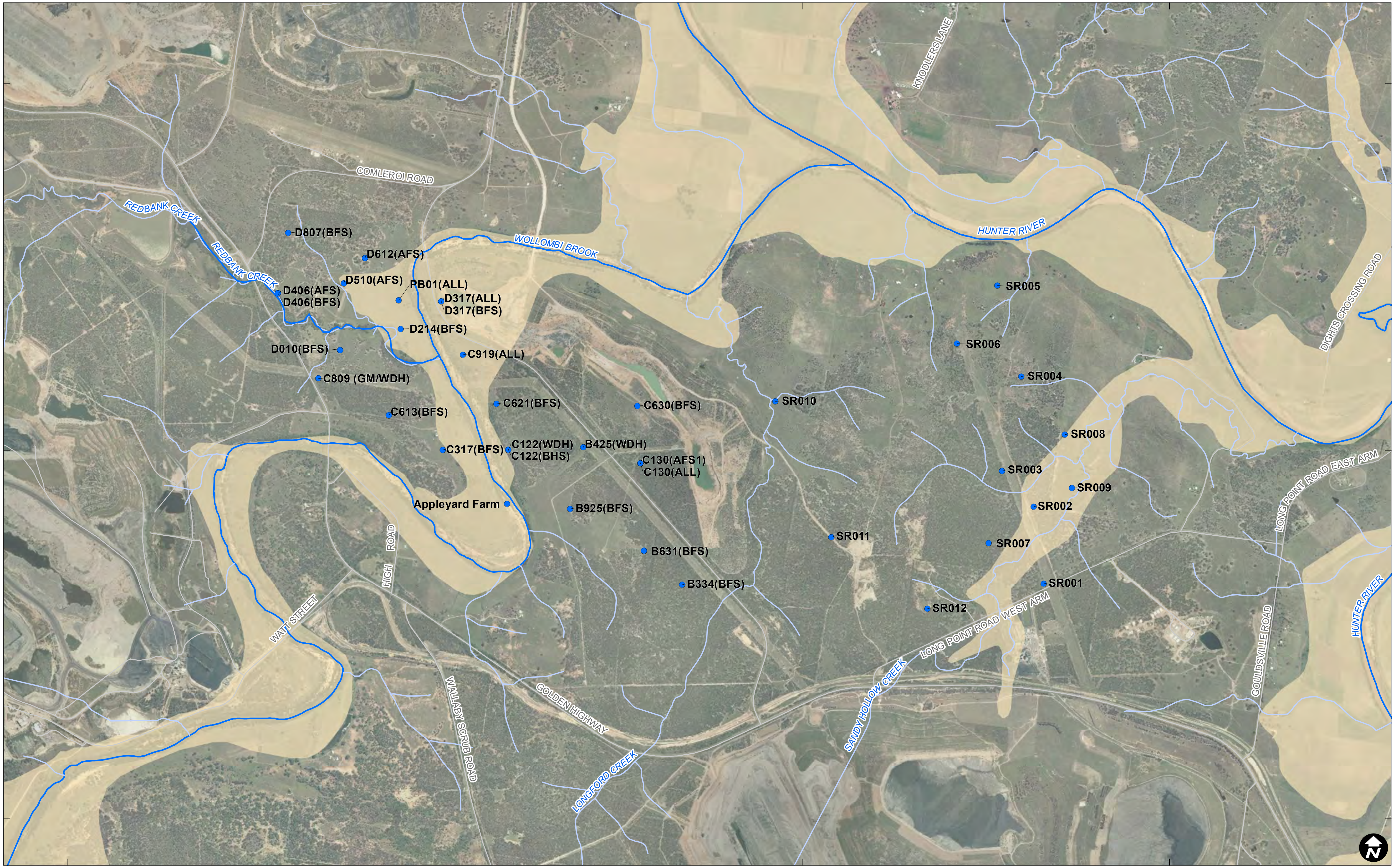
www.slrconsultingaustralia.com.au

1
2
3

- Monitoring point
- Quaternary alluvium (1:100k)
- Dual Carriageway
- Standard Road
- Major watercourse
- Minor watercourse

Hunter Valley Operations
2018 Groundwater Level and Quality Review
Groundwater Monitoring Network – Carrington and North Pit

Figure 4-2



H:\Projects-SLR\620-BNE\620-BNE\620.12182 HVO Groundwater Compliance\06 SLR Data\01 GIS\01 ArcGIS\SLR62012182_F01_Groundwater_002.mxd

0 200 400 600 800 m

Scale:1:25,000
GDA 1994 MGA Zone 56

14-Feb-2019

Sheet Size : A3

1
2
3

- Monitoring point
- Dual Carriageway
- Standard Road
- Major watercourse
- Minor watercourse
- Quaternary alluvium (1:100k)

Hunter Valley Operations
2018 Groundwater Level and Quality Review
Groundwater Monitoring Network – Cheshunt, Riverview and Lemington

Figure 4-3

SLR
www.slrconsultingaustralia.com.au

4.2 Groundwater Monitoring Methodology

HVO engages qualified suitably experienced contractors to carry out sampling and analysis. SLR understands that sampling is undertaken in accordance with relevant Australian Standards and other regulatory guidelines. Samples are analysed by laboratories that are National Association of Testing Authorities (NATA) accredited or equivalent for the parameters being analysed.

According to the WMP, sampling is undertaken via bailer method for all samples requiring only pH and EC. Groundwater bores are purged (3 x casing volumes where possible) prior to sample extraction for all samples requiring comprehensive laboratory analysis.

4.3 Groundwater Triggers

The WMP includes groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts. These criteria are summarised in **Table 4-1**.

Table 4-1 Groundwater Impact Assessment Criteria

Criteria	Description
1	The groundwater level does not decline more than 2 m at any privately owned bores and wells identified in the HVO complex EA's (with the exception of a single bore on land owned by the Ravensworth mine (10011459) which is predicted to decline by a maximum of 2.7 m.)
2	Water quality does not lower the beneficial use category of the groundwater source beyond 40 m from the mining pit. This will be identified using groundwater triggers (EC) for individual monitoring bores specified in the Groundwater Monitoring Programme.
3	The alluvial groundwater source within 40 m of the recognised GDE communities does not experience more than a 10% reduction in piezometric levels predicted in the EA's for HVO North and HVO South (allowing for typical climatic variation).

For Criteria 1, assessment of groundwater level trends over 2018 is discussed in **Section 5.2**. There are no private bores identified within the WMP and no routine monitoring of private landholder bores.

Criteria 2 relates to the trigger levels established for electrical conductivity (EC) based on the 95th percentile of baseline data, and the trigger levels for pH based on the 5th and 95th percentiles, as presented in the WMP and summarized **Table 4-2**. Groundwater quality readings from the site monitoring bores have been compared to the relevant trigger levels in **Section 5.3**. In the 2018 update of the WMP the Bayswater Seam trigger levels were removed.

For Criteria 3, it is assumed that surface water flows are assessed as part of the surface water annual review. Predicted 'indirect' take of water form alluvium and subsequent reductions in baseflow contributions are discussed in **Section 5.4**. These predictions are derived from the existing regional-scale numerical groundwater model developed by AGE (2017) as part of the HVO South Modification 5.

Table 4-2 Groundwater Quality Triggers by Location

Location	Target Seam/ Stratigraphy	EC (95th) µS/cm	pH (5th)	pH (95th)
Carrington	Alluvium	6,154	7.0	8.0
Carrington	Interburden	10,824	6.7	7.4
Carrington	Broonie	8,628	6.8	7.1
Carrington West Wing	Alluvium	2,775	7.0	7.5
Carrington West Wing	LBL	3,531	7.3	7.6
Cheshunt	Mt Arthur	3,350	6.5	7.6
Cheshunt	Interburden	6,213	6.9	7.7
Cheshunt	Piercefield	2,596	6.4	6.8
Cheshunt / North Pit	Alluvium	4,462	6.6	7.5
Lemington South	Bowfield	12,440	6.7	7.9
Lemington South	Woodlands Hill	20,240	6.6	7.6
Lemington South	Arrowfield	15,324	6.8	7.5
Lemington South	Alluvium	22,700 3,938	6.8 6.6	7.0 7.7
Lemington South	Glen Munro	1,894	6.5	7.2
Lemington South	Interburden	11,408	6.7	7.1
North Pit	Spoil	12,460	6.5	7.8
West Pit	Sandstone / Siltstone	13,428	6.9	8.0

In 2018, trigger levels for groundwater levels for the five bores were set following the investigation of bore CFW55R. Each individual trigger level and corresponding groundwater level are shown in **Table 4-3**.

Table 4-3 Carrington Alluvium SWL Trigger Levels

Bore	SWL Trigger (mAHD) (5th Percentile)	SWL Trigger (mAHD) (95th Percentile)
CFW55R	57.06	59.41
CFW57	58.24	59.24
CGW52a	58.23	60.52
CGW53a	58.33	59.19
CGW55a	57.49	58.43

4.4 Network Review

Over the life of HVO the groundwater monitoring network has expanded through localised groundwater assessments and studies conducted at site. Consequently, the monitoring network at HVO is extensive and includes numerous bores within close proximity. As shown in **Section 4.1** there are also limited details on the screened interval and total depth of several site monitoring bores.

A range of site investigations were conducted at HVO over 2018, which included inspection of bores at West Pit (G1 to G3) and Carrington (CFW55R) and installation of ten new investigation bores at Carrington (GW_120 to GW_129). A summary of observations for the existing bores is listed below and bore construction details of the new bores are presented in **Appendix B**.

Bore G2, near West Pit, recorded pH above the trigger level of 8.5. In May 2018 a site visit was conducted to check the bore condition. G2 is constructed with 50 mm PVC casing to a total depth of approximately 3.04 m below ground level. It is unknown what interval the screen is present at, and what the intersected geology comprises. Following the site visit a review of water quality data highlighted that the trend of elevated pH in bore G2 is likely a result of sampling methodology. Annual low-flow sampling provides stable results, but the quarterly non-purge bailing method provides inconsistent data. During the investigation the water level, pH and EC of bores G1, G2 and G3 were also reviewed. Recommendations included review of available records/data relating to the construction of the dam; review the condition of bores G1 to G3 plus adjacent bores using a downhole camera and tag line; based on findings from the downhole camera survey, conduct bore repairs for site monitoring bores and abandon adjacent bores; install dataloggers into bores G1 to G3 to collect more robust timeseries data; extend casing height for bore G3 and install a cap that enables pressure release; and measure/meter volume of water pumped into Parnell's Creek Dam to assist with the site water balance and early detection of potential volume losses.

It was also identified that bore CFW55R, near Carrington, had multiple exceedances above the EC trigger of 6,324 µS/cm and pH under the trigger level of 7.0. In May 2018 a site investigation was undertaken to assess the bore condition. CFW55R is constructed with 50 mm PVC casing to a total depth of 15.4 m below ground level (mbgl), with a screened interval of 10.4 to 15.4 mbgl, within alluvium. Based on the site visit and review of available data, it was identified that North Void may intersect palaeochannel alluvium sediments at the north-western end of North Void. These sediments have the potential to form a groundwater flow pathway between North Void, through spoil and into the alluvial sediments around bore CFW55R.

As a result of the trigger exceedance investigation for bore CFW55R it was decided to drill a series of additional monitoring bores. From 3rd October 2018 to 25th October 2018 a total of ten new monitoring bores were drilled and constructed (GW_120 to GW_129); eight intersecting alluvium, one intersecting weathered sandstone and one intersecting waste rock material. Each of the monitoring bores were constructed with 50 mm or 125 mm diameter PVC casing and completed with a lockable steel monument cover and concrete base.

Four of the newly installed bores and one existing bore (CFW57) were equipped with a datalogger to collect timeseries water level data, and two newly installed bores were equipped with a datalogger to collect timeseries water level, EC and temperature data. Slug tests were conducted on the newly installed bores and selected existing bores. An initial round of groundwater quality sampling was conducted on the newly installed bores following development by SLR, and a full round of monitoring was conducted by AECOM in November 2018.

In accordance with the development consent conditions, the groundwater monitoring program shall include monitoring of groundwater bores on privately-owned land that could be affected by the development. However, no private bores are predicted to be subject to impacts for the current approved operations and therefore there is currently no monitoring of private bores. As part of Modification 5, groundwater levels could potentially be impacted at registered bore (10011459) on land owned by Glencore. Further review of bore 10011459 is recommended to understand the construction and use of the bore and whether it is suitable for inclusion in ongoing groundwater monitoring.

5 Monitoring Results

5.1 Data Recovery

As per the WMP, groundwater level monitoring and sampling was carried out at 104 monitoring bores that have a trigger level set. An additional 14 monitoring bores, with no trigger level compliance, were also sampled and measured as part of the monitoring programme. Sites with a data capture rate of less than 100 per cent are outlined in **Table 5-1**.

Table 5-1 Groundwater Monitoring Data Recovery

Location	Type	Data Recovery	Comments
Appleyard Farm	SWL	90%	Monthly. No data recorded month 11
C919(ALL)	SWL	80%	Monthly. No data recorded month 5 and 10 and dry month 11
	WQ	25%	No data recorded Q2, Q3, and Q4
CGW47a	SWL, WQ	50%	Bore dry Q3 and Q4
CHPZ8A	SWL, WQ	0%	Bore dry
GW_101	SWL, WQ	0%	Bore dry
HV3(2)	SWL	0%	No data recorded
PB01(ALL)	SWL, WQ	80%	Monthly. No data recorded month 5 and 10 and dry month 12
4036C	SWL	0%	Bore dry
4051C	SWL	0%	Blocked
BZ4A(2)	WQ	75%	No data recorded Q3
B425(WDH)	SWL	0%	Bore dry
C122(BFS)	SWL, WQ	0%	Bore dry
C809 (GM/WDH)	SWL, WQ	50%	No data recorded first half of year
CGW45	SWL, WQ	0%	Bore blocked
D214(BFS)	SWL, WQ	75%	No data recorded Q2
D010(BFS)	WQ	50%	No data recorded first half of year
D010(GM)	WQ	50%	No data recorded first half of year
D010(WDH)	WQ	50%	No data recorded first half of year
D406(AFS)	SWL, WQ	50%	No data recorded first half of year
D406(BFS)	SWL, WQ	50%	No data recorded first half of year
D510(AFS)	SWL, WQ	50%	No data recorded first half of year
D510(BFS)	SWL, WQ	50%	No data recorded first half of year
D612(AFS)	SWL, WQ	50%	No data recorded first half of year
D612(BFS)	SWL, WQ	50%	No data recorded first half of year
D807(BFS)	SWL, WQ	50%	No data recorded first half of year
DM7	SWL, WQ	0%	Bore dry
GW_107	SWL, WQ	0%	Bore dry
GW_108	SWL, WQ	0%	Bore dry

5.2 Water Levels

A summary of the water level results is provided for each of the main water bearing units (alluvium, Permian coal measures and spoil) below. Routine water level readings for 2018 are presented in **Appendix C**.

5.2.1 Alluvium

Over 2018, four alluvial bores were recorded as dry (GW_100, GW_101, CHPZ8A, BUNC45A). Two bores were recorded as dry part way through the year (C919(ALL) in Q4 and CGW47a in Q3 and Q4). The sudden decline in groundwater levels at CGW47a appears unique to the bore, and is not observed in nearby bores. CGW47a has historically recorded large (i.e. 5 m) fluctuations in groundwater levels that appear inconsistent with trends at other bores and may relate to the condition of the bore and should be further reviewed.

Where saturated, groundwater within the alluvium occurred between 0.33 m and 23.2 m below surface over 2018. Discussion of water level trends is included for each of the mine locations from **Section 5.2.1.1** to **Section 5.2.1.4**.

5.2.1.1 West Pit

Time series groundwater levels for the five alluvial/regolith bores north and north-west of West Pit are presented in **Figure 5-1**. Over 2018 groundwater elevations within the three bores (G1, G2 and G3) on the south-western side of Parnell's Creek Dam (18W) ranged between 107.1 mAHD and 109.7 mAHD (2.3 m and 0.3 m depth). Groundwater levels increased slightly over 2018, consistent with rainfall trends.

Bores GW_100 and GW_101 are located along Parnell's Creek, downslope of the dam (18W). Comparison between groundwater levels and screened depths indicates the bores are likely dry and readings may relate to water within the sump at the base of the bore.

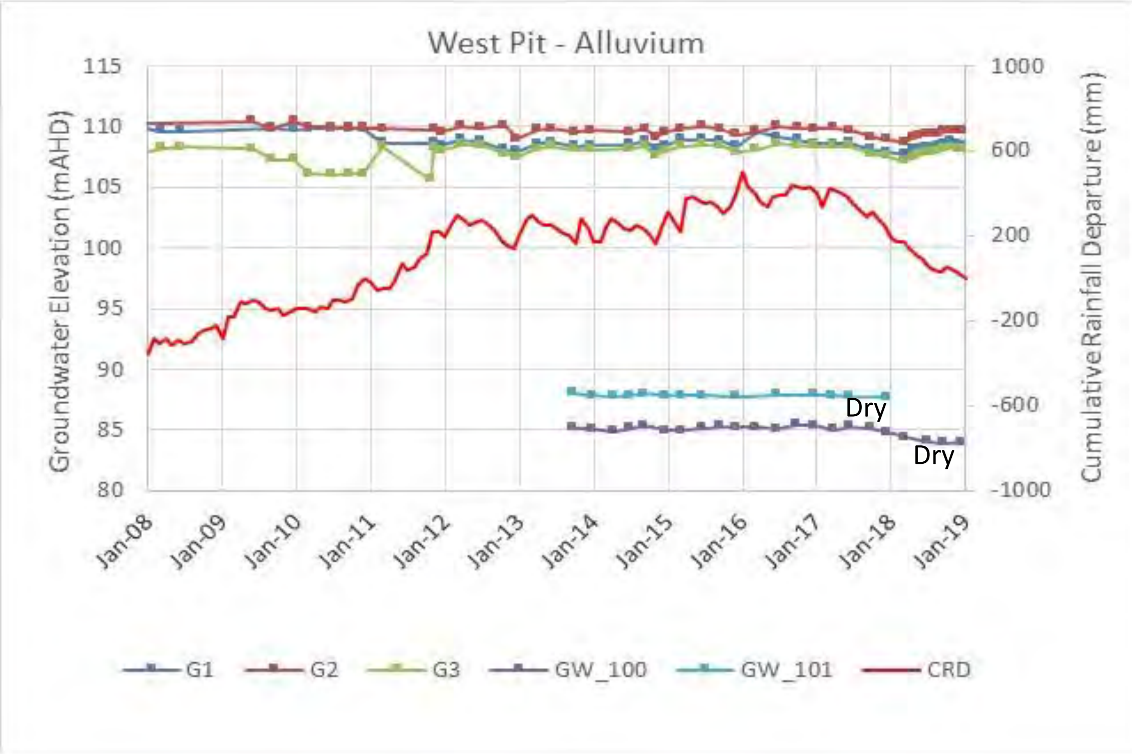


Figure 5-1 Hydrograph of Alluvial Bores – West Pit

5.2.1.2 Carrington West Wing and Carrington

Time series groundwater levels for bores within the alluvium on the western limb of the palaeochannel near Carrington and Carrington West Wing are shown in **Figure 5-2**. Over 2018 groundwater elevations within the four bores in this area ranged between 58.52 mAHD and 59.69 mAHD (9.53 m and 12.63 m depth). Groundwater levels declined by 0.37 m up to 1.12 m within the bores over 2018, which appears to correlate with climate and stream flow trends.

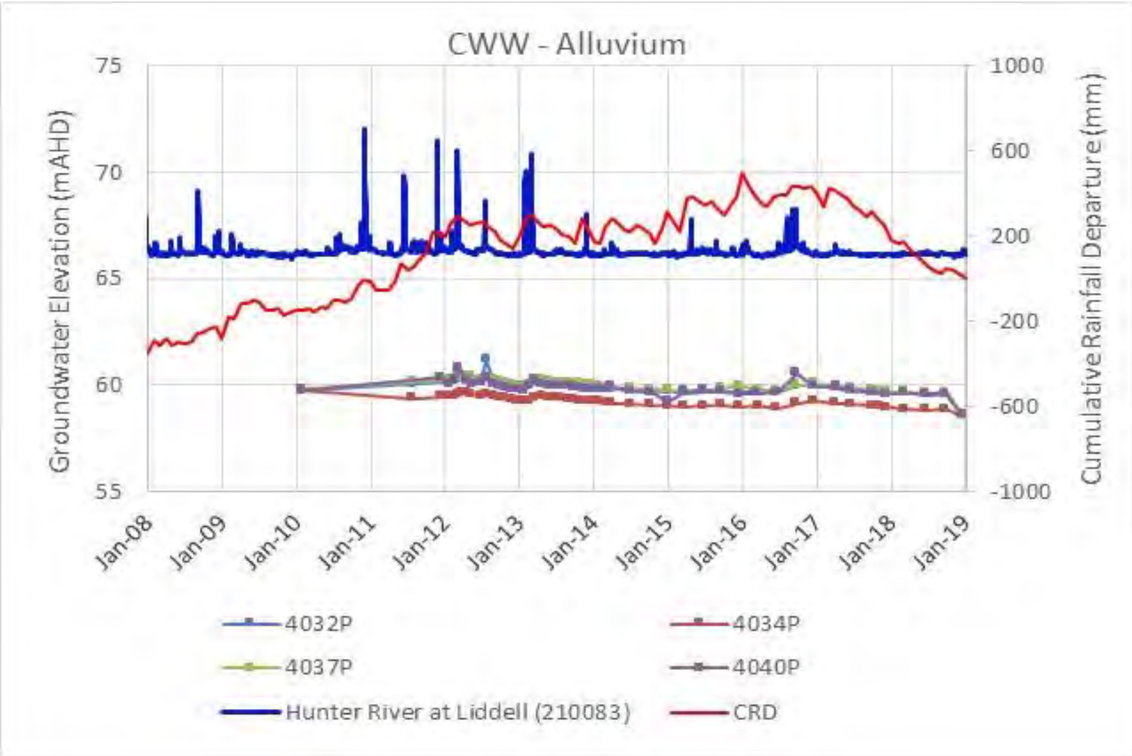


Figure 5-2 Hydrograph of Alluvial Bores – Carrington (Western Limb)

Time series groundwater levels for bores within the floodplain alluvium on the northern end of the palaeochannel (CGW32 and GW_106) and the two bores on the western limb of the palaeochannel (CGW39 and CGW47a) near Carrington and Carrington West Wing are shown in **Figure 5-3**. Over 2018 groundwater elevations within the four bores in this area ranged between 54.64 mAHD and 59.95 mAHD (11.5 m and 23.2 m depth). However, bore CGW47a was recorded as dry in Q3 and Q4. Groundwater levels declined by 0.51 m up to 0.85 m within the bores over 2018, which appears to correlate with climate and stream flow trends and may also relate to localised drawdown towards the Carrington Pit final void.

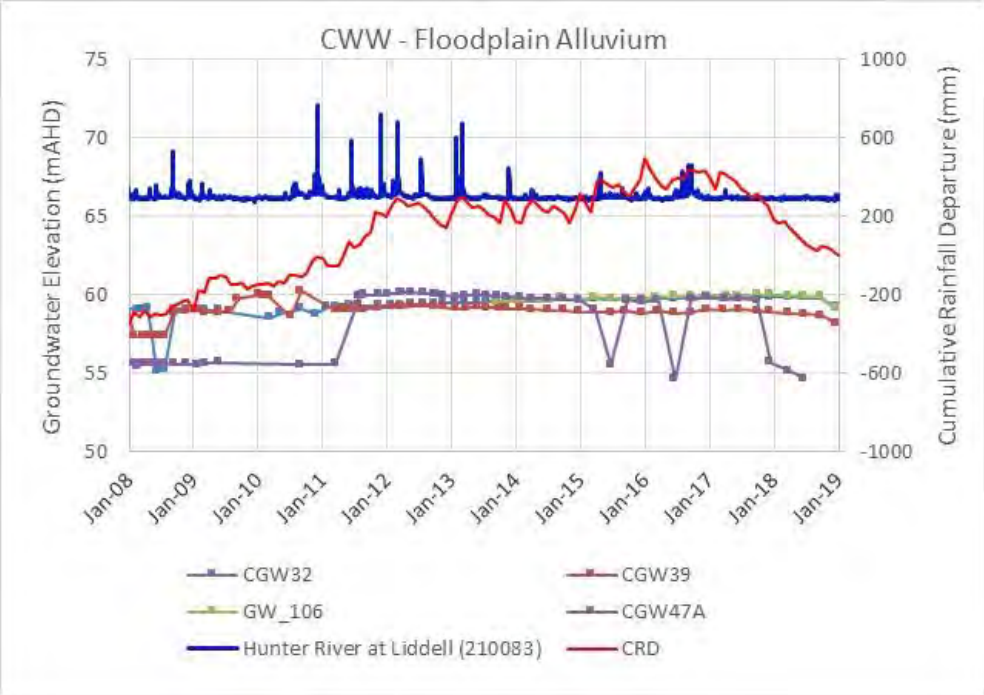


Figure 5-3 Hydrograph of Floodplain Alluvial Bores – Carrington (Western Limb)

Time series groundwater levels for bores within the alluvium on the five bores on the eastern limb of the palaeochannel near Carrington and Carrington West Wing are shown in **Figure 5-4**. The groundwater levels in all five bores, CFW55R, CGW53a, CFW57, CGW55a, and CGW52a, remained relatively stable until September 2018 where all bores declined slightly by up to 1.04 m. Groundwater levels ranged between 57.38 mAHD (13.22 m depth – CGW55a) and 59.27 mAHD (10.51 m depth – CFW55R).

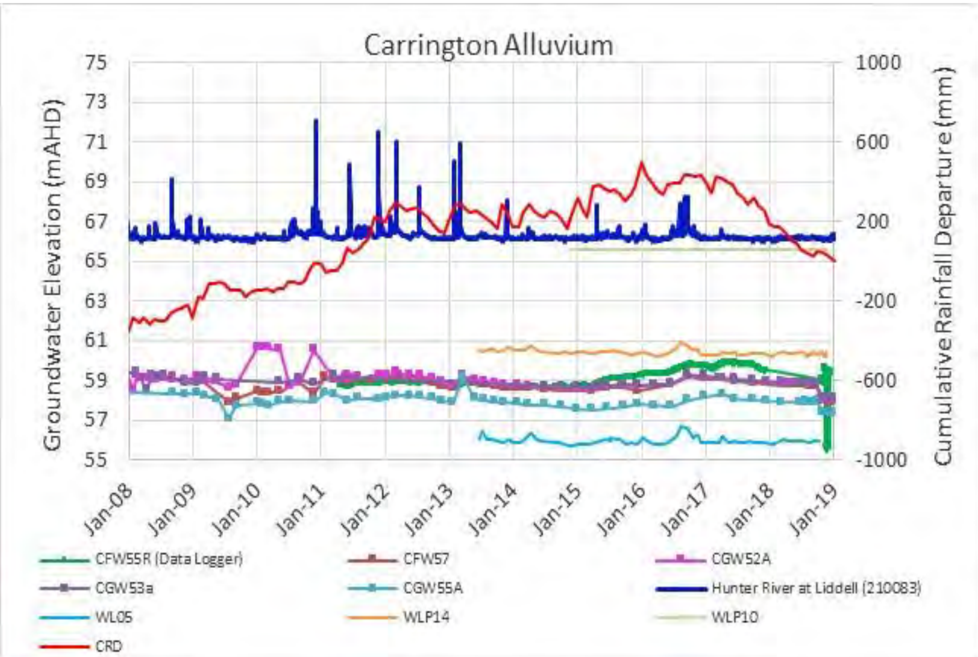


Figure 5-4 Hydrograph of Alluvial Bores – Carrington

Over 2018, groundwater level triggers were assigned for five alluvial bores at Carrington, CFW55R, CFW57, CGW52a, CGW53a and CGW55a. The four bores stayed within the trigger levels until Q4, where groundwater levels declined slightly below the 5th percentile trigger level. The purpose of the monitoring is to ensure no additional seepage into the alluvium at this location, therefore the decline in levels indicates a decline in seepage.

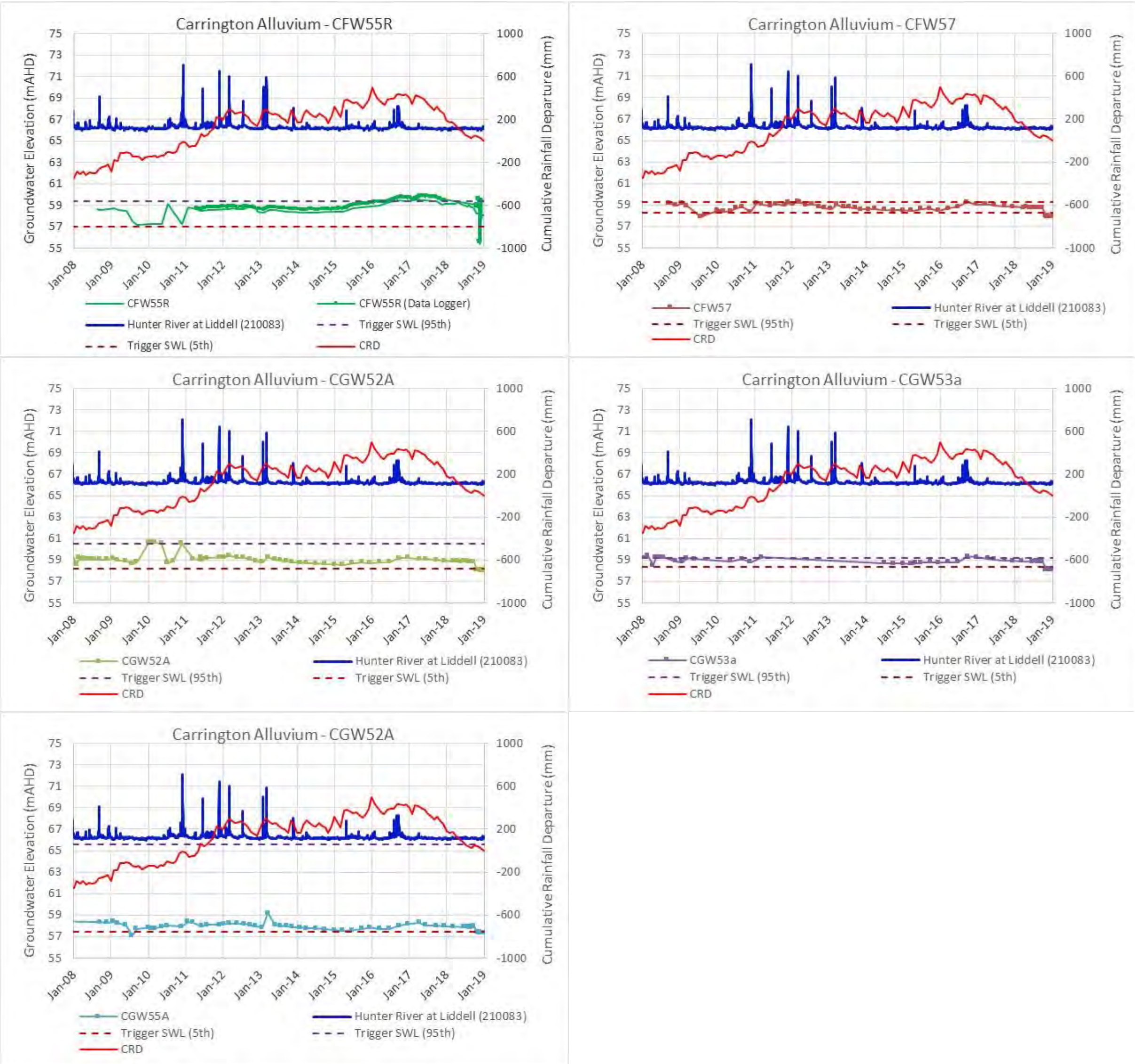


Figure 5-5 Hydrograph of Alluvial Bores – Carrington – Individual Trigger Levels

5.2.1.3 Cheshunt Pit

Time series groundwater levels for bores within the alluvium north and south of the Hunter River, between North Pit and Cheshunt Pit are shown in **Figure 5-6**. Two bores (CHPZ8A and BUNC45A) recorded groundwater levels at or below the base of the screen and are believed to be dry. Where the alluvium is saturated, groundwater levels ranged between 51.76 mAHD and 59.98 mAHD (2.55 m and 17.45 m depth). Groundwater levels generally declined by up to 1 m within the alluvial bores over 2018, which appears to correlate with climate and stream flow trends.

At the start of 2018 groundwater levels at bore PZ2CH400 were 0.49 m higher (55.27 mAHD) compared to upstream bore PZ3CH800 bore (54.78 mAHD). Over 2018 groundwater levels at PZ2CH400 increased the most, by 5.36 m, and remained higher than upstream bore PZ3CH800, by 5.24 m by the end of the year. Bore PZ2CH400 is located immediately east of the North Pit barrier wall and around 180 m east of spoil bore 4119P. Bore 4119P recorded spoil water elevations between 52.2 mAHD and 53.98 mAHD over 2018, lower than alluvial levels at bore PZ2CH400. The cause of the elevated groundwater levels at bore PZ2CH400 is unclear but does not appear to relate to the North Pit spoil.

It is also noted that bore BZ1-1 is included in the WMP as being within the alluvium; however as identified in prior annual reviews (AGE 2013a) the bore likely intersects interburden material. It is recommended that this bore be updated in the WMP as intersecting interburden.

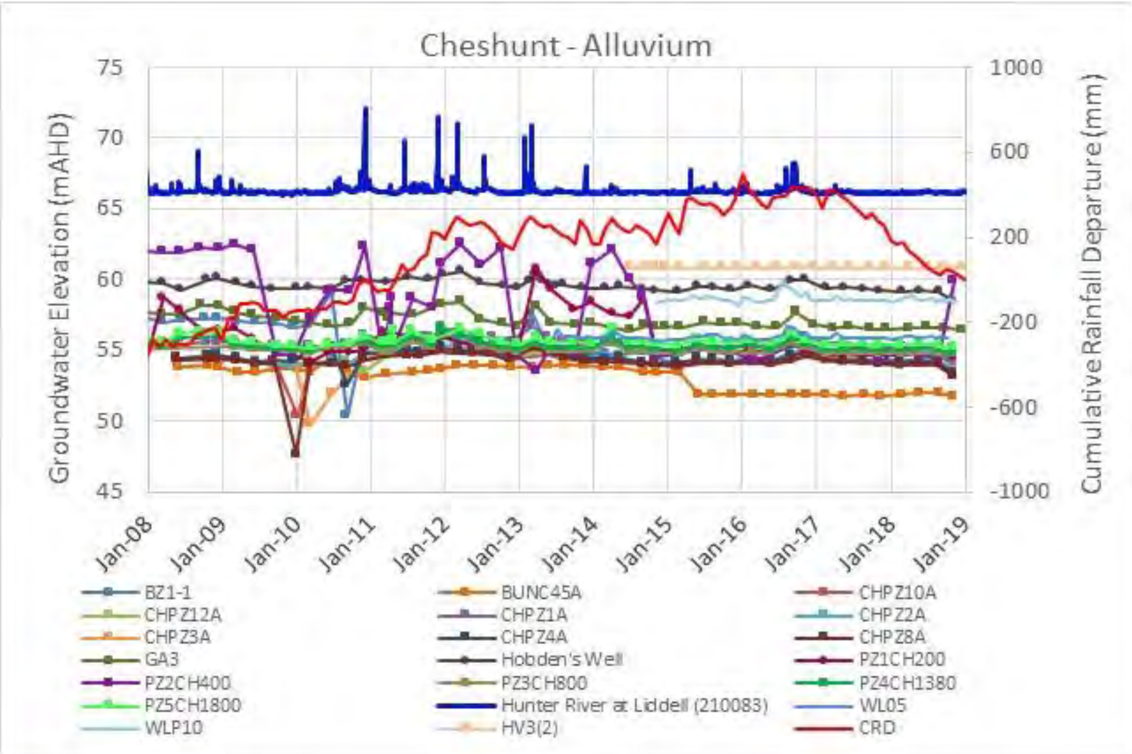


Figure 5-6 Hydrograph of Alluvial Bores – Cheshunt/North Pit

5.2.1.4 Lemington South

Time series groundwater levels for four bores within the alluvium at Lemington South, along the Wollombi Brook, are shown in **Figure 5-7**. As shown in **Figure 5-7**, groundwater levels fluctuated the most within bore Appleyard Farm, which is located over 1.2 km upstream of Lemington South Pit and within 50 m of Wollombi Brook. These fluctuations show close correlation with stream flow levels as recorded stream gauge Wollombi Brook at Warkworth, which is located approximately 350 m upstream of the bore. Bores C919(ALL) and PB01(ALL) are located approximately 150 m from Wollombi Brook and show a more muted response to stream flow. Bore D317(ALL) is located adjacent to the Lemington South Pit, approximately 190 m from Wollombi Brook.

Over 2018 groundwater elevations within the alluvial bores Appleyard Farm, PB01(ALL) and C919(ALL) ranged between 36.09 mAHD and 46.67 mAHD. However, bore C919(ALL) was recorded as dry in Q4. Groundwater levels fluctuated over 2018, but generally showed a decline of up to 1.22 m in line with declining stream flow and rainfall.

Groundwater levels remained stable within bore D317(ALL) at around 44.4 mAHD and have been relatively stable since 2012, however there was a decline in April 2018 of approximately 0.3 m. Historical data indicates groundwater is present at around 15 m depth; however, available bore details indicate the bore is screened from 9.2 m to 12.2 m. It is therefore anticipated that bore D317(ALL) is dry.

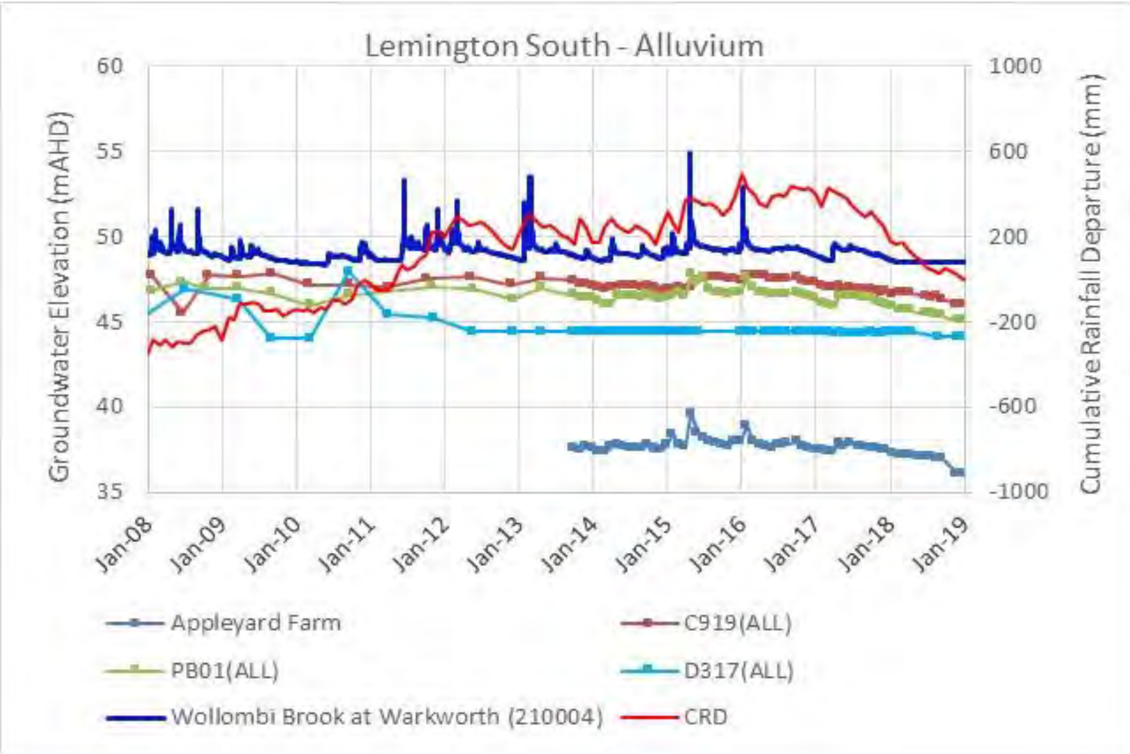


Figure 5-7 Hydrograph of Alluvial Bores – Lemington South

5.2.2 Permian Coal Measures

Over 2018, three bores in the Permian coal measures were recorded as dry (4036C, C122(BFS) and B425(WDH)), and two bores were reported as blocked (CGW45 and 4051C). There are eight vibrating wire piezometers (VWP's) that monitor the coal seam and interburden sequences of the Permian coal measures in the Carrington mine area (GW_100a, GW_101a, GW_102, GW_103, GW_104, GW_105, GW_109 and GW_110).

Discussion in water level trends within the Permian coal measures is included for each of the mine locations from **Section 5.2.2.1** to **Section 5.2.2.4**.

5.2.2.1 West Pit

Three of the four bores targeting the Permian coal measures at West Pit were monitored over 2018, bores NPz2, NPz3 and NPz5. One bore (NPz4) was monitored up to December 2016. Review of the geology mapped at the bores identified that NPZ2 intersects the Saltwater Creek Formation (Pswc), which underlies the Vane Subgroup mined at West Pit. The Saltwater Creek Formation comprises laminated sequences of siltstone and sandstone, and the underlying Mulbring Siltstone comprises low permeability siltstone and claystone units and is considered to act as a confining unit. Bore NPz3 intersects Mulbring Siltstone (Pmm), while bore NPz5 intersects Denman Formation (Pswj).

Groundwater elevations for the bores at West Pit are presented in **Figure 5-8**. Over 2018 groundwater elevations within bore NPz2 remained fairly stable until Q4 where water levels declined by 0.88 m between September and December. In bore NPz3 groundwater elevations increased by up to 0.86 m between April and June, declined by 1.61 m between June and September, then increased again by 0.78 m between September and December. These two bores are located upslope, on the northwest side of West Pit. The cause for the groundwater trends at NPz2 is unclear and would require further information regarding historical land use activities in the region. However, based on available information, the cause for the changes in groundwater level at NPz2 do not appear to correlate to mine activities conducted at West Pit.

Bore NPz5 is located down-slope (south) of the West Pit highwall and recorded a 2.3 m decline in groundwater levels over 2018. This decline is likely a response to mining at West Pit, and consistent with groundwater drawdown predictions for the approved operations (see **Section 2.2**).

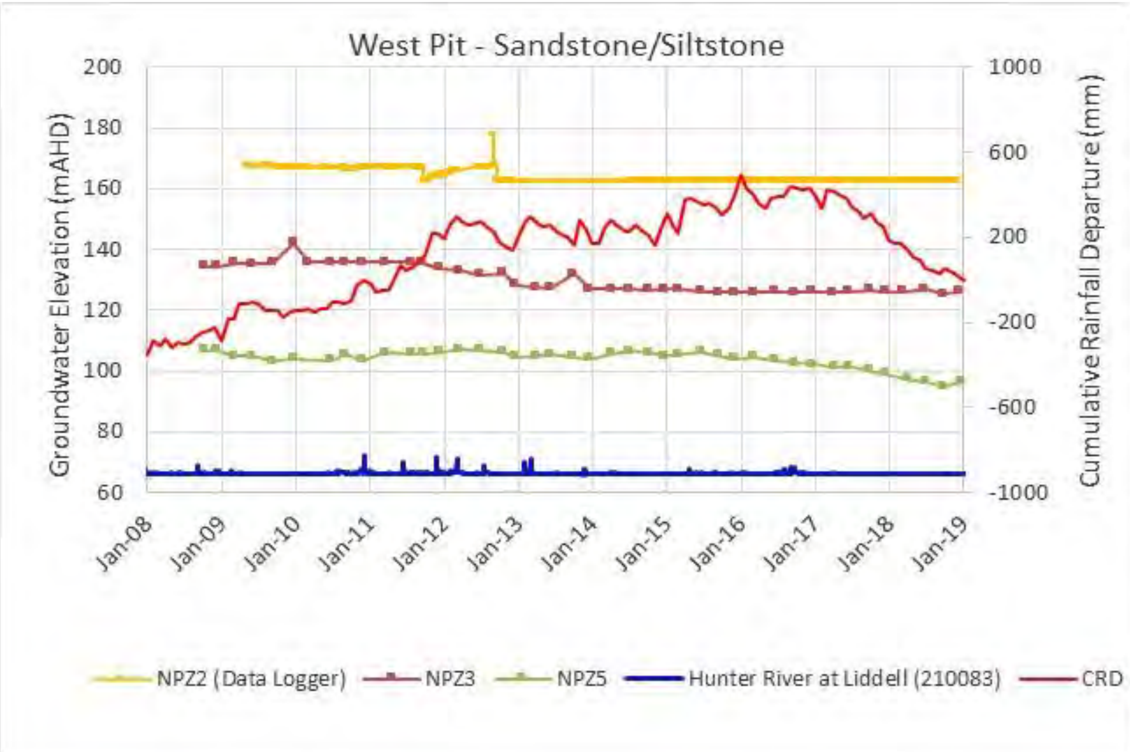


Figure 5-8 Hydrograph of Permian Coal Measures Bores – West Pit Bores

Eight vibrating wire piezometers (VWPs) were installed in the West Pit area (GW_100a, GW_101a, GW_102, GW_103, GW_104, GW_105, GW_109, and GW_110) in 2012, intersecting the Permian coal measures. Bores GW_103, GW_104 and GW_105 are located to the south of West Pit. Bore GW_109 is located to the west of Carrington Pit, and bore GW_110 is located north of Carrington Pit. Groundwater level trends for the VWPs are presented in **Figure 5-9**. Review of the data identified that some sensors have previously failed, including VWP1 in GW_101a and VWP3 in GW_109. In addition calibration details for GW_110 were not available at the time of reporting, therefore data could not be converted and graphed.

