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SSE Generation Ireland Limited
Great Island Generating Station, Campile, New Ross, Wexford.

Groundwater Assessment Report

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Executive Summary

AXIS Environmental Services Ltd. were commissioned by SSE Generation Ireland Limited (SSE) to complete a Groundwater Assessment Report summarising the quality of groundwater monitoring results from 2009 to 2019. Sampling and testing were carried out by an independent laboratory during the assessment period.

SSE generation station is located in the townland of Great Island, 3.5km west of Campile village and approximately 15km south of New Ross, Co. Wexford. It is located on the confluence of the River Suir and the River Barrow estuary.

The station is a modern gas fired, combined cycle gas turbine power plant (CCGT). The plant operates on natural gas, with gas oil stored as a backup fuel in the event of a gas supply failure or interruption.

There are no licensed or unlicensed emissions to ground at the installation. There was however, historical waste disposal activities carried out at the site from previous operators. There are two areas at the installation which were used between the 1960's and mid 90's for deposition of excess rock fill, building materials and spoil. Certain parts of a northern segment of Cell 1 was used for deposition of general waste during the operation of the generation station. The CCGT does not impact on these areas in any way, however in line with Industrial Emissions (IE) Licence conditions there is a requirement to monitor groundwater quality in the area.

There are thirteen groundwater wells in total at the installation. The Industrial Emissions Licence requires that these ten listed wells are monitored as follows:

Table 1-1: EPA Licence Requirements (Condition C.5)

Location: BH2, BH13, MW101, MW102, MW103, MW106, MW107, MW200, MW202

Parameter	Monitoring Frequency	Analysis Method / Techniques
pH	Annually	Standard Method
Coliforms	Annually	Standard Method
Vanadium	Annually	Standard Method
Ammonia ^{Note 1}	Annually	Standard Method
Mineral Oil	Annually	Standard Method
Arsenic	Annually	Standard Method
Total Petroleum Hydrocarbons	Annually	Standard Method
Aluminium	Annually	Standard Method
Polyromantic hydrocarbons	Annually	Standard Method

Note 1: Only relates to BH2, BH3, MW106, MW20, MW202

Location: BH5, BH7, BH19, BH10

Parameter	Monitoring Frequency	Analysis Method / Techniques
pH	Biennially	Standard Method
Ammonia	Biennially	Standard Method
Vanadium	Annually	Standard Method
Lead	Biennially	Standard Method
Chromium	Biennially	Standard Method
Total Petroleum Hydrocarbons	Biennially	Standard Method
Polyromantic hydrocarbons	Biennially	Standard Method

This report forms part of routine monitoring summary report and not a contaminated land investigation.

Parameters that were determined in excess of the thresholds outlined in Schedule 5 of S.I. No 9 of 2010 as amended by S.I. 366 of 2016 included:

Table 1-2: Summary of Parameters above Thresholds

Parameter	Borehole	Exceedance of Threshold Limits in S.I. No. 366 of 2016										
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Aluminium	BH2											
	MW101											
	MW200											
	MW202											
	MW101											
	MW200											
Ammonia	MW202											
	BH3											
	BH5											
	BH10											
	MW101											
	MW102											
	MW103											
	MW106											
Arsenic	MW200											
	MW202											
	BH2											
	BH10											
	MW101											
	MW102											
Lead	MW103											
	MW202											
TPH	BH307											
	MW106											
	BH2											
	BH2											
	BH5											
	BH7											
	BH10											
	MW101											
	MW102											
	MW103											
PAH	MW200											
	MW106											
	MW202											
	BH2											
	BH5											
	BH10											

Note 1: Blank cells indicate either compliance with S.I. No. 366 of 2016 or samples were not collected and analysed in that year.
Note 2: Laboratory LOD for PAH was often above the threshold of S.I. No. 366 of 2016, therefore making compliance assessment not possible

From assessment groundwater well analysis at the installation for the monitoring period 2009 – 2019, and comparison against previous groundwater reports, the conclusions are that:

- SSE would be required to maintain its testing schedule in line with the specifications of its Industrial Emissions Licence;
- The frequency and extent of sampling is sufficient to meet the requirements of this licence;
- There are areas of contamination determined from the groundwater wells, most likely due to historical practices and waste deposition in close proximity to these sample wells;
- The site does not require remediation currently as the concentrations detected in the wells do not make this site unsuitable for industrial purposes. Should the future requirements for this site change from industrial purposes, then further investigations and potential remediation measures may be required;
- There is Total Petroleum Hydrocarbon contamination in all but one groundwater well tested. The concentrations are very variable. At times, TPH has not been detected in some wells, followed by a rebound in concentration some years later.
- PAHs were largely below the laboratories limit of detection, with no exceedances determined in any well since 2015;
- Concentrations of arsenic were variable and found in 6 different wells at elevated concentrations over the 10-year sampling programme. The levels are relatively stable and decreasing.

The summary report finds that there is contamination in the groundwater wells at the installation. The site is required to continue monitoring its wells for the parameters in Condition C.5 of Technical Amendment a to the IE licence P0606-03. There is no immediate requirement for remediation unless the site would intend to change its use.

1. Introduction

AXIS Environmental Services Ltd. were commissioned by SSE Generation Ireland Limited (SSE) to complete a Groundwater Assessment Report summarising the quality of groundwater monitoring results from the installation between 2009 and 2019.

Monitoring of groundwater has been carried out by SSE in line with IE Licence conditions issued to the company. Monitoring was carried out by an independent accredited laboratory and results were issued to, recorded and reported to the EPA by SSE.

As part of the environmental management system, SSE review and summarise the analytical results in graphical format for presentation and submission to the Environmental Protection Agency. The purpose of this report is to review the results from 2009 to 2019 for overview reference of the analytical quality of groundwater and to highlight any areas of exceedance, concern or recommendations for future investigations.

2. Site Description

Great Island Generating Station is located in South-West Co. Wexford near Campile at the confluence of the River Suir with the River Barrow estuary. The station was constructed on lands that were formerly in agricultural use and some lands were reclaimed from the estuary during development of the site. The total area of the site is approximately 143 acres.

The station is now a modern gas fired, combined cycle gas turbine power plant (CCGT). The plant operates on natural gas, with gas oil stored as a backup fuel in the event of a gas supply failure or interruption. There are no emissions to ground at the installation and have not been any recorded incidents or process failures that could give rise to groundwater or soil contamination since the new plant was commissioned.

The station historically consisted of three generating units with a total electricity generating capacity of 240 Megawatt of electricity (MWe), two 60MWe units (U1 and U2) and one 120MWe unit (U3). These were conventional steam generation units. Each of the units consisted of a boiler, steam turbine and auxiliary plant that were independent of each other. Units 1 and 2 were commissioned in 1967 and 1968 respectively, which were re-commissioned in 1992. Unit 3 was commissioned in 1972 and re-commissioned in 1993. The station was fired on Heavy Fuel Oil shipped directly to site and stored in the station's own oil tank farm area. Distillate Oil was used for start-up.

There were historical waste disposal activities carried out at the site by previous operators. There are two areas on the site which were used between the 1960's and mid 90's for deposition of excess rock fill, building materials and spoil. Certain parts of a northern segment of Cell 1 was used for deposition of general waste during the operation of the generation station. The CCGT does not impact on these areas in any way, however by IE Licence is required to monitor groundwater quality in the vicinity of these cells.

The generation station was constructed on man-made ground, surrounded by an area of estuarine sediments of silt and clays, with a gravelly texture. The aquifer below is classified as regionally important fissured bedrock (Aquifer Code Rf) with extreme vulnerability. The installation is surrounded by areas of medium to high vulnerability and areas with rock very close or at the surface of the ground. Groundwater was classified under the water framework Directive with "good" status between 2010 and 2015.

The CCGT plant incorporates the following processes:

- A gas turbine, burning natural gas, or gasoil as a backup fuel, which drives a generator for electricity production;
- Exhaust gases from the gas turbine pass through a Heat Recovery Steam Generator (HRSG) to generate high pressure steam;
- The steam generated in the HRSG drives a steam turbine, providing additional electrical power;
- The steam is condensed back to water via a condenser for re-use in the HRSG. This condenser is cooled by the once-through cooling water system.

Materials or chemicals of environmental significance used and stored at the installation include:

Table 2-1 Main Site Chemicals

Chemical	Use	Management Method
Sodium Hypochlorite	Anti-fouling agent	Bunded Storage
Ammonium Hydroxide	pH correction	Bunded Storage
Tri-sodium Phosphate	Prevent scaling	Bunded Storage
Gas oil	Back-up fuel	Bunded Storage
Sulphuric acid	WTP membrane clean	Bunded Storage
Trac 104	Biocide and pH correction in CCCW	Bunded Storage
Sodium Bisulphite	WTP free chlorine removal	Bunded Storage
Sodium Hydroxide	WTP membrane clean	Bunded Storage

3. Methodology

Sampling and analysis were carried out by SSE as part of the environmental management program for the installation and in accordance with the requirements of the IE Licence.

The results have been assessed against S.I. No. 9/2010 – European Communities Environmental Objectives (Groundwater) Regulations 2010 as amended by S.I. No. 366/2016 – European Union Environmental Objectives (Groundwater) (Amendment) Regulations 2016.

4. Results

4.1 Borehole 2 (BH2)

Table 4-1: Summary of Results

Parameter	Units	S.I. No. 366/2016	BH2							
			Apr-09	Jun-09	Sep-10	Apr-11	Apr-12	Sep-12	Sep-18	May-19
Aluminium	ug/l	150	328	142	17	39	351	16	11	<10
Ammonia	mg/l as NH ₄	0.175	-	-	-	<0.1	0.11	<0.1	<0.10	<0.1
Arsenic	ug/l	7.5	2.00		<1	<1	<1	0.66	1.3	0.58
Chromium	ug/l	37.5	-	-	-	-	-	-	0.64	<0.25
Lead	ug/l	7.5	-	-	-	-	-	-	0.81	0.28
Mineral Oil	ug/l	-	70	80	<10	<10	32	22	44	<10
pH	Units	6.5 – 9.5 ²	7.6	-	7.6	7.9	7.8	7.5	6.9	7.6
PAH	ug/l	0.075	0.11	0.05	<0.20	<0.20	<0.20	<0.20	<0.04	<0.2
TPH	ug/l	7.5	50	70	54	53	90	58	130	40
Vanadium	ug/l	-	-	-	-	<10	<10	170	3	1.1
Total Coliforms	cfu/100ml	0/100mls ²	-	-	-	>100	>100 ¹	>100	>100	>100
Faecal Coliforms	cfu/100ml	0/100mls ²	-	-	-	0	23 ¹	0	>100	>100

Note 1: (cfu/20mls)

Note 2: Limits obtained from S.I. No. 122 of 2014 European Union (Drinking Water) Regulations 2014

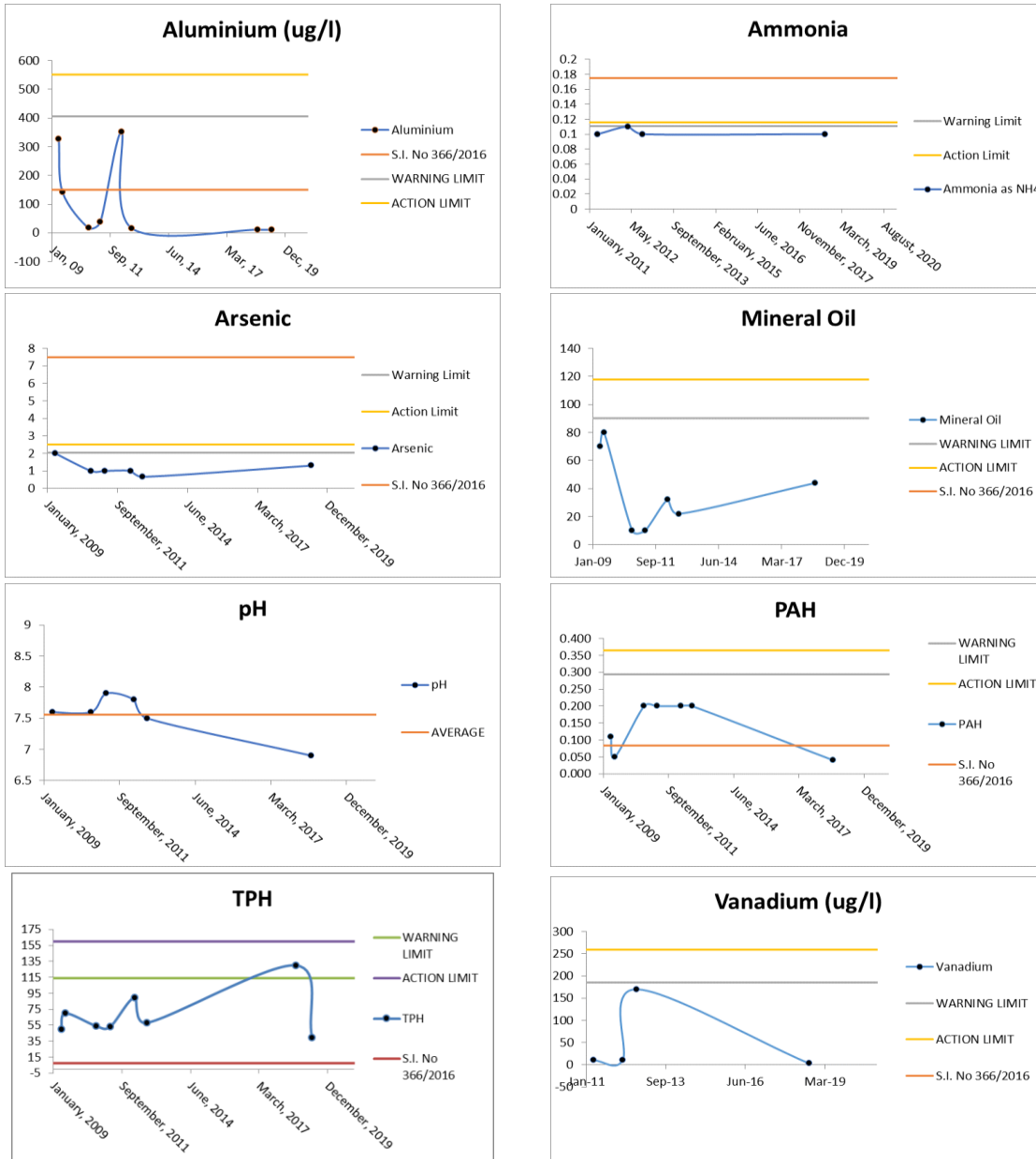
BH2 was determined to be in compliance with the Groundwater Regulations (366/2016) for the majority of parameters tested. The borehole was noted to have occasional spikes in Aluminium, notably in 2009 and repeated again in 2012. More recent samples tested in 2018 and 2019 have indicated that the concentrations of Aluminium are within both guidance and legislative values.

