

2 SEAM (PTY) LTD

QUARTERLY WATER MONITORING REPORT: VLAKLAAGTE COAL MINE

For the period January 2022 to March 2022

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LIST OF ABBREVIATIONS

DWS:	Department of Water and Sanitation
EC:	Electrical Conductivity
EMPr:	Environmental Management Programme
EMSM:	Environmental Monitoring Systems Manual
IWWMP:	Integrated Water and Waste Management Plan
km:	Kilometre
mbgl:	Metres below ground level
OC:	Opencast
ODW:	Office Drinking Water
PCD:	Pollution Control Dam
RQO:	Resource Quality Objectives
SANAS:	South African National Accreditation System
SANS:	South African National Standard
SAWQG:	South African Water Quality Guidelines



SO₄: Sulphate
WQPL: Water Quality Planning Limits
WULA: Water Use Licence Application
WUL: Water Use Licence
Zyntha: Zyntha Consulting (Pty) Ltd



1 INTRODUCTION

Zyntha Consulting (Pty) Ltd (“Zyntha”) was appointed by 2 Seam (Pty) Ltd to compile the Vlaklaagte Coal Mine Quarterly Water Monitoring Reports for 2022. Quarterly reports are a requirement of the Environmental Management Programme (EMPr) and as per the requirements stated in Appendix V, Section 5.2 of the Water Use Licence (WUL No.: **06/B11B/AICGJ/7070**) of Vlaklaagte Coal Mine. This report is the first quarterly report for 2022.

Vlaklaagte is situated in the Emalahleni Local Municipality within the Nkangala District Municipality. The closest town is Kriel, which is located approximately 10 km south-west of Vlaklaagte. Refer to **Figure 1** for the locality of the Vlaklaagte Coal Mine.

On a quarterly basis, the reports detail the data collected for the following:

- Surface Water and Groundwater Chemistry;
- Bacteriological Results; and
- Groundwater Levels.

The water quality data is continually received from Regen Waters Laboratory (“Regen”). Regen has been appointed to conduct water sampling and analysis. Standard sampling methods are utilised by Regen. Please refer to **Annexure 1** for Regen Waters Laboratory SANAS accreditation certificate. The data received from Regen is computerised to a dedicated database that is stored at Zyntha.

This report has been compiled for Vlaklaagte Coal Mine for the period of January 2022 to March 2022. The report also includes additional information such as an audit of monitoring actions performed, a parameter trend analysis for each water monitoring point and Piper, Wilcox & Schoeller plots.



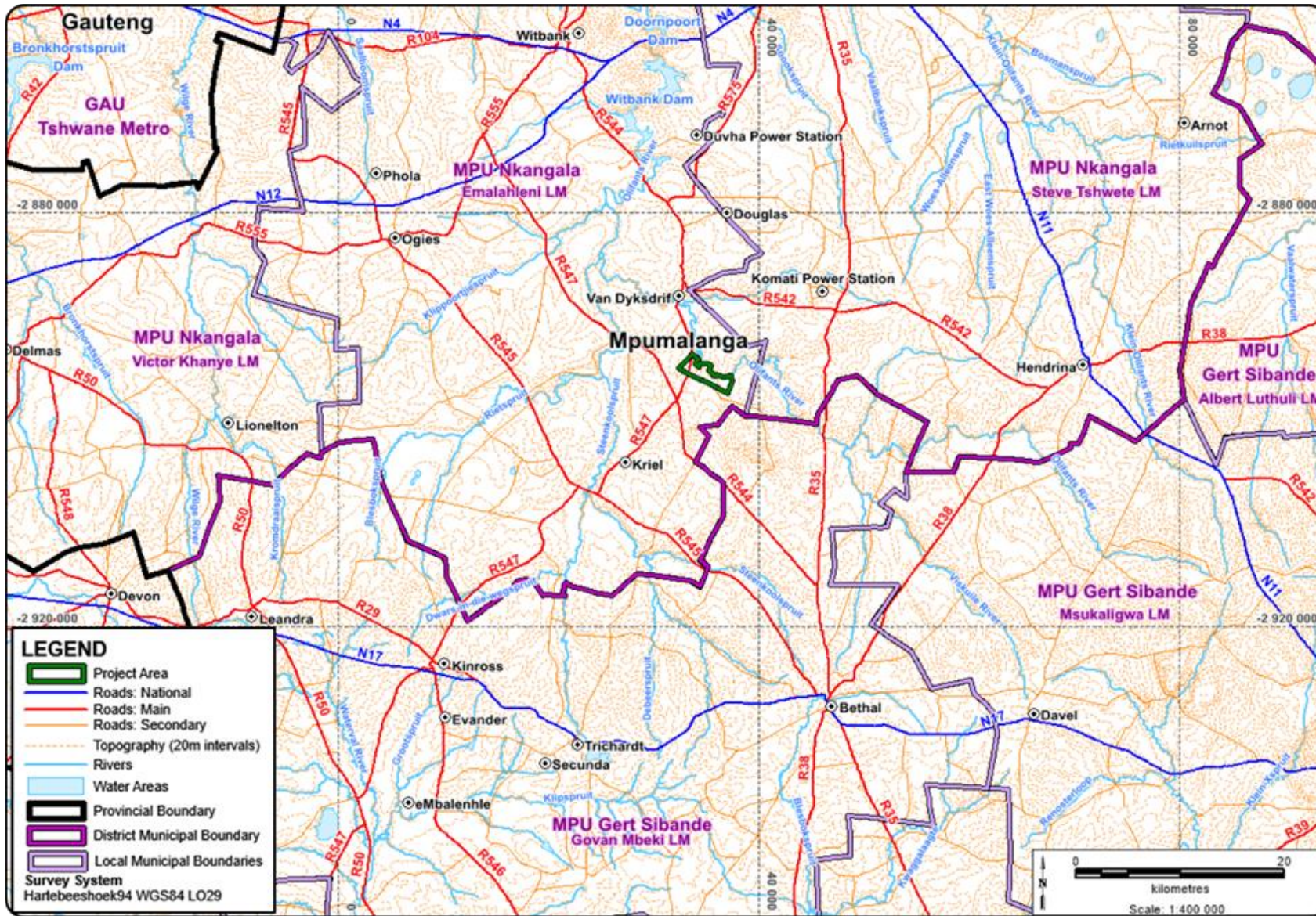


Figure 1: Regional locality of the Vlaklaagte Coal Mine



The report has the following objectives: -

- To comply with the monitoring commitments agreed to in the EMPr and IWWMP;
- To comply with the reporting commitments stipulated in the EMPr and comply with reporting requirements of the WUL;
- To determine the effectiveness of the measures implemented on-site to prevent and manage water pollution;
- To measure compliance of the monitoring results to the Resource Quality Objectives (RQO) of the catchment, water qualities set in the WUL and/or baseline water qualities (prior to the commencement of mining);
- To recommend additional remediation measures if current measures are futile;
- To develop a data basis and identify trends; and
- To serve as an auditing tool to measure effectiveness and compliance.



2 WATER MONITORING NETWORK

The surface water monitoring network is depicted in **Table 1** and **Figure 2**. All contaminated sources must be measured against the water quality parameters included in the WUL. Surface water monitoring is conducted on a monthly basis, as required by the EMPr and WUL.

As per the approved WUL, the following conditions dictate the actions to be taken regarding the monitoring network:

Appendix IV, Condition 2.3.18:

“The Licensee must measure groundwater quality (notably pH, Electrical conductivity (mS/m), Calcium (Ca) (mg/l), Magnesium (Mg) (mg/l), Potassium (K) (mg/l), Sodium (Na) (mg/l), Chloride (Cl) (mg/l), Sulphate (SO₄) (mg/l), Aluminium (Al) (mg/l), Iron (Fe) (mg/l), Manganese (Mn) (mg/l), BTEX & TPH (mg/l) and Nitrate (NO₃ as N) (mg/l) in all monitoring boreholes in a 1 km radius around all the mining operations every month to establish any pollution impacts on the watercourses, notably the wetland, and must be evaluated by a professional, registered wetland specialist and geo-hydrologist when water quality levels increase and/or deteriorate more than 50% from the previous monitoring event and be reported to the Provincial Head for written comment within thirty (30) days after each monitoring event.”

Appendix IV, Condition 2.3.19:

“The Licensee must sample and analyse twice a year (dry – July and wet – January season) all surface and groundwater monitoring points for a full spectrum of heavy metals and submit this information with conditions 3.3.1, 3.3.17 and 3.3.18 to the Provincial Head.”

Appendix IV, Condition 4.3:

“Six (6) monthly monitoring reports must be submitted to the responsible Authority until otherwise agreed in writing with the Provincial Head.”

Appendix V, Condition 2.1:

“The Licensee shall not exceed the quality of the waste or water containing waste disposed of into waste water management facilities listed in Table 6”

Parameter	Pollution Control Dams Water Qualities (Average results over twelve months)
pH	8.46
Electrical Conductivity (EC) in mS/m	232
Total Dissolved Solids (TDS) in mg/l	2700
Chlorides (Cl) in mg/l	39.78



Parameter	Pollution Control Dams Water Qualities (Average results over twelve months)
Sulphate (SO ₄) in mg/l	2000
Sodium (Na) in mg/l	290.8
Iron as Fe	0.01
Manganese as Mn	0.02
Aluminium as Al	0.02

Appendix V, Condition 3.2:

“The date, time and monitoring point in respect of each sample taken must be recorded together with the results of the analysis”

Appendix VII, Condition 4:

“The quantity of water removed from underground must be metered and recorded on a daily basis”

Appendix VII, Condition 8:

“The date and time of monitoring in respect of each sample taken must be recorded together with the results of analysis”

The groundwater monitoring network is depicted in **Table 2** and **Figure 3**. BH2 and BH3 will not be discussed in this report as both boreholes were destroyed by opencast mining. Vlaklaagte should consider drilling two new boreholes within close proximity to the original boreholes.

All of the boreholes are sampled on a monthly basis, except for BH-1 which is sampled quarterly. Water level measurements are taken on a monthly basis at all of the boreholes except at the Office Drinking Water (ODW) monitoring point as this borehole is fitted with a pump, making water level measurements impossible. Bacteriological analysis is also currently being conducted at ODW.

The current surface water monitoring plan was re-evaluated and adjusted. The following monitoring points were removed:

- 2S_SW5
- 2S_SW6
- 2S_SW10
- 2S_SW11
- 2S_SW12



- 2S_SW13
- 2S_SW15
- 2S_SW17
- SWL01
- SWL02
- SWL03

The removal of the abovementioned points was effective from June 2020. The April to June 2020 report was the last report containing the assessment of the abovementioned surface water monitoring points. The monitoring programme was in discussion with 2 Seam re-evaluated and a new cost-effective programme was implemented as the removed points did not significantly contribute in the understanding of possible impact on water quality. One monitoring point, 2S_SW16 (historical Void), has been re-introduced to the network as a result of 2S_SW9 being occasionally dry. 2S_SW4 was moved further upstream since it was mined out. Sampling of this point commenced in October 2021.



Table 1: Surface Water Monitoring Network

Site Label	Sampling Frequency	Sampled (Y/N)	Reason, if not sampled	Latitude	Longitude
2S_SW1	Monthly	Y		26°10'5.85"S	29°21'20.98"E
2S_SW2	Monthly	Y		26°10'10.03"S	29°22'26.91"E
2S_SW3	Monthly	Y		26° 9'9.71"S	29°20'44.10"E
2S_SW4	Monthly	Y		26° 9'52.2" S	29°20'36.7" E
2S_SW5	Monthly	N	Removed	26° 9'24.93"S	29°19'35.13"E
2S_SW6	Monthly	N	Removed	26° 9'11.31"S	29°20'28.73"E
2S_SW7	Monthly	Y		26°10'8.78"S	29°20'29.03"E
2S_SW8	Monthly	Y		26°10'13.28"S	29°20'35.96"E
2S_SW9	Monthly	Y		26°10'16.46"S	29°22'23.45"E
2S_SW10	Monthly	N	Removed	26°11'31.48"S	29°22'12.37"E
2S_SW11	Monthly	N	Removed	26°11'13.94"S	29°20'26.14"E
2S_SW12	Monthly	N	Removed	26°10'54.48"S	29°19'57.30"E
2S_SW13	Monthly	N	Removed	26°11'23.83"S	29°22'21.70"E
2S_SW14	Monthly	Y		26°10'34.49"S	29°22'20.12"E
2S_SW15	Monthly	N	Removed	26°10'30.44"S	29°22'19.30"E
2S_SW16	Monthly	Y		26°10'28.84"S	29°22'5.67"E
2S_SW17	Monthly	N	Removed	26°10'25.11"S	29°21'57.91"E
2S_SW18	Monthly	Y		26° 9'55.58"S	29°20'23.83"E
SWL01	Monthly	N	Removed	26° 9' 40.49" S	29° 19' 20.6" E
SWL02	Monthly	N	Removed	26° 9' 15.19" S	29° 20' 9.3" E
SWL03	Monthly	N	Removed	26° 9' 7.4" S	29° 20' 32.81" E
VLK-SW7	Monthly	Y		26°10'5.38"S	29°20'22.77"E



Table 2: Groundwater Monitoring Network

Site Label	Sampling Frequency	Bacteriological	Water Levels	Sampled (Y/N)	Reason, if not sampled	Description	Latitude	Longitude
BH1	Monthly	N/A	Monthly	Y		Monitoring borehole located West of Block 5, just below 4 seam floor	26°09'21.2" S	29°19'57.1"E
BH2	Monthly	N/A	Monthly	N	Borehole destroyed.	Monitoring borehole located Block 2 / Block 3A, Just below 2 seam floors.	26°10'31.50"S	29°21'3.79"E
BH3	Monthly	N/A	Monthly	N	Borehole destroyed.	Monitoring borehole located Block 1, Just below 2 seam floor	26°10'15.17"S	29°22'19.77"E
BH4	Monthly	N/A	Monthly	Y		Monitoring borehole located Block 5, Just below 4 seam floor	26° 9'44.45"S	29°20'19.69"E
BH5	Monthly	N/A	Monthly	Y		Monitoring borehole located Mined Out Block 1, Just below 2 seam floor / historical mining depth	26°10'14.16"S	29°21'13.54"E
ODW	Monthly	Yes	N/A	Y		Monitoring point for purpose of portable water uses	26°10'42.2" S	29°21'34.0"E
BH-1	Quarterly	N/A	Monthly	Y		Mining monitoring borehole located close to OC void	26°10'10.37"S	29°20'10.49"E