Bores GW_100a and GW_102 are located to the west of West Pit and recorded relatively stable groundwater levels over time. Bores GW_103 and GW_105 show a gradual decline in water levels in all three VWPs over time. In comparison, groundwater levels in GW_104 rose in the Lower Pikes Gully Seam and interburden material (VWP1 and VWP2), but VWP3 that intersects sandstone above the Barrett Seam, groundwater levels declined over time.

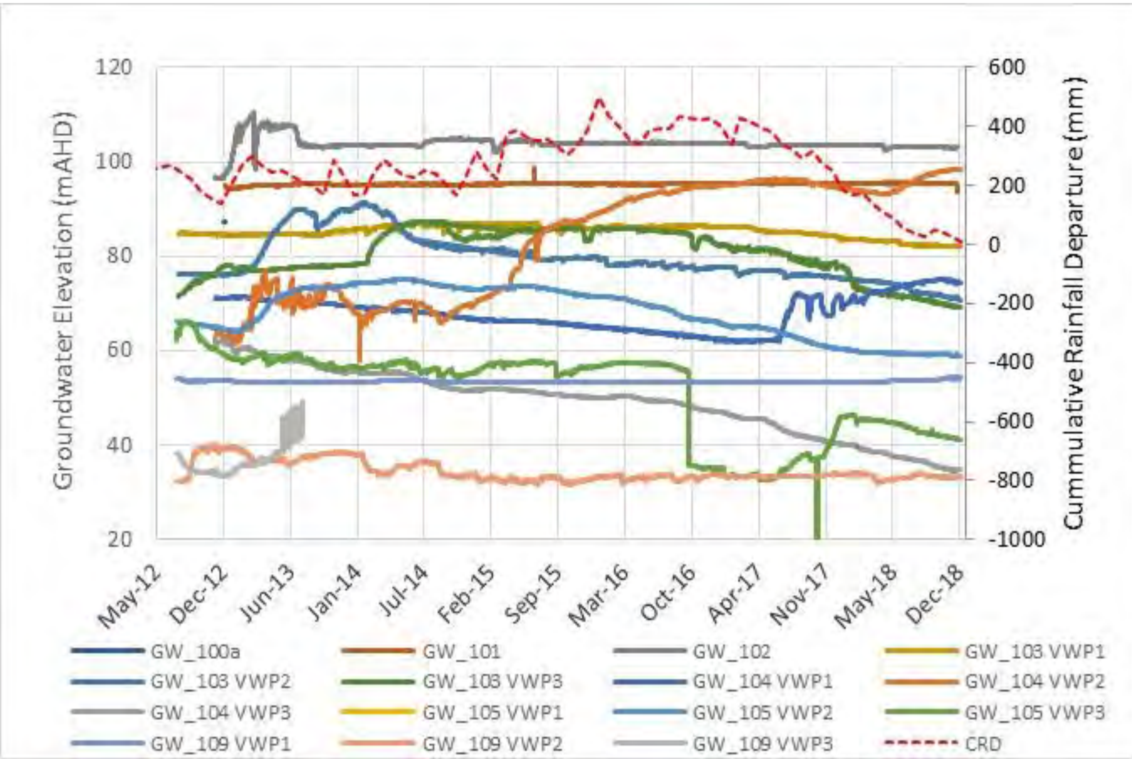


Figure 5-9 Hydrograph of Permian Coal Measures Bores – West Pit VWPs

5.2.2.2 Carrington and Carrington West Wing

The WMP includes seven monitoring bores with screens that intersect the Permian coal measures at Carrington and Carrington West Wing. This includes two bores within the Bayswater Seam (CGW45 and CGW46), two within the Broonie Seam (CGW52, CGW53) and three within the interburden material (4036C, 4051C and CGW51a). Two of the bores (CGW45 and 4051C) were reported as blocked in 2018, and one was recorded as dry (4036C). Time series groundwater elevations for the seven bores are presented in **Figure 5-10**.

Bore CGW46 intersects the shallow Bayswater Seam (approximately 13 m deep) underlying alluvium on the western limb of the palaeochannel. Over 2018, groundwater within the bore remained relatively stable, recorded at depths of between 12.84 m and 12.96 m. Groundwater levels within the bore are close to the base of the bore and have remained relatively stable since 2012, which may indicate the bore is dry. Further review of the condition of the bore is recommended. Bore CGW53 recorded fluctuations in groundwater levels throughout the year with an overall 0.93 m decline in groundwater levels.

Bore 4036C was recorded as dry throughout 2018. Groundwater levels within bore CGW52 remained relatively stable at depths of between 35.94 m and 36.52 m. Bore construction details are not available for this bore. Both bores are located within the area of predicted drawdown for approved operations across HVO, therefore the stable groundwater trends indicate the water levels are at the base of the bores (i.e. the bores are effectively dry).

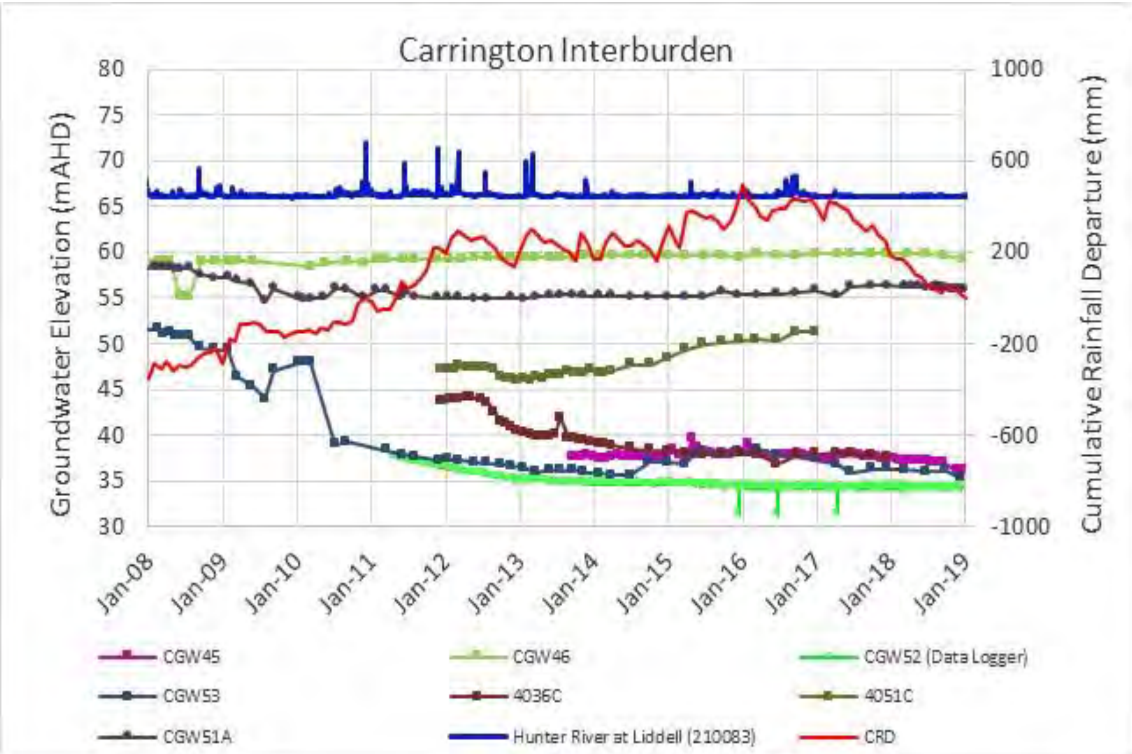


Figure 5-10 Hydrograph of Permian Coal Measures Bores – Carrington

5.2.2.3 Cheshunt Pit

The WMP includes 13 monitoring bores with screen that intersects the Permian coal measures at Cheshunt Pit. This includes nine bores within the Mt Arthur Seam (BC1a, BZ1-3, BZ2A(1), BZ3-3, BZ4A(2), CHPZ3D, CHPZ8D, CHPZ12D, HG2a), one within the Piercefield Seam (BUNC45D) and three within the interburden material (BZ3-1, BZ8-2 and HG2).

Time series groundwater elevations for the bores are presented in **Figure 5-11** to **Figure 5-13**. Sustained groundwater level drawdown in response to the approved mining is visible within four of the bores intersecting the Mt Arthur Seam (BZ1-3, BZ2A(1), BZ3-3 and BZ4A(2)). Bore BC1a also intersects the Mt Arthur Seam and showed drawdown from 2011 to 2014 (48.5 mAHD), followed by a gradual recovery in groundwater levels (48.8 mAHD) in 2017. A decline was recorded in November 2018 of 0.3m (48.5 mAHD). However, adjacent Mt Arthur Seam bore HG2a shows relatively stable groundwater elevations of around 41.1 mAHD since 2012. The condition and construction of the bores requires further review in order to understand the cause for the variability in trends.

The remaining Mt Arthur Seam bores (CHPZ3D, CHPZ8D and CHPZ12D) and Piercefield Seam bore (BUNC45D) are located over 1 km north-east of Cheshunt Pit, north of the rehabilitated Barry's Pit. All four bores show relatively stable groundwater levels until Q4 of 2018, where CHPZ3D, CHPZ8D and CHPZ12D declined by up to 1.2 m. Bore BUNC45D remained stable until Q4 of 2018 where the groundwater level declined by 0.4 m.

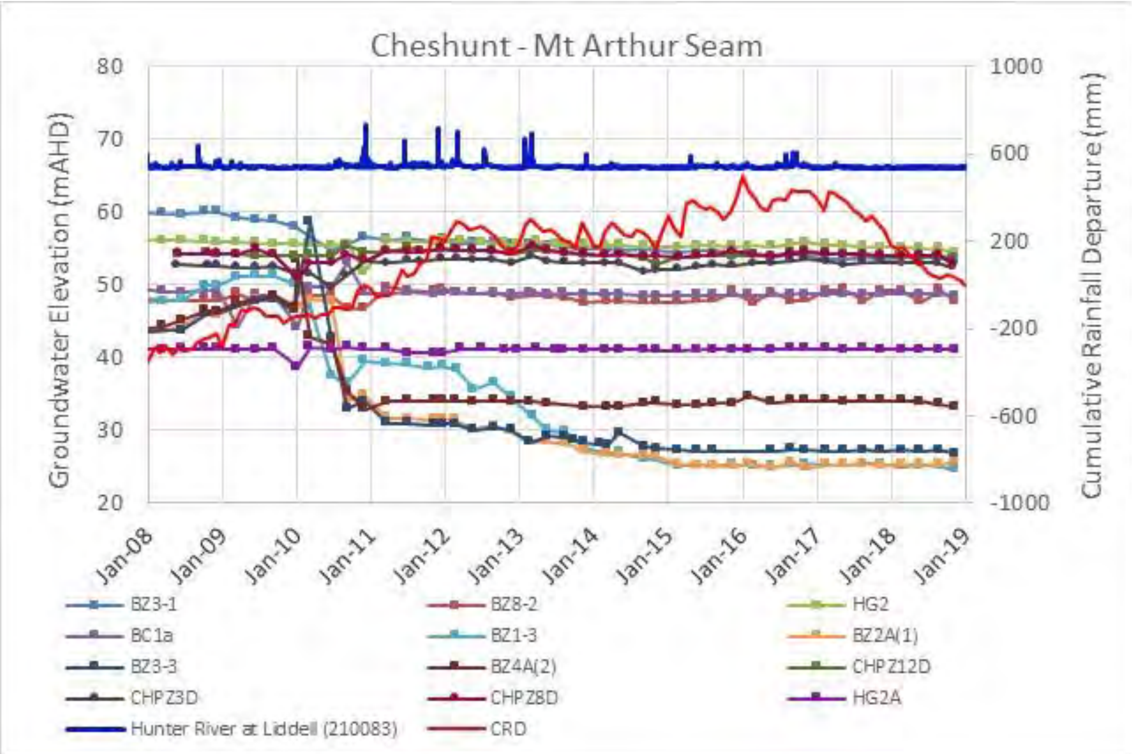


Figure 5-11 Hydrograph of Permian Coal Measures – Cheshunt Mt Arthur Seam

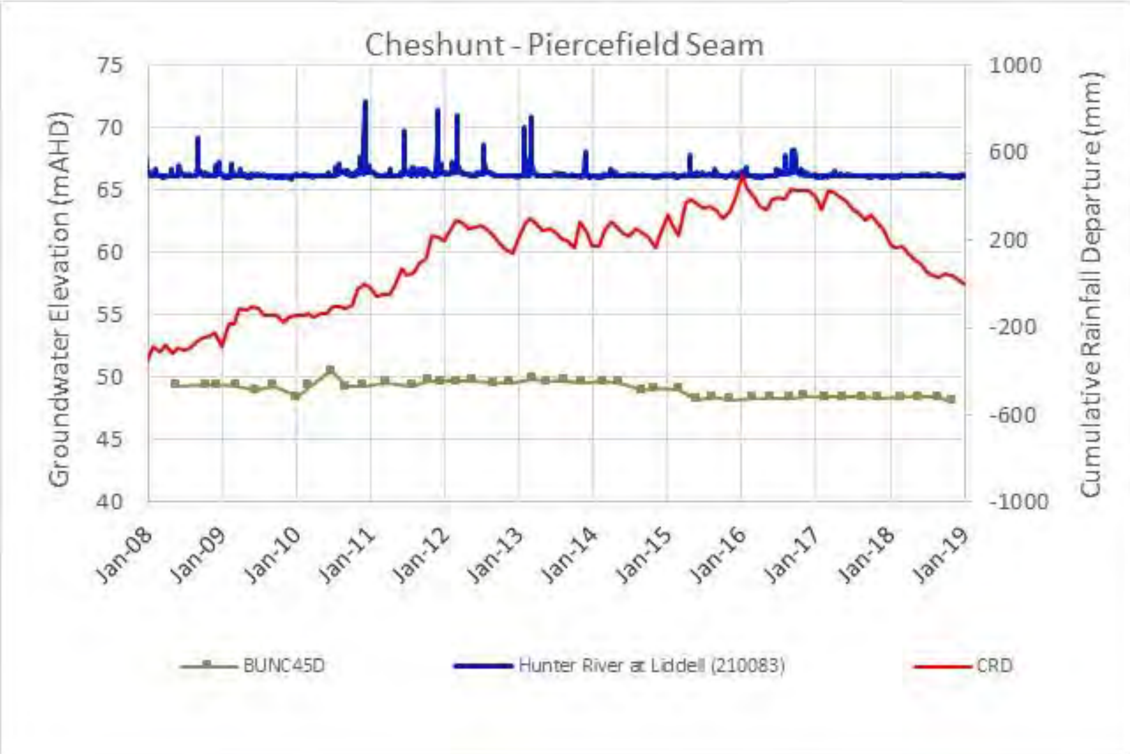


Figure 5-12 Hydrograph of Permian Coal Measures – Cheshunt Piercefield Seam

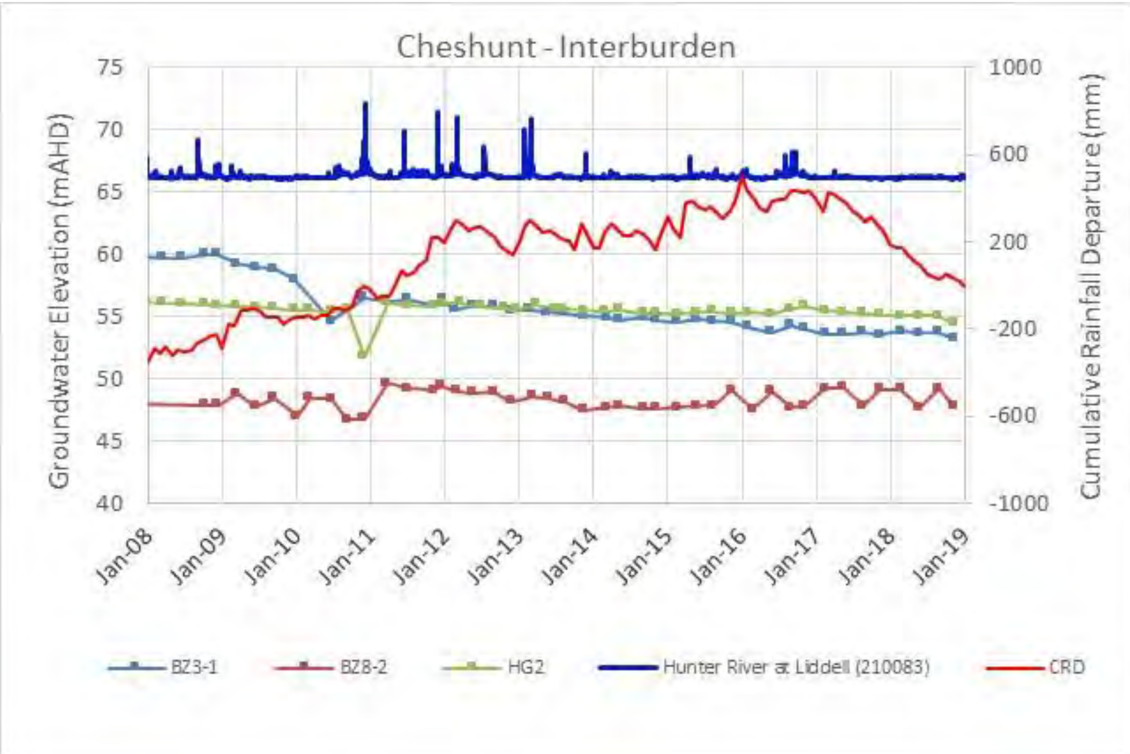


Figure 5-13 Hydrograph of Permian Coal Measures – Cheshunt Interburden

5.2.2.4 Lemington South

The WMP includes 29 monitoring bores with screen that intersects the Permian coal measures at Lemington South. This includes:

- Four bores within the Arrowfield Seam - C130(AFS1), D406(AFS), D510(AFS) and D612(AFS);
- One bore within the shallow interburden material (siltstone/sandstone) - C130(ALL);
- Eight bores within the Glen Munro Seam and/or Woodlands Hill Seam - B425(WDH), B631(WDH), C122(WDH), C130(WDH), C317(WDH), C809(GM/WDH), D010(WDH) and D010(GM); and
- 16 bores within the Bowfield Seam - B334(BFS), B631(BFS), B925(BFS), C122(BFS), C130(BFS), C317(BFS), C613(BFS), C621(BFS), C630(BFS), D010(BFS), D214(BFS), D317(BFS), D406(BFS), D510(BFS), D612(BFS) and D807(BFS).

Time series data for bores targeting the Arrowfield Seam are presented in **Figure 5-14**. As shown in **Figure 5-14**, all Arrowfield Seam bores recorded declining groundwater levels over 2018, consistent with climate trends. It is noted that ground elevations and consequently groundwater elevations for adjacent bores D612(AFS) and D510(AFS) declined by just over 2 m. Groundwater levels in bores C130(AFS1) and D406(AFS) both declined over 2018 by up to 0.87 m. It should be noted that all four bores only had one water level measurement in 2018.

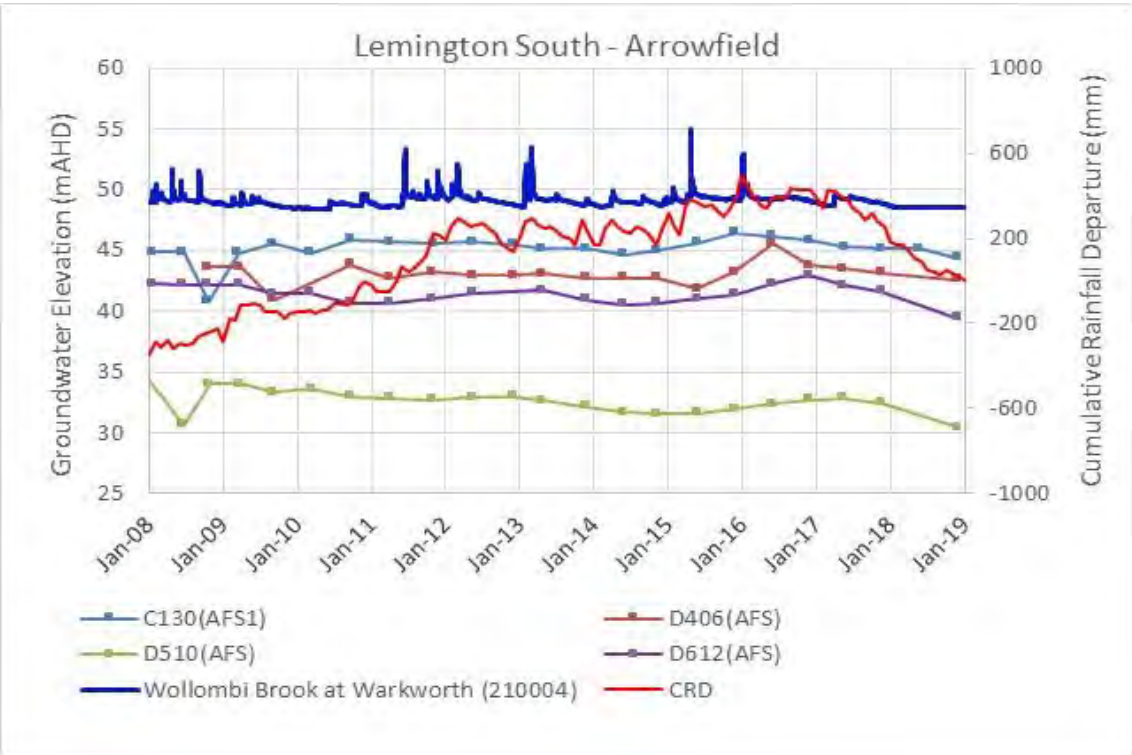


Figure 5-14 Hydrograph of Arrowfield Seam – Lemington South

Time series data for bores targeting the shallow interburden, Woodlands Hill Seam and Glen Munro Seam are presented in **Figure 5-15**. As shown in **Figure 5-15**. Groundwater elevations for all bores except B425(WDH) ranged between 45.73 mAHD and 47.51 mAHD (8.56 m and 25.84 m depth). Over 2018 the groundwater levels declined between 0.44 m (C130(WDH)) and 0.76 m (B631(WDH)). For bores C809(GM/WDH), D010(WDH), and D010(GM) only had groundwater levels recorded once during 2018. Following the decline of groundwater levels in bore B425(WDH) during 2017, the bore was recorded as dry throughout 2018. These elevations and trends correspond more closely with trends observed for the Bowfield Seam bores. Further review of the construction and target lithology of bore B425(WDH) is recommended.

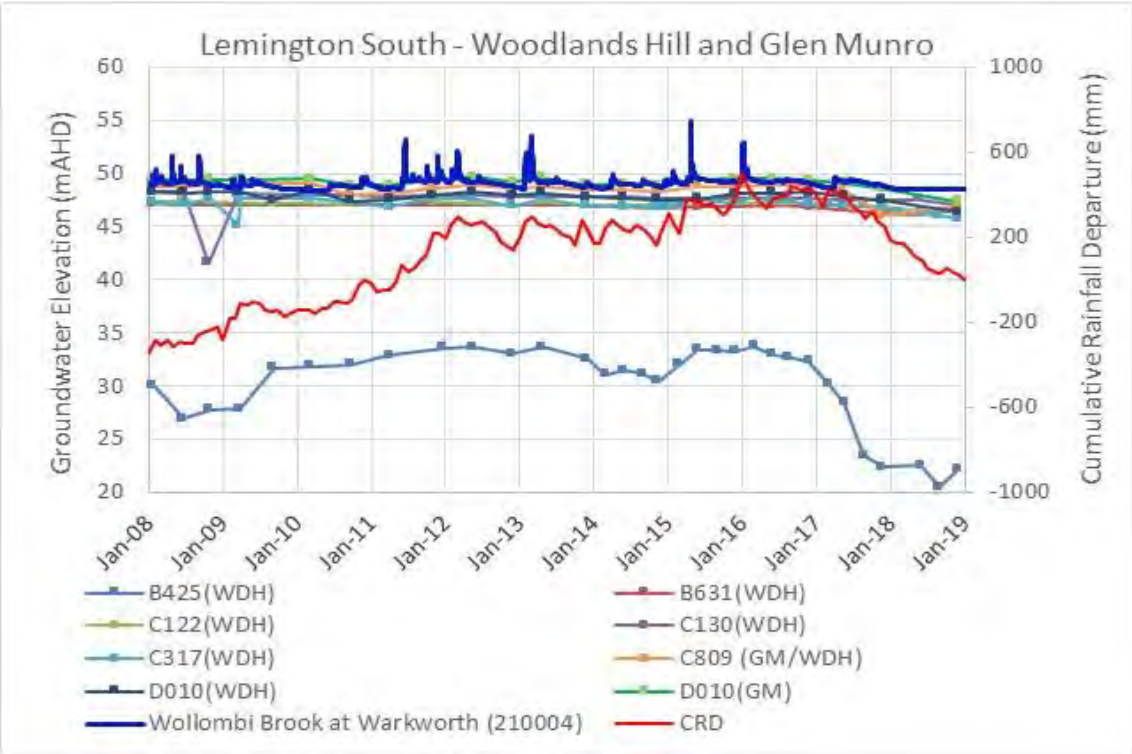


Figure 5-15 Hydrograph of Woodlands Hill Seam and Glen Munro Seam – Lemington South

Time series data for bores targeting the Bowfield Seam are presented in **Figure 5-16**. As shown in **Figure 5-16**, groundwater elevations ranged between 5.87 mAHD and 59.07 mAHD (24.83 m and 56.58 m depth). Interpolated groundwater elevation contours for the Bowfield Seam are presented in **Figure 5-17**, based on December 2018 readings.

Over 2018 the groundwater levels were only measured once (Q4) in bores D010(BFS), D406(BFS), D510(BFS), D612(BFS) and D807(BFS). When comparing groundwater levels in Q4 between 2017 and 2018 bores B334(DFS), D406(BFS), D510(BFS), D612(BFS) have remained relatively stable. Whereas bore C630(BFS) declined by 1.4 m, D010(BFS) declined by 1.93 m. In comparison, bore D807(BFS) rose by 3.83 m over 2018. The bore is located on the northern side of Wollombi Brook near Redbank Creek. The rise may relate to local land use changes and should be further reviewed to understand the source.

Bores D214(BFS), D317(BFS), D613(BFS), B631(BFS), B925(BFS), C130(BFS), C317(BFS), C621(BFS) and recorded a more visible decline in groundwater levels, by between 2.7 m (B214(BFS)) and 6.04 m (B925(BFS)) over 2018. The bores are located between 300 m (B925(BFS)) and 2.3 km (D214(BFS)) of the LUG bore. The LUG bore intersects the historical Lemington Underground workings, which mined through the Bowfield Seam. Over 2018 (calendar year) 874.9 ML of water was abstracted from the bore. The groundwater level drawdown is therefore likely related to abstraction from the bore. This is shown in **Figure 5-17**, which illustrates groundwater flow towards LUG Bore to the southwest. This trend is visible in a range of bores intersecting the Permian coal measures in the area.

Alluvial bore Appleyard Farm is the closest alluvial bore to the LUG Bore. As discussed in **Section 5.2.1.4**, groundwater trends within the bore reflect rainfall and stream flow trends. The bore shows no clear impacts related to groundwater abstraction from the historical underground mine, but ongoing review is recommended.

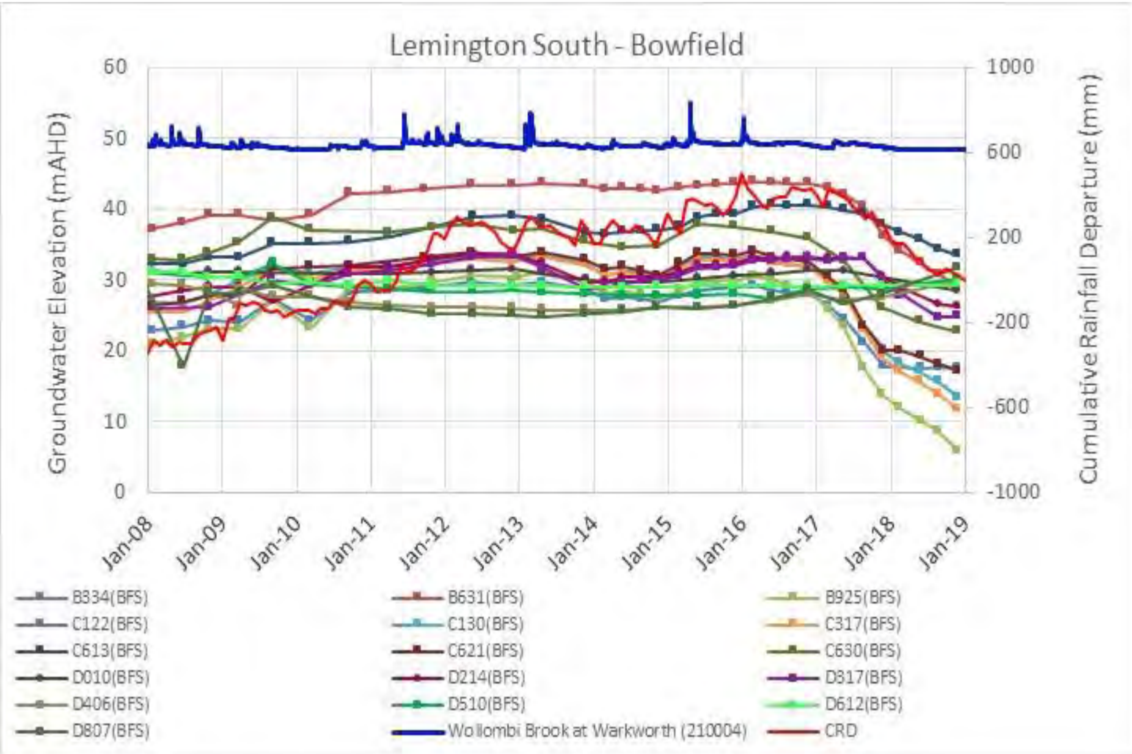
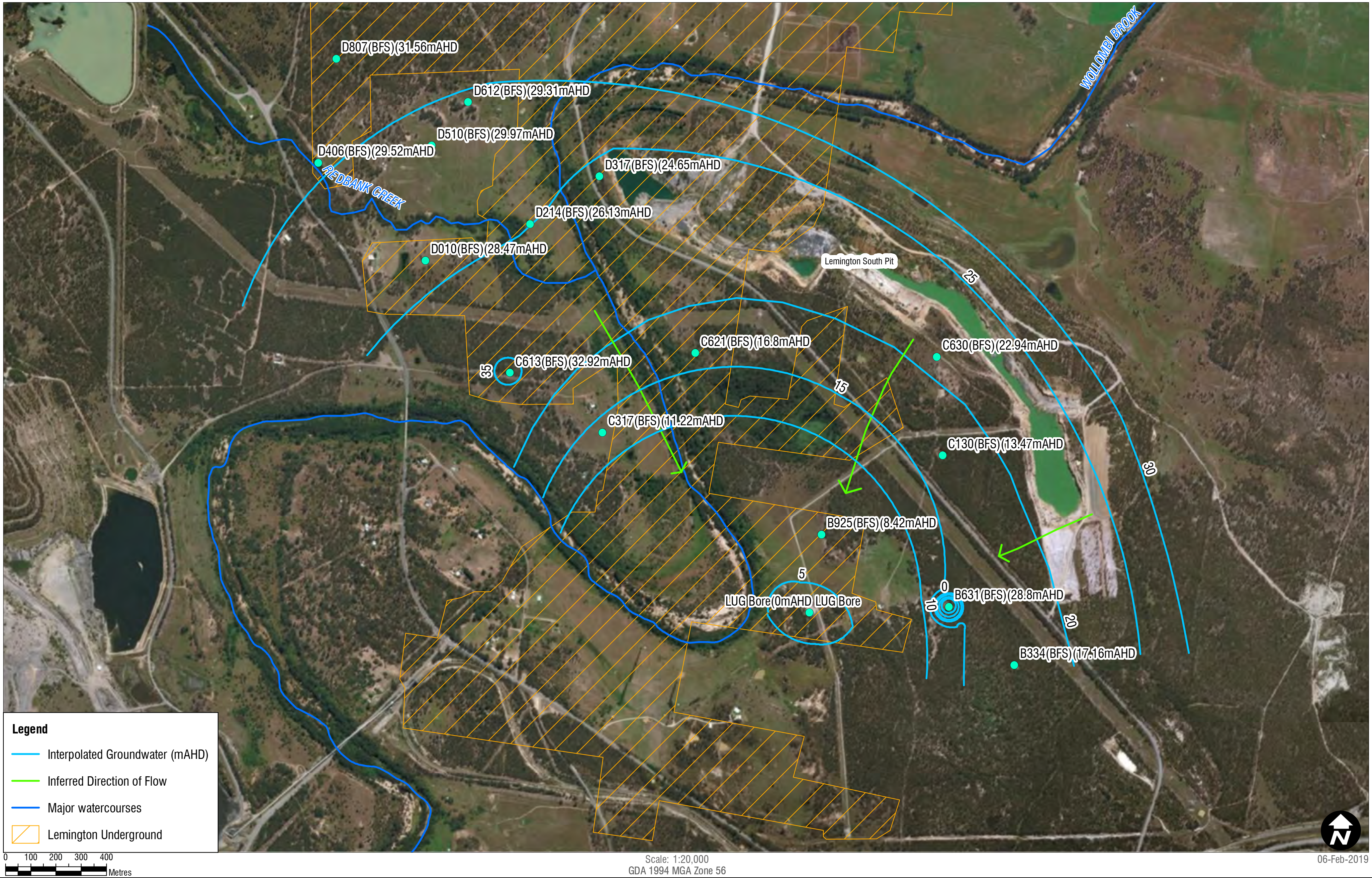


Figure 5-16 Hydrograph of Bowfield Seam – Lemington South



Scale: 1:20,000
GDA 1994 MGA Zone 56

06-Feb-2019

Sheet Size : A4

SLR
www.slrconsulting.com

Hunter Valley Operations
2018 Review
Interpolated LUG Bore Groundwater Drawdown - Bowfield Seam

FIGURE 5.17

5.2.3 Spoil

The WMP includes 15 monitoring bores that intersect spoil material within North Pit. Bores GW_107 and GW_108 that intersect spoil within Carrington Pit were recorded as dry throughout the year, as was DM7 which is located within North Pit.

Time series groundwater levels for the spoil are presented in **Figure 5-18**. Over 2018 groundwater elevations within the bores ranged between 33.24 mAHD and 77.96 mAHD (9.42 m and 36.02 m depth). Groundwater within the spoil flows from northern-most bore DM1 (77.96 mAHD) in a southerly directly towards southern-most bore MB14HVO03 (33.24 mAHD). Over the course of 2018 groundwater levels declined by between 0.18 m and 1.89 m, consistent with rainfall trends.

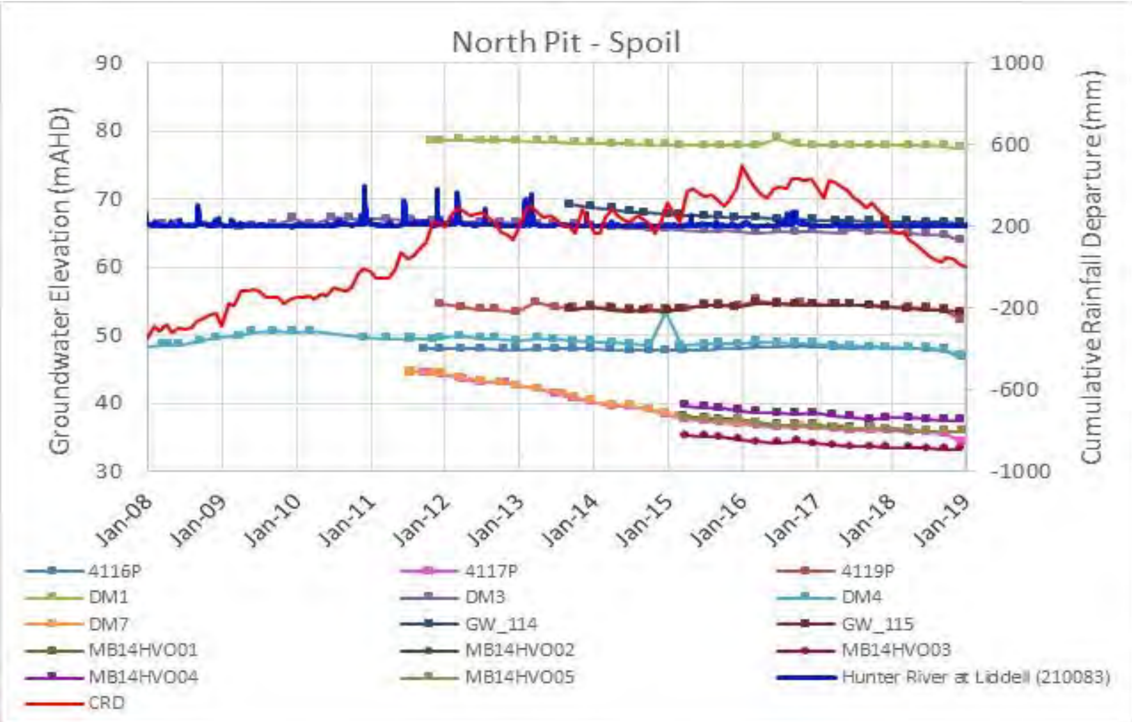


Figure 5-18 Hydrograph of Spoil Bores – North Pit

5.3 Water Quality

A summary of the water quality results is provided for each of the main water bearing units (alluvium, Permian coal measures and spoil) below. Routine EC and pH readings and historical trends are presented in **Appendix D** and **Appendix E**, respectively.

5.3.1 Alluvium

Routine monitoring of EC and pH was conducted for all alluvial monitoring bores over 2018 on a quarterly basis. An exception to this were bores GW_101 and CHPZ8A, which were recorded as dry over 2018. Bore C919(ALL) was recorded as dry in Q4 and bore CGW47a was recorded as dry in Q3 and Q4. In addition, although bore GW_100 has water quality records, the groundwater level recorded was below the base of the screen and is likely dry.

Alluvial groundwater quality over 2018 ranges between locations, as discussed below:

- West Pit: EC ranges between 4,480 µS/cm and 11,120 µS/cm and pH ranges between 7.1 and 8.8;
- Carrington and Carrington West Wing area: EC ranges between 965 µS/cm and 9,490 µS/cm and pH ranges between 6.6 and 7.8;
- Between Cheshunt Pit and North Pit: EC ranges between 369 µS/cm and 3,670 µS/cm and pH ranges between 6.3 and 7.6; and
- Lemington South Pit: EC ranges between 440 µS/cm and 4,830 µS/cm and pH ranges between 6.7 and 7.5.

Discussion in water quality trends and triggers is included for each of the mine locations from **Section 5.3.1.1** to **Section 5.3.1.4**.

Full water quality analysis was conducted for the site alluvial bores in accordance with the WMP. Exceptions to this include bores C919(ALL), CHPZ8A and GW_101, which had insufficient water available to sample. Full water quality data is presented in **Appendix F** and summarised below:

- Total aluminium: variable readings from below laboratory limit of reporting to 19 mg/L (PZ2CH400) over 2018;
- Total arsenic: concentrations generally below the limit of reporting or less than 0.01 mg/L;
- Total cadmium: concentrations generally below the limit of reporting or less than 0.0002 mg/L; and
- Total zinc: concentrations generally below the limit of reporting or less than 0.2 mg/L. Exceptions to this was a reading of 0.3 mg/L for bore 4032P.

5.3.1.1 West Pit

Over the 2018 monitoring period, the following triggers for EC and pH were exceeded at the West Pit bores:

- Only one bore exceeded the trigger level for EC. It is noted that field records showed EC readings for bore GW_100 above 10,751 µS/cm. However, review of the groundwater level data indicates the bore is dry and samples likely relate to sediment at the base of the bore and is not considered representative of the groundwater unit; and
- Bore G2 recorded pH of over the trigger level of 8.6 in Q1.

Bore G2 apparently intersects alluvium and regolith material, but no details on the bore depth or construction are available. Over 2018 pH readings of between 7.4 to 8.8 were recorded. Historical and current pH readings for G2 show regular fluctuations of between 7.5 and 8.8. However, there was a slight trend of increasing pH with time until the start of 2018 where pH levels have begun to decline over time.

Bore G2 is located in a transect with G1 and G3 on the south-western side of Parnell's Creek Dam (18W) at West Pit. Parnell's Creek Dam is used to store mine water abstracted from West Pit during operations. Historical water quality records (2011 to present) indicate the dam contains water with a pH range of 8.1 to 10.3. A review of bore G2 was conducted in 2018, which included a site visit and a review of water quality data. The review highlighted that the trend of elevated pH in bore G2 is likely a result of sampling methodology, but further work to assess the condition of the bores and water balance within the dam was recommended.

5.3.1.2 Carrington and Carrington West Wing

Over the 2018 monitoring period, the following triggers for EC and pH were exceeded at the Carrington and Carrington West Wing bores:

- Bore GW_106 pH below 6.8 in Q1;
- Bore CGW49 recorded EC above 2,775 µS/cm in Q2; and
- Bore CFW55R recorded EC above 6,154 µS/cm and pH below 7 in Q1, Q2, Q3, and Q4.

Bore GW_106 intersects a remnant patch of palaeochannel alluvium between West Pit and Carrington Pit. Since monitoring commenced at the bore in September 2013, bore GW_106 has recorded an average EC of 9,137 µS/cm and ranging between 8,610 µS/cm and 9,540 µS/cm. Review of EC readings at GW_106 and nearby bore CGW32 (**Appendix E**) shows EC levels remained relatively stable and are below historical readings. The results show no adverse impacts due to mining and highlight that the established trigger levels do not reflect historical trends.

Bore CGW49 intersects alluvium within the western limb of the palaeochannel. Additional data identified since the last annual review, dating back to January 2004, shows that bore CGW49 has recorded an average EC of 4,760 µS/cm and ranging between 2,060 µS/cm and 8,180 µS/cm. Historical data shows a pH range of between 6.6 and 8.1, with a decline in pH observed from December 2014.

Review of EC readings at CGW49 (**Appendix E**) shows EC levels fluctuated slightly over 2018, but remained consistent with historical concentrations. The results show no adverse impacts due to mining and highlight that the established trigger levels do not reflect historical trends.

Bore CFW55R is an alluvial bore located approximately 50 m north of Carrington Billabong, 80 m west of the North Void Tailings. Following on from the 2017 annual groundwater review work has been conducted to investigate trigger exceedances at the bore. In 2018 this investigation included installation of additional groundwater monitoring bores, hydraulic testing and increased groundwater monitoring. Assessment of trigger exceedances and impacts is ongoing and has been conducted in consultation with the regulatory authority.

5.3.1.3 Cheshunt Pit

Over the 2018 monitoring period, the following triggers for EC and pH were exceeded at the Cheshunt Pit bores:

- Bore GA3 recorded a pH below the 6.6 trigger level in Q4, but pH remained within the trigger limits for the remainder of the monitoring period with no adverse impacts identified;
- Hobden's Well recorded pH of over 7.5 in Q4, but within historical reading range of 7.2 to 7.8 with no adverse impacts identified;

- Bore BZ1-1 recorded a pH over 7.5 in Q4, but pH remained within the trigger limits for the remainder of the monitoring period with no adverse impacts identified. As noted earlier, bore BZ1-1 intersects interburden rather than alluvium (AGE 2013a), therefore this should be updated in the WMP; and
- HV3(2) recorded a pH below the 6.6 trigger level in Q4. The level recorded in December 2018 was 6.3 and this may reflect an isolated spike, but ongoing monitoring should be conducted to verify.

Bore CHPZ8A apparently intersects alluvium/regolith material and constructed with screen from 4 m to 6 m below ground. The bore is nested, with CHPZ8D screened within the shallow Mt Arthur Seam from 6 m to 9.5 m below ground. Given the similar screened intervals, it is anticipated that the two bores monitor the same weathered Permian coal measures. Over 2018 both bores recorded groundwater levels of between 52.85 mAHD and 54.1 mAHD, which is only slightly above the base of bore CHPZ8A. It is anticipated that bore CHPZ8A is generally dry, and water quality results likely represent sediment at the base of the bore.

5.3.1.4 Lemington South

Over the 2018 monitoring period, the following triggers for EC and pH were exceeded at the Lemington South bores:

- Bore PB01(ALL) recorded EC above 3,938 µS/cm in Q1 and Q4.