The limit for Total PAH under SI No. 366/2016 is very low at 0.075 ug/l. The limit of detection for the laboratory was above this value and therefore compliance assessment cannot be accurately accomplished. However, the concentrations of PAH have generally not been detected in this well since 2009, with one sample in 2018 indicating that background concentrations were below the 366/2016 threshold at 0.04 ug/l.

Total Petroleum Hydrocarbons (TPH) were detected in elevated concentrations; well above the limit provided in 366/2016 during each sampling campaign.

The presence of total and faecal coliforms is not concern as this water is not used as drinking water at the installation and there are no groundwater wells listed in the locality with the exception of these test wells on site. The source of contamination could be from either local external sources (agriculture) or more likely from biological degradation of waste that is stored beneath the ground at the installation.

Fig 4.1



4.2 Borehole 3 (BH3)

Table 4-2: Summary of Results

Parameter	Units	S.I. No. 366/2016	BH3								
			Apr-09	Jun-09	Sep-10	Apr-11	Apr-12	Sep-16	Sep-17	Sep-18	May-19
Aluminium	ug/l	150	136	-	<10	<10	<10	-	68	<10	<10
Ammonia	mg/l as NH ₄	0.175	-	-	-	<0.1	<0.1	1.2	<0.1	<0.1	<0.1
Arsenic	ug/l	7.5	41	120	<1	<1	<1.0	-	22	7.9	0.58
Chromium	ug/l	37.5	-	-	-	-	-	4	<1	<0.25	0.39
Lead	ug/l	7.5	-	-	-	-	-	<1	<1	<0.09	0.24
Mineral Oil	ug/l	-	<10	-	<10	<10	14	-	<10	<10	<10
pH	Units	6.5 – 9.5 ²	7.4	-	8	7.9	7.6	7.9	7.6	7.7	7.6
PAH	ug/l	0.075	<0.05	-	<0.20	<0.20	<0.20	<0.04	<0.04	<0.04	<0.20
TPH	ug/l	7.5	<10	<10	57	46	48	86	<10	<10	<10
Vanadium	ug/l	-	-	-	-	<10	<10	8.5	6.8	2.1	2.5
Total Coliforms	cfu/100ml	0/100mls ²	-	-	-	>100	>100	-	>100	>100	>100
Faecal Coliforms	cfu/100ml	0/100mls ²	-	-	-	0	23	-	20	>100	>100

Note 1: The Borehole changed location in 2016

Note 2: Limits obtained from S.I. No. 122 of 2014 European Union (Drinking Water) Regulations 2014

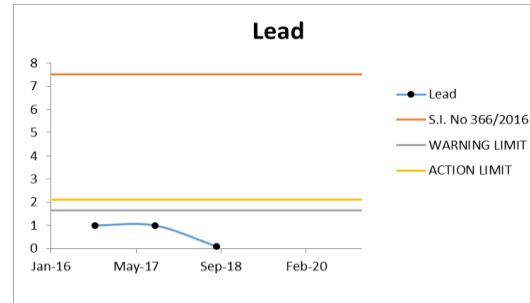
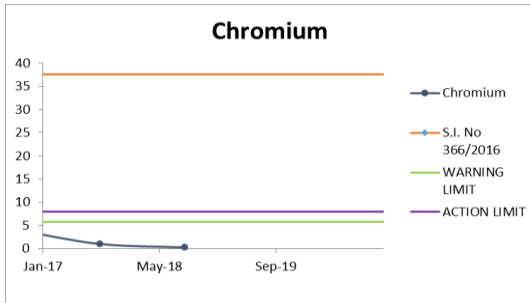
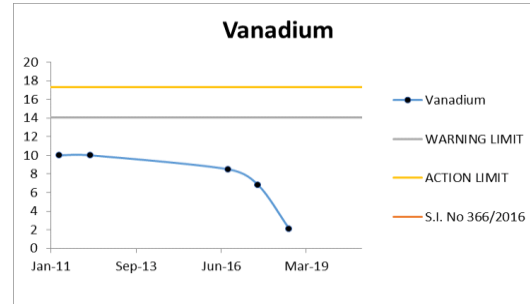
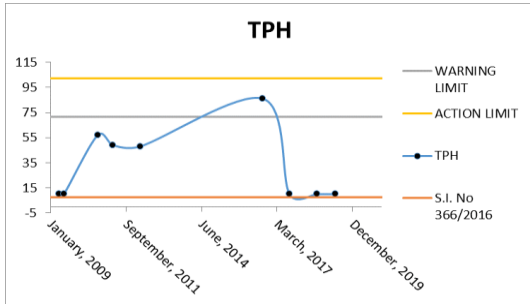
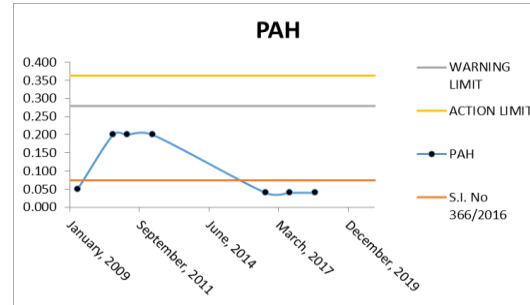
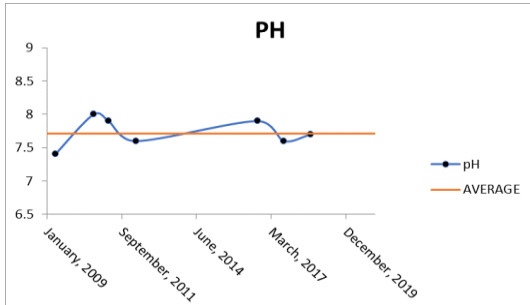
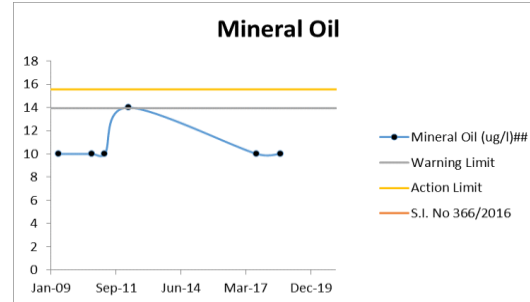
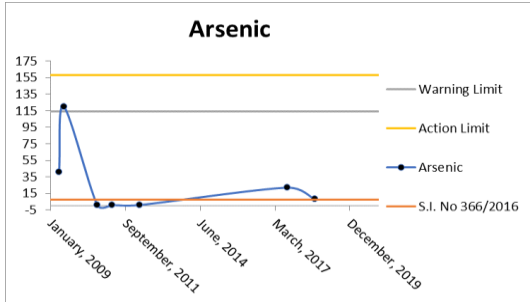
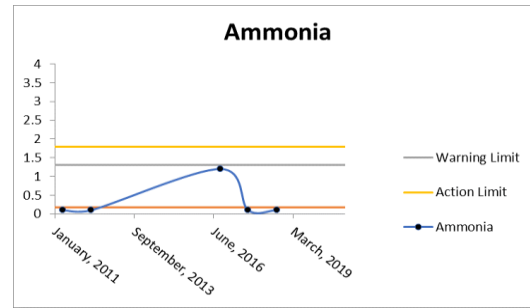
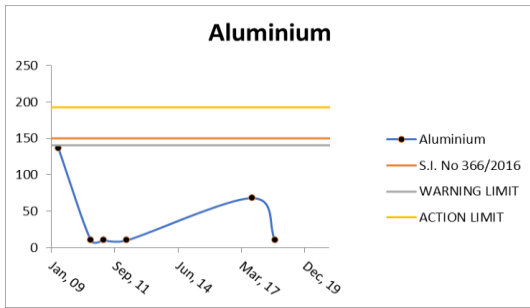
BH3 was relocated from its original position in 2016, however the name was retained for reporting purposes. This well was determined to be in compliance with the Groundwater Regulations (366/2016) for the majority of parameters tested. The borehole was noted to have occasional spikes in arsenic and ammonia. Arsenic was present in elevated concentrations in 2009, but dissipated during 2010 – 2012. This parameter observed to rebound in samples for 2017 and 2018 which is possibly due to the relocation of the well. The concentrations were below the 366/2016 threshold according to the most recent sample obtained in 2019.

There was elevated ammonia detected in the well in 2016 which was again possibly due to the relocation of this well. The concentrations post 2016 have all been less than the limit of detection for this test and well below 366/2016 threshold values.

TPH's were detected in elevated concentrations in this well from 2010 – 2012 and again in 2016. The concentrations detected were above the legislative threshold outlined in 366/2016.

The limit for Total PAH under SI No. 366/2016 is low at 0.075 ug/l. The limits of detection for the laboratory were above this value on certain occasions and therefore compliance assessment cannot be accurately completed. However, the concentrations of PAH have not been positively detected in this well since 2009 and one sample analysed in 2018 did indicate that background concentrations were below the Regulation threshold at <0.04 ug/l.

The presence of total and faecal coliforms is not concern as this water is not used as drinking water at the installation and there are no groundwater wells listed in the locality with the exception of these test wells on site. There was a trend noted in that from 2011 the levels have been rising of faecal coliforms in this well. Given that the result in 2017 was within range, it could be assumed that the biological quality of this water is deteriorating and therefore attention should be maintained on the water quality within this well.



4.3 Borehole 5 (BH5)

Table 4-3: Summary of Results

Parameter	Units	S.I. No. 366/2016	BH5								
			Apr-09	Sep-10	Apr-11	Sep-11	Apr-12	Sep-12	Sep-13	Sep-14	Sep-15
Aluminium	ug/l	150	-	-	-	-	-	-	-	-	-
Ammonia	mg/l as NH ₄	0.175	-	-	<0.1	1.2	1.1	0.16	0.66	<0.10	-
Arsenic	ug/l	7.5	-	-	-	-	-	-	-	-	-
Chromium	ug/l	37.5	<1	<1	<1	<1	<1	<1	<1	0.92	-
Lead	ug/l	7.5	4	<2	<2	<2	<2	<2	<2	0.74	-
Mineral Oil	ug/l	-	-	-	-	-	-	-	-	-	-
pH	Units	6.5 – 9.5 ¹	7.1	7.4	8	7.4	7.4	6.9	7.3	6.3	-
PAH	ug/l	0.075	<0.05	<0.20	0.37	0.24	<0.20	<0.20	<0.20	<0.20	-
TPH	ug/l	7.5	<10	190	20	300	150	77	280	<10	-
Vanadium	ug/l	-	320	130	210	150	190	1	140	110	120
Total Coliforms	cfu/100ml	0/100mls ¹	-	-	-	-	-	-	-	-	-
Faecal Coliforms	cfu/100ml	0/100mls ¹	-	-	-	-	-	-	-	-	-
Parameter	Units	S.I. No. 366/2016	BH5								
			Sep-16	Sep-17	Sep-18	May-19					
Aluminium	ug/l	150	-	83	<10	<10					
Ammonia	mg/l as NH ₄	0.175	<0.10	<0.10	0.92	<0.1					
Arsenic	ug/l	7.5	-	1.3	0.57	2.2					
Chromium	ug/l	37.5	<1	<1	<0.25	0.6					
Lead	ug/l	7.5	1.3	<1	0.11	6.8					
Mineral Oil	ug/l	-	-	26	12	<10					
pH	Units	6.5 – 9.5 ¹	6.5	6.6	6.4	6.4					
PAH	ug/l	0.075	<0.04	<0.04	<0.04	<0.2					
TPH	ug/l	7.5	22	46	19	26					
Vanadium	ug/l	-	160	140	110	250					
Total Coliforms	cfu/100ml	0/100mls ¹	-	>100	>100	>100					
Faecal Coliforms	cfu/100ml	0/100mls ¹		>100	>100	>100					