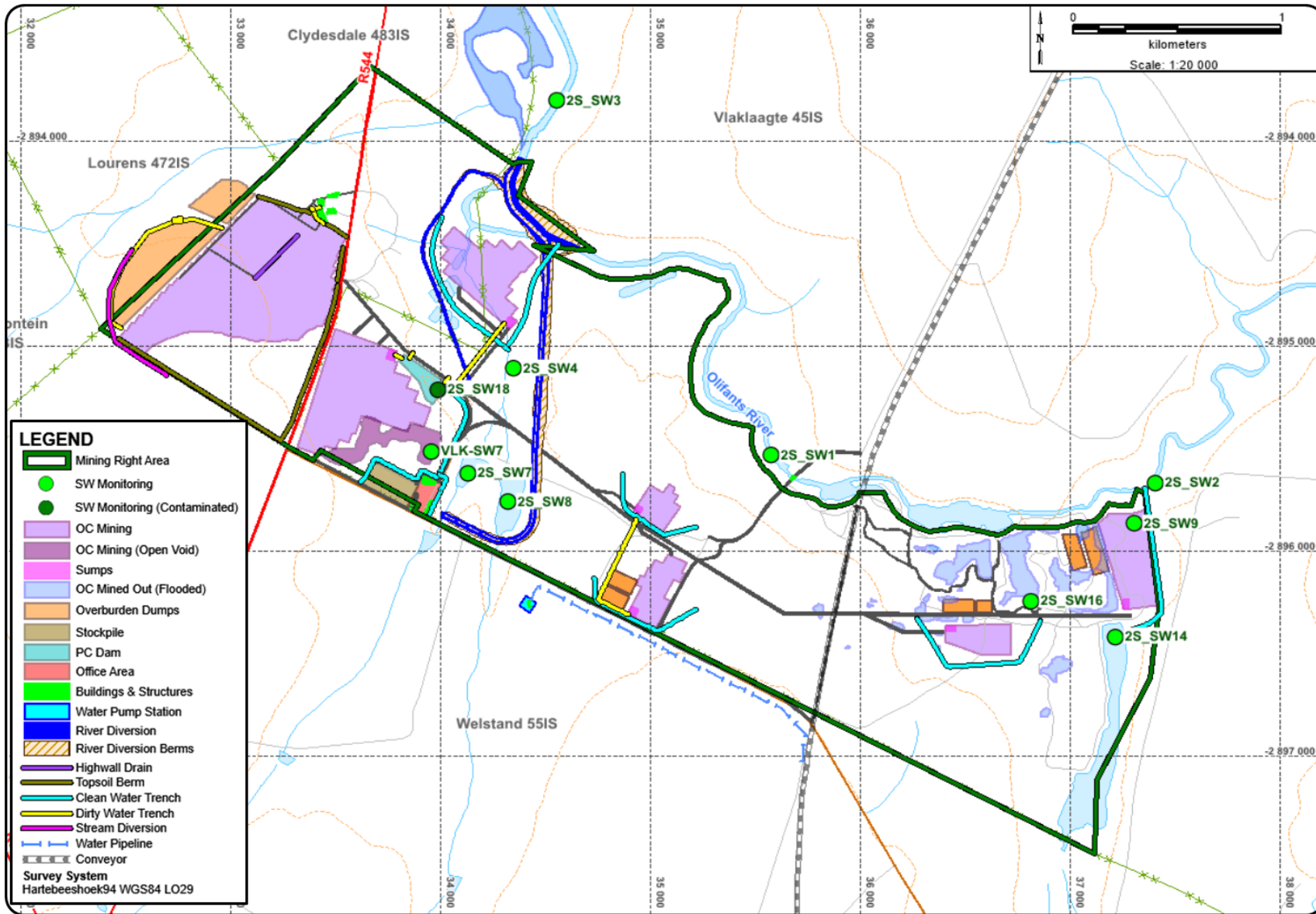


Figure 2: Vlaklaagte Surface Water Monitoring Network



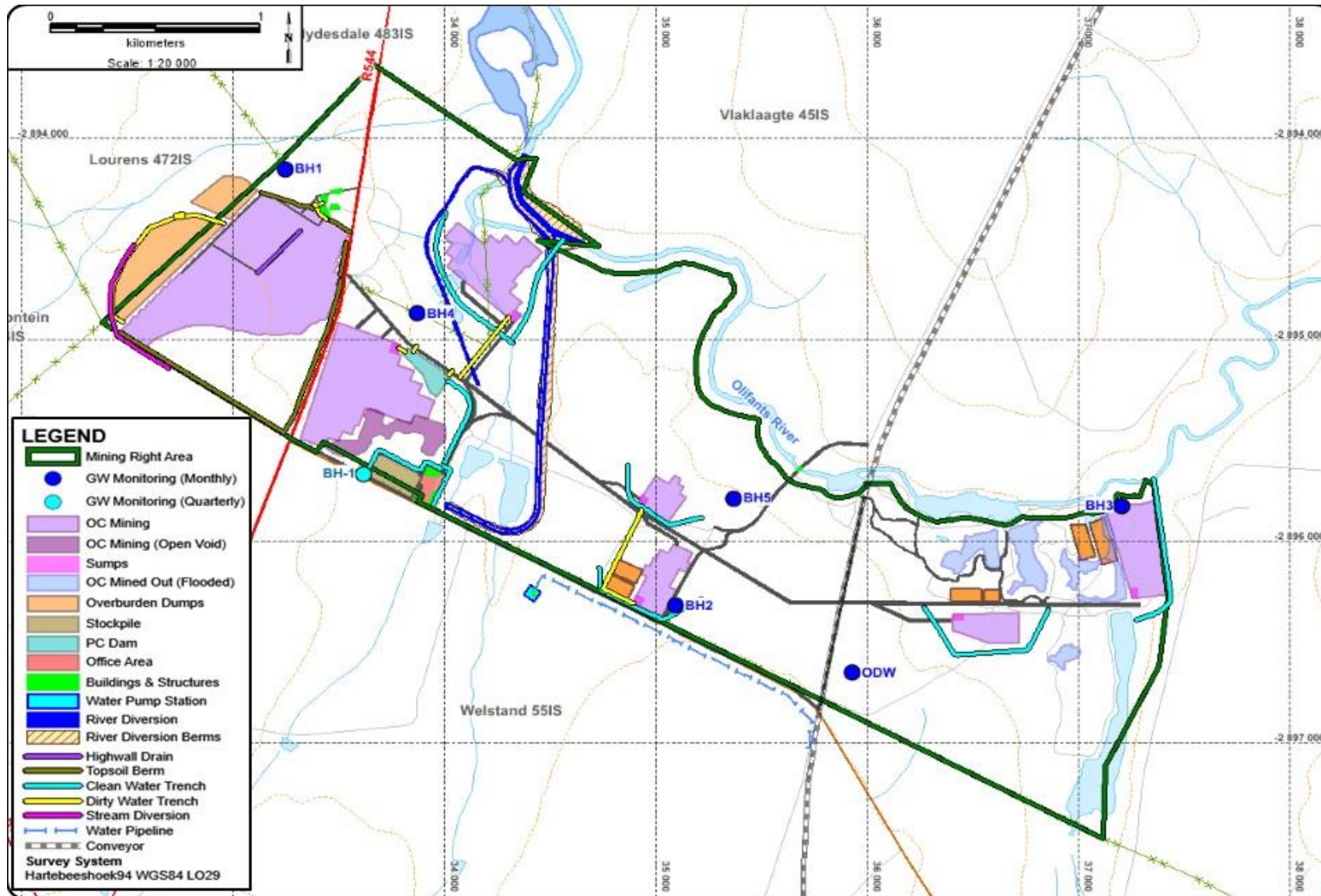


Figure 3: Vlaklaagte Groundwater Monitoring Network



3 COMPLIANCE DESCRIPTION AND STANDARDS

3.1 Surface Water

No guidelines were published in the WUL for surface water analysis and no RQO were set for the biophysical node in which Vlaklaagte is located. Based on this, the water quality standards that will be used to measure compliance at Vlaklaagte is the Water Quality Planning Limits (WQPL) for the Upper Olifants. The WQPL for the Upper Olifants Catchment was published by the Department of Water and Sanitation (DWS, 2016) and Quaternary Catchment B11B, in which Vlaklaagte Coal Mine is located, falls under Management Unit 8. Refer to **Table 3** for the surface water quality guidelines. The quality of the water to be disposed of into the Pollution Control Dam (PCD) was specified in Table 6 of the WUL. These parameters were used to measure the compliance of the PCD water quality, refer to **Table 3**.

The Time Dependant Graphs, included in **Section 5** of this report, provides a clear indication of compliance for each parameter tested for the 2022 monitoring period. The following parameters have been included in the graphs:

pH, EC, TDS, CaCO₃, Ca, Cl, F, Na, SO₄, Fe, Mn, Al, Mg, N and K.

As part of the reporting process, Sulphate (SO₄) ions and pH were used as the contaminants of concern. The Sulphate concentration was used as a macro indicator of potential pollution and is considered as a critical factor that determines potential contamination from a mining environment. Evaluation of each contaminant of concern for each monitoring point would render this report unproductive, therefore SO₄ values were used to determine compliance.

Each result is colour coded with regards to the compliance on the maps for easy reference. Refer to **Table 4**, **Table 5**, **Table 6** and **Table 7** for the colour coding. Green represents compliance and red represents non-compliance. The Piper, Wilcox and Schoeller Diagrams, a graphic indication of overall water quality for each monitoring point, are also included in **Section 5**.

Table 3: Surface water quality guidelines

Determinants	Units	Upper Olifants Water Quality Planning Limits – Management Unit 8
pH at 25° C	pH units	≥ 6.5 to ≤ 8.4
Conductivity	mS/m	≤ 90
TDS	mg/l	≤ 350
Alkalinity	mg/l CaCO ₃	≤ 120



Determinants	Units	Upper Olifants Water Quality Planning Limits – Management Unit 8
Nitrate	mg/l N	≤ 0.5
Chloride (Dissolved)	mg/l Cl	≤ 40
Sulphate	mg/l SO ₄	≤ 150
Fluoride	mg/l F	≤ 0.75
Sodium (Dissolved)	mg/l Na	≤ 50
Potassium (Dissolved)	mg/l K	≤ 25
Calcium (Dissolved)	mg/l Ca	≤ 50
Magnesium (Dissolved)	mg/l Mg	≤ 30
Aluminium	mg/l Al	≤ 0.02
Iron	mg/l Fe	≤ 0.3
Manganese	mg/l Mn	≤ 0.05
WUL PCD Quality Parameters		
pH at 25° C	pH units	≤ 8.46
Conductivity	mS/m	≤ 232
TDS	mg/l	≤ 2700
Chloride	mg/l Cl	≤ 39.78
Sulphate	mg/l SO ₄	≤ 2000
Sodium (Dissolved)	mg/l Na	≤ 290.8
Aluminium	mg/l Al	≤ 0.02
Iron	mg/l Fe	≤ 0.01
Manganese	mg/l Mn	≤ 0.02

Table 4: Legend for SO₄ concentration compliance (Surface Water)

WQPL – Upper Olifants MU8	Colour code	Risk classification
SO ₄ ≤ 150 mg/l		Compliant
SO ₄ > 150 mg/l		Non-compliant

Table 5: Legend for SO₄ concentration compliance (PCD)

WUL	Colour code	Risk classification
SO ₄ ≤ 2000 mg/l		Compliant
SO ₄ > 2000 mg/l		Non-compliant



Table 6: Legend for pH compliance (Surface Water)

WQPL – Upper Olifants MU8	Colour code	Risk classification
$6.5 \leq \text{pH} \leq 8.4$		Compliant
$\text{pH} < 6.5$ or $\text{pH} > 8.4$		Non-compliant

Table 7: Legend for pH compliances (PCD)

WUL	Colour code	Risk classification
$\text{pH} \leq 8.46$		Compliant
$\text{pH} > 8.46$		Non-compliant

3.2 Groundwater

No guidelines were published in the WUL for groundwater analysis and no RQO were set for the biophysical node in which Vlaklaagte is located. Based on this, the water quality standards that will be used to measure compliance at Vlaklaagte is SANS 241:2015 (Refer to **Table 8**) but the baseline water qualities that were recorded in the Hydrogeological Assessment (GCS, 2017) will be used for BH5 (**Table 12**)

It should be noted that no specific parameters have been set by SANS 241:2015 for the following elements:

- Alkalinity;
- Calcium;
- Magnesium; and
- Potassium.

The South African Water Quality Guidelines (SAWQG) will be used to measure the aforementioned elements (refer to **Table 9**).

The Time Dependant Graphs, included in **Section 5** of this report, provide a clear indication of compliance for each parameter tested for the 2022 monitoring period. The following parameters have been included in the graphs:

pH, EC, TDS, CaCO₃, Ca, Cl, F, Na, SO₄, Fe, Mn, Al, Mg, N and K.

As part of the reporting process, Sulphate (SO₄) ions and pH were used as the contaminants of concern. The Sulphate concentration was used as a macro indicator of potential pollution and is considered as a critical factor that determines potential contamination from a mining



environment. Evaluation of each contaminant of concern for each monitoring point would render this report unproductive, therefore SO₄ values were used to determine compliance.

Each result is colour coded with regards to the compliance on the maps for easy reference. Refer to **Table 10** and **Table 11** for the colour coding. Green represents compliance and red represents non-compliance. The Piper, Wilcox and Schoeller Diagrams, a graphic indication of overall water quality for each monitoring point, are also included in **Section 5**.

Table 8: SANS 241:2015 Drinking Water Guideline

Determinants	Units	Acceptable (Aesthetic)	Tolerable (Acute Health – 1 / Chronic Health / Operational)
TDS	mg/l	≤1 200	-
pH at 25° C	pH units	-	≥ 5 to ≤ 9.7
Conductivity	mS/m	≤170	-
Sodium	mg/l Na	≤200	-
Chloride	mg/l Cl	≤300	-
Sulphate	mg/l SO ₄	≤250	≤500
Nitrate	mg/l N	-	≤11
Fluoride	mg/l F	-	≤1.5
Ammonia	mg/l N	≤1.5	-
Iron	mg/l Fe	≤0.3	≤2
Manganese	mg/l Mn	≤0.1	≤0.4
Aluminium	mg/l Al	-	≤0.3

Table 9: South African Water Quality Guideline

Determinants	Units	SAWQG (No Risk)	SAWQG (Low Risk)
Alkalinity	mg/l CaCO ₃	300	600
Potassium	mg/l K	50	100
Calcium	mg/l as Ca	0 - 32	32 - 80
Magnesium	mg/l as Mg	0 - 30	30 - 50

Table 10: Legend for SO₄ concentration compliance (Groundwater)

Geohydrological Assessment (May 2017) Baseline BH5	Colour code	Risk classification
SO ₄ ≤ 1 172 mg/l		Compliant
SO ₄ > 1 172 mg/l		Non-compliant



(SANS 241: 2015)	Colour code	Risk classification
SO ₄ ≤ 250 mg/l		Compliant
SO ₄ >250 mg/l		Non-compliant

Since the baseline data does not provide a range for pH, the compliance of pH was also measured against SANS 241: 2015.

Table 11: Legend for pH compliance (Groundwater)

SANS 241:2015	Colour code	Risk classification
5 ≤ pH ≤ 9.7		Compliant
pH < 5 or pH > 9.7		Non-compliant
Geohydrological Assessment (May 2017) Baseline BH5	Colour code	Risk classification
pH ≤ 8.05 mg/l		Compliant
pH > 8.05 mg/l		Non-compliant

Table 12: Groundwater quality guidelines for BH5

Determinants	Units	BH5
pH at 25° C	pH units	≤ 8.05
	pH units (SANS 241-1: 2015)	≥ 5 to ≤ 9.7
Conductivity	mS/m	≤ 297
TDS	mg/l (SANS 241-1: 2015)	≤ 1 200
Alkalinity	mg/l CaCO ₃	≤ 357
Nitrate	mg/l N	≤ 75.5
Chloride	mg/l Cl	≤ 97.6
Sulphate	mg/l SO ₄	≤ 1172
Fluoride	mg/l F	≤ 0.603
Sodium	mg/l Na	≤ 181
Potassium	mg/l K	≤ 13.6
Calcium	mg/l Ca	≤ 284
Magnesium	mg/l Mg	≤ 167
Aluminium	mg/l Al	≤ 0.002
Iron	mg/l Fe	≤ 0.004
Manganese	mg/l Mn	≤ 0.352



4 MONITORING ACTIONS PERFORMED

The following monitoring actions were performed for the January 2022 to March 2022 monitoring period:

- Groundwater Monitoring (levels and qualities analysed); and
- Surface Water Monitoring (qualities analysed).

Regen Water Laboratory conducted water quality sampling and analyses for Vlaklaagte. The monitoring audit table is a summary of the field forms that are used during the sampling run and an overview of the actions performed. Refer to **Table 13**. A detailed audit of the water quality monitoring of each monitoring point is carried out monthly and quarterly which is included in this report in order to determine the current critical points.

The colour coding in the table below indicates the following:









	Analysis complete
	Dry
	Sampling not required
	Measurement not required
	Water level measured
	Demolished/destroyed
	Removed from network
	Water levels not measured



Table 13: Monitoring Audit Table

Site	Type	pH	EC	TDS	Ca	Mg	Na	K	CaCO ₃	Cl	SO ₄	N	F	Al	Fe	Mn	Levels	
January 2022																		
2S_SW1	SW																	
2S_SW2	SW																	
2S_SW3	SW																	
2S_SW4	SW																	
2S_SW7	SW																	
2S_SW8	SW																	
2S_SW9	SW																	
2S_SW14	SW																	
2S_SW16	SW																	
2S_SW18	SW																	
VLK SW 7	SW																	
BH1	GW																	
BH2	GW																	
BH3	GW																	
BH4	GW																	
BH5	GW																	
BH-1	GW (Q)																	
ODW	GW																	
February 2022																		
2S_SW1	SW																	
2S_SW2	SW																	
2S_SW3	SW																	
2S_SW4	SW																	
2S_SW7	SW																	
2S_SW8	SW																	



Site	Type	pH	EC	TDS	Ca	Mg	Na	K	CaCO ₃	Cl	SO ₄	N	F	Al	Fe	Mn	Levels	
2S_SW9	SW																	Green
2S_SW14	SW																	Green
2S_SW16	SW																	Green
2S_SW18	SW																	Green
VLK SW7	SW																	Green
BH1	GW																	Blue
BH2	GW	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
BH3	GW	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
BH4	GW																	Blue
BH5	GW																	Blue
BH-1	GW (Q)	Purple	Purple	Purple	Purple	Purple	Purple	Purple	Purple	Purple	Purple	Purple	Purple	Purple	Purple	Purple	Purple	Blue
ODW	GW																	Green
March 2022																		
2S_SW1	SW																	Green
2S_SW2	SW																	Green
2S_SW3	SW																	Green
2S_SW4	SW																	Green
2S_SW7	SW																	Green
2S_SW8	SW																	Green
2S_SW9	SW																	Green
2S_SW14	SW																	Green
2S_SW16	SW																	Green
2S_SW18	SW																	Green
VLK SW7	SW																	Green
BH1	GW																	Blue
BH2	GW	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
BH3	GW	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
BH4	GW																	Blue



Site	Type	pH	EC	TDS	Ca	Mg	Na	K	CaCO ₃	Cl	SO ₄	N	F	Al	Fe	Mn	Levels	
BH5	GW																	
BH-1	GW (Q)																	
ODW	GW																	



5 WATER COMPLIANCE STATUS

5.1 Vlaklaagte Surface Water Compliance

The analyses of the surface water results are discussed per monitoring point below. Refer to **Annexure 2** for the full laboratory analysis. As previously in **Section 3**, compliance is compared against the WQPL of the Upper Olifants Catchment

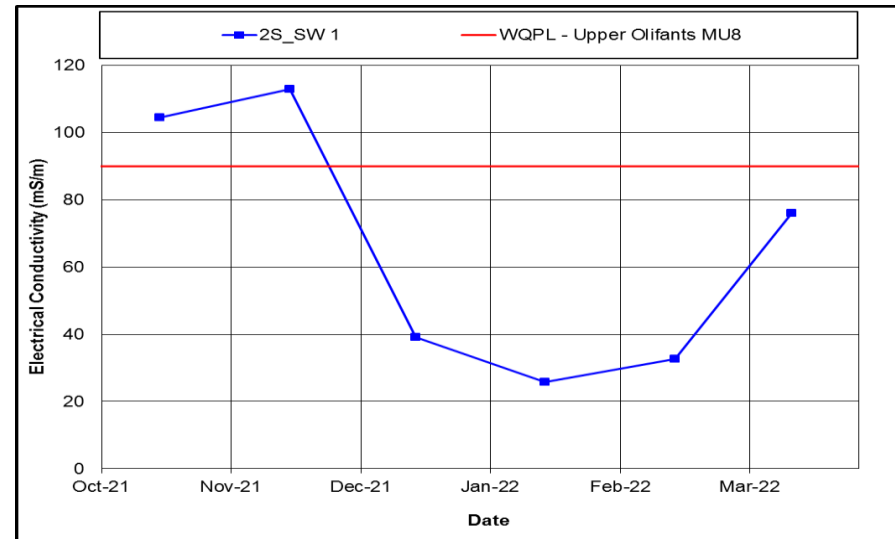
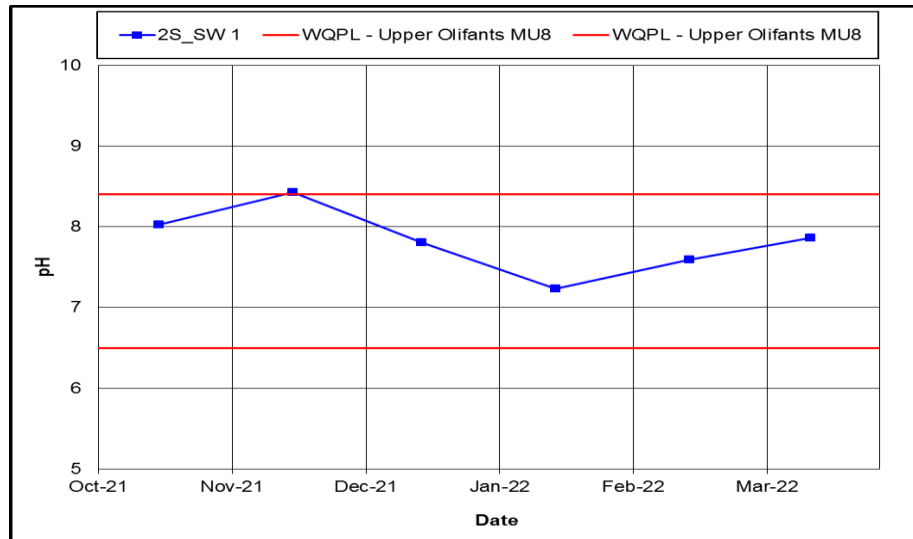
5.1.1. 2S_SW 1