Since monitoring commenced at the bore in January 2000, PB01(ALL) has recorded an average EC of 2,524 µS/cm and ranging between 840 µS/cm and 4,830 µS/cm. Review of EC readings at PB01(ALL) show EC levels have historically fluctuated. PB01(ALL) records large fluctuations in EC, however there appears to be a slight trend of rising EC over time up to 4,830 µS/cm in 2018. This coincides with a slight decline in groundwater levels. Groundwater trends for PB01(ALL) generally correlate to streamflow within Wollombi Brook and groundwater elevations range between 45.1 mAHD and 47.8 mAHD. Groundwater levels are between 6.6 m and 9.3 m below surface. Water level and EC trends for PB01(ALL) are presented in **Figure 5-19.** The data is compared to trends for Wollombi Brook as recorded at HITS station Wollombi Brook @ Warkworth (Station 210004). **Figure 5-19** shows that water levels within bore PB01(ALL) roughly mimic water level trends within the Wollombi Brook, indicating a degree recharge to the alluvium from stream flow.

Bore PB01(ALL) is located on the northern banks of the Wollombi Brook, in an area with no active mining or land clearance. The results indicate the spikes in EC may relate to natural fluctuations and adverse impacts due to mining have been identified.

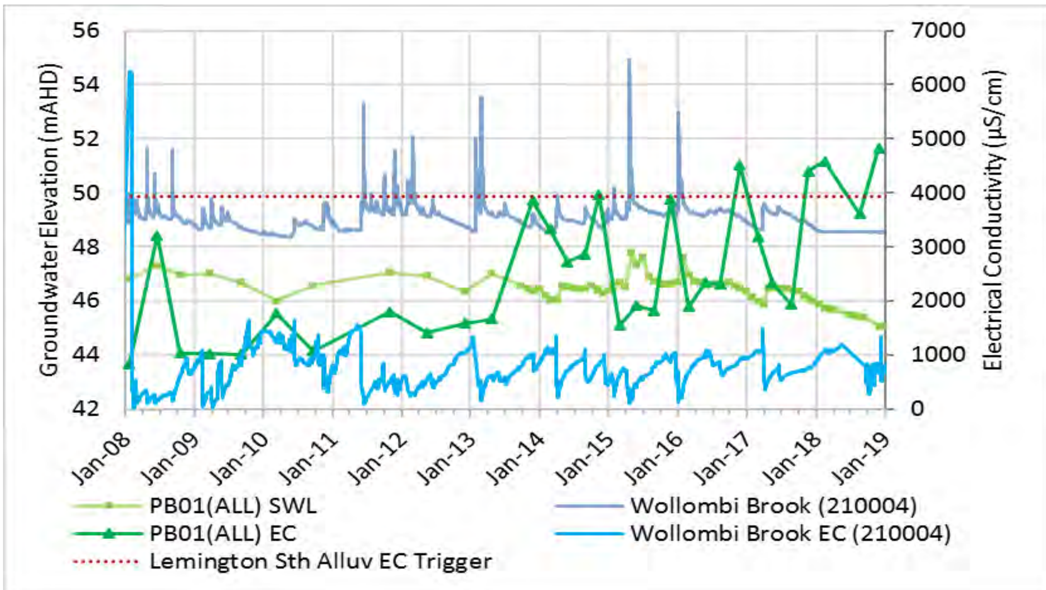


Figure 5-19 Water Level and EC Trends for PB01(ALL) and Wollombi Brook

5.3.2 Permian Coal Measures

Routine monitoring of EC and pH was conducted for all monitoring bores intersecting the Permian coal measures on a quarterly or six-monthly basis over 2018. Exceptions to this were bores 4036C, B425(WDH), C122(BFS) that were dry all year and bores 4051C and CGW45 that were blocked. Bores BZ4A(2), C809(GM/WDH), D010(BFS), D010(GM), D214(BFS), D406(AFS), D406(BFS), D510(AFS), D510(BFS), D612(AFS), D612(BFS), and D807(BFS) were only measured once during 2018.

Over 2018 groundwater quality within the Permian coal measures varied within and between locations, as discussed below:

- West Pit: EC ranges between 6,460 µS/cm and 14,800 µS/cm and pH ranges between 6.8 and 8.0;
- Carrington and Carrington West Wing area: EC ranges between 2,650 µS/cm and 9,310 µS/cm and pH ranges between 6.4 and 7.6;
- Between Cheshunt Pit and North Pit: EC ranges between 837 µS/cm and 4,280 µS/cm and pH ranges between 6.3 and 7.7; and
- Lemington South Pit: EC ranges between 3,720 µS/cm and 24,200 µS/cm and pH ranges between 6.6 and 8.

Discussion in water quality trends and triggers is included for each of the mine locations from **Section 5.3.2.1** to **Section 5.3.2.4**.

In accordance with the WMP full water quality analysis was conducted for the bores targeting the Permian coal measures. Analysis was also conducted for bores not specified within the WMP. Full water quality data is presented in **Appendix F** and summarised below:

- Total aluminium: variable readings from below laboratory limit of reporting to 5.3 mg/L (CFW59) over 2018;
- Total arsenic: concentrations generally below the limit of reporting or less than 0.06 mg/L;

- Total cadmium: concentrations generally below the limit of reporting or less than 0.001 mg/L;
- Total lead and selenium: concentrations below the limit of reporting or less than 0.03 mg/L;
- Total zinc: concentrations generally below the limit of reporting or less than 0.4 mg/L.

5.3.2.1 West Pit

Over the 2018 monitoring period, the following triggers were exceeded for the West Pit bores:

- Bore NPz2 recorded EC over the trigger level of 13,428 µS/cm in Q1 and Q3; and
- Bore NPz5 recorded pH under the trigger level of 6.9.

Bore NPz2 is located approximately 4.5 km north-east of Plashett Reservoir and 1 km north-west of the West Pit mine area. The bore intersects interburden material (siltstone/sandstone) of the deeper Permian coal measures; with a screened interval between 57-60 mbgl. Historical EC readings for NPz2 since 2008 show regular fluctuations of between 12,590 µS/cm and 19,400 µS/cm at the site. The 2018 readings of 12,900 µS/cm and 14,800 µS/cm are therefore considered consistent with historical concentrations. Based on available information, the cause for the changes in EC at NPz2 do not appear to correlate to mine activities conducted at West Pit. It is also recommended that the groundwater quality trigger level be updated to include historical data. In addition, the purpose of the bore should be reviewed.

Bore NPz5 is located approximately 1.4 km east of the West Pit mine area. The bore intersects interburden material (siltstone/sandstone) of the Permian coal measures; with a screened interval between 40-43 mbgl. Historical pH readings for NPz5 since 2008 show regular fluctuations between 6.8 and 7.9 at the site. The 2018 reading of 6.8 is therefore considered consistent with historical concentrations.

5.3.2.2 Carrington and Carrington West Wing

Over the 2018 monitoring period, the following triggers were exceeded for the Carrington and Carrington West Wing bores:

- No bores exceeded triggers for EC;
- Bore CGW52 both recorded a pH under the trigger level of 6.8 in Q2 and Q3; and
- Bore CGW53 both recorded a pH under the trigger level of 6.8 in Q1 and Q2.

Bore CGW52 and CGW53 are located along the Hunter River and apparently intersect the Broonie Seam; however, no construction details for the bores are available. Historical pH readings for the bores since 2005 show regular fluctuations of between 6.4 and 8.6. The 2018 readings ranging from 6.4 to 6.7 are considered consistent with historical concentrations, with no adverse impacts identified.

5.3.2.3 Cheshunt Pit

Over the 2018 monitoring period, the following triggers were exceeded at the Cheshunt Pit bores:

- No bores exceeded triggers for EC;
- Bore BZ3-3 recorded a pH under the trigger level of 6.5 in Q4;
- Bore BZ4A(2) recorded pH under the trigger level of 6.5 in Q1 and Q2;
- Bore BZ8-2 recorded pH under the trigger level of 6.9 in Q and Q4; and

- Bore HG2 recorded pH under the trigger level of 6.9 in Q1, Q2 and Q4.

Bores BZ3-3 and BZ4A (2) intersect the Mt Arthur Seam and are positioned between Cheshunt Pit and the Hunter River. The trigger range for the bores is 6.5 to 7.6, while the range in historical data for the bores is 6 to 7.4. The 2018 readings for the two bores are considered consistent with historical recorded concentrations, with no adverse impacts identified.

Bores BZ8-2 and HG2 intersect interburden material and are also located between Cheshunt Pit and the Hunter River. Historical pH readings for the two bores since 2004 show regular fluctuations of between 6.3 and 7.8. The 2018 readings are considered consistent with historical recorded concentrations, with no adverse impacts identified.

5.3.2.4 Lemington South

Over the 2018 monitoring period, the following triggers were exceeded at the Lemington South bores:

- Bore B631(BFS) recorded an EC above 12,440 µS/cm in Q4 and a pH under 6.6 in Q4;
- Bore C130(WDH) recorded an EC above 20,240 µS/cm in Q2 and Q4;
- Bore C130(ALL) recorded an EC above 11,480 µS/cm in Q1, Q2, Q3, and Q4;
- Bore C630(BFS) recorded a pH above 7.9 in Q4;
- Bore D010(GM) recorded an EC above 1,894 µS/cm in Q4; and
- Bore D612(AFS) recorded an EC above 15,366 µS/cm in Q2 and Q4 and a pH of 6.7 in Q4.

Bore B631(BFS) is located approximately 560 m south-west of Lemington South Pit and around 660 m east of LUG Bore. The bore intersects the Bowfield Seam (BFS). Historical readings for bore B631(BFS) since 2000 show regular fluctuations of EC between 9,250 µS/cm and 15,780 µS/cm and pH of 5.7 to 7.3 for pH. The 2018 readings are therefore considered consistent with historical concentrations. However, it is noted that the slight decline in pH for B631(BFS) may correspond with the decline in groundwater levels within the Bowfield Seam.

Bore C130(WDH) is located between Lemington South Pit and LUG Bore and intersects the Woodlands Hill Seam (WDH). Historical readings since 2000 show regular fluctuations of EC between 18,210 µS/cm and 21,000 µS/cm and pH of 6.4 to 7.5 for pH. The 2018 readings for pH are therefore considered consistent with historical concentrations. The 2018 readings for EC were 20,600 µS/cm and 21,000 µS/cm and are at the top end of the historical readings.

Bore C130(ALL) is located between Lemington South Pit and LUG Bore and intersects interburden. Historical readings since 2000 show regular fluctuations of between 19,500 µS/cm and 24,200 µS/cm for EC and 6.4 to 7.9 for pH. The 2018 readings are therefore considered consistent with historical concentrations.

Bore C630(BFS) is located between Lemington South Pit and LUG Bore and intersects the Bowfield Seam (BFS). Historical readings since 2008 show regular fluctuations of between 11,000 µS/cm and 15,890 µS/cm for EC and 7.1 to 8.3 for pH. The 2018 readings are therefore considered consistent with historical concentrations.

Bore D612(AFS) is located between Lemington South Pit and LUG Bore and intersects the Arrowfield Seam (AFS). Historical readings since 2008 show regular fluctuations of between 11,000 µS/cm and 15,890 µS/cm for EC and 6.7 to 7.6 for pH.

Bore D010(GM) is located between Lemington South Pit and LUG Bore and intersects the Glen Munro Seam (GM). Historical readings since 2008 show regular fluctuations of between 9,050 µS/cm and 12,310 µS/cm for EC and 6.5 to 8.1 for pH. The 2018 readings are therefore considered consistent with historical concentrations.

At Lemington there is a general trend of rising EC within the bores intersecting the Permian coal measures. The rise in EC for some bores is within the range of historical readings, but a trend is visible. There are no known changes in local land use in the area that could result in introduction of more saline groundwater. The trend of rising EC appears to correlate to the decline in groundwater levels around the LUG Bore that is used to abstract water stored within the Lemington Underground. EC is a measure of the ability of water to conduct an electrical current and relates to the concentration of dissolved ions in the water, which can comprise dissolved salts, alkalis, chlorides, sulphides and carbonate compounds. The change in EC around LUG Bore likely relates to changes in local recharge processes and geochemistry in response to abstraction, but further review and collection of full water quality data is recommended to verify.

5.3.3 Spoil

Routine monitoring of EC and pH was conducted for the spoil monitoring bores over 2018 on a quarterly basis. Exceptions to this were bore DM7, GW_107 and GW_108 which were recorded as “dry” throughout the year. Over 2018, water within the spoil material at North Pit recorded an EC of between 1,600 µS/cm and 16,230 µS/cm, and a pH of between 5.4 and 7.2. Exceedances for EC was recorded for bores 4116P and MB14HVO05.

Bore 4116P is located at the southern end of North Pit and recorded EC of 13,070, 13,560 and 13,060 µS/cm in Q2, Q3 and Q4, respectively. Historical readings since 2011 show regular fluctuations of between 10,890 µS/cm and 13,280 µS/cm for EC. The 2018 readings are slightly above the range of historical readings. Review of water quality and water level data for nearby bores indicates this trend is unique to bore 4116P. The groundwater level trends indicate the bore is currently dry and there is potential that historical readings may not have been based on representative groundwater samples. It is recommended that the condition of bore 4116P be reviewed, including a check of the total depth and potential presence of sediments within the base of the bore.

Bore MB14HVO05 recorded EC more than the trigger level of 12,460 µS/cm (16,230 µS/cm) in Q1. The field records indicate that a point sample was collected for bore MB14HVO05 in Q1 of 2018. This methodology does not provide a representative sample of the groundwater unit. The reading appears to be anomalous in comparison to other EC readings for the bore.

In accordance with the WMP full water quality analysis was conducted for the site bores targeting the spoil material, with the exception of dry bores GW_107, GW_108 and DM7. Additional analysis was also conducted for bores not specified within the WMP. Full water quality data is presented in **Appendix F** and summarised below:

- Total aluminium: variable readings from below laboratory limit of reporting to 26 mg/L (MB14HVO05) over 2018;
- Total arsenic: concentrations generally below the limit of reporting or less than 0.2 mg/L with the exception of DM4 with a reading of 0.48 mg/L. The reading is outside of historical fluctuations for bore DM4. However, the field notes during the year note suspended solids present in the bore which may impact water quality results. It is recommended that the bore is purged to clear out the suspend solids;
- Total cadmium: concentrations generally below the limit of reporting or less than 0.02 mg/L;

- Total lead: concentrations below the limit of reporting or less than 0.01 mg/L, with the exception of MB14HVO05 that recorded concentrations of 0.1 mg/L in Q1 and Q3 2018. As outlined above, the results for MB14HVO05 are not considered representative;
- Total selenium: concentrations below the limit of reporting or less than 0.01 mg/L, with the exception of MB14HVO05 (0.3 mg/L in Q1 and 0.2 mg/L in Q3). As outlined above, the results for MB14HVO05 are not considered representative; and
- Total zinc: concentrations generally below the limit of reporting or less than 0.5 mg/L, with the exception of MB14HVO05 that recorded zinc concentration of 15 mg/L (Q1) and 16 mg/L (Q3) 2018. As outlined above, the results for MB14HVO05 are not considered representative.

5.4 Groundwater Take

Interception of groundwater occurs at site due to a range of activities, including direct interception of groundwater with mining activities and abstraction from water supply bores, and indirect interception via induced inter-formation flows due to depressurisation of the Permian coal measures. Each activity is discussed below, and the estimated groundwater take for the various water sources summarised in **Section 5.4.3**.

5.4.1 Groundwater Inflows to Mine Operations

A numerical groundwater model was developed for the HVO South Modification 5. The model was calibrated up to December 2015 and replicates mine progression on a quarterly basis to the year 2039. Year 3 model results (predictive model) represent predicted groundwater conditions and take for the 2018 reporting period for inclusion in this report. The AGE (2015) report does not report predicted take for West Pit and includes inflows for Carrington West Wing that did not commence operations in 2018. To account for this, the predicted inflows to West Pit for model Year 3 were extracted from the model and added to the total take from the North Coast Fractured and Porous Rock water source. In addition, the volume of water taken as part of the modelled Carrington West Wing was subtracted from the total take.

5.4.2 Bore Abstraction

Lemington Underground (LUG) bore is an abstraction bore constructed into the abandoned LUG mine void underlying HVO. The bore is licensed to take up to 1,800 ML of water from the North Coast Fractured and Porous Rock aquifer (20BL173392) per water year. The bore is equipped with a flow meter, with total monthly abstraction is documented. Based on the flow volumes recorded, from July 2017 to June 2018 1,127 ML of water was abstracted from the LUG bore, which is within the licensed allocation of 1,800 ML/year. From June 2018 to December 2018 574 ML of water was abstracted.

As the bore intersects LUG that mined the Permian coal measures, groundwater levels within bores intersecting the coal measures around the bore have been reviewed to identify the extent of groundwater drawdown. As discussed in **Section 5**, groundwater levels within the Bowfield Seam of the Permian coal measures around South Lemington have declined by up to 6.04 m to a distance of 1.3 km from LUG Bore. However, only limited drawdown (maximum 0.78 m decline) was recorded for bores within the shallower coal measures surrounding LUG Bore. In addition, no clear impacts related to groundwater abstraction from the historical underground mine were observed for nearby alluvial bore Appleyard Farm.

5.4.3 Summary of Groundwater Take For 2018

The predicted take of groundwater from the various groundwater sources associated with HVO is presented in **Table 5-2**.

Table 5-2 Predicted Groundwater Take for 2018

	Hunter Regulated (ML)	Hunter Unregulated (ML)	North Coast Fractured and Porous Rock (ML)
HVO Mine Operations†	107	342	905
LUG Bore Abstraction	-	-	1,127*
Total	**107**	**342**	**2,032**

Note: *† HVO Mine Operation predictions from HVO South Modification 5 include Carrington West Wing that was not commenced, and excludes West Pit*

** take over water year (July 2017 to end of June 2018)*

As shown in **Table 5-2**, over the 2018 reporting year the total take under the Hunter Regulated water source was estimated at 107 ML, total take from Hunter Unregulated water source was estimated at 342 ML and around 2,032 ML from the North Coast Fractured and Porous Rock water source.

5.5 Verification of Model Predictions

In accordance with Schedule 4 Condition 27 (c) under DA 450-10-2003 (HVO North) and Schedule 3 Condition 27 (c) under PA 06_0261 (HVO South), the WMP includes requirements to validate and recalibrate (if necessary) the groundwater model for the development. This includes an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions. The numerical groundwater model was developed by AGE (2016) as part of the HVO South Modification 5 assessment. In 2016 the numerical groundwater model was adequately calibrated and the model independently peer reviewed by Dr Frans Kalf. It is anticipated verification and review of the numerical groundwater model will be undertaken as part of the 2019 annual groundwater review, unless undertaken earlier in conjunction with other site projects.

6 Conclusions and Recommendations

6.1 Conclusions

This annual groundwater review covers data collected over 2018 and was completed in compliance with:

- Condition 27 of Development Consent DA 450 10 2003 for HVO North;
- Condition 28 of the Project Approval PA 06 0261 24 for HVO South; and
- Individual bore license conditions (20BL173587-89, 20BL173847 and 20BL173392).

Over 2018 operations across HVO included active mining at West Pit, Cheshunt Pit, and Riverview Pit. Two tailings facilities were used over the year (Dam 6W and North Void DM6) and groundwater was abstracted from LUG Bore.

Review of climate data indicates the region generally experienced below average rainfall over 2018 (450 mm). Similar trends are reflected in stream levels for the Hunter River and Wollombi Brook from the HITS stations and site monitoring locations (WL03, WL05, WL10 and WL14).

The groundwater bore network at HVO is extensive, with 137 bores that were installed progressively over the life of the operations. According to the WMP, sampling is undertaken via bailer method for all samples requiring only pH and EC. It is unclear if this approach utilises industry guideline compliant point source sampling equipment to obtain representative samples. Over 2018 monitoring of the groundwater bore network was largely conducted in accordance with the Groundwater Monitoring Program outlined within the WMP. However, water level and water quality readings were not taken in every quarter for 29 bores due to a range of factors such as dry or blocked bore conditions and access restrictions.

Review of groundwater level trends indicates that where saturated, water within the alluvium declined slightly over 2018, generally in line with climate and stream flow trends. Groundwater within the Permian coal measures remained relatively stable to slightly declining over 2018. However, declines in groundwater level within the Bowfield Seam were observed at Lemington South, which appears to relate to abstraction of water from LUG Bore.

Review of water quality results and comparison to trigger levels for EC and pH identified several trigger exceedances over 2018. It was identified that several bores exceeded triggers for EC and pH; however, 2018 readings were in line with historical trends for these bores. Groundwater quality trends that may indicate potential impacts from mine operations were observed for bore CFW55R, which is located within the alluvium near Carrington Pit and North Void DM6.

Quantification of groundwater take was undertaken based on reported volumes estimated for approved operations as part of Modification 5 (AGE 2017) and metered abstraction volumes from LUG Bore. Based on this, over the 2018 reporting year the total take under the Hunter Regulated water source was estimated at 107 ML, total take from Hunter Unregulated water source was estimated at 342 ML and around 2,032 ML from the North Coast Fractured and Porous Rock water source. These volumes are within the licensed take for each groundwater source.

6.2 Recommendations

Based on review of the available data for 2018, the following recommendations have been made:

- Review of the groundwater monitoring network should be conducted to clearly outline the purpose and applicability of each bore for assessing potential groundwater related impacts. This includes assessing bore depth and construction, as well as review of landholder bores potentially impacted by approved operations (i.e. registered bore 10011459).
- Check surveyed ground and casing elevations for bores, particularly bores D612(AFS) and D510(AFS).
- Review groundwater quality triggers to ensure they adequately capture historical trends for bores.
- Continue to conduct investigation and management measures for bore CFW55R, in line with requirements from regulatory authority.
- Further works in relation to bores G1 to G3, including:
    - Review of available records/data relating to the construction of Parnell's dam;
    - Review the condition of bores G1 to G3 plus adjacent bores using a downhole camera and tag line;
    - Based on findings from the downhole camera survey, conduct bore repairs for site monitoring bores and abandon adjacent bores;
    - Install dataloggers into bores G1 to G3 to collect more robust timeseries data;
    - Extend casing height for bore G3 and install a cap that enables pressure release; and
    - Measure/meter volume of water pumped into Parnell's Creek Dam to assist with the site water balance and early detection of potential volume losses.
- Review the bore condition and construction to investigate the elevated groundwater levels at bore PZ2CH400.
- Confirm the geology at NPZ2 and NPZ3 and review applicability of the bore for compliance monitoring, and account for historical data for trigger levels if kept in the network.
- Review of the condition of the bore CGW46 to confirm if it is dry.
- Review the condition and construction of bores BC1a, BZ1-3, BZ2A(1), BZ3-3,BZ4A(2) and B425(WDH) in order to understand the cause for the variability in trends.
- Review local land use activities around D807(BFS) to understand trends.
- Collect additional groundwater quality data (i.e. major ions) from bores around LUG Bore (Lemington) in order to further assess water quality changes in response to groundwater level decline.
- Review trigger levels for bores GW_106, CGW49 and CGW32 to account for historical trends.
- Review the condition of bore 4116P, including a check of the total depth and potential presence of sediments within the base of the bore. As well as review the applicability of having spoil bores for compliance monitoring.
- Clear out/purge bore DM4 to remove sediment.
- Review the WMP to ensure bores are assigned to the correct geological unit, this includes updating BZ1-1 as intersecting interburden rather than alluvium.

7 References

Australasian Groundwater and Environmental Consultants 2013a, *2012 HVO South Groundwater Impacts Report,* prepared for Coal & Allied Operations Pty Ltd, March 2013.

Australasian Groundwater and Environmental Consultants 2013b, *HVO North Modification Fine Reject Emplacement Groundwater Assessment*, prepared for Coal & Allied Operations Pty Ltd, June 2013.

Australasian Groundwater and Environmental Consultants 2016, HVO North Modification 6 Groundwater Study, prepared for EMM Consulting for Coal & Allied Operations Pty Ltd, November 2016.

Australasian Groundwater and Environmental Consultants 2017, *HVO South Modification 5 Groundwater Study*, prepared for EMM Consulting for Coal & Allied Operations Pty Ltd, January 2017.

Environmental Resources Management Mitchell McCotter Pty Ltd 1997, *Extension of Mining Operations at Ravensworth Mine: Environmental Impact Statement*, Volume 1, prepared for Peabody Resources Limited, August 1997.

Environmental Resources Management 2008, *Groundwater Assessment, Hunter Valley Operations South Coal Project*, Annex J, prepared for Coal & Allied Operations Pty Ltd, January 2008.

Mackie Environmental Research 1998, *Hunter Valley South Mining Extension: Groundwater and Surface Water Management Studies*, prepared for Rio Tinto Coal, July 1998.

Mackie Environmental Research 2003, *West Pit Extension Groundwater Assessment*, prepared for Coal & Allied, 2003.

Mackie Environmental Research 2005, *Assessment of River Leakage Within the Cheshunt Pit Buffer Zone*, prepared for Coal & Allied, April 2005.

Mackie Environmental Research 2010, *Carrington West Wing Modification – Groundwater Assessment*, prepared for Coal & Allied, in Carrington West Wing Environmental Assessment (EA), Volume 2, Appendix E – Groundwater Study, March 2010.

Mackie Martin & Associates 1992, Hunter Valley Mine Alluvial Floodplain Groundwater Studies, prepared for Coal & Allied, Appendix D – Groundwater Study, August 1992

APPENDIX A

Groundwater Monitoring Program

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	Geology	Groundwater Monitoring Program				
							Water Level	EC	pH	Full WQ	Alk/Acidity
4032P	CWW	308609	6402945	69.35	7.4-13.4	Palaeochannel alluvium	Q	Q	Q	6M	
4034P	CWW	308239	6402959	71.15	5.6-14.6	Palaeochannel alluvium	Q	Q	Q	6M	
4036C	Carrington	308272	6402688	70.7	33.1-34.1	Interburden (Siltstone/Sandstone)	Q	Q	Q		
4037P	CWW	308277	6402702	70.74	8.3-14.3	Palaeochannel alluvium	Q	Q	Q	6M	
4040P	CWW	308675	6402724	69.16	5.9-11.9	Palaeochannel alluvium	Q	Q	Q		
4051C	Carrington	308664	6402721	68.92	31.8-32.8	Interburden (Siltstone/Sandstone)	Q	Q	Q		
4116P	North Pit	310681	6400978	70.17	20.9-23.5	Spoil	Q	Q	Q	6M	
4119P	North Pit	312501	6402048	63.51	14.9-17.5	Spoil	Q	Q	Q	6M	
Appleyard Farm	Lemington	315491	6394639	43.4	7-10	Alluvium	M	Q	Q	A	
B334(BFS)	Lemington	316684	6394088	73.37	58.5-64.5	Bowfield Seam	Q	6M	6M		
B425(WDH)	Lemington	316010	6395024	57.88	31.5-35.5	Woodlands Hill Seam	Q	6M	6M	A	
B631(BFS)	Lemington	316425	6394319	72.11	78-84	Bowfield Seam	Q	6M	6M		
B631(WDH)	Lemington	316424	6394319	71.98	29.8-32.3	Woodlands Hill Seam	6M	6M	6M		
B925(BFS)	Lemington	315921	6394604	62.45	81-87	Bowfield Seam	Q	6M	6M	A	
BC1a	Cheshunt	312421	6400872	66.08	21.98	Mt Arthur Seam	Q	Q	Q		
BUNC45A	Cheshunt/ North Pit	313667	6402055	72.9	17.3-20.3	Regolith	Q	Q	Q	6M	
BUNC45D	Cheshunt Pit	313677	6402060	73.36	25.9-28.9	Mt Arthur Seam	Q	Q	Q	6M	
BZ1-1	Cheshunt/ North Pit	311472	6400483	71.39	21-24	Interburden	Q	Q	Q	6M	
BZ1-3	Cheshunt	311472	6400483	71.39	53-56	Mt Arthur Seam	Q	Q	Q	6M	
BZ2A(1)	Cheshunt	311671	6400561	71.17	49.1-52.1	Mt Arthur Seam	Q	Q	Q		
BZ3-1	Cheshunt	311840	6400640	69.97	**TD 26.5**	Interburden	Q	Q	Q		
BZ3-3	Cheshunt	311840	6400640	69.97	41.5-44.5	Mt Arthur Seam	Q	Q	Q		
BZ4A(2)	Cheshunt	312029	6400705	74.4	38-41	Mt Arthur Seam	Q	Q	Q		
BZ8-2	Cheshunt	312685	6401010	67.8	18-21	Interburden	Q	Q	Q	6M	
C122(WDH)	Lemington	315501	6395007	58.44	19.6-22.6	Woodlands Hill Seam	6M	6M	6M		
C122(BFS)	Lemington	315501	6395007	58.2	-	Bowfield Seam	Q	Q	Q		
C130(AFS1)	Lemington	316400	6394916	63.17	42-44	Arrowfield Seam	6M	6M	6M	A	
C130(ALL)	Lemington	316400	6394916	63.04	15-17	Interburden	Q	Q	Q	A	
C130(BFS)	Lemington	316400	6394916	62.98	55.5-64.5	Bowfield Seam	6M	6M	6M		
C130(WDH)	Lemington	316400	6394916	63.14	19-21.5	Woodlands Hill Seam	6M	6M	6M		
C317(BFS)	Lemington	315054	6395007	60.38	70-76.5	Bowfield Seam	Q	6M	6M		
C317(WDH)	Lemington	315054	6395007	60.12	31-33.5	Woodlands Hill Seam	Q	6M	6M		
C613(BFS)	Lemington	314688	6395243	63.64	77-85	Bowfield Seam	Q	6M	6M		
C621(BFS)	Lemington	315421	6395321	58.37	47-56	Bowfield Seam	Q	6M	6M		
C630(BFS)	Lemington	316378	6395306	68.81	40.3-48.3	Bowfield Seam	6M	6M	6M		
C809 (GM/WDH)	Lemington	314207	6395493	59.13	28-38	Woodlands Hill Seam	6M	6M	6M		
C919(ALL)	Lemington	315192	6395655	57.94	7.5-13.5	Alluvium	M	Q	Q	A	
CFW55R	Carrington	310439	6402180	69.78	9.4-16.4	Palaeochannel alluvium	Q	Q	Q	6M	
CFW57	Carrington	310084	6402053	70.05	8.4-15.4	Palaeochannel alluvium	Q	Q	Q	6M	

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	Geology	Groundwater Monitoring Program				
							Water Level	EC	pH	Full WQ	Alk/Acidity
CGW32	CWW	308598	6404872	78.48	14-23	Palaeochannel alluvium	Q	Q	Q		
CGW39	CWW	308566	6403694	70.31	5-14	Alluvium	Q	Q	Q	6M	
CGW45	CWW	308042	6403349	71.83	28.6	Bayswater Seam	Q	Q	Q		
CGW46	CWW	308413	6403276	71.95	13.6	Bayswater Seam	Q	Q	Q	6M	
CGW47a	CWW	308731	6403405	70.39	16.47	Broonie Seam	Q	Q	Q	6M	
CGW49	CWW	308778	6403098	69.05	13.3	Bayswater Seam	Q	Q	Q		
CGW51a	Carrington	310149	6402419	70.04	13 - 16	Interburden (Siltstone/Sandstone)	Q	Q	Q		
CGW52	Carrington	309906	6402255	70.7	39.6-42.6	Broonie Seam	Q	Q	Q		
CGW52a	Carrington	309902	6402249	70.61	15 - 18	Alluvium	Q	Q	Q		
CGW53	Carrington	309606	6402333	69.87	38.5-41.5	Broonie Seam	Q	Q	Q		
CGW53a	Carrington	309606	6402333	69.83	11.7 – 14.7	Alluvium	Q	Q	Q		
CGW55a	Carrington	309840	6402457	70.56	12.8 – 15.8	Alluvium	Q	Q	Q		
CHPZ10A	Cheshunt/ North Pit	313334	6402297	62.57	9.5-12.6	Alluvium	Q	Q	Q	6M	
CHPZ12A	Cheshunt/ North Pit	313238	6402013	63.13	9.5-11.5	Alluvium	Q	Q	Q	6M	
CHPZ12D	Cheshunt	313236	6402019	63.26	12-15	Mt Arthur Seam	Q	Q	Q	6M	
CHPZ1A	Cheshunt/ North Pit	312820	6401697	65.9	15-18.7	Alluvium	Q	Q	Q	6M[2]	
CHPZ2A	Cheshunt/ North Pit	312941	6401539	65.14	13.7-16.9	Alluvium	Q	Q	Q	6M	
CHPZ3A	Cheshunt/ North Pit	313086	6401756	63.18	14.5-11.5	Alluvium	Q	Q	Q	6M	
CHPZ3D	Cheshunt	313094	6401756	62.96	20.5-23.6	Mt Arthur Seam	Q	Q	Q	6M	
CHPZ4A	Cheshunt/ North Pit	312904	6402123	65.45	10.9-14.2	Alluvium	Q	Q	Q	6M	
CHPZ8A	Cheshunt/ North Pit	313503	6402051	60.05	4-6	Alluvium	Q	Q	Q	6M	
CHPZ8D	Cheshunt	313508	6402047	59.89	6-9.5	Mt Arthur Seam	Q	Q	Q	6M	
D010(BFS)	Lemington	314355	6395687	55.94	60-66.5	Bowfield Seam	6M	6M	6M		
D010(GM)	Lemington	314355	6395687	55.95	12.5-17	Glen Munro Seam	6M	6M	6M	A	
D010(WDH)	Lemington	314355	6395687	56	19.5-22.5	Woodlands Hill Seam	6M	6M	6M		
D214(BFS)	Lemington	314768	6395831	56.67	43-52.5	Bowfield Seam	Q	6*M	6*M		
D317(BFS)	Lemington	315043	6396019	59.64	39-44.2	Bowfield Seam	Q	6M	6M		
D406(AFS)	Lemington	313931	6396074	57.41	24-27.5	Arrowfield Seam	6M	6M	6M		
D406(BFS)	Lemington	313931	6396074	57.36	51-57	Bowfield Seam	6M	6M	6M		
D510(AFS)	Lemington	314380	6396141	54.99	25.5-30.5	Arrowfield Seam	6M	6M	6M		
D510(BFS)	Lemington	314380	6396141	54.98	34-38	Bowfield Seam	6M	6M	6M		
D612(AFS)	Lemington	314524	6396314	62.16	24.01	Arrowfield Seam	6M	6M	6M		
D612(BFS)	Lemington	314524	6396314	62.1	29.15	Bowfield Seam	6M	6M	6M		
D807(BFS)	Lemington	314002	6396484	59.94	36-41	Bowfield Seam	6M	6M	6M		
DM1	North Pit	311778	6405164	102.73	29.15	Spoil (Base)	Q	Q	Q	A	Q
DM3	North Pit	311971	6403310	94.14	41.5	Spoil (Base)	Q	Q	Q	A	Q
DM4	North Pit	312222	6401418	64.85	55-	Spoil (Base)	Q	Q	Q	A	Q
DM7	North Pit	311136	6400961	69.26	32-	Spoil	Q	Q	Q	A	Q
G1	West Pit	305694	6407301	110	<10	Alluvium	Q	Q	Q	A	
G2	West Pit	305660	6407451	110.6	3.04	Alluvium	Q	Q	Q	A	
G3	West Pit	305636	6407556	108.6	<10	Alluvium	Q	Q	Q	A	

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	Geology	Groundwater Monitoring Program				
							Water Level	EC	pH	Full WQ	Alk/Acidity
GA3	Cheshunt/ North Pit	310159	6400876	67.02	12	Coal	Q	Q	Q		
GW_100	West Pit	303729	6406436	89.6	4.4-5	Alluvium	Q	Q	Q	A	
GW_100a (VWP)	Carrington	303722	6406445	89.4	51	Barrett Seam and Interburden	Q*				
GW_101	West Pit	304374	6406728	100.5	9-12	Alluvium	Q	Q	Q	A	
GW_101a (VWP)	Carrington	304362	6406721	100.5	51	Interburden (Siltstone/Sandstone)	Q*				
GW_102 (VWP)	Carrington	305280	6406668	114.6	60.5	Interburden (Sandstone with minor coal)	Q*				
GW_103 (VWP)	Carrington	306769	6404610	103.2	25.5 64.5 119.5	Coal - undifferentiated and weathered Siltstone and coal Sandstone - mg, fresh	Q*				
GW_104 (VWP)	Carrington	307549	6404657	86.7	59 107 135	Lower Pikes Gully Seam Sandstone IB (near Upper Liddell Seam) Sandstone (above Barret)	Q*				
GW_105 (VWP)	Carrington	308597	6405442	93.1	33 103.5 154	Coal - undifferentiated Coal - tuffaceous Coal	Q*				
GW_106	CWW	309092	6405224	82.3	24-27	Palaeochannel alluvium or weathered sandstone	Q	Q	Q	A	
GW_107	Carrington	308738	6404103	73.5	24.2-27.2	Carrington Spoil	Q	Q	Q	A	
GW_108	Carrington	309695	6403971	84.4	52.5-58.5	Carrington Spoil	Q	Q	Q	A	
GW_109 (VWP)	Carrington	309232	6402706	85.2	31.5 65 89.5	Coal - slightly weathered Coal - tuffaceous Bayswater Seam	Q*				
GW_110 (VWP)	Carrington	310503	6404598	124.6	38 63 93	Sandstone - fresh Sandstone Bayswater Seam	Q*				
GW_114	North Pit	312272	6403981	98.2	27-30	Spoil	Q	Q	Q	A	
GW_115	North Pit	312227	6402216	68.3	22.2-28.2	Spoil	Q	Q	Q	A	
GW_120	Carrington	310463	6402239	69.97	12-15	Alluvium	TBC	TBC	TBC	TBC	
GW_121	Carrington	310332	6401877	68	5-8	Alluvium	TBC	TBC	TBC	TBC	
GW_122	Carrington	310225	6401781	69.06	12-15	Interburden	TBC	TBC	TBC	TBC	
GW_123	Carrington	310259	6402014	68.99	9.9-12.9	Alluvium	TBC	TBC	TBC	TBC	
GW_124	Carrington	310170	6401924	68.9	11.7-14.7	Alluvium	TBC	TBC	TBC	TBC	
GW_125	Carrington	310118	6402315	68.46	10.4-13.4	Alluvium	TBC	TBC	TBC	TBC	
GW_126	Carrington	310055	6402214	70.29	11.8-14.8	Alluvium	TBC	TBC	TBC	TBC	
GW_127	Carrington	309973	6402109	68.92	11.1-14.1	Alluvium	TBC	TBC	TBC	TBC	
GW_128	Carrington	310314	6402307	69.77	8.7 - 11.7	Alluvium	TBC	TBC	TBC	TBC	
GW_129	Carrington	310553	6402211	72.3	12.3 - 21.3	Spoil	TBC	TBC	TBC	TBC	

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	Geology	Groundwater Monitoring Program				
							Water Level	EC	pH	Full WQ	Alk/Acidity
HG2	Cheshunt	312469	6400886	67.4	11-17	Interburden	Q	Q	Q		
HG2a	Cheshunt	312469	6400886	66.82	25.8-27.8	Mt Arthur Seam	Q	Q	Q		
Hobdens Well	Cheshunt/ North Pit	312540	6401093	71	13.9	Alluvium	Q	Q	Q	A	
HV3(2)	Cheshunt/ North Pit	310776	6400546	68.06	-	Hunter River Alluvium	Q	Q	Q		
LUG Bore	Lemington	315874	6394295		-		M	Q	Q	A	
NPz2	West Pit	307800	6411340	190.475	57-60	Sandstone/Siltstone	Q	Q	Q	A	
NPz3	West Pit	306305	6409131	148.4	93.3-96.6	Siltstone	Q	Q	Q	A	
NPz5	West Pit	310730	6406550	113.76	40-43	Sandstone/Siltstone	Q	Q	Q	A	
PBO1(ALL)	Lemington	314754	6396026	54.37	9.5-12.5	Alluvium	M	Q	Q	A	
PZ1CH200	Cheshunt/ North Pit	312646	6402256	62.06	>8.9-11.1	Alluvium	Q	Q	Q		
PZ2CH400	Cheshunt/ North Pit	312635	6402051	62.53	>9.9-11.2	Hunter River Alluvium	Q	Q	Q	6M[2]	
PZ3CH800	Cheshunt/ North Pit	312522	6401674	64.16	10.47	Hunter River Alluvium	Q	Q	Q	6M[2]	
PZ4CH1380	Cheshunt/ North Pit	312196	6401176	64.93	14.58	Hunter River Alluvium	Q	Q	Q		
PZ5CH1800	Cheshunt/ North Pit	311852	6400928	66.1	15	Hunter River Alluvium	Q	Q	Q		
SR001	Southern	319146	6394094	58.44	60	Coal	6M	6M	6M		
SR002	Southern	319079	6394620	56.99	38-41	Bayswater Seam	6M	6M	6M		
SR003	Southern	318863	6394864	61.33	64.44	Bayswater Seam	6M	6M	6M		
SR004	Southern	318994	6395506	78.15	40.64	Bayswater Seam	6M	6M	6M		
SR005	Southern	318831	6396128	65.36	27.08	Bayswater Seam	6M	6M	6M		
SR006	Southern	318555	6395732	83.31	92.25	Bayswater Seam	6M	6M	6M		
SR007 (RC_11)	Southern	318772	6394373	60.9	31.5-37.5	Overburden and Vaux Seam coal	6M	6M	6M	A	
SR008 (RC_7)	Southern	319290	6395111	56.8	24.4-30.4	Siltstone/sandstone below Lemington Seam	6M	6M	6M	A	
SR009 (RC_8)	Southern	319338	6394746	56.1	30.4-36.4	Lemington Seam	6M	6M	6M	A	
SR010 (RC_6)	Southern	317319	6395338	57.5	24.6-30.6	Conglomerate and Warkworth Seam	6M	6M	6M	A	
SR011 (RC_14)	Southern	317699	6394412	88.2	41.4-47.4	Mt Arthur Seam and underburden	6M	6M	6M	A	
SR012(HQ_11)	Southern	316354	6393926	76.2	23.4-29.4	Overburden - conglomerate and sandstone	6M	6M	6M	A	
MB14HVO01	North Pit	310587	6401003	71.3	90	Spoil	Q	Q	Q	A	
MB14HVO02	North Pit	310469	6401001	70.9	90	Spoil	Q	Q	Q	A	
MB14HVO03	North Pit	311387	6400950	67.1	80	Spoil	Q	Q	Q	A	
MB14HVO04	North Pit	311491	6401392	67.1	55	Spoil	Q	Q	Q	A	
MB14HVO05	North Pit	310675	6401127	71.7	85	Spoil	Q	Q	Q	A	

Notes:

(VWP) indicates that the hole is fitted with a grouted vibrating wire piezometer.
Q - Data downloaded quarterly*
RE – Rain Event sampling (≥30mm rainfall in 24hrs, max 2 sampling events per quarter),
M – Monthly,
Q – Quarterly,
6M – Six Monthly
A – Annual
[2] Comprehensive analysis 2

APPENDIX B

Bore Construction Details (GW_120 to GW_129)

Bore ID	Easting	Northing	Ground Level (mAHD)	PVC Casing Height (magl)	Bore Dia (mm)	Screened Interval (mbgl)	Gravel Pack (mbgl)	Bentonite Seal (mbgl)	Standing Water Level (mbgl)	Lithology	Logger
GW_120	310463.29	6402238.69	69.97	0.75	50	12-15	7.5 - 15	6 - 7.5	10.93	Alluvium: sand and gravel	Level and salinity logger (LTC)
GW_121	310332.15	6401877.02	68.00	0.59	50	5 - 8 plus 1m sump to 9 m	3.9 - 9	9-10	Dry	Alluvium: sand and clays overlying weathered siltstone	-
GW_122	310224.68	6401780.89	69.06	0.65	50	12-15	11 - 15.4	9.9 - 11	10.8	Permian: weathered sandstone (sand)	Level and salinity logger (LTC)
GW_123	310259.41	6402014.43	68.99	1.02	125	9.9 - 12.9	7.5 - 12.9	6 - 7.5 and 12.9 - 13.5	9.98	Alluvium: sand and gravel/cobbles overlying coal measures.	Level logger
GW_124	310170.45	6401923.87	68.90	0.71	50	11.7 - 14.7	11 - 14.8	9.9 - 11	10.17	Alluvium: sand and gravel	Level logger
GW_125	310117.84	6402315.39	68.46	0.66	50	10.4 – 13.4	7.9 – 13.4	6.5 – 7.9	9.4	Alluvium: sand and gravel	Level logger
GW_126	310055.02	6402213.87	70.29	0.95	125	11.8 - 14.8	10 - 15.1	9-10	10.85	Alluvium: sand and gravel	-
GW_127	309972.92	6402109.09	68.92	0.73	50	11.1 - 14.1	8 - 14.1	6-8	9.95	Alluvium: sand and gravel	-
GW_128	310314.12	6402307.34	69.77	0.97	125	8.7 - 11.7	7 - 12.8	5.8 - 7	10.82	Alluvium: sand and gravel overlying weathered Permian (clay) from 12.7 m	-
GW129	310552.71	6402210.50	72.30	0.73	50	12.3 - 21.3	10 - 21.3	8-10 and 21.3 - 25	11.29	Spoil and weathered siltstone/shale	Level logger

