Annual Groundwater Monitoring Report 2020

Hail Creek Mine

Environmental Authority EPML00661913

Glencore

August 2020

Version 1.0 (FINAL)

by

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EXECUTIVE SUMMARY

Groundwater levels and quality at Hail Creek Mine in 2019/2020 were reviewed in comparison with the proposed trigger values in the mine's Environmental Authority (EA), the ANZECC (2000) stock watering guidelines for beef cattle, and historical data dating back to October 2013.

Groundwater levels in the alluvium bores have declined since 2013, correlating with a decline in the area's residual rainfall that recharges the alluvium aquifer. Between 2016 and 2019, the average 12-month drawdown ranged between 0.42 m and 1.69 m. In the 2019/2020 reporting year, the maximum 6-month drawdown was 1.1 m in GWMB32, which was within the proposed EA trigger of <2 metres drawdown per six-month period.

Water quality was generally within acceptable concentrations and proposed EA trigger values, although some analytes, namely salinity (EC and TDS) in GWMB14A and dissolved iron in GWMB13A, were above proposed EA triggers.

Salinity in bore GWMB14A has gradually increased since 2014 and is now similar to the ANZECC stock watering guideline.

Iron in GWMB13A shows high variability which appears more related to sampling variability rather than a change in the aquifer.

Total Petroleum Hydrocarbons in the C10 – C36 fraction were detected in Bore GWMB32 in January 2020; however, the bore was near dry and not able to be sampled subsequently to confirm the result.

Continued monitoring of groundwater levels and quality, as per the EA conditions, is recommended.

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1. OBJECTIVE & SCOPE

This annual alluvial groundwater monitoring report has been completed to determine Hail Creek Mine's compliance against the site's Environmental Authority (EA) (EPML00661913) groundwater conditions (see Attachment).

This report reviews groundwater quality data obtained in the 12 months between Aug 2019 and July 2020, and makes comparison with data dating back to 2013.

2. INTRODUCTION

2.1 BACKGROUND

Hail Creek Mine (HCM) is an open cut coal mine located on the Hail Creek Mining Lease (ML4738) in the Bowen Basin approximately 100km west of Mackay, Queensland. Construction of HCM commenced in December 2001 with production of coal first occurring in August 2003.

Coal is mined by conventional open-cut strip-mining methods prior to crushing and washing in the Coal Handling and Preparation Plant (CHPP). Mining activity is progressing from west to east towards Hail Creek in two strips simultaneously with mining of the upper Elphinstone Seam, preceding mining of the underlying Hynds Seam. Interburden and overburden are used to infill mined areas or deposited in spoil piles and out-of-pit dumps. CHPP rejects are disposed of within the spoil dumps and fines within an emplacement facility. HCM has commenced mining operations east of Hail Creek in an area known as 'The Eastern Margin'. Mining in the Eastern Margin consists of two pits: Exevale and Carrinyah pits (north to south). The Eastern Margin will be mined using conventional truck and shovel methods.

2.2 ENVIRONMENTAL VALUES

The *Environmental Protection (Water) Policy 2009* for the Fitzroy River Sub-basin outlines water quality objectives to enhance or protect environmental values, and applies to all surface and groundwaters draining to the sub-basin of the Fitzroy River (DEHP, 2013a).

HCM lies within the *Central Tributaries* sub-catchment of the Isaac River sub-basin (DEHP, 2013b). As per the Fitzroy Basin Groundwater Zones Plan (WQ1310), there is insufficient information to derive groundwater chemistry zone profiles for the area in which HCM is located (DEHP, 2013c).

2.3 GROUNDWATER HYDROLOGY

The HCM operations are located on the eastern and western margin of the Hail Creek Syncline which contains sedimentary strata of Permian and Triassic age, with a thin cover of Quaternary alluvial strata. The syncline trends south-southeast with an axis coincident with the alignment of Hail Creek (Hail Creek, 2017).

The stratigraphic sequence in the Hail Creek Syncline is shown in Figure 1 and Figure 2, and is described in Hail Creek (2017) as:

- *Quaternary alluvium consisting of clay, sandy clay and palaeochannels of sand and gravel. The extent of the alluvium is limited to narrow corridors along watercourses within the Hail Creek Syncline. The alluvium is not considered to be a significant aquifer, as it is depleted in several locations during the dry season.*
- *The Rewan Group of Early Triassic age which consists of lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanilithic pebble conglomerate (at base). Rewan Group sediments were deposited in a fluvial-lacustrine environment.*
- *The Blackwater Group of Late Permian age, the component formations which are:*
    - *The Rangal Coal Measures characterised by calcareous sandstone, calcareous shale, mudstone, coal, concretionary limestone. The Rangal Coal Measures hosts the economic seams mined at HCM;*
    - *The Fort Cooper Coal Measures which consist of lithic sandstone, conglomerate, mudstone, carbonaceous shale, coal, tuff and tuffaceous (cherty) mudstone; overlying;*
    - *The Moranbah Coal Measures which include labile sandstone, siltstone, mudstone, coal and conglomerate.*
- *The Early to Late Permian Back Creek Group, a sedimentary sequence of siliciclastic rocks including quartzose to lithic sandstone, siltstone, carbonaceous shale, minor coal and sandy coquinite.*

Figure 1 – Hail Creek Syncline Cross-section

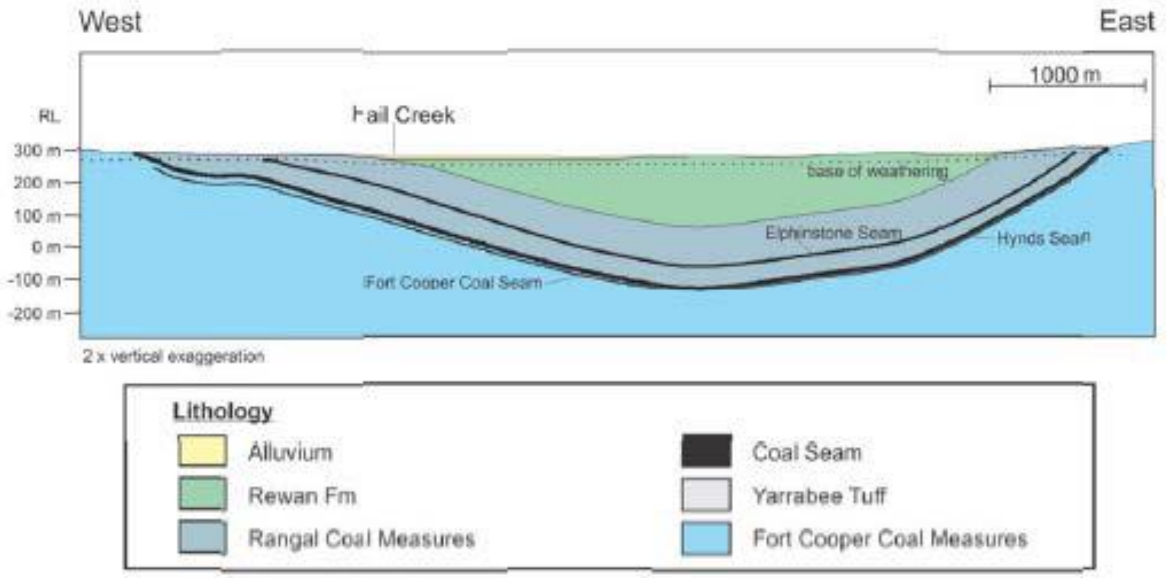
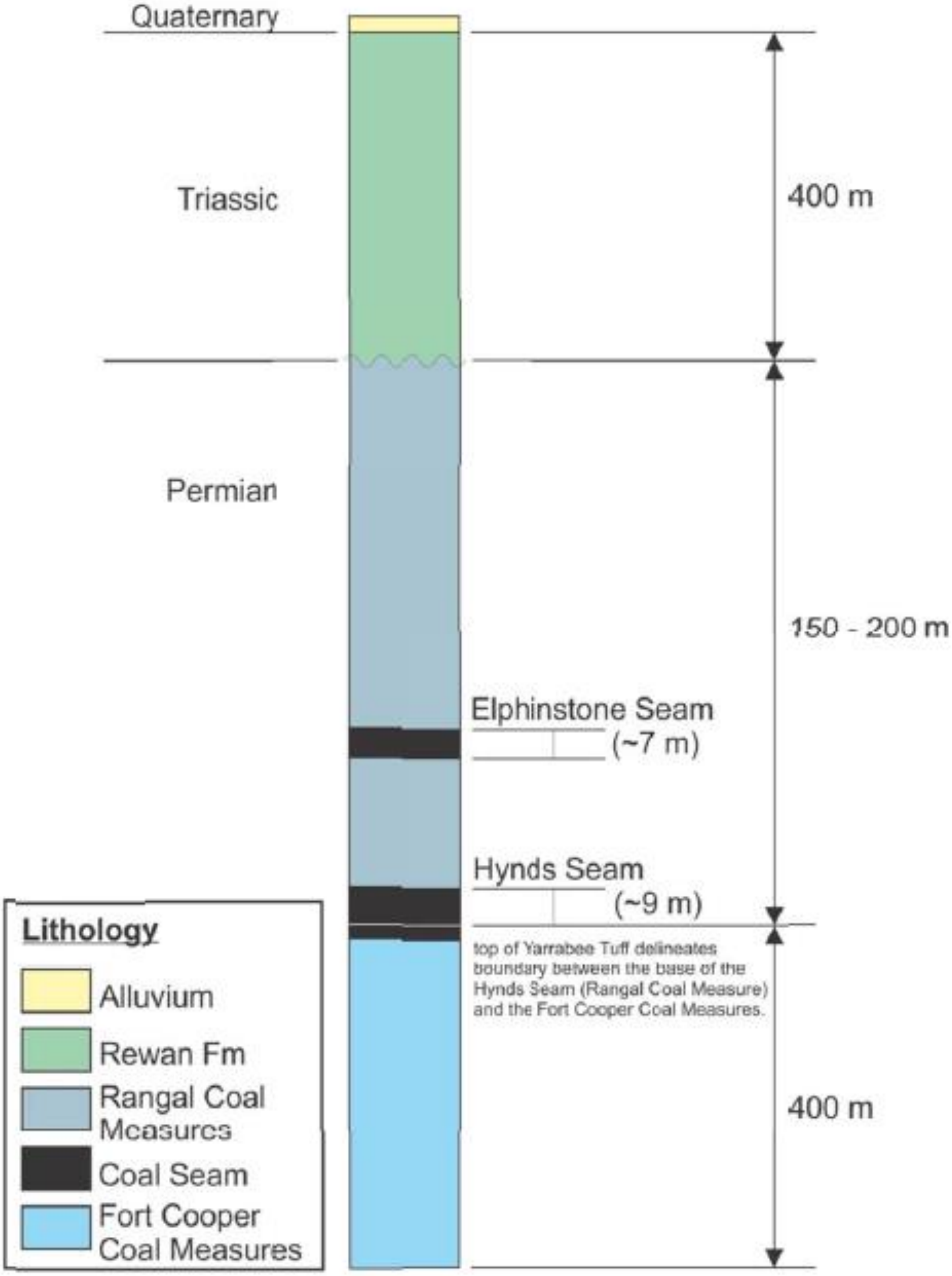


Figure 2 – Hail Creek Syncline Stratigraphic Column



The conceptual hydrogeological model developed by Douglas Partners (2015) recognises two groundwater systems at the HCM operations:

- deep aquifers within coal seams underlying Permian to Triassic Strata; and
- a shallow aquifer within pockets of the saturated Quaternary alluvium.

Strata of the underlying Permian to Triassic strata host groundwater resources, primarily within coal seams.

The Permian aquifers:

- are characterised by low permeability and storage where water is predominantly stored and transmitted via secondary porosity features such as fractures, faults, discontinuities of the rock mass, and though coal cleat;
- are confined by the lower permeability host rock matrix;
- contain poor quality (brackish) groundwater; and
- are poorly recharged due to low permeability confining strata.

Groundwater can potentially be found within the alluvium associated with surface water features such as Hail and Brumby creeks and their tributaries. These sediments within the alluviums are generally quite thin and poorly developed across the mining lease. Typically, the alluvial aquifer is characterised by:

- pockets of reasonable quality groundwater with low yields;
- discontinuous extent and shallow thickness; and
- moderate permeability and storage.

Given the above, the alluvial aquifer areas associated with the HCM lease are not considered to be a viable groundwater resource.

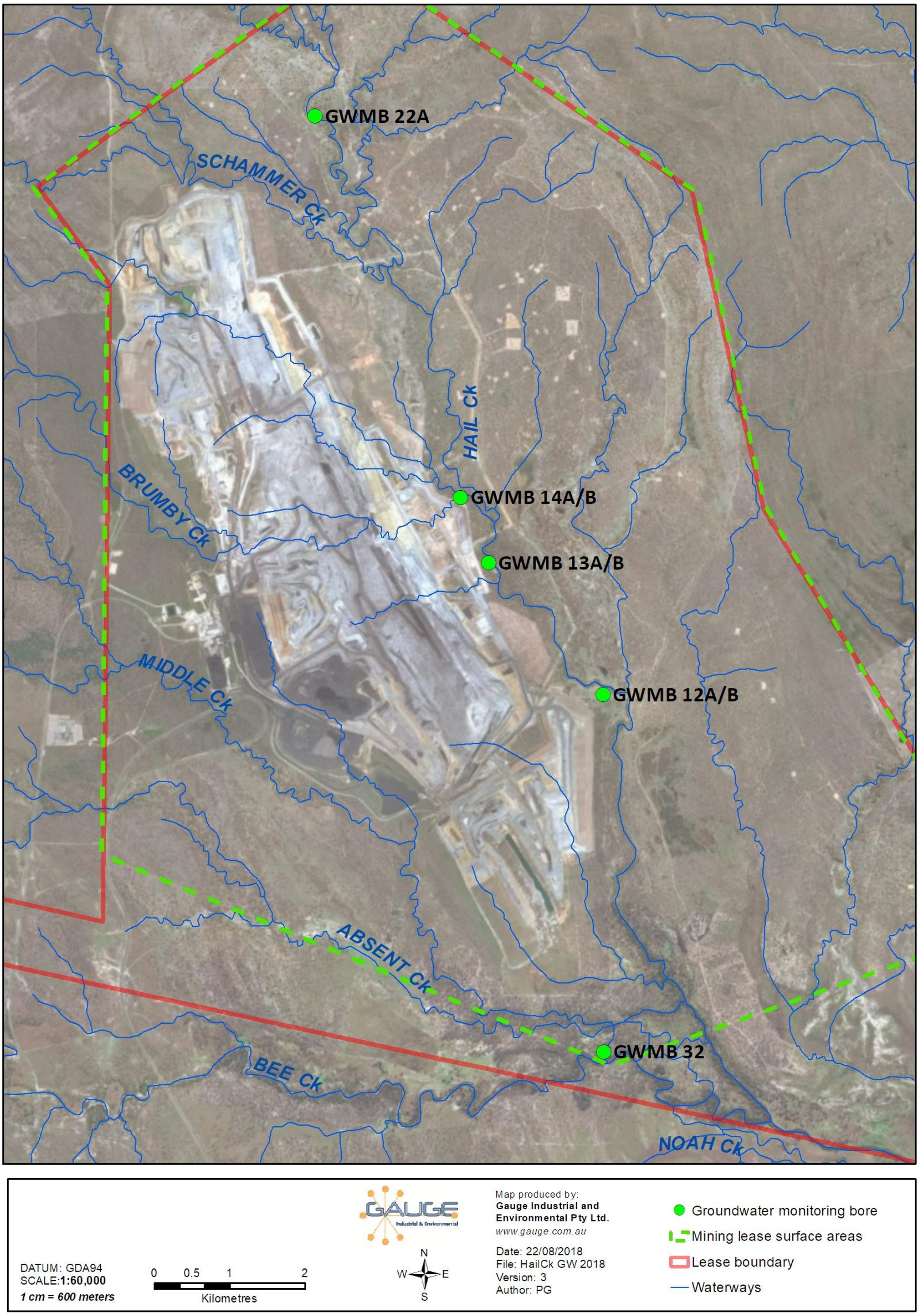
Regionally, the groundwater flow direction is towards the southeast, in line with existing surface drainage and heavily influenced by topographical features. The bulk of groundwater recharge occurs over the topographical highs of Carborough Range, Mt Gotthardt and the mountain ranges to the north and northeast past Homevale National Park.

Brumby Waterhole is a system consisting of a series of three pools on a tributary of Hail Creek believed to be maintained to some extent by groundwater seepage. Douglas Partners (2015) concluded the waterhole is 1.3m to 1.8m above the regional groundwater table, suggesting there is no regional hydraulic conductivity.

2.1 Groundwater Monitoring Network

The alluvium groundwater is monitored at five (5) bores (Figure 3). Bore GWMB 32 was constructed in 2017 to replace the collapsed bore GWMB31 listed in the mine's EA. Bore GWMB 12A was dry during the 2018/2019 monitoring period so laboratory samples were not taken, and GWMB 22A was dry in April 2020.

Figure 3 – Hail Creek Mine site plan with location of Alluvial Groundwater bores



3. GROUNDWATER LEVELS

Groundwater levels measured between 2016 and July 2020 recorded an average twelve-month drawdown between 0.42 m and 1.69m (Table 1).