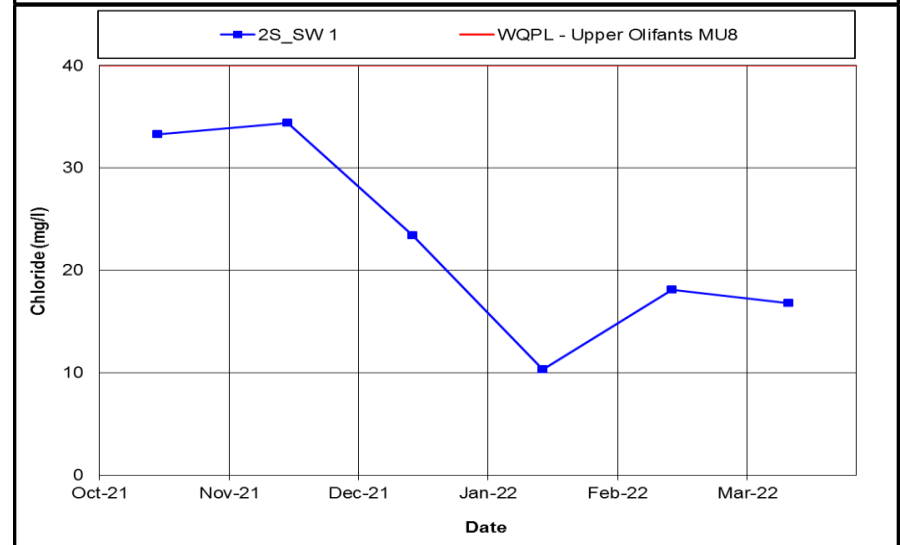
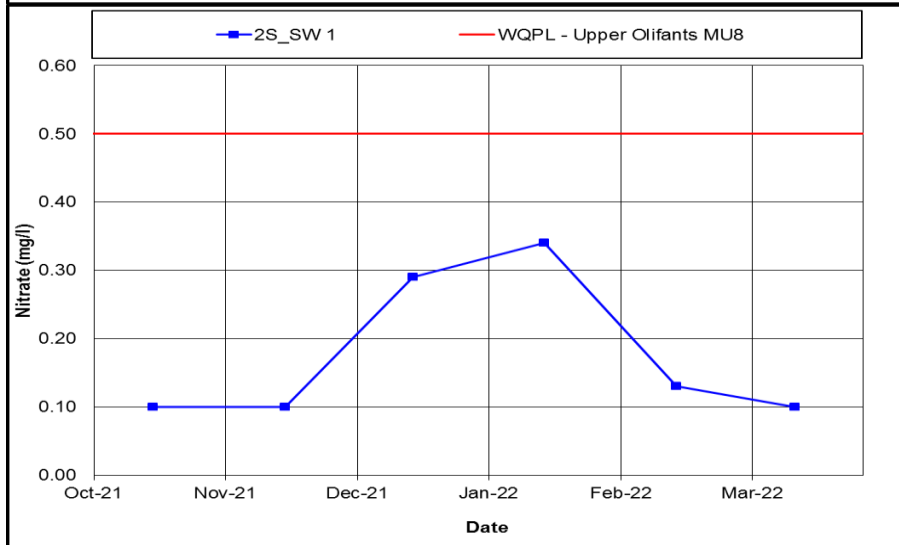
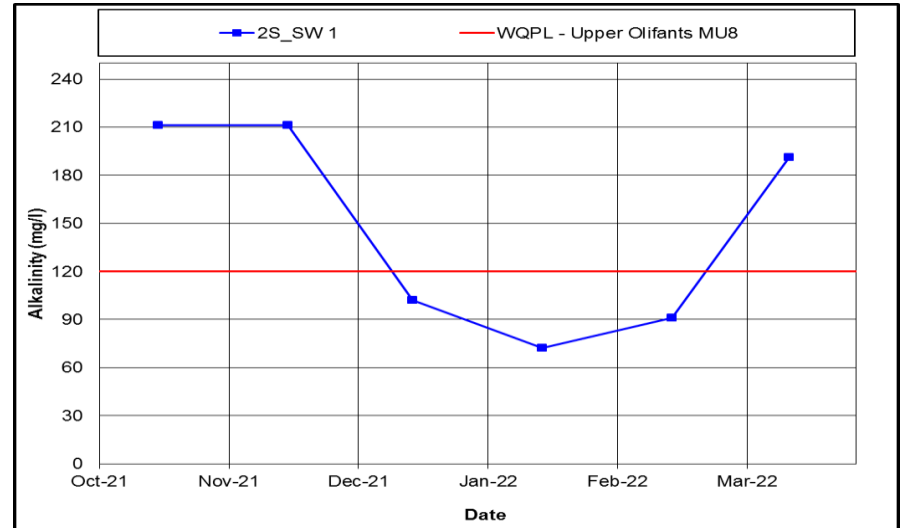
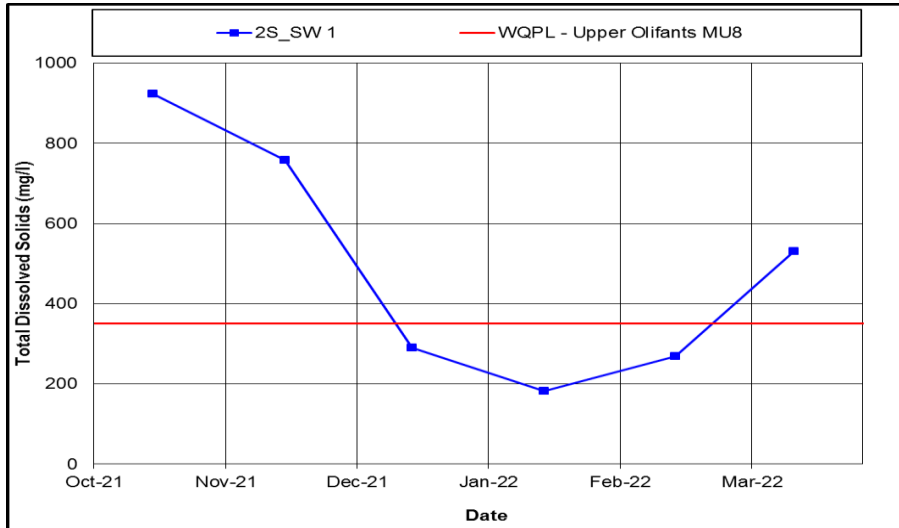
The results analysis is indicated in **Table 14** below. The data is also represented graphically in **Figure 4**. Majority of the parameters did comply with the WQLP. Some exceedances were noted, but only Aluminium and Iron did not comply with the WQPL in terms of average.

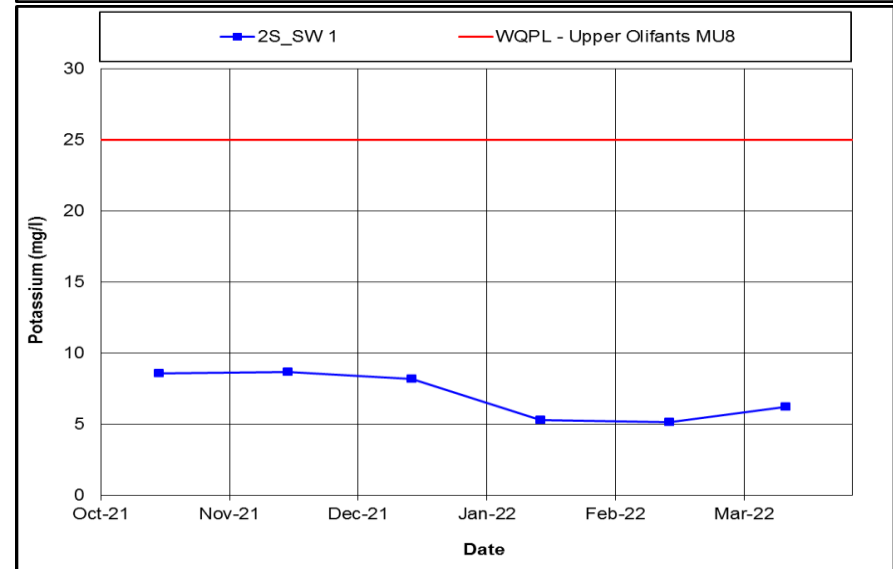
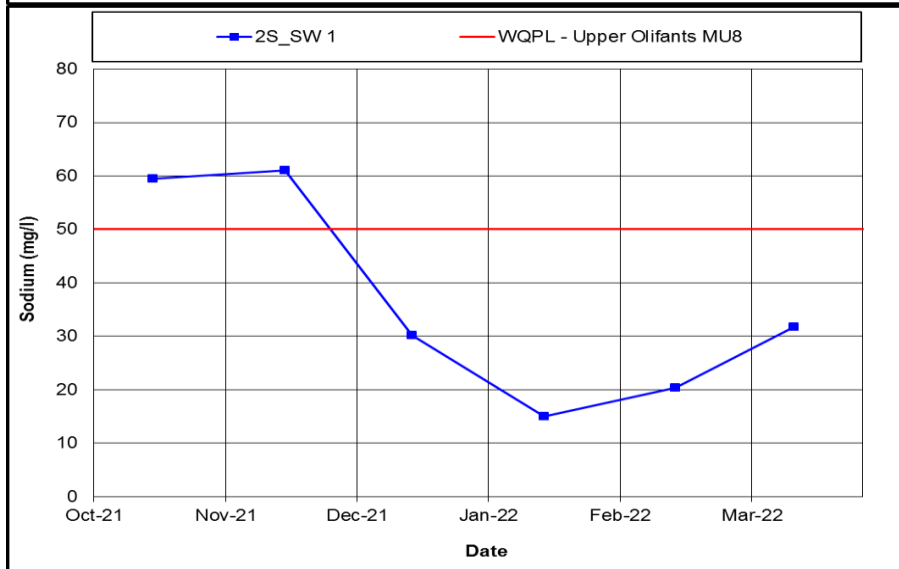
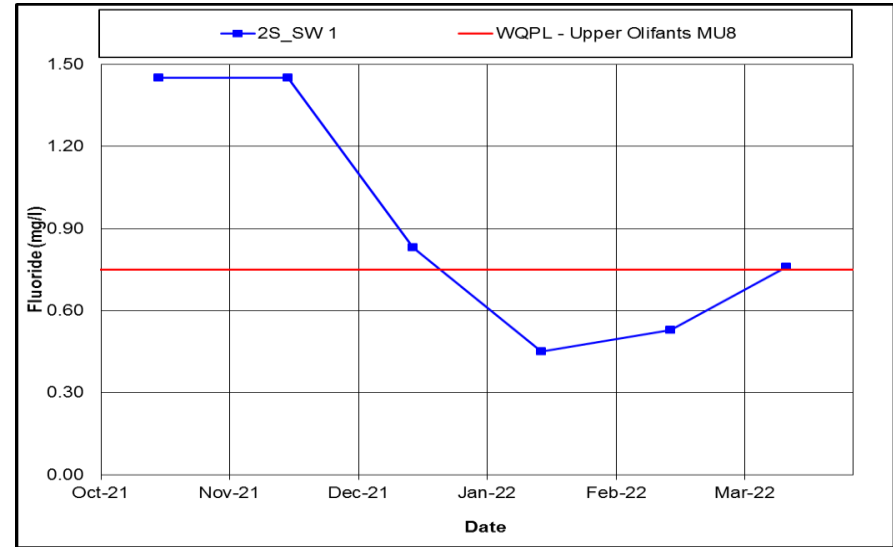
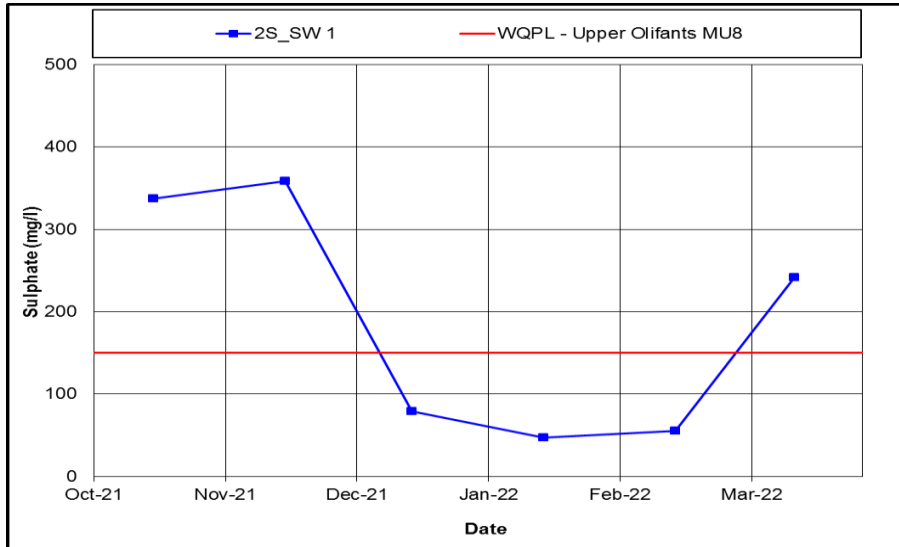


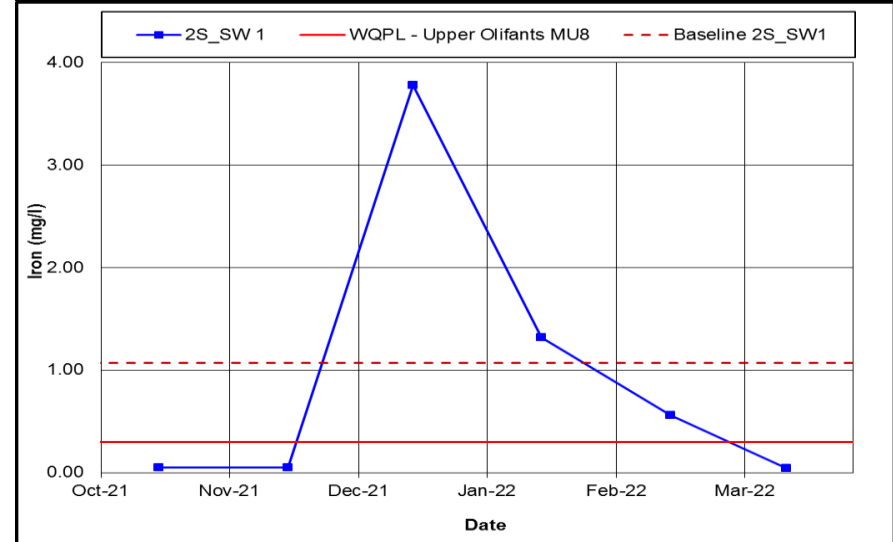
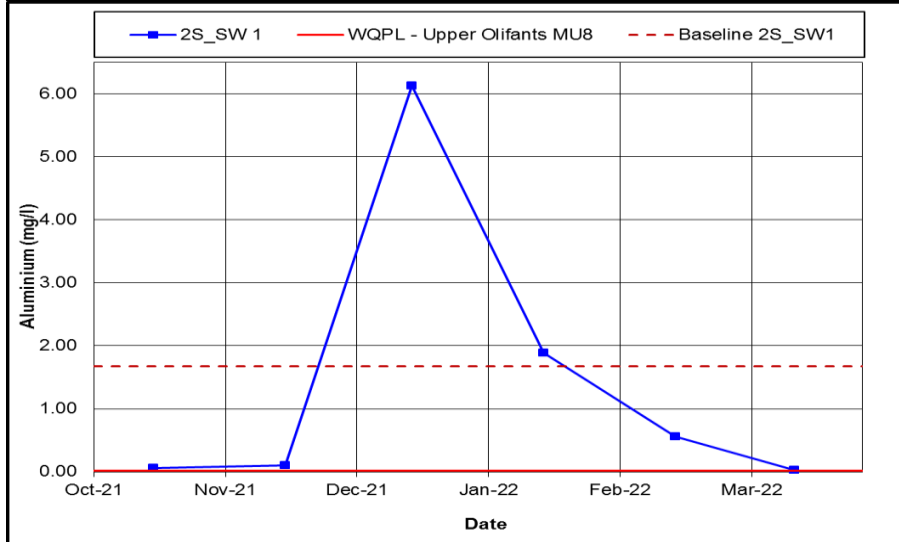
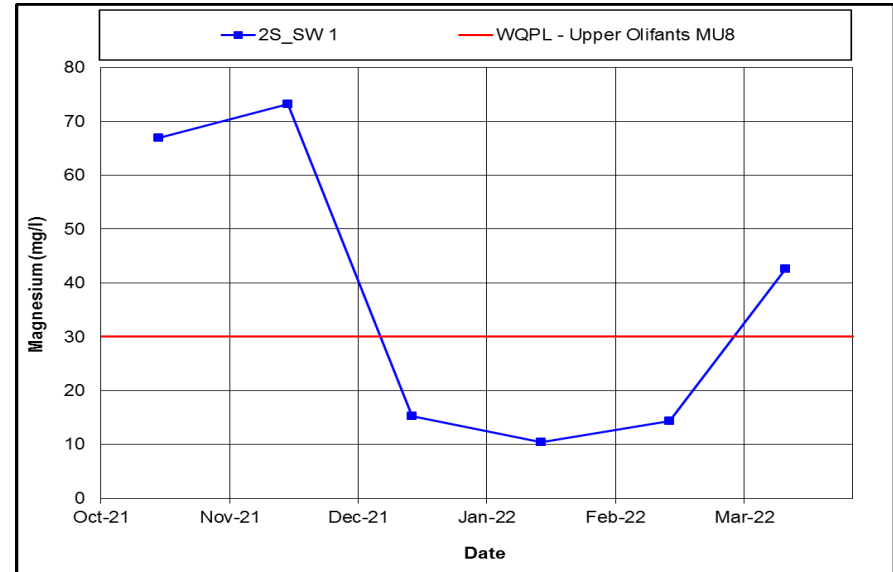
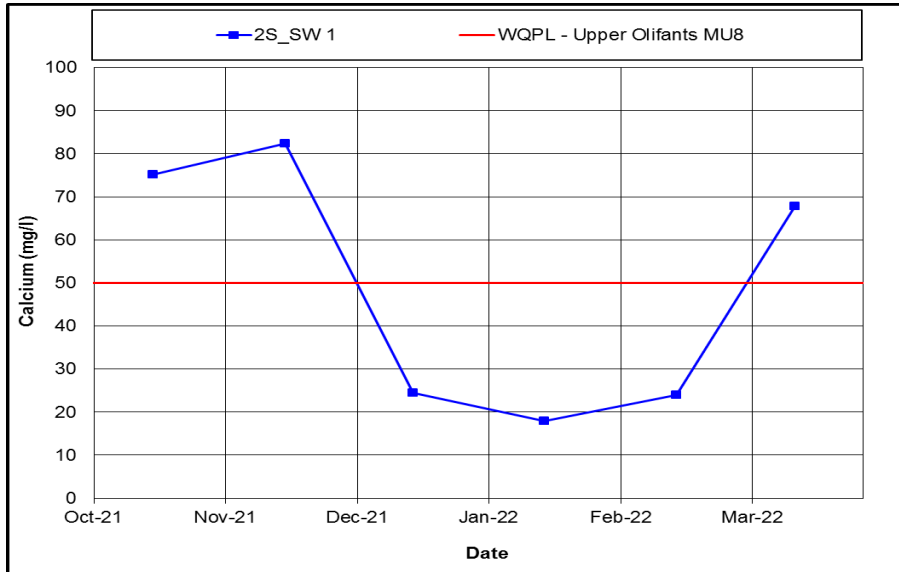
Table 14: 2S_SW 1 Analysis Results