Note: *Coordinates are in GDA94 Z56* *mbgl – metres below ground level* *magl – metres above ground level*

APPENDIX C

Groundwater Level Readings 2018

Alluvium

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	WMP Geology	SWL (mAHD)			
							Q1	Q2	Q3	Q4
4032P	Alluvium	308609	6402945	69.35	7.4-13.4	Alluvium	59.65	59.53	59.59	58.61
4034P	CWW	308239	6402959	71.15	5.6-14.6	Alluvium	58.89	58.85	58.87	58.52
4037P	CWW	308277	6402702	70.74	8.3-14.3	Alluvium	59.69	59.61	59.65	58.57
4040P	CWW	308675	6402724	69.16	5.9-11.9	Alluvium	59.63	59.57	59.56	58.59
Appleyard Farm	Lemington	315491	6394639	43.4	7-10	Alluvium	37.18	37.1	37	36.12
BUNC45A	Cheshunt/ North Pit	313667	6402055	72.9	17.3-20.3	Alluvium	51.93	51.98	52.05	51.76
BZ1-1	Cheshunt/ North Pit	311472	6400483	71.39	21-24	Alluvium (actually interburden)	54.34	54.31	54.65	53.94
C919(ALL)	Lemington	315192	6395655	57.94	7.5-13.5	Alluvium	46.66		46.48	Bore Dry
CFW55R	Carrington	310439	6402180	69.78	9.4-16.4	Alluvium	59.16	59.27	58.91	58.26
CFW57	Carrington	310084	6402053	70.05	8.4-15.4	Alluvium	58.74	58.78	58.76	57.95
CGW32	CWW	308598	6404872	78.48	14-23	Flood Plain	59.82	59.79	59.78	59.19
CGW39	CWW	308566	6403694	70.31	5-14	Flood Plain	58.81	58.74	58.69	58.16
CGW47a	CWW	308731	6403405	70.39	16.47	Flood Plain	55.15	54.64	Bore Dry	Bore Dry
CGW49	CWW	308778	6403098	69.05	13.3	Alluvium	59.6	59.56	59.55	58.99
CGW52a	Carrington	309902	6402249	70.61	15- 18	Alluvium	58.87	58.87	58.87	58.07
CGW53a	Carrington	309606	6402333	69.83	11.7 – 14.4	Alluvium	58.9	58.86	58.87	58.11
CGW55a	Carrington	309840	6402457	70.56	12.8 – 15.5	Alluvium	57.91	57.88	57.92	57.38
CHPZ10A	Cheshunt/ North Pit	313334	6402297	62.57	9.5-12.6	Alluvium	53.95	53.99	54.01	53.19
CHPZ12A	Cheshunt/ North Pit	313238	6402013	63.13	9.5-11.5	Alluvium	54.07	54.1	54.12	53.77
CHPZ1A	Cheshunt/ North Pit	312820	6401697	65.9	15-18.7	Alluvium	55.21	55.24	55.22	54.22
CHPZ2A	Cheshunt/ North Pit	312941	6401539	65.14	13.7-16.9	Alluvium	54.26	54.29	54.27	53.64
CHPZ3A	Cheshunt/ North Pit	313086	6401756	63.18	14.5-11.5	Alluvium	54.15	54.19	54.19	53.48
CHPZ4A	Cheshunt/ North Pit	312904	6402123	65.45	10.9-14.2	Alluvium	54.17	54.191	54.2	53.43
CHPZ8A	Cheshunt/ North Pit	313503	6402051	60.05	4-6	Alluvium	Bore Dry	Bore Dry	Bore Dry	Bore Dry
G1	West Pit	305694	6407301	110	-	Alluvium	107.69	108.1	108.25	108.87
G2	West Pit	305660	6407451	110.6	3.04	Alluvium	108.68	109.13	109.31	109.7
G3	West Pit	305636	6407556	108.6	-	Alluvium	107.1	107.49	107.92	108.27
GA3	Cheshunt/ North Pit	310159	6400876	67.02	12	Alluvium	56.58	56.63	56.58	56.47
GW_100	West Pit	303729	6406436	89.6	4.4-5	Alluvium	84.41	84.06	83.94	83.96
GW_101	West Pit	304374	6406728	100.5	9-12	Alluvium	Bore Dry	Bore Dry	Bore Dry	Bore Dry
GW_106	CWW	309092	6405224	82.3	24-27	Flood Plain	59.95	59.91	59.88	59.1
Hobden's Well	Cheshunt/ North Pit	312540	6401093	71	13.9	Alluvium	59.18	59.23	59.2	58.49
HV3(2)	Cheshunt/ North Pit	310776	6400546	68.06	-	Alluvium	57.62	57.64	57.58	57.08
PB01(ALL)	Lemington	314754	6396026	54.37	9.5-12.5	Alluvium	45.75		45.41	45.07
PZ1CH200	Cheshunt/ North Pit	312646	6402256	62.06	>8.9-11.1	Alluvium	54.73	54.78	54.78	54.56
PZ2CH400	Cheshunt/ North Pit	312635	6402051	62.53	>9.9-11.2	Alluvium	55.27	54.65	54.62	59.98
PZ3CH800	Cheshunt/	312522	6401674	64.16	10.5	Alluvium	54.78	54.86	54.8	54.74

	North Pit									

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	WMP Geology	SWL (mAHD)			
							Q1	Q2	Q3	Q4
PZ4CH1380	Cheshunt/ North Pit	312196	6401176	64.93	14.6	Alluvium	55.06	55.17	55.08	54.86
PZ5CH1800	Cheshunt/ North Pit	311852	6400928	66.1	15.0	Alluvium	55.37	55.48	55.39	55.2

Permian Coal Measures

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	WMP Geology	SWL			
							Q1	Q2	Q3	Q4
4036C	Carrington	308272	6402688	70.7	33.1-34.1	Interburden	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**
4051C	Carrington	308664	6402721	68.92	31.8-32.8	Interburden	**Blocked**	**Blocked**	**Blocked**	**Blocked**
B334(BFS)	Lemington	316684	6394088	73.37	58.5-64.5	Bowfield	17.75	17.58	17.6	17.53
B425(WDH)	Lemington	316010	6395024	57.88	31.5-35.5	Woodlands Hill	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**
B631(BFS)	Lemington	316425	6394319	72.11	78-84	Bowfield	34.11	32.43	30.84	28.91
B631(WDH)	Lemington	316424	6394319	71.98	29.8-32.3	Woodlands Hill		46.14		46.9
B925(BFS)	Lemington	315921	6394604	62.45	81-87	Bowfield	11.91	10.15	8.61	5.87
BC1a	Cheshunt	312421	6400872	66.08	21.98	Mt Arthur	48.78	48.76	48.76	48.48
BUNC45D	Cheshunt Pit	313677	6402060	73.36	25.9-28.9	Piercefield	48.41	48.4	48.43	48.04
BZ1-3	Cheshunt	311472	6400483	71.39	53-56	Mt Arthur	25.02	25.14	25.17	24.59
BZ2A(1)	Cheshunt	311671	6400561	71.17	49.1-52.1	Mt Arthur	25.22	25.27	25.28	25.78
BZ3-1	Cheshunt	311840	6400640	69.97	26.5	Interburden	53.84	53.7	53.77	53.28
BZ3-3	Cheshunt	311840	6400640	69.97	41.5-44.5	Mt Arthur	27.3	27.18	27.25	26.83
BZ4A(2)	Cheshunt	312029	6400705	74.4	38-41	Mt Arthur	34.05	33.94	33.61	33.19
BZ8-2	Cheshunt	312685	6401010	67.8	18-21	Interburden	49.14	47.69	49.26	47.74
C122(WDH)	Lemington	315501	6395007	58.44	19.6-22.6	Woodlands Hill		46.48		46.34
C122(BFS)	Lemington	315501	6395007	58.2	-	Bowfield	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**
C130(AFS1)	Lemington	316400	6394916	63.17	42-44	Arrowfield		45.17		44.39
C130(ALL)	Lemington	316400	6394916	63.04	15-17	Interburden	47.53	47.51	47.48	47.09
C130(BFS)	Lemington	316400	6394916	62.98	55.5-64.5	Bowfield	18.3	17.12	15.62	13.47
C130(WDH)	Lemington	316400	6394916	63.14	19-21.5	Woodlands Hill		47.51		47.07
C317(BFS)	Lemington	315054	6395007	60.38	70-76.5	Bowfield	17.1	15.67	13.88	11.6
C317(WDH)	Lemington	315054	6395007	60.12	31-33.5	Woodlands Hill	46.4	46.21	46.06	45.73
C613(BFS)	Lemington	314688	6395243	63.64	77-85	Bowfield	36.75	35.73	34.36	33.56
C621(BFS)	Lemington	315421	6395321	58.37	47-56	Bowfield	19.99	19.23	18.14	17.17
C630(BFS)	Lemington	316378	6395306	68.81	40.3-48.3	Bowfield		24.15		22.75
C809 (GM/WDH)	Lemington	314207	6395493	59.13	28-38	Woodlands Hill				46.89
CGW45	CWW	308042	6403349	71.83	28.6	LBL	**Blocked**	**Blocked**	**Blocked**	**Blocked**
CGW46	CWW	308413	6403276	71.95	13.6	Bayswater	59.11	59.04	59.07	58.99
CGW51a	Carrington	310149	6402419	70.04	-	Interburden	56.28	56.25	56.21	56
CGW52	Carrington	309906	6402255	70.7	39.6-42.6	Broonie	34.76	34.68	34.66	34.18
CGW53	Carrington	309606	6402333	69.87	38.5-41.5	Broonie	36.24	36.02	36.06	35.31
CHPZ12D	Cheshunt	313236	6402019	63.26	12-15	Mt Arthur	53.92	53.95	53.96	53.69
CHPZ3D	Cheshunt	313094	6401756	62.96	20.5-23.6	Mt Arthur	53.02	53.03	53.05	52.39
CHPZ8D	Cheshunt	313508	6402047	59.89	6-9.5	Mt Arthur	54.01	54.1	54.05	52.85
D010(BFS)	Lemington	314355	6395687	55.94	60-66.5	Bowfield				28.47

D010(GM)	Lemington	314355	6395687	55.95	12.5-17	Glen Munro				47.39
D010(WDH)	Lemington	314355	6395687	56	19.5-22.5	Woodlands Hill				46.38

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	WMP Geology	SWL			
							Q1	Q2	Q3	Q4
D214(BFS)	Lemington	314768	6395831	56.67	43-52.5	Bowfield	29		26.55	26.3
D317(BFS)	Lemington	315043	6396019	59.64	39-44.2	Bowfield	27.89	27.89	24.73	24.79
D406(AFS)	Lemington	313931	6396074	57.41	24-27.5	Arrowfield				42.62
D406(BFS)	Lemington	313931	6396074	57.36	51-57	Bowfield				29.88
D510(AFS)	Lemington	314380	6396141	54.99	25.5-30.5	Arrowfield				30.42
D510(BFS)	Lemington	314380	6396141	54.98	34-38	Bowfield				30.15
D612(AFS)	Lemington	314524	6396314	62.16	24.01	Arrowfield				39.46
D612(BFS)	Lemington	314524	6396314	62.1	35.06	Bowfield				29.31
D807(BFS)	Lemington	314002	6396484	59.94	36-41	Bowfield				31.8
HG2	Cheshunt	312469	6400886	67.4	11-17	Interburden	55.09	55.06	55.07	54.42
HG2a	Cheshunt	312469	6400886	66.82	25.8-27.8	Mt Arthur	41.12	41.13	41.12	41.08
NPz2	West Pit	307800	6411340	190.475	57-60	Sandstone / Siltstone	161.805	161.905	161.825	160.945
NPz3	West Pit	306305	6409131	148.4	93.3-96.6	Sandstone / Siltstone	126.13	126.99	125.38	126.16
NPz5	West Pit	310730	6406550	113.76	40-43	Sandstone / Siltstone	97.37	96.35	95.07	96.23
SR001	Southern	319146	6394094	58.44	60			48.2		47.26
SR002	Southern	319079	6394620	56.99	38-41			43.79		43.41
SR003	Southern	318863	6394864	61.33	64.44			44.22		43.46
SR004	Southern	318994	6395506	78.15	40.64			44.21		43.14
SR005	Southern	318831	6396128	65.36	27.08			43.66		42.78
SR006	Southern	318555	6395732	83.31	92.25			43.73		42.73
SR007	Southern	318772	6394373	60.9	31.5-37.5		25.77	25.81	25.81	25.88
SR008	Southern	319290	6395111	56.8	24.4-30.4		47.53	47.46	47.46	47.26
SR009	Southern	319338	6394746	56.1	30.4-36.4		49.47	49.41	49.41	49.21
SR010	Southern	317319	6395338	57.5	24.6-30.6		47.25	47.2	47.2	47.1
SR011	Southern	317699	6394412	88.2	41.4-47.4		54	53.9	53.9	53.69
SR012	Southern	316354	6393926	76.2	23.4-29.4		50.48	50.23	50.23	49.79

Spoil

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	WMP Geology	SWL			
							Q1	Q2	Q3	Q4
GW_107	Carrington	308738	6404103	73.5	24.2-27.2	Spoil	Bore Dry	Bore Dry	Bore Dry	Bore Dry
GW_108	Carrington	309695	6403971	84.4	52.5-58.5	Spoil	Bore Dry	Bore Dry	Bore Dry	Bore Dry
4116P	North Pit	310681	6400978	70.17	20.9-23.5	Spoil	48.16	47.99	47.92	46.69
4119P	North Pit	312501	6402048	63.51	14.9-17.5	Spoil	54.09	53.98	53.82	52.2
DM1	North Pit	311778	6405164	102.73	29.15	Spoil	77.96	77.94	77.85	77.55
DM3	North Pit	311971	6403310	94.14	50-	Spoil	65	64.83	64.77	63.9
DM4	North Pit	312222	6401418	64.85	55-	Spoil	48.14	48.14	47.81	46.92
DM7	North Pit	311136	6400961	69.26	32-	Spoil	Bore Dry	Bore Dry	Bore Dry	Bore Dry
GW_114	North Pit	312272	6403981	98.2	27-30	Spoil	66.7	66.63	66.63	66.49
GW_115	North Pit	312227	6402216	68.3	22.2-28.2	Spoil	53.9	53.8	53.8	53.38
MB14HVO01	North Pit	310587	6401003	71.3	90	Spoil	36.07	35.88	35.93	35.87

MB14HVO02	North Pit	310469	6401001	70.9	90	Spoil	36.06	35.87	35.92	35.87
MB14HVO03	North Pit	311387	6400950	67.1	80	Spoil	33.51	33.36	33.24	33.26

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	WMP Geology	SWL			
							Q1	Q2	Q3	Q4
MB14HVO04	North Pit	311491	6401392	67.1	55	Spoil	37.83	37.67	37.57	37.56
MB14HVO05	North Pit	310675	6401127	71.7	85	Spoil	36.02	35.85	35.88	35.84

APPENDIX D

Groundwater Quality Data 2018

Alluvium

ID	Location	Q1		Q2		Q3		Q4		EC Trigger	pH Trigger (5th Percentile)	pH Trigger (95th Percentile)
		EC	pH	EC	pH	EC	pH	EC	pH			
4032P	CWW	1604	7.1	1697	7.2	1648	7.3	1571	7.3	2775	7	7.5
4034P	CWW	1646	7.3	1598	7.4	1531	7.4	1538	7.4	2775	7	7.5
4037P	CWW	1231	7.1	1244	7.3	1205	7.4	1223	7.2	2775	7	7.5
4040P	CWW	1037	7.1	1063	7.2	1025	7	965	7.2	2775	7	7.5
Appleyard Farm	Lemington	440	**7**	454	7	501	6.9	527	6.7	22700 3938	6.8 6.6	7.0 7.7
BUNC45A	Cheshunt/ North Pit	2040	6.7	2060	6.7	2050	6.8	2110	6.8	4462	6.6	7.5
BZ1-1	Cheshunt/ North Pit	3670	7.5	3030	7.2	3230	7.4	2540	**7.6**	4462	6.6	7.5
C919(ALL)	Lemington	860	7.5							3938	6.6	7.7
CFW55R	Carrington	**8820**	**6.7**	**9490**	**6.8**	**9340**	**6.8**	**8980**	**6.9**	6154	7	8
CFW57	Carrington	5200	7.1	5610	7.3	5670	7.3	5940	7.3	6154	7	8
CGW32	CWW	8970	7.2	9110	7.2	8940	7	8890	7.1	9280	6.8	7.8
CGW39	CWW	6430	7.2	6600	7.4	6250	7.4	6220	7.4	9280	6.8	7.8
CGW47a	CWW	4620	7.3	4960	7.7	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	9280	6.8	7.8
CGW49	CWW	2720	7.3	**2830**	7.4	2740	7.5	2770	7.4	2775	7	7.5
CGW52a	Carrington	2100	7.6	2230	7.7	2240	7.7	2260	7.7	6154	7	8
CGW53a	Carrington	1268	7.3	1607	7.5	1321	7.3	1329	7.4	6154	7	8
CGW55a	Carrington	1648	7.7	1642	7.7	1636	7.8	1665	7.8	6154	7	8
CHPZ10A	Cheshunt/ North Pit	988	6.8	741	6.7	750	6.9	801	6.9	4462	6.6	7.5
CHPZ12A	Cheshunt/ North Pit	808	6.8	824	6.7	804	6.9	841	6.8	4462	6.6	7.5
CHPZ1A	Cheshunt/ North Pit	752	6.9	784	6.9	832	7.1	736	7	4462	6.6	7.5
CHPZ2A	Cheshunt/ North Pit	881	6.9	882	7	851	7	946	7.1	4462	6.6	7.5
CHPZ3A	Cheshunt/ North Pit	760	6.8	766	6.7	738	6.9	772	6.9	4462	6.6	7.5
CHPZ4A	Cheshunt/ North Pit	762	7	800	6.8	778	7.1	770	6.7	4462	6.6	7.5
CHPZ8A	Cheshunt/ North Pit	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	4462	6.6	7.5
G1	West Pit	6020	7.3	6400	7.3	5070	7.5	9880	7.2	10751	7.1	8.6
G2	West Pit	4480	**8.8**	4810	7.7	4600	7.6	4610	7.4	10751	7.1	8.6
G3	West Pit	5150	7.5	5120	7.6	4960	7.6	5030	7.4	10751	7.1	8.6
GA3	Cheshunt/ North Pit	797	6.9	774	7	849	6.9	806	**6.5**	4462	6.6	7.5
GW_100	West Pit	**11120**	7.4	**10810**	7.3	**10980**	7.1	**10930**	7.4	10751	7.1	8.6
GW_101	West Pit	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	10751	7.1	8.6
GW_106	CWW	9040	**6.6**	9260	6.9	8720	6.8	8970	6.8	9280	6.8	7.8
Hobden's Well	Cheshunt/ North Pit	873	7.3	870	**7.6**	869	7.5	951	**7.6**	4462	6.6	7.5
HV3(2)	Cheshunt/ North Pit	770	6.9	770	6.9	933	6.9	862	**6.3**	4462	6.6	7.5
PB01(ALL)	Lemington	**4580**	7			3610	7	**4830**	7.2	3938	6.6	7.7
PZ1CH200	Cheshunt/ North Pit	500	7.1	805	6.7	738	7.3	700	6.9	4462	6.6	7.5
PZ2CH400	Cheshunt/ North Pit	769	6.7	888	6.6	1083	7.1	470	6.7	4462	6.6	7.5
PZ3CH800	Cheshunt/ North Pit	920	6.9	860	6.6	853	6.9	843	6.9	4462	6.6	7.5

ID	Location	Q1		Q2		Q3		Q4		EC Trigger	pH Trigger (5th Percentile)	pH Trigger (95th Percentile)
		EC	pH	EC	pH	EC	pH	EC	pH			
PZ5CH1800	Cheshunt/ North Pit	395	7.1	369	6.8	419	7.1	412	7.1	4462	6.6	7.5

Permian Coal Measures

ID	Location	Q1		Q2		Q3		Q4		EC Trigger	pH Trigger (5th Percentile)	pH Trigger (95th Percentile)
		EC	pH	EC	pH	EC	pH	EC	pH			
4036C	Carrington	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	10824	6.7	7.4
4051C	Carrington	**Blocked**	**Blocked**	**Blocked**	**Blocked**	**Blocked**	**Blocked**	**Blocked**	**Blocked**	10824	6.7	7.4
B334(BFS)	Lemington			6680	7.3			7360	7.4	12440	6.7	7.9
B425(WDH)	Lemington	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	20240	6.6	7.6
B631(BFS)	Lemington			11980	6.8			**13240**	**6.6**	12440	6.7	7.9
B631(WDH)	Lemington			11430	6.8			13030	6.7	20240	6.6	7.6
B925(BFS)	Lemington			4120	6.9			5110	6.9	12440	6.7	7.9
BC1a	Cheshunt	863	7	862	7	903	7	894	7.2	3350	6.5	7.6
BUNC45D	Cheshunt	2490	6.6	2370	6.7	2320	6.6	2540	6.7	2596	6.4	6.8
BZ1-3	Cheshunt	1293	7.3	1193	7.4	1182	7.4	1204	7.6	3350	6.5	7.6
BZ2A(1)	Cheshunt	1847	6.7	1820	6.6	1830	6.6	1798	6.6	3350	6.5	7.6
BZ3-1	Cheshunt	1700	7.7	1497	7.7	1328	7.6	1223	7.7	6213	6.9	7.7
BZ3-3	Cheshunt	1488	6.5	1145	6.5	913	6.5	1011	**6.4**	3350	6.5	7.6
BZ4A(2)	Cheshunt	1032	**6.3**	837	**6.3**			842	7.4	3350	6.5	7.6
BZ8-2	Cheshunt	1194	6.9	1155	**6.8**	1250	7.1	1284	**6.6**	6213	6.9	7.7
C122(WDH)	Lemington			13210	7.4			14050	7.2	20240	6.6	7.6
C122(BFS)	Lemington							**Bore Dry**	**Bore Dry**	12440	6.7	7.9
C130(AFS1)	Lemington			12980	7.4			13450	7.3	15324	6.8	7.5
C130(ALL)	Lemington	**24200**	7	**23500**	7	**22400**	6.9	**23500**	6.8	11408	6.7	7.1
C130(BFS)	Lemington			4290	7.7			4200	7.6	12440	6.7	7.9
C130(WDH)	Lemington			**20600**	6.6			**21000**	6.7	20240	6.6	7.6
C317(BFS)	Lemington			8590	7.3			8550	7.2	12440	6.7	7.9
C317(WDH)	Lemington			7900	7.4			7860	7.4	20240	6.6	7.6
C613(BFS)	Lemington			9200	7.2			9280	7.1	12440	6.7	7.9
C621(BFS)	Lemington			4310	7.1			5660	7.2	12440	6.7	7.9
C630(BFS)	Lemington			3870	7.9			4070	**8**	12440	6.7	7.9
C809 (GM/WDH)	Lemington							9840	7	20240	6.6	7.6
CGW45	CWW	**Blocked**	**Blocked**	**Blocked**	**Blocked**	**Blocked**	**Blocked**	**Blocked**	**Blocked**	3531	7.3	7.6
CGW46	CWW	2720	**7.5**	2810	**7.5**	2690	**7.6**	2650	**7.5**	Trigger Removed	Trigger Removed	Trigger Removed
CGW51a	Carrington	9280	7.1	9310	7.4	9200	7.4	9080	7.4	10824	6.7	7.4
CGW52	Carrington	7960	6.8	8290	**6.6**	8040	**6.4**	8160	7	8628	6.8	7.1
CGW53	Carrington	7300	**6.7**	7699	**6.7**	7020	6.9	7450	7	8628	6.8	7.1
CHPZ12D	Cheshunt	1317	6.8	1289	6.7	1286	6.8	1290	7	3350	6.5	7.6
CHPZ3D	Cheshunt	1017	6.5	1099	6.5	1005	6.5	1037	6.6	3350	6.5	7.6
CHPZ8D	Cheshunt	1317	7.1	1227	6.9	1336	7.2	1299	7.1	3350	6.5	7.6
D010(BFS)	Lemington							10700	7.1	12440	6.7	7.9
D010(GM)	Lemington							**11540**	6.9	1894	6.5	7.2
D010(WDH)	Lemington							9330	7	20240	6.6	7.6
D214(BFS)	Lemington							7620	7.8	12440	6.7	7.9
D317(BFS)	Lemington	3720	6.8	3720	6.8			3930	6.8	12440	6.7	7.9

ID	Location	Q1		Q2		Q3		Q4		EC Trigger	pH Trigger (5th Percentile)	pH Trigger (95th Percentile)
		EC	pH	EC	pH	EC	pH	EC	pH			
D406(AFS)	Lemington							12070	6.9	15324	6.8	7.5
D406(BFS)	Lemington							7250	7.3	12440	6.7	7.9
D510(AFS)	Lemington							13110	7	15324	6.8	7.5
D510(BFS)	Lemington							10790	7.4	12440	6.7	7.9
D612(AFS)	Lemington							**15580**	6.8	15324	6.8	7.5
D612(BFS)	Lemington							11420	7	12440	6.7	7.9
D807(BFS)	Lemington							10170	7	12440	6.7	7.9
HG2	Cheshunt	4260	**6.8**	4280	**6.8**	3840	6.9	3920	**6.8**	6213	6.9	7.7
HG2a	Cheshunt	1437	6.9	1481	7	1416	7	1446	6.9	3350	6.5	7.6
NPz2	West Pit	**13660**	7.4	12900	7.3	**14800**	7.6	13290	7.2	13428	6.9	8
NPz3	West Pit	12900	8	12450	7.9	12560	8	12890	7.6	13428	6.9	8
NPz5	West Pit	7350	7.2	7490	7.2	6460	7.1	6900	**6.8**	13428	6.9	8
SR001	Southern			17600	6.7			16340	6.7			
SR002	Southern			15660	6.9			15520	6.8			
SR003	Southern			10840	7			10460	6.9			
SR004	Southern			13260	6.8			12950	6.8			
SR005	Southern			3550	6.5			3460	6.4			
SR006	Southern			11600	6.8			11400	6.8			
SR007	Southern	6050	6.6	6020	6.6	6020	6.6	6090	6.6			
SR008	Southern	2980	7.3	15260	6.8	15260	6.8	13350	6.7			
SR009	Southern	4890	7.7	6010	7.4	6010	7.4	6070	7.2			
SR010	Southern	2120	7.4	6210	7	6210	7	6170	6.9			
SR011	Southern	15260	6.6	16620	6.6	16620	6.6	16730	6.5			
SR012	Southern	14710	6.8	14570	6.9	14570	6.9	13400	6.7			

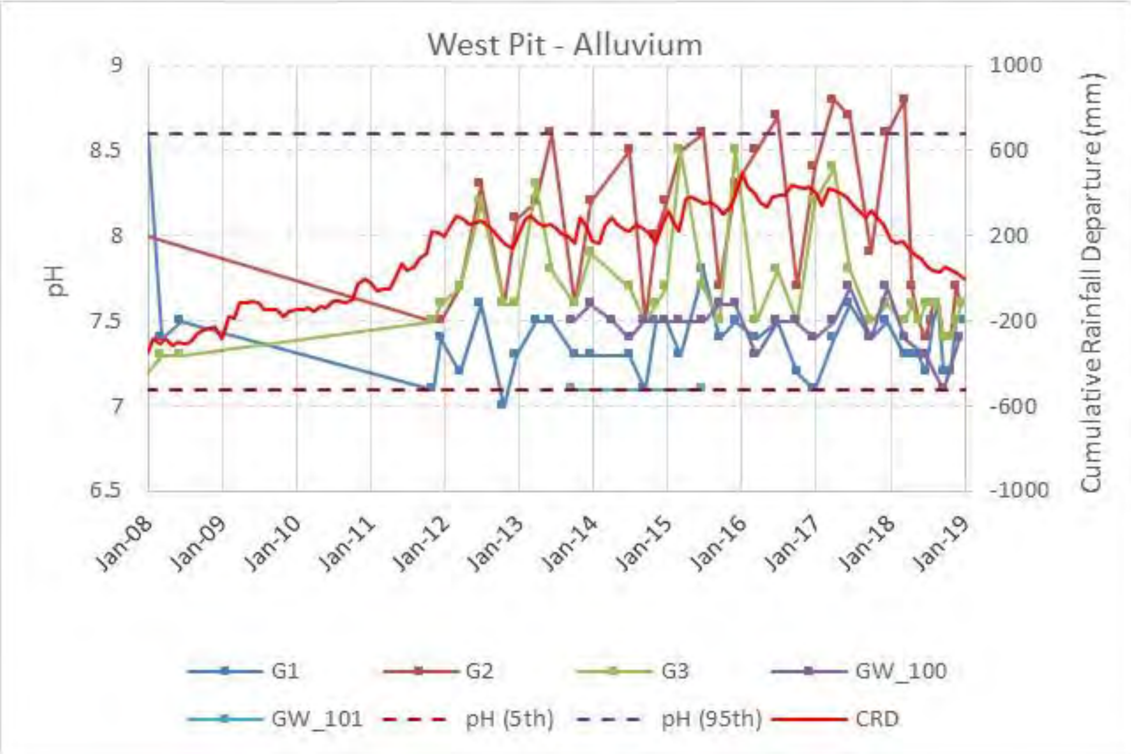
Spoil

ID	Location	Q1		Q2		Q3		Q4		EC Trigger	pH Trigger (5th Percentile)	pH Trigger (95th Percentile)
		EC	pH	EC	pH	EC	pH	EC	pH			
GW_107	Carrington	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**			
GW_108	Carrington	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**			
4116P	North Pit			**13070**	7.1	**13560**	7	**13060**	6.9	12460	6.5	7.8
4119P	North Pit			2290	7	2360	7	3930	7.2	12460	6.5	7.8
DM1	North Pit	9650	6.6	9870	6.6	9680	6.6	9880	6.6	12460	6.5	7.8
DM3	North Pit	9070	6.5	9680	6.5	9500	6.5	9100	6.5	12460	6.5	7.8
DM4	North Pit	5930	6.9	6080	7	5960	6.9	5970	7	12460	6.5	7.8
DM7	North Pit	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	**Bore Dry**	12460	6.5	7.8
GW_114	North Pit	8100	6.5	8540	6.6	8540	6.6	8280	6.6	12460	6.5	7.8
GW_115	North Pit	7180	6.9	7390	6.9	7390	6.9	7260	6.9	12460	6.5	7.8
MB14HVO01	North Pit	7300	6.8	5530	7.1	7360	6.7	6110	6.8	12460	6.5	7.8
MB14HVO02	North Pit	7300	6.8	6760	7.2	7020	6.8	6970	7	12460	6.5	7.8
MB14HVO03	North Pit	6020	6.9	5490	7.1	6080	6.9	5840	7	12460	6.5	7.8
MB14HVO04	North Pit	5850	6.8	5650	7	5990	6.9	5680	7	12460	6.5	7.8
MB14HVO05	North Pit	**16230**	5.4	7500	6.8	1600	5.7	7620	6.6	12460	6.5	7.8

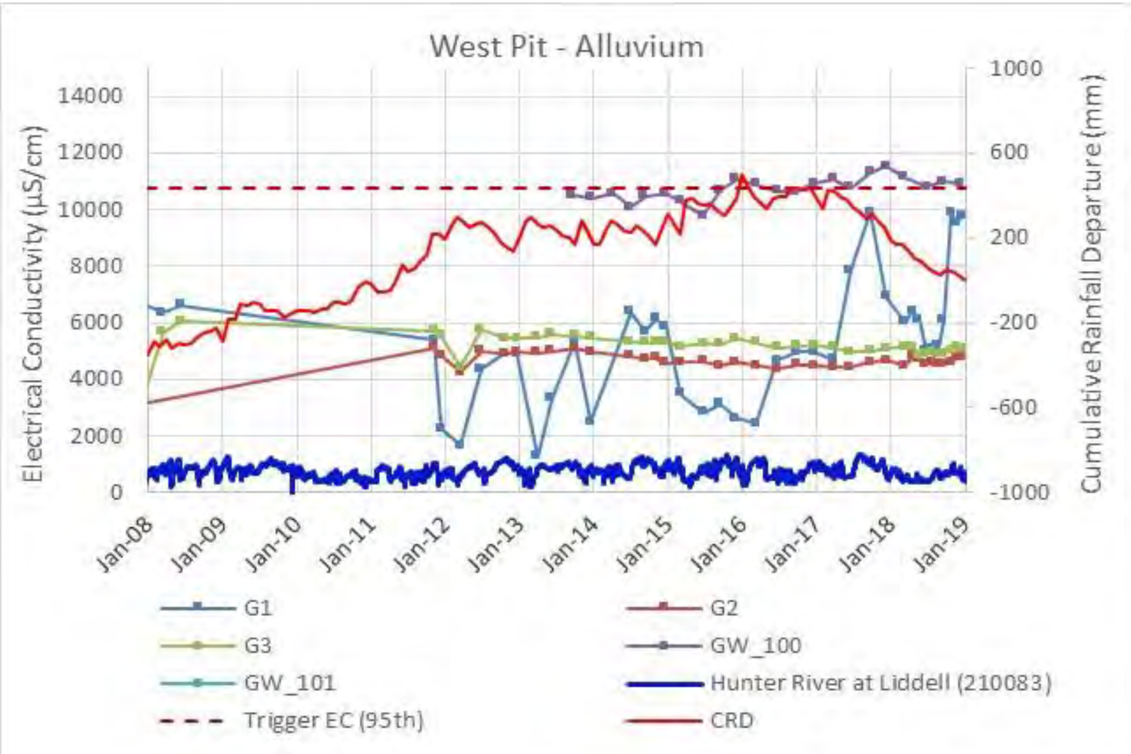
APPENDIX E

Groundwater Quality Graphs – By Location and Geology

West Pit – Alluvium: pH

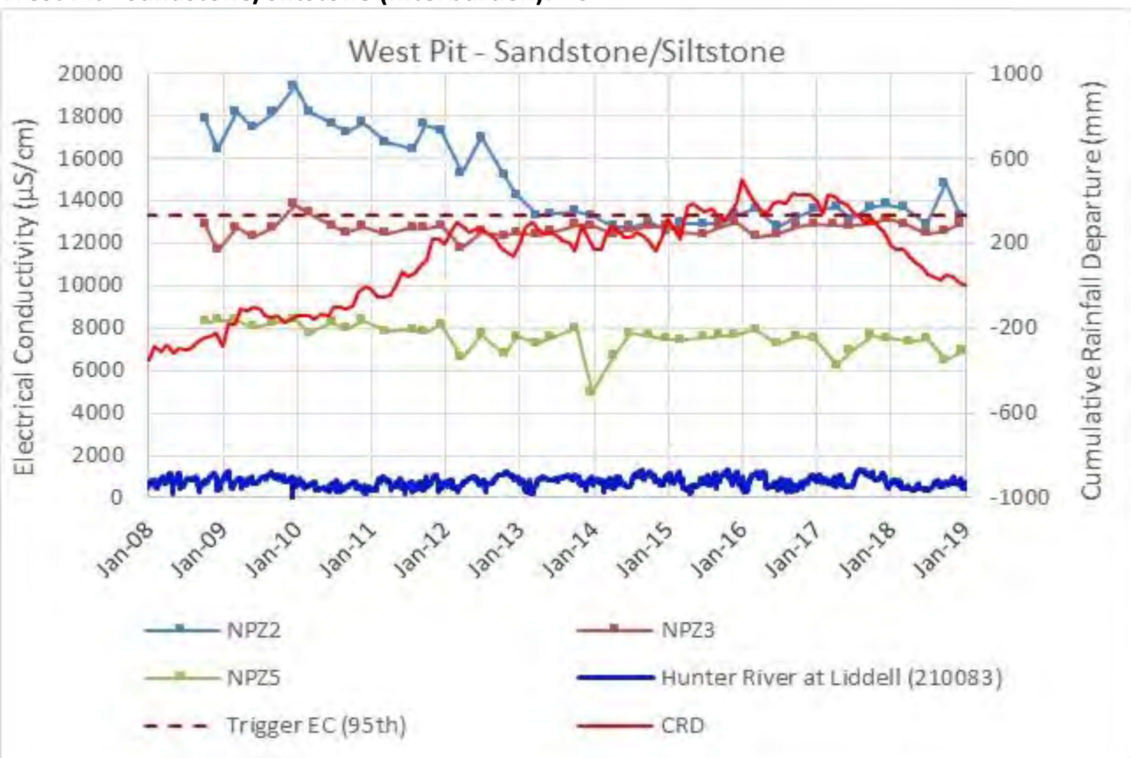


West Pit – Alluvium: EC

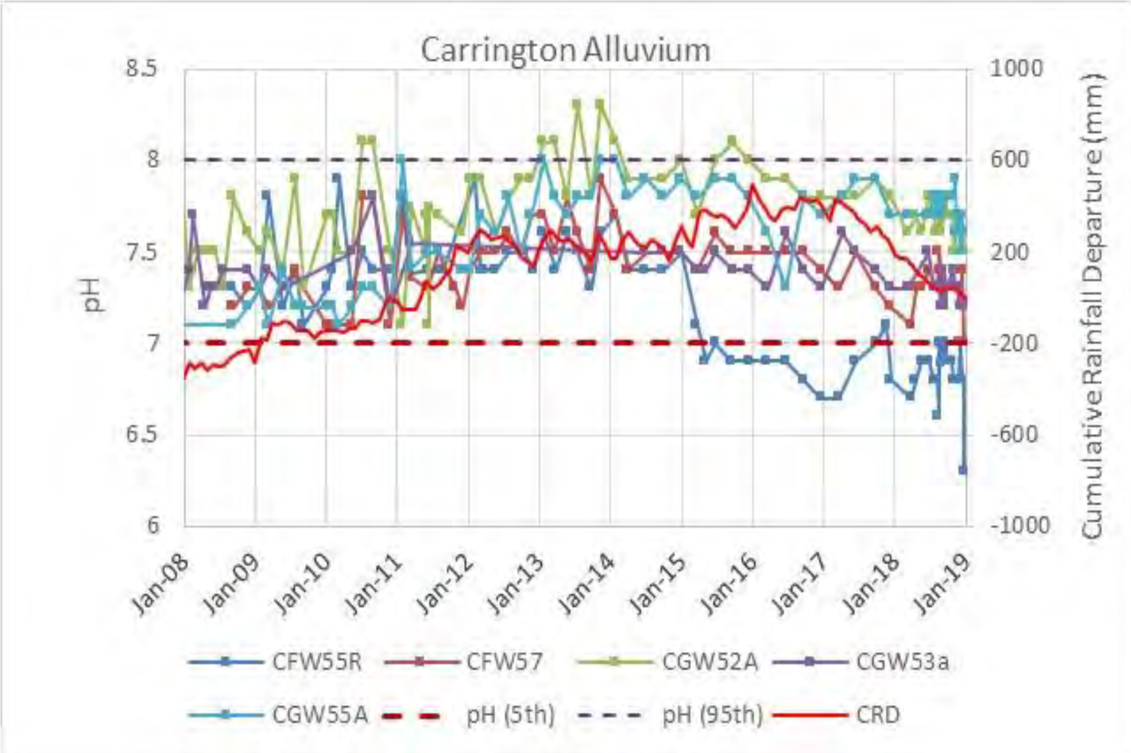


West Pit - Sandstone/Siltstone (Interburden): pH

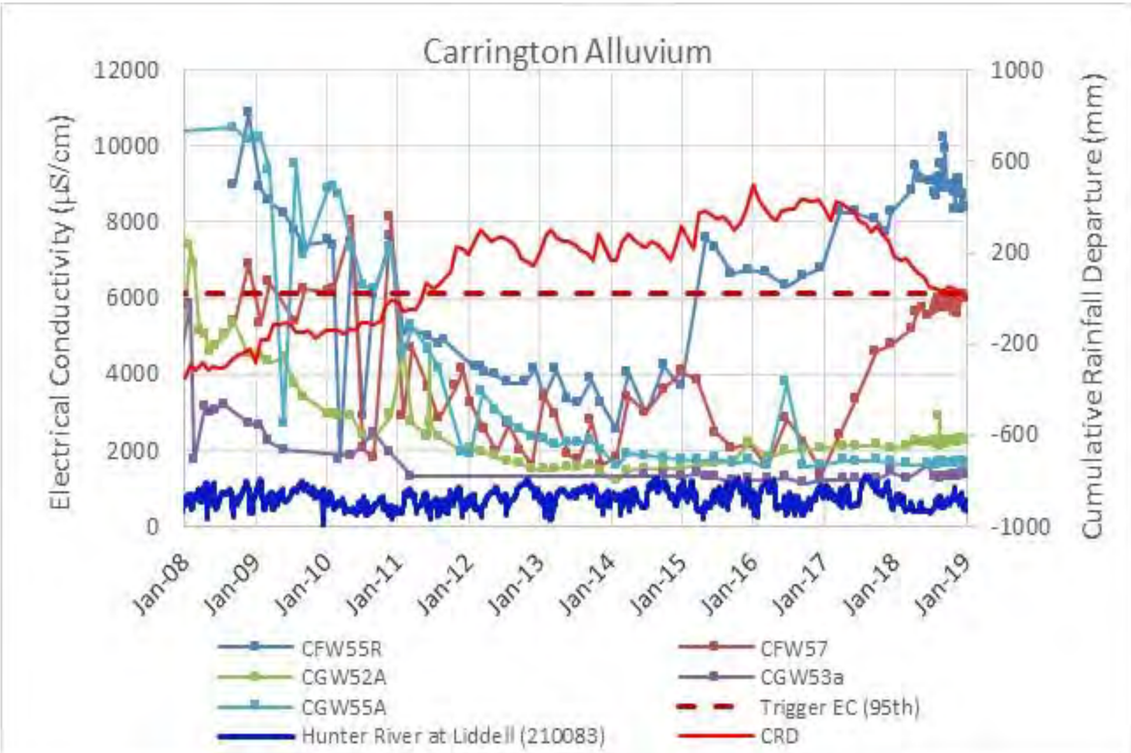
West Pit - Sandstone/Siltstone (Interburden): EC