Note 1: Limits obtained from S.I. No. 122 of 2014 European Union (Drinking Water) Regulations 2014

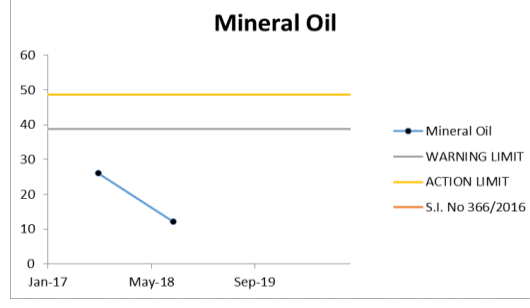
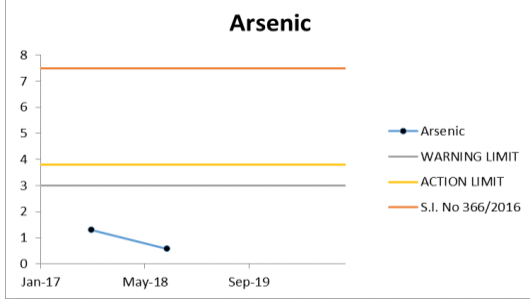
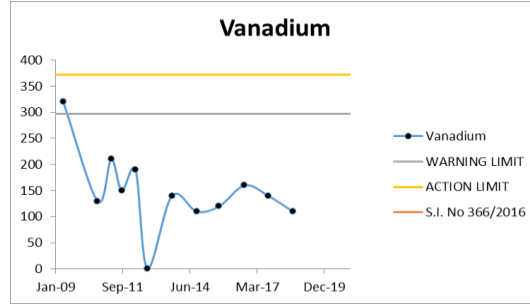
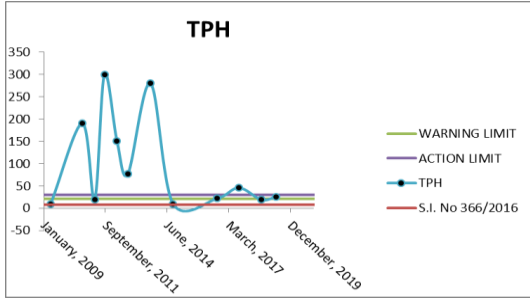
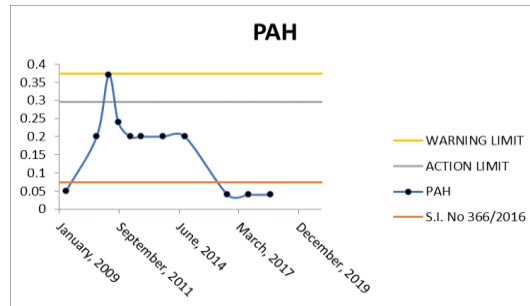
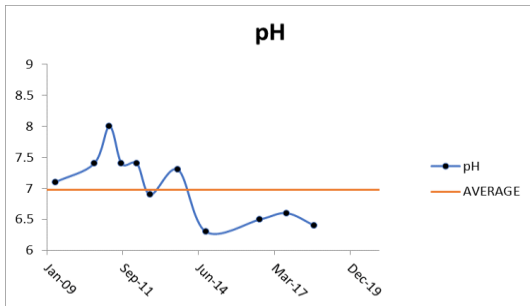
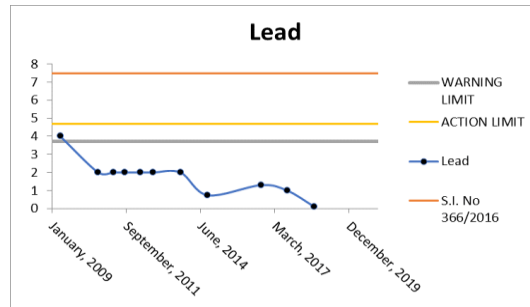
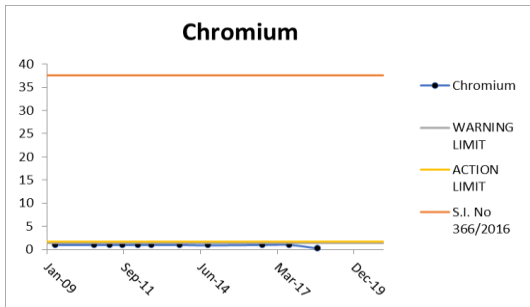
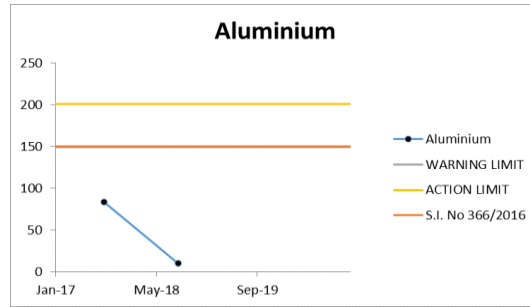
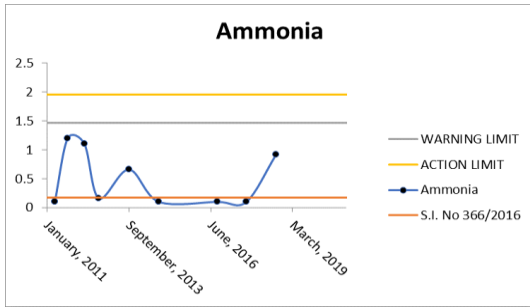
Water quality in BH5 was generally in compliance with the Groundwater Regulations for most parameters tested.

There were elevated PAHs detected in this well in 2011 but these concentrations have dissipated and have been below the limit of detection for the test since.

Historically there were problems with elevated ammonia concentrations in this groundwater well. While concentrations over the years had dissipated, there was a rebound in ammonia in 2018 which was not in line with the general trend for this well in the preceding 3 years. The 2019 sample indicated the ammonia was less than the limits of detection for this test once more. There is no apparent trend with ammonia in this well, therefore there would not be any actions required, however this should be monitored closely to ensure its source does not become an on-going issue.

PAHs were detected in this well above the 366/2016 threshold twice in 2011, however have not been present in concentrations above the limit of detection since.

The concentrations of TPH were variable in this well over the sampling period. The concentrations were less than the limit of detections during some monitoring campaigns up to maximum of 300 ug/l in the water which was well in excess of the required 7.5 ug/l outlined in 366/2016. Ten of the twelve samples were deemed out of compliance with the groundwater regulations for TPH.



4.4 Borehole 7 (BH7)

Table 4-4: Summary of Results

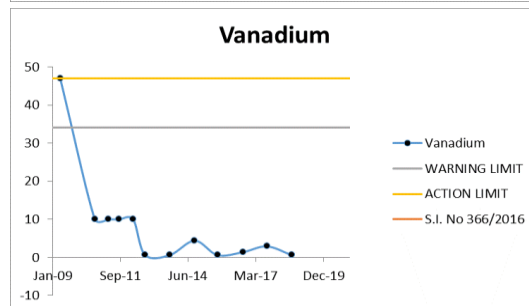
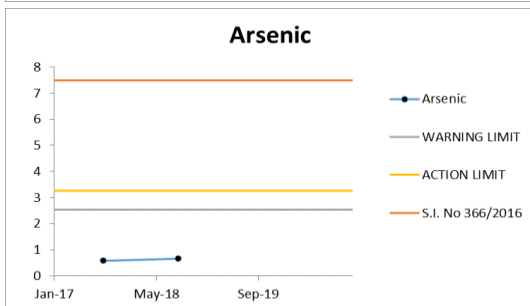
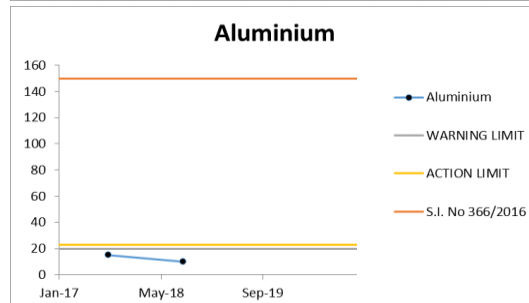
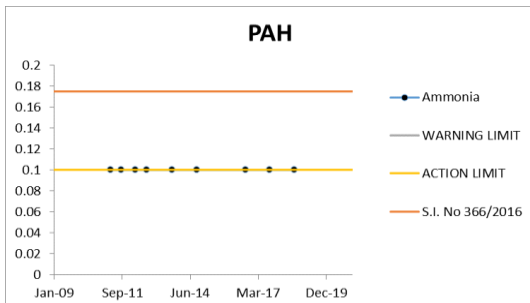
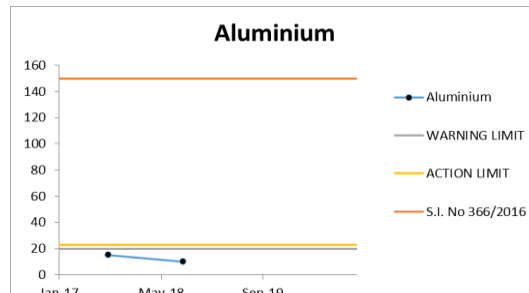
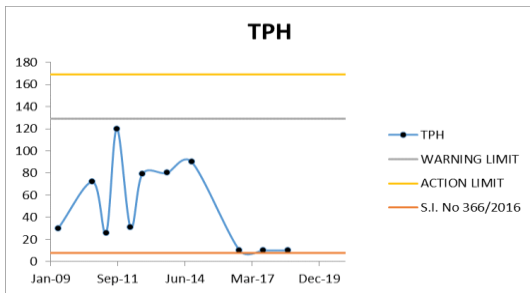
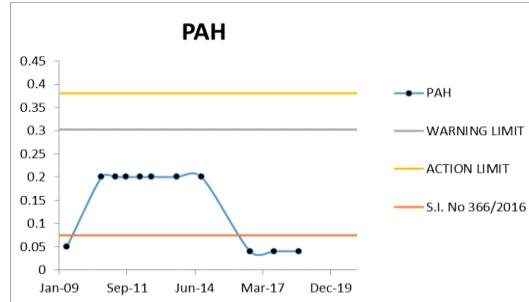
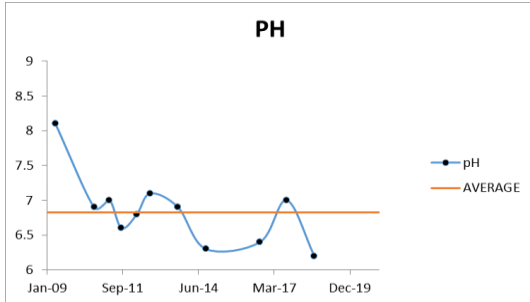
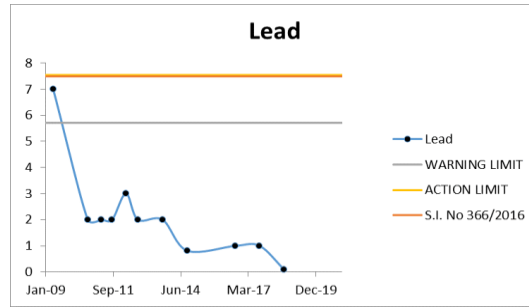
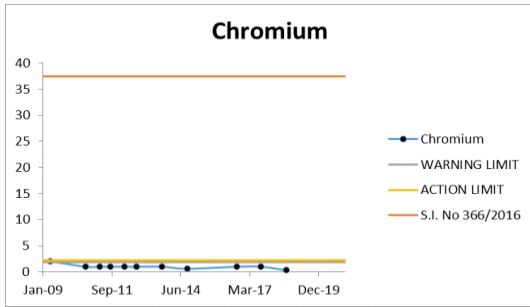
Parameter	Units	S.I. No. 366/2016	BH7								
			Apr-09	Jun-09	Sep-10	Apr-11	Sep-11	Apr-12	Sep-12	Sep-13	Sep-14
Aluminium	ug/l	150	-	-	-	-	-	-	-	-	-
Ammonia	mg/l as NH ₄	0.175	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.10	<0.10
Arsenic	ug/l	7.5	-	-	-	-	-	-	-	-	-
Chromium	ug/l	37.5	2	-	<1	<1	<1	<1	<1	<1	0.60
Lead	ug/l	7.5	7	-	<2	<2	<2	3	<2	<2	0.81
Mineral Oil	ug/l	-	-	-	-	-	-	-	-	-	-
pH	Units	6.5 – 9.5 ¹	8.1	-	6.9	7	6.6	6.8	7.1	6.9	6.3
PAH	ug/l	0.075	<0.05	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
TPH	ug/l	7.5	30	-	72	26	120	31	79	80	90
Vanadium	ug/l	-	47	-	10	<10	<10	<10	0.64	<0.60	4.4
Total Coliforms	cfu/100ml	0/100mls ¹	-	-	-	-	-	-	-	-	-
Faecal Coliforms	cfu/100ml	0/100mls ¹	-	-	-	-	-	-	-	-	-
Parameter	Units	S.I. No. 366/2016	BH7								
			Sep-15	Sep-16	Sep-17	Sep-18	May-19				
Aluminium	ug/l	150	-	-	15	<10	<10				
Ammonia	mg/l as NH ₄	0.175	-	<0.10	<0.10	<0.10	<0.1				
Arsenic	ug/l	7.5	-	-	0.58	0.66	1.9				
Chromium	ug/l	37.5	-	<1	<1	0.31	<0.25				
Lead	ug/l	7.5	-	<1	<1	<0.09	1				
Mineral Oil	ug/l	-	-	-	<10	<10	20				
pH	Units	6.5 – 9.5 ¹	-	6.4	7	6.2	6.6				
PAH	ug/l	0.075	-	<0.04	<0.04	<0.04	<0.20				
TPH	ug/l	7.5	-	<10	<10	<10	44				
Vanadium	ug/l	-	<0.6	1.4	2.9	<0.6	1.2				
Total Coliforms	cfu/100ml	0/100mls ¹	-	-	-	-	-				
Faecal Coliforms	cfu/100ml	0/100mls ¹	-	-	-	-	-				

Note 1: Limits obtained from S.I. No. 122 of 2014 European Union (Drinking Water) Regulations 2014

The water quality in Borehole 7 was generally of high quality for the parameters tested. There were occasions during the monitoring period when the pH has decreased below the lower threshold allowable for drinking water quality of 6.5 however this is not deemed significant or a consistent deterioration.