Sample Date	Parameters														
	pH	EC (mS/m)	TDS (mg/l)	Alk (mg/l)	N (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	F (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
Non-Compliance	<6,5	>90	>350	>120	>0,5	>40	>150	>0,75	>50	>25	>50	>30	>0,02	>0,3	>0,05
	>8,4														
Average	7.56	44.83	326.67	118.00	0.19	15.07	114.83	0.58	22.33	5.52	36.57	22.43	0.83	0.64	0.02
Jan-22	7.23	25.80	182.00	72.00	0.34	10.30	47.20	0.45	15.00	5.27	18.00	10.40	1.89	1.32	0.01
Feb-22	7.59	32.70	268.00	91.00	0.13	18.10	55.30	0.53	20.30	5.11	23.90	14.30	0.56	0.56	0.04
Mar-22	7.86	76.00	530.00	191.00	0.10	16.80	242.00	0.76	31.70	6.19	67.80	42.60	0.03	0.04	0.02









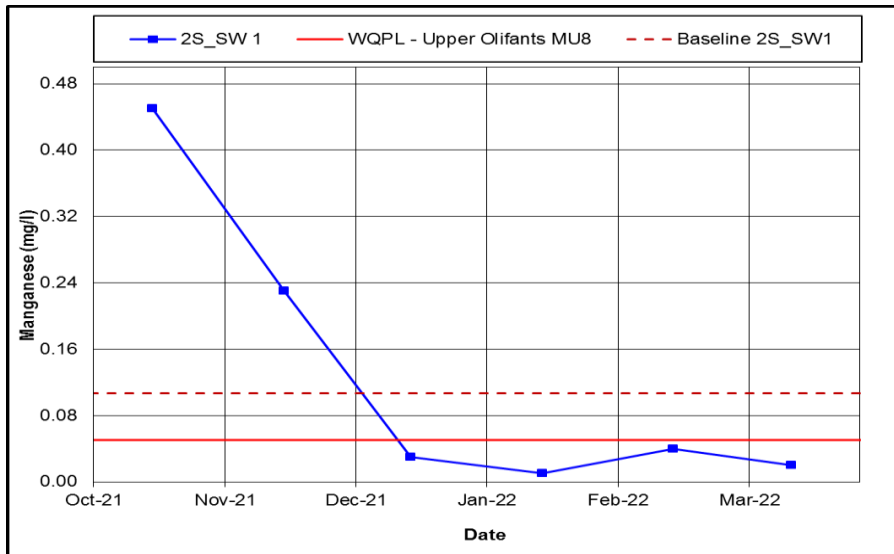


Figure 4: 2S_SW 1 Compliance Graphs



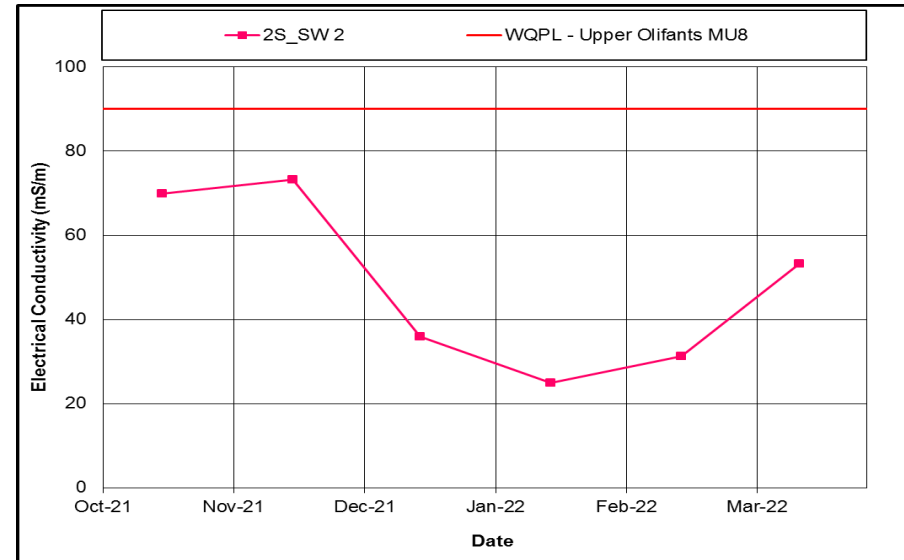
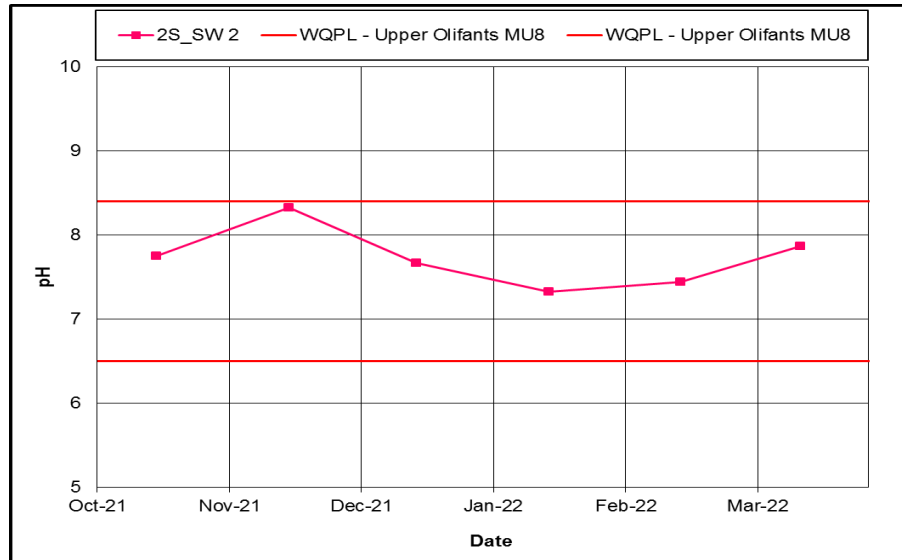
5.1.2. 2S_SW 2

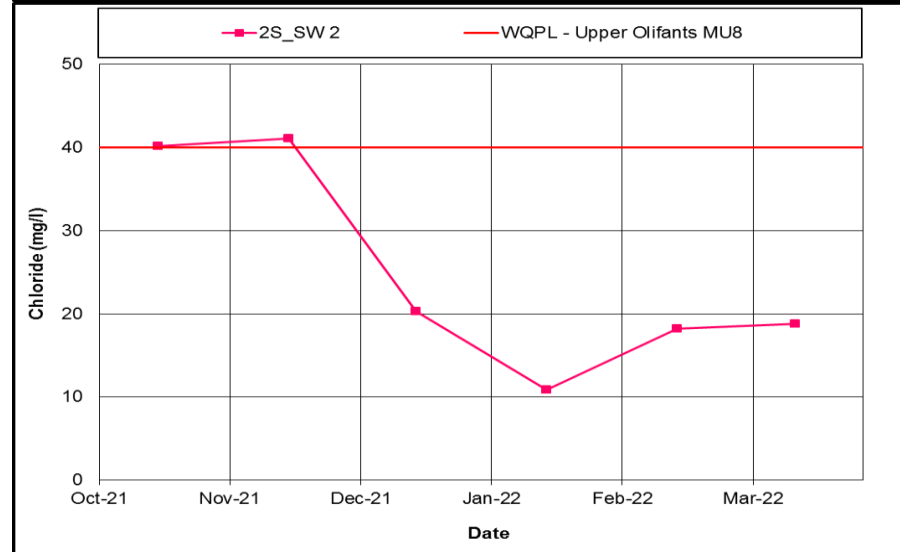
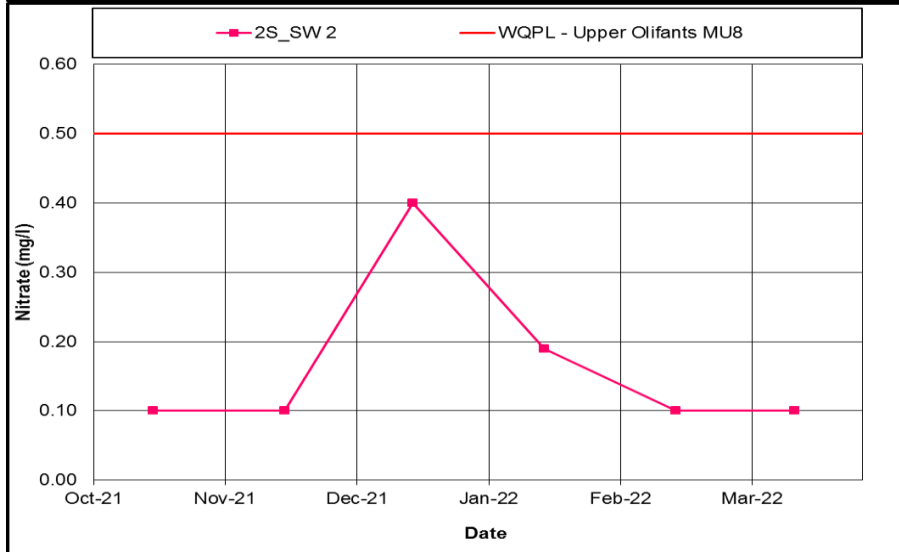
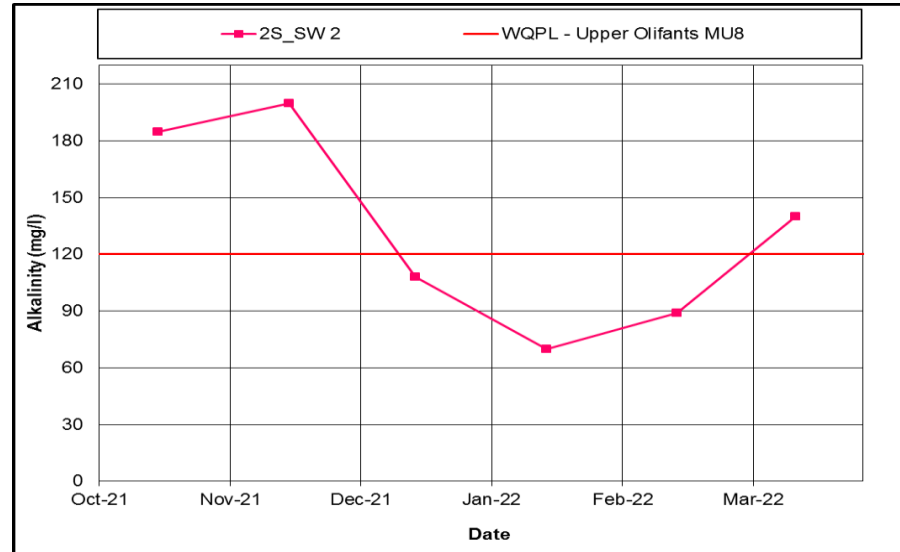
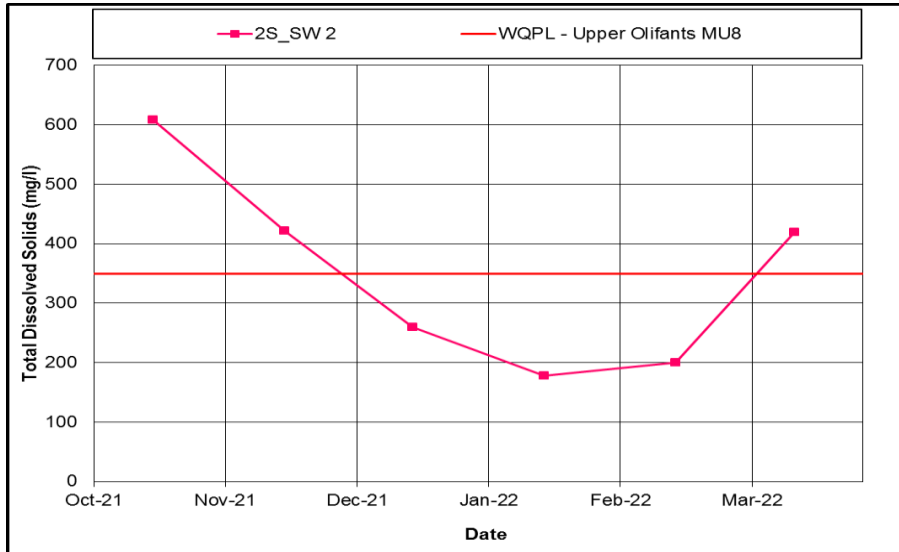
Table 15 below indicates that majority of the parameters complied with the WQPL. Also refer to **Figure 5** for the graphical representation. Majority of the parameters did comply with the WQPL. Some exceedances were noted, but only Aluminium and Iron did not comply with the WQPL in terms of average.

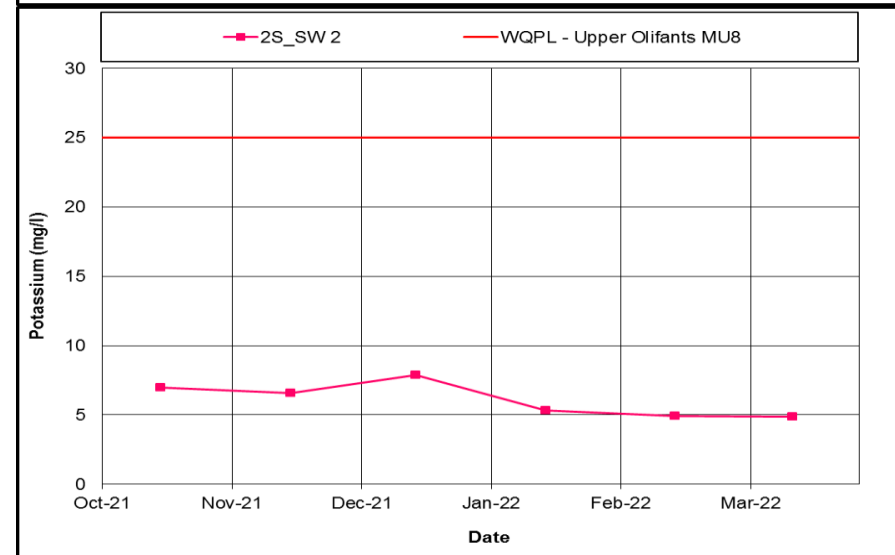
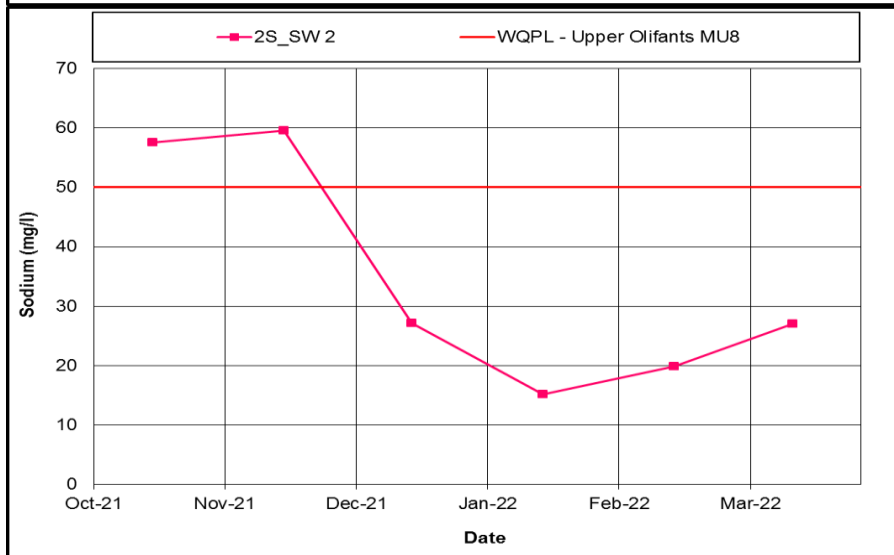
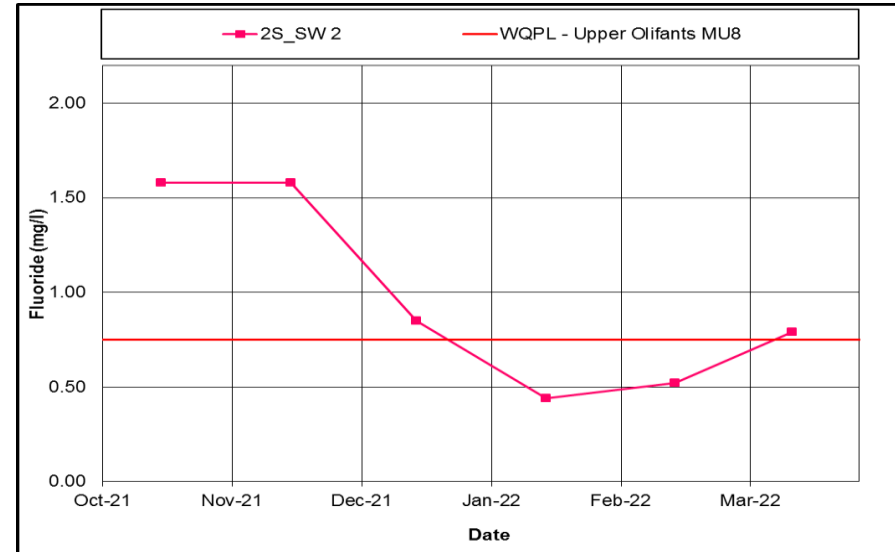
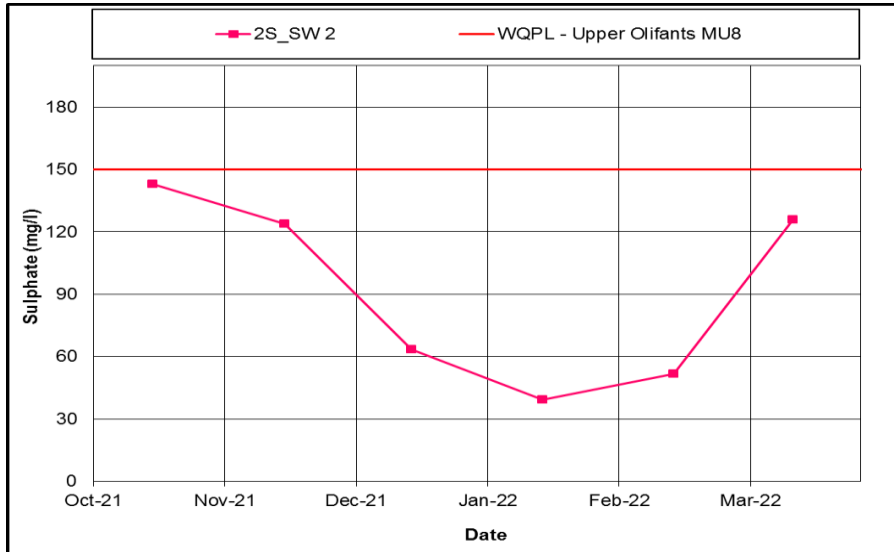