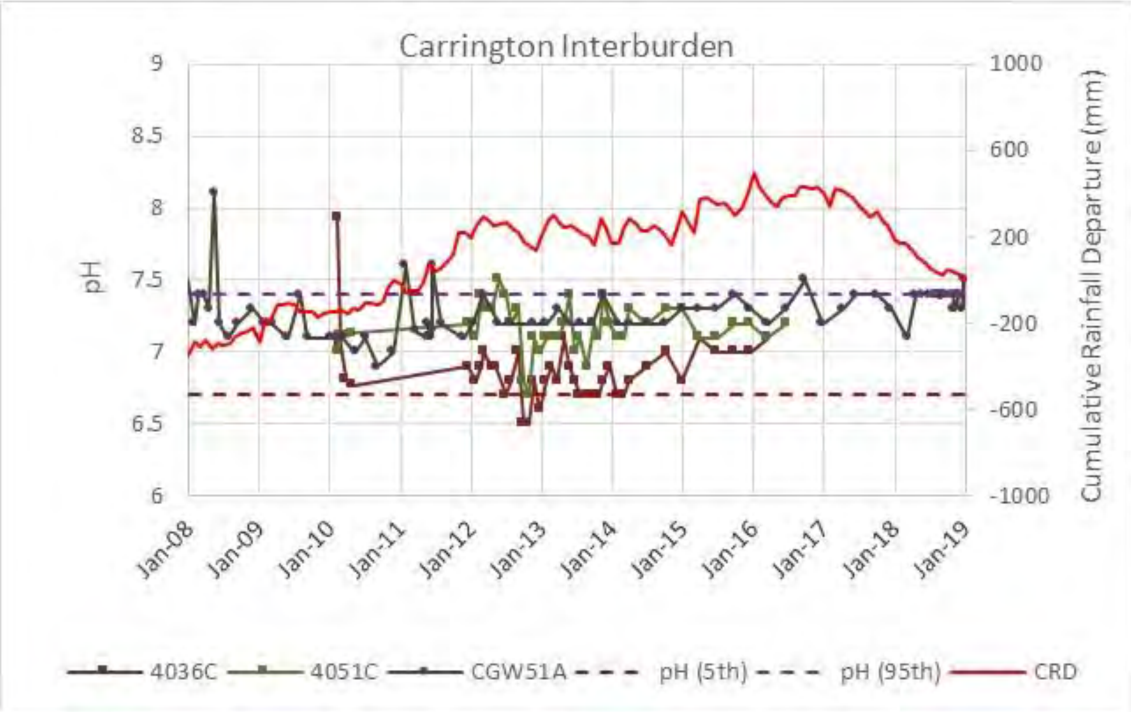
Carrington Pit – Alluvium: pH



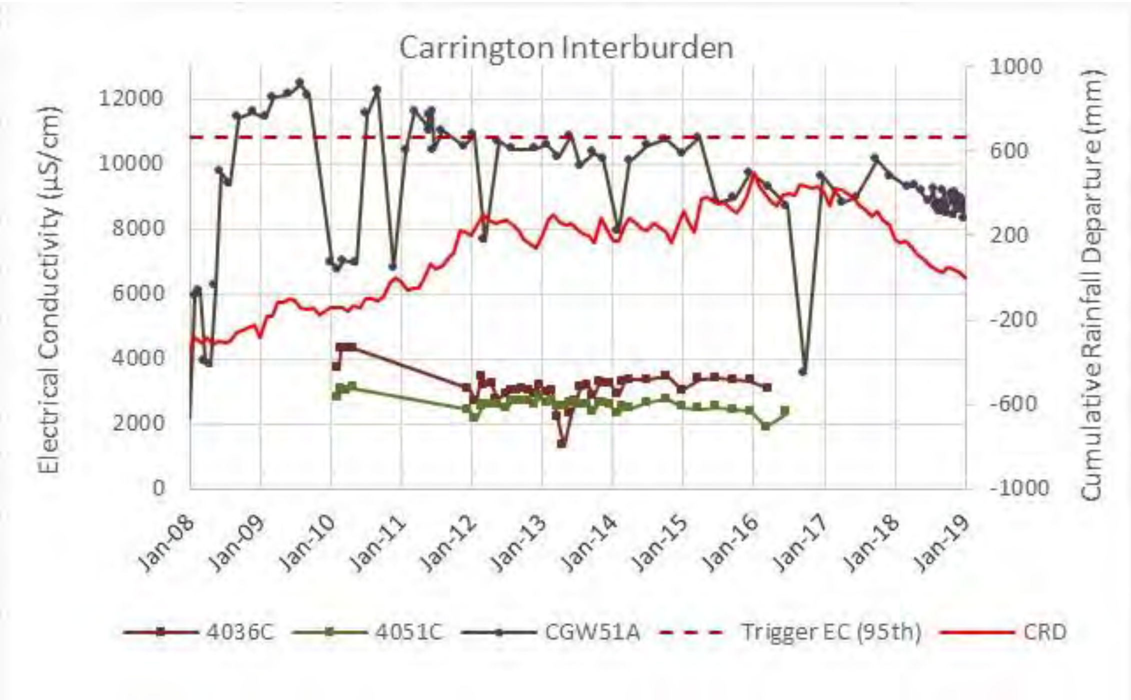
Carrington Pit – Alluvium: EC



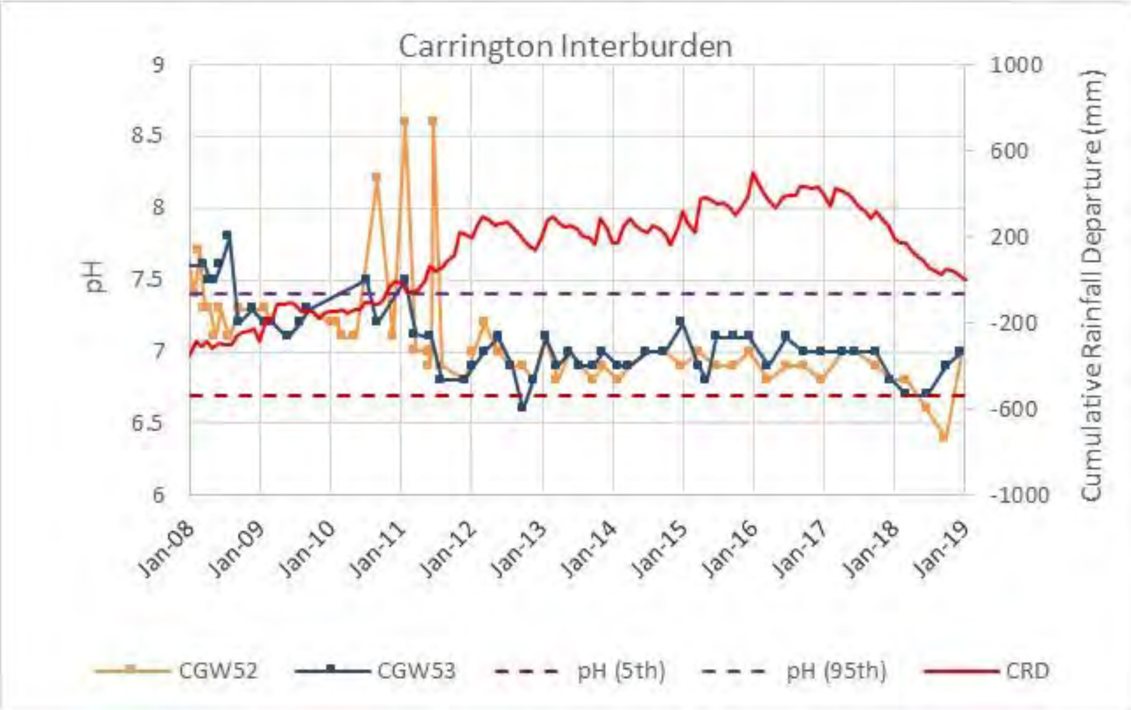
Carrington Pit – Interburden: pH



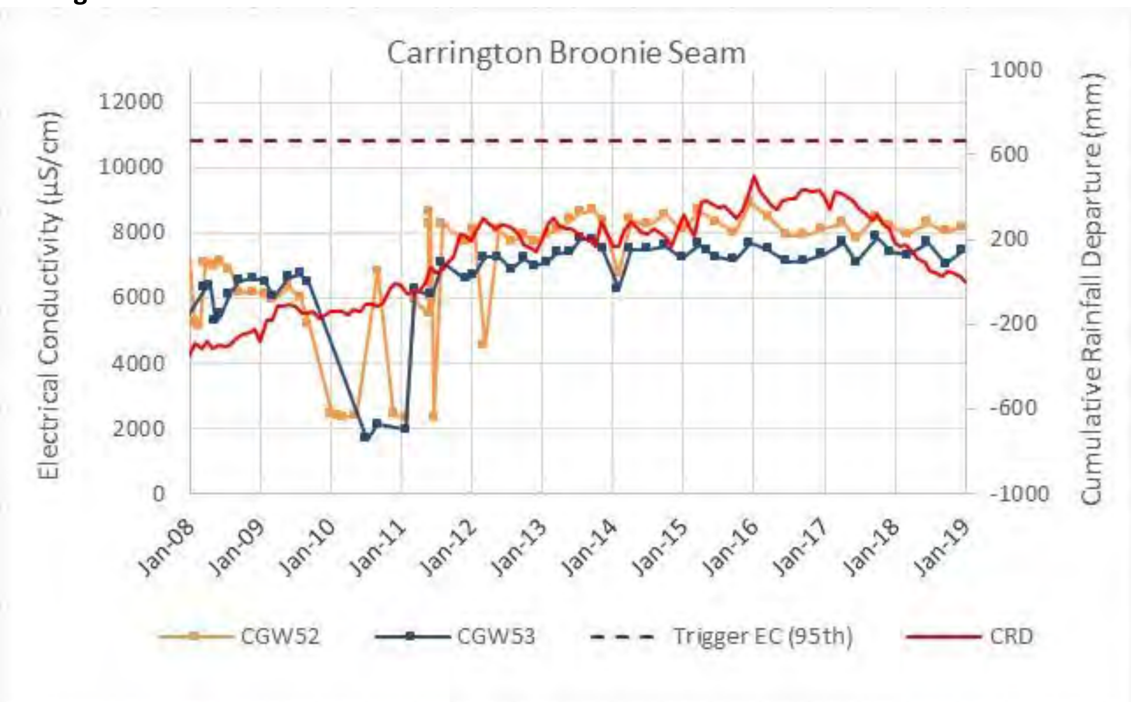
Carrington Pit – Interburden: EC



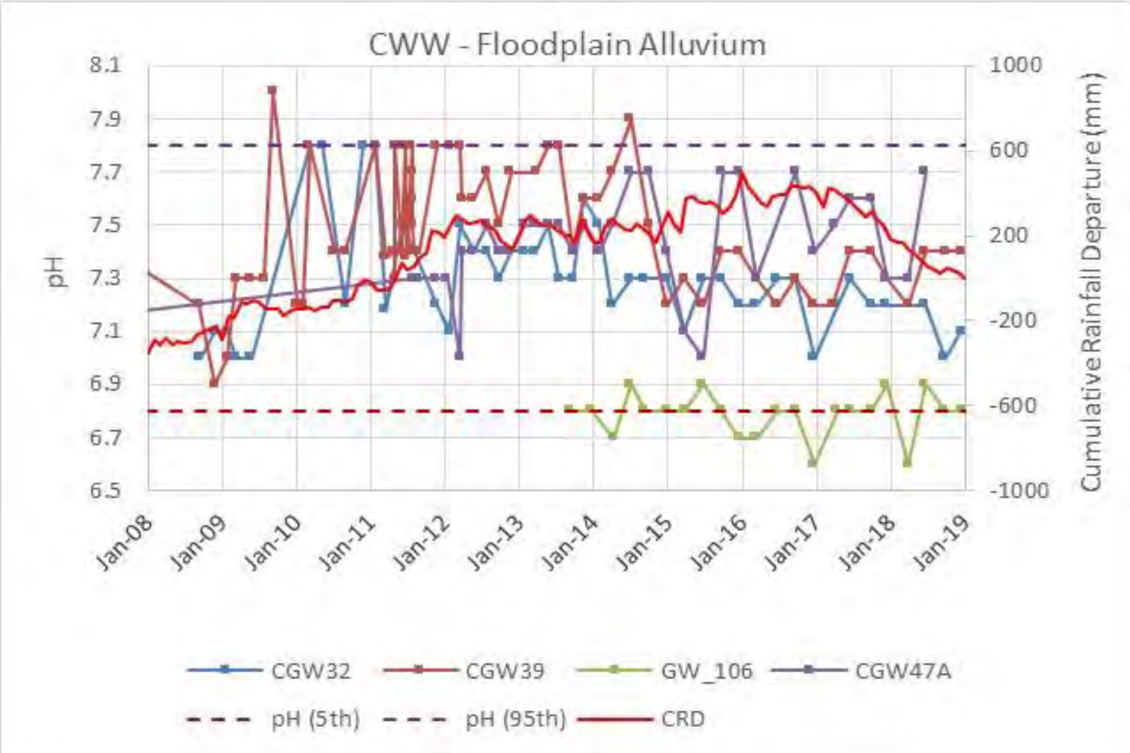
Carrington Pit – Broonie Seam: pH



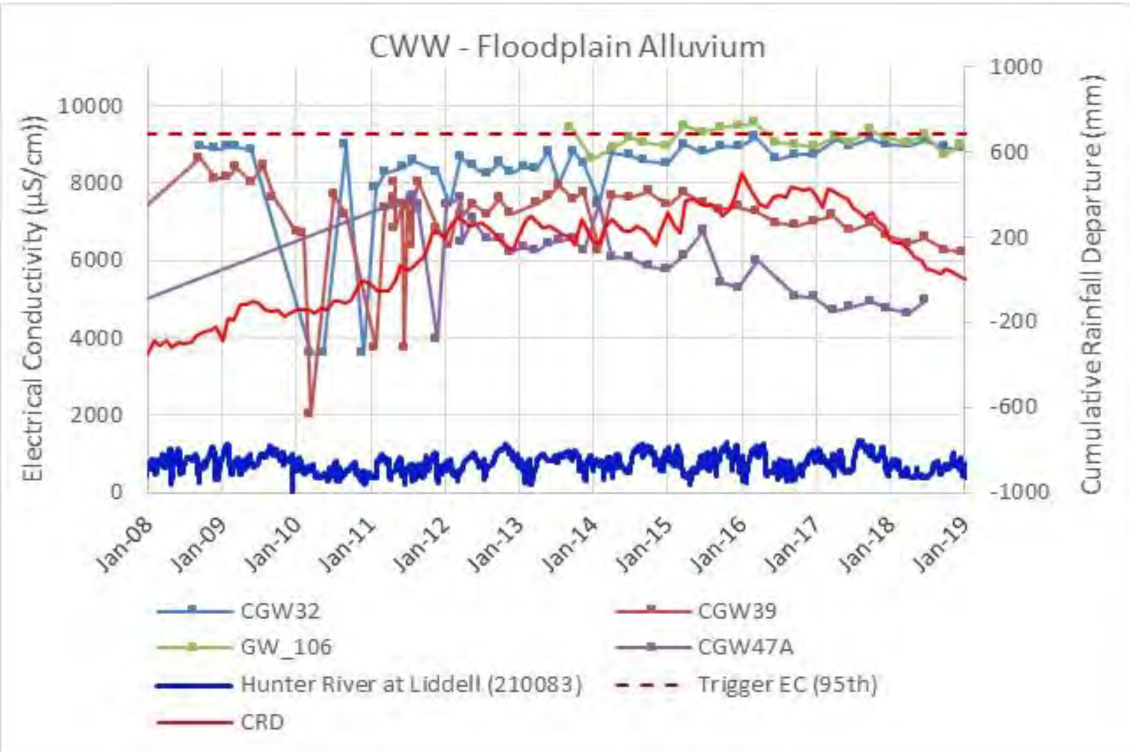
Carrington Pit – Broonie Seam: EC



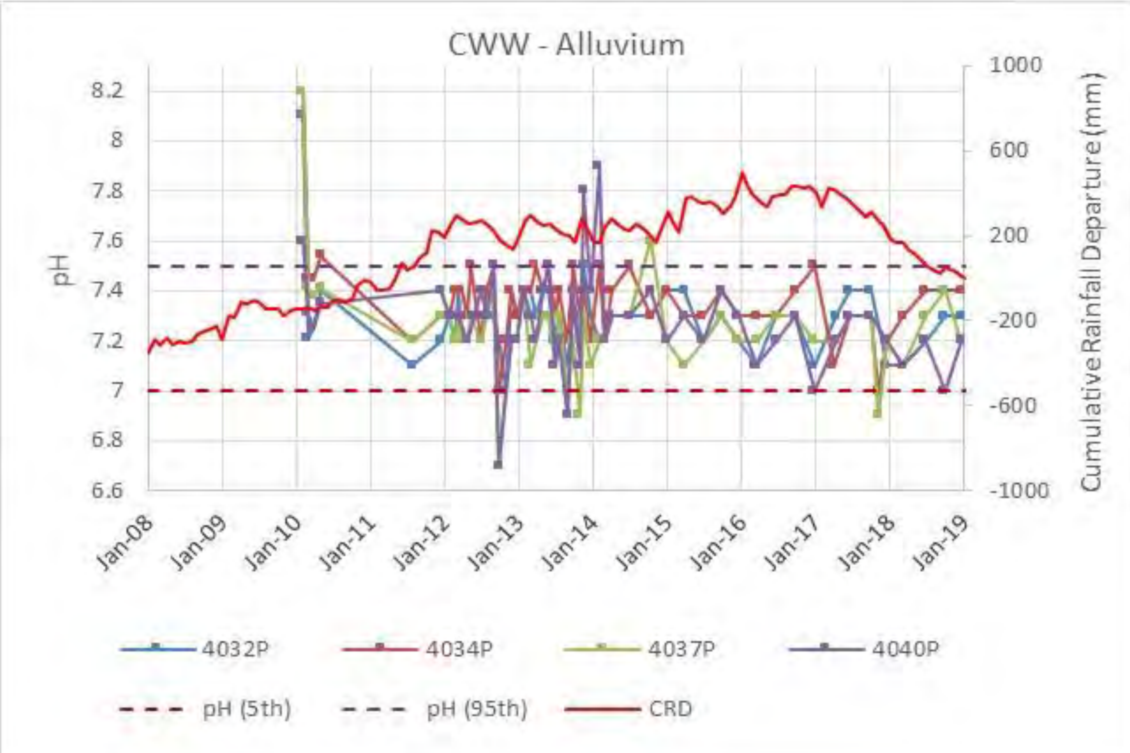
CWW Area - Flood Plain Alluvium: pH



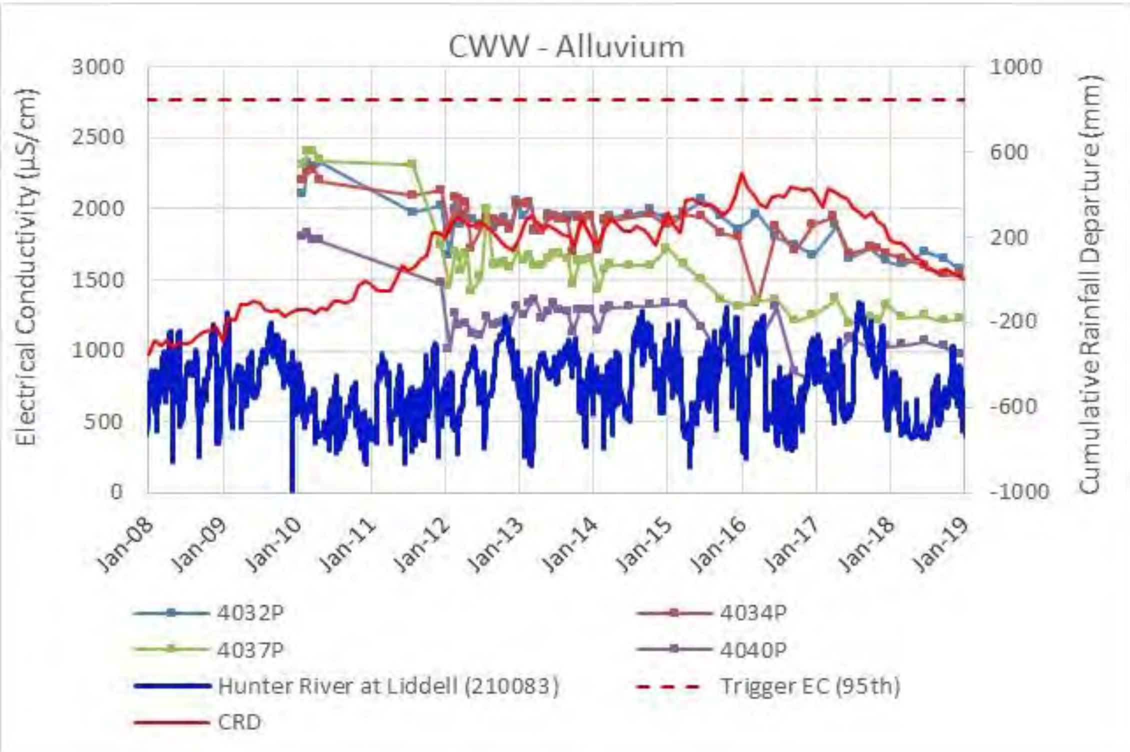
CWW Area - Flood Plain Alluvium: EC



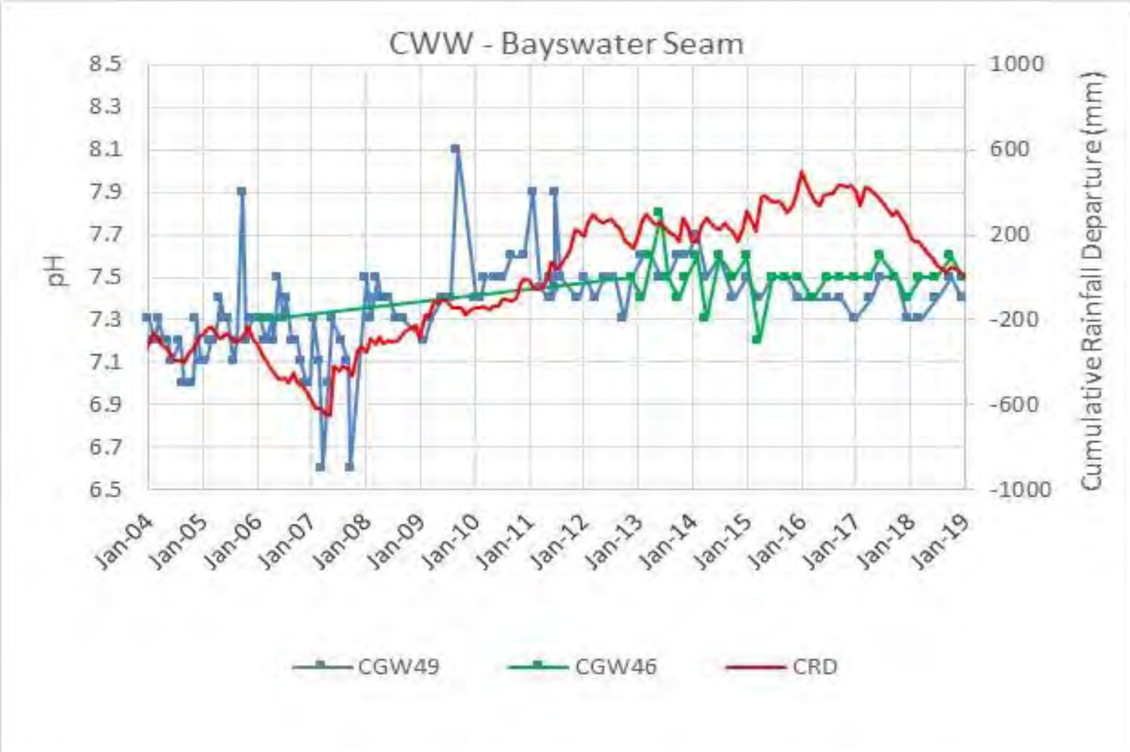
CWW Area – Alluvium: pH



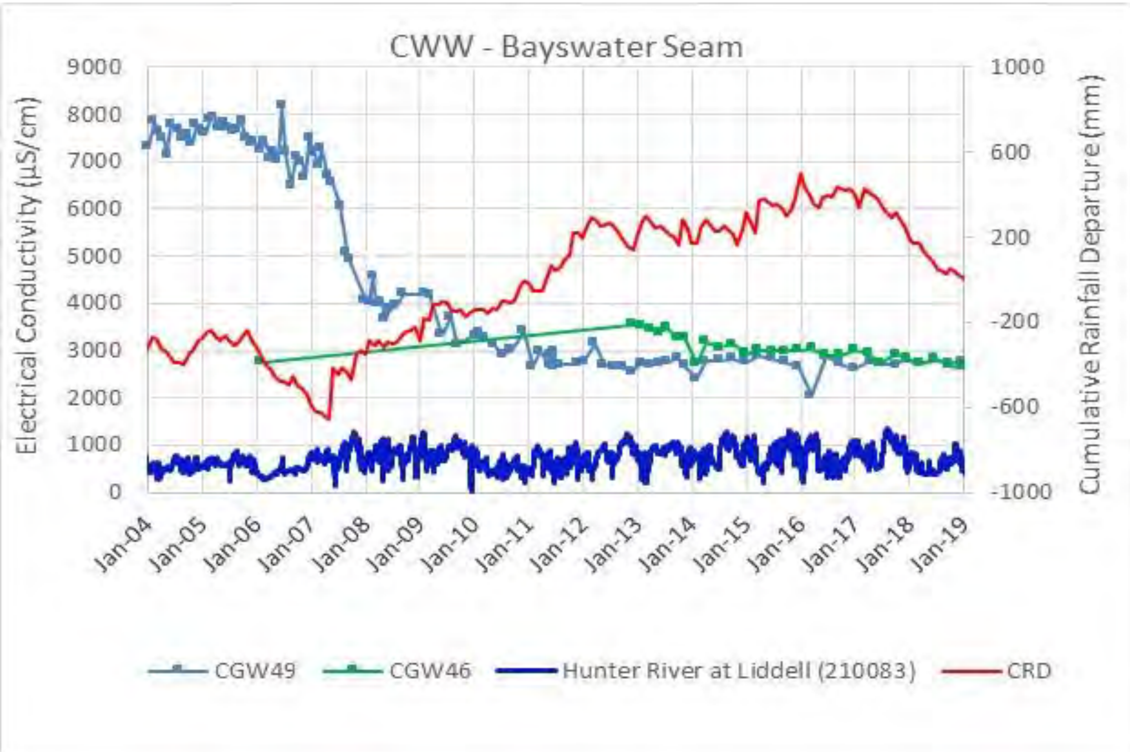
CWW Area – Alluvium: EC



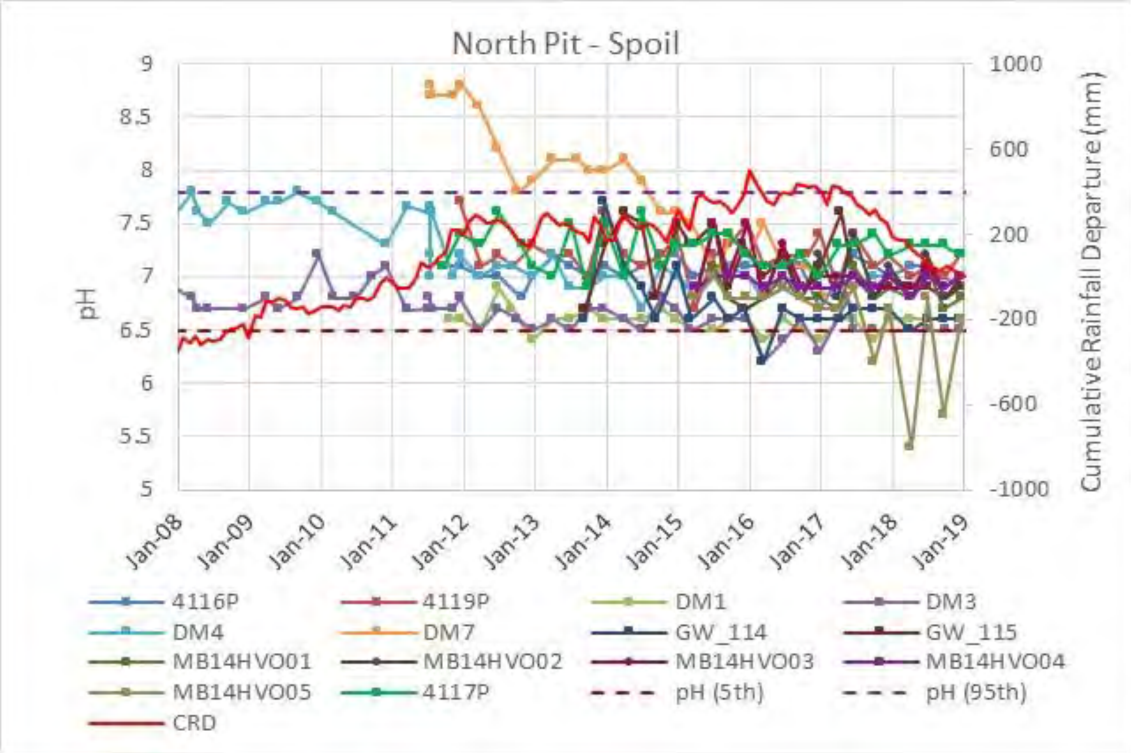
CWW Area - Bayswater Seam: pH



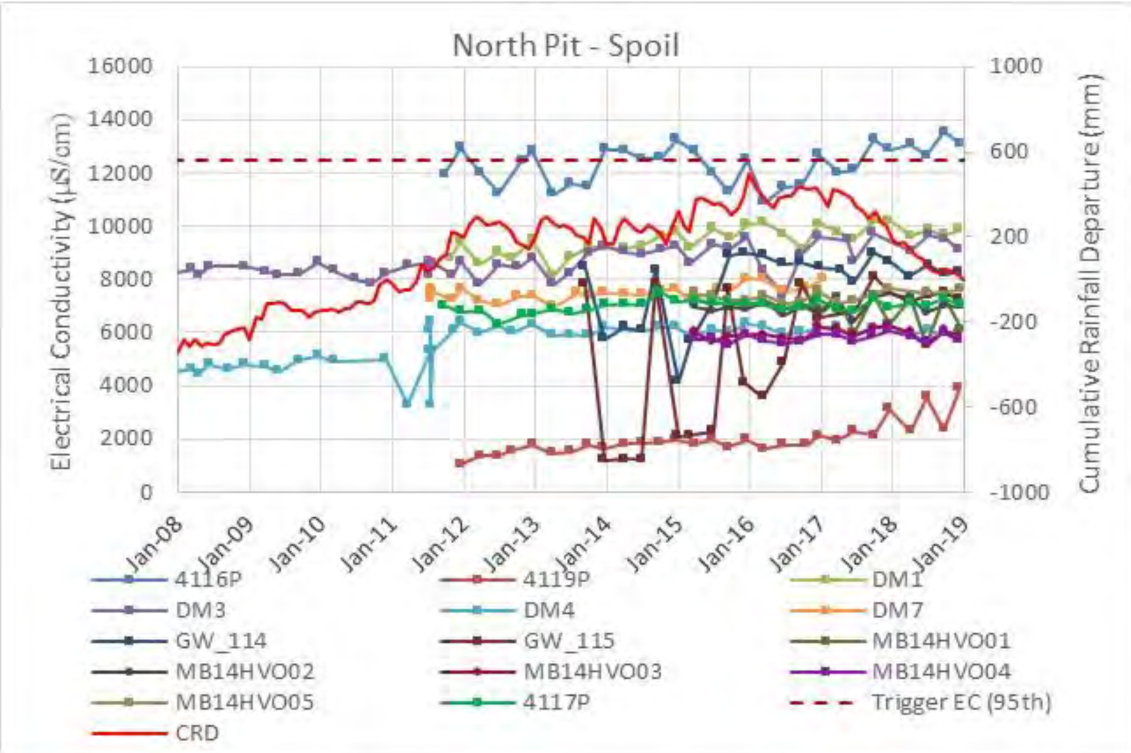
CWW Area - Bayswater Seam: EC



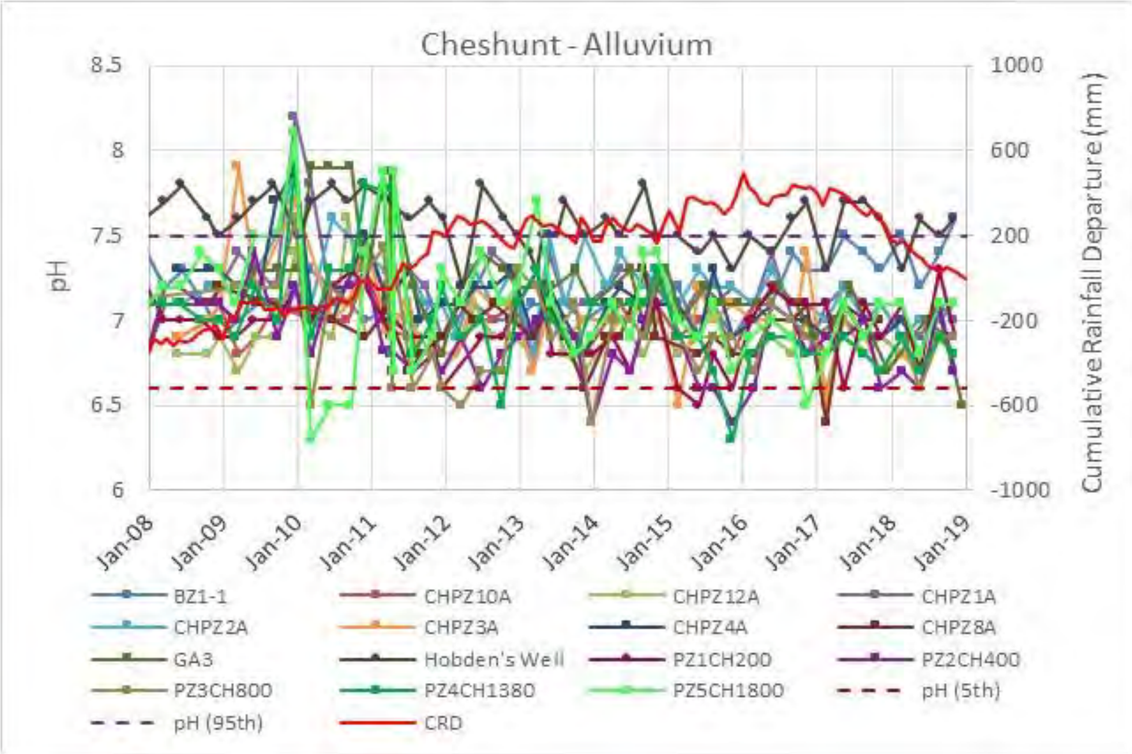
North Pit – Spoil: pH



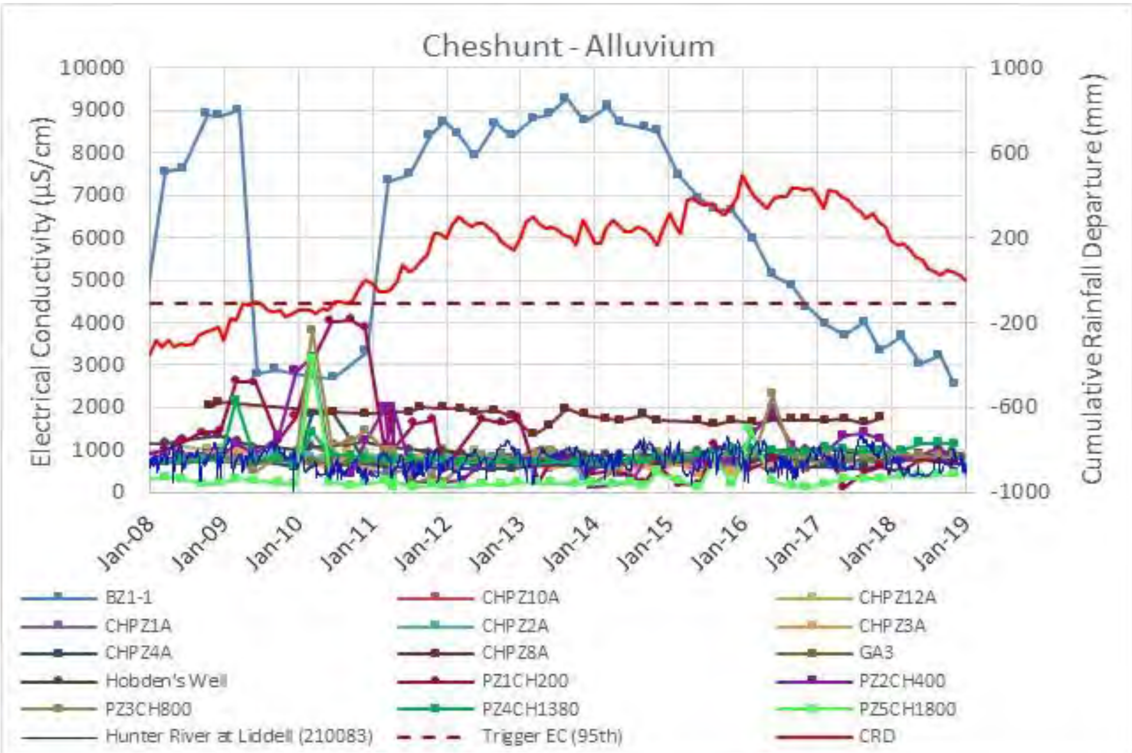
North Pit – Spoil: EC



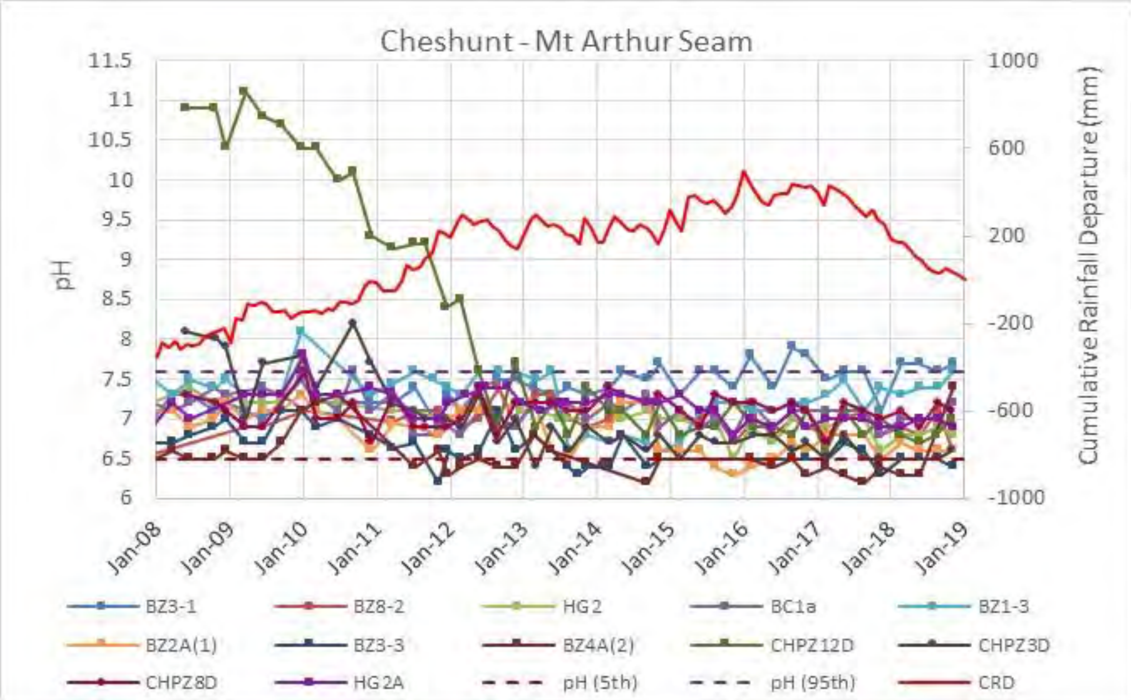
Cheshunt Pit/ North Pit – Alluvium: pH



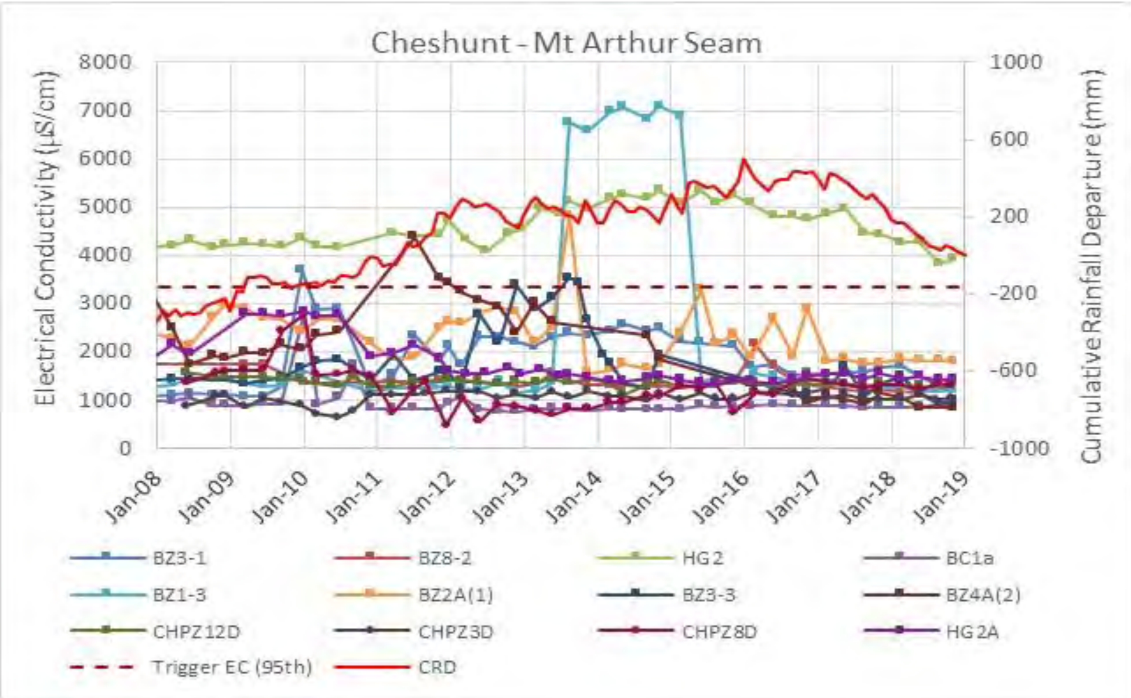
Cheshunt Pit/ North Pit – Alluvium: EC



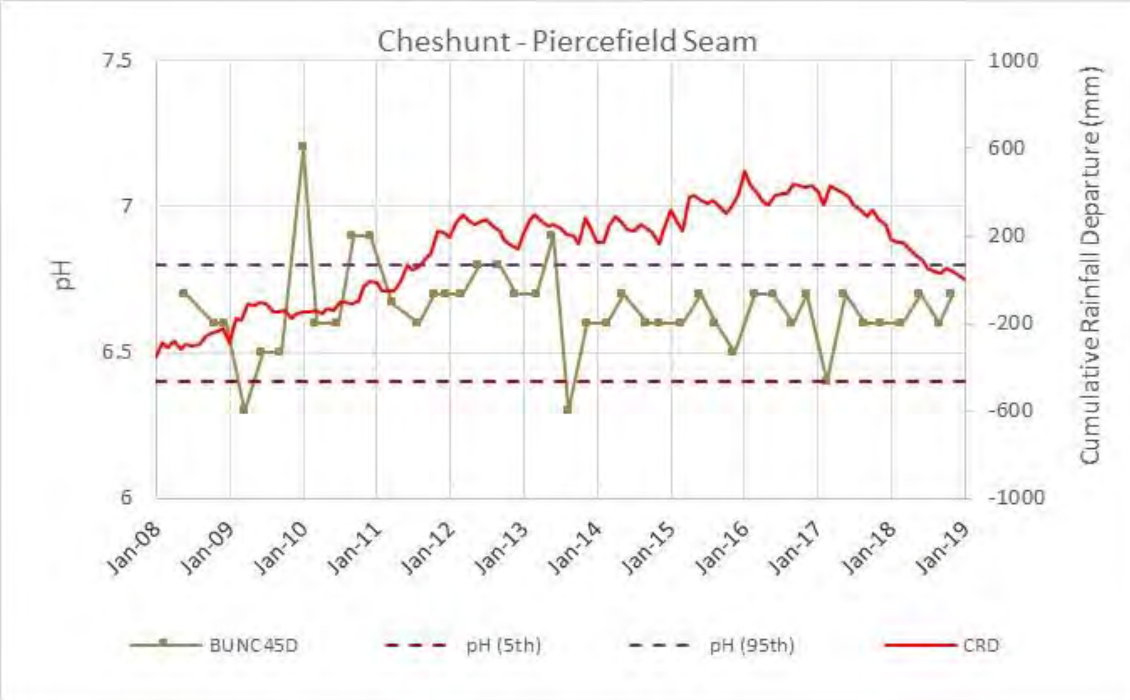
Cheshunt Pit - Mt Arthur Seam: pH



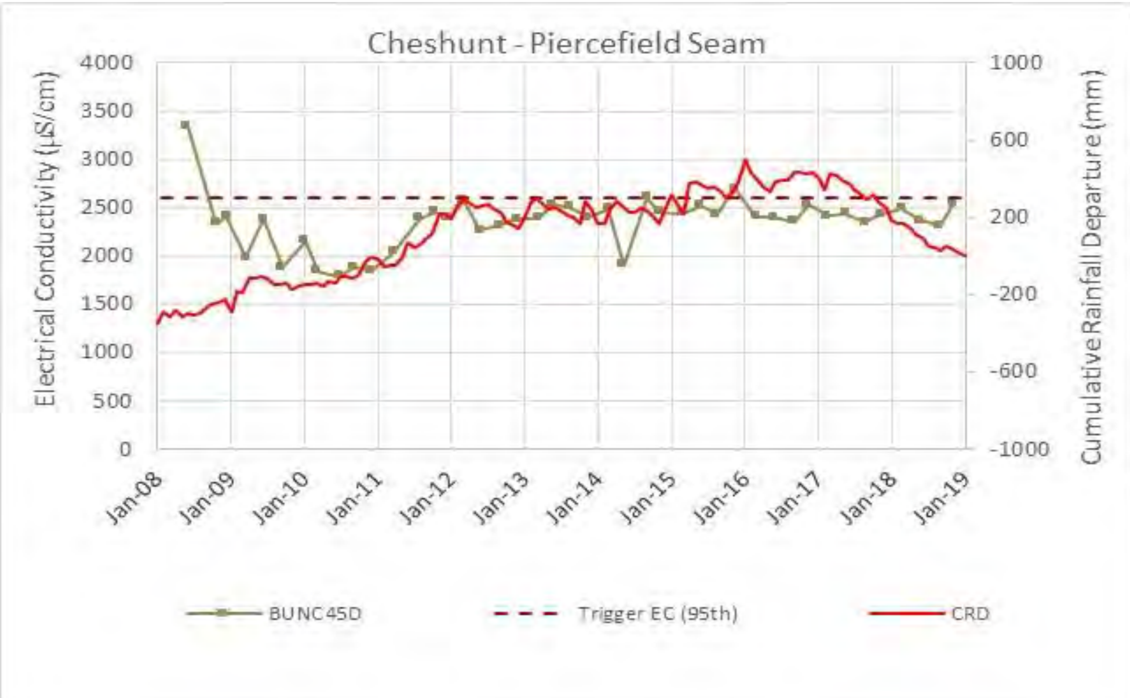
Cheshunt Pit - Mt Arthur Seam: EC



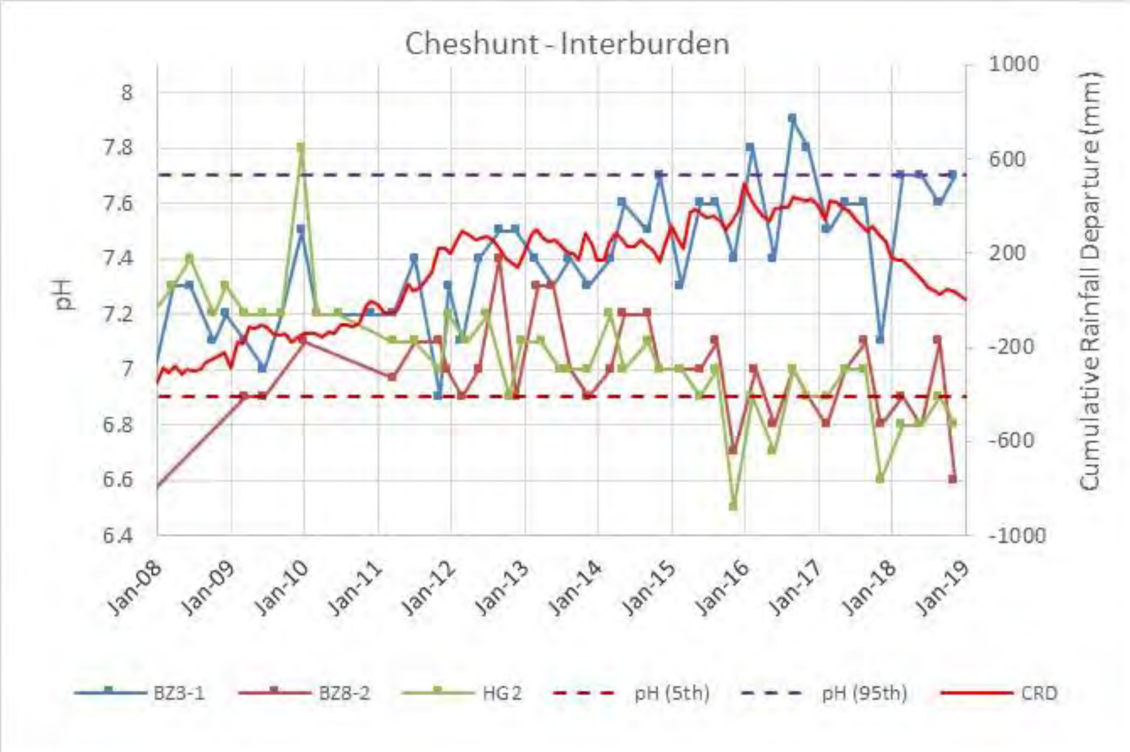
Cheshunt Pit – Piercefield: pH



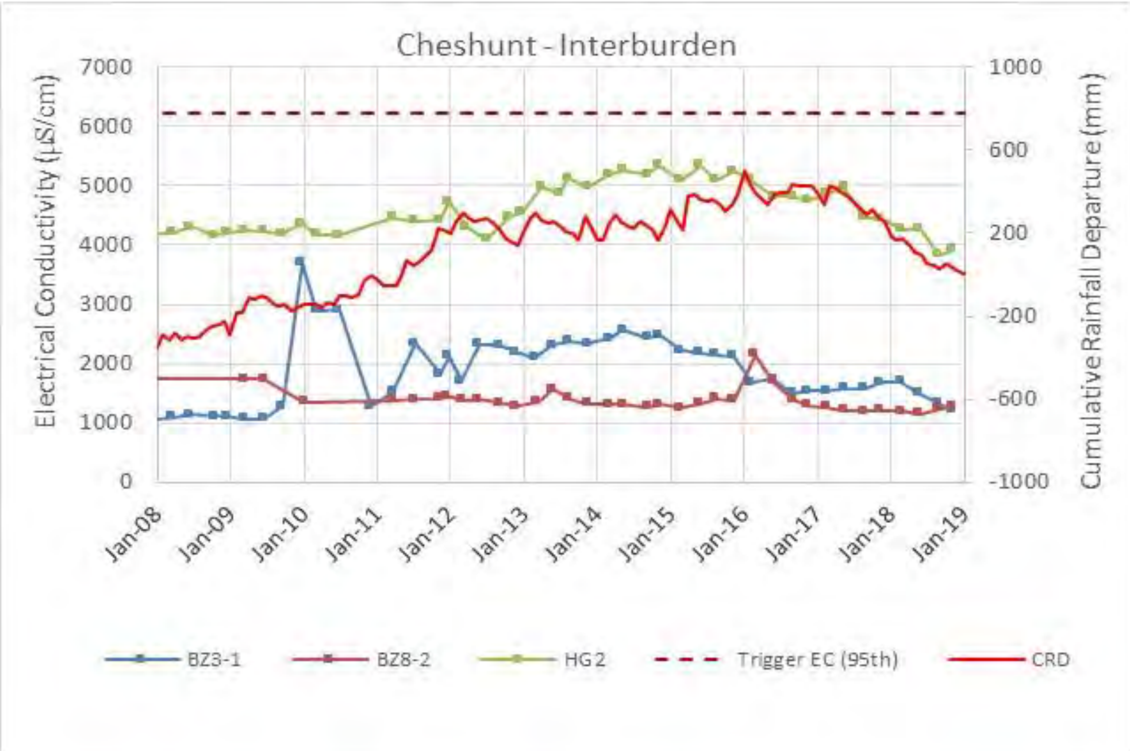
Cheshunt Pit – Piercefield: EC



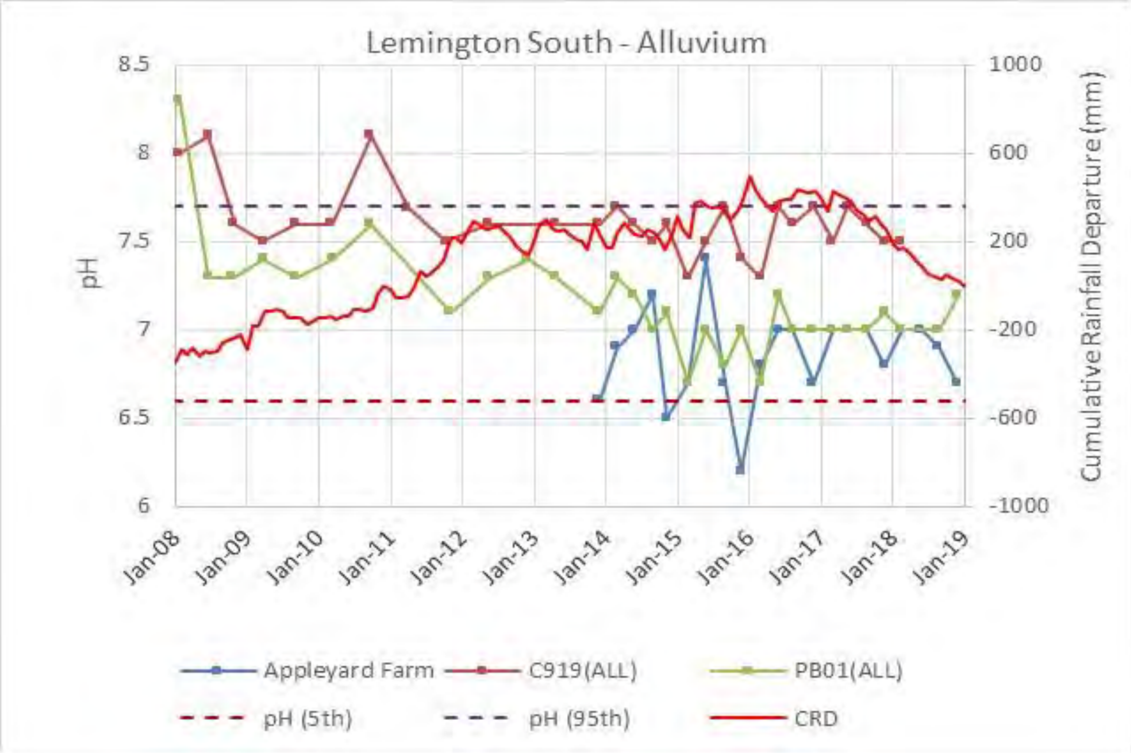
Cheshunt Pit – Interburden: pH



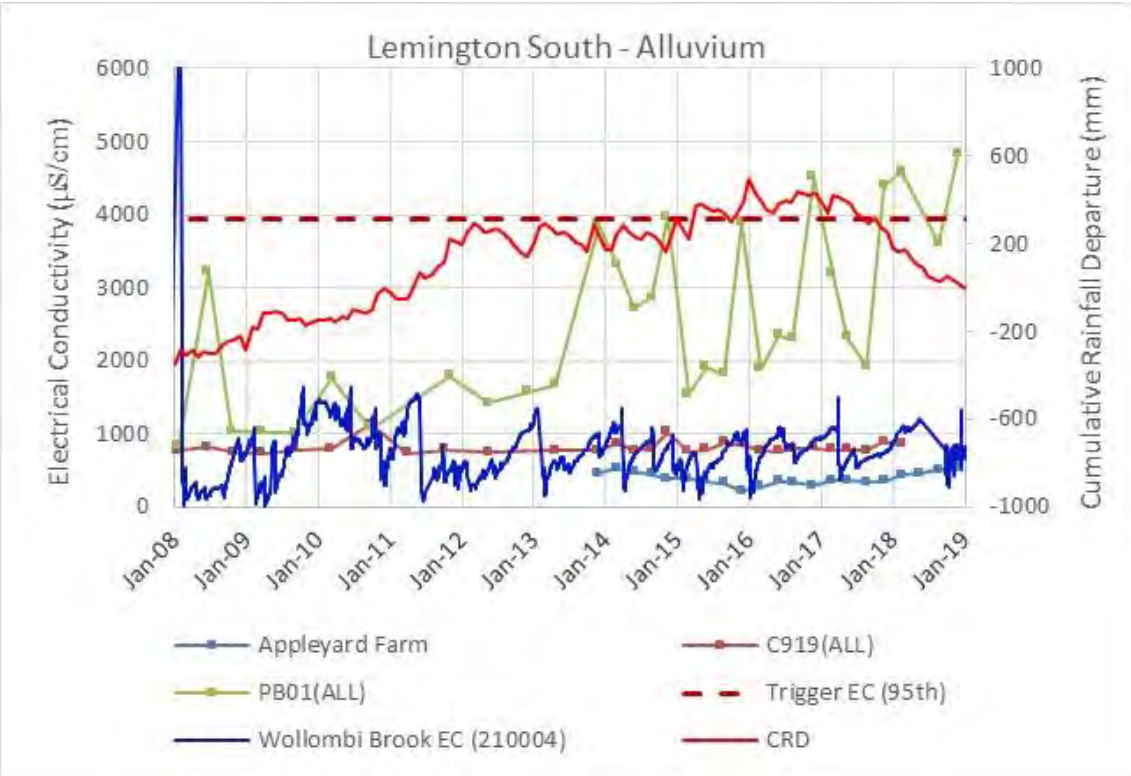
Cheshunt Pit – Interburden: EC



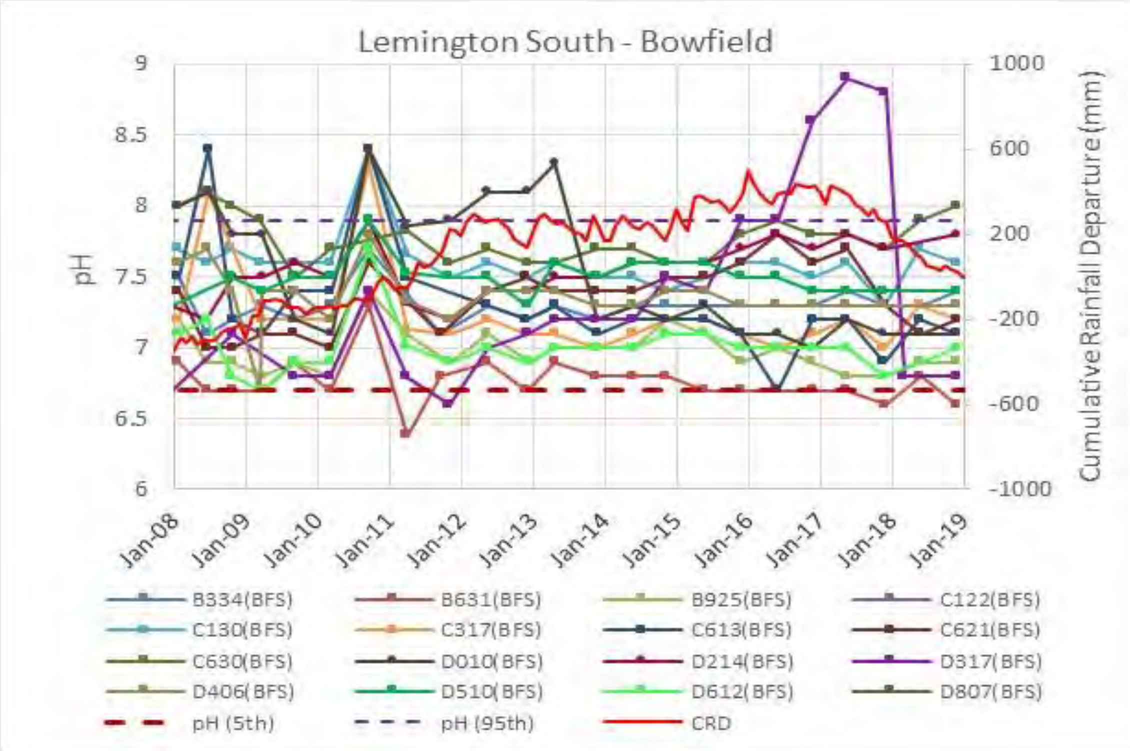
Lemington South Pit – Alluvium: pH



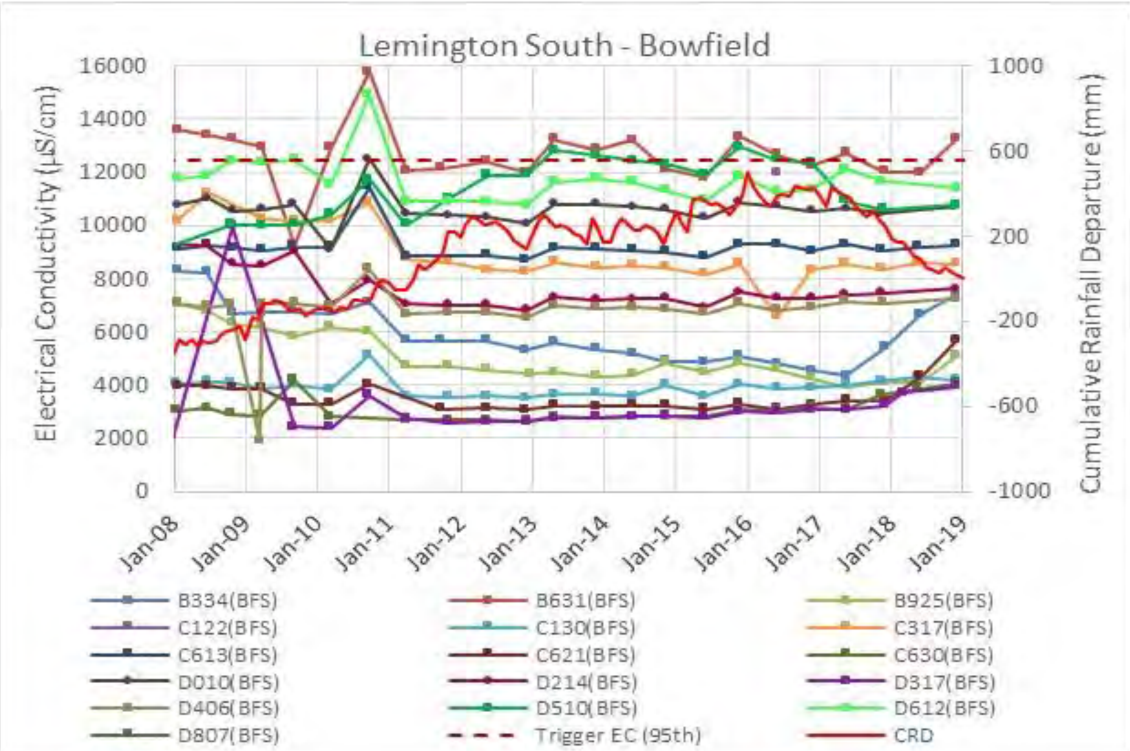
Lemington South Pit – Alluvium: EC



Lemington South Pit – Bowfield Seam: pH



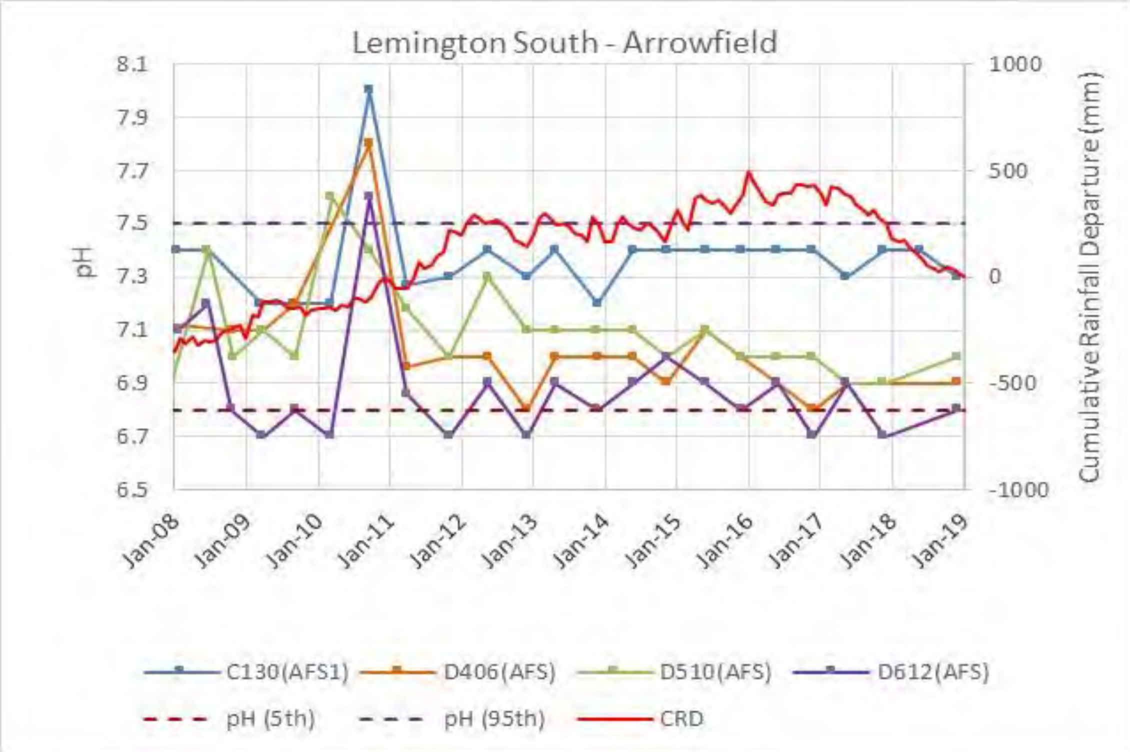
Lemington South Pit – Bowfield Seam: EC



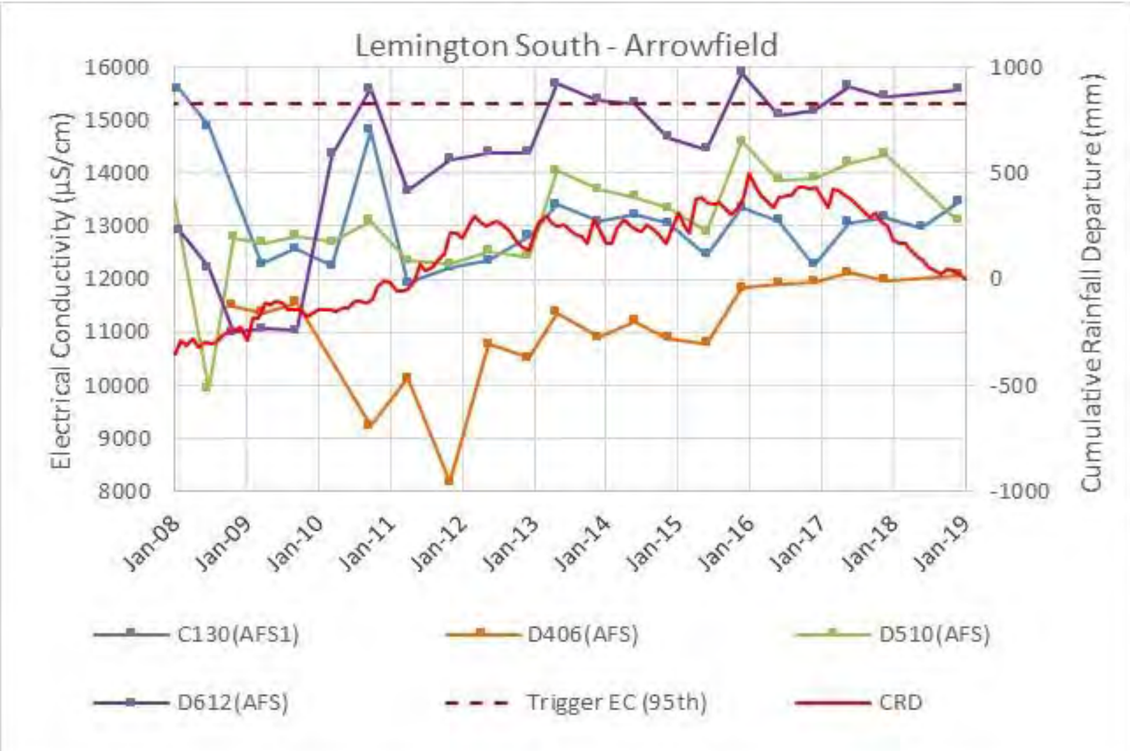
Lemington South Pit - Woodlands Hill Seam: pH

Lemington South Pit - Woodlands Hill Seam: EC

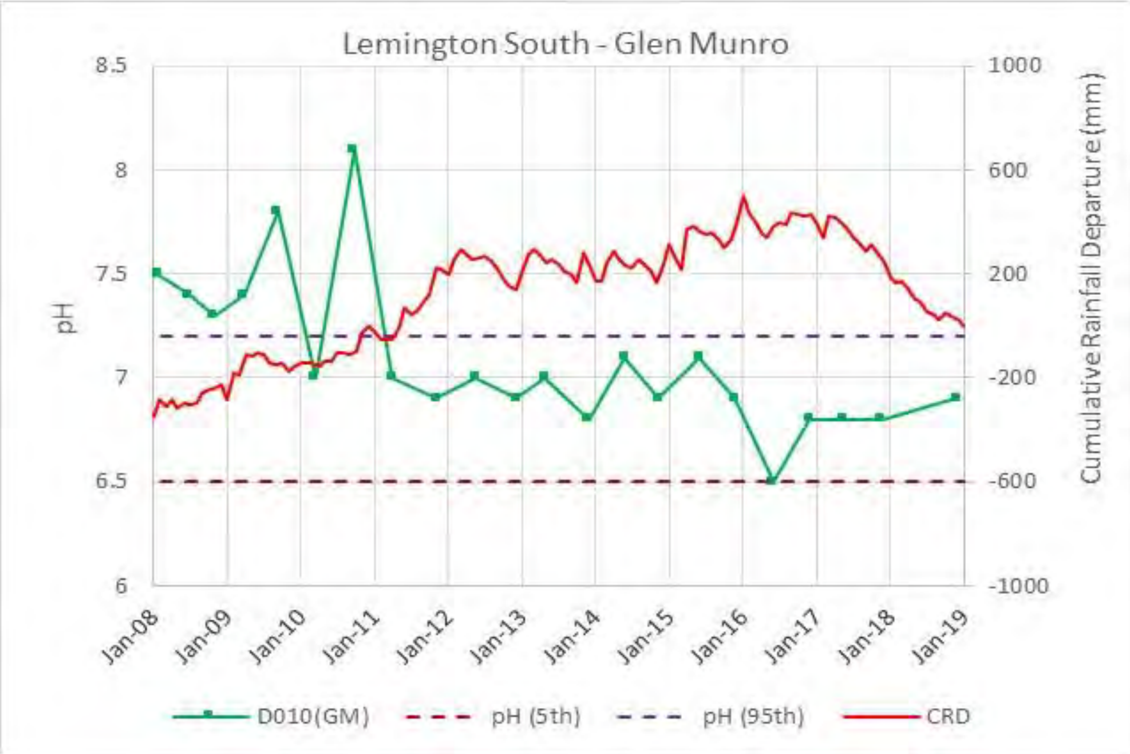
Lemington South Pit – Arrowfield Seam: pH



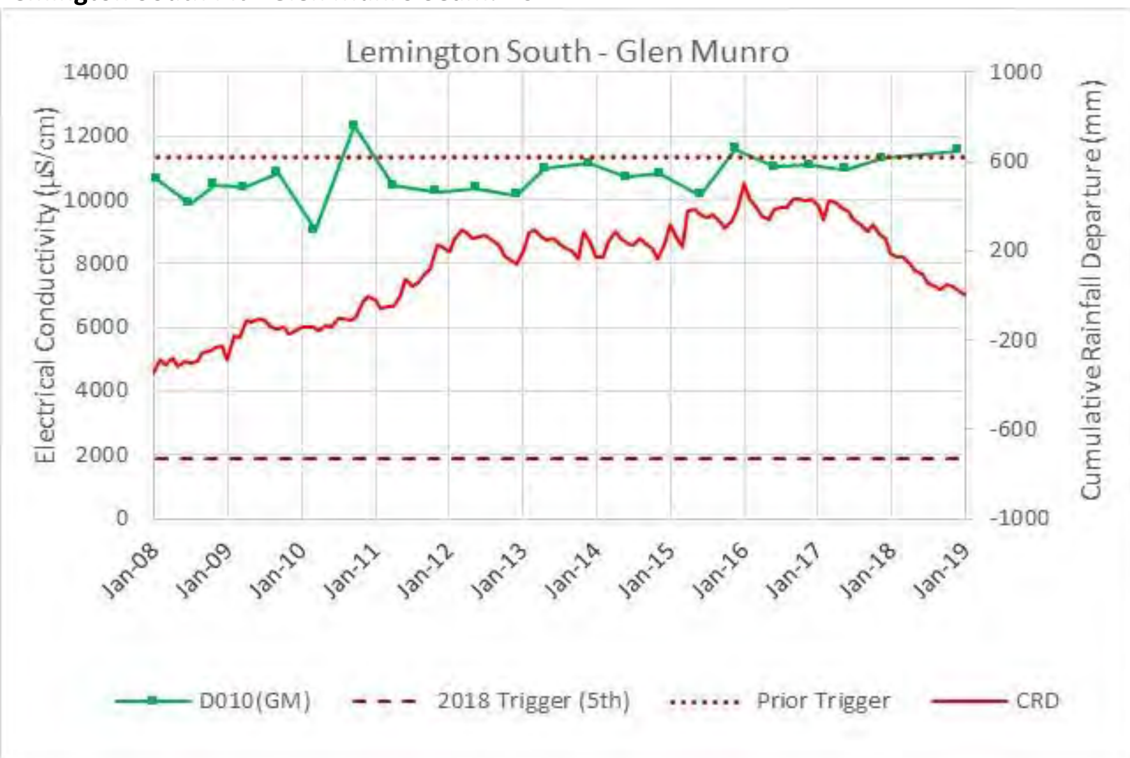
Lemington South Pit – Arrowfield Seam: EC



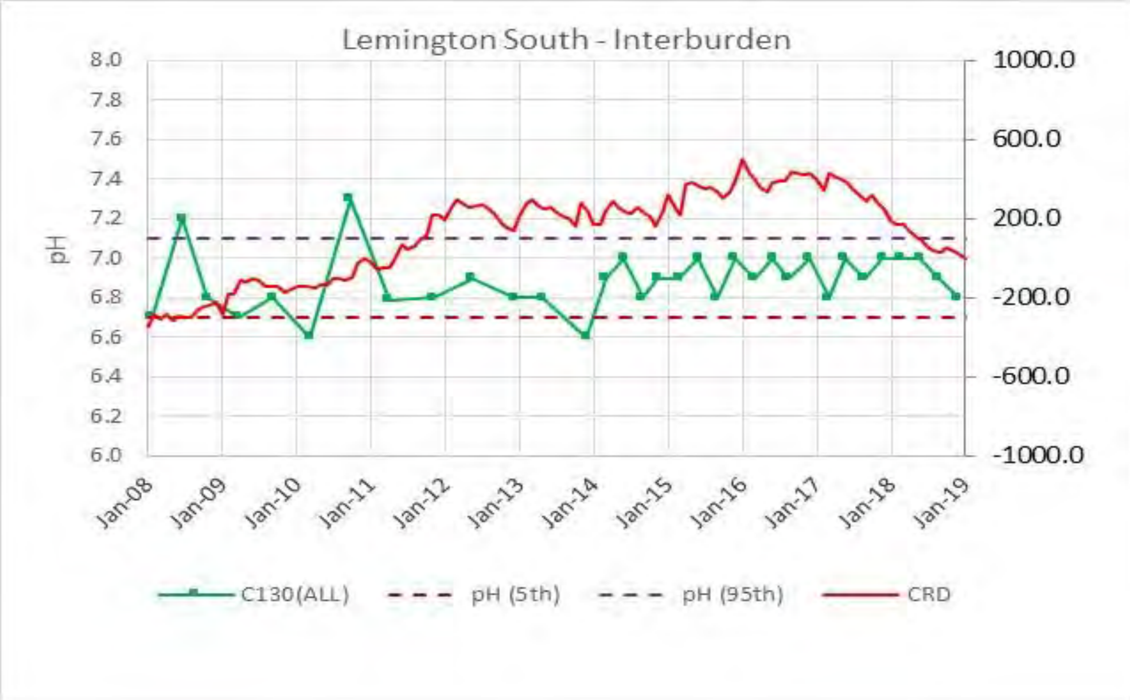
Lemington South Pit - Glen Munro Seam: pH



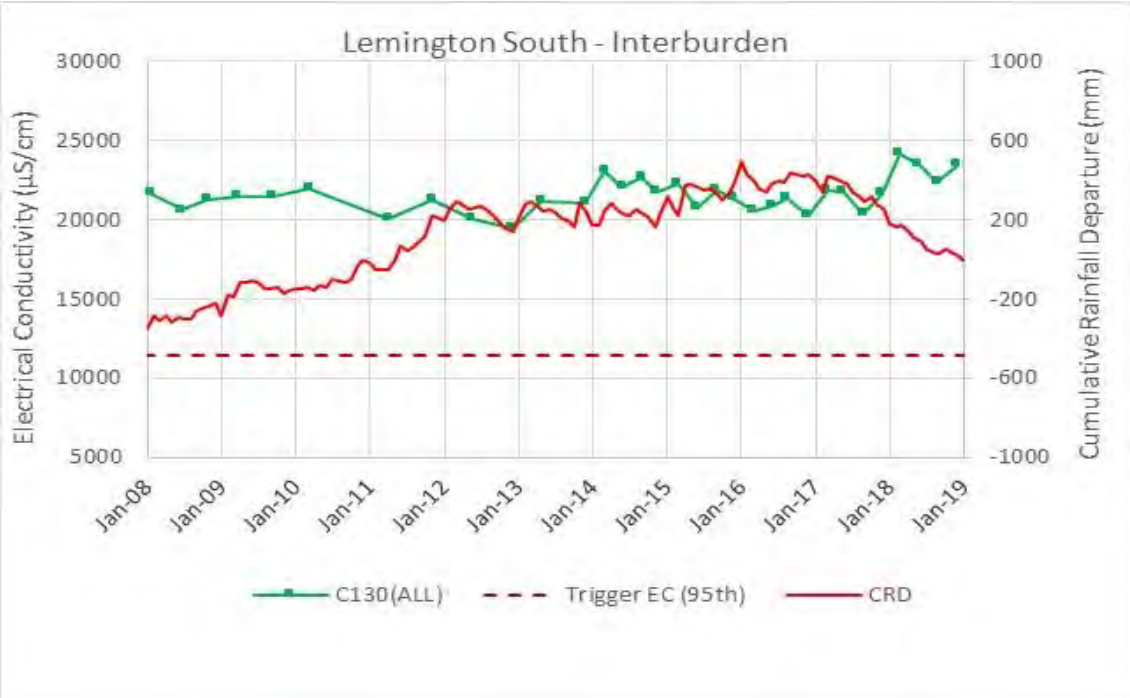
Lemington South Pit - Glen Munro Seam: EC



Lemington South Pit – Interburden: pH



Lemington South Pit – Interburden: EC



APPENDIX F

Full Water Quality Data 2018

Station	Date	Geology	Comprehensive Anlysis Event	pH Field	EC Field (uS/cm (25TRef))	TDS - Total (mg/l)	Depth to Stand Pipe (m)	SWL (mAHD)	Al - Total (mg/l)	Alk - Total (mg/l)	As - Total (mg/l)	B (mg/l)	Beryllium (mg/l)	Bicarbonate Alkalinity as CaCO3	Ca - Total (mg/l)	CaCO3 - Total Hard (mg/l)	Carbonate Alkalinity as CaCO3	Cd - Total (mg/l)	Cl- (mg/l)	Cu - Total (mg/l)	F (mg/l)	Fe - Filtered (mg/L)	Hg - Total (mg/l)	Hydroxide Alk (mg/l)	K - Total (mg/l)	Li (mg/l)	Mg - Total (mg/l)	Mn - Total (mg/l)	Na - Total (mg/l)	Ni - Total (mg/l)	Pb - Total (mg/l)	Se (mg/l)	Si (mg/l)	SO4 - Total (mg/l)	Sr - Total (mg/l)	Total Iron (mg/L)	Zn - Total (mg/l)
Appleyard Farm	16-01-2018	Alluvium	A				6.89	37.31													0.6	2.24													1.19		
Appleyard Farm	26-11-2018	Alluvium	A	6.7	527	608		36.12	0.006	58	<0.001	0.046		58	14		0	<0.0001	115	<0.001			<0.0001	0	3.6		12		47	0.002	<0.001	<0.001		4.6			0.009
C919(ALL)	13-04-2018	Alluvium	A				11.58	46.66																													
CHPZ10A	21-02-2018	Alluvium	6M	6.8	988	612	9.42	53.95	0.014	200	<0.001	0.046		200	64			<0.0001	160	<0.001			<0.0001		1.4		46		82	0.004	<0.001	<0.001		65			0.005
CHPZ10A	17-08-2018	Alluvium	6M	6.9	750	456	9.36	54.01	0.011	213	<0.001	0.047		213	53		0	<0.0001	97	<0.001			<0.0001	0	1		32		40	0.001	<0.001	<0.001		20			0.01
CHPZ12A	21-02-2018	Alluvium	6M	6.8	808	506	9.36	54.07	0.017	210	<0.001	0.045		210	66			<0.0001	108	<0.001			<0.0001		1		39		47	0.002	<0.001	0.003		34			0.006
CHPZ12A	17-08-2018	Alluvium	6M	6.9	804	540	9.31	54.12	0.031	209	<0.001	0.046		209	57		0	<0.0001	107	<0.001			<0.0001	0	0.9		35		42	<0.001	<0.001	0.003		34			<0.005
CHPZ1A	23-02-2018	Alluvium	6M*	6.9	752	411	11.69	55.21	0.051	203	<0.001	0.033	<0.001	203	52			<0.0001	102	<0.001			<0.0001		2.4	<0.005	33	0.005	56	<0.001	<0.001	<0.001	21	24			<0.005
CHPZ1A	28-08-2018	Alluvium	6M*	7.1	832	525	11.68	55.22	0.016	229	<0.001	0.032	<0.001	229	51		0	<0.0001	117	<0.001			<0.0001	0	2.2	<0.005	33	0.002	51	<0.001	<0.001	<0.001	23	23		<0.005	0.008
CHPZ2A	21-02-2018	Alluvium	6M	6.9	881	472	11.52	54.26	<0.005	214	<0.001	0.044		214	52			<0.0001	125	<0.001			<0.0001		1.1		39		91	0.001	<0.001	<0.001		45			<0.005
CHPZ2A	27-08-2018	Alluvium	6M	7	851	541	11.51	54.27	0.04	228	<0.001	0.044		228	43		0	<0.0001	117	<0.001			<0.0001	0	0.9		34		78	0.003	<0.001	<0.001		43			0.009
CHPZ3A	23-02-2018	Alluvium	6M	6.8	760	415	9.71	54.15	0.48	174	<0.001	0.04		174	48			<0.0001	115	0.008			<0.0001		1.2		35		56	0.002	<0.001	<0.001		29			0.008
CHPZ3A	17-08-2018	Alluvium	6M	6.9	738	450	9.67	54.19	<0.005	185	<0.001	0.04		185	40		0	<0.0001	102	<0.001			<0.0001	0	0.9		31		49	<0.001	<0.001	<0.001		27			<0.005
CHPZ4A	21-02-2018	Alluvium	6M	7	762	412	12.02	54.17	0.59	193	<0.001	0.035		193	56			<0.0001	110	0.001			<0.0001		2.4		32		52	0.003	<0.001	<0.001		24			0.007
CHPZ4A	17-08-2018	Alluvium	6M	7.1	778	408	11.99	54.2	0.2	209	<0.001	0.035		209	52		0	<0.0001	107	0.001			<0.0001	0	2		31		47	0.004	<0.001	<0.001		26			0.008
G1	20-04-2018	Alluvium	A	7.3	6400	4030	1.9	108.1	0.092	658	0.002	0.25		658	130			<0.0001	1350	<0.001			<0.0001		4.6		140		1200	0.003	0.001	<0.001		940			0.017
G1	22-05-2018	Alluvium	6M	7.3	6110	3810	1.89	108.11	0.067	648	0.002	0.22		648	130			<0.0001	1175	<0.001			<0.0001		4.6		140		1300	0.003	<0.001	<0.001		870			0.025
G1	26-06-2018	Alluvium	A	7.2	5000	3500	1.71	108.29	0.087	628	0.001	0.28		628	95			<0.0001	975	<0.001			<0.0001		3.7		120		980	0.002	<0.001	<0.001		820			0.021
G1	23-08-2018	Alluvium	A	7.6	5180	3360	1.66	108.34	0.023	621	<.001	0.23		621	98		0	<0.0001	991				<0.0001	0	3.3		110		920	0.003	<.001	<.001		880			0.014