In the 2019/2020 reporting year, the maximum six-month drawdown was 1.1m in GWMB32 between January and July 2020, within the proposed EA trigger of <2 metres drawdown per six-month period.

Bore GWMB12A remained dry and not recovered since April 2018.

GWMB14A and GWMB32 were dry in April 2020, and GWMB14A contained a small amount of water in July 2020.

Table 1 – Groundwater Level (mBGL)

Date	GWMB12A	GWMB13A	GWMB14A	GWMB22A	GWMB32
20/04/16	-	-	-	7.81	-
27/04/17	9.44	13.13	12.82	-	-
31/10/17	9.78	13.90	13.13	9.24	9.55
18/4/18	10.57	14.61	14.13	9.89	9.90
17/10/18	10.80 (dry)	15.29	16.39	10.62	10.45
16/01/19	10.80 (dry)	15.09	16.20	10.95	11.03
14/04/19	10.80 (dry)	15.77	15.97	11.12	11.16
09/07/19	10.80 (dry)	16.01	16.79	11.49	11.54
16/10/19	10.80 (dry)	16.3	16.79	11.70	12.10
14/01/20	10.80 (dry)	16.6	17.5	12.00	13.1
20/04/20	10.80 (dry)	16.59	17.61	DRY	DRY
21/07/20	10.80 (dry)	16.88	17.92	12.57	DRY (14.2)
Drawdown (m) since 2016/2017	**>1.36** (bore dry)	**3.75**	**3.76**	**4.76**	**4.65**
Time period (months)	39	39	51	51	33*
Average Drawdown (m) per 12 months	**0.42**	**1.15**	**0.88**	**1.12**	**1.69**
Historical maximum drawdown (m) in any 6-month period	**0.79** (Oct17-Apr18)	**0.92** (Jan19-Jul19)	**2.26** (Apr18-Oct18) Recovered to 1.84 within 12-month period	**0.73** (Apr18-Oct18)	**1.10** (Jan20-Jul20)
Max. drawdown in 2019/2020 in any 6-month period	**Dry**	**0.59** (Jul19-Jan20)	**0.82** (Oct19-Apr20)	**0.57** (Jan20-Jul20)	**1.10** (Jan20-Jul20)

* newly constructed bore (in 2017)

Figure 4 shows groundwater levels in alluvium bores generally declining since 2016, following a similar trend to Cumulative Mass Residual Rainfall (CMRR) curve for the area (Nebo and Moranbah Bureau of Meteorology (BOM) Weather Stations).

The CMRR curve is the cumulative deviation from mean monthly rainfall over time. Positive slopes on the rainfall residual curve indicate periods of above average rainfall, whereas negative slopes indicate periods of below average rainfall. The rainfall residual often closely correlates with rainfall recharge of groundwater and is useful for assessing longer-term climatic influence on groundwater levels.

Departures in groundwater levels from the curve can indicate changes in groundwater levels associated with influences outside of rainfall, such as pumping.

Monthly rainfall data dating back to 1909 shows that the area has been in a period of negative rainfall since 2013/2014 (Figure 5). The data indicates the decline in groundwater levels in these shallow alluvium bores is likely related to a decline in recharge from rainfall and related surface waters.

Figure 4 – Groundwater levels (mbgl) in comparison to Cumulative Mass Residual Rainfall

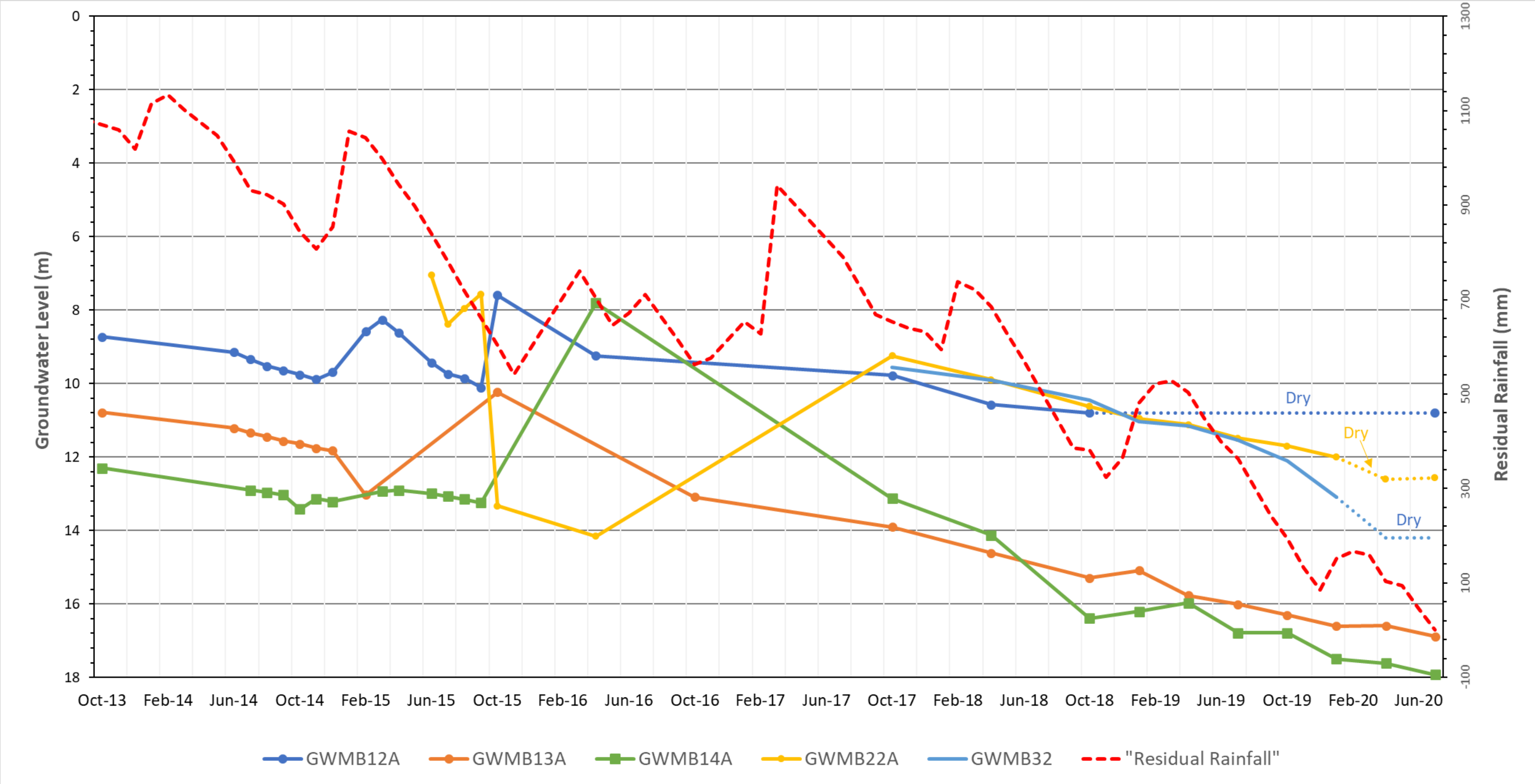
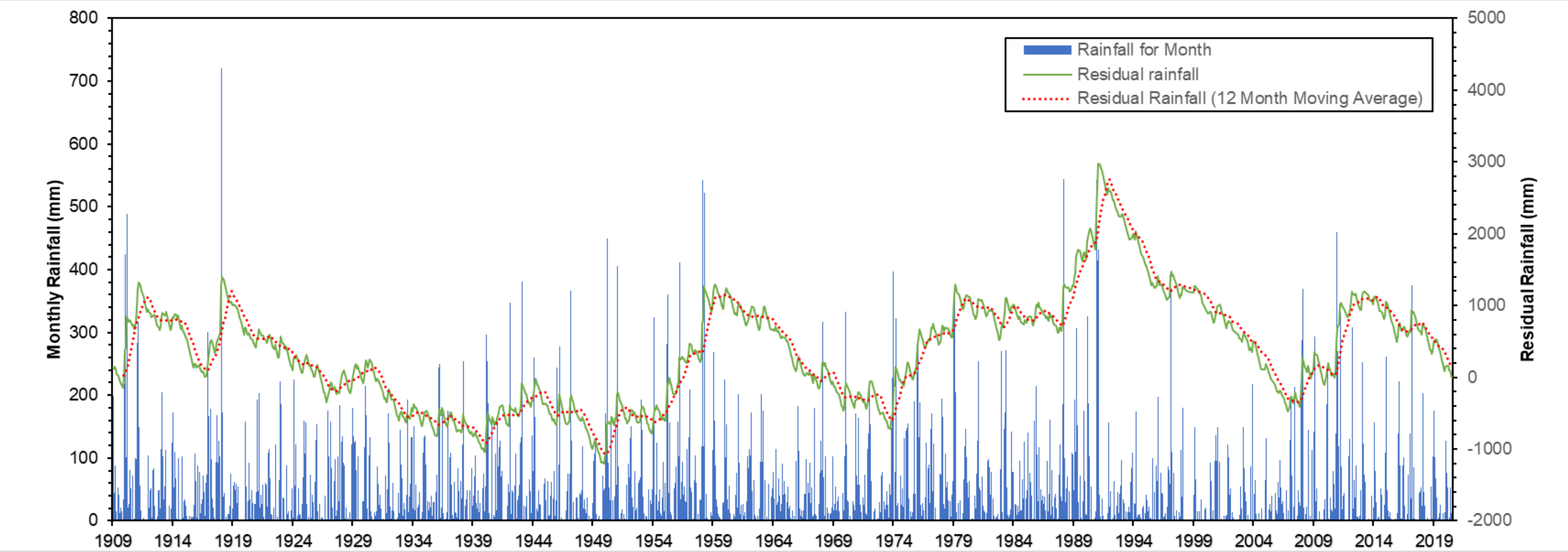


Figure 5 – Long term Monthly and Cumulative Mass Residual Rainfall at Nebo and Moranbah BOM Stations



*Nebo (33054) until Jan 2020, then Moranbah (34035) afterwards.

4. WATER QUALITY AND COMPARISON TO PROPOSED EA TRIGGERS

4.1 MONITORING AND ANALYSIS

Groundwater monitoring data was provided by Glencore Hail Creek Mine. Monitoring and sample collection were undertaken by site personnel until late 2018, and now conducted by Australian Laboratory Services (ALS). Laboratory analysis was performed by laboratories carrying NATA registration for the analytes tested. Raw data is provided in Appendix B, with test results below the Limit of Reporting (LOR) converted to the LOR value for the purposes of statistical analysis and graphing.

4.2 ANALYTES MONITORED AND TRIGGER VALUES

Table E2 of the mine's EA sets out the analytes and contaminant trigger levels to be monitored on a 6-monthly basis. HCM provided recommended trigger levels (Table 2) as required under Condition E7 for inclusion in site to the Department of Environment and Science (DES) on 30 June 2017. At this date, no confirmation has been received from the DES in regard to the acceptance of the proposed trigger values. For the purpose of this work, it has been assumed there are no objections to the proposed trigger values HCM submitted.

Table 2 – Proposed Groundwater Contaminant Trigger Levels

Parameter	Units	Trigger Levels*	Limit Type
Groundwater Level	m	>2.0	Maximum
pH	pH Units	6.5 – 9.0	Range
Electrical Conductivity	µS/cm	4200	Maximum
Total Dissolved Solids (TDS)	mg/L	2472	Maximum
Calcium (Ca)	mg/L	No Limit	Interpretative purposes only[#]
Magnesium (Mg)	mg/L	No Limit	Interpretative purposes only[#]
Sodium (Na)	mg/L	No Limit	Interpretative purposes only[#]
Potassium (K)	mg/L	No Limit	Interpretative purposes only[#]
Chloride (Cl)	mg/L	No Limit	Interpretative purposes only[#]
Sulfate (SO_4)	mg/L	No Limit	Interpretative purposes only[#]
Carbonate (CO_3)	mg/L	No Limit	Interpretative purposes only[#]
Bicarbonate (HCO_3)	mg/L	No Limit	Interpretative purposes only[#]
Phosphate (PO_4)	mg/L	1.96	Maximum
Nitrate (NO_3)	mg/L	0.46	Maximum
Dissolved Metals and Metalloids			
Iron (Fe)	µg/L	120	Maximum
Aluminium (Al)	µg/L	55	Maximum
Arsenic (As)	µg/L	13	Maximum
Mercury (Hg)	µg/L	TBA[&]	Maximum
Antimony (Sb)	µg/L	TBA[&]	TBA
Total Petroleum Hydrocarbons (TPH)			
TPH C6 – C9	µg/L	TBA[&]	Maximum
TPH C10 – C36	µg/L	TBA[&]	Maximum

* Interim trigger levels, final to be provided as per EA Condition E7

[#] The measurement of cations and anions are used to interpret the groundwater chemistry and identify the groundwater source e.g. by using piper diagrams

[&] These analytes have been proposed to be excluded – all dissolved data to date has been below the laboratory level of detection

4.3 Results

Groundwater quality data dating back to 2014 was plotted against proposed EA trigger values to determine if the quality remains within those limits (Appendix A, Figure 6 to Figure 27). Bore GWMB12A remained dry (since April 2018), and GWMB14A was dry in April 2020, and contained insufficient water to sample in July 2020.

4.3.1 pH

The pH of all bores was neutral and remained within the EA trigger range of pH 6.5 – 9.0 and the 2019/2020 data remained within the historical range since 2014 (Figure 6).

4.3.2 Salinity and Major Ions

Salinity, measured as Electrical Conductivity (EC) and Total Dissolved Solids (TDS), mostly remained below the proposed EA triggers of 4,200 µS/cm and 2,472 mg/L respectively (Figure 8 and Figure 10).

The exception was GWMB14A which has gradually increased in salinity since 2014 from approximately 4,000 µS/cm to 6,000 µS/cm in 2020; above the proposed EC trigger (4,200 µS/cm) and similar to the ANZECC stock watering guideline (approximately 5,970 µS/cm). TDS followed a similar trend, increasing from approximately 2,500 mg/L in 2014 to a maximum of 3,980 mg/L in January 2020; above the proposed EC trigger (2,472 mg/L) and nearing the ANZECC stock watering guideline (4,000 mg/L). All other bores remained below the EC and TDS ANZECC stock watering guideline for beef cattle.

Cations and anions contributing to salinity generally remained steady or slightly increased between August 2019 and July 2020 (Figure 11 and Figure 18). Magnesium, chloride, calcium and sulfates were the main ions contributing to the increase in salinity in GWMB14A, whilst sodium, potassium and bicarbonate concentrations decreased. As water levels in GWMB14A had declined since 2014, in correlation with the declining residual rainfall, some concentration of salts may have occurred. The increase in concentration is expected to occur across all ions, however, in this case some ions decreased in concentration, signifying a more complex process within the change in salinity.

4.3.3 Nutrients

Phosphate, calculated from the filterable reactive phosphate results using molecular mass ratios, were well below the proposed trigger value (1.96 mg/L) in all bores, ranging between 0 and 1 mg/L (Figure 19).

Nitrates have been below the proposed trigger (0.46 mg/L) since 2015, except for the occasional outlier which did not persist into subsequent testing (Figure 20).

Nutrients generally do not appear to be enriched above proposed trigger values in the alluvium bores.

4.3.4 Metals

Aluminium remains below the proposed trigger value of 55 µg/L, with no increase over time (Figure 21).

Antimony was added to the monitoring suite when the EA was amended in October 2016, and has remained below detection limits in 2019/2020 (Figure 22). There is no proposed trigger value or ANZECC (2000) guideline for this analyte.

Arsenic has remained relatively steady in all alluvium bores over the monitoring period, ranging from <1 to 3 µg/L, and well below the proposed trigger value (13 µg/L) (Figure 23).

Iron was below the proposed trigger (120 µg/L) in all bores except a single reading of 720 µg/L for GWMB22 in January 2020 and bore GWMB13A which recorded 25 – 940 µg/L (Figure 24). In GWMB13A this was lower than the previous peak of 1,930 µg/L recorded in July 2019. There has recently been high variability in this bore, with levels below detection (<50 µg/L) in January, April and October 2019, similar to historical concentrations. Similar variability was seen in bore GWMB14A back in 2016 which has since settled to below detection limits. The results suggest sampling or analysis variability related to iron.

Mercury was below the laboratory detection limit for all samples in 2019/2020 (Figure 25). There is no proposed trigger value or ANZECC (2000) guidelines for this analyte.

Metals were below the proposed trigger values, with iron detected above the proposed trigger for iron, likely attributed to sampling or analysis variability.

4.3.5 Petroleum Hydrocarbons

Total Petroleum Hydrocarbons (TPH) in C6 – C9 fraction were below detection for all samples (Figure 26). TPH analysis of the C10-C36 fraction included Silica Gel Clean-up which removes natural hydrocarbons, so that only petroleum derived hydrocarbons are recorded. All results were below detection (<50 µg/L) except a single detection in bore GWMB32 in January 2020, when 1,800 µg/L was recorded (Figure 27). The sample was taken when water available in the bore was very low and noted on the sampling field sheet as cloudy and thick brown in colour/texture, and required bailing to obtain a sample. There was insufficient water to confirm the result during subsequent sampling events in April and July. This was the first detection of C10-C36 TPHs in bore GWMB32, and is possibly a result of sampling a near dry bore. Continued monitoring is recommended to determine if detection persists when water returns to the bore.