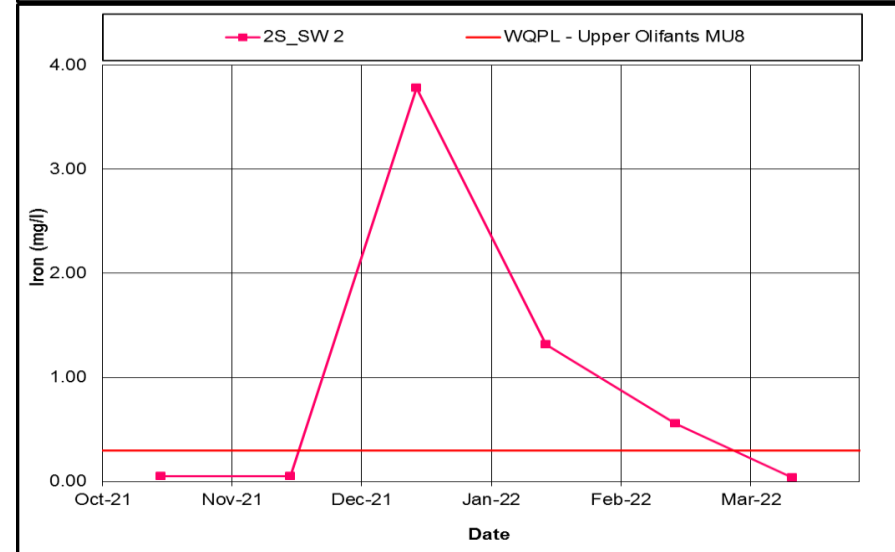
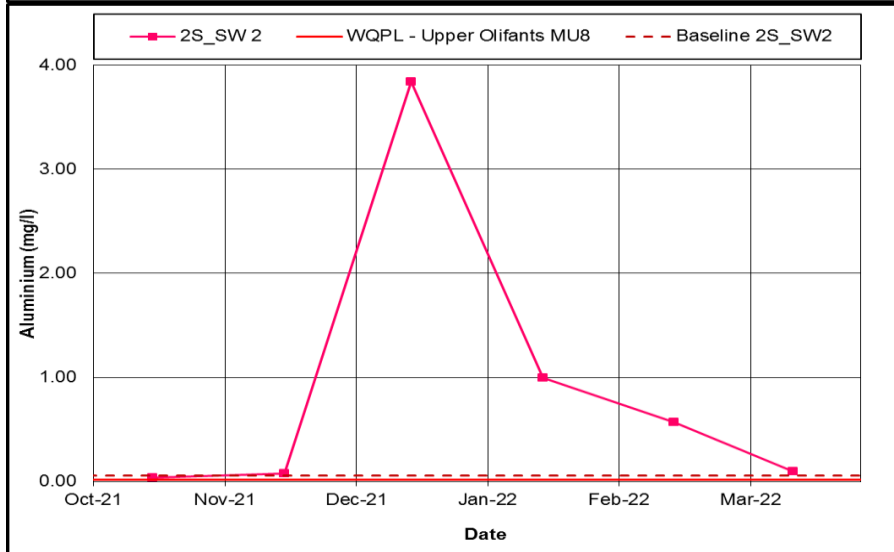
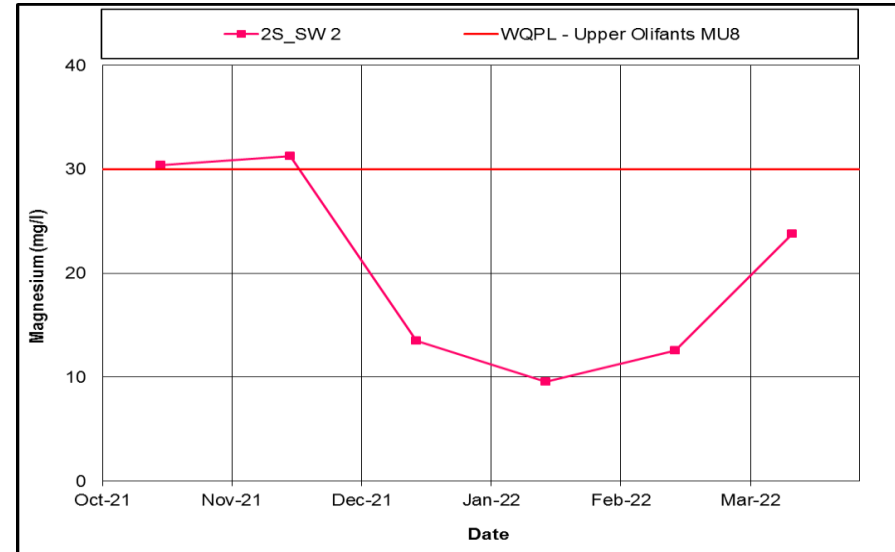
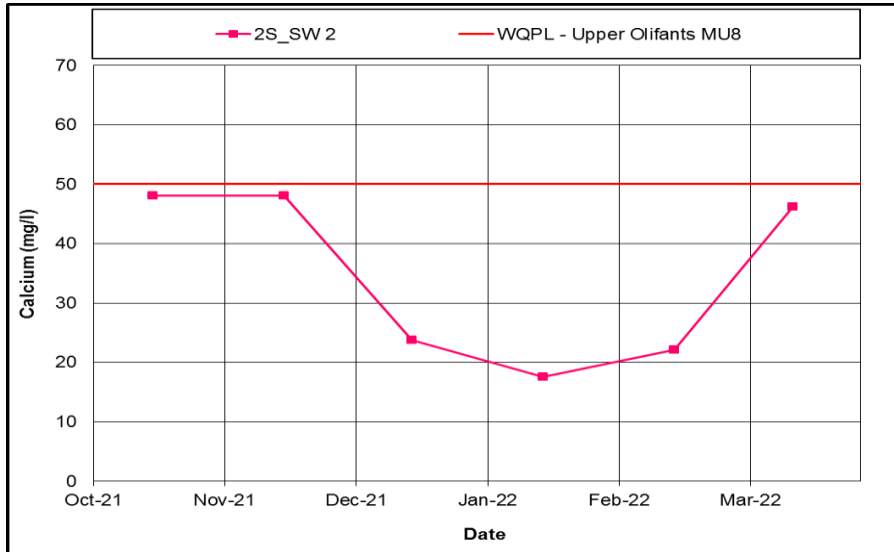
Table 15: 2S_SW 2 Analysis Result

Sample Date	Parameters														
	pH	EC (mS/m)	TDS (mg/l)	Alk (mg/l)	N (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	F (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
Non-Compliance	<6,5	>90	>350	>120	>0,5	>40	>150	>0,75	>50	>25	>50	>30	>0,02	>0,3	>0,05
	>8,4														
Average	7.55	36.47	266.00	99.67	0.13	15.97	72.37	0.58	20.70	5.04	28.63	15.31	0.56	0.48	0.01
Jan-22	7.33	24.90	178.00	70.00	0.19	10.90	39.30	0.44	15.20	5.32	17.60	9.54	1.00	0.78	0.01
Feb-22	7.44	31.20	200.00	89.00	0.10	18.20	51.80	0.52	19.90	4.94	22.10	12.60	0.57	0.58	0.02
Mar-22	7.87	53.30	420.00	140.00	0.10	18.80	126.00	0.79	27.00	4.85	46.20	23.80	0.10	0.08	0.01









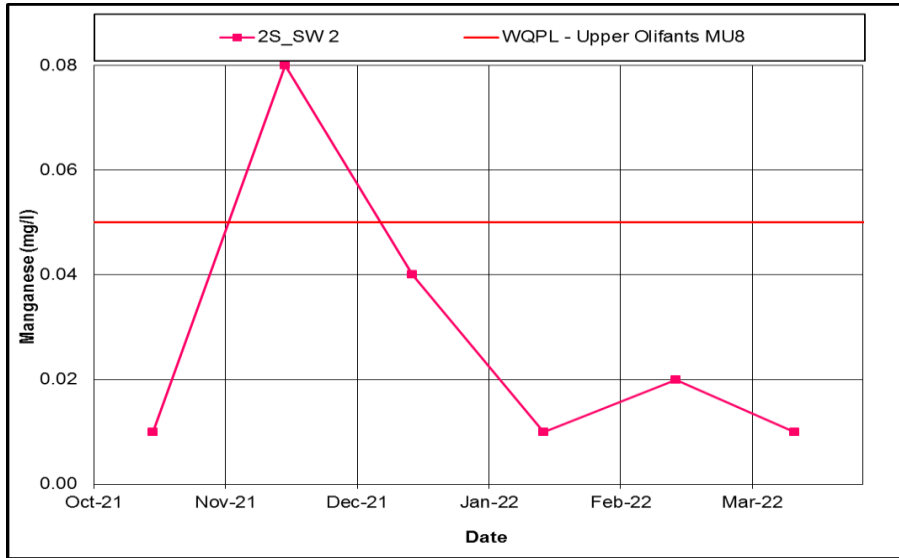


Figure 5: 2S_SW 2 Compliance Graphs



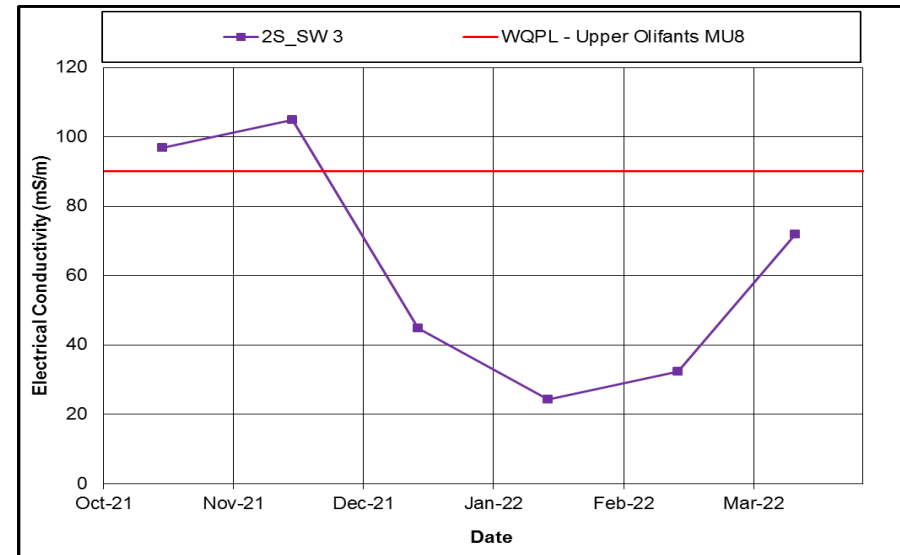
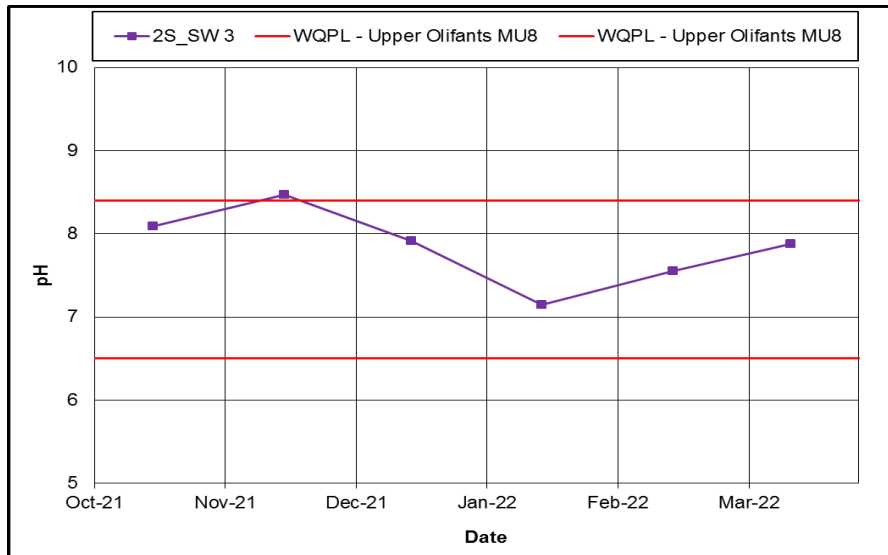
5.1.3. 2S_SW 3

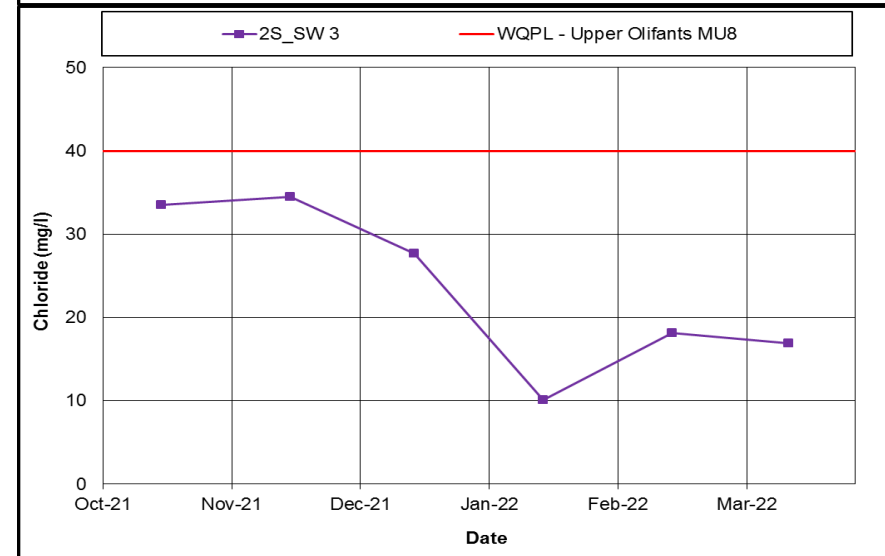
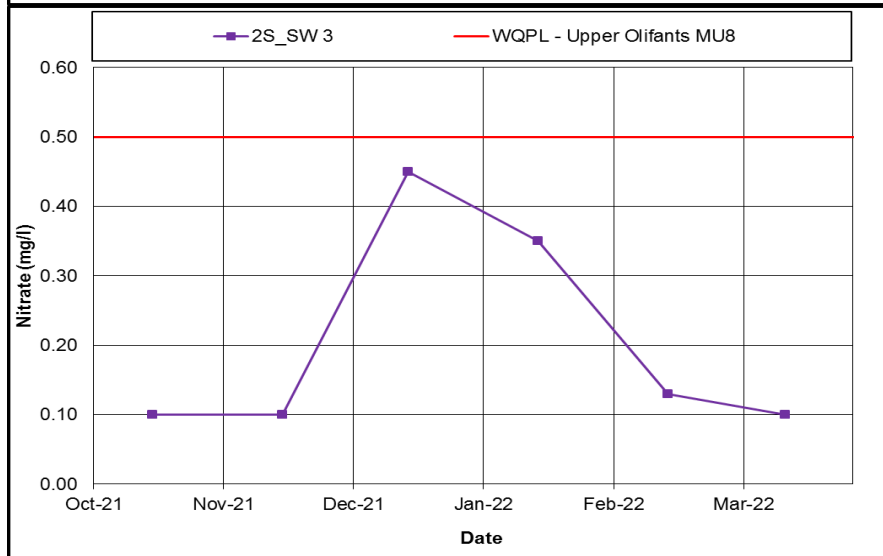
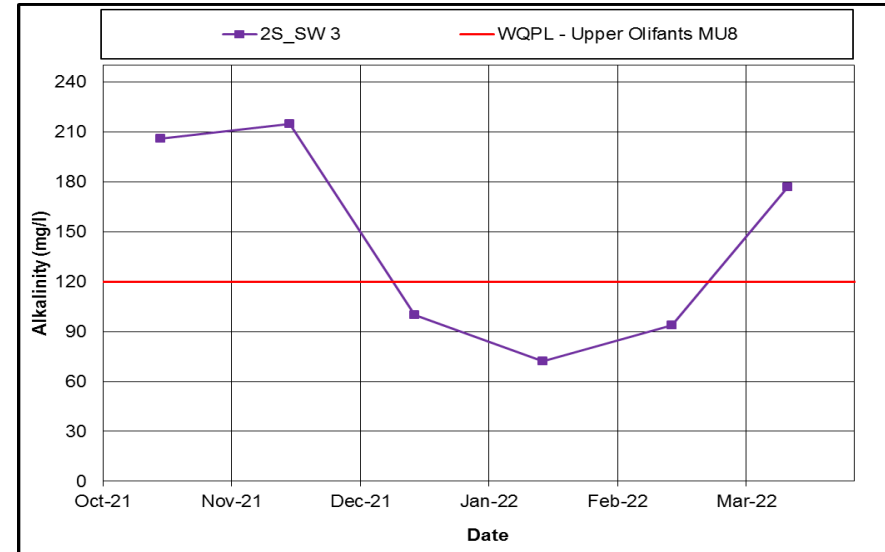
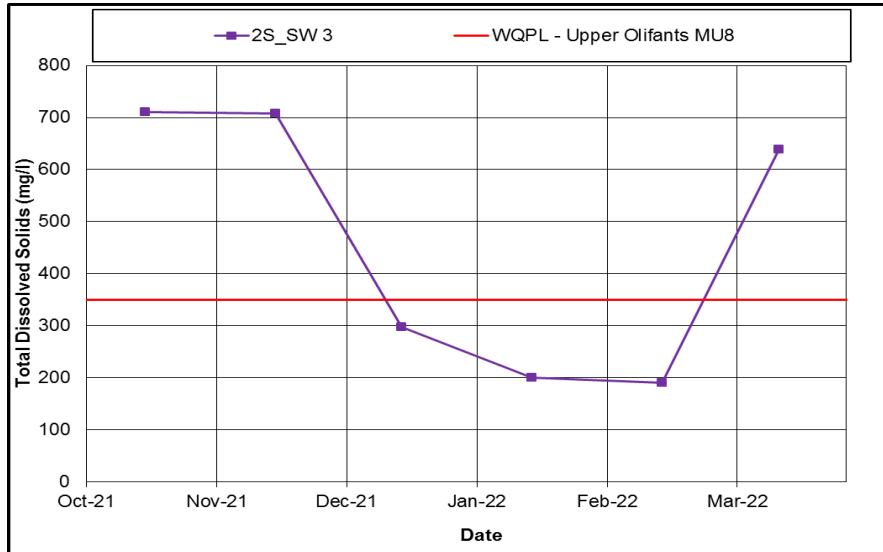
Majority of the parameters complied with the WQPL, refer to **Table 16** for the data and **Figure 6** for the graphical representations. Majority of the parameters did comply with the WQPL. Some exceedances were noted, but only Aluminium, Iron and Manganese did not comply with the WQPL in terms of average.