There was persistent TPH contamination of groundwater in this well. In more recent years (2016 – 2018) the concentrations were below the limit of detection, however there was a rebound in TPH levels in 2019 with 44 ug/l detected in the water. Of the twelve samples taken, nine were deemed to exceed the Groundwater Regulations limits.

All other parameters were determined compliant with threshold values for the Groundwater Regulations. The limit of detection between 2010 and 2013 was in excess of the threshold for PAH, therefore a proper assessment could not be made for these years. Historical and subsequent samples were determined to be below detection limits for PAHs.



4.5 Borehole 10 (BH10)

Table 4-5: Summary of Results

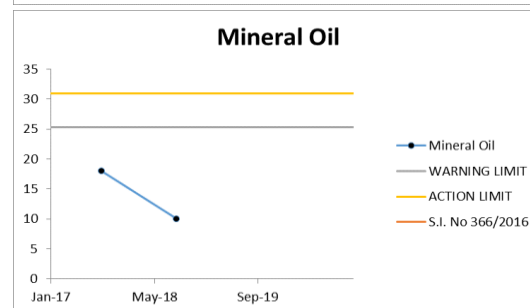
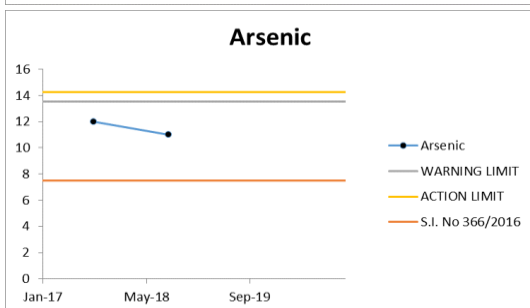
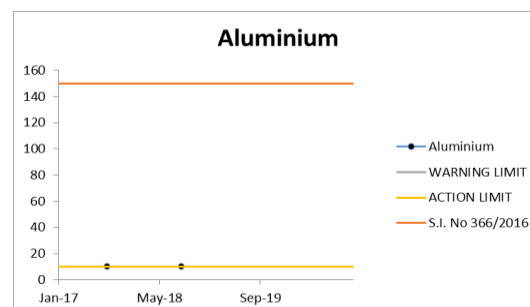
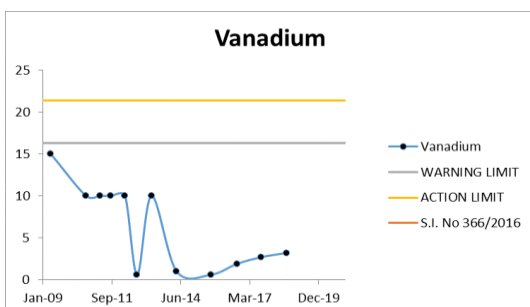
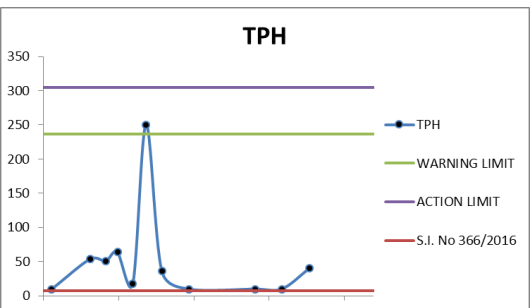
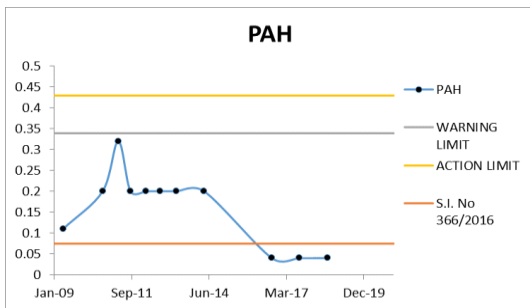
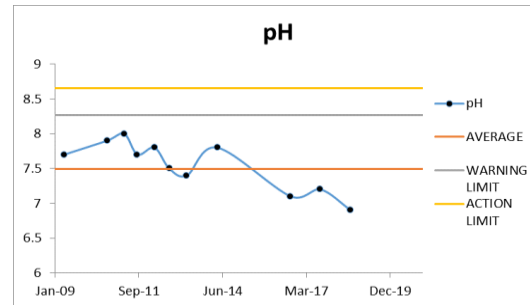
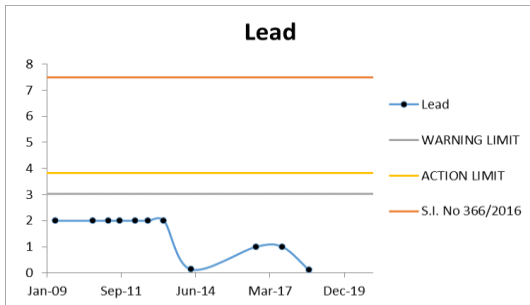
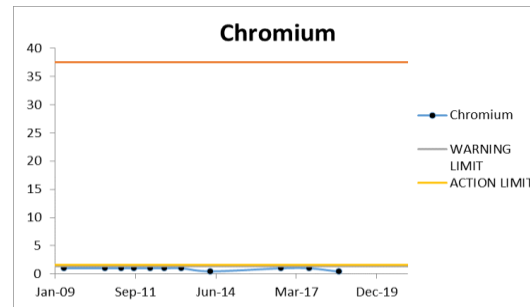
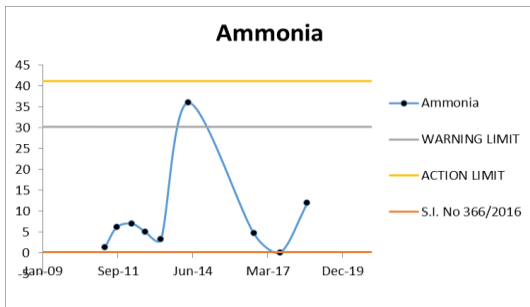
Parameter	Units	S.I. No. 366/2016	BH10								
			Apr-09	Sep-10	Apr-11	Sep-11	Apr-12	Sep-12	Apr-13	Apr-14	Sep-15
Aluminium	ug/l	150	-	-	-	-	-	-	-	-	-
Ammonia	mg/l as NH ₄	0.175	-	-	1.4	6.2	7	5.1	3.3	36	-
Arsenic	ug/l	7.5	-	-	-	-	-	-	-	-	-
Chromium	ug/l	37.5	<1	<1	<1	<1	<1	<1	<1	0.45	-
Lead	ug/l	7.5	<2	<2	<2	<2	<2	<2	2	0.13	-
Mineral Oil	ug/l	-	-	-	-	-	-	-	-	-	-
pH	Units	6.5 – 9.5 ¹	7.7	7.9	8	7.7	7.8	7.5	7.4	7.8	-
PAH	ug/l	0.075	0.11	<0.20	0.32	<0.20	<0.20	<0.20	<0.20	<0.20	-
TPH	ug/l	7.5	<10	110	120	130	140	110	43	260	-
Vanadium	ug/l	-	15	<10	<10	<10	<10	<0.60	<10	1.0	<0.6
Total Coliforms	cfu/100ml	0/100mls ¹	-	-	-	-	-	-	-	-	-
Faecal Coliforms	cfu/100ml	0/100mls ¹	-	-	-	-	-	-	-	-	-
Parameter	Units	S.I. No. 366/2016	BH10								
			Sep-16	Sep-17	Sep-18	May-19					
Aluminium	ug/l	150	-	<10	<10	<10					
Ammonia	mg/l as NH ₄	0.175	4.7	<0.1	12	<0.1					
Arsenic	ug/l	7.5	-	12	11	0.68					
Chromium	ug/l	37.5	<1	<1	0.39	0.9					
Lead	ug/l	7.5	<1	<1	0.10	3.1					
Mineral Oil	ug/l	-	-	18	<10	13					
pH	Units	6.5 – 9.5 ¹	7.1	7.2	6.9	6.9					
PAH	ug/l	0.075	<0.04	<0.04	<0.04	<0.2					
TPH	ug/l	7.5	68	61	57	44					
Vanadium	ug/l	-	1.9	2.7	3.2	2.5					
Total Coliforms	cfu/100ml	0/100mls ¹	-	>100	>100	>100					
Faecal Coliforms	cfu/100ml	0/100mls ¹	-	42	>100	>100					

Note 1: Limits obtained from S.I. No. 122 of 2014 European Union (Drinking Water) Regulations 2014

This well demonstrated varying concentration of ammonia between 2011 and 2019, ranging in concentrations from below laboratory detection limits to 36 mg/l in 2014. There has been persistent exceedance of the regulatory limits, with eight of the ten samples analysed determined to have been in excess of 0.175mg/l.

There has been TPH in the well consistently since 2010, the highest concentration detected was 260 ug/l in 2014, well above the limits outlined in the Groundwater Regulations of 7.5 ug/l. Concentrations have been steadily declining in this well since 2014 down to 44 ug/l in 2019.

There were elevated PAH concentrations detected in this well in 2009 and again in 2011. All samples have been below the laboratory limit of detection since, albeit that detection limit is above the required threshold.



4.6 Borehole 307 (BH307)

Table 4-6: Summary of Results

Parameter	Units	S.I. No. 366/2016	BH 307	
			Sep-18	May-19
Aluminium	ug/l	150	<10	<10
Ammonia	mg/l as NH ₄	0.175	<0.10	<0.1
Arsenic	ug/l	7.5	0.20	1.9
Chromium	ug/l	37.5	0.26	3.1
Lead	ug/l	7.5	9.9	3.8
Mineral Oil	ug/l	-	<10	<10
pH	Units	6.5 – 9.5 ¹	6.7	6.4
PAH	ug/l	0.075	<0.04	<0.2
TPH	ug/l	7.5	<10	14
Vanadium	ug/l	-	<0.6	6.6
Total Coliforms	cfu/100ml	0/100mls ¹	67	>100
Faecal Coliforms	cfu/100ml	0/100mls ¹	12	>100

Note 1: Limits obtained from S.I. No. 122 of 2014 European Union (Drinking Water) Regulations 2014

Borehole 307 was a new borehole added to the test schedule in 2018. There was elevated lead in the sample in 2018; and while present again in 2019 it had decreased below the 366/2016 threshold.

The water in this well has been classified as slightly acidic; the 2019 sample determined below the drinking water regulation range of 6.5 pH units. There are elevated coliform counts in this groundwater well, however this parameter is not limited by the Regulations and the well is not used for drinking water.

With exception of the aforementioned, all parameters were deemed compliant with the relevant threshold parameters for groundwater.