5. CONCLUSIONS AND RECOMMENDATIONS

Groundwater levels in the alluvium bores have declined since 2013, correlating with the decline in residual rainfall that recharges the alluvium aquifer in the area. Between 2016 and 2020 the average 12-month drawdown ranged between 0.42 m and 1.69 m. In the 2019/2020 reporting year, the maximum 6-month drawdown was 1.1 m in GWMB32, which is within the proposed EA trigger of <2 metres drawdown per six-month period.

Water quality was generally within acceptable concentrations and proposed EA trigger values. Some analytes, namely salinity (EC and TDS) in GWMB14A and dissolved iron in GWMB13A, were above proposed triggers.

Salinity in bore GWMB14A has gradually increased since 2014 and is now similar to the ANZECC stock watering guideline. Iron in GWMB13A shows high variability which appears more related to sampling variability rather than a change in the aquifer, as October 2019 results were below the limit of detection (similar to historical concentrations), and the 2020 results were below the peak concentration recorded in July 2019.

Total Petroleum Hydrocarbons were detected in Bore GWMB32 in January 2020; however, the bore was near dry and not able to be sampled subsequently to confirm the result.

It is recommended that monitoring continues for levels and water quality according to the mine's EA conditions.

6. REFERENCES

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Rio Tinto (2018). Hail Creek Mine. *Annual Alluvial Groundwater Monitoring Report*. Rio Tinto Coal Australia. 25th August 2018.

APPENDIX A – WATER QUALITY PLOTS

Figure 6 – pH (Laboratory)

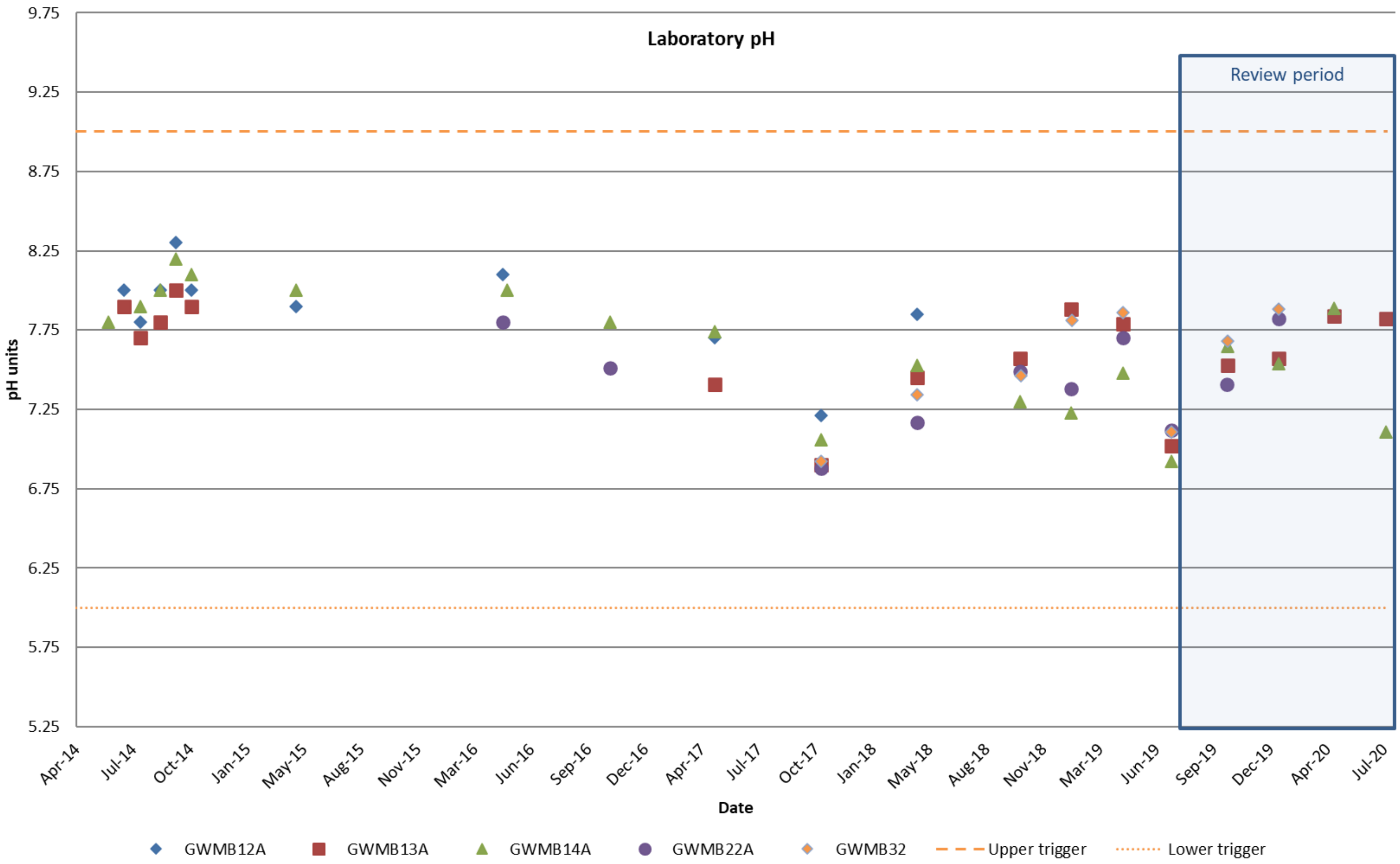


Figure 7 – pH (Field)

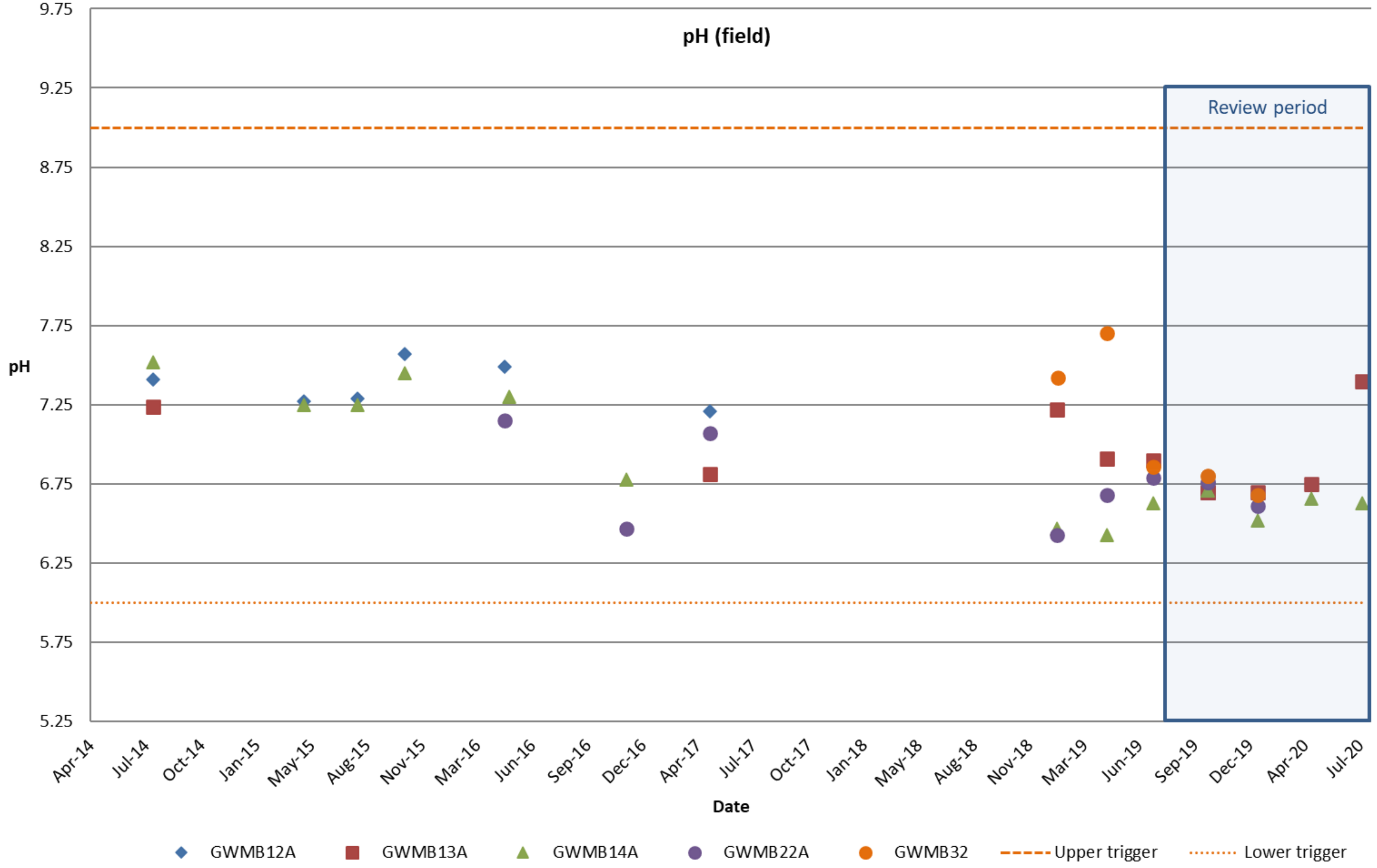


Figure 8 – Electrical Conductivity (Laboratory)

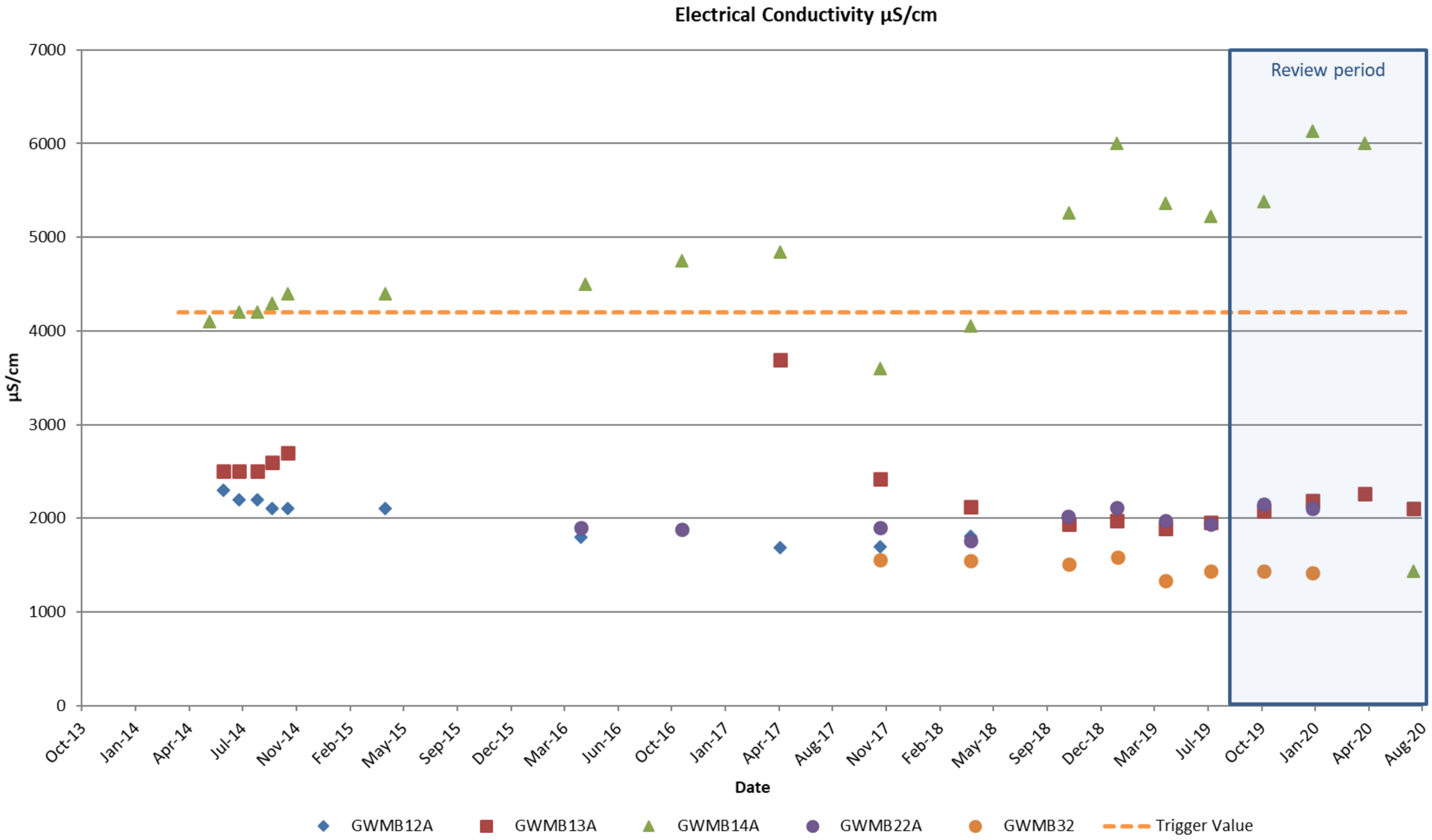


Figure 9 – Electrical Conductivity (Field)