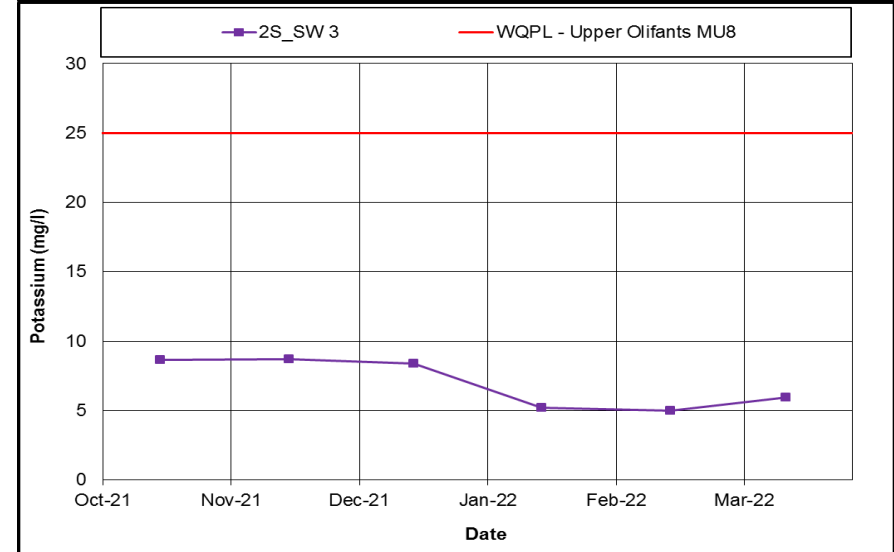
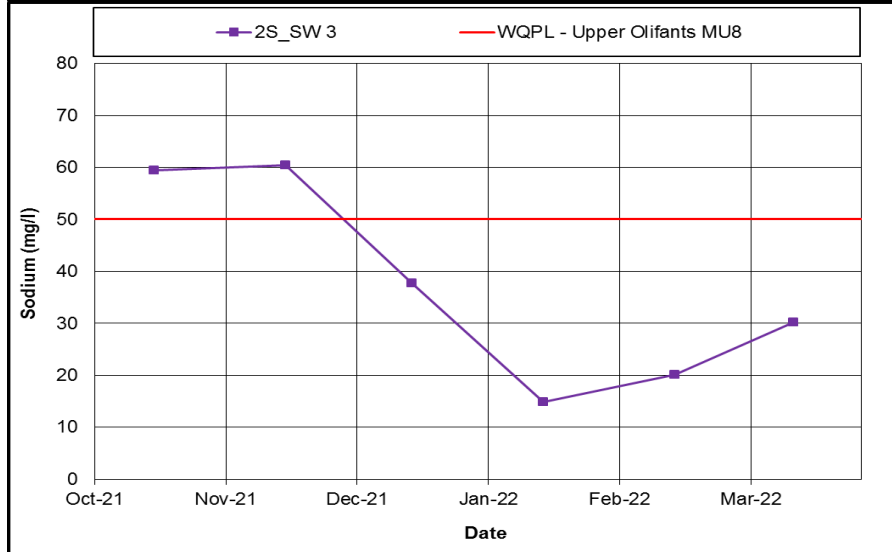
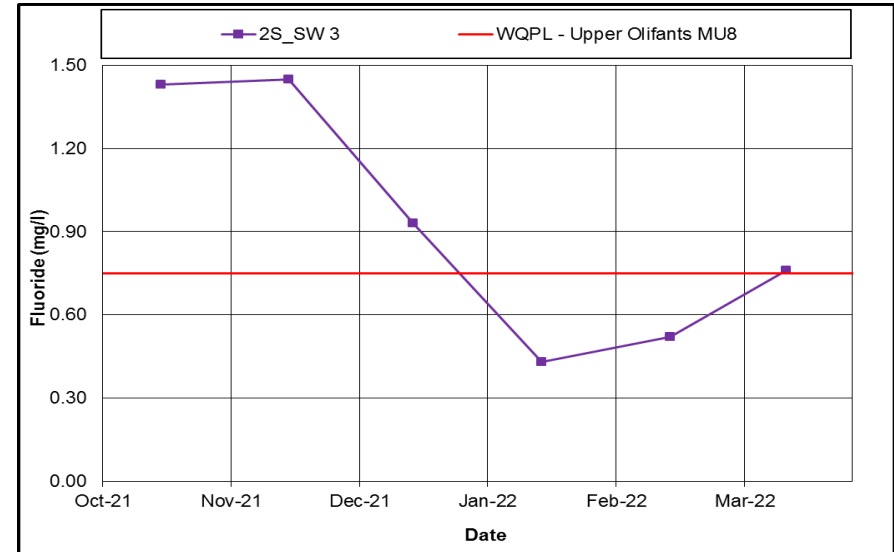
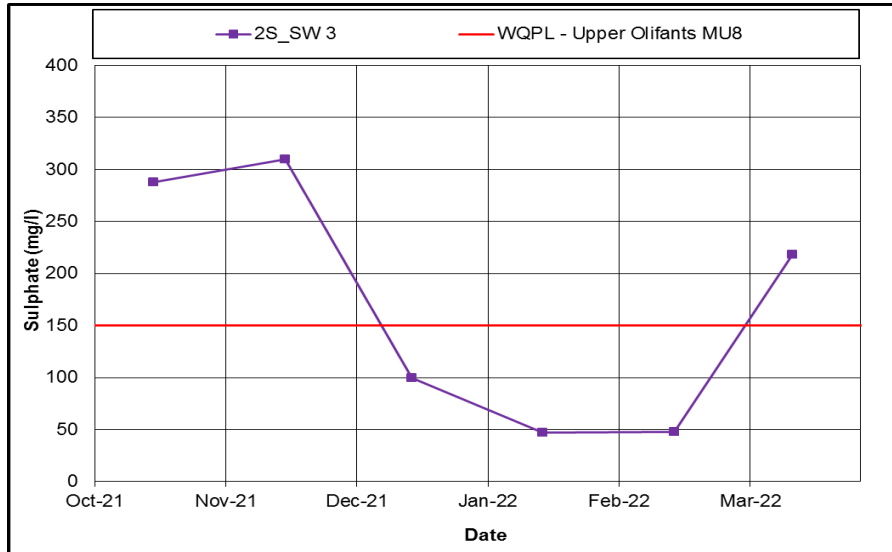


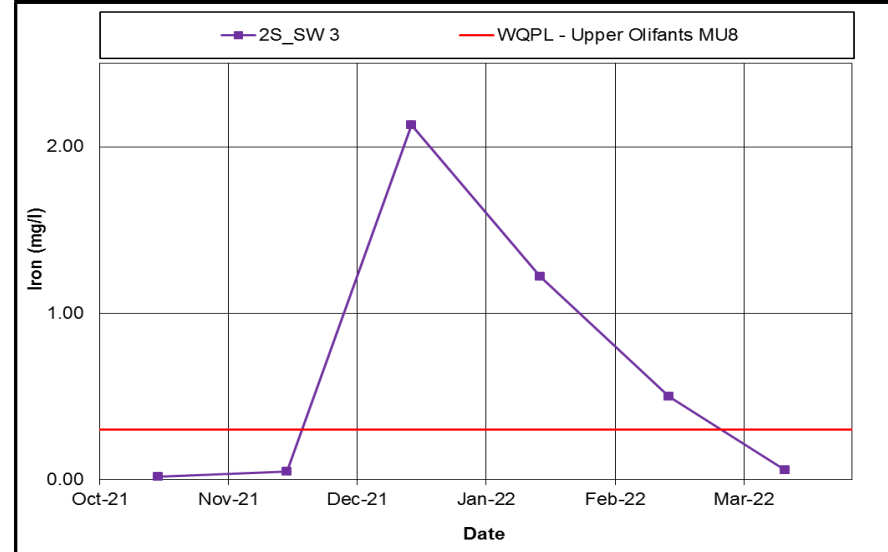
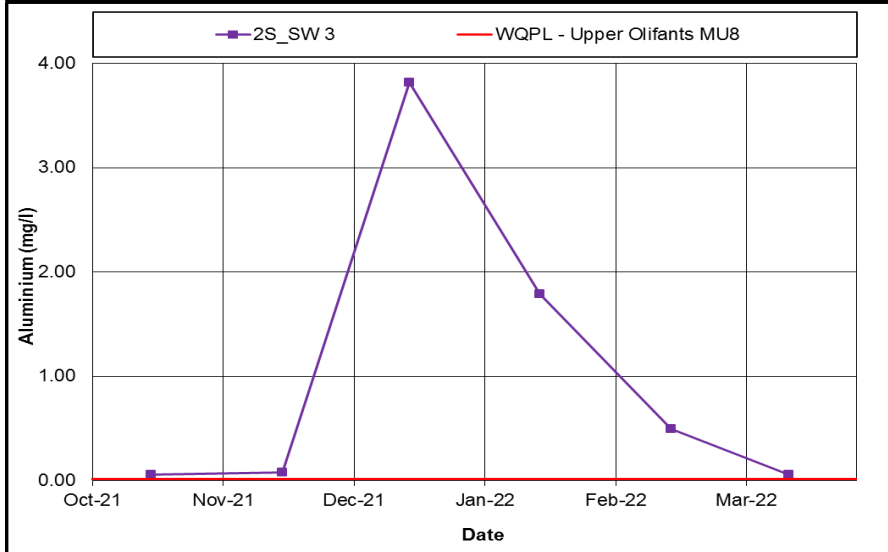
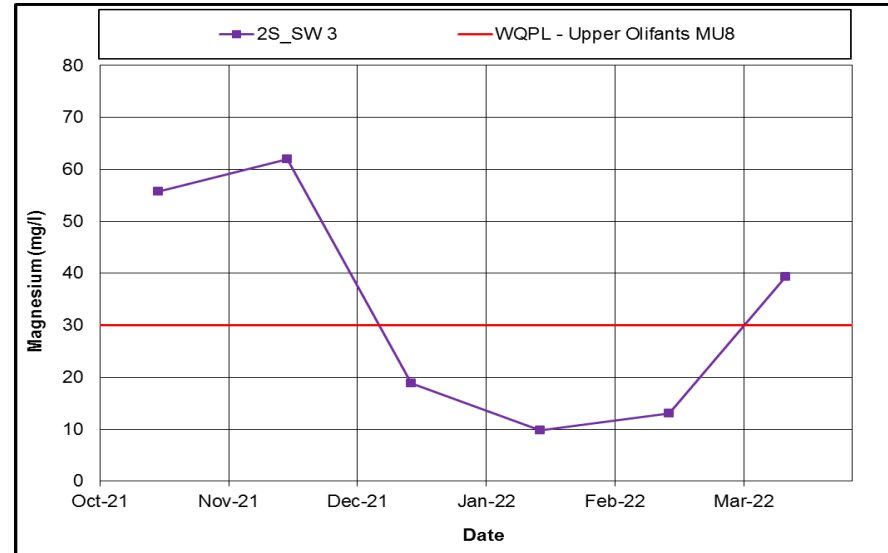
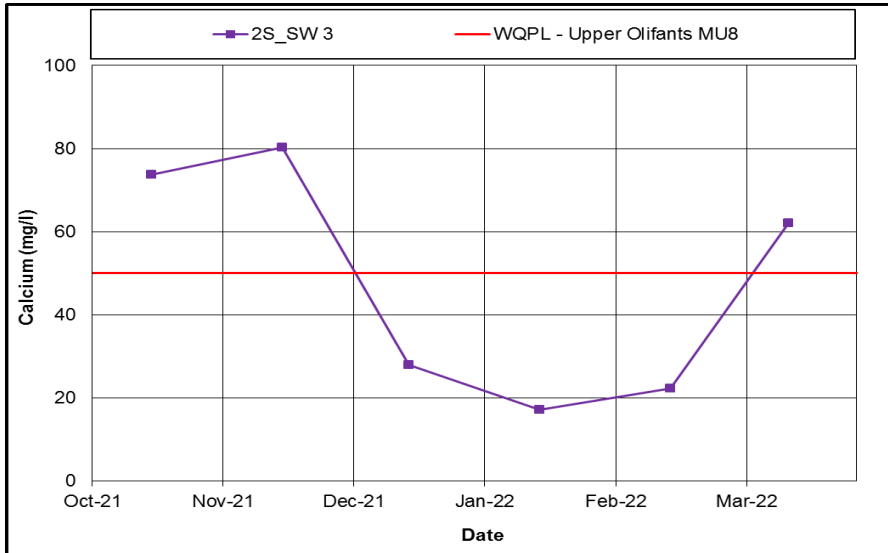
Table 16: 2S_SW 3 Analysis Result

Sample Date	Parameters														
	pH	EC (mS/m)	TDS (mg/l)	Alk (mg/l)	N (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	F (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
Non-Compliance	<6,5	>90	>350	>120	>0,5	>40	>150	>0,75	>50	>25	>50	>30	>0,02	>0,3	>0,05
	>8,4														
Average	7.53	42.80	342.67	114.33	0.19	15.03	104.40	0.57	21.70	5.39	33.83	20.75	0.78	0.59	0.08
Jan-22	7.15	24.20	200.00	72.00	0.35	10.10	47.40	0.43	14.80	5.21	17.20	9.76	1.79	1.22	0.01
Feb-22	7.55	32.40	190.00	94.00	0.13	18.10	47.80	0.52	20.10	5.02	22.30	13.10	0.50	0.50	0.02
Mar-22	7.88	71.80	638.00	177.00	0.10	16.90	218.00	0.76	30.20	5.95	62.00	39.40	0.06	0.06	0.20









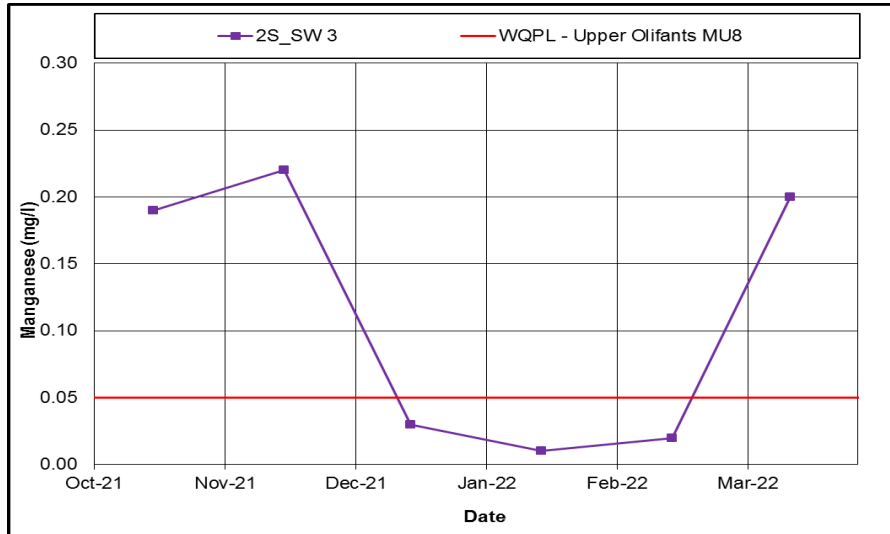


Figure 6: 2S_SW 3 Compliance Graphs



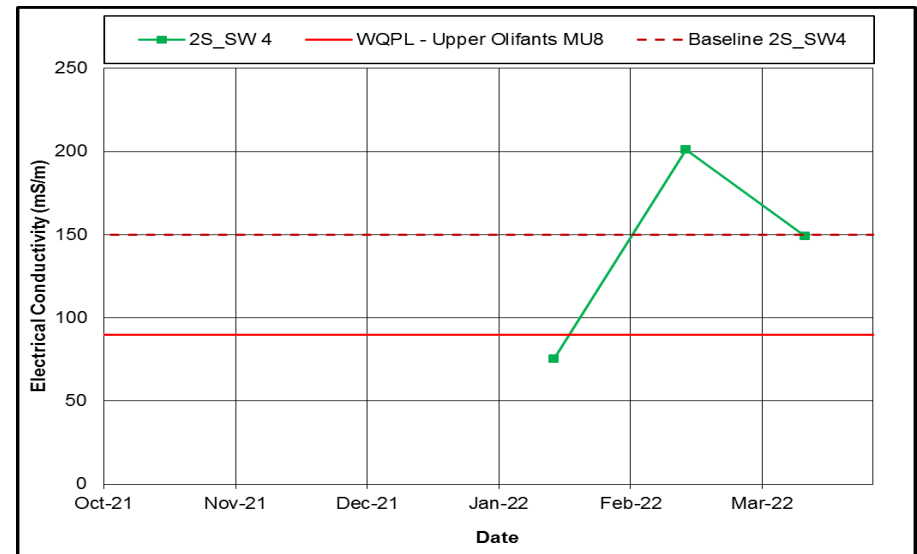
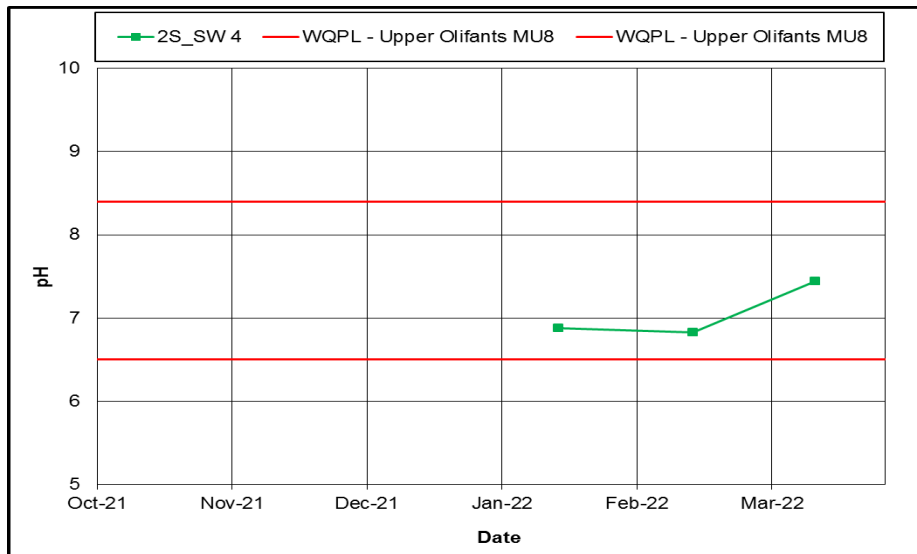
5.1.4. 2S_SW 4