4.7 Borehole MW101 (MW101)

Table 4-7: Summary of Results

Parameter	Units	S.I. No. 366/2016	MW101								
			Apr-09	Jun-09	Sep-10	Apr-11	Apr-12	Apr-13	Apr-14	Sep-15	Sep-16
Aluminium	ug/l	150	217	-	<10	<10	25	<10	19	93	-
Ammonia	mg/l as NH ₄	0.175	-	-	-	-	-	-	-	-	15
Arsenic	ug/l	7.5	33	39	12	5	6.7	9.1	6.3	4.8	12
Chromium	ug/l	37.5	<0.01	-	-	-	-	-	-	-	-
Lead	ug/l	7.5	-	-	-	-	-	-	-	-	-
Mineral Oil	ug/l	-	<10	-	<10	11	25	79	71	17	<10
pH	Units	6.5 – 9.5 ¹	8.2	-	8.4	8.4	8.2	8.4	8.7	8.1	7.9
PAH	ug/l	0.075	<0.05	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.04
TPH	ug/l	7.5	10	-	54	51	64	180	250	36	29
Vanadium	ug/l	-	-	-	-	<10	<10	<10	8.9	7.2	19
Total Coliforms	cfu/100ml	0/100mls ¹	-	-	-	30	30	>100	69	6	17
Faecal Coliforms	cfu/100ml	0/100mls ¹	-	-	-	0	0	11	0	-	-
Parameter	Units	S.I. No. 366/2016	MW101								
			Sep-17	Sep-18	May-19						
Aluminium	ug/l	150	11	<10	<10						
Ammonia	mg/l as NH ₄	0.175	2.4	29	18						
Arsenic	ug/l	7.5	9.9	8.5	10						
Chromium	ug/l	37.5	1.4	1.9	1.9						
Lead	ug/l	7.5	<1	0.62	1.4						
Mineral Oil	ug/l	-	<10	<10	21						
pH	Units	6.5 – 9.5 ¹	7.4	7.9	7.3						
PAH	ug/l	0.075	<0.04	<0.04	<0.2						
TPH	ug/l	7.5	<10	<10	40						
Vanadium	ug/l	-	13	14	14						
Total Coliforms	cfu/100ml	0/100mls ¹	3	>100	>100						
Faecal Coliforms	cfu/100ml	0/100mls ¹	1	22	76						

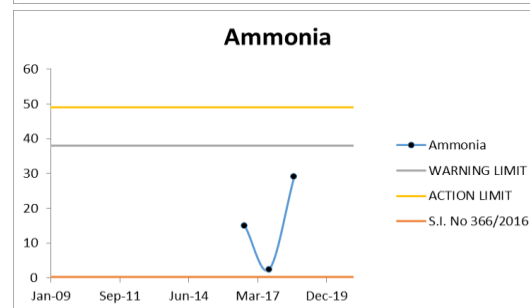
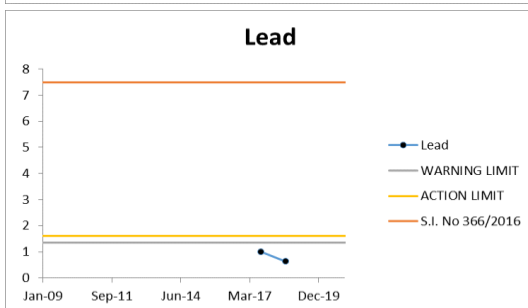
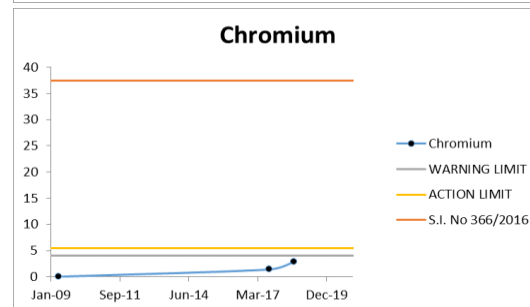
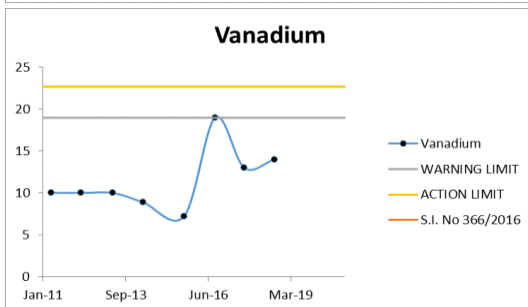
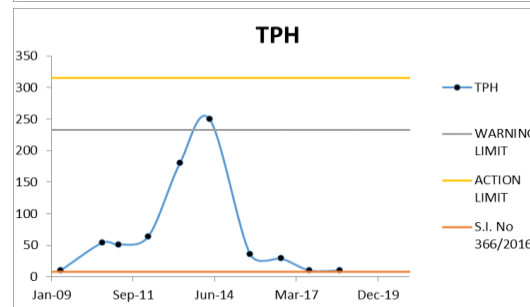
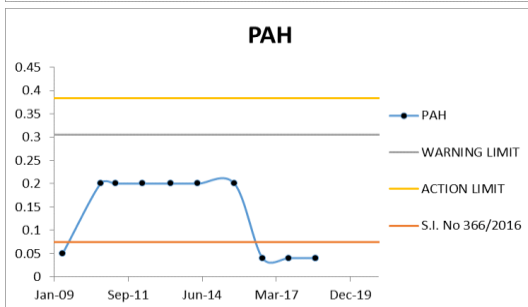
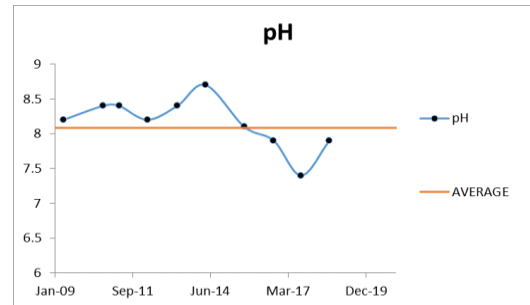
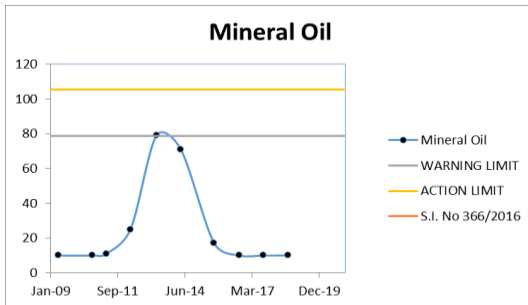
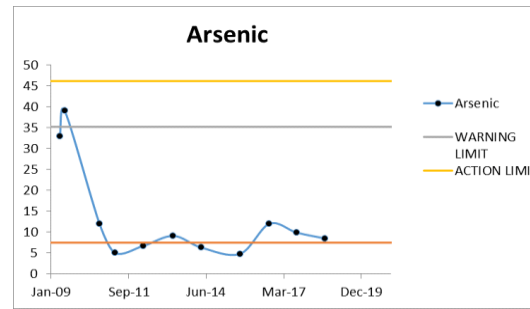
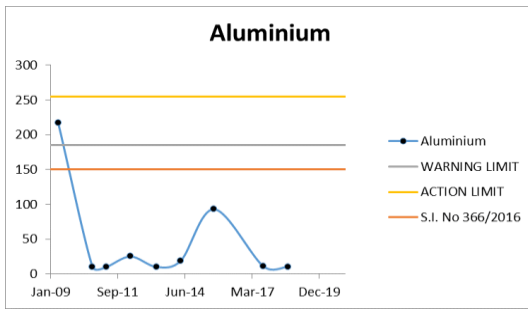
Note 1: Limits obtained from S.I. No. 122 of 2014 European Union (Drinking Water) Regulations 2014

This well was determined to be contaminated with a range of compounds over the sampling period. The well had initially exhibited elevated Aluminium however this was observed over the years since 2009 below the groundwater directive threshold.

The well has consistently shown elevated concentrations of ammonia, with 4 samples analysed and 4 samples exceeding the limit during the period. The concentration of ammonia has increased from a low of 2.4 mg/l in 2017 to a high of 29 in 2018. These concentrations exceed the threshold given in 366/2016 of 0.175 mg/l.

Arsenic has regularly been elevated during the monitoring period, with 8 of the twelve samples exceeding threshold limits in 366/2016. Levels of arsenic in the water have been relatively variable with concentrations ranging from 5 to 39 ug/l. In the past 3 years the concentrations have been relatively consistent, just above the threshold of the Groundwater Directive.

TPHs have been detected in the well each year with the exception of 2017 – 2018 (9 exceedances in 11 samples). However, TPH concentrations rebounded in 2019 to 40 ug/l, above the threshold limit of 7.5 ug/l.



4.8 Borehole MW102 (MW102)

Table 4-8: Summary of Results

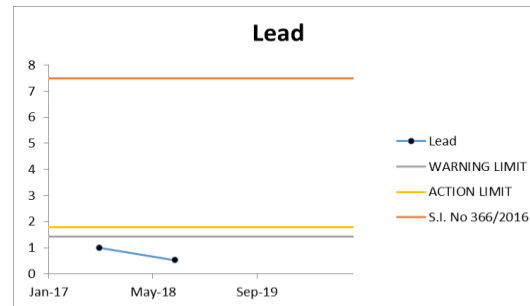
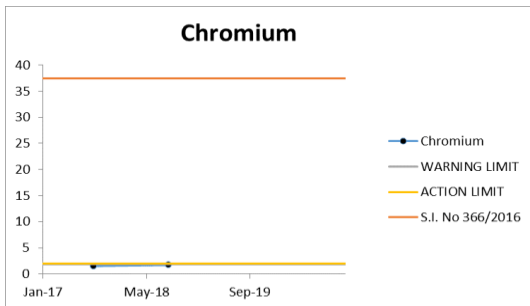
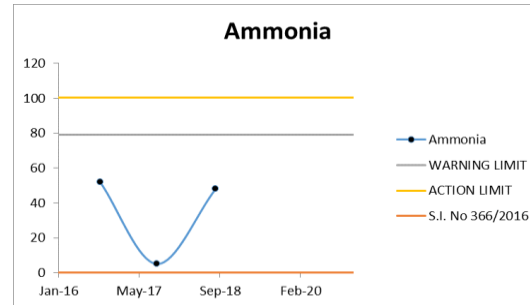
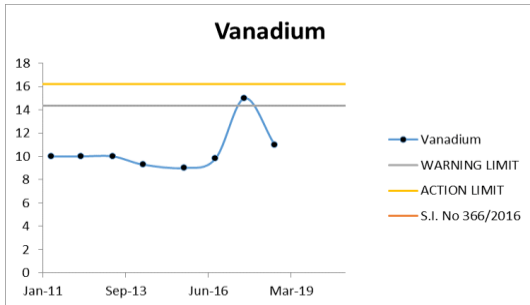
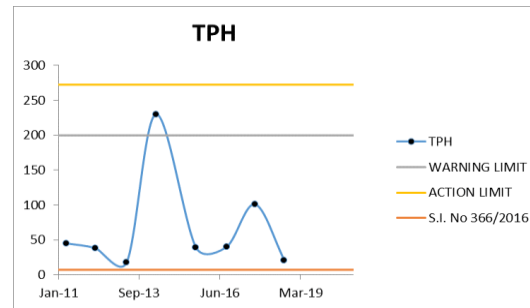
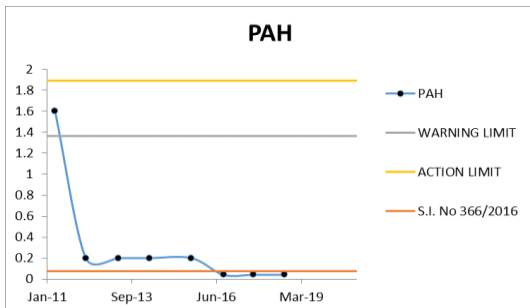
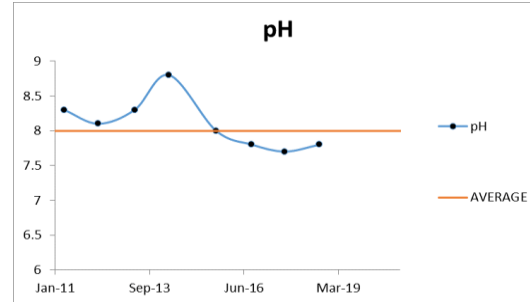
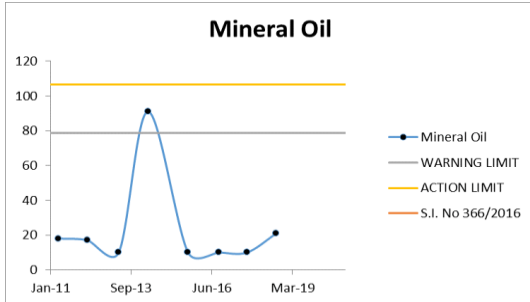
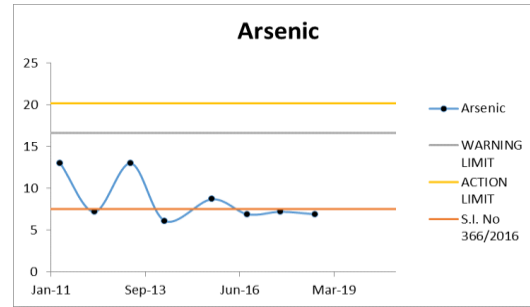
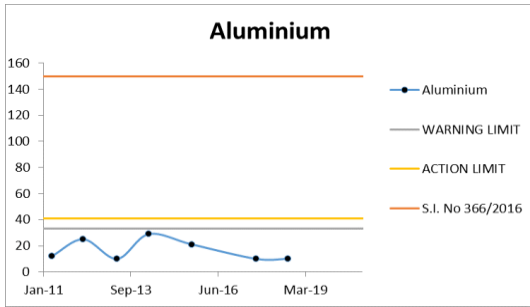
Parameter	Units	S.I. No. 366/2016	MW102								
			Apr-11	Apr-12	Apr-13	Apr-14	Sep-15	Sep-16	Sep-17	Sep-18	May-19
Aluminium	ug/l	150	12	25	<10	29	21	-	<10	<10	<10
Ammonia	mg/l as NH ₄	0.175	-	-	-	-	-	52	5.1	48	40
Arsenic	ug/l	7.5	13	7.2	13	6.1	8.7	6.9	7.2	6.9	16
Chromium	ug/l	37.5	-	-	-	-	-	-	1.5	1.7	2.6
Lead	ug/l	7.5	-	-	-	-	-	-	<1	0.52	2.9
Mineral Oil	ug/l	-	18	17	10	91	<10	<10	<10	21	16
pH	Units	6.5 – 9.5 ¹	8.3	8.1	8.3	8.8	8.0	7.8	7.7	7.8	7.2
PAH	ug/l	0.075	1.6	<0.20	<0.20	<0.20	<0.20	<0.04	<0.04	<0.04	<0.2
TPH	ug/l	7.5	45	38	18	230	39	40	10	21	34
Vanadium	ug/l	-	<10	<10	<10	9.3	9.0	9.8	15	11	19
Total Coliforms	cfu/100ml	0/100mls ¹	95	78	>100	76	50	41	7	>100	>100
Faecal Coliforms	cfu/100ml	0/100mls ¹	4	13	3	0	-	-	2	33	>100

Note 1: Limits obtained from S.I. No. 122 of 2014 European Union (Drinking Water) Regulations 2014

TPHs have consistently exceeded the Groundwater Directive limits of 7.5 ug/l over the monitoring period. The levels were determined to range from 10 to 230 ug/l. The trend is that this pollutant is in decline in this well since 2014, nevertheless is still above the threshold associated with this parameter.