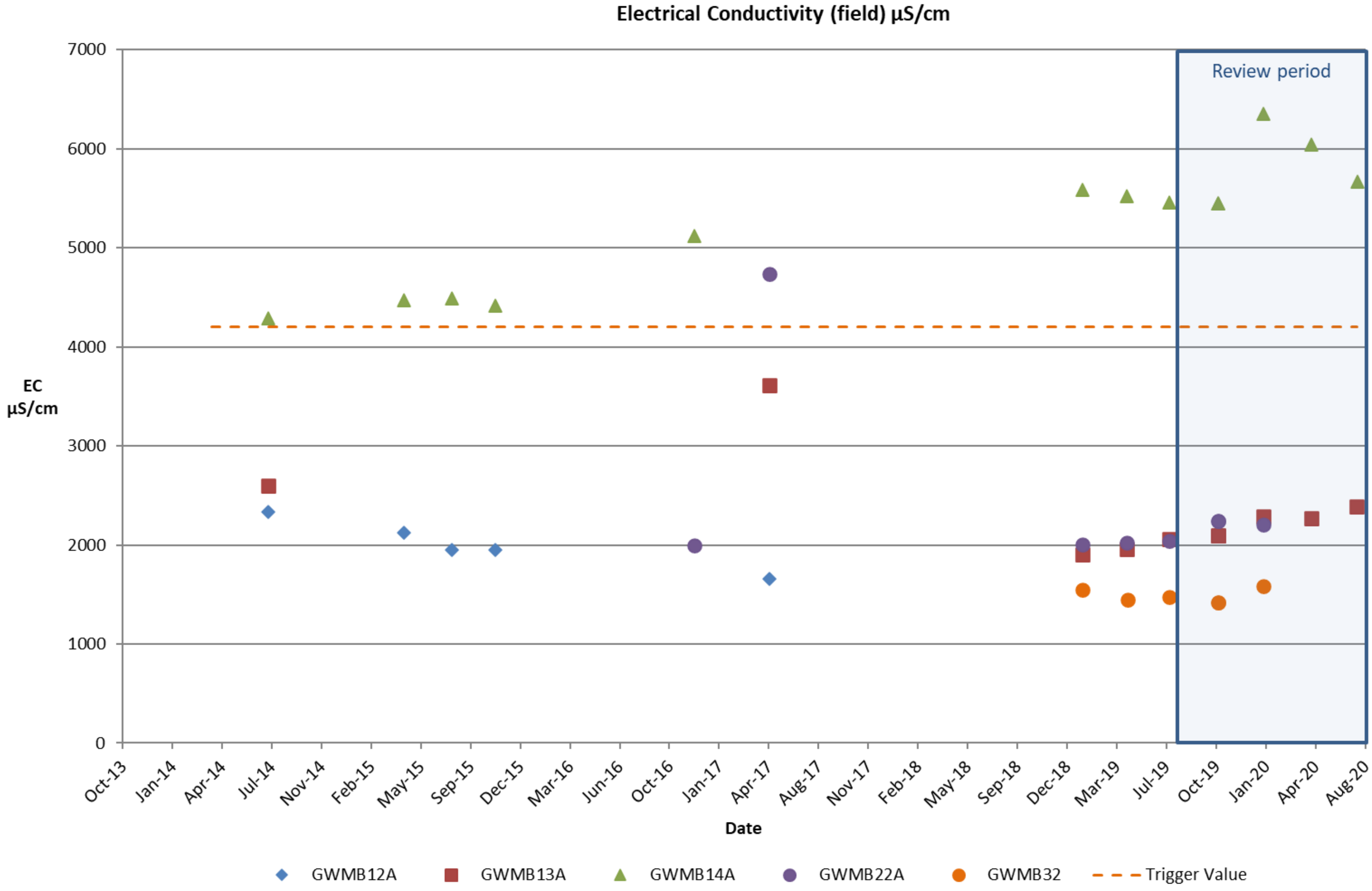


Figure 10 – Total Dissolved Solids

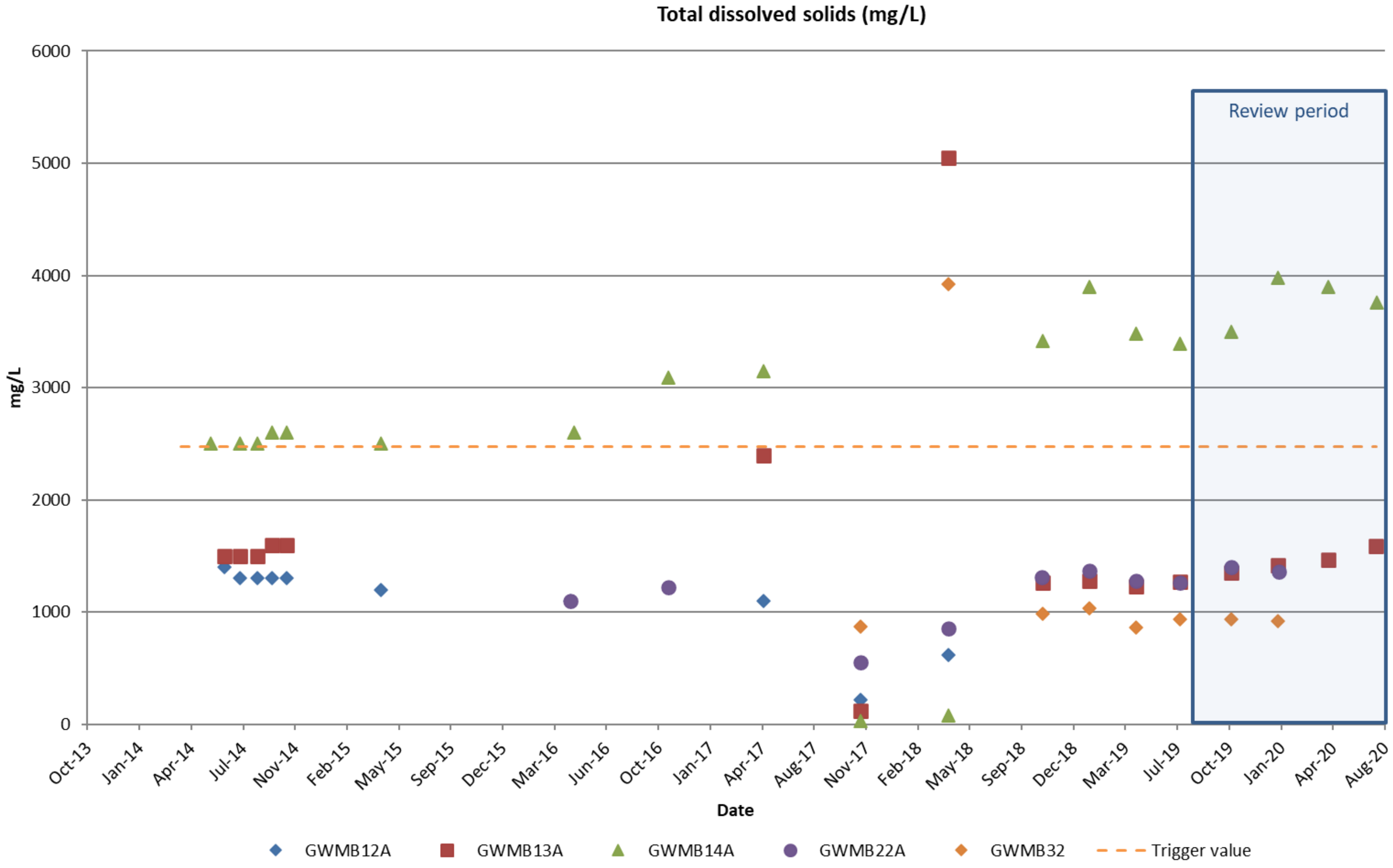


Figure 11 – Carbonate Alkalinity

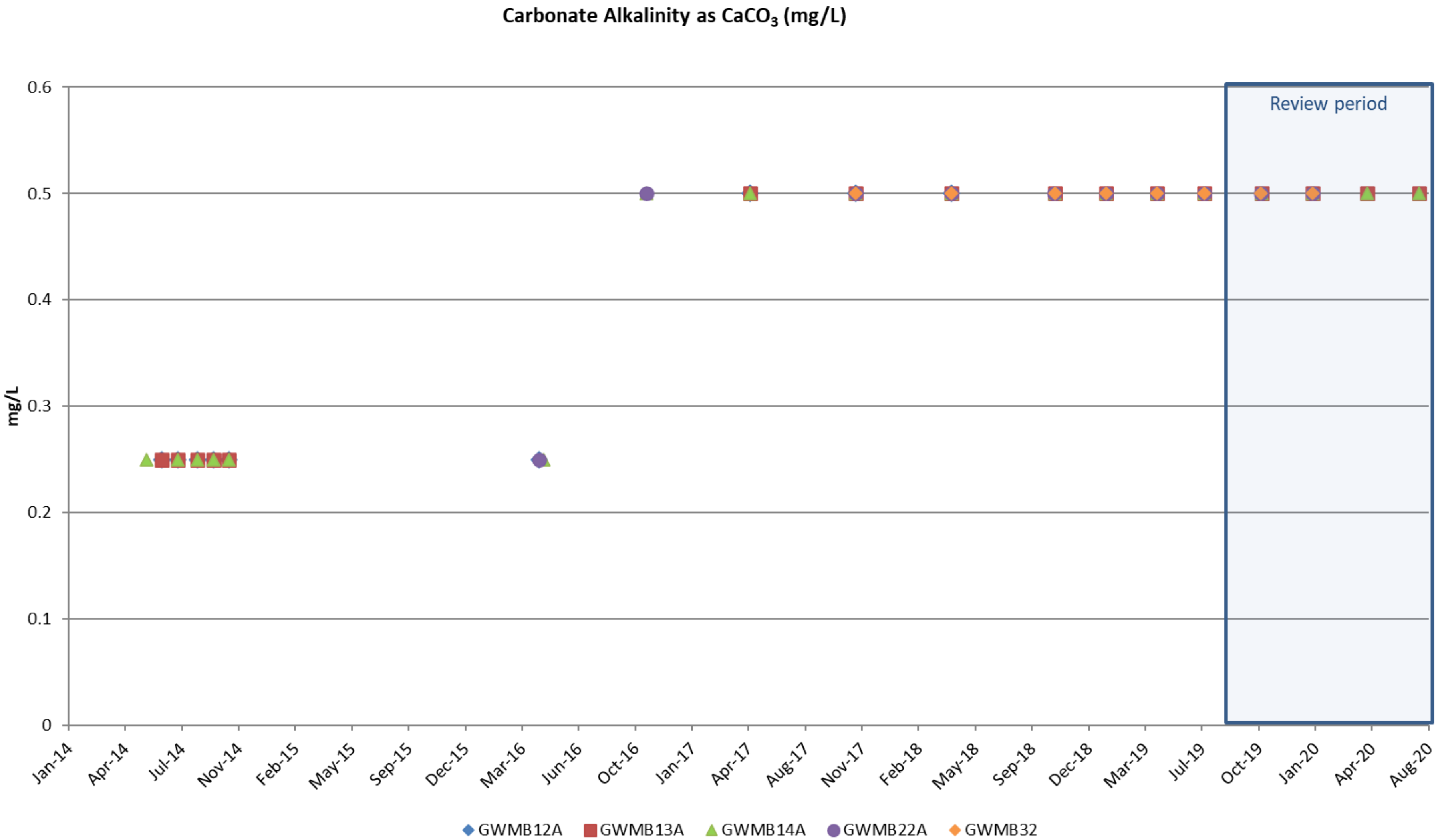


Figure 12 – Bicarbonate Alkalinity

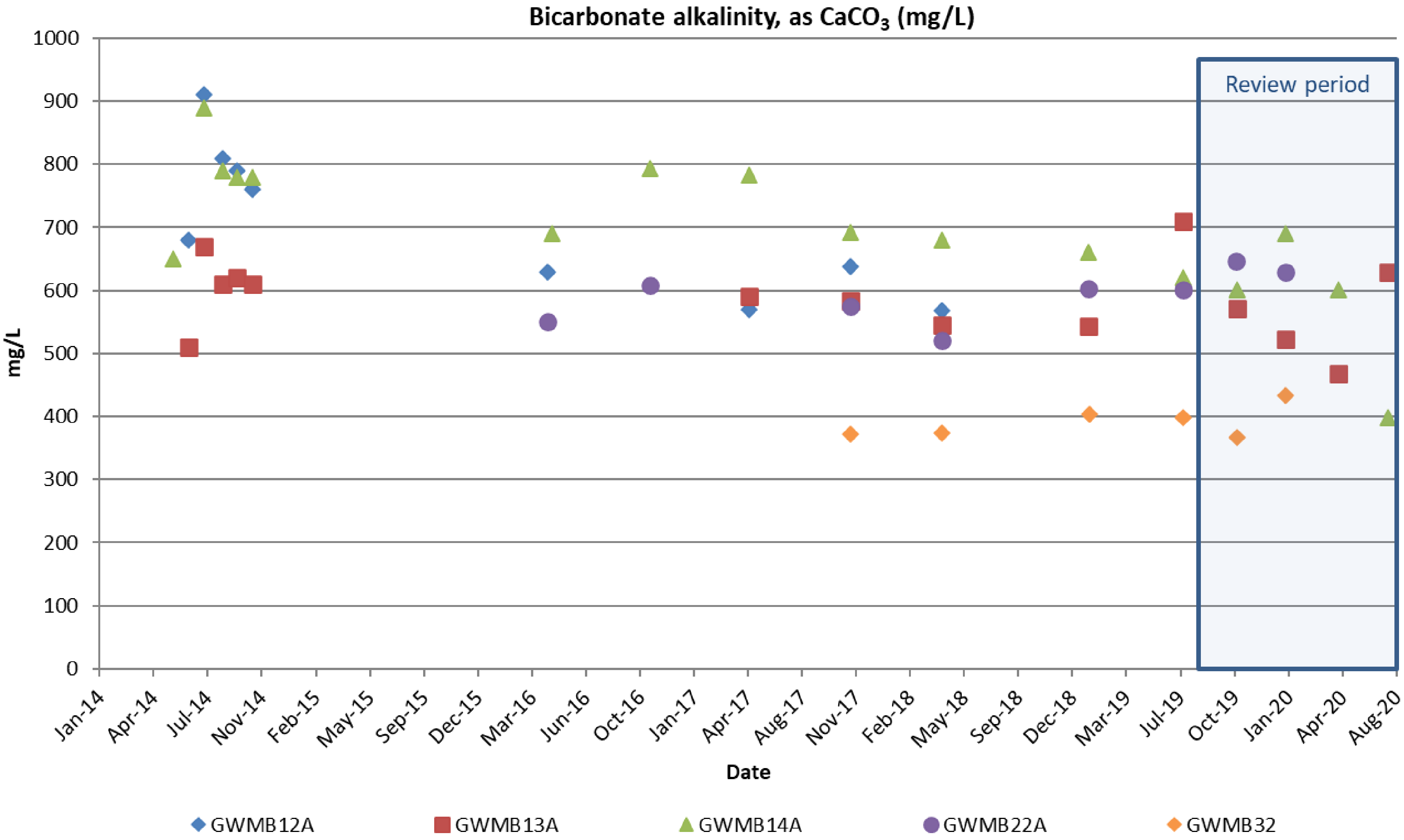


Figure 13 – Sulfate

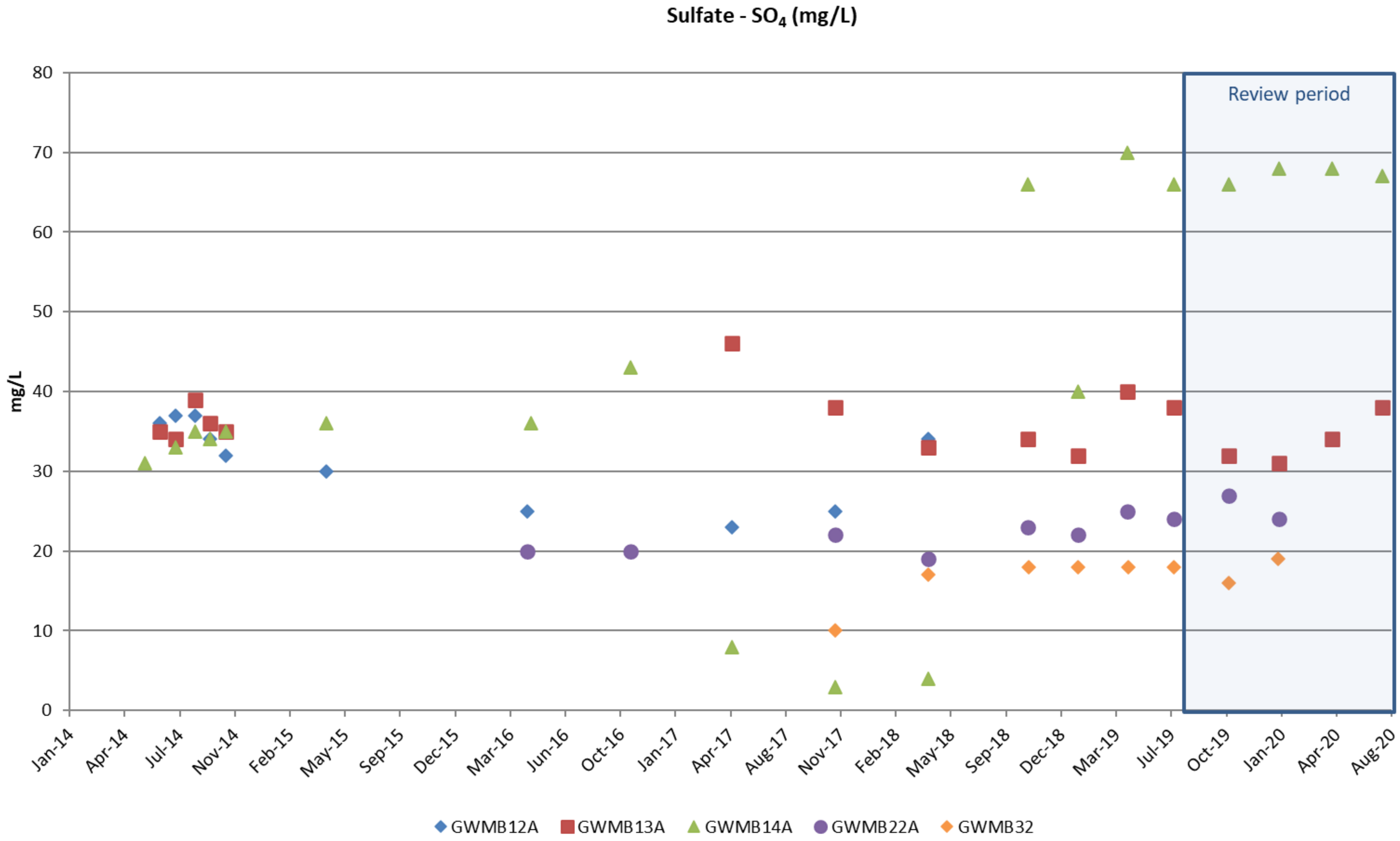