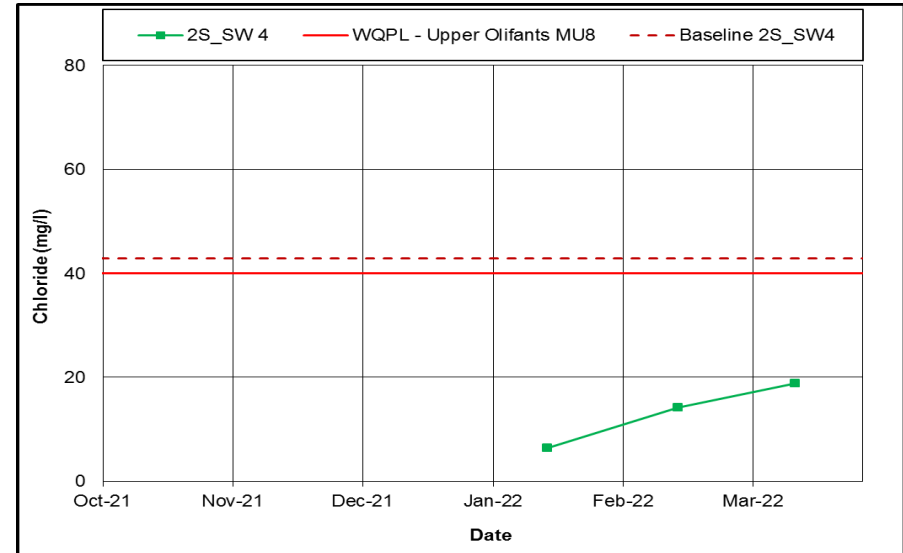
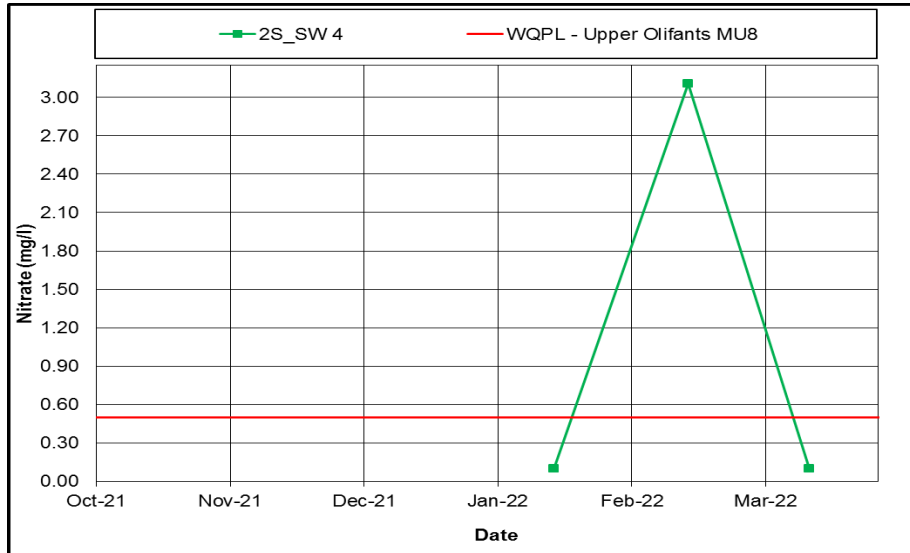
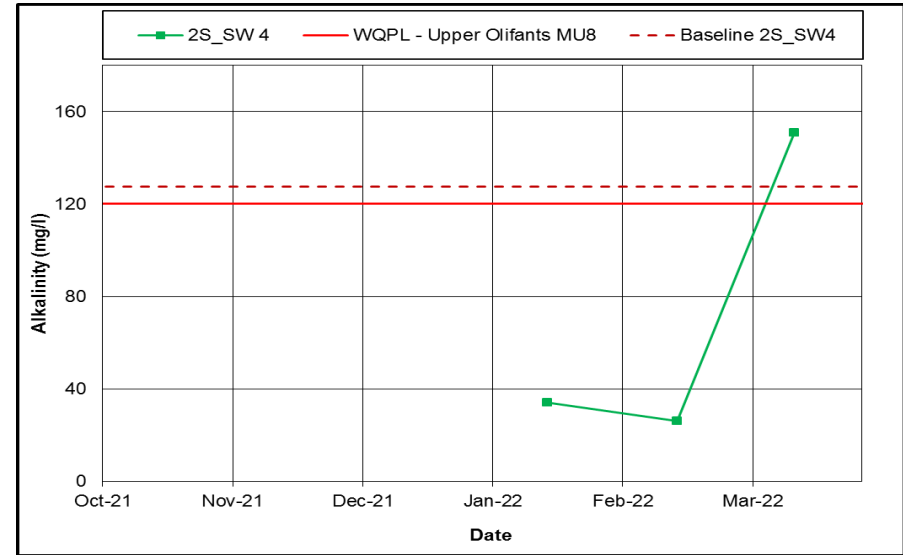
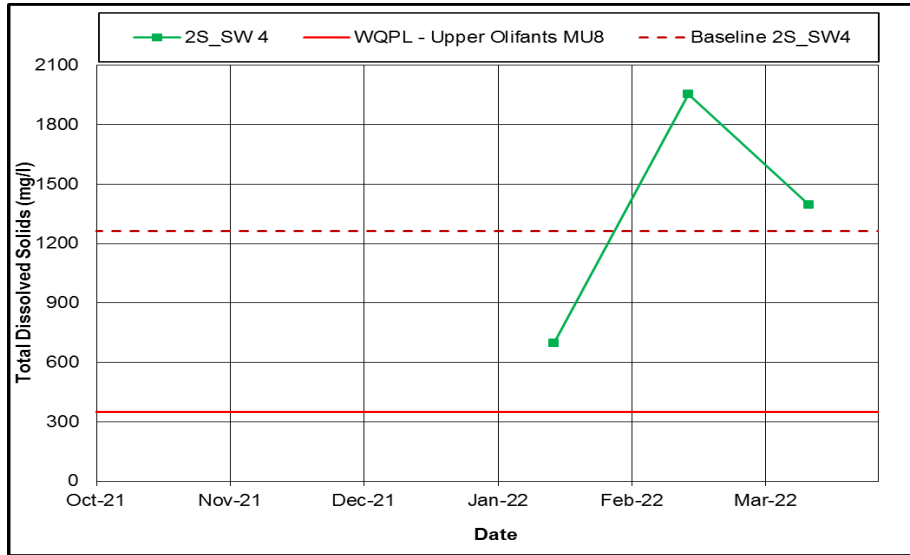
In **Table 17**, one can see that the majority of the parameters did not comply with the WQPL guidelines. In **Figure 7** compliance is also depicted with some baseline comparison. Majority of the parameters did not comply with the WQLP.

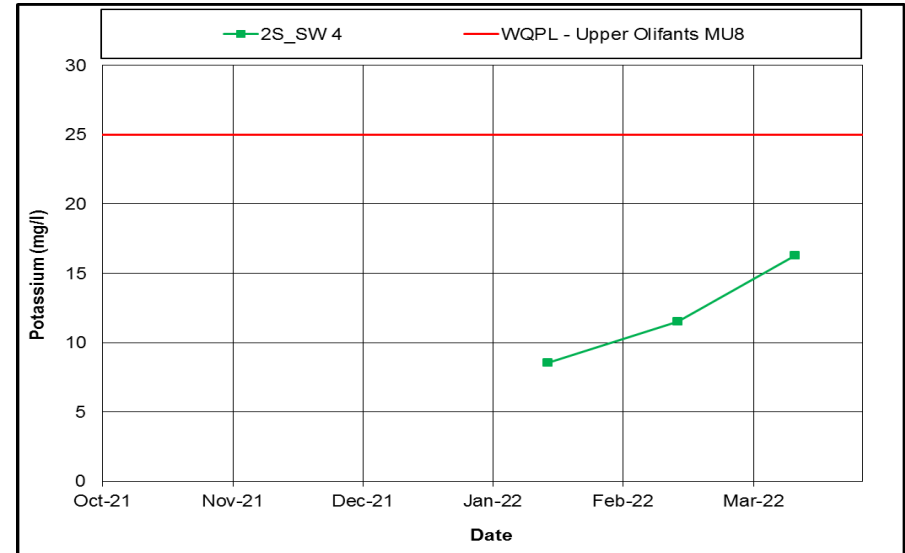
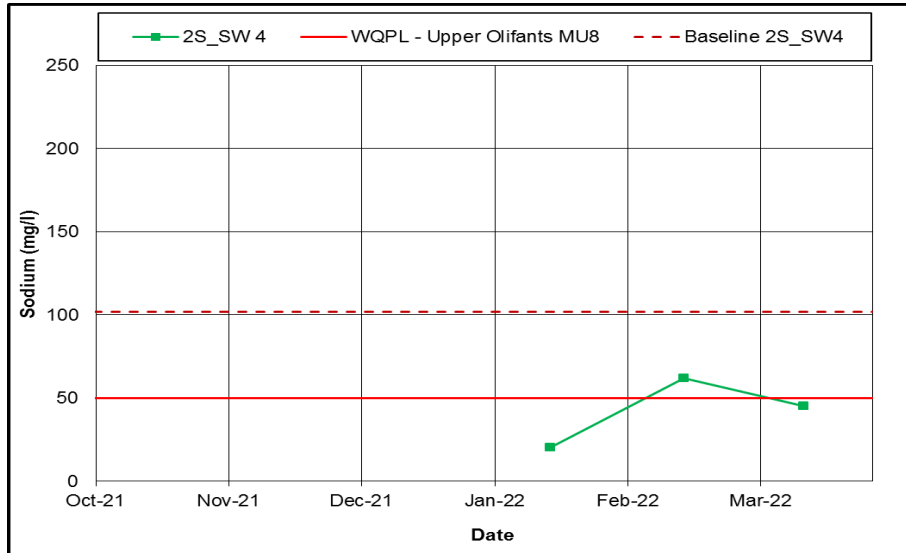
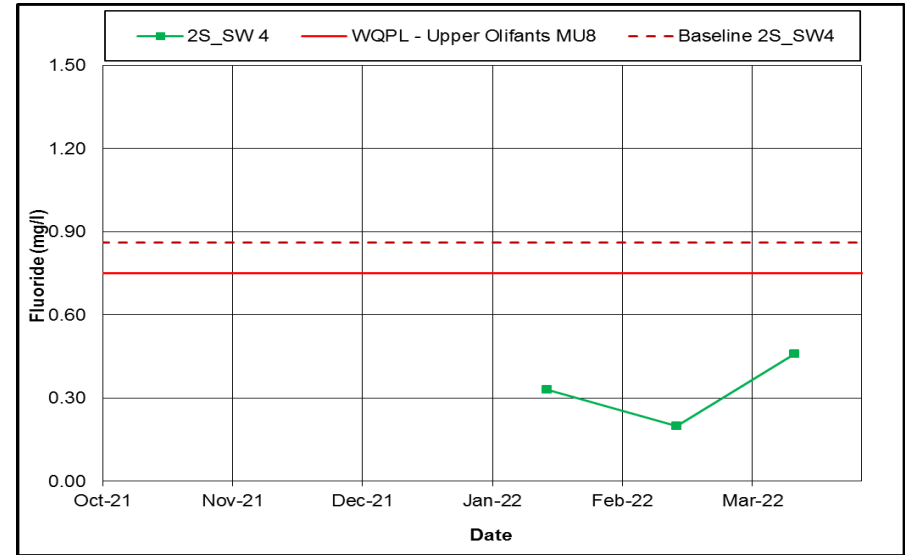
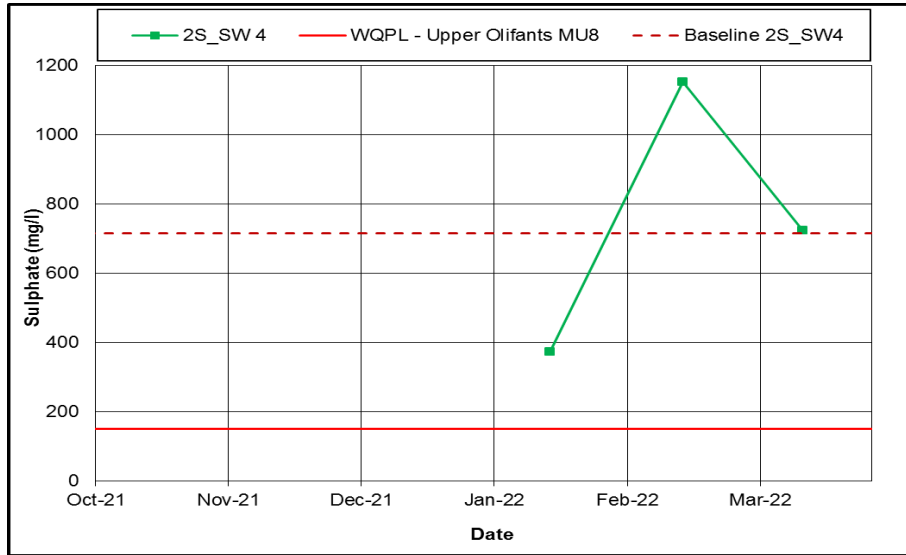


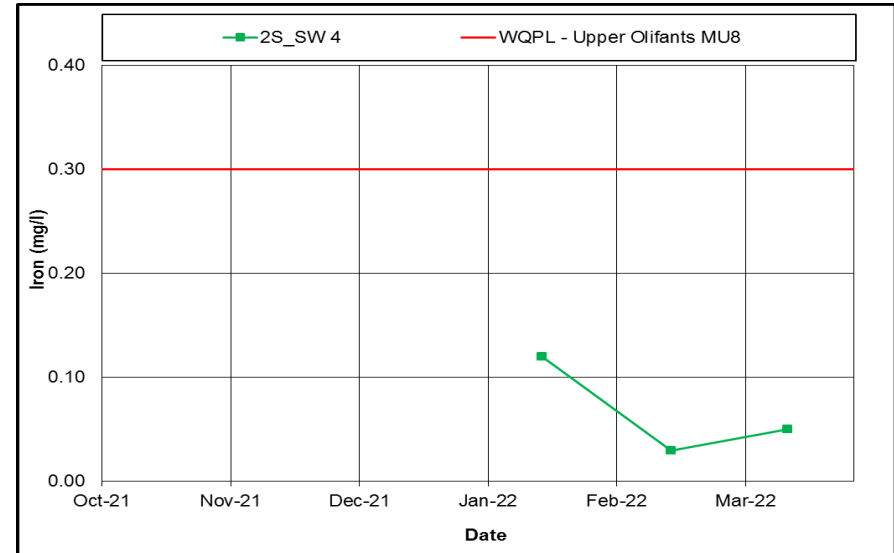
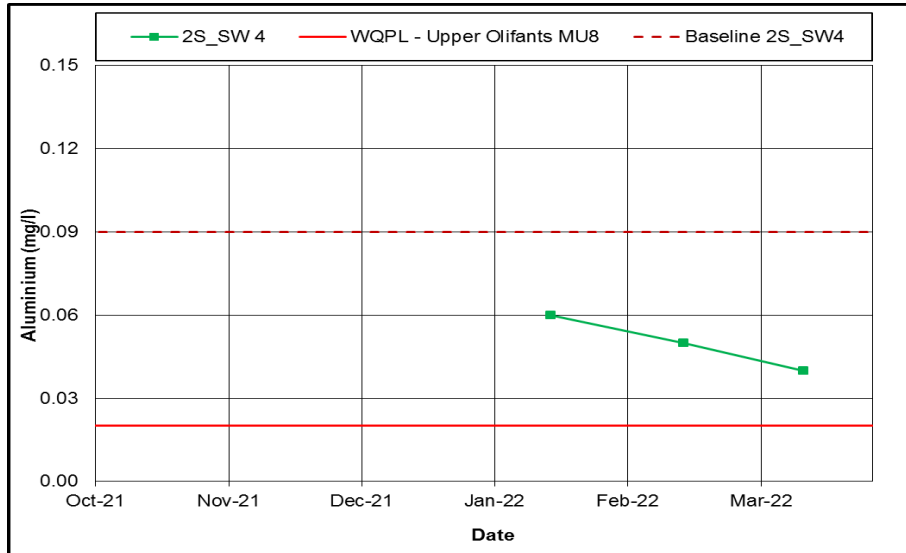
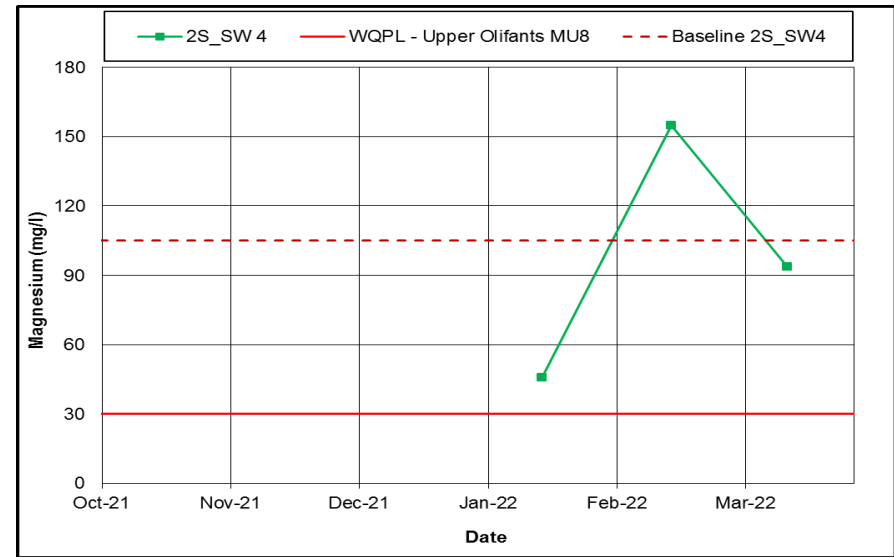
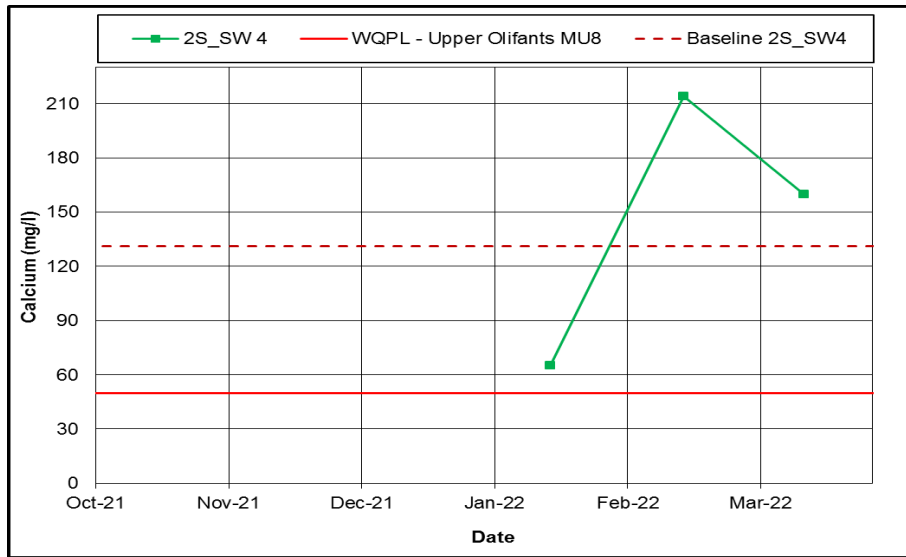
Table 17: 2S_SW 4 Analysis Results

Sample Date	Parameters														
	pH	EC (mS/m)	TDS (mg/l)	Alk (mg/l)	N (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	F (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
Non-Compliance	<6,5	>90	>350	>120	>0,5	>40	>150	>0,75	>50	>25	>50	>30	>0,02	>0,3	>0,05
	>8,4														
Average	7.05	141.80	1 348.00	70.33	1.10	13.13	750.00	0.33	42.60	12.12	146.40	98.17	0.05	0.07	4.91
Jan-22	6.88	75.40	696.00	34.00	0.10	6.40	374.00	0.33	20.50	8.57	65.20	45.80	0.06	0.12	0.32
Feb-22	6.83	201.00	1 954.00	26.00	3.11	14.20	1 152.00	0.20	61.90	11.50	214.00	155.00	0.05	0.03	8.32
Mar-22	7.44	149.00	1 394.00	151.00	0.10	18.80	724.00	0.46	45.40	16.30	160.00	93.70	0.04	0.05	6.10