G1	23-08-2018	Alluvium	A	7.6	5180	3360	1.66	108.34	0.023	621	<0.001	0.23		621	98		0	<0.0001	991				<0.0001	0	3.3		110		920	0.003	<0.001	<0.001		880			0.014
G1	20-09-2018	Alluvium	6M	7.2	6120	3790	1.49	108.51	0.041	590	<0.001	0.2		590	130		0	<0.0001	1238	0.002			0.0001	0	4		140		1000	0.005	<0.001	0.001		1000			0.025
G1	26-10-2018	Alluvium	6M	7.2	9880	6460		108.87	0.057	385	<0.001	0.13		385	210		0	<0.0001	2331	0.001			<0.0001	0	6.8		210		1700	0.007	<0.001	0.003		1800			0.034
G1	22-11-2018	Alluvium	A	7.5	9550	6220		108.56	0.014	428	<0.001	0.13		428	190		0	<0.0001	2006	<0.001			<0.0001	0	6.6		190		1600	0.006	<0.001	0.001		1600			0.026
G1	19-12-2018	Alluvium	A	7.5	9750	5890		108.41	0.047	463	<0.001	0.14		463	200		0	<0.0001	2104	<0.001			<0.0001	0	6.5		190		1700	0.005	<0.001	0.001		1600			0.022
G2	20-04-2018	Alluvium	A	7.7	4810	2660	1.47	109.13	0.79	667	0.001	0.41		667	44			<0.0001	830	<0.001			<0.0001		7.4		110		930	0.004	<0.001	0.003		590			0.011
G2	22-05-2018	Alluvium	A	7.5	4690	2790	1.34	109.26	0.072	670	<0.001	0.39		670	47			<0.0001	800	<0.001			<0.0001		7.6		100		1000	<0.001	<0.001	<0.001		620			<0.005
G2	26-06-2018	Alluvium	A	7.4	4560	2880	1.24	109.36	0.057	671	<0.001	0.4		671	43	942	0	<0.0001	800	<0.001			<0.0001	0	7.8		110		930	<0.001	<0.001	<0.001		620	2.12		0.008
G2	27-07-2018	Alluvium	A	7.6	4600	2750	1.29	109.31	0.056	675	<0.001	0.5		675	45		0	<0.0001	750	<0.001			0.0001	0	7.3		100		870	0.001	<0.001	<0.001		600			<0.005
G2	23-08-2018	Alluvium	A	7.6	4540	2800	1.17	109.43	0.029	678	<0.001	0.36		678	44		0	<0.0001	806				<0.0001	0	6.8		90		830	<0.001	<0.001	<0.001		640			0.006
G2	20-09-2018	Alluvium	A	7.4		2850	1.01	109.59	0.046	680	<0.001	0.34		680	46		0	<0.0001	801	<0.001			0.0001	0	6.9		96		820	0.001	<0.001	<0.001		630			0.007
G2	26-10-2018	Alluvium	A	7.4	4610	2930		109.7	0.043	669	<0.001	0.37		669	43		0	<0.0001	801	<0.001			<0.0001	0	7.2		99		770	0.003	<0.001	<0.001		700			<0.005
G2	22-11-2018	Alluvium	A	7.7	4760	2770		109.62	0.033	669	<0.001	0.31		669	43		0	<0.0001	783	<0.001			<0.0001	0	6.9		94		770	0.002	<0.001	<0.001		630			<0.005
G2	19-12-2018	Alluvium	A	7.6	4750	3020		109.63	0.032	678	<0.001	0.36		678	46		0	<0.0001	807	<0.001			<0.0001	0	7.1		100		850	0.003	<0.001	<0.001		600			<0.005
G3	20-04-2018	Alluvium	6M	7.6	5120	2990	1.11	107.49	0.18	738	<0.001	0.38		738	37			<0.0001	910	<0.001			<0.0001		3.4		83		1100	0.001	0.002	<0.001		610			0.006
G3	22-05-2018	Alluvium	6M	7.5	4820	2980	0.94	107.66	0.089	735	<0.001	0.33		735	37		0	<0.0001	875	<0.001			<0.0001	0	3.7		83		1100	0.001	<0.001	<0.001		600			0.005
G3	26-06-2018	Alluvium	6M	7.6	4910	3110	0.73	107.87	0.11	730	<0.001	0.32		730	34		0	<0.0001	825	<0.001			<0.0001	0	3.4		83		1000	0.002	<0.001	<0.001		620			<0.005
G3	27-07-2018	Alluvium	6M	7.6	4960	2890	0.68	107.92	0.13	723	<0.001	0.37		723	35		0	<0.0001	825	<0.001			0.0001	0	3.4		85		1000	0.003	<0.001	<0.001		600			0.005
G3	23-08-2018	Alluvium	A	7.6	4880	3070	0.59	108.01	0.034	720	<.001	0.28		720	33		0	<0.0001	874				<0.0001	0	3.1		73		950	0.004	<.001	<.001		650			0.007
G3	20-09-2018	Alluvium	A	7.4		3070	0.46	108.14	0.13	721	<0.001	0.27		721	34		0	<0.0001	874	<0.001			0.0001	0	3.2		77		870	0.003	<0.001	<0.001		640			0.012
G3	26-10-2018	Alluvium	A	7.4	5030	3140		108.27	0.043	721	<0.001	0.3		721	34		0	<0.0001	826	<0.001			<0.0001	0	3.4		80		880	0.002	<0.001	<0.001		720			<0.005
G3	22-11-2018	Alluvium	A	7.5	5120	3120		108.17	0.012	709	<0.001	0.26		709	34		0	<0.0001	783	<0.001			<0.0001	0	3.6		76		870	0.001	<0.001	<0.001		650			<0.005
G3	19-12-2018	Alluvium	A	7.6	5070	3130		108.15	0.055	715	<0.001	0.29		715	36		0	<0.0001	856	<0.001			<0.0001	0	3.7		81		950	0.003	<0.001	<0.001		630			<0.005
GW_100	20-09-2018	Alluvium	A	7.1	10980	7390	5.66	83.94	0.12	2946	<0.001	0.54		2946	6.1		0	<0.0001	2380	0.002			<0.0001	0	67		96		2600	0.003	<0.001	0.001		310			0.005
GW_101	13-03-2018	Alluvium	A																		0.3	<0.05													0.617		
Hobden's Well	28-08-2018	Alluvium	A	7.5	869	535	12.5	59.2	0.12	255	<0.001	0.039		255	36			<0.0001	112	<0.001			<0.0001		1.1		37		85	<0.001	<0.001	<0.001		31	0.587		0.043
PB01(ALL)	19-12-2018	Alluvium	A					45.07								74					0.1	1.75													0.133		
CGW39	29-03-2018	Alluvium?	6M	7.2	6430	3660	12.03	58.81	0.014	888	<0.001	0.09		888	140			<0.0001	1680	<0.001		0.04	<0.0001		10		220		1000	<0.001	<0.001	0.018		260	0.37		<0.005
CGW39	27-09-2018	Alluvium?	6M	7.4	6250	3780	12.15	58.69	2.7	886	0.002	0.092		886	130		0	<0.0001	1676	0.004		4.29	<0.0001	0	10		220		950	0.035	0.001	0.016		260	0.768		0.016
C130(AFS1)	28-11-2018	Arrowfield Seam	A	7.3	13450	7380		44.39	0.077	751	0.002	0.17		751	110		0	0.0004	4452	0.003			<0.0001	0	45		130		2300	0.012	0.001	<0.001		<5.0			0.018
CGW46	08-03-2018	Bayswater Seam	6M	7.5	2720	1490	12.84	59.11	2.7	715	0.002	0.14		715	51			<0.0001	445	0.006			<0.0001		5.6		76		400	0.006	0.002	0.013		110			0.038
CGW46	27-09-2018	Bayswater Seam	6M	7.6	2690	1600	12.88	59.07	4.9	698	0.003	0.11		698	51			0.0001	456	0.038			<0.0001		8.3		82		420	0.011	0.006	0.027		110			0.23
B925(BFS)	28-11-2018	Bowfield Seam	A	6.9	5110	2760		5.87	0.14	1275	<0.001	0.12		1275	18		0	<0.0001	1076	0.004			<0.0001	0	13		16		1000	0.001	<0.001	<0.001		<2.0			0.011
D010(GM)	26-11-2018	Glen Munro Seam	A	6.9	11540	7020		47.39	0.016	1178	<0.001	0.12		1178	130		0	<0.0001	3424	0.005			<0.0001	0	49		350		1700	0.001	<0.001	<0.001		360			0.011
PZ2CH400	23-02-2018	Hunter River Alluvium	6M*	6.7	769	323	7.36	55.27	2.4	305	0.001	0.037	<0.001	305	47			<0.0001	36	0.015			<0.0001		29	<0.005	13	0.28	15	0.011	0.003	<0.001	14				0.057
PZ2CH400	28-08-2018	Hunter River Alluvium	6M*	7.1	1083	637	8.01	54.62	19	258	0.006	0.05	<0.001	258	80		0	0.0002	117	0.068			<0.0001	0	8.8	<0.005	35	0.74	53	0.042	0.021	0.006	29	44		2.2	0.2
PZ3CH800	23-02-2018	Hunter River Alluvium	6M*	6.9	920	512	9.38	54.78	11	305	0.002	0.039	<0.001	305	91			<0.0001	92	0.017			<0.0001		6.7	<0.005	49	0.4	50	0.026	0.01	0.003	28				0.11
PZ3CH800	28-08-2018	Hunter River Alluvium	6M*	6.9	853	565	9.36	54.8	5.7	302	0.001	0.038	<0.001	302	70			<0.0001	83	0.01			<0.0001		3.1	<0.005	39	0.21	43	0.013	0.007	0.002	31	41		<0.005	0.04
BZ1-1	22-02-2018	Interburden	A	7.5	3670	2040	17.45	54.34	2.5	665	0.002	0.094		665	30			<0.0001	770	0.006			<0.0001		17		74		780	0.005	0.004	0.001		100			0.04