Figure 14 – Calcium

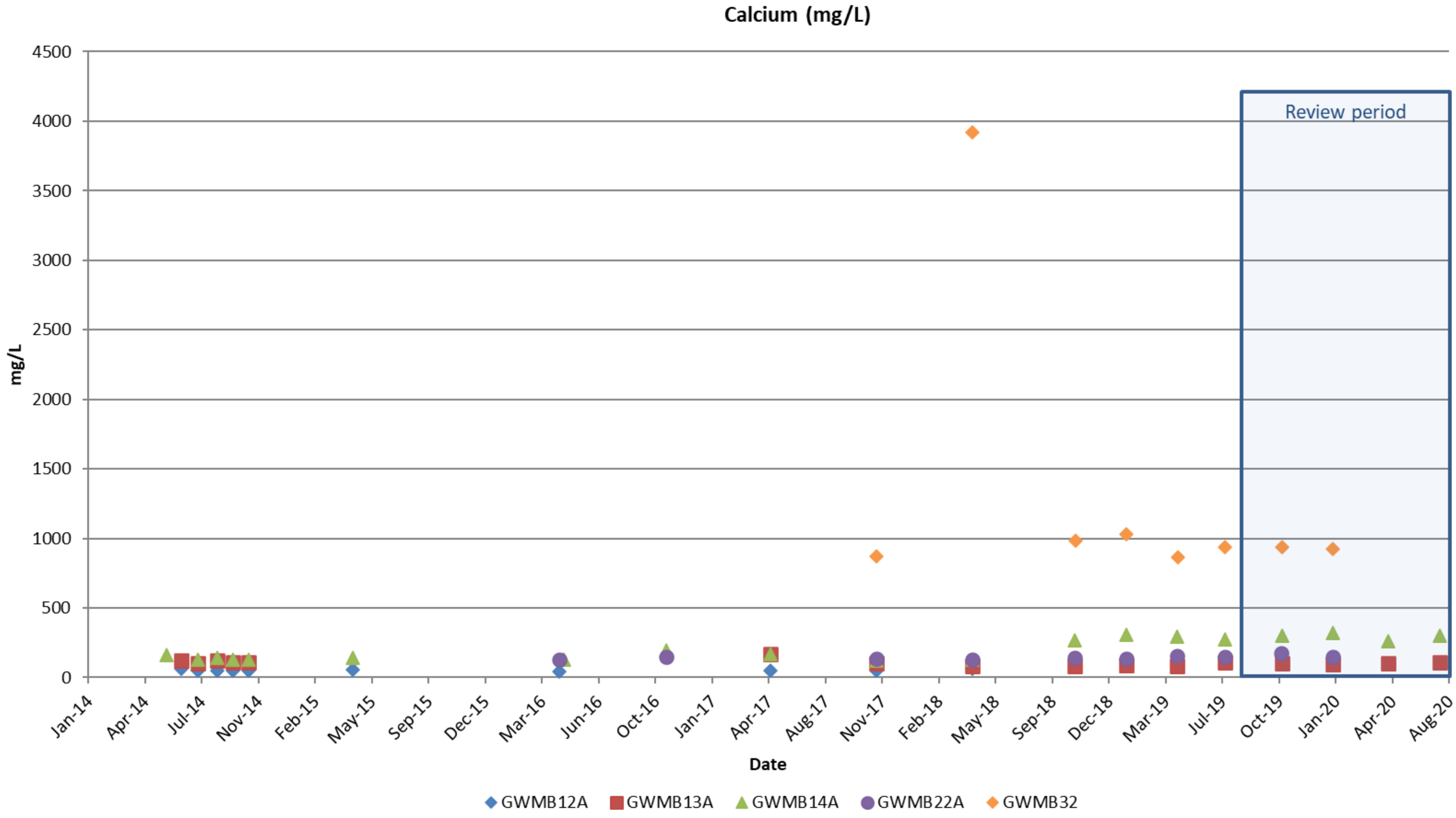


Figure 15 – Magnesium

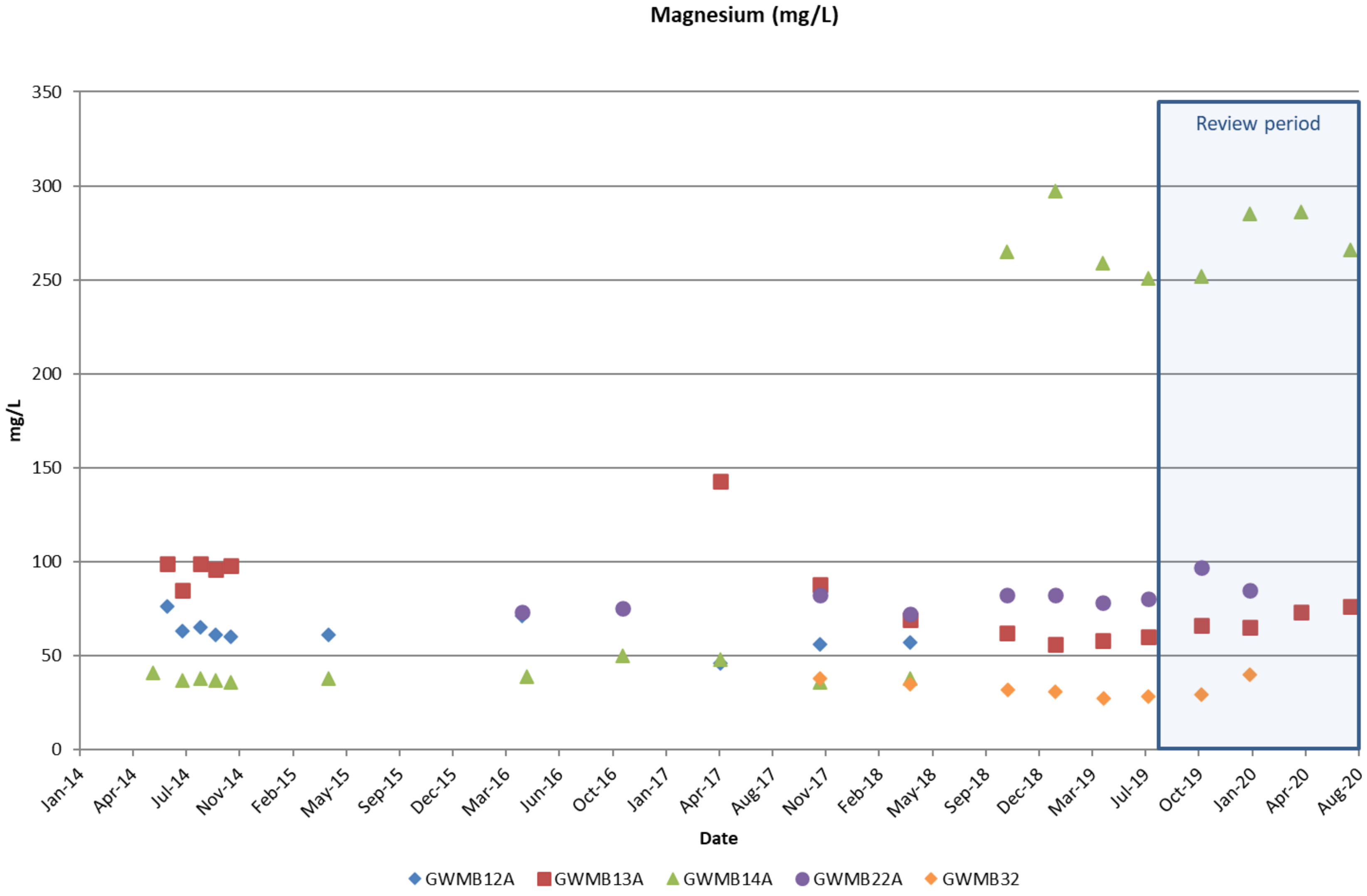


Figure 16 – Chloride

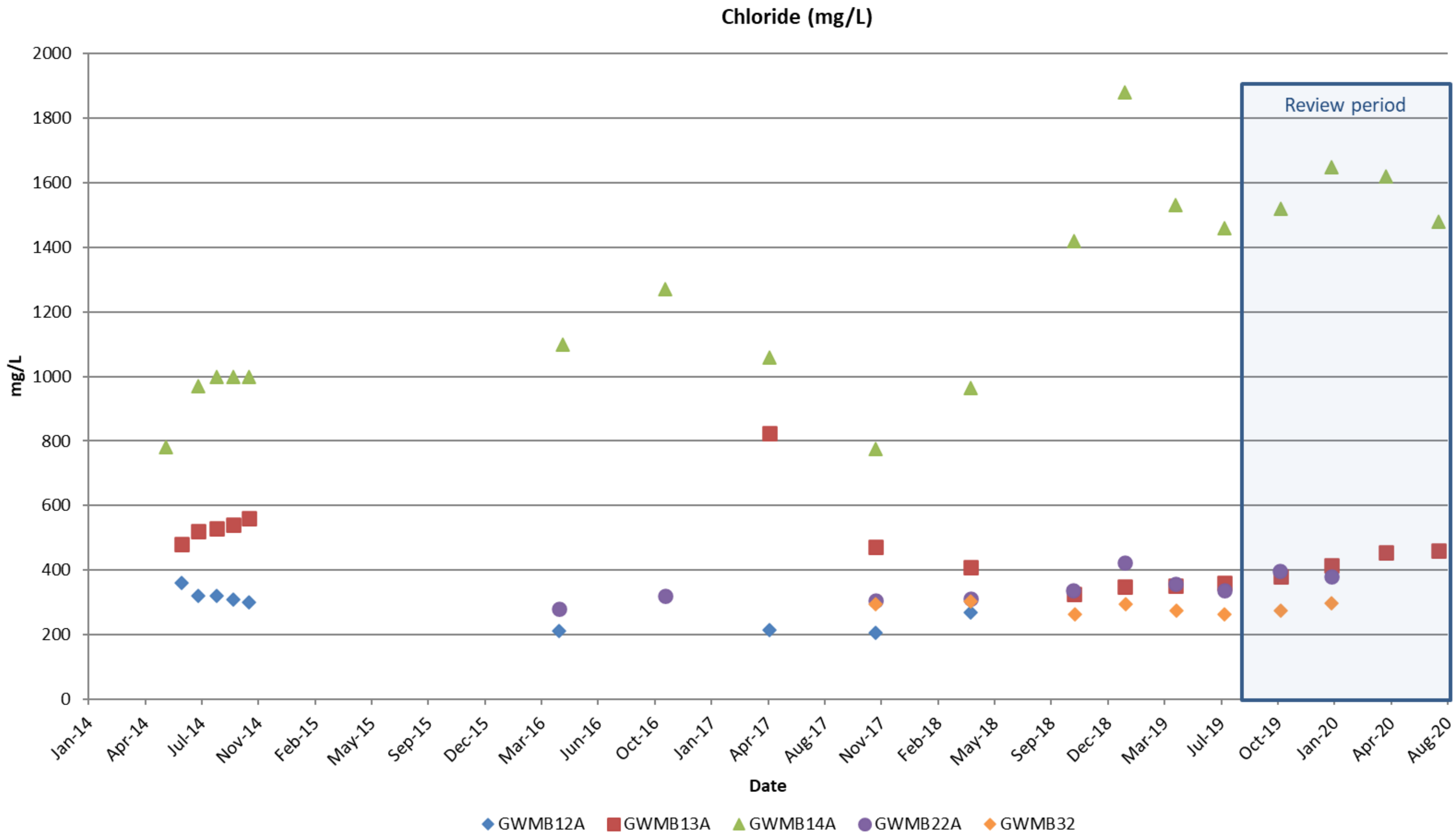


Figure 17 – Sodium

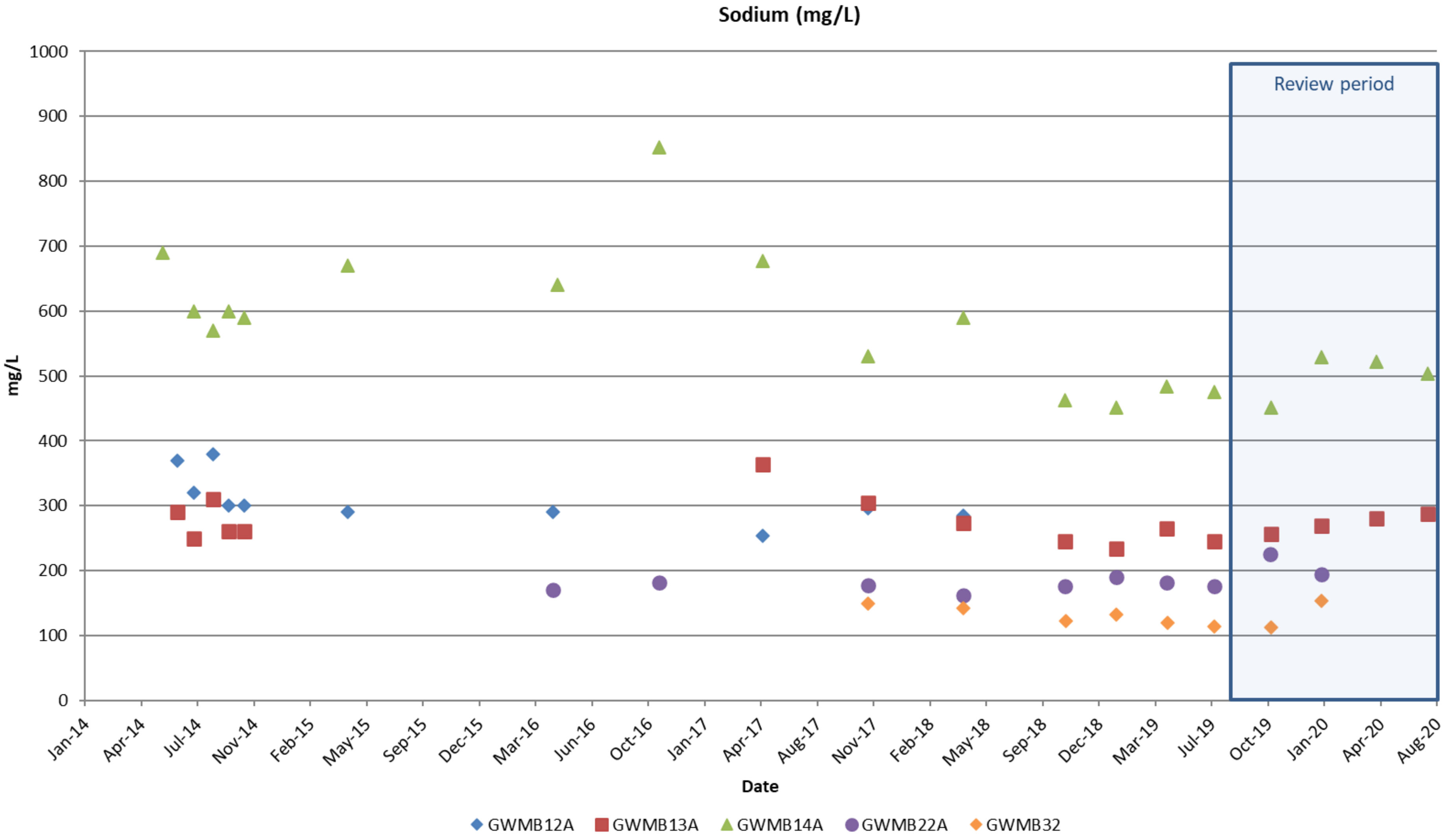


Figure 18 – Potassium

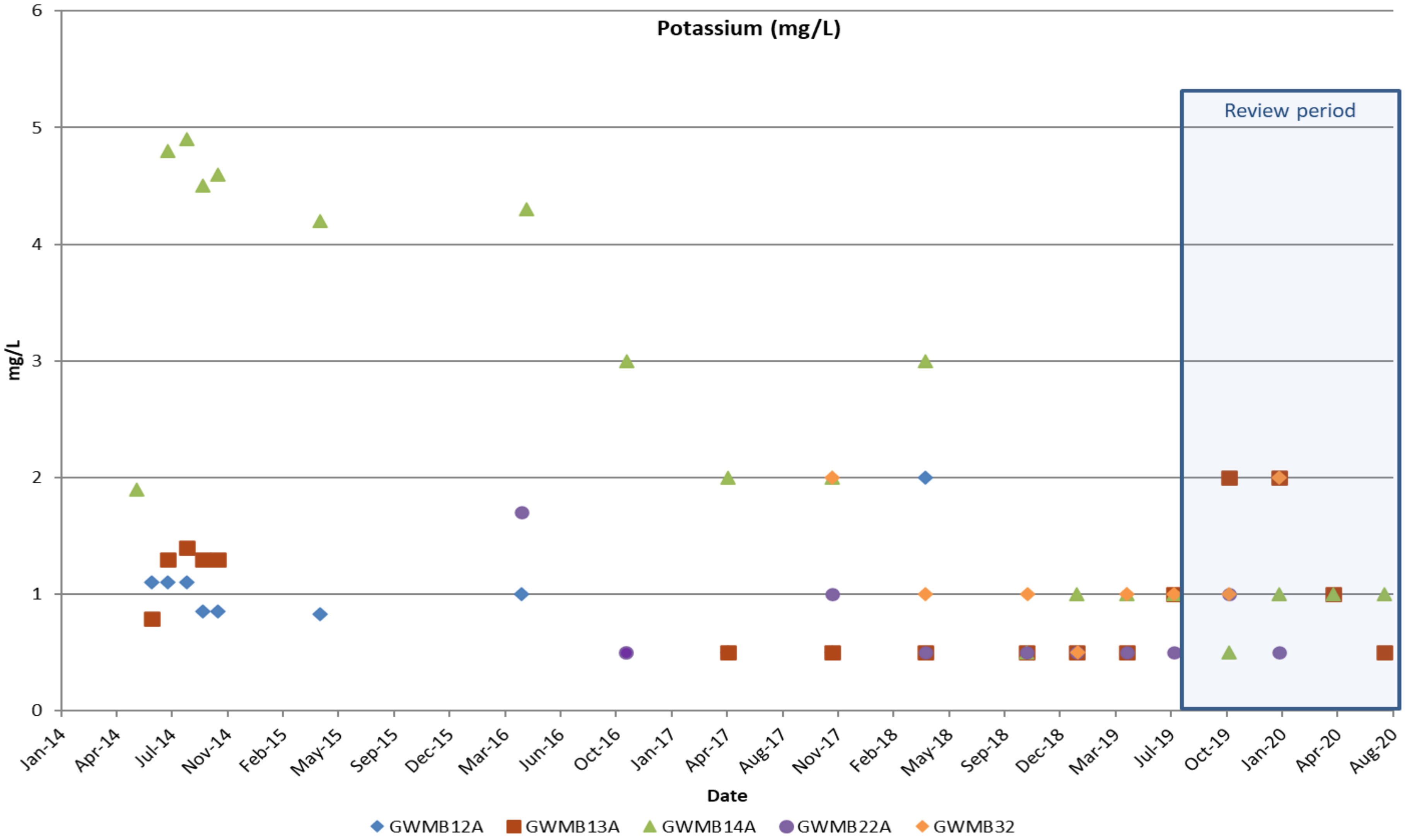


Figure 19 – Phosphate