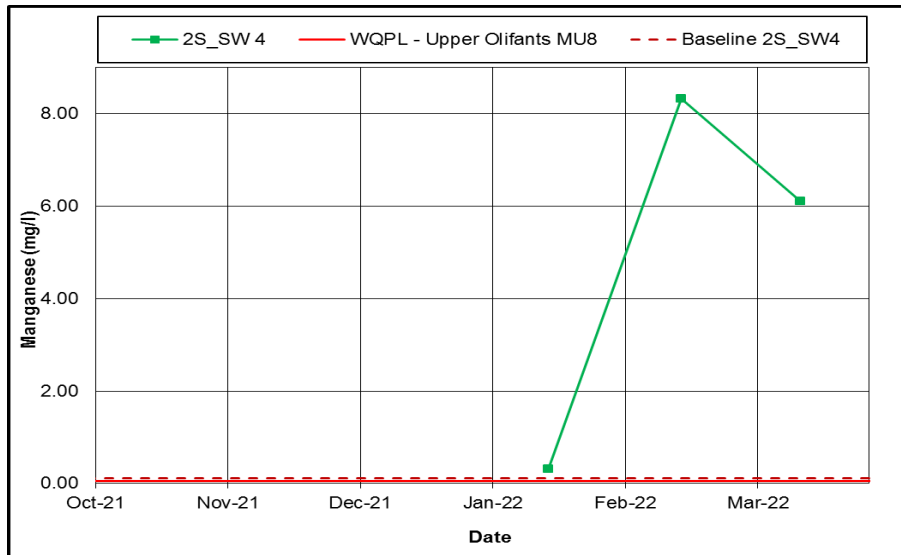


Figure 7: 2S_SW 4 Compliance Graphs



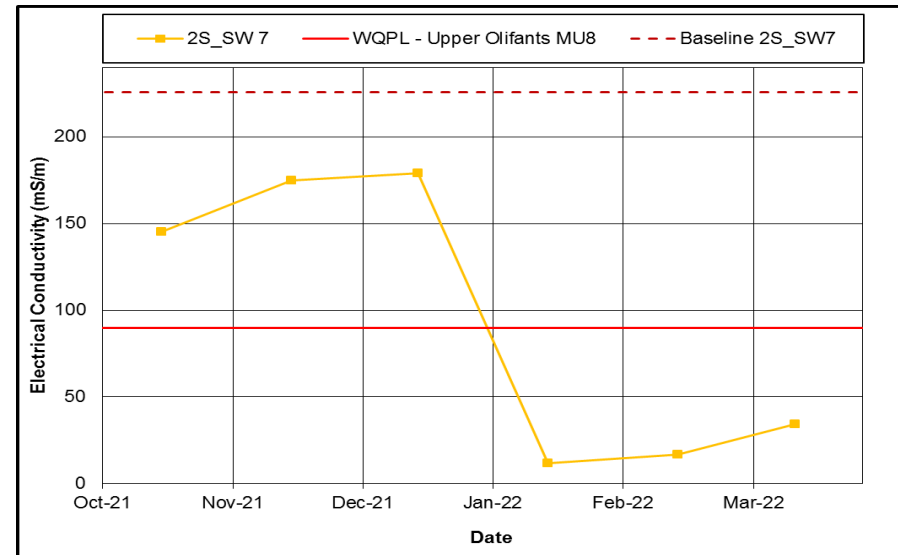
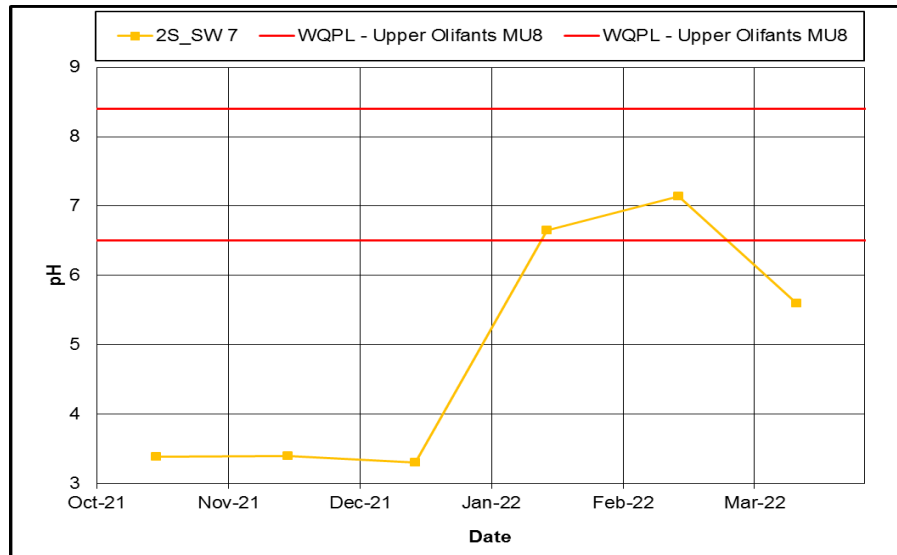
5.1.5. 2S_SW 7

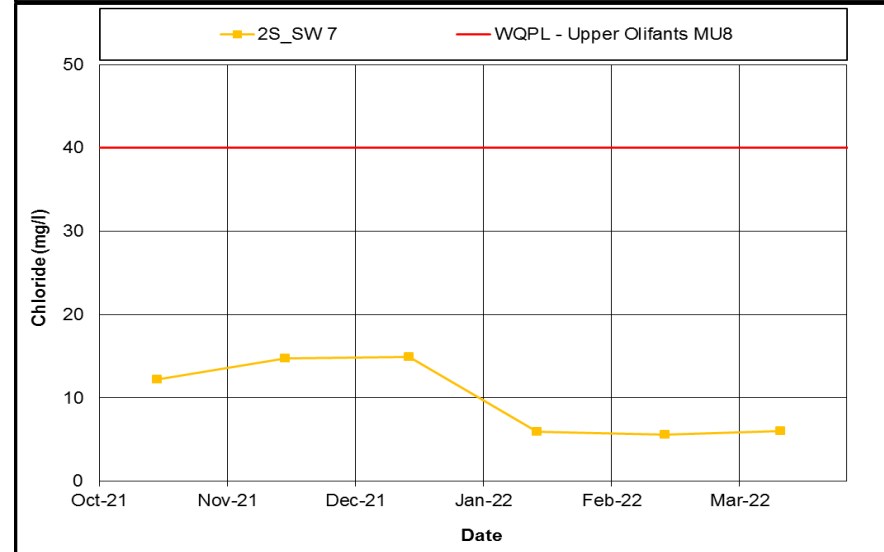
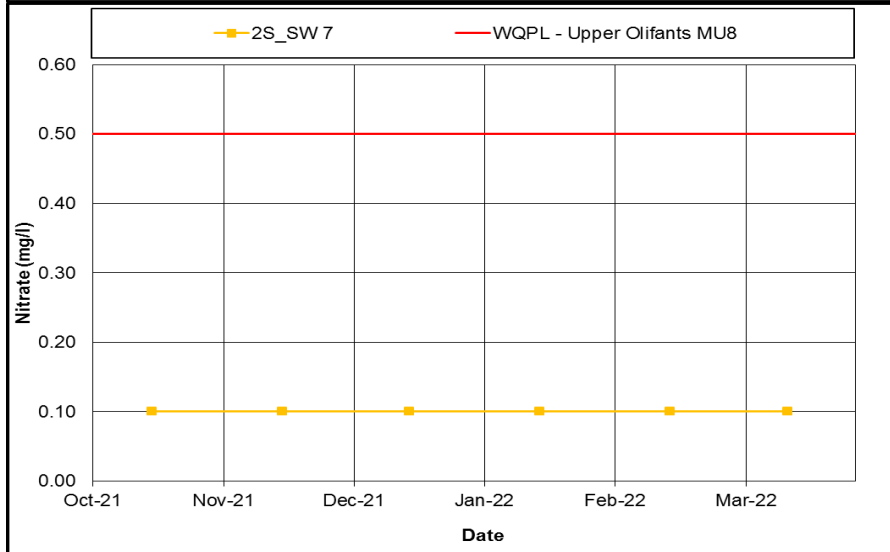
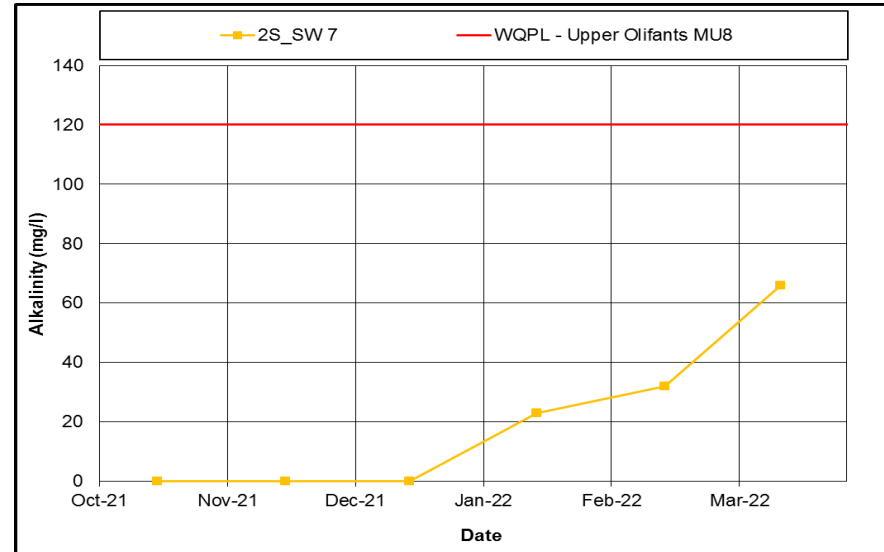
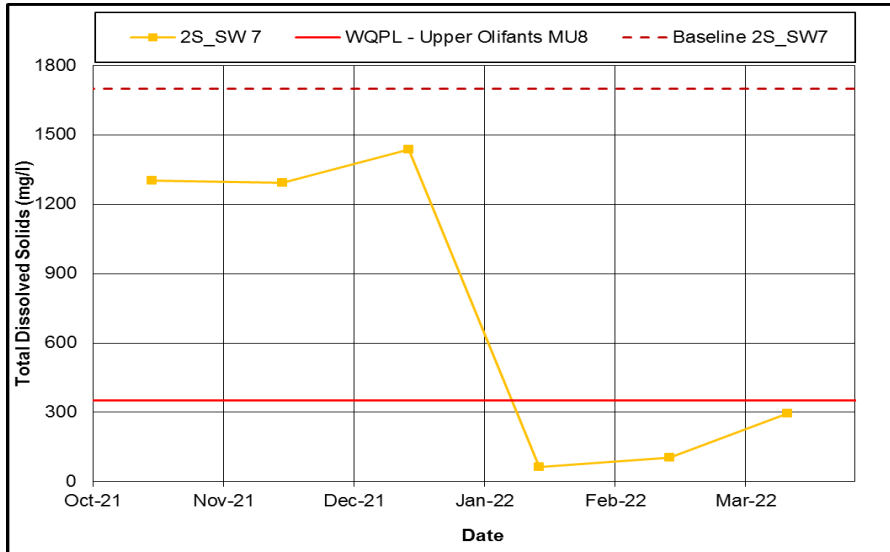
It can be seen from **Table 18** that majority of parameters were compliant. Refer to **Figure 8** for a graphically representation of the data. Majority of the parameters comply with the WQLP except for pH, Aluminium, Iron and Manganese.

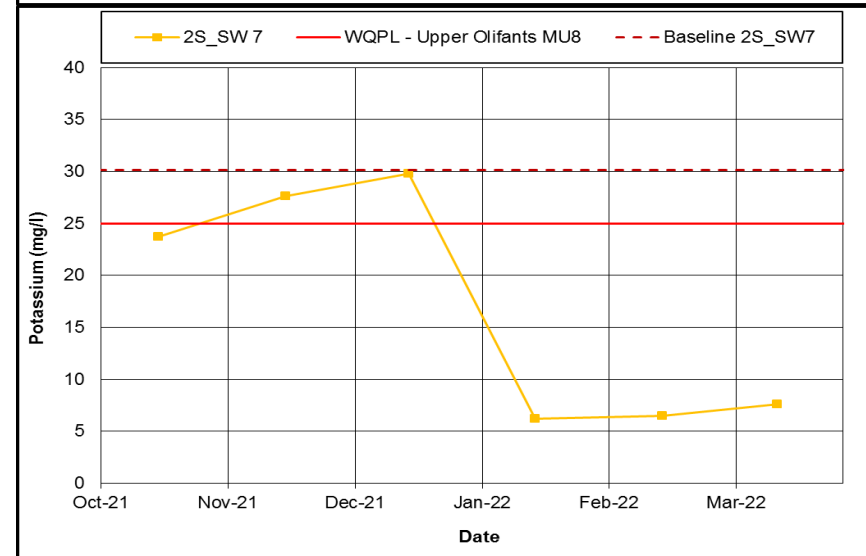
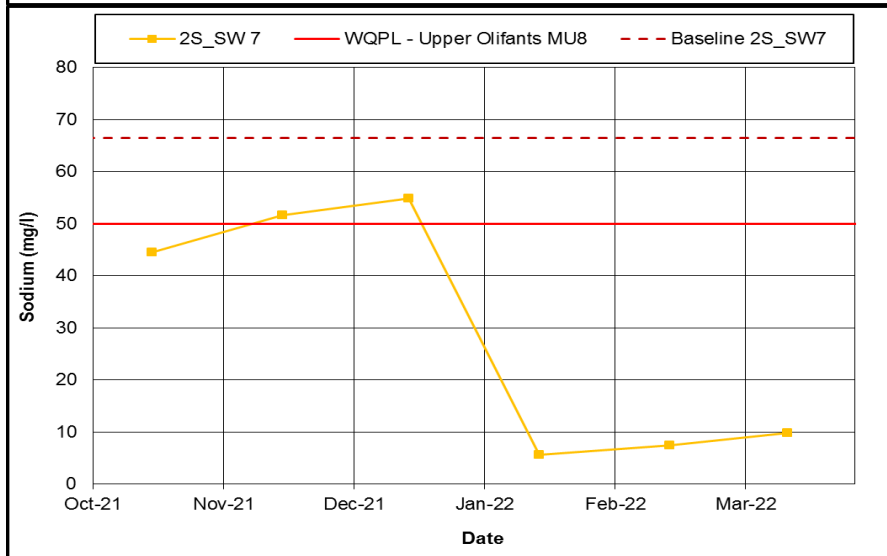
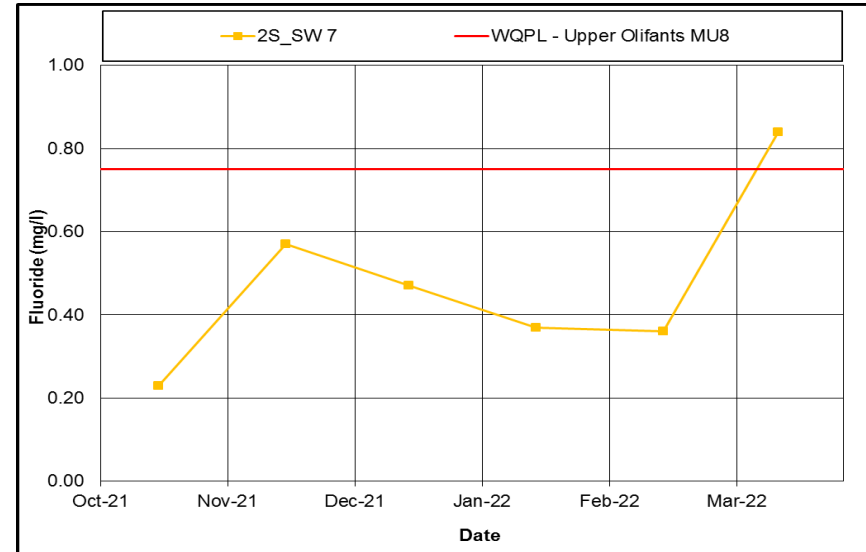
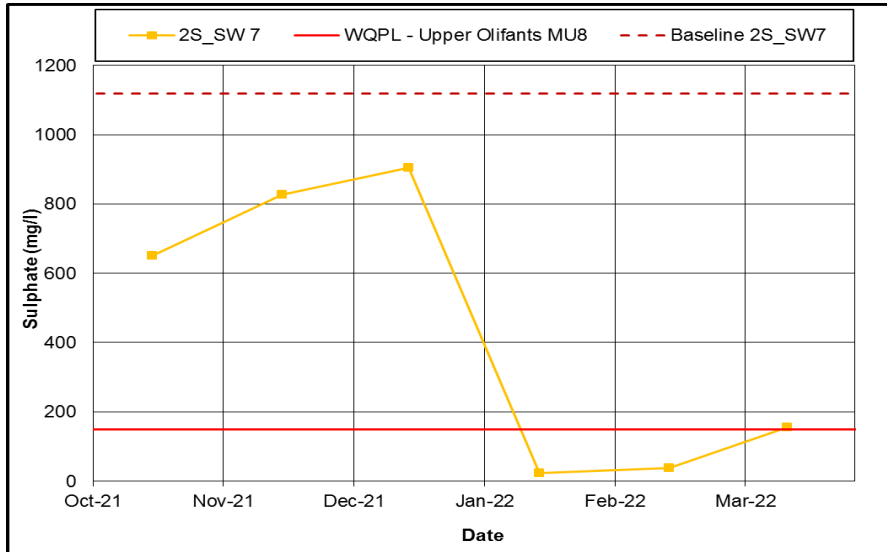


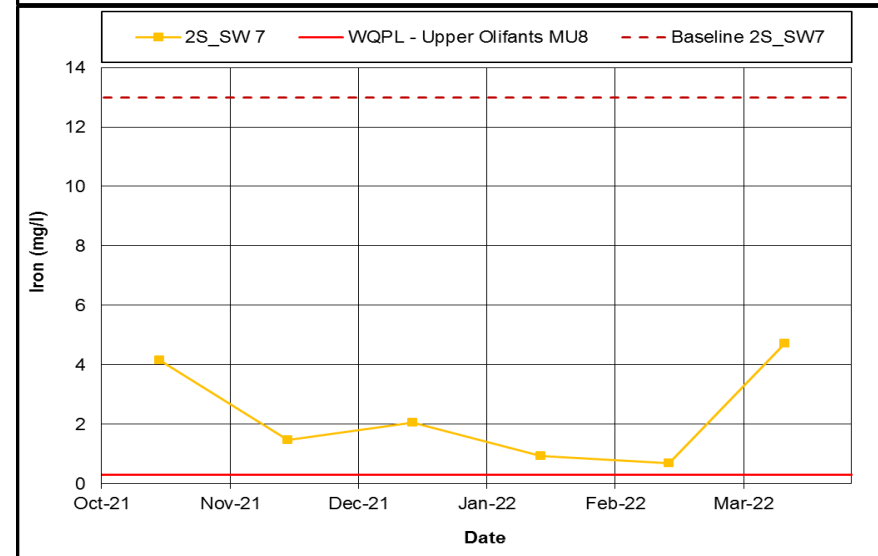