Station	Date	Geology	Comprehensive Anlysis Event	pH Field	EC Field (uS/cm (25TRef))	TDS - Total (mg/l)	Depth to Stand Pipe (m)	SWL (mAHD)	Al - Total (mg/l)	Alk - Total (mg/l)	As - Total (mg/l)	B (mg/l)	Beryllium (mg/l)	Bicarbonate Alkalinity as CaCO3	Ca - Total (mg/l)	CaCO3 - Total Hard (mg/l)	Carbonate Alkalinity as CaCO3	Cd - Total (mg/l)	Cl- (mg/l)	Cu - Total (mg/l)	F (mg/l)	Fe - Filtered (mg/L)	Hg - Total (mg/l)	Hydroxide Alk (mg/l)	K - Total (mg/l)	Li (mg/l)	Mg - Total (mg/l)	Mn - Total (mg/l)	Na - Total (mg/l)	Ni - Total (mg/l)	Pb - Total (mg/l)	Se (mg/l)	Si (mg/l)	SO4 - Total (mg/l)	Sr - Total (mg/l)	Total Iron (mg/L)	Zn - Total (mg/l)
BZ1-1	27-08-2018	Interburden	A	7.4	3230	1820	17.14	54.65	7.1	661	0.005	0.09		661	20			0.0001	622	0.021			<0.0001		12		47		540	0.01	0.015	0.004		94			0.099
BZ8-2	23-02-2018	Interburden	6M	6.9	1194	685	18.66	49.14	0.022	318	<0.001	0.061		318	43			<0.0001	187	<0.001			<0.0001		10		53		160	<0.001	<0.001	<0.001		46			<0.005
BZ8-2	28-08-2018	Interburden	6M	7.1	1250	726	18.54	49.26	18	306	0.022	0.073		306	30			0.0002	175	0.038			<0.0001		26		43		130	0.03	0.029	0.015		47			0.13
C130(ALL)	28-11-2018	Interburden?	A	6.8	23500	13700		47.09	2.6	960	0.002	0.039		960	240	28	0	0.0014	8072	0.017			<0.0001	0	67		670		3700	0.009	0.033	0.004		800	0.047		0.047
BUNC45D	23-02-2018	Mt Arthur Seam	A	6.6	2490	1280	25.31	48.41	1	770	0.002	0.16		770	87			<0.0001	365	0.003			<0.0001		14		63		470	0.004	0.002	<0.001		2.2			0.045
BUNC45D	28-08-2018	Mt Arthur Seam	A	6.6	2320	1440	25.29	48.43	1.1	793	0.002	0.15		793	71			<0.0001	359	0.004			<0.0001		12		50		350	0.004	0.002	<0.001		<1	2.48		0.054
BZ1-3	22-02-2018	Mt Arthur Seam	6M	7.3	1293	723	46.77	25.02	0.19	385	<0.001	0.098		385	16			<0.0001	155	<0.001			<0.0001		12		26		270	0.005	<0.001	<0.001		37			0.021
BZ1-3	27-08-2018	Mt Arthur Seam	6M	7.4	1182	736	46.62	25.17	2.7	376	0.001	0.093		376	12			<0.0001	155	0.005			<0.0001		9.9		22		200	0.006	0.004	0.001		38			0.041
CHPZ12D	21-02-2018	Mt Arthur Seam	6M	6.8	1317	742	9.59	53.92	0.038	511	<0.001	0.12		511	18			<0.0001	115	<0.001			<0.0001		9.3		13		300	0.002	<0.001	<0.001		<1			0.008
CHPZ12D	17-08-2018	Mt Arthur Seam	6M	6.8	1286	700	9.55	53.96	0.023	532	<0.001	0.12		532	15		0	<0.0001	107	<0.001			<0.0001	0	7.8		12		260	0.001	<0.001	<0.001		<1			0.008
CHPZ3D	23-02-2018	Mt Arthur Seam	6M	6.5	1017	521	10.58	53.02	0.006	394	<0.001	0.14		394	17			<0.0001	88	<0.001			<0.0001		6.7		11		230	<0.001	<0.001	<0.001		<1			0.01
CHPZ3D	17-08-2018	Mt Arthur Seam	6M	6.5	1005	885	10.55	53.05	0.046	413	<0.001	0.14		413	13		0	<0.0001	78	0.001			<0.0001	0	5.7		10		200	0.002	<0.001	<0.001		<1			0.007
CHPZ8D	23-02-2018	Mt Arthur Seam	6M	7.1	1317	769	7.09	54.01	0.46	513	<0.001	0.061		513	150			<0.0001	135	0.003			<0.0001		4.1		80		49	0.001	<0.001	<0.001		11			0.021
CHPZ8D	28-08-2018	Mt Arthur Seam	6M	7.2	1336	813	7.05	54.05	0.42	540	0.001	0.064		540	120			<0.0001	107	0.002			<0.0001		4.5		65		40	0.002	<0.001	<0.001		13			0.022
4032P	08-03-2018	Palaeochannel alluvium	6M	7.1	1604	955	10.64	59.65	3.5	504	0.002	0.11		504	61			<0.0001	225	0.016			<0.0001		1.8		69		190	0.009	0.001	0.006		67			0.046
4032P	27-09-2018	Palaeochannel alluvium	6M	7.3	1648	1020	10.7	59.59	9.3	520	0.003	0.094		520	61		0	0.0001	233	0.049			<0.0001	0	3.8		73		200	0.03	0.004	0.008		65			0.25
4034P	08-03-2018	Palaeochannel alluvium	6M	7.3	1646	915	12.57	58.89	0.53	495	0.005	0.1		495	55			<0.0001	235	0.009			<0.0001		3.2		70		170	0.004	<0.001	0.001		67			0.021
4034P	22-06-2018	Palaeochannel alluvium	A	7.4	1598		12.61	58.85																													
4034P	27-09-2018	Palaeochannel alluvium	A	7.4	1531	926	12.59	58.87	1.1	449	0.007	0.08		449	54		0	<0.0001	223	0.015			<0.0001	0	3		76		180	0.005	0.001	0.006		65			0.033
4037P	08-03-2018	Palaeochannel alluvium	A	7.1	1231	738	12.08	59.69	0.15	402	0.001	0.07		402	62			<0.0001	190	0.013			<0.0001		1.2		47		110	0.002	<0.001	0.003		48			0.025
4037P	27-09-2018	Palaeochannel alluvium	A	7.4	1205	714	12.12	59.65	0.24	355	0.001	0.056		355	61		0	<0.0001	175	0.009			<0.0001	0	1.5		55		120	0.002	<0.001	0.003		42			0.018
4037P	18-12-2018	Palaeochannel alluvium	A	7.2	1223			58.57													1	<0.05													1.08		
CFW55R	29-03-2018	Palaeochannel alluvium	A	6.7	8820	5860	11.12	59.16	16	752	0.012	0.13		752	120			0.0002	1774	0.056			<0.0001		44		270		1700	0.084	0.011	0.006		1800			0.054
CFW55R	19-04-2018	Palaeochannel alluvium	A	6.8	9490	6130	11.01	59.27	0.57	743	0.001	0.3		743	130			0.0001	2149	0.003			<0.0001		44		290		1800	0.042	<0.001	0.001		1900			0.005
CFW55R	21-05-2018	Palaeochannel alluvium	A	6.9	9130	5880	11.13	59.15	1.3	752		0.12		752	120			<0.0001	1700				<0.0001		45		270		1900	0.02	<0.001	0.004		1900			0.01
CFW55R	27-06-2018	Palaeochannel alluvium	A	6.9	9050	6260	11.29	58.99	0.41	754	<0.001	0.14		754	120			<0.0001	1799				<0.0001		47		280		1900	0.02	<0.001	<0.001		1900			<0.005
CFW55R	25-07-2018	Palaeochannel alluvium	A	6.8	8760	6310	11.37	58.91	0.66	771	0.001	0.11		771	110			<0.0001	2100	0.005					43		250		1500	0.015	<0.001	<0.001		1800			<0.005
CFW55R	01-08-2018	Palaeochannel alluvium	A	6.8	8780	5920	11.28	59		773				773	110		0		1850					0	44		230		1600					1700			
CFW55R	09-08-2018	Palaeochannel alluvium	A	6.8	8670	5840	11.25	59.03		768				768	110		0		1943					0	38		240		1500					1700			
CFW55R	15-08-2018	Palaeochannel alluvium	6M	6.6	9100	6300	11.28	59		750				750	110				1894						41		250		1600					1900			
CFW55R	15-08-2018	Palaeochannel alluvium	6M	6.6	9100	6300	11.28	59		750				750	110		0		1894		0.3	1.56		0	41		250		1600					1900	3.72		
CFW55R	22-08-2018	Palaeochannel alluvium	6M	7	9180	6180	11.36	58.92	1.9	734	0.002	0.12		734	120		0	<0.0001	2040				<0.0001	0	47		250		1700	0.16	<.001	0.003		2000			0.01
CFW55R	28-08-2018	Palaeochannel alluvium	6M	7	9510	6640	11.4	58.88		738				738	120				1894						49		250		1700					2000			
CFW55R	05-09-2018	Palaeochannel alluvium	6M	6.9	8860	6010	11.44	58.84		749				749	110				1846		1.2	<0.05			41		240		1700					1700	3.88		
CFW55R	13-09-2018	Palaeochannel alluvium	6M	7	10230	6700	11.46	58.82		745				745	120				1894						44		270		1800					2200			
CFW55R	19-09-2018	Palaeochannel alluvium	6M	7	9930	7080	11.49	58.79	0.21	749	<0.001	0.086		749	130			<0.0001	2088	0.003			<0.0001		51		270		1800	0.007	<0.001	0.004		2100			<0.005

Station	Date	Geology	Comprehensive Anlysis Event	pH Field	EC Field (uS/cm (25TRef))	TDS - Total (mg/l)	Depth to Stand Pipe (m)	SWL (mAHD)	Al - Total (mg/l)	Alk - Total (mg/l)	As - Total (mg/l)	B (mg/l)	Beryllium (mg/l)	Bicarbonate Alkalinity as CaCO3	Ca - Total (mg/l)	CaCO3 - Total Hard (mg/l)	Carbonate Alkalinity as CaCO3	Cd - Total (mg/l)	Cl- (mg/l)	Cu - Total (mg/l)	F (mg/l)	Fe - Filtered (mg/L)	Hg - Total (mg/l)	Hydroxide Alk (mg/l)	K - Total (mg/l)	Li (mg/l)	Mg - Total (mg/l)	Mn - Total (mg/l)	Na - Total (mg/l)	Ni - Total (mg/l)	Pb - Total (mg/l)	Se (mg/l)	Si (mg/l)	SO4 - Total (mg/l)	Sr - Total (mg/l)	Total Iron (mg/L)	Zn - Total (mg/l)
CFW55R	27-09-2018	Palaeochannel alluvium	6M	6.9	8860	4470	11.51	58.77		759				759	110				1700						43		240		1500					1700			
CFW55R	25-10-2018	Palaeochannel alluvium	6M	6.9	8980	5850		58.26	0.57	766	<0.001	0.12		766	120		0	<0.0001	1603	0.004			<0.0001	0	46		260		1500	0.031	<0.001	<0.001		1800			0.007
CFW55R	01-11-2018	Palaeochannel alluvium	6M	6.8	8770	5590		58.22		761				761	110		0		1651					0	47		220		1500					1700			
CFW55R	07-11-2018	Palaeochannel alluvium	6M	6.8	8310	5650		58.24		767				767	110		0		1761					0	38		230		1600					1600			
CFW55R	13-11-2018	Palaeochannel alluvium	6M	6.8	8840	5770		58.23		763				763	100		0		1761					0	43		220		1500					1700			
CFW55R	22-11-2018	Palaeochannel alluvium	6M	6.8	9130	6330		58.21	0.059	750	<0.001	0.091		750	110		0	<0.0001	1614	0.002			<0.0001	0	45		230		1600	0.021	<0.001	0.003		1800			<0.005
CFW55R	30-11-2018	Palaeochannel alluvium	6M	6.8	9130	5760		58.17		760				760	110		0		1761					0	45		230		1700					1900			
CFW55R	04-12-2018	Palaeochannel alluvium	6M	7	8910	6040		58.16		746				746	110		0		1910					0	46		240		1600					1800			
CFW55R	11-12-2018	Palaeochannel alluvium	6M	6.8	8330	5740		58.14		764				764	110		0		1859					0	46		230		1600					1600			
CFW55R	19-12-2018	Palaeochannel alluvium	6M	6.8	8740	5950		58.1	0.4	755	<0.001	0.11		755	100		0	<0.0001	1663	0.002			<0.0001	0	41		230		1600	0.015	<0.001	0.001		1600			<0.005
CFW55R	27-12-2018	Palaeochannel alluvium	6M	6.3	8390	5880		58.12		762				762	100		0		1810					0	44		240		1700					1600			
CFW57	29-03-2018	Palaeochannel alluvium	6M	7.1	5200	3160	12.01	58.74	0.37	678	<0.001	0.11		678	110			<0.0001	1060	0.001			<0.0001		7.2		160		870	0.005	<0.001	0.006		670			<0.005
CFW57	20-04-2018	Palaeochannel alluvium	6M	7.3	5610	3420	11.97	58.78	0.15	671	0.002	0.27		671	110			<0.0001	1175	<0.001			<0.0001		7		170		970	0.006	<0.001	0.01		730			0.011
CFW57	23-05-2018	Palaeochannel alluvium	6M	7.3	5710	3590	11.98	58.77	0.21	672	<0.001	0.13		672	110			<0.0001	1100	<0.001	1.1	<0.05	<0.0001		7.8		180		1100	0.011	<0.001	0.007		830	3.58		0.006
CFW57	25-06-2018	Palaeochannel alluvium	6M	7.4	5550	3680	11.98	58.77	0.33	651	<0.001	0.14		651	110			<0.0001	1125	0.006			<0.0001		7.8		190		1000	0.098	<0.001	0.006		880			0.007
CFW57	27-07-2018	Palaeochannel alluvium	6M	7.3	5670	3830	11.99	58.76	1.2	666	<0.001	0.091		666	120			<0.0001	1050	<0.001			0.0002		8.1		190		1000	0.011	<0.001	0.006		910			<0.005
CFW57	02-08-2018	Palaeochannel alluvium	6M	7.3	5730	3670	12.01	58.74		663				663	110				1190						8.1		170		940					940			
CFW57	02-08-2018	Palaeochannel alluvium	6M	7.3	5730	3670	12.01	58.74		663				663	110		0		1190					0	8.1		170		940					940			
CFW57	10-08-2018	Palaeochannel alluvium	6M	7.3	5850	3810	12.03	58.72		668				668	110				1190						7		170		900					920			
CFW57	10-08-2018	Palaeochannel alluvium	6M	7.3	5850	3810	12.03	58.72		668				668	110		0		1190					0	7		170		900					920			
CFW57	15-08-2018	Palaeochannel alluvium	6M	7.5	5970	3870	12.02	58.73		667				667	110				1141						7.8		180		960					1000			
CFW57	23-08-2018	Palaeochannel alluvium	6M	7.4	5810	3810	12.04	58.71	0.2	664	<0.001	0.14		664	110	311		<0.0001	1166				<0.0001		7.7		170		940	0.008	<0.001	0.006		1000	0.879		0.005
CFW57	29-08-2018	Palaeochannel alluvium	6M	7.3	5770	3820	12.02	58.73		670				670	110				1093						7.9		170		970					950			
CFW57	05-09-2018	Palaeochannel alluvium	6M	7.3	5710	3740	12.01	58.74		664				664	120				1020						7.7		180		1000					940			
CFW57	13-09-2018	Palaeochannel alluvium	6M	7.2	6060	4000	12	58.75		669				669	110				1117						6.8		170		960					1100			
CFW57	19-09-2018	Palaeochannel alluvium	6M	7.3	5923	3950	12.03	58.72	0.37	667	<0.001	0.11		667	120			<0.0001	1166	0.002			<0.0001		8.2		180		980	0.03	<0.001	0.006		1000			0.005
CFW57	26-09-2018	Palaeochannel alluvium	6M	7.3	5710	3770	12.05	58.7		654				654	120				1214						7.8		180		940					1000			
CFW57	02-11-2018	Palaeochannel alluvium	6M	7.3	5940	3670		57.95		656				656	120		0		1117					0	8.4		180		930					990			
CFW57	08-11-2018	Palaeochannel alluvium	6M	7.3	5620	3770		57.94		660				660	110		0		1101					0	6.8		180		990					950	0.771		
CFW57	13-11-2018	Palaeochannel alluvium	6M	7.3	6070	3640		57.95		660				660	110		0		1223					0	7.9		180		900					980			
CFW57	21-11-2018	Palaeochannel alluvium	6M	7.3	5600	3730		57.95	0.059	650	<0.001	0.11		650	110		0	<0.0001	1150	<0.001			<0.0001	0	7.7		170		860	0.002	<0.001	0.008		940			<0.005
CFW57	05-12-2018	Palaeochannel alluvium	6M	7.2	5960	3900		57.93		654				654	120		0		1223					0	8		180		930					950			
CFW57	13-12-2018	Palaeochannel alluvium	6M	7.4	5970	3710		57.9		657				657	120		0		1272					0	8.4		190		940					940			
CFW57	18-12-2018	Palaeochannel alluvium	6M	7.4	6090	4190		57.9	0.015	658	0.002	0.12		658	110		0	<0.0001	1125	<0.001			<0.0001	0	7.8		180		970	<0.001	<0.001	0.002		880			<0.005

Station	Date	Geology	Comprehensive Anlysis Event	pH Field	EC Field (uS/cm (25TRef))	TDS - Total (mg/l)	Depth to Stand Pipe (m)	SWL (mAHD)	Al - Total (mg/l)	Alk - Total (mg/l)	As - Total (mg/l)	B (mg/l)	Beryllium (mg/l)	Bicarbonate Alkalinity as CaCO3	Ca - Total (mg/l)	CaCO3 Total Hard (mg/l)	Carbonate Alkalinity as CaCO3	Cd - Total (mg/l)	Cl- (mg/l)	Cu - Total (mg/l)	F (mg/l)	Fe - Filtered (mg/L)	Hg - Total (mg/l)	Hydroxide Alk (mg/l)	K - Total (mg/l)	Li (mg/l)	Mg - Total (mg/l)	Mn - Total (mg/l)	Na - Total (mg/l)	Ni - Total (mg/l)	Pb - Total (mg/l)	Se (mg/l)	Si (mg/l)	SO4 - Total (mg/l)	Sr - Total (mg/l)	Total Iron (mg/L)	Zn - Total (mg/l)
CFW57	27-12-2018	Palaeochannel alluvium	A	7	5960	3720		57.93		650				650	110		0		1076					0	8.2		180		920					860			
GW_106	24-09-2018	Palaeochannel alluvium or weathered sandstone?	6M	6.8	8720	5400	23.22	59.88	0.2	1126	0.001	0.17		1126	150		0	<0.0001	2526	0.004			<0.0001	0	49		340		1500	0.029	<0.001	0.004		610			0.014
BUNC45A	23-02-2018	Regolith	A	6.7	2040	1170	21.27	51.93	0.97	490	0.001	0.097		490	64			<0.0001	340	0.002			<0.0001		8.3		42		390	0.003	<0.001	<0.001		68			0.032
BUNC45A	28-08-2018	Regolith	A	6.8	2050	1280	21.15	52.05	0.5	508	<0.001	0.094		508	51			<0.0001	359	0.002			<0.0001		6.4		36		320	0.001	<0.001	<0.001		63			0.017
NPz2	24-09-2018	Sandstone/Siltstone	A	7.6	14800	10370	29.25	161.825	0.16	756	0.001	0.44		756	130		0	<0.001	3837	<0.002			<0.0001	0	33		200		3300	<0.002	<0.001	<0.002		2400			0.019
NPZ5	27-09-2018	Sandstone/Siltstone	A	7.1	6460	4150	19.42	95.07	0.049	1005	<0.001	0.099		1005	110			<0.0001	1651	0.005	0.6	2.66	<0.0001		53		290		980	0.001	<0.001	<0.001		530	18.3		0.01
NPZ3	24-09-2018	Siltstone	A	8	12560	6310	23.02	125.38	0.35	451	<0.001	0.64		451	21			<0.001	4420	0.002			<0.0001		9.8		11		2600	0.008	0.005	<0.002		<5			0.024
4116P	06-04-2018	Spoil	A	7.1	13070	8350	23.32	48.16	17	774	0.012	0.14		774	170			0.0008	3774	0.031			<0.0001		40		600		2100	0.055	0.015	0.005		990			0.17
4116P	21-09-2018	Spoil	A	7	13560	8530	23.56	47.92	14	759	0.013	0.14		759	160		0	0.001	3885	0.045			0.0001	0	57		570		2000	0.091	0.019	0.005		1000			0.24
4119P	05-04-2018	Spoil	6M	7	2290	1470	10.65	54.09	0.024	598	0.058	0.089		598	82			<0.0001	220	<0.001			<0.0001		18		62		340	0.011	<0.001	<0.001		270			0.008
4119P	24-09-2018	Spoil	6M	7	2360	1570	10.92	53.82	0.09	614	0.07	0.092		614	93		0	<0.0001	291	<0.001			<0.0001	0	18		73		360	0.015	<0.001	<0.001		310			0.023
GW_114	24-09-2018	Spoil	A	6.6	8200	5710	31.61	66.59	4.7	809	0.016	0.19		809	170		0	0.0005	1797	0.017			<0.0001	0	66		480		1300	0.19	0.008	0.002		2100			0.15
MB14HVO01	05-04-2018	Spoil	A	6.8	7300	4960	35.23	36.07	<0.005	823	0.063	0.14		823	190		0	<0.0001	1450	<0.001			<0.0001	0	27		230		1200	0.047	<0.001	<0.001		1200			0.011
MB14HVO01	21-09-2018	Spoil	A	6.7	7360	4860	35.37	35.93	0.006	826	0.068	0.17		826	200		0	0.0002	1627	<0.001			<0.0001	0	38		240		1200	0.058	<0.001	<0.001		1300			0.013
MB14HVO02	05-04-2018	Spoil	A	6.8	7300	4980	34.84	36.06	0.01	761	0.13	0.13		761	190		0	<0.0001	1524	<0.001			<0.0001	0	28		270		1100	0.056	<0.001	<0.001		1200			0.02
MB14HVO02	24-09-2018	Spoil	A	6.8	7020	4710	34.98	35.92	0.015	755	0.15	0.14		755	200		0	<0.0001	1578	<0.001			<0.0001	0	40		290		1100	0.071	<0.001	<0.001		1300			0.029
MB14HVO03	05-04-2018	Spoil	A	6.9	6020	3960	33.59	33.51	<0.005	826	0.1	0.13		826	180		0	<0.0001	1090	<0.001			<0.0001	0	26		190		910	0.003	<0.001	<0.001		1100			<0.005
MB14HVO03	21-09-2018	Spoil	A	6.9	6080	3850	33.86	33.24	0.022	835	0.15	0.14		835	180		0	0.0002	1117	<0.001			<0.0001	0	35		190		920	0.014	<0.001	<0.001		1100			0.008
MB14HVO04	05-04-2018	Spoil	A	6.8	5850	4080	29.27	37.83	1.5	760	0.11	0.12		760	250		0	<0.0001	1000	0.003			<0.0001	0	25		220		790	0.071	0.001	<0.001		1200			0.071
MB14HVO04	21-09-2018	Spoil	A	6.9	5990	3940	29.53	37.57	0.35	775	0.1	0.13		775	240		0	<0.0001	1117	0.004			<0.0001	0	34		210		830	0.083	<0.001	<0.001		1300			0.032
MB14HVO05	06-04-2018	Spoil	A	5.4	16230	23540	35.68	36.02	26	0	0.15	0.48		0	480		0	0.021	870	0.083			<0.0001	0	100		1200		2000	1.1	0.053	0.28		17000			15
MB14HVO05	21-09-2018	Spoil	A	5.7	1600	19400	35.82	35.88	26	9	0.16	0.38		9	280		0	0.024	1100	0.068			<0.0001	0	91		960		1800	1.1	0.072	0.19		14000			16
DM1	06-04-2018	Spoil (Base)	A	6.6	9650		25.09	77.96		841				841																							
DM1	03-07-2018	Spoil (Base)	A	6.6	9870		25.11	77.94		841				841																							
DM1	24-09-2018	Spoil (Base)	A	6.6	9680	6800	25.2	77.85	0.57	851	0.01	0.15		851	120			0.0014	2477	0.006			<0.0001		73		570		1500	0.019	0.005	<0.001		1600			0.11
DM1	10-12-2018	Spoil (Base)	A	6.6	9880			77.55		797				797																							
DM3	06-04-2018	Spoil (Base)	A	6.5	9070		29.97	65		822				822																					0.321		
DM3	03-07-2018	Spoil (Base)	A	6.5	9680		30.14	64.83		828				828																							
DM3	26-09-2018	Spoil (Base)	A	6.5	9500	6460	30.2	64.77	0.64	830	0.001	0.082		830	220		0	<0.0001	2186	0.029			<0.0001	0	39		540		1300	0.034	0.004	0.001		1800			0.093
DM3	10-12-2018	Spoil (Base)	A	6.5	9100			63.9		813				813																							
DM4	06-04-2018	Spoil (Base)	A	6.9	5930		17.55	48.14		919				919																							
DM4	03-07-2018	Spoil (Base)	A	7	6080		17.55	48.14		908				908																							
DM4	24-09-2018	Spoil (Base)	A	6.9	5960	4100	17.88	47.81	11	940	0.48	0.15		940	160			0.0002	947	0.025			<0.0001		49		160		1100	0.025	0.007	0.003		1200			0.16
DM4	10-12-2018	Spoil (Base)	A	7	5970			46.92		920				920																							

ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
5 Foelsche Street
Darwin NT 0800
Australia
T: +61 8 8998 0100
F: +61 2 9427 8200

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Suite 2, 2 Domville Avenue
Hawthorn VIC 3122
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

ROCKHAMPTON
rockhampton@slrconsulting.com
M: +61 407 810 417

SYDNEY
2 Lincoln Street
Lane Cove NSW 2066
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TAMWORTH
PO Box 11034
Tamworth NSW 2340
Australia
M: +61 408 474 248
F: +61 2 9427 8200

TOWNSVILLE
Level 1, 514 Sturt Street
Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

AUCKLAND
68 Beach Road
Auckland 1010
New Zealand
T: +64 27 441 7849

NELSON
5 Duncan Street
Port Nelson 7010
New Zealand
T: +64 274 898 628

NEW PLYMOUTH
Level 2, 10 Devon Street East
New Plymouth 4310
New Zealand
T: +64 0800 757 695

APPENDIX 2: REHABILITATION MAINTENANCE SCHEDULE

Location	Maintenance	Relative Priority	2019				2020				Section 240 Issue
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
HVOWES201601 [West North 190, 6.2 ha]											
Priorities 1. Additional monitoring 2. Weed control 3. Understanding growth medium	Re-monitoring, investigate soil issues	2									Vegetation, Weeds
	Soil amelioration (if required)										
	Weed control / spray out										
	Seeding										
HVOWES201604 [Wilton 210, 3.7 ha]											
Priorities 1. Weed control 2. Understanding growth medium 3. Increase diversity	Weed control	2									Weeds
	Selective seeding (if required)										
HVOCAR200902 [Carrington, 7.7 ha]											
Priorities 1. Open canopy 2. Weed control 3. Increase diversity	Stem thinning	5									Weeds
	Weed control										
	Selective seeding										
HVOCHE201201 [Cheshunt Rim, 20.8 ha]											
Priorities 1. Understanding growth medium 2. Addressing medium constraints 3. Plan development	Investigate soil issues	5									Vegetation
	Develop re-establishment plan										
	Plan execution										
HVOLEM201601 [Lemington South, 5 ha]											
Priorities 1. Weed control	Weed control	4									Weeds
	Selective seeding (if required)										
HVORIV201401 [Riverview 145, 5.8 ha]											
Priorities 1. Weed control	Weed control	3									Weeds
	Selective seeding (if required)										
HVORIV201402 [Riverview 145, 10 ha]											
Priorities 1. Weed control	Weed control	3									Weeds
	Selective seeding (if required)										
HVORIV201403 [Riverview 145/155, 4.8 ha]											
Priorities 1. Weed control 2. Soil amelioration 3. Manage for re-disturbance	Investigate soil issues	1									Vegetation, Weeds
	Soil amelioration (if required)										
	Weed control										

Location	Maintenance	Relative Priority	2019				2020				Section 240 Issue
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
	Selective seeding (if required)										
HVORIV201404 [Riverview 155, 8.4 ha]											
Priorities 1. Weed control 2. Soil amelioration 3. Manage for re-disturbance	Investigate soil issues	1									Vegetation
	Weed control / spray out										
	Soil amelioration										
	Seeding										
HVORIV201405 [Riverview 155, 14.3 ha]											
Priorities 1. Weed control 2. Manage for re-disturbance	Investigate soil issues	1									Vegetation
	Weed control / spray out										
	Soil amelioration										
	Seeding										
HVORIV201501 [Riverview 155, 2.4 ha]											
Priorities 1. Weed control	Weed control	2									Weeds
	Selective seeding (if required)										
HVORIV201503 [Riverview 145, 6.2 ha]											
Priorities 1. Weed control	Weed control	2									Weeds
	Selective seeding (if required)										

Notes:

1. Work to occur across the periods shown, however may not occur in all periods shown.
2. Relative priorities balance addressing at-risk areas with maintaining areas demonstrating favourable trajectories.
3. 2020 work plans are indicative only. Final 2020 plans to be informed by observations and trajectory at 2019 monitoring events, and will be detailed in annual reporting. Work plans beyond 2020 to be informed by future monitoring.
4. Changes to work plans may occur due to weather events and climatic influences. Where work components are not undertaken details will be provided in annual reporting.
5. Maintenance of HVORIV201403, HVORIV201404 and HVORIV201405 reflect that blocks are temporary rehabilitation and blocks will be progressively re-disturbed with mine advance.

Legend - Rehabilitation Trajectory (after CPS monitoring)	
(blue)	Tracking towards success but needs work
(yellow)	Stable but need work to improve
(orange)	Failing
(red)	Failed

Legend - Planned work	
(dark grey)	Primary task timing
(light grey)	Secondary timing (contingency / follow-up as needed)

APPENDIX 3: ABORIGINAL HERITAGE MANAGEMENT PLANS COMPLIANCE AUDIT INSPECTIONS

Hunter Valley Operations Aboriginal Heritage Management Plans Compliance Audit Inspections

Report prepared for

Hunter Valley Operations

December 2018

Joel Deacon

ARROW HERITAGE SOLUTIONS

1805_HVO_AHMP_Compliance_Audits_Report

Introduction

The Hunter Valley Operations Joint Venture (HVOJV) manages the Hunter Valley Operations (HVO) mining complex and associated Biodiversity Areas located in the Hunter Valley. The HVOJV provides management services that include accountability for Aboriginal cultural heritage management & community consultation.

The development of HVO mining operations has occurred through a process of expansion and acquisition and as a result there are two separate development approvals that apply to the operation. The mining & processing activities at HVO are geographically divided by the Hunter River, with movements of coal, overburden, equipment, materials and personnel between two operational areas - HVO North (DA_450-10-2003) and HVO South (PA_06_0261).

Each consent contains a condition requiring the development of an Aboriginal Heritage Management Plan (AHMP). Such plans have been developed (in consultation with the Aboriginal community through the HVO Cultural Heritage Working Group [CHWG]) and approved for each operational area. Within each of these plans provision is made to conduct annual AHMP compliance inspections with members of the Aboriginal community throughout the life of operations. The purpose of the compliance inspections is to afford the Aboriginal stakeholders and the HVOJV:

- the opportunity to visit mine operations and mine areas to inspect the operational compliance with AHMP provisions and Ground Disturbance Permit procedures;
- to inspect and monitor the condition and management of various sites; and
- to review the effectiveness and performance of AHMP provisions in the management of cultural heritage at the mine.

The aim is to conduct these compliance inspections at least annually. Due to the number of cultural heritage sites within the AHMP areas & the time foreseen to inspect all sites, it is not feasible to inspect every site during the same field trip. Therefore, a regular, rolling program of compliance inspections has been implemented that will visit all sites at each location periodically each & every year. A record will be kept of each compliance inspection against each cultural heritage site, so that it can be ensured that each site is inspected regularly.

Proposed Activity and Project Brief

The compliance inspections involved the following elements:

- An AHMP compliance inspection report pro-forma will be completed for the nominated inspection areas and Aboriginal cultural heritage sites visited;
- Photographs of the inspected Aboriginal cultural heritage sites will also be taken;
- The pro-forma will note the outcomes of the inspections including evidence of compliance and non-compliance with AHMP provisions, recommendations on modifications and improvements to management provisions, recommendations on corrective actions, and other comments associated with AHMP provisions;
- Specific site condition monitoring inspection of site CM-CD1, as per Schedule 15 of the HVO North HMP.

Timing & Personnel

The HVO North AHMP compliance inspection program was conducted on Wednesday 5th and Thursday 6th December 2018. The HVO South AHMP compliance inspection program was conducted on Friday 7th December. The personnel involved in these inspections were:

Name	Organisation	Wed 5 Dec	Thu 6 Dec	Fri 7 Dec
Joel Deacon	Arrow Heritage Solutions	X	X	X
Peter Bowman	HVO	X	X	X
Mary Franks	Plains Clans of the Wonnarua People	X	X	
Steve Verey	Plains Clans of the Wonnarua People	X	X	
Will Moon	Plains Clans of the Wonnarua People	X	X	
David Horton	Wanaruah Local Aboriginal Land Council	X		X
Deidre Perkins	Wanaruah Local Aboriginal Land Council	X		X
Leanne Kirkman	Wanaruah Local Aboriginal Land Council	X		X

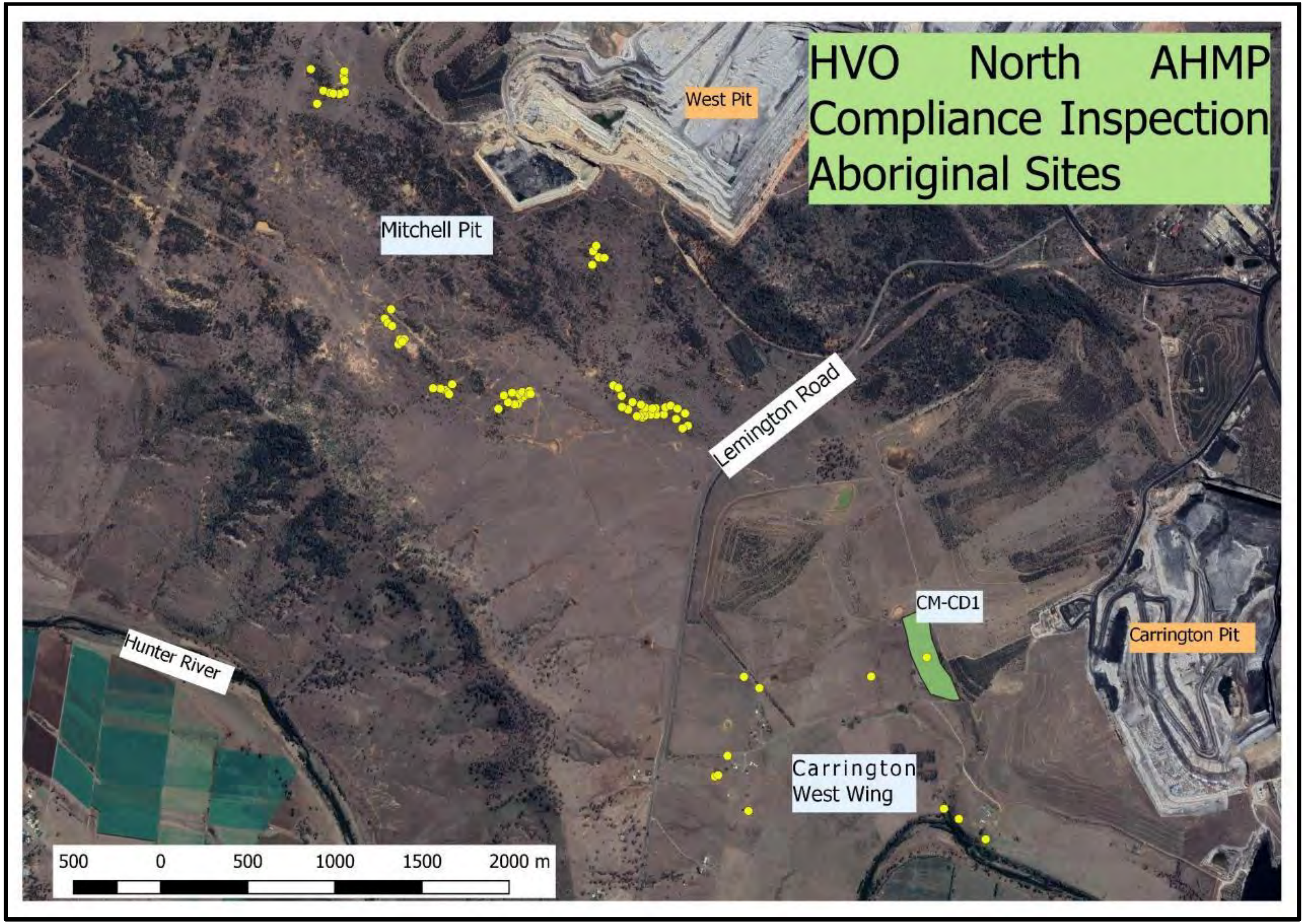
Arrow Heritage Solutions were engaged as independent heritage consultants to conduct the AHMP compliance inspections, and Joel Deacon acted as technical advisor and author of this report. HVO's Environment & Community Officer Peter Bowman arranged the compliance inspection programs and escorted the field team. Representatives of the Plains Clans of the Wonnarua People (including their archaeologist, Will Moon) participated in the HVO North AHMP compliance inspection, while representatives of the Wanaruah Local Aboriginal Lands Council participated in that for HVO South.

HVO North AHMP Compliance Inspection

A total of 79 Aboriginal heritage sites were inspected either side of Lemington Road at HVO North in the Carrington West Wing and Mitchell Pit areas (see Map 1). Although not active mining zones, these areas were selected for inspection as they are located adjacent to mining pits and frequently accessed for a variety of associated activities for drilling and environmental programs.

Results

The following table summarises the results of the HVO North compliance inspection and summarises the information recorded on the individual pro-forma inspection sheets. Using a mobile mapper pre-loaded with the GIS co-ordinates for each Aboriginal heritage site, the field team travelled to each location and attempted to re-locate each site. Sometimes this was not possible due to poor ground surface visibility (GSV), a result which in itself was not overly significant as long as it was determined that the vicinity had not been inadvertently disturbed. The presence and condition of barricading or fencing was noted, as well as the presence and nature of various potential site disturbing factors (e.g erosion, animal, human). General observations of each site were made if necessary, and, based on information provided for all of the above factors, management recommendations were discussed and agreed by the field team for each site.