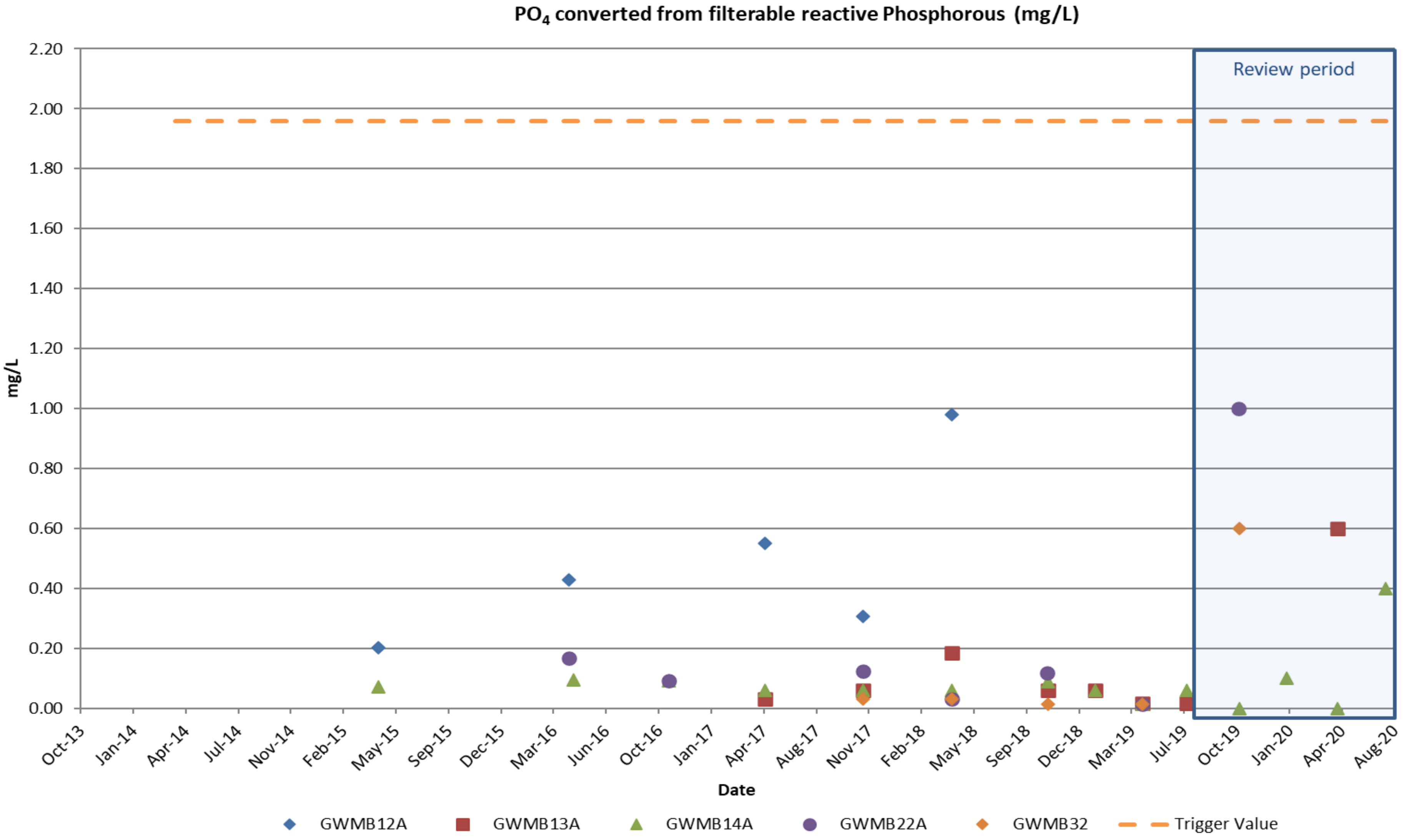


Figure 20 – Nitrate

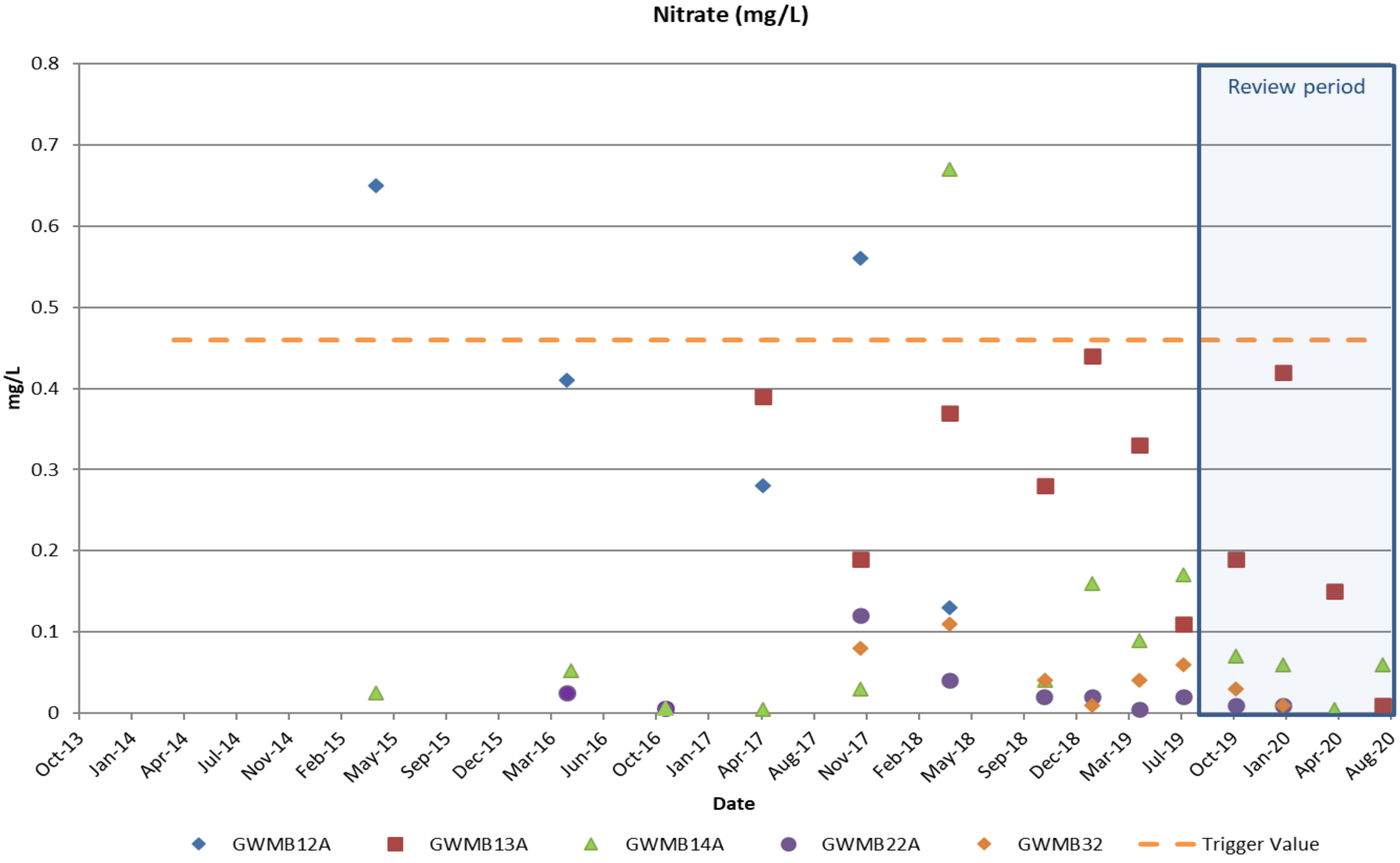


Figure 21 – Aluminium (dissolved)

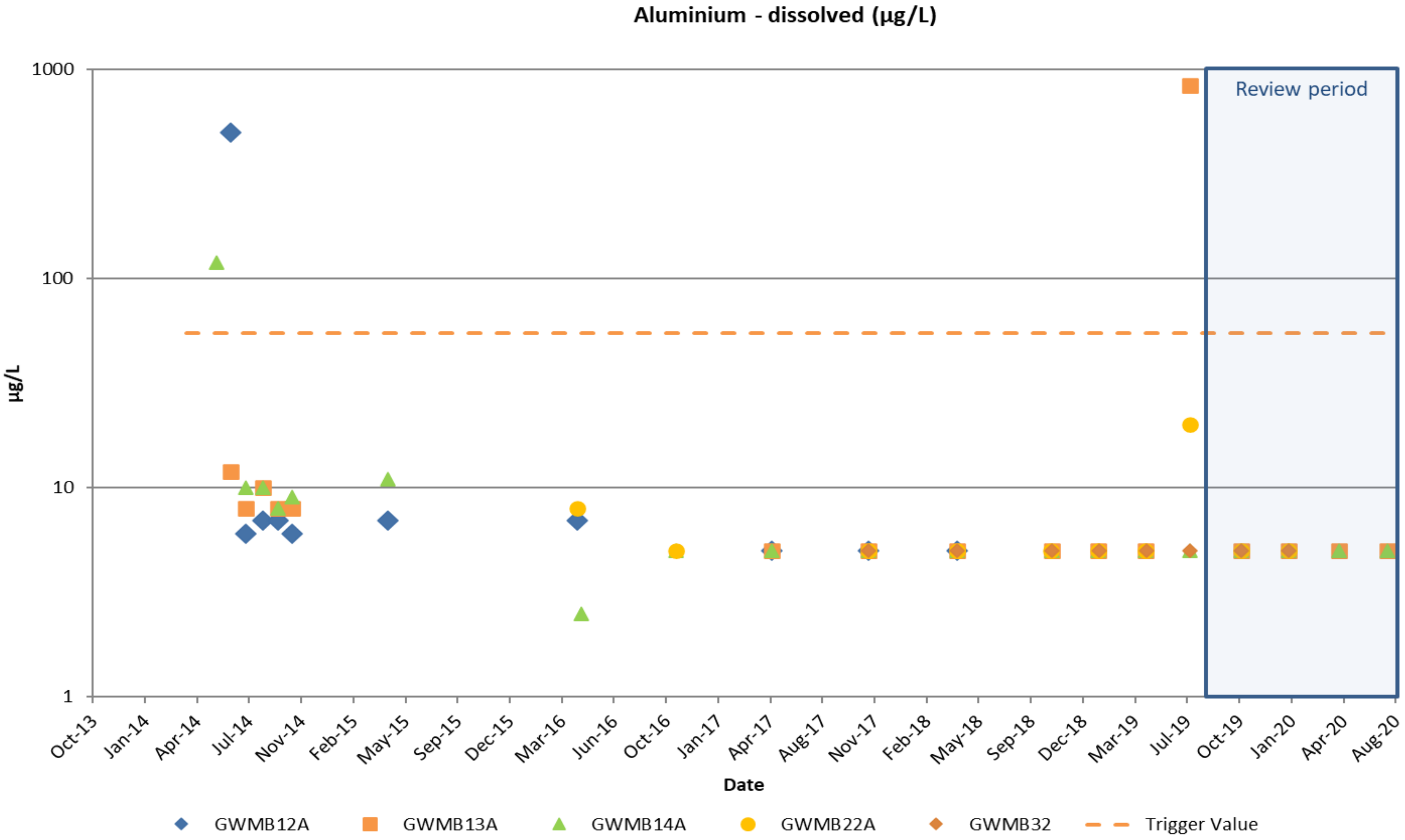


Figure 22 – Antimony (dissolved)

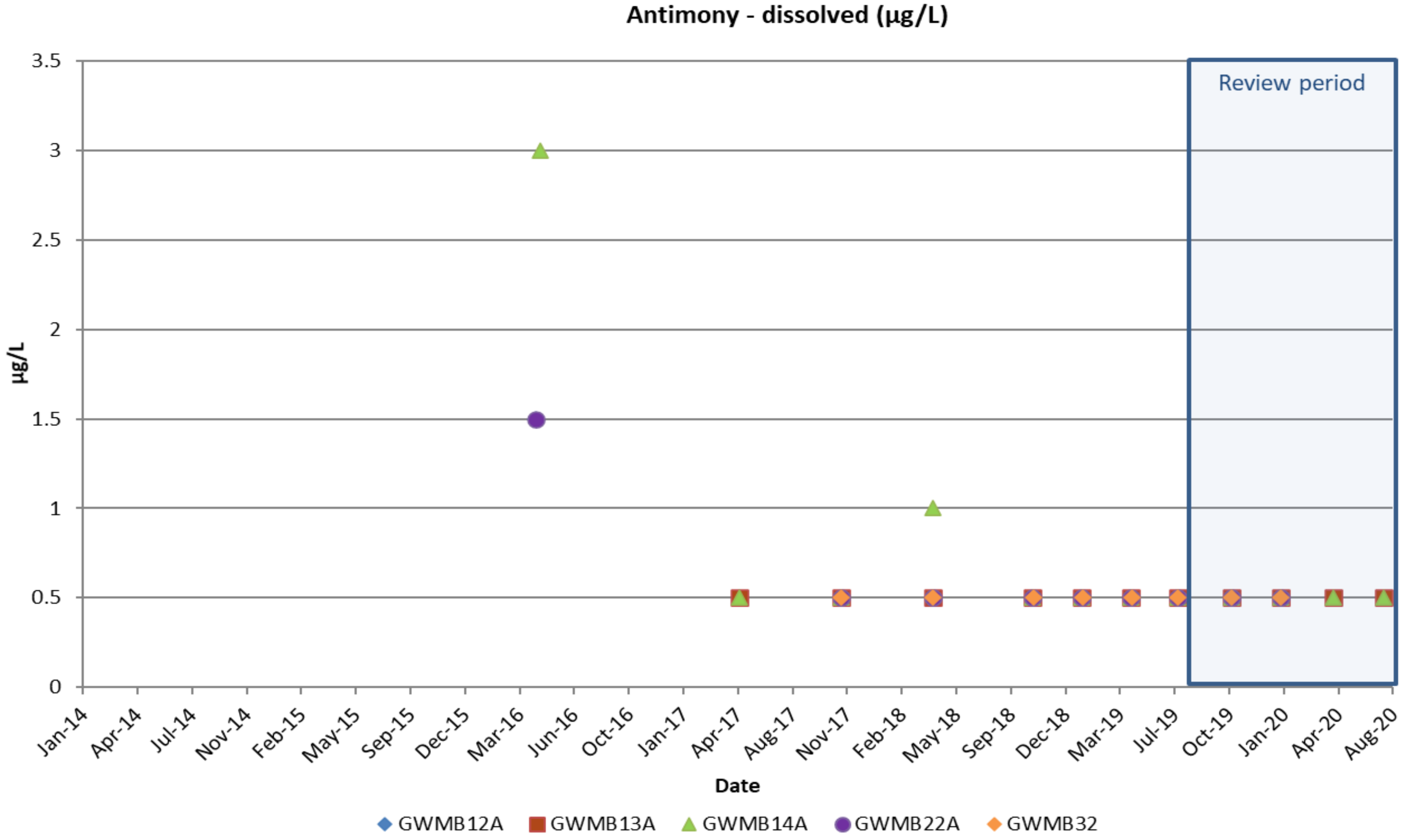


Figure 23 – Arsenic (dissolved)

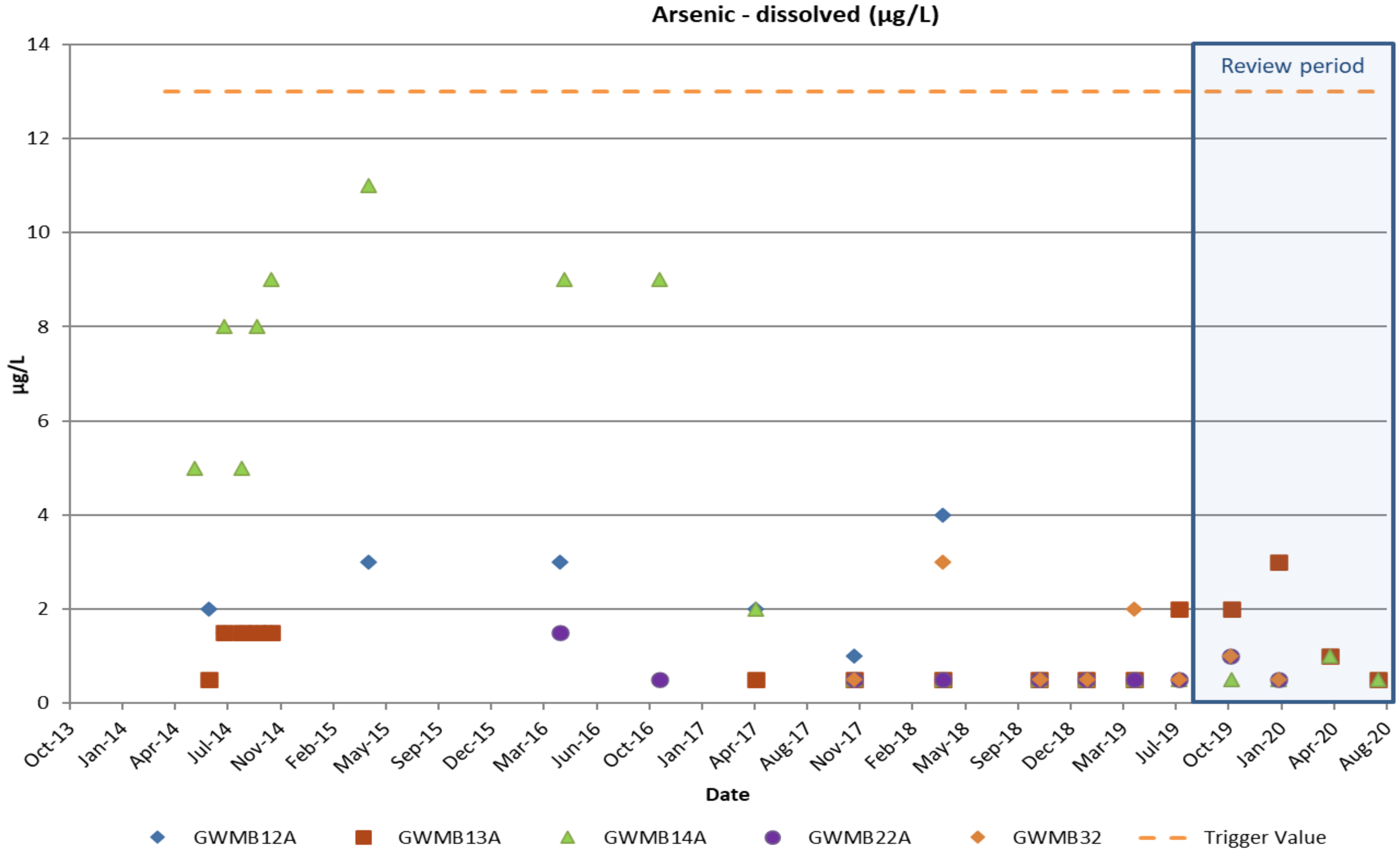


Figure 24 – Iron (dissolved)