PAHs were detected above the limit of detection on one occasion, in 2011. The limit of detection (LOD) for certain PAH samples was above the threshold in the Directive, however samples taken between 2016 and 2018 would indicate that concentrations in this well are below that required.

The well had elevated concentrations of Arsenic in 2011 – 2013 which subsequently dropped below the threshold throughout samples taken between 2014 and 2018. The samples taken in 2019 would indicate a rebound of arsenic in the well.



4.9 Borehole MW103 (MW103)

Table 4-9: Summary of Results

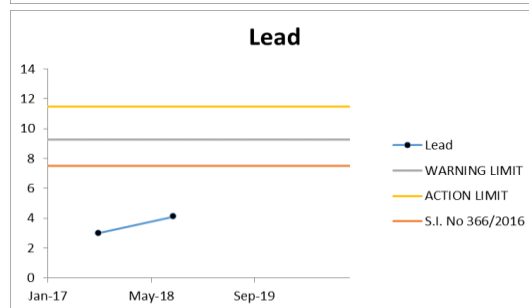
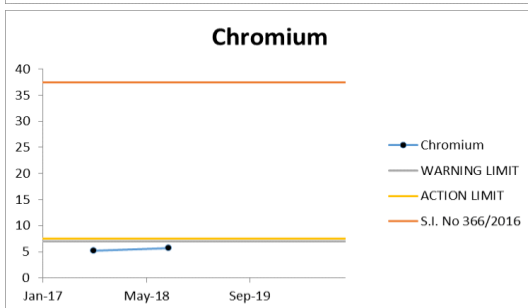
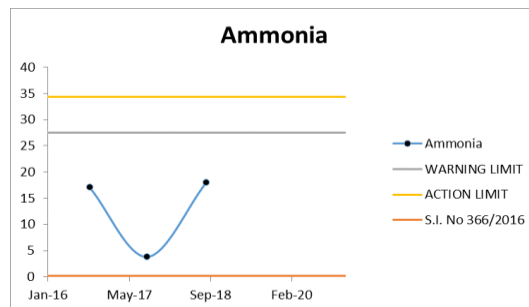
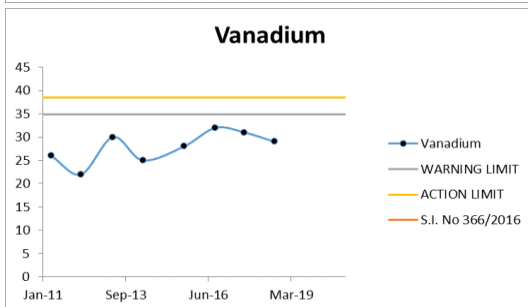
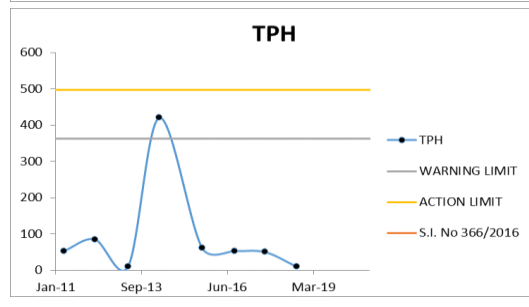
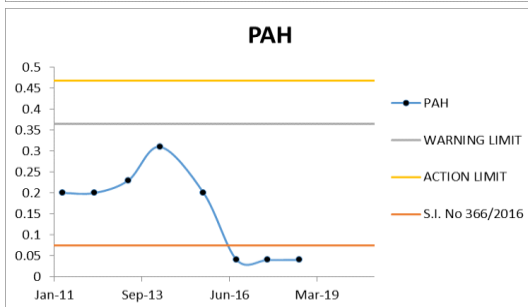
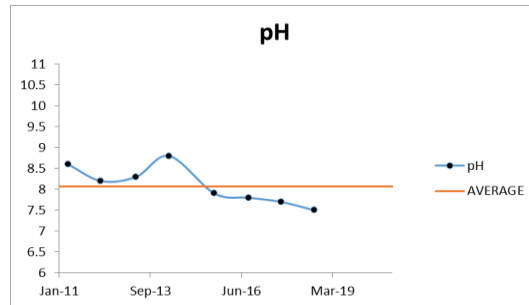
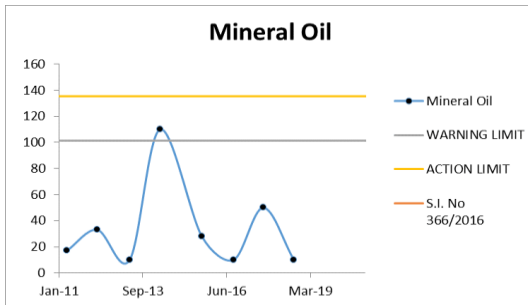
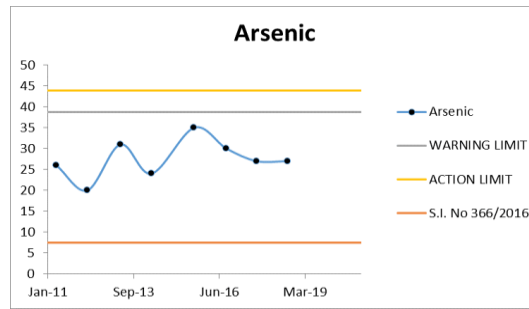
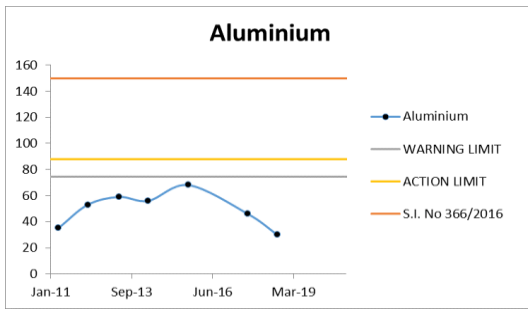
Parameter	Units	S.I. No. 366/2016	MW103								
			Apr-11	Apr-12	Apr-13	Apr-14	Sep-15	Sep-16	Sep-17	Sep-18	May-19
Aluminium	ug/l	150	35	53	59	56	68	-	46	30	37
Ammonia	mg/l as NH ₄	0.175	-	-	-	-	-	17	3.8	18	17
Arsenic	ug/l	7.5	26	20	31	24	35	30	27	27	36
Chromium	ug/l	37.5	-	-	-	-	-	-	5.2	5.7	6.4
Lead	ug/l	7.5	-	-	-	-	-	-	3	4.1	7.3
Mineral Oil	ug/l	-	17	33	<10	110	28	<10	50	<10	<10
pH	Units	6.5 – 9.5 ¹	8.6	8.2	8.3	8.8	7.9	7.8	7.7	7.5	7.8
PAH	ug/l	0.075	<0.20	<0.20	0.23	0.31	<0.20	<0.04	<0.04	<0.04	<0.2
TPH	ug/l	7.5	53	85	11	420	61	53	50	<10	<10
Vanadium	ug/l	-	26	22	30	25	28	32	31	29	37
Total Coliforms	cfu/100ml	0/100mls ¹	66	>100	>100	75	>100	>100	>100	>100	>100
Faecal Coliforms	cfu/100ml	0/100mls ¹	10	25	0	1	-	-	>76	>100	>100

Note 1: Limits obtained from S.I. No. 122 of 2014 European Union (Drinking Water) Regulations 2014

There has been persistent exceedance of the ground water threshold limit for Arsenic since 2011 in this well. The concentrations ranged from 20 ug/l to a high of 36 ug/l, against a threshold limit of 7.5 ug/l.

The TPH concentrations were also determined in elevated concentrations, from 53 ug/l in 2011 to a high of 420 in 2014. This parameter has been steadily decreasing since 2014 where it was determined below the limit of detection for this test.

PAHs were detected above the threshold of the Groundwater Directive in 2013 and 2014 however have since been determined compliant in samples obtained between 2016 and 2018. There was nothing detected in the 2019 sample however the LOD is in excess of the groundwater threshold. This does not allow for adequate assessment of compliance in 2019.



4.10 Borehole MW200 (MW200)

Table 4-10: Summary of Results

Parameter	Units	S.I. No. 366/2016	MW200								
			Apr-09	Sep-10	Apr-11	Apr-12	Apr-13	Apr-14	Sep-15	Sep-16	Sep-17
Aluminium	ug/l	150	90	<10	13	18	<10	25	5	17	<10
Ammonia	mg/l as NH ₄	0.175			<0.1	<0.1	0.11	<0.10	0.54	0.11	<0.10
Arsenic	ug/l	7.5	3.7	<1	<1	<1.0	1.2	0.43	0.68	2.7	1.1
Chromium	ug/l	37.5	-	-	-	-	-	-	-	-	-
Lead	ug/l	7.5	-	-	-	-	-	-	-	-	-
Mineral Oil	ug/l	-	<10	25	38	46	36	160	20	20	73
pH	Units	6.5 – 9.5 ¹	6.9	7.1	7.3	7.3	7.1	7.1	6.9	6.7	7
PAH	ug/l	0.075	<0.05	0.23	0.41	<0.20	<0.20	<0.20	<0.20	<0.04	<0.04
TPH	ug/l	7.5	<10	65	280	120	84	470	130	100	270
Vanadium	ug/l	-	-	-	<10	<10	<10	0.8	<0.6	2.1	3.9
Total Coliforms	cfu/100ml	0/100mls ¹	-	-	>100	>100	>100	>100	>100	61	>100
Faecal Coliforms	cfu/100ml	0/100mls ¹	-	-	3	62	0	10	-	-	64
Parameter	Units	S.I. No. 366/2016	MW200								
			Sep-18	May-19							
Aluminium	ug/l	150	174	<10							
Ammonia	mg/l as NH ₄	0.175	0.14	<0.1							
Arsenic	ug/l	7.5	0.54	2							
Chromium	ug/l	37.5	<0.25	0.75							
Lead	ug/l	7.5	0.16	5.2							
Mineral Oil	ug/l	-	87	24							
pH	Units	6.5 – 9.5 ¹	7.1	6.5							
PAH	ug/l	0.075	<0.04	<0.2							
TPH	ug/l	7.5	210	74							
Vanadium	ug/l	-	0.7	3.6							
Total Coliforms	cfu/100ml	0/100mls ¹	>100	>100							
Faecal Coliforms	cfu/100ml	0/100mls ¹	>100	>100							