Map 1: Location of Aboriginal heritage sites inspected during the HVO North AHMP compliance inspection program

Site Name	Date Inspected	Site re-identified?	Site intact?	Site fenced/ barricaded?	Fencing/ barricading intact?	Natural erosion	Livestock damage	Human disturbance	Animal disturbance	Pests & weeds	General observations	Management recommendations
CM-19	5/12/2018	No	Yes	Yes	No	No	cattle	No	No	No	-	re-instate barricade; audit in 2019
CM-32	5/12/2018	No	Yes	Yes	Yes	No	No	No	No	No	-	re-instate barricade; audit in 2020
CM-55	5/12/2018	Yes	Yes	No	No	Yes	cattle	No	No	No	much larger than originally recorded	cattle-proof fence along both banks of creek from original recording up to boxthorn bush
CM-CD1*	5/12/2018	Yes	Yes	Yes	No	No	cattle	farm rubbish	rabbits	No	-	extend & mend fence on western perimeter; install more signage; clean up rubbisgh under supervision
HVO-1121	5/12/2018	No	No	No	No	No	cattle	on dam wall	No	No	-	discuss options to protect with HVO
HVO-1122	5/12/2018	No	No	No	No	No	cattle	on dam wall	No	No	-	discuss options to protect with HVO
HVO-1123	5/12/2018	No	No	No	No	No	cattle	No	No	No	cattle gravitate to tree	cattle-proof fence around tree
HVO-1124	5/12/2018	No	No	No	No	No	No	on driveway	No	No	-	discuss option to close driveway with HVO
HVO-1125	5/12/2018	No	Yes	Yes	Yes	No	No	No	No	No	site on steep creek bank behind protective farm fence (not found)	Nil
HVO-1714	6/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-1717	6/12/2018	Yes	Yes	No	No	Yes	No	on contour	No	No	-	Remove stock until site is salvaged
HVO-1738	6/12/2018	Yes	Yes	No	No	sheet wash	No	No	No	No	-	Remove stock until site is salvaged
HVO-177	6/12/2018	Yes	Yes	No	No	No	No	No	No	No	-	Remove stock until site is salvaged
HVO-1792	5/12/2018	Yes	Yes	Yes	No	No	No	No	No	No	-	re-instate wire & signage
HVO-1793	5/12/2018	Yes	Yes	Yes	No	Yes	cattle	on dam wall	No	Scotch thistle; Bathurst burr	-	re-instate wire & signage; remove weeds
HVO-199	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-201	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-204	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-205	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-206	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-208	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-209	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-210	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-211	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-212	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-214	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-215	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	potential hearth - deteriorating	Audit in 2019; suggest salvage next program; remove stock until site is salvaged
HVO-216	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	additional broken axe	Remove stock until site is salvaged
HVO-217	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-218	5/12/2018	Yes	Yes	No	No	No	No	No	No	No	-	Remove stock until site is salvaged
HVO-219	5/12/2018	Yes	Yes	No	No	No	No	No	No	No	-	Remove stock until site is salvaged
HVO-220	5/12/2018	Yes	Yes	No	No	No	No	No	No	No	-	Remove stock until site is salvaged
HVO-221	5/12/2018	Yes	Yes	No	No	No	No	No	No	No	-	Remove stock until site is salvaged
HVO-223	5/12/2018	Yes	Yes	No	No	No	No	No	No	boxthorn	-	Remove stock until site is salvaged
HVO-224	5/12/2018	Yes	Yes	No	No	No	No	No	No	No	-	Remove stock until site is salvaged

HVO-230	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-231	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-232	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-236	5/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-290	6/12/2018	Yes	Yes	No	No	No	No	No	No	No	-	Remove stock until site is salvaged
HVO-291	6/12/2018	Yes	Yes	No	No	No	No	No	No	No	-	Remove stock until site is salvaged
HVO-292	6/12/2018	Yes	Yes	No	No	No	No	No	No	No	one additional silcrete flake	Remove stock until site is salvaged
HVO-294	6/12/2018	Yes	Yes	No	No	No	No	No	No	No	revegetation has obscured most artefacts	Remove stock until site is salvaged
HVO-295	6/12/2018	Yes	Yes	No	No	sheet wash	No	No	No	No	-	Remove stock until site is salvaged
HVO-296	6/12/2018	No	Yes	No	No	sheet wash	No	No	No	No	-	Audit in 2019; remove stock until site is salvaged
HVO-297	6/12/2018	Yes	Yes	No	No	No	No	No	No	No	-	Remove stock until site is salvaged
HVO-298	6/12/2018	Yes	Yes	No	No	sheet wash	No	No	No	No	-	Remove stock until site is salvaged
HVO-300	6/12/2018	Yes	Yes	No	No	No	No	No	No	No	-	Remove stock until site is salvaged
HVO-311	6/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-313	6/12/2018	No	Yes	No	No	sheet wash	No	No	No	No	-	Audit in 2019; remove stock until site is salvaged
HVO-314	6/12/2018	No	Yes	No	No	sheet wash	No	No	No	No	-	Remove stock until site is salvaged
HVO-450	6/12/2018	Yes	Yes	No	No	No	No	on contour	No	No	-	Remove stock until site is salvaged
HVO-452	6/12/2018	Yes	Yes	No	No	sheet wash	No	No	No	No	-	Remove stock until site is salvaged
HVO-453	6/12/2018	Yes	Yes	No	No	sheet wash	No	No	No	No	-	Remove stock until site is salvaged
HVO-454	6/12/2018	Yes	Yes	No	No	Yes	No	on contour	No	No	-	Remove stock until site is salvaged
HVO-455	6/12/2018	Yes	Yes	No	No	No	No	No	No	No	-	Remove stock until site is salvaged
HVO-528	5/12/2018	Yes	Yes	No	No	No	No	No	No	No	-	Remove stock until site is salvaged
HVO-529	5/12/2018	Yes	Yes	No	No	No	No	No	No	No	-	Remove stock until site is salvaged
HVO-626	6/12/2018	Yes	Yes	No	No	No	No	on contour	No	No	-	Remove stock until site is salvaged
HVO-627	6/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-628	6/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-629	6/12/2018	Yes	Yes	No	No	No	No	No	No	No	-	Remove stock until site is salvaged
HVO-632	6/12/2018	Yes	Yes	No	No	No	No	No	No	No	-	Remove stock until site is salvaged
HVO-637	6/12/2018	Yes	Yes	No	No	No	No	on contour	No	No	-	Remove stock until site is salvaged
HVO-793	6/12/2018	No	Yes	Yes	No	No	No	No	No	No	site had been barricaded during drilling program - no impacts	Audit in 2019; remove stock until site is salvaged
HVO-794	6/12/2018	Yes	Yes	No	No	sheet wash	No	No	No	No	-	Remove stock until site is salvaged
HVO-795	6/12/2018	Yes	Yes	No	No	sheet wash	No	No	No	No	-	Remove stock until site is salvaged
HVO-796	6/12/2018	Yes	Yes	No	No	sheet wash	No	No	No	No	-	Remove stock until site is salvaged
HVO-800	6/12/2018	Yes	Yes	No	No	sheet wash	No	No	No	No	-	Remove stock until site is salvaged

HVO-801	6/12/2018	Yes	Yes	No	No	sheet wash	No	No	No	No	-	Remove stock until site is salvaged
HVO-803	6/12/2018	Yes	Yes	No	No	sheet wash	No	No	No	No	-	Remove stock until site is salvaged
HVO-905	6/12/2018	No	Yes	No	No	severe	No	No	No	No	-	Audit in 2019; remove stock until site is salvaged
HVO-930	6/12/2018	Yes	Yes	No	No	No	No	No	No	termites	-	Remove stock until site is salvaged
HVO-940	6/12/2018	Yes	Yes	No	No	Yes	No	on contour	No	No	-	Remove stock until site is salvaged
HVO-941	6/12/2018	Yes	Yes	No	No	sheet wash	No	No	No	No	-	Remove stock until site is salvaged
HVO-943	6/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged
HVO-944	6/12/2018	Yes	Yes	No	No	Yes	No	on dam wall	No	No	-	Remove stock until site is salvaged
HVO-945	6/12/2018	No	No	No	No	Yes	No	No	No	No	-	Audit in 2019; remove stock until site is salvaged
HVO-978	6/12/2018	Yes	Yes	No	No	Yes	No	No	No	No	-	Remove stock until site is salvaged

Table 1: Results of HVO North Aboriginal Sites Compliance Inspection

- See specific section below for CM-CD1 inspection.

Aboriginal Site Management Recommendations

Management recommendations were provided for almost all Aboriginal heritage sites visited. At some sites, more than one management action was recommended. The nature of these recommendations are described below.

Reinstate barricade, wire and/or signage

Sites: CM19, CM32, HVO-1792, HVO-1793

These sites have been fenced or barricaded in the past and are located in areas that are subject to moderate levels of activity, grazing or are in close proximity to access ways. It is recommended that the barricading, fencing and signage at these sites be repaired or re-instated to prevent inadvertent disturbance.

Audit in 2019

Sites: CM19, CM32, HVO-215, HVO-296, HVO-313, HVO-793, HVO-905, HVO-945

Due to poor GSV at some locations as a result of sheet-wash erosion, heavy leaf litter or ground covering vegetation, some Aboriginal heritage sites were unable to be relocated. As the surrounding area was noted as being undisturbed, it is not suggested that the sites have been damaged, rather it is recommended that further attempts are made to relocate these sites during the 2019 AHMP compliance audit inspection. One of these sites, HVO-215, has been recorded as a hearth, which is deteriorating mainly due to its exposure to sheet wash and erosion. If this site is not salvaged in the near future then it should be regularly monitored to ensure it does not succumb to the elements prior to being excavated.

Cattle proof fence along both banks of creek

Sites: CM55

This particular site was originally recorded as a small exposure of artefacts, and was barricaded as such. Upon inspection during this program, the site was found to extend c.130m to the west, within eroded exposures along both sides of an ephemeral drainage channel. As the site is located within a cattle grazing paddock, it is recommended that cattle-proof fencing is installed along both sides of the channel, offset to c.10-20m from each bank, to protect the site from trampling. This would also help stabilise the erosion that is occurring.

Discuss options to protect with HVO

Sites: HVO-1121, HVO-1122, HVO-1124

These three Aboriginal heritage sites are located in areas that have been previously heavily disturbed and continue to be used. HVO-1121 and 1122 are located on the bank of a dam, but were unable to be relocated. This dam is in constant use as a watering point within a grazing paddock. HVO-1124 is located on the edge of a gravelled driveway leading to an occupied farm house, and was also unable to be relocated. It is recommended that HVO investigate the feasibility of fencing off the dam wall & re-routing the driveway to protect these site locations. If this is not practical, then consideration should be given to applying for an Aboriginal Heritage Impact Permit (AHIP) under Section 90 of the *National Parks and Wildlife Act* to enable the salvage of these sites.

Site CM-55 extent along ephemeral channel

Remove stock until site is salvaged

Sites: All Mitchell Pit sites

Much of the Mitchell Pit area is also used for grazing cattle. Cattle have the potential to disturb sites and trample artefacts, particularly in the vicinity of the main ephemeral watercourse that bisects the area. Many of the larger, more complex Mitchell Pit Aboriginal heritage sites are located along this watercourse.

As the location of these sites is known, the 'low impact activities' provisions of the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (Code of Practice - Department of Environment, Climate Change and Water, 2010) are not applicable. In short, these provisions allow the conduct of various activities deemed low impact, such as grazing, as long as due diligence has been exercised in line with the Code of Practice. In this instance, as the presence of Aboriginal objects has been confirmed, there is no legal defence if damage is caused to them, even by low impact activities.

With this in mind, it is recommended that cattle are excluded from that part of the Mitchell Pit area containing Aboriginal heritage sites until these sites are salvaged. HVO currently have a valid AHIP covering the majority of the recorded Mitchel Pit sites, which provides the legal authority to salvage at any time, in accordance with the AHIP conditions. If future mining development is likely in the area in the near future, then the salvage of these sites before any further potential cattle damage would be prudent. Cattle should continue to be excluded from those areas where Aboriginal heritage sites are located but that are not covered by the Mitchell Pit AHIP.

Evidence of stock at site HVO-291 (dung throughout exposure

Cattle proof fence around tree

Sites: HVO-1123

This site was originally recorded under a large tree in a cattle grazing paddock. As this tree offers one of the few shade opportunities on the property, it has been heavily used by the herd for respite from the heat and, as such, has resulted in significant disturbance of the ground surface. The site was not relocated during this inspection. To prevent further disturbance, it is recommended that cattle proof fencing be installed around the tree to remove cattle from the immediate area.

HVO-1123 and cattle disturbance around tree

Remove weeds

Sites: CM55, HVO-1793, HVO-223

Introduced weeds or noxious plants were identified at three sites, being African boxthorn (CM55 and HVO-223), Scotch thistle and Bathurst burr (HVO-1793). Although the presence of such species is not specifically detrimental to the Aboriginal heritage sites, their presence is noted so that these areas can be included in HVO's regular weed eradication programs. If these areas are to be treated, then access for any poisoning or plant removal must be on foot, with no unnecessary ground disturbance to be conducted.

Suggest salvage next program

Sites: HVO-215

As explained above, HVO-215 is a deteriorating hearth that should be salvaged as soon as is practical, however, it is located outside of the current Mitchell Pit AHIP area. Consideration should be given to applying for an AHIP to allow for this site's excavation and removal, potentially in combination with HVO-1121, 1122 and 1124. Cattle should be excluded from this area in the meantime to prevent further deterioration.

GDP Inspection

As well as inspecting the condition of specific Aboriginal heritage sites, the AHMP compliance audits also offer the opportunity to inspect areas that have been subject to previous works authorised under the HVO Ground Disturbance Permit (GDP) system. GDPs often contain specific conditions to ensure the proponent's activities do not inadvertently disturb sites. GDPs also have specific work areas that are mapped and outside of which ground disturbance is not authorised.

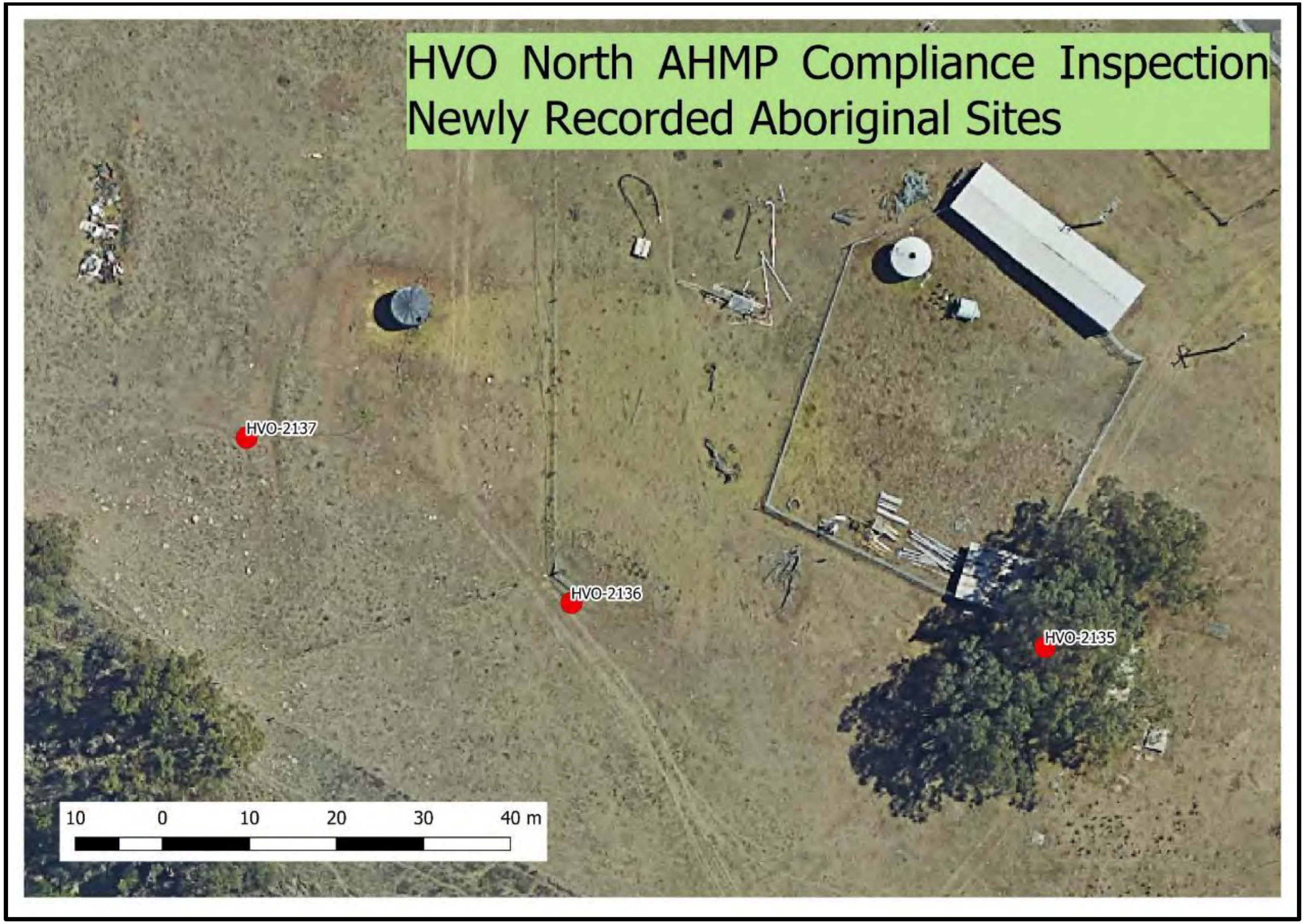
A GDP was issued for a seismic drilling program at Mitchell Pit in 2017 that required the clearing of three long access lines. Although a large portion of these lines intersected an area in which Aboriginal heritage sites had been salvaged, there were some areas that required the proponent to ensure they remained strictly on the approved corridor so that they avoided disturbing nearby sites.

During the AHMP compliance audit inspection, the field team travelled along the seismic line routes to assess conformance with the GDP conditions. Using a mobile mapper with the seismic routes pre-plotted, it was found that there was 100% agreement between the physical location of the seismic routes and the authorised GPS co-ordinates, and no nearby Aboriginal heritage sites had been inadvertently impacted.

Newly Recorded Aboriginal Heritage Sites

During the course of the AHMP compliance inspection, three previously unrecorded Aboriginal heritage sites were located and added to the HVO Aboriginal Heritage Sites Database, as well as the Aboriginal Heritage Information Management System (AHIMS) managed by the Office of Environment and Heritage (see Appendix A for site cards and Map 2 below). These sites were located in areas that been subject to previous Aboriginal heritage assessments and constitute 'new finds' as described in Provision 36 of the HVO North HMP. The artefacts were found on exposed areas that are subject to fluctuating levels of GSV depending on local rainfall events and seasonal variations. The details of these sites are as follows:

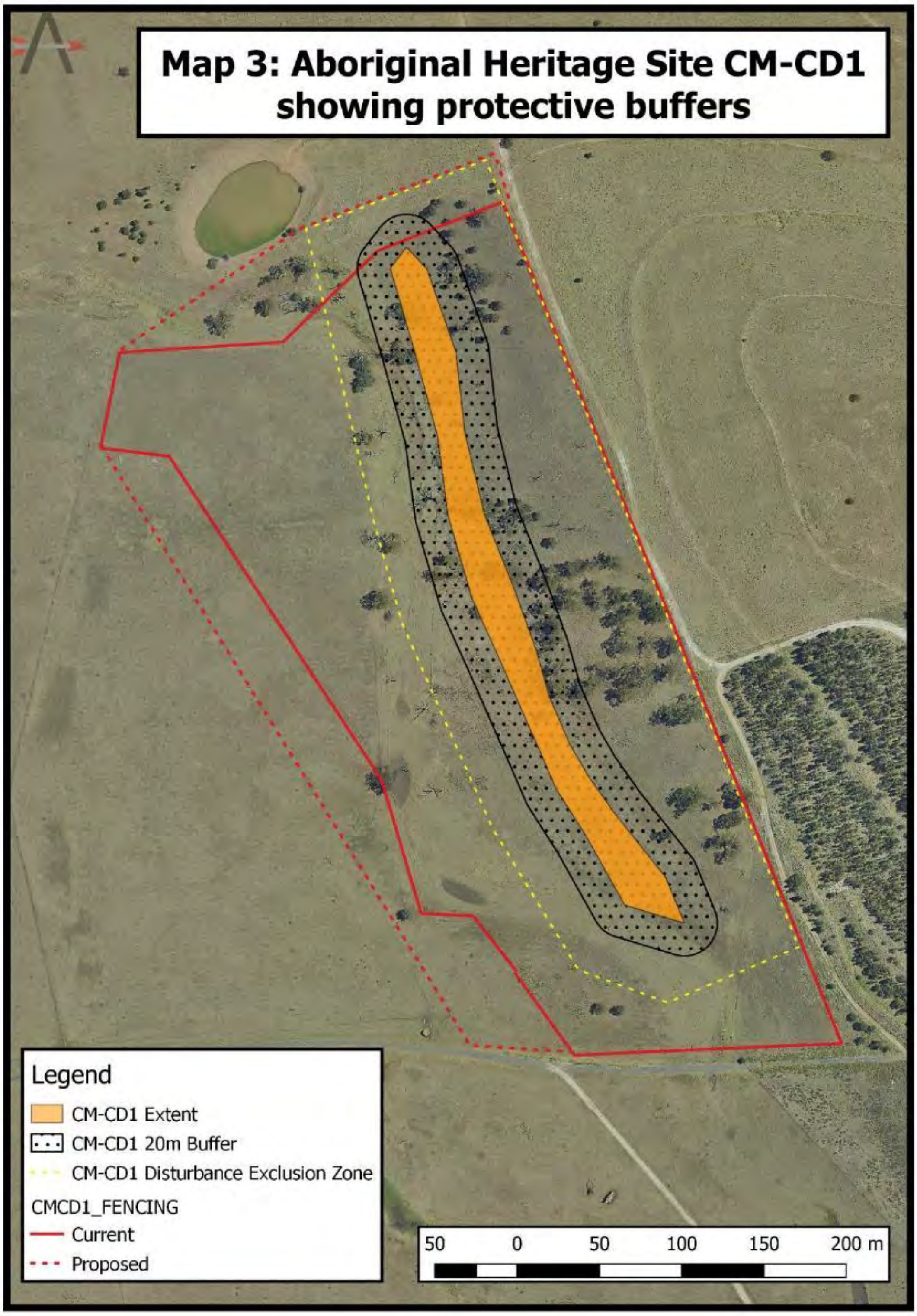
Site Name	AHIMS ID	Easting	Northing	Contents	Description
		(GDA94, Z56)			
HVO-2135	37-2-5858	309145	6402553	4F(M)	Found in disturbed context near old shed and removed farmhouse
HVO-2136	37-2-5859	309091	6402558	1F(M), 1F(QZ)	Found in disturbed context on old farm track
HVO-2137	37-2-5860	309054	6402577	1 F(S)	Found in disturbed context near farm pipe



Map 2: Location of newly recorded HVO North Aboriginal sites

CM-CD1

The HVO North HMP (Schedule 15) contains a specific Plan of Management for Aboriginal site CM-CD1 (AHIMS ID 37-2-1877) that includes a description of measures that would be implemented to protect, monitor and manage potential impacts on the site by HVO North's mining operations and associated activities. CM-CD1 includes an area c.450m long and up to 25m in width and is located immediately to the west of HVO Carrington Pit and c.900m north of the Hunter River.



As part of the brief for the HVO North AHMP compliance inspection audit, the consultant was also required to audit the current condition of CM-CD1 with reference to the management measures outlined in Schedule 15 of the HVO AHMP. These specific measures, and the outcomes of the audit, are as follows:

1. A disturbance exclusion buffer area will be maintained around Aboriginal cultural heritage site 37-2-1877 (CM-CD1) of not less than 20m from the boundary of the recorded extent of the CM-CD1 site and incorporating the Older Stratum.

   During the inspection of CM-CD1 on 5 December 2018, no ground disturbance was noted within the disturbance exclusion buffer area (as depicted on the map above and the co-ordinates in 2. below). It should be noted that historic rubbish piles containing derelict fencing and other farm debris is present within the disturbance exclusion zone.

2. The CM-CD1 disturbance exclusion buffer area will be aligned within the following coordinates (MGA 94):
   i. North-East corner at E308805 and N6403833
   ii. North-West corner at E308696 and N6403791
   iii. South-West corner at E308861 and N6403341
   iv. South-East corner at E308996 and N6403355

   See Point 1.

3. The CM-CD1 disturbance exclusion buffer area is to be zoned as a Zone 1 Restricted Access Area within the HVO North CHZS. All development disturbance activities are to be excluded from within the buffer area.

   The CM-CD1 disturbance exclusion area is not currently zoned as Zone 1 in the HVO North CHZS.

4. The CM-CD1 disturbance exclusion buffer area will be delineated with stock-proof fencing and appropriate signage denoting that the area is a Restricted Access Area and no ground disturbance is authorised within the buffer area except where such ground disturbance is authorised under the provisions of this Plan of Management. Ground disturbance, such as for archaeological investigations, may require a consent under relevant legislation.

   Existing stock-proof fencing has been utilized at CM-CD1 to delineate the majority of the CM-CD1 site area. The northern tip of the CM-CD1 disturbance exclusion area does extend outside of this fencing and portions of the western fence are dilapidated and no longer excluding stock from the site. Some Cultural Heritage Site signage is visible on the fence.

5. Access within the CM-CD1 disturbance exclusion buffer area will be limited to authorised personnel and visitors only either on foot (e.g. for monitoring inspections) or in light vehicles (e.g. for pest, weed and fire management) for the purposes of implementing the management provisions approved under this Plan of Management.

   No evidence was noted to suggest the contrary has occurred.

6. An annual site condition monitoring inspection will be conducted by HVO personnel with representatives of the CHWG and the results of the inspection reported as an element of the HVO North DA 450-10-2003 Annual Environmental Management Report. The results of the inspection will also be reported to Aboriginal community stakeholders through the CHWG and/or other relevant Aboriginal community consultation forum.

   This report documents the 2018 annual site condition monitoring inspection.

7. A series of condition and disturbance monitoring photo points will be established within the CM-CD1 disturbance exclusion buffer area and condition monitoring images taken during the course of the annual monitoring inspection.

   Five unpegged photographic monitoring points were established, and photographs taken of CM-CD1. These points were located in the north-west, north-east, south-west and south-east of the site, as well as the centre. These photographs and their locational information are contained in Appendix B of this report.

8. HVO will determine the nature and risks of potential impacts of blasting activities upon site CM-CD1 as an element of the HVO North blast management plan. Consistent with the results of the risk assessment process used to inform the development of the HVO North blast management plan, HVO will implement appropriate management measures to protect site CM-CD1 from any adverse impact that may be caused by blasting in a manner consistent with the provisions of this Plan of Management. In accordance with Schedule 4 of Condition 40 of the Approval, regular visual monitoring will be undertaken to confirm that impacts have not been caused by blasting vibration or from flyrock impacts.

   No evidence of any blasting-related disturbance or flyrock impacts were noted during the site inspection.

9. As mining, and related blasting activities, approach the CM-CD1 disturbance exclusion buffer area, regular visual monitoring to confirm that impacts have not been caused by blasting vibration will be conducted by HVO personnel. Damage to CM-CD1 caused by flyrock is considered a very low risk, however, if it is evident, through regular monitoring, that this risk profile may increase in the future, protective management measures will be considered.

   See above Point 8.

10. A variety of land management activities will be required to maintain the cultural and environmental values of the CM-CD1 disturbance exclusion buffer area. Land management activities approved under this HMP are as follows.
    i. Hand or light vehicle spraying of weeds.
    ii. Brush cutting by hand to control weeds and vegetation.
    iii. Prescribed burning and fire protection management.
    iv. Maintenance of fencing including replacement of posts as required.

    No evidence was noted of any adverse impacts to CM-CD1 by any of the land management practices listed above.

Recommendations

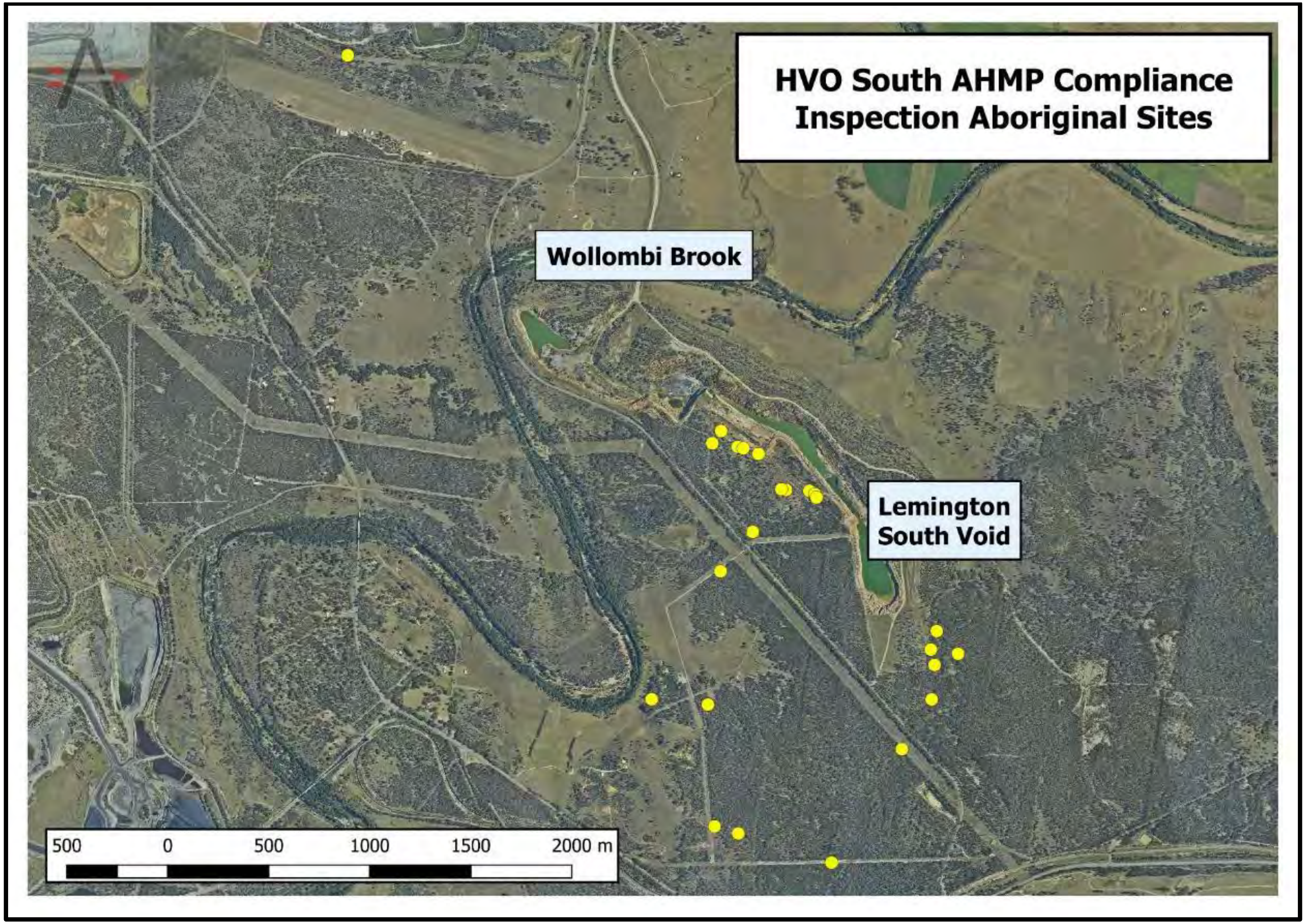
1. Remove historic farm litter and debris from within CM-CD1 fenced area.
2. Edit the HVO North CHZS to reflect the CM-CD1 disturbance exclusion area as Zone 1.
3. Alter the CM-CD1 northern fence alignment to encompass the northern tip of the CM-CD1 disturbance exclusion area (as per map above).
4. Alter the CM-CD1 western fence alignment, which is dilapidated in segments, to follow the suggested line on the map above.
5. Install new Cultural Heritage Site signage around the CM-CD1 fenced area, particularly in locations on likely approach routes.
6. Peg the photographic point locations (co-ordinates in Appendix B) so that the same points can be used from year to year.
7. Ensure that the HVO North Blast Management Plan contains sufficient information to ensure no adverse blasting impacts affect CM-CD1.

HVO South AHMP Compliance Inspection

A total of 25 Aboriginal heritage sites were inspected in the Lemington South area at HVO South (see Map 4). Although not active mining zones, these areas were selected for inspection as they are located in areas that are frequently accessed for a variety of activities associated with water and environmental management.

Results

The following table summarises the results of the HVO South compliance inspection and summarises the information recorded on the individual pro-forma inspection sheets. Using a mobile mapper pre-loaded with the GIS co-ordinates for each Aboriginal heritage site, the field team travelled to each location and attempted to re-locate each site. Sometimes this was not possible due to poor ground surface visibility (GSV), a result which in itself was not overly significant as long as it was determined that the vicinity had not been inadvertently disturbed. The presence and condition of barricading or fencing was noted, as well as the presence and nature of various potential site disturbing factors (e.g erosion, animal, human). General observations of each site were made if necessary, and, based on information provided for all of the above factors, management recommendations were discussed and agreed by the field team for each site.



Map 4: Location of Aboriginal heritage sites inspected during the HVO South AHMP compliance inspection program

Site Name	Date Inspected	Site re-identified?	Site intact?	Site fenced/ barricaded?	Fencing/ barricading intact?	Natural erosion	Livestock damage	Human disturbance	Animal disturbance	Pests & weeds	General observations	Management recommendations
HVO-112	7/12/2018	No	Yes	Yes	Yes	No	No	No	No	No	not found	audit in 2019
HVO-120	7/12/2018	Yes	Yes	No	No	No	No	on track	No	No	-	Nil
HVO-121	7/12/2018	Yes	Yes	No	No	No	No	No	No	ant nest	-	Nil
HVO-122	7/12/2018	No	Yes	No	No	No	No	No	No	No	tree fallen over site point	audit in 2019
HVO-123	7/12/2018	Yes	Yes	No	No	No	No	clearing	No	No	-	barricade if area becomes active again
HVO-124	7/12/2018	Yes	Yes	No	No	No	No	old track	No	No	-	Nil
HVO-125	7/12/2018	Yes	Yes	Yes	No	No	No	No	No	No	-	Nil
HVO-126	7/12/2018	No	Yes	Yes	No	Yes	No	No	No	No	-	audit in 2019
HVO-127	7/12/2018	No	Yes	Yes	No	sheet wash	No	fence line & track	No	prickly pear	-	audit in 2019; fix barricading if area becomes active again; remove pear
HVO-128	7/12/2018	Yes	Yes	Yes	Yes	No	No	No	No	No	-	Nil
HVO-129	7/12/2018	Yes	Yes	Yes	No	No	No	No	No	No	-	fix barricading if area becomes active again
HVO-130	7/12/2018	Yes	Yes	Yes	Yes	No	No	No	No	No	-	Nil
HVO-132	7/12/2018	Yes	Yes	Yes	Yes	Yes	No	on track	No	No	-	Nil
HVO-59	7/12/2018	Yes	Yes	Yes	Yes	No	No	No	No	No	-	Nil
HVO-69	7/12/2018	No	Yes	Yes	No	No	No	No	No	No	-	audit in 2019; fix barricading if area becomes active again
HVO-70	7/12/2018	No	Yes	Yes	Yes	No	No	on track	No	No	-	audit in 2019
HVO-71	7/12/2018	No	Yes	Yes	Yes	No	No	No	No	No	-	barricade off track edges as more artefacts sighted
HVO-72	7/12/2018	Yes	Yes	Yes	Yes	No	No	No	No	No	one extra found	barricade off track edges as more artefacts sighted
HVO-73	7/12/2018	Yes	Yes	Yes	Yes	No	No	on bund	No	No	-	Nil
HVO-74	7/12/2018	No	Yes	Yes	No	No	No	on bund	No	No	-	audit in 2019
HVO-75	7/12/2018	Yes	Yes	Yes	No	Yes	No	No	No	No	more artefacts than first recorded	salvage site as artefacts eroding into pit
HVO-76	7/12/2018	Yes	Yes	Yes	No	No	No	No	No	No	-	fix barricading if area becomes active again
HVO-77	7/12/2018	Yes	Yes	Yes	No	No	No	old workings	No	No	-	fix barricading if area becomes active again
HVO-78	7/12/2018	Yes	Yes	Yes	Yes	No	No	No	No	No	-	Nil
WB-20	7/12/2018	No	Yes	Yes	Yes	No	No	No	No	No	-	audit in 2019

Table 2: Results of HVO South Aboriginal Sites Compliance Inspection

Aboriginal Site Management Recommendations

Management recommendations were provided for many of the Aboriginal heritage sites visited. At some sites, more than one management action was recommended. The nature of these recommendations are described below.

Reinstate barricade, wire and/or signage if area becomes more active

Sites: HVO-69, HVO-76, HVO-77, HVO-123, HVO-127, HVO-129

These sites have been fenced or barricaded in the past and are located in areas that are currently not subject to any regular activity. It is recommended that the barricading, fencing and signage at these sites be repaired or re-instated if and when the areas become more active in the future to prevent inadvertent disturbance.

An example of dilapidated barricading at HVO-76

Audit in 2019

Sites: HVO-69, HVO-70, HVO-74, HVO-112, HVO-122, HVO-126, HVO-127, WB-20

Due to poor GSV at some locations as a result of sheet-wash erosion, heavy leaf litter or ground covering vegetation, some Aboriginal heritage sites were unable to be relocated. As the surrounding area was noted as being undisturbed, it is not suggested that the sites have been damaged, rather it is recommended that further attempts are made to relocate these sites during the 2019 AHMP compliance audit inspection.

Barricading along both sides of track

Sites: HVO-71, HVO-72

These two sites were originally recorded as small, discrete locations of artefacts either side of a track, and were barricaded as such. Upon inspection during this program, artefacts were noted as occurring throughout the exposure and outside of the barricaded areas, although not on the track itself. It is recommended that the barricading be altered so that it is installed along both sides of the track as it crosses this exposure, to protect the site from inadvertent vehicle disturbance – in effect, restricting vehicle movement off the track and onto areas containing artefacts.

Remove weeds

Sites: HVO-127

Prickly pear was identified at this site. Although the presence of this species is not specifically detrimental to Aboriginal heritage sites, its presence is noted so that this area can be included in HVO's regular weed eradication programs. If this area is to be treated, then access for any poisoning or plant removal must be on foot, with no unnecessary ground disturbance to be conducted.

Suggest salvage next program

Sites: HVO-75

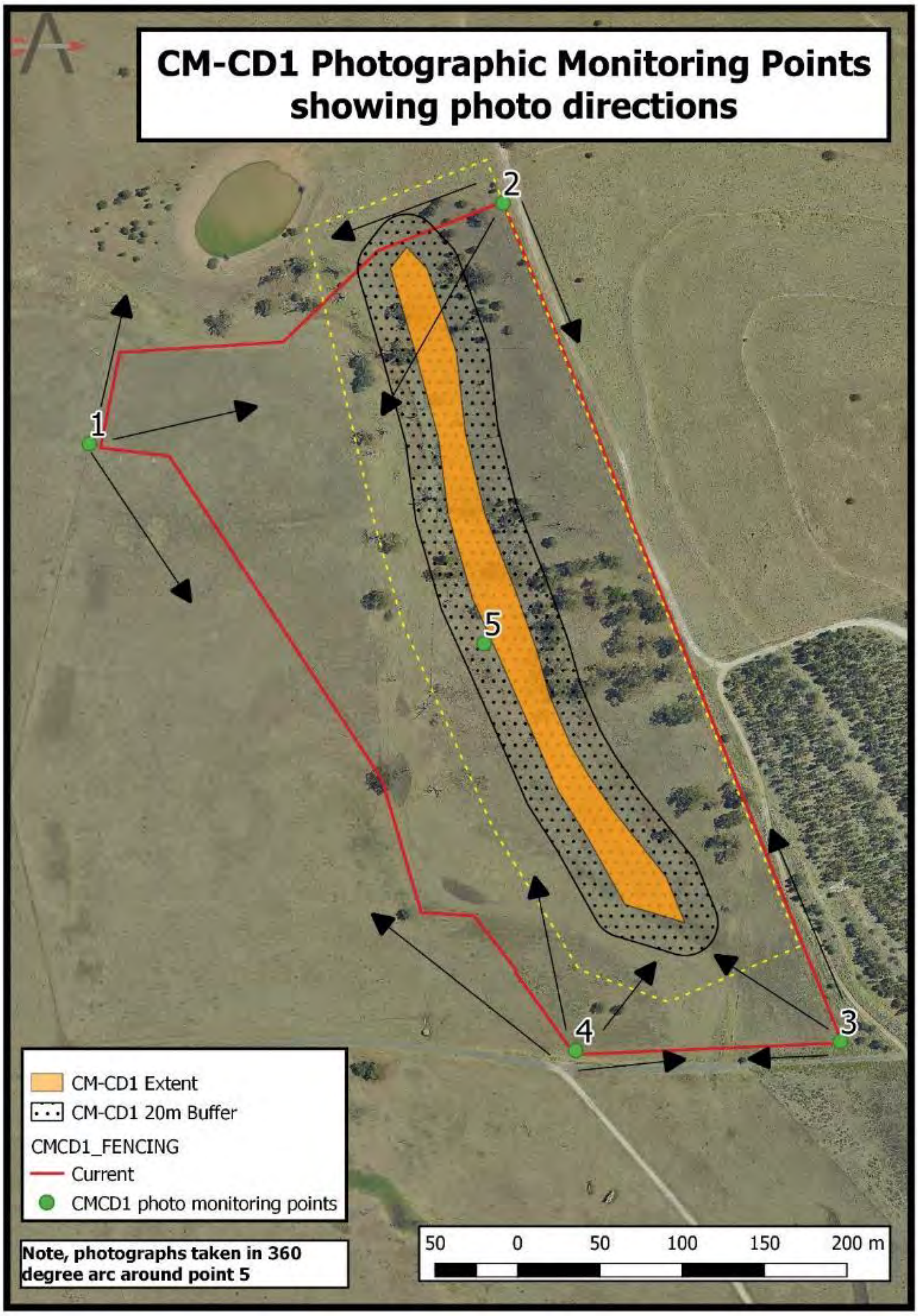
Upon inspection, HVO-75 contained more artefacts then originally recorded, no doubt due to ongoing erosion that is evident in the area. Sheet wash and rain run-off is passing through the site and emptying into the South Lemington void immediately adjacent. Therefore, there is a moderate risk that artefacts from HVO-75 are also being washed into this void. HVO-75 should be salvaged as soon as is practicable to prevent any further possible damage. An AHIP is not required to implement this measure, as the salvage of this site, with Aboriginal community participation, is authorised under the HVO South AHMP.

APPENDIX A – NEW AHIMS SITE CARDS

APPENDIX B – CM-CD1 PHOTO MONITORING RESULTS

Photo Point #	Location at CM-CD1	Easting	Northing
1	North-west	308614	6403653
2	North-east	308814	6403807
3	South-east	309022	6403297
4	South-west	308860	6403290
5	Centre	308809	6403513

Co-ordinates (GDA94, z56) for CM-CD1 photo monitoring points



Location of CM-CD1 photo monitoring points

CM-CD1 Monitoring Point 1 photographs

CM-CD1 Monitoring Point 2 photographs

CM-CD1 Monitoring Point 3 photographs

CM-CD1 Monitoring Point 4 photographs

CM-CD1 Monitoring Point 5 photographs

Planning & Environment
Resources Regulator

Tony Galvin
General Manager
Hunter Valley Operations
PO Box 315
Singleton NSW 2330

Our ref: EAMSG0002593
DOC19/770276

By email:
tony.galvin@hvo.com.au
andrew.speechly@hvo.com.au

27 September 2019

Dear Mr Galvin

Hunter Valley Operations, Coal & Allied Operations Pty Limited, Anotero Pty Ltd & Liddell Tenements Pty Limited, Annual Environmental Review 2018 for Hunter Valley Operations

We refer to your Annual Environmental Review received by the Resources Regulator within the NSW Department of Planning, Industry & Environment (Resources Regulator) on 5 April 2019* (Department Reference: DOC19/302004).

(Note* - An original submission attempt dated 29 March 2019 was unable to be downloaded)

NOTICE OF SATISFACTORY ANNUAL ENVIRONMENTAL REVIEW

Pursuant to Condition 3 of CCL 708 (Act 1973), Condition 4 of CCL 714, CL 327, CL 398, CCL 755, CL 359, CL 360, CL 584 and CML 4 (all Mining Act 1973), Condition 2 of ML 1465 and ML 1406 (all Mining Act 1992), Condition 3 of ML 1734, ML 1474, ML 1482, ML 1500, ML 1589, ML 1704, ML 1705, ML 1706, ML 1707, ML1710, ML1748, ML 1428, ML 1526, ML 1560, ML 1732, ML 1753 (all Mining Act 1992), Condition 4 of ML 1634, ML 1682 ML 1622 (all Mining Act 1992), Condition 6 of ML 1337 (Mining Act 1992), Condition 9 of ML 1359 (Mining Act 1992) and Condition 16 of ML 1324 (Mining Act 1992) the above-mentioned Annual Environmental Review is to the satisfaction of the Secretary for the NSW Department of Planning, Industry & Environment and the Minister for Resources.

It is the responsibility of the Authorisation Holder to ensure that all operations are consistent with relevant Project Approval or Development Consent requirements and that all necessary approvals and consents from the relevant Government Departments or Local Council are obtained to permit the operations.

It is requested that you address the following item in future Annual Environmental Review submissions for Hunter Valley Operations:

- Provide details of the titleholders for each of the Mining Titles. The 2018 Report does not clearly identify the relevant titleholders.

DEFINITIONS

In this letter, words have the meaning given to those terms in the *Mining Act 1992*, unless otherwise specified below.

Annual Environmental Review means the document named *"Annual Environmental Review, Hunter Valley Operations, March 2019"* prepared by Hunter Valley Operations Pty Ltd, dated 28 March 2019, and covering the period from 1 January 2018 to 31 December 2018.

If you have any questions about this letter, please contact Matthew Quinn, Inspector Environment, directly on (02) 4063 6630

Yours sincerely,

Greg Kininmonth 27/09/2019

Greg Kininmonth
Manager Environmental Operations
Compliance Operations
Resources Regulator
NSW Department of Planning, Industry & Environment

Signed under delegation from the Minister for Resources.
Signed under delegation from the Secretary of the NSW Department of Planning, Industry & Environment.

Andrew Speechly
Manager Environment and Community
Hunter Valley Operations
PO Box 315
Singleton NSW 2330

Planning Services - Compliance
Contact: James Epstein
Phone: 0429 395 691
Email: james.epstein@planning.nsw.gov.au

Our ref: DA 450-10-2003 as modified, PA 06_0261 as modified (#18376)

Hunter Valley Operations - DA 450-10-2003 (North) & MP 06_0261 (South) Revised Annual Review 2018

Dear Mr Speechly

Reference is made to the revised Annual Review for the period 1 January 2018 to 31 December 2018, resubmitted to the Department of Planning, Industry and Environment (the Department) on 26 July 2019 following the Department's letter dated 14 June 2019 requiring amendments under Schedule 2, Condition 4 of DA 450-10-2003 (HVO North) and Project Approval MP 06_0261 (HVO South) (the Approvals, as modified).

The Department has reviewed the revised Annual Review and considers it to generally satisfy the requirements of the Approvals and the Department's *Annual Review Guideline* (2015). Please note that acceptance of the Annual Review is not endorsement of the compliance status of the project.

In accordance with the provisions of Schedule 2, Condition 4 of the Approvals, it is requested that the following items are addressed in all subsequent Annual Reviews:

a. Please include high resolution maps that adequately show the operations in a regional context, as required by Section 2 of the Department's *Annual Review Guidelines*;

The Department notes that a separate community complaints register is now available on the project website. Please ensure that it remains publicly available and is updated quarterly as required by Schedule 5, Condition 12(a) and Schedule 5, Condition 9(a) of the Approvals.

Non-compliances identified in the Annual Review will be assessed in accordance with the Department's Compliance Policy. Further correspondence may be sent in relation to non-compliances.

Please contact James Epstein on the details above to discuss this matter.

Yours sincerely

16/8/19

Leah Cook
Team Leader - Compliance
As Nominee of the Secretary