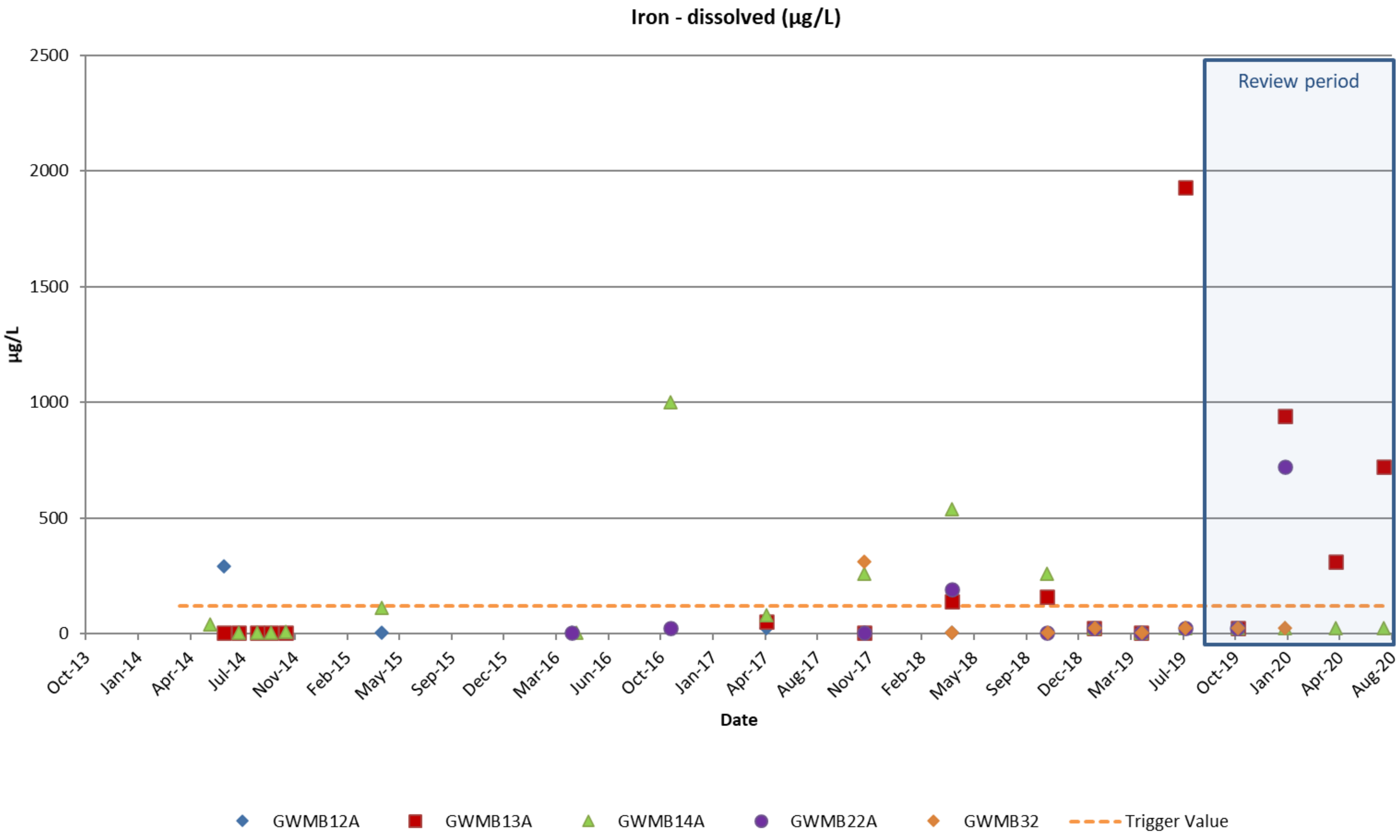


Figure 25 – Mercury (dissolved)

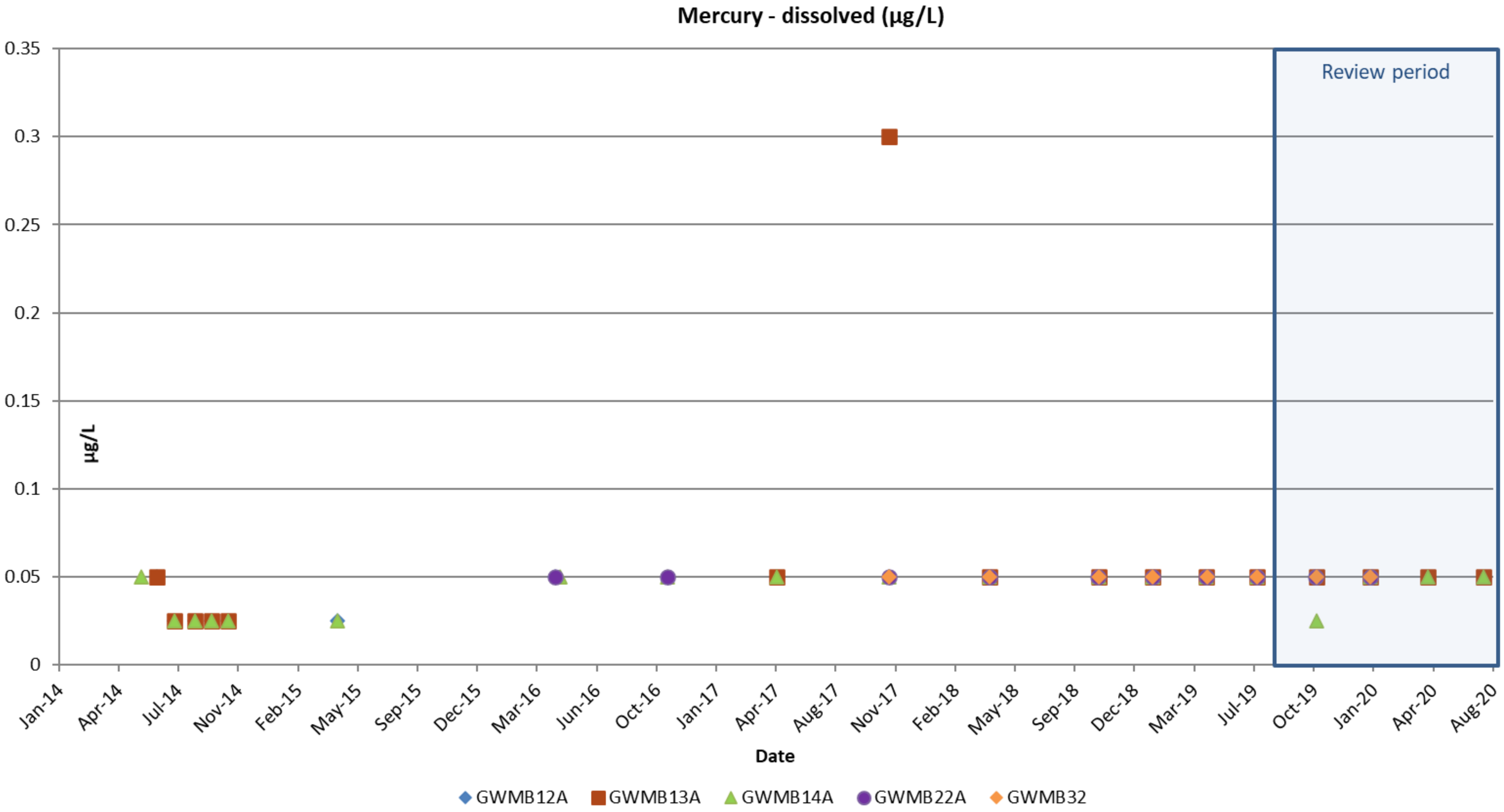


Figure 26 – Total Petroleum Hydrocarbons (C6 – C9)

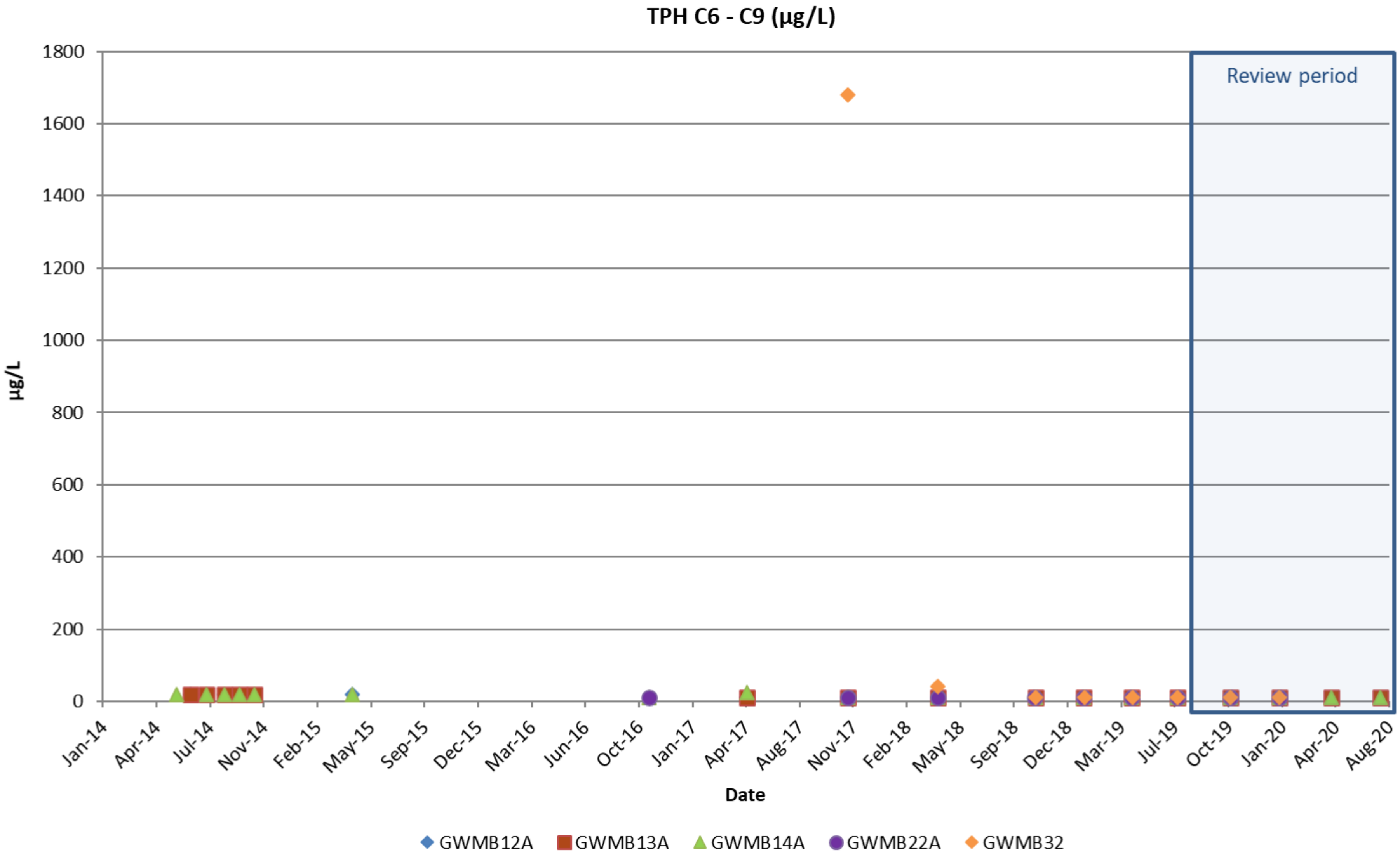
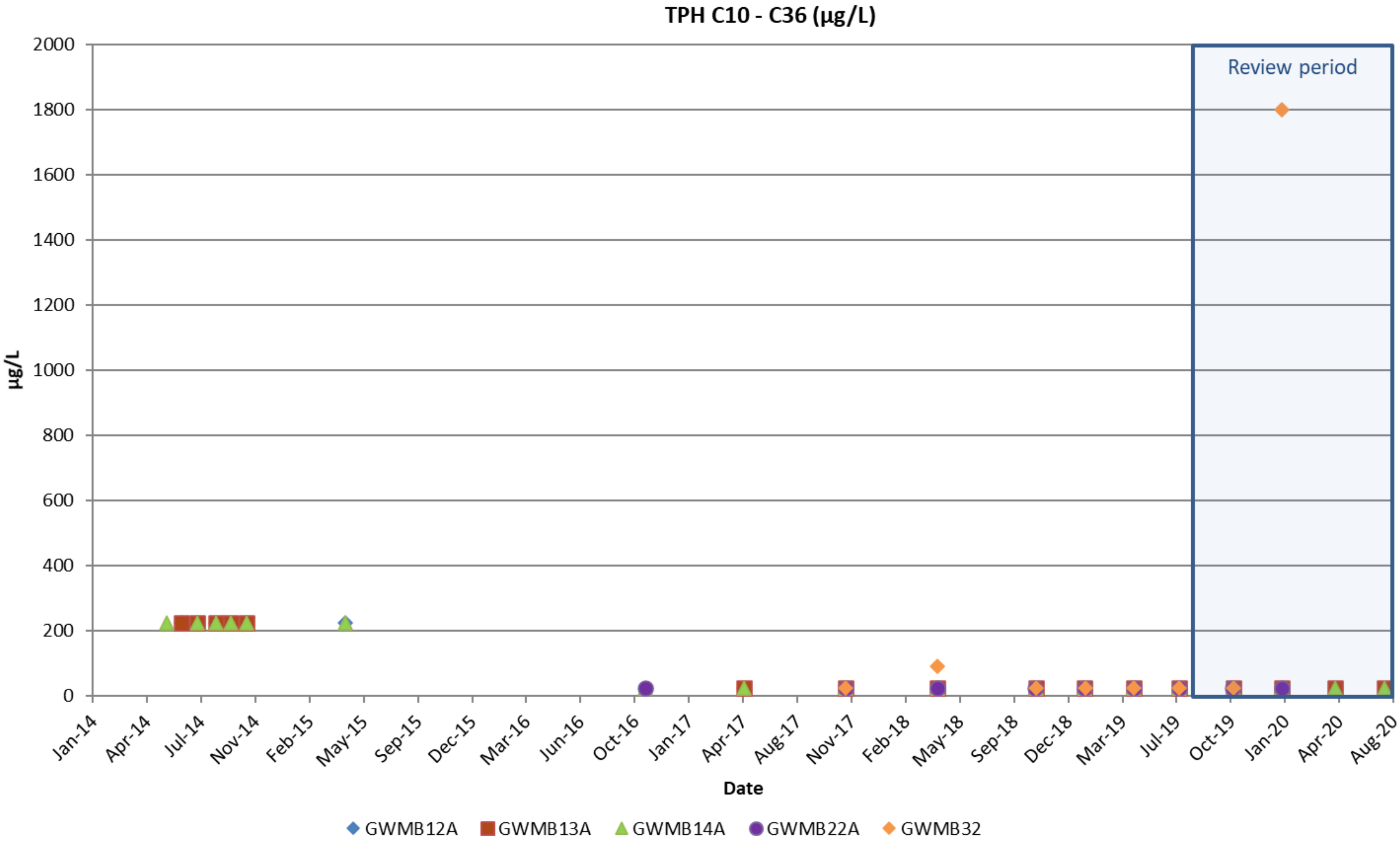


Figure 27 – Total Petroleum Hydrocarbons (C10 – C36)



APPENDIX B – GROUNDWATER MONITORING DATA

The groundwater monitoring data presented here has been produced after reviewing the raw data provided by Hail Creek Mine and making adjustments as described in the Methodology section of this report.