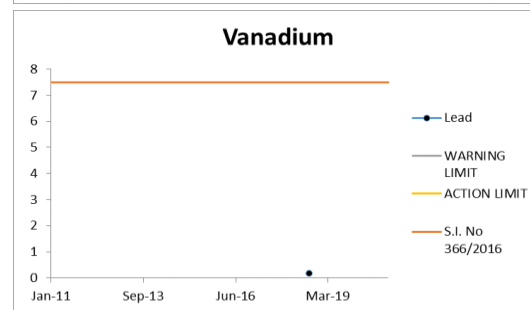
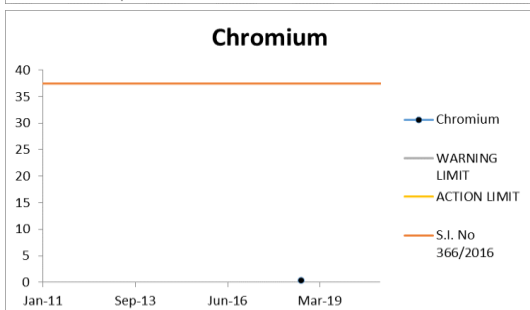
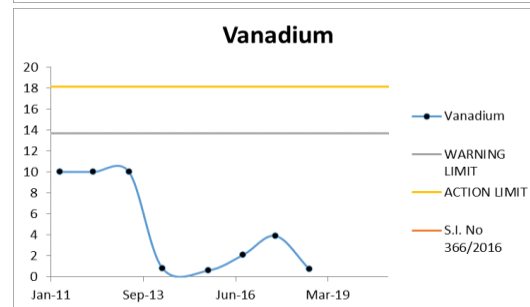
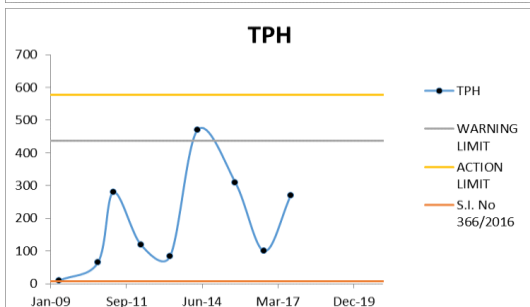
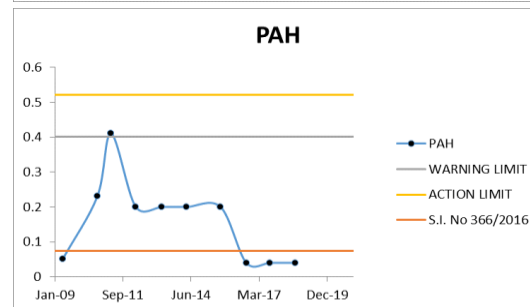
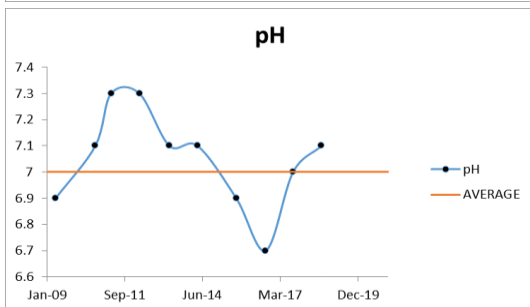
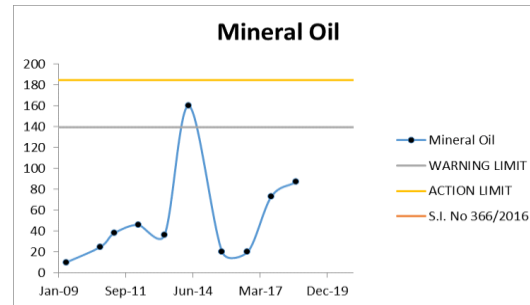
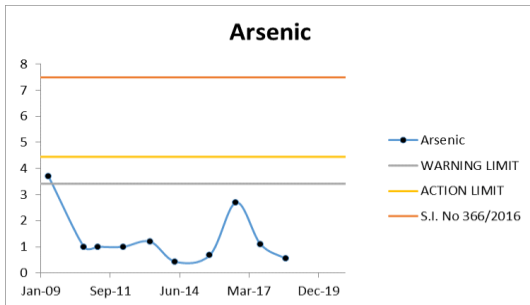
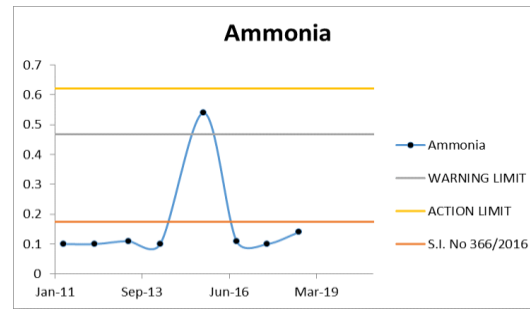
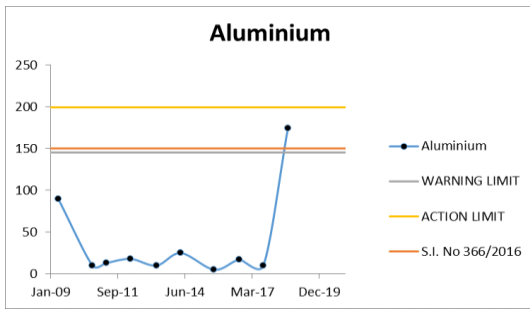
Note 1: Limits obtained from S.I. No. 122 of 2014 European Union (Drinking Water) Regulations 2014

TPHs were consistently detected above the threshold outlined in 366/2016 from 2010 to 2019. The concentrations are variable, however constantly well above the 366/2016 limit of 7.5 ug/l. The concentrations were determined to range from 65 to 470 ug/l.

PAHs were detected in the well in 2010 and 2011 but have been below the laboratories limit of detection since.

There was one incidence of aluminium identified in the well above the threshold however this was observed to revert from 174 ug/l in 2018 to below the limit of detection in 2019.

Ammonia was determined to exceed the limit once during the period, in 2015 at a concentration of 0.54 mg/l, however has decreased to <0.1 mg/l in the 2019 sample.



4.11 Borehole MW106 (MW106)

Table 4-11: Summary of Results

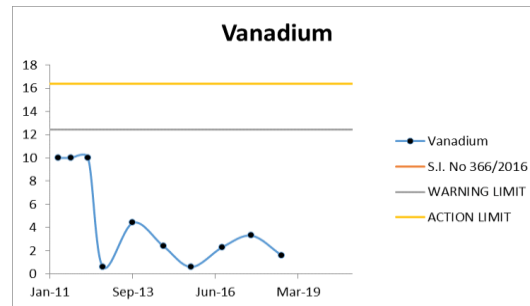
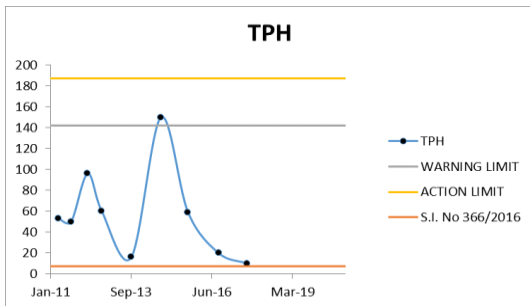
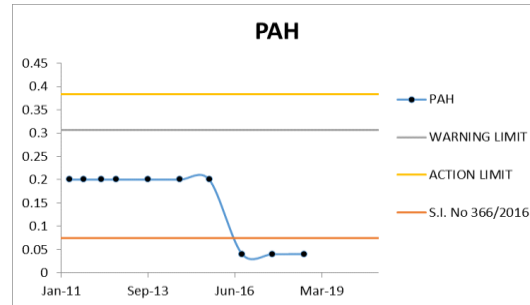
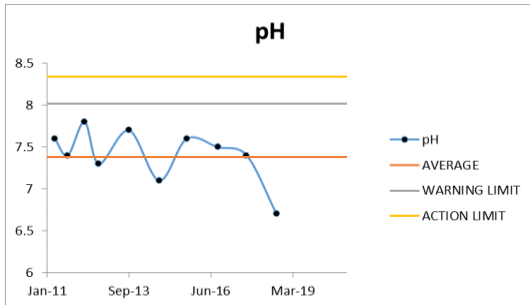
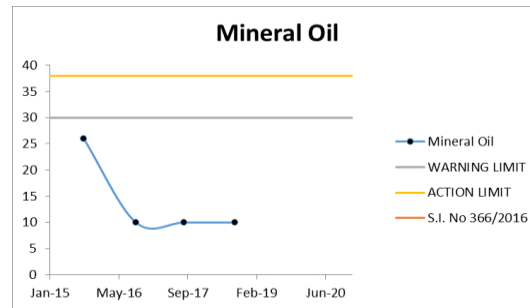
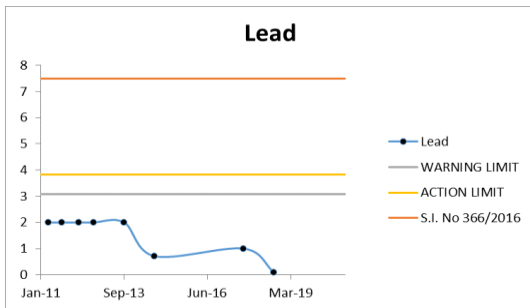
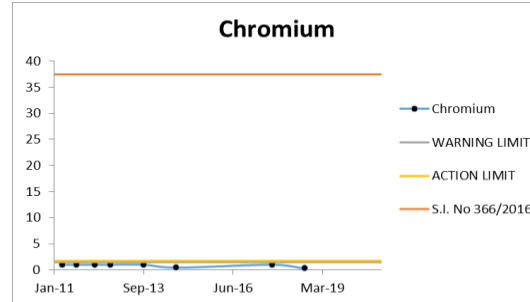
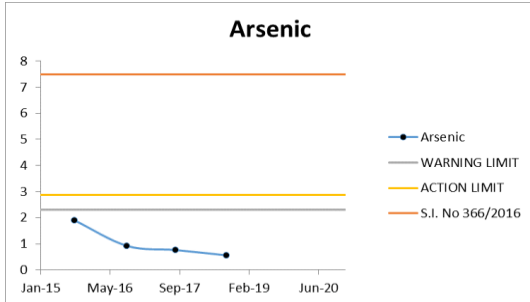
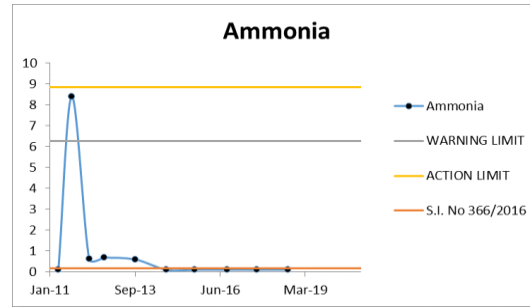
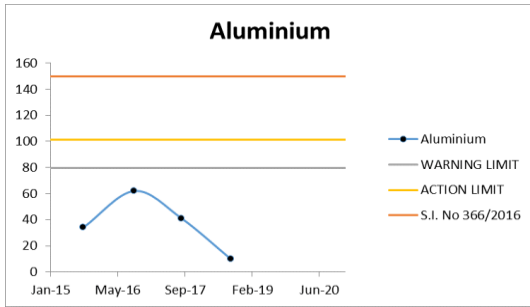
Parameter	Units	S.I. No. 366/2016	MW106								
			Apr-11	Sep-11	Apr-12	Sep-12	Sep-13	Sep-14	Sep-15	Sep-16	Sep-17
Aluminium	ug/l	150	-		-	-	-	-	34	62	41
Ammonia	mg/l as NH ₄	0.175	<0.1	8.4	0.63	0.68	0.6	<0.10	<0.10	<0.10	<0.10
Arsenic	ug/l	7.5	-		-	-	-	-	1.9	0.92	0.76
Chromium	ug/l	37.5	<1	<1	<1	<1	<1	0.42	-	-	<1
Lead	ug/l	7.5	<2	<2	<2	<2	<2	0.71	-	-	<1
Mineral Oil	ug/l	-	-		-	-	-	-	26	<10	<10
pH	Units	6.5 – 9.5 ¹	7.6	7.4	7.8	7.3	7.7	7.1	7.6	7.5	7.4
PAH	ug/l	0.075	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.04	<0.04
TPH	ug/l	7.5	53	50	96	60	16	150	59	20	<10
Vanadium	ug/l	-	<10	<10	<10	0.62	4.4	2.4	<0.6	2.3	3.3
Total Coliforms	cfu/100ml	0/100mls ¹	-	-	-	-	-	-	>100	>100	>100
Faecal Coliforms	cfu/100ml	0/100mls ¹	-	-	-	-	-	-	-	-	-
Parameter	Units	S.I. No. 366/2016	MW106								
			Sep-18	May-19							
Aluminium	ug/l	150	<10	<10							
Ammonia	mg/l as NH ₄	0.175	<0.10	<0.1							
Arsenic	ug/l	7.5	0.56	1.6							
Chromium	ug/l	37.5	<0.25	1.6							
Lead	ug/l	7.5	<0.09	8.9							
Mineral Oil	ug/l	-	<10	<10							
pH	Units	6.5 – 9.5 ¹	6.7	7.1							
PAH	ug/l	0.075	<0.04	<0.2							
TPH	ug/l	7.5	<10	<10							
Vanadium	ug/l	-	1.6	3.6							
Total Coliforms	cfu/100ml	0/100mls ¹	>100	>100							
Faecal Coliforms	cfu/100ml	0/100mls ¹	>100	>100							

Note 1: Limits obtained from S.I. No. 122 of 2014 European Union (Drinking Water) Regulations 2014

This well like many others at the installation displays elevated concentrations of TPH consistently in the well from 2010 to 2017. The concentrations were observed to decrease over the years and were determined below the laboratories limit of detection in 2018 – 2019.

The well had a historical issue with elevated ammonia 2011 – 2013, but concentrations in later years also have declined to below the limit of detection.

There was one elevated lead result detected in this well in 2019 which was not generally not observed in previous recordings.