Following is the key to adjustments made:

<LOR data, converted to 50% LOR. All values in red were below the Limit of Reporting (LOR) value shown.
Data removed as erroneous is designated with a purple empty cell.

Table 3 – Water Quality – Laboratory Analysis

Sample Name	Sample Date	Lab pH	Electrical Conductivity	TDS by calc/dried	Calcium	Magnesium	Sodium	Potassium	Chloride	SO4	CO3	HCO3	Filterable Reactive Phosphorus	PO4 conversion	NO3	Dissolved Metals					TPH/TRH C6-C9	TPH/TRH C10-C36
																Fe	Al	As	Hg	Sb		
		pH Units	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
GWMB12A	24-Jun-14	8	2300	1400	64	76	370	1.1	360	36	0.25	680				290	500	2	0.05		20	225
GWMB12A	23-Jul-14	7.8	2200	1300	51	63	320	1.1	320	37	0.25	910				2.5	6	1.5	0.025		20	225
GWMB12A	26-Aug-14	8	2200	1300	52	65	380	1.1	320	37	0.25	810				2.5	7	1.5	0.025		20	225
GWMB12A	23-Sep-14	8.3	2100	1300	49	61	300	0.85	310	34	0.25	790				2.5	7	1.5	0.025		20	225
GWMB12A	21-Oct-14	8	2100	1300	48	60	300	0.85	300	32	0.25	760				2.5	6	1.5	0.025		20	225
GWMB12A	22-Apr-15	7.9	2100	1200	54	61	290	0.83		30			0.066	0.20	0.65	2.5	7	3	0.025		20	225
GWMB12A	20-Apr-16	8.1	1800	1100	44	71	290	1	210	25	0.25	630	0.14	0.43	0.41	2.5	7	3	0.05	1.5		
GWMB12A	27-Apr-17	7.7	1690	1100	47	46	254	0.5	215	23	0.5	570	0.18	0.55	0.28	25	5	2	0.05	0.5	10	25
GWMB12A	31-Oct-17	7.21	1700	214	47	56	296	0.5	207	25	0.5	638	0.1	0.31	0.56	2.5	5	1	0.05	0.5	10	25
GWMB12A	18-Apr-18	7.85	1810	619	65	57	285	2	270	34	0.5	568	0.32	0.98	0.13	2.5	5	4	0.05	0.5	10	25
GWMB13A	24-Jun-14	7.9	2500	1500	120	99	290	0.79	480	35	0.25	510				5	12	0.5	0.05		20	225
GWMB13A	23-Jul-14	7.7	2500	1500	100	85	250	1.3	520	34	0.25	670				2.5	8	1.5	0.025		20	225
GWMB13A	26-Aug-14	7.8	2500	1500	120	99	310	1.4	530	39	0.25	610				2.5	10	1.5	0.025		20	225
GWMB13A	23-Sep-14	8	2600	1600	110	96	260	1.3	540	36	0.25	620				2.5	8	1.5	0.025		20	225
GWMB13A	21-Oct-14	7.9	2700	1600	110	98	260	1.3	560	35	0.25	610				2.5	8	1.5	0.025		20	225
GWMB13A	27-Apr-17	7.41	3690	2400	171	143	364	0.5	823	46	0.5	590	0.01	0.03	0.39	50	5	0.5	0.05	0.5	10	25
GWMB13A	31-Oct-17	6.9	2420	116	104	88	305	0.5	472	38	0.5	583	0.02	0.06	0.19	2.5	5	0.5	0.3	0.5	10	25
GWMB13A	18-Apr-18	7.45	2120	5050	83	69	273	0.5	409	33	0.5	545	0.06	0.18	0.37	140	5	0.5	0.05	0.5	10	25
GWMB13A	17-Oct-18	7.57	1940	1260	83	62	245	0.5	327	34	0.5		0.02	0.06	0.28	160	5	0.5	0.05	0.5	10	25
GWMB13A	15-Jan-19	7.88	1970	1280	87	56	234	0.5	348	32	0.5	544	0.02	0.06	0.44	25	5	0.5	0.05	0.5	10	25
GWMB13A	15-Apr-19	7.79	1890	1230	85	58	265	0.5	352	40	0.5		0.005	0.02	0.33	2.5	5	0.5	0.05	0.5	10	25
GWMB13A	9-Jul-19	7.02	1960	1270	111	60	245	1	360	38	0.5	710	0.005	0.02	0.11	1930	840	2	0.05	0.5	10	25
GWMB13A	24-Jun-14	7.53	2080	1350	99	66	257	2	379	32	0.5	571	0.005	2.70	0.19	25	5	2	0.05	0.5	10	25
GWMB13A	23-Jul-14	7.57	2190	1420	93	65	269	2	415	31	0.5	523	0.01	3.90	0.42	940	5	3	0.05	0.5	10	25
GWMB13A	26-Aug-14	7.84	2260	1470	105	73	281	1	454	34	0.5	469	0.005	0.60	0.15	310	5	1	0.05	0.5	10	25
GWMB13A	23-Sep-14	7.82	2100	1590	112	76	287	0.5	461	38	0.5	629	0.005	7.10	0.01	720	5	0.5	0.05	0.5	10	25
GWMB14A	28-May-14	7.8	4100	2500	160	41	690	1.9	780	31	0.25	650				38	120	5	0.05		20	225
GWMB14A	23-Jul-14	7.9	4200	2500	130	37	600	4.8	970	33	0.25	890				2.5	10	8	0.025		20	225
GWMB14A	26-Aug-14	8	4200	2500	140	38	570	4.9	1000	35	0.25	790				2.5	10	5	0.025		20	225
GWMB14A	23-Sep-14	8.2	4300	2600	130	37	600	4.5	1000	34	0.25	780				2.5	8	8	0.025		20	225
GWMB14A	21-Oct-14	8.1	4400	2600	130	36	590	4.6	1000	35	0.25	780				9	9	9	0.025		20	225
GWMB14A	22-Apr-15	8	4400	2500	140	38	670	4.2		36			0.023	0.07	0.025	110	11	11	0.025		20	225

Sample Name	Sample Date	Lab pH	Electrical Conductivity	TDS by calc/dried	Calcium	Magnesium	Sodium	Potassium	Chloride	SO4	CO3	HCO3	Filterable Reactive Phosphorus	PO4 conversion	NO3	Dissolved Metals					TPH/TRH C6-C9	TPH/TRH C10-C36
																Fe	Al	As	Hg	Sb		
		pH Units	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
GWMB14A	28-Apr-16	8	4500	2600	130	39	640	4.3	1100	36	0.25	690	0.031	0.10	0.053	2.5	2.5	9	0.05	3		
GWMB14A	26-Oct-16	7.8	4750	3090	198	50	853	3	1270	43	0.5	794	0.03	0.09	0.005	1000	5	9	0.05		10	25
GWMB14A	27-Apr-17	7.74	4840	3150	171	48	677	2	1060	8	0.5	783	0.02	0.06	0.005	80	5	2	0.05	0.5	25	25
GWMB14A	31-Oct-17	7.06	3600	29	121	36	531	2	774	3	0.5	692	0.02	0.06	0.03	260	5	0.5	0.05	0.5	10	25
GWMB14A	18-Apr-18	7.53	4050	82	128	38	590	3	963	4	0.5	680	0.02	0.06	0.67	540	5	0.5	0.05	1	10	25
GWMB14A	17-Oct-18	7.3	5260	3420	265	265	462	0.5	1420	66	0.5		0.03	0.09	0.04	260	5	0.5	0.05	0.5	10	25
GWMB14A	15-Jan-19	7.23	6000	3900	306	297	452	1	1880	40	0.5	661	0.02	0.06	0.16	25	5	0.5	0.05	0.5	10	25
GWMB14A	15-Apr-19	7.48	5360	3480	297	259	484	1	1530	70	0.5		0.005	0.01	0.09	2.5	5	0.5	0.05	0.5	10	25
GWMB14A	9-Jul-19	6.92	5220	3390	272	251	476	1	1460	66	0.5	621	0.02	0.06	0.17	25	5	0.5	0.05	0.5	10	25
GWMB14A	16-Oct-19	7.65	5380	3500	304	252	451	0.5	1520	66	0.5	602	0.03	0.00	0.07	25	5	0.5	0.025	0.5	10	25
GWMB14A	14-Jan-20	7.54	6130	3980	319	285	529	1	1650	68	0.5	691	0.02	0.10	0.06	25	5	0.5	0.05	0.5	10	25
GWMB14A	20-Apr-20	7.89	6000	3900	264	286	522	1	1620	68	0.5	601	0.02	0.00	0.005	25	5	1	0.05	0.5	10	25
GWMB14A	21-Jul-20	7.11	1440	3760	299	266	504	1	1480	67	0.5	399	0.005	0.40	0.06	25	5	0.5	0.05	0.5	10	25
GWMB22A	20-Apr-16	7.8	1900	1100	130	73	170	1.7	280	20	0.25	550	0.055	0.17	0.025	2.5	8	1.5	0.05	1.5		
GWBD22A	26-Oct-16	7.51	1880	1220	146	75	182	0.5	319	20	0.5	608	0.03	0.09	0.005	25	5	0.5	0.05		10	25
GWMB22A	31-Oct-17	6.88	1900	550	135	82	177	1	306	22	0.5	575	0.04	0.12	0.12	2.5	5	0.5	0.05	0.5	10	25
GWMB22A	18-Apr-18	7.17	1760	852	127	72	162	0.5	312	19	0.5	521	0.01	0.03	0.04	190	5	0.5	0.05	0.5	10	25
GWMB22A	16-Oct-18	7.49	2020	1310	143	82	176	0.5	336	23	0.5		0.04	0.12	0.02	2.5	5	0.5	0.05	0.5	10	25
GWMB22A	15-Jan-19	**7.38**	**2110**	**1370**	**136**	**82**	**190**	0.5	**424**	**22**	0.5	**603**	**0.02**		**0.02**	25	5	0.5	0.05	0.5	10	25
GWMB22A	15-Apr-19	7.7	1970	1280	153	78	182	0.5	358	25	0.5		0.005	0.01	0.005	2.5	5	0.5	0.05	0.5	10	25
GWMB22A	9-Jul-19	**7.12**	**1940**	**1260**	**148**	**80**	**176**	0.5	**338**	**24**	0.5	**601**	**0.03**		**0.02**	25	**20**	0.5	0.05	0.5	10	25
GWMB22A	15-Oct-19	7.41	2150	1400	177	97	225	1	397	27	0.5	646	0.02	1.00	0.01	25	5	1	0.05	0.5	10	25
GWMB22A	14-Jan-20	7.82	2100	1360	146	85	194	0.5	379	24	0.5	629	0.005	7.10	0.01	720	5	0.5	0.05	0.5	10	25
GWMB22A	20-Apr-20	No sample																				
GWMB22A	21-Jul-20	No sample																				
GWMB32	31-Oct-17	6.92	1560	868	134	38	149	2	294	10	0.5	372	0.005	0.03	0.08	310	5	0.5	0.05	0.5	1680	25
GWMB32	18-Apr-18	7.34	1550	3920	146	35	142	1	303	17	0.5	374	0.01	0.03	0.11	2.5	5	3	0.05	0.5	40	90
GWMB32	18-Oct-18	7.46	1510	982	151	32	123	1	264	18	0.5		0.005	0.01	0.04	2.5	5	0.5	0.05	0.5	10	25
GWMB32	16-Jan-19	**7.81**	**1580**	**1030**	**136**	**31**	**132**	0.5	**295**	**18**	0.5	**404**	**0.02**		**0.01**	25	5	0.5	0.05	0.5	10	25
GWMB32	16-Apr-19	7.86	1330	864	157	27	119	1	273	18	0.5		0.005	0.01	0.04	2.5	5	2	0.05	0.5	10	25
GWMB32	9-Jul-19	**7.11**	**1440**	**936**	**152**	**28**	**114**	**1**	**262**	**18**	0.5	**399**	0.005		**0.06**	25	5	0.5	0.05	0.5	10	25
GWMB32	16-Oct-19	7.68	1440	936	157	29	112	1	274	16	0.5	367	0.01	0.60	0.03	25	5	1	0.05	0.5	10	25
GWMB32	14-Jan-20	7.88	1420	923	178	40	153	2	298	19	0.5	433	0.005	66.90	0.01	25	5	0.5	0.05	0.5	10	1,800

Sample Name	Sample Date	Lab pH	Electrical Conductivity	TDS by calc/dried	Calcium	Magnesium	Sodium	Potassium	Chloride	SO4	CO3	HCO3	Filterable Reactive Phosphorus	PO4 conversion	NO3	Dissolved Metals					TPH/TRH C6-C9	TPH/TRH C10-C36
																Fe	Al	As	Hg	Sb		
		pH Units	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
GWMB32	20-Apr-20	No sample																				
GWMB32	21-Jul-20	No sample																				

Table 4 – Water Quality – Field Measurements

Bore	Date	Time	Temperature	pH	ORP	EC	Turbidity	DO
			°C	-	mV	µS/cm	NTU	mg/L
GWMB12A	23/07/2014	14:29	25	7.41		2332	154	-
GWMB12A	22/04/2015	10:58	24.9	7.27	7.3	2124	-	2.92
GWMB12A	28/07/2015	16:29	24.25	7.29	18	1950	440	6.87
GWMB12A	22/10/2015	11:35	26.89	7.57	68	1950	266	7.25
GWMB12A	20/04/2016	12:30	26.24	7.49	76		187	7.09
GWMB12A	27/04/2017	9:47	25.65	7.21	-185	1660	245	2.56
GWMB12A	31/10/2017	0:00	25.02				24	
GWMB13A	23/07/2014	13:30	23.7	7.24		2600	394	-
GWMB13A	27/04/2017	10:58	25.85	6.81	-93	3610	266	0.32
GWMB13A	31/10/2017	0:00	34.23				53	
GWMB13A	15/01/2019	16:50	29.81	7.22		1904	7	
GWMB13A	15/04/2019	14:00	29.81	6.91		1963	7	
GWMB13A	9/07/2019	15:00	24.61	6.9		2062	254	
GWMB13A	16/10/2019	10:40	28.42	6.7		2099	99	
GWMB13A	16/10/2019	10:40		6.7		2099	24	
GWMB13A	14/01/2020	15:10		6.7		2286	57	
GWMB13A	20/04/2020	11:40	29.26	6.75		2270	169	
GWMB13A	21/07/2020	8:45	24.74	7.4		2385	OR	
GWMB14A	23/07/2014	11:42	25	7.52		4290	42.2	-
GWMB14A	22/04/2015	12:32	24.96	7.25	112	4469	-	2.72
GWMB14A	28/07/2015	15:15	24.44	7.25	21	4490	13.6	6.79
GWMB14A	22/10/2015	12:39	25.74	7.45	-24	4420	40.1	1.6
GWMB14A	28/04/2016	8:45	24.95	7.3	69		33	2.43
GWMB14A	26/11/2016	8:34	27.18	6.78	-88	5120	78.2	1.76
GWMB14A	27/04/2017	0:00	26.96				OR	
GWMB14A	31/10/2017	0:00	26.96				OR	
GWMB14A	15/01/2019	15:40	26.48	6.47		5590	27	
GWMB14A	15/04/2019	15:00	25.28	6.43		5523	11	
GWMB14A	9/07/2019	14:20		6.63		5462	344	
GWMB14A	16/10/2019	11:25	25.28	6.71		5451	OR	

Bore	Date	Time	Temperature	pH	ORP	EC	Turbidity	DO
			°C	-	mV	µS/cm	NTU	mg/L
GWMB14A	16/10/2019	11:25	26.79	6.71		5451	120000	
GWMB14A	14/01/2020	14:30	29.55	6.52		6351	806	
GWMB14A	20/04/2020	12:40	29.55	6.66		6046	806	
GWMB14A	21/07/2020	10:40	24.62	6.63		5670	Overrange	
GWMB22A	20/04/2016	8:30	24.14	7.15	220		128	7.53
GWMB22A	26/11/2016	7:56	25.76	6.47	134	2000	331	0.93
GWMB22A	27/04/2017	10:26	25.73	7.07	-277	4740	9.1	6.34
GWMB22A	31/10/2017	0:00	24.8				132	
GWMB22A	15/01/2019	14:30	31.65	6.43		2008	OR	
GWMB22A	15/04/2019	17:15		6.68		2020	0	
GWMB22A	9/07/2019	12:45		6.79		2037		
GWMB22A	15/10/2019	16:10		6.76		2240		
GWMB22A	15/10/2019	16:10		6.76		2240		
GWMB22A	14/01/2020	16:30	NR	6.61		2204	NR	
GWMB32	16/01/2019	13:57		7.42		1545	83	
GWMB32	16/04/2019	17:55		7.7		1445	12	
GWMB32	9/07/2019	16:40		6.86		1476	17	
GWMB32	16/10/2019	8:30	NR	6.8		1417	NR	
GWMB32	16/10/2019	8:30	NR	6.8		1417	NR	
GWMB32	14/01/2020	12:30		6.68		1580	2	