4.12 Borehole MW202 (MW202)

Table 4-12: Summary of Results

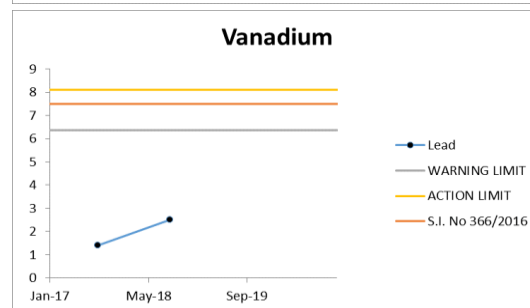
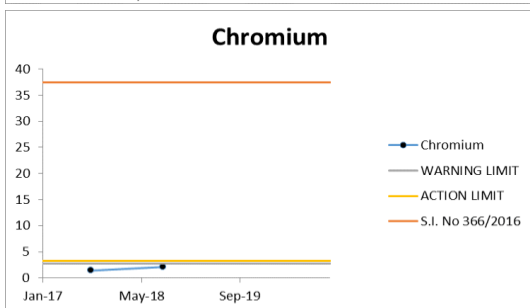
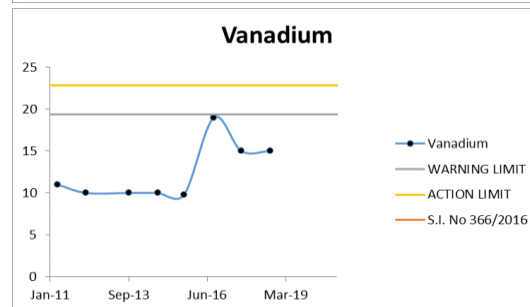
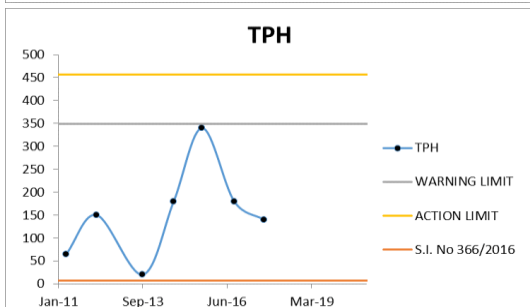
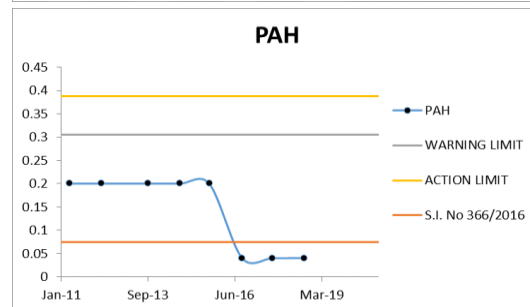
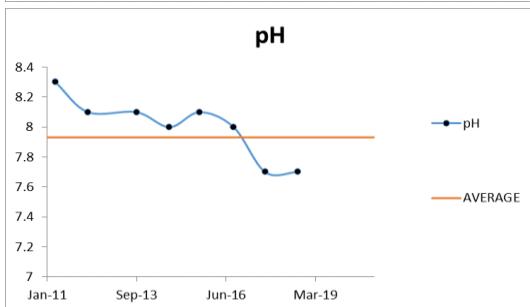
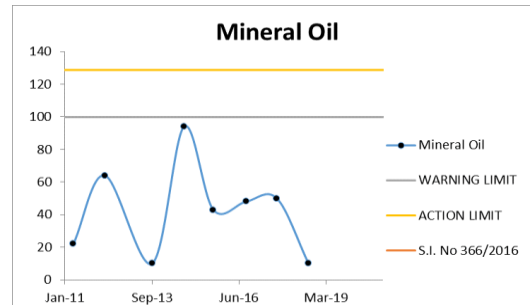
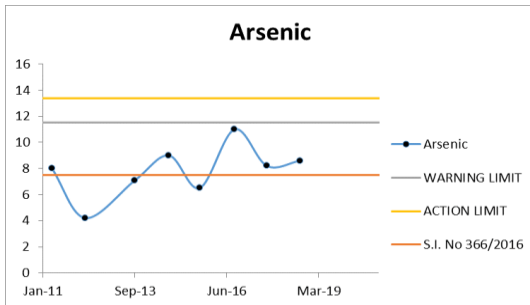
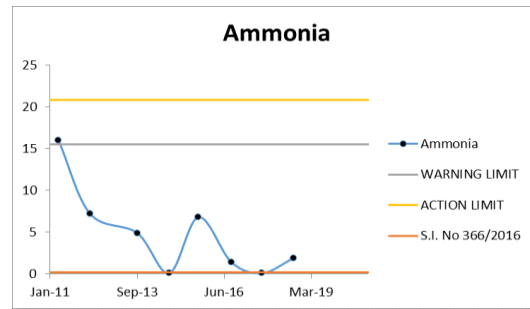
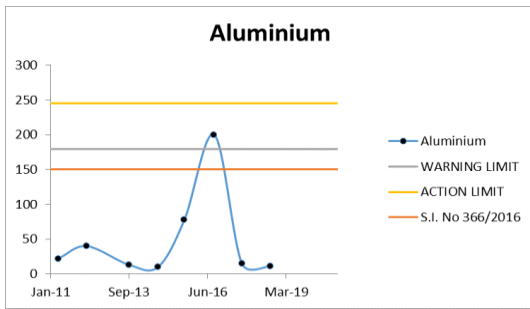
Parameter	Units	S.I. No. 366/2016	MW202								
			Apr-11	Apr-12	Sep-13	Sep-14	Sep-15	Sep-16	Sep-17	Sep-18	May-19
Aluminium	ug/l	150	22	40	13	<10	78	200	15	11	17
Ammonia	mg/l as NH ₄	0.175	16	7.2	4.9	<0.10	6.8	1.4	<0.10	1.9	2.3
Arsenic	ug/l	7.5	8	4.2	7.1	9	6.5	11	8.2	8.6	7.6
Chromium	ug/l	37.5	-	-	-	-	-	-	1.4	2.1	2.2
Lead	ug/l	7.5	-	-	-	-	-	-	1.4	2.5	4.8
Mineral Oil	ug/l	-	22	64	<10	94	43	48	50	<10	38
pH	Units	6.5 – 9.5 ¹	8.3	8.1	8.1	8	8.1	8.0	7.7	7.7	7.4
PAH	ug/l	0.075	<0.20	<0.20	<0.20	<0.20	<0.20	<0.04	<0.04	<0.04	<0.2
TPH	ug/l	7.5	65	150	20	180	340	180	140	<10	84
Vanadium	ug/l	-	11	<10	10	10	9.8	19	15	15	17
Total Coliforms	cfu/100ml	0/100mls ¹	52	>100	>100	57	10	78	>100	73	>100
Faecal Coliforms	cfu/100ml	0/100mls ¹	16	31	-	-	-	-	-	18	44

Note 1: Limits obtained from S.I. No. 122 of 2014 European Union (Drinking Water) Regulations 2014

This well has a persistent contamination issues with ammonia, being elevated on 7 of the 9 occasions it was tested between 2011 and 2019. There is a varied range of ammonia within this well, detected from <0.1 to 16 mg/l, with occasional drop off in concentrations and bounce back over the years.

TPH was also consistently above the threshold with the exception of 2018 where it was detected below the limit of detection for the test. This result is not consistent as the general range for TPH in this water was from 20 to 340 ug/l.

All other parameters where limits of detection allow, were determined as compliant with threshold levels outlined in 366/2016.



4.13 Borehole MW203 (MW203)

Table 4-13: Summary of Results

Parameter	Units	S.I. No. 366/2016	MW203	
			Sep-18	May-19
Aluminium	ug/l	150	<10	<10
Ammonia	mg/l as NH ₄	0.175	<0.10	<0.1
Arsenic	ug/l	7.5	1.6	0.88
Chromium	ug/l	37.5	0.52	0.37
Lead	ug/l	7.5	0.12	0.17
Mineral Oil	ug/l	-	<10	<10
pH	Units	6.5 – 9.5 ¹	6.9	6.8
PAH	ug/l	0.075	<0.04	<0.2
TPH	ug/l	7.5	<10	<10
Vanadium	ug/l	-	1.9	1.6
Total Coliforms	cfu/100ml	0/100mls ¹	>100	>100
Faecal Coliforms	cfu/100ml	0/100mls ¹	>100	>100

Note 1: Limits obtained from S.I. No. 122 of 2014 European Union (Drinking Water) Regulations 2014

There were only 2 samples obtained from this well during the period however the quality of water is compliant for the parameters tested with the limits applied in 366/2016 where laboratory LODs allow an assessment be made.

5. Conclusions

Sampling has been carried out for predefined parameters in line with requirements outlined in the Industrial Emissions Licence Condition C.5 on an annual and biennial basis.

There is widespread total and faecal coliform contamination of groundwater across the survey site. The source of coliform contamination could be either local agricultural or more likely waste decomposition in the cells. Water in this area is not used for drinking purposes.

Concentrations of aluminium were deemed to exceed the Groundwater Regulation's Threshold 9 times from 7 different wells over the 10-year monitoring campaign. The concentrations of aluminium detected were not deemed hazardous and would not impact on the site from continuing to operate for its designated industrial purposes.

There was significant number of wells determined to exceed S.I. No. 366 of 2016 for ammonia. There were 9 wells which experienced elevated ammonia concentrations on a regular basis during the monitoring period. The source of this would most likely be the decomposition of organic material from the waste disposal cells.

TPH was observed in elevated concentrations in all wells tested at some stage over the monitoring period with the exception of MW203. The source of this parameter was most likely from historical practices and waste deposition on site. This would be the parameter of most significance in the groundwater wells due to its persistence and existence across the sample area.

PAHs were randomly determined in 6 different wells. The laboratory limit of detection was oftentimes in excess of the limits applied in S.I. No. 366 of 2016, therefore assessment against the standards was not possible. It is recommended that a suitable limit of detection is obtained for this parameter as some years the LOD was below the required range and more often it was above it. However, from the results available, PAH contamination in the groundwaters has dissipated over the years and has not been detected in any well since 2013.

Heavy metals analysed include Arsenic, Vanadium and Lead. Lead concentrations were compliant with the Groundwater Regulations in all wells with the exception of BH307 (2018) and MW106 (2019). This parameter is not a significant issue for the site, however should be monitored closely as the concentrations detected have increased in recent years. Arsenic concentrations have been very variable throughout the site groundwater wells. In general, the concentrations have complied with the Regulations, however there were 15 occasions whereby an exceedance was noted over the 10-year period assessed.

Figure 1: Location Of Existing Bores – 21st May 2018

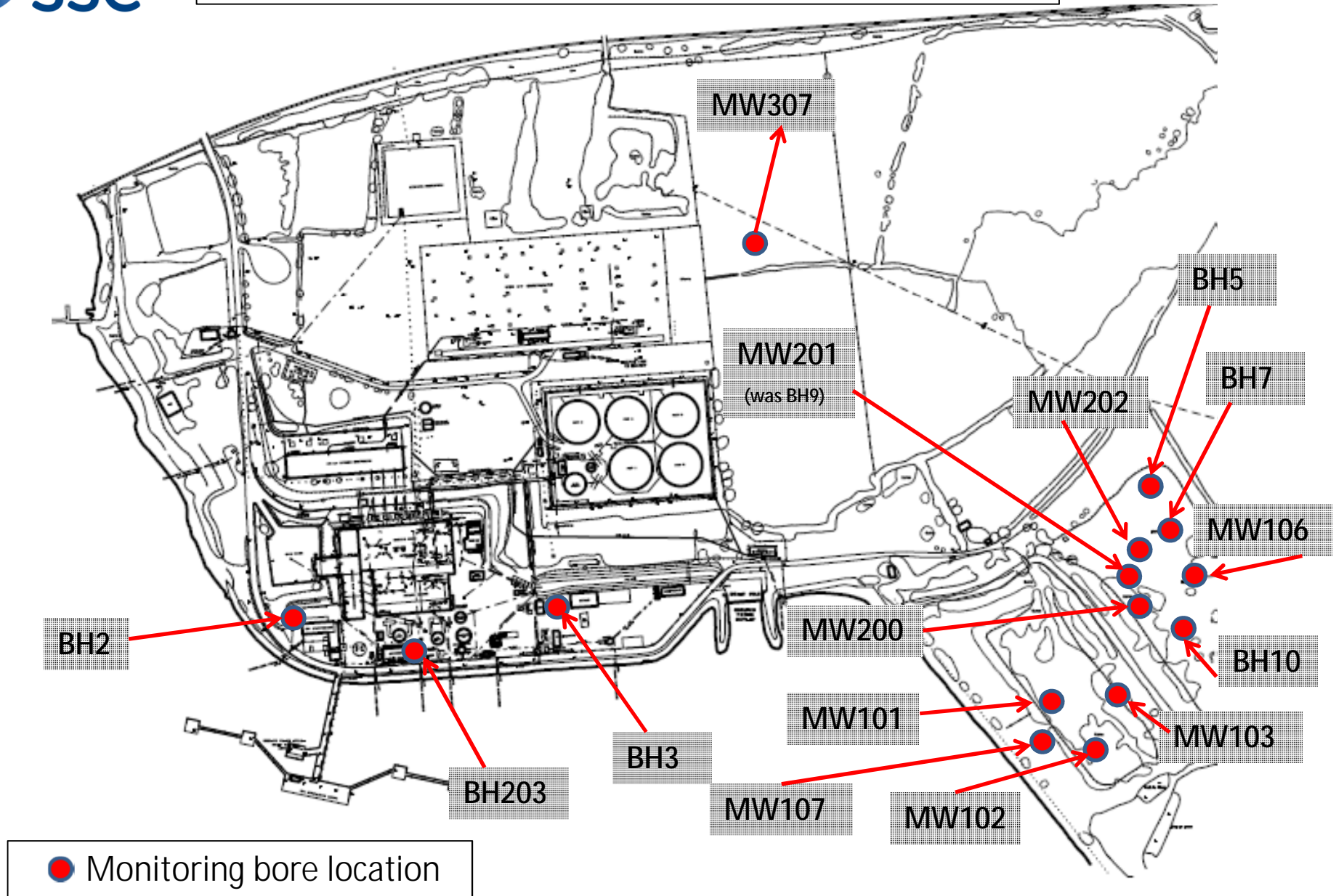


Figure 1: Location Of Existing Bores – 21st May 2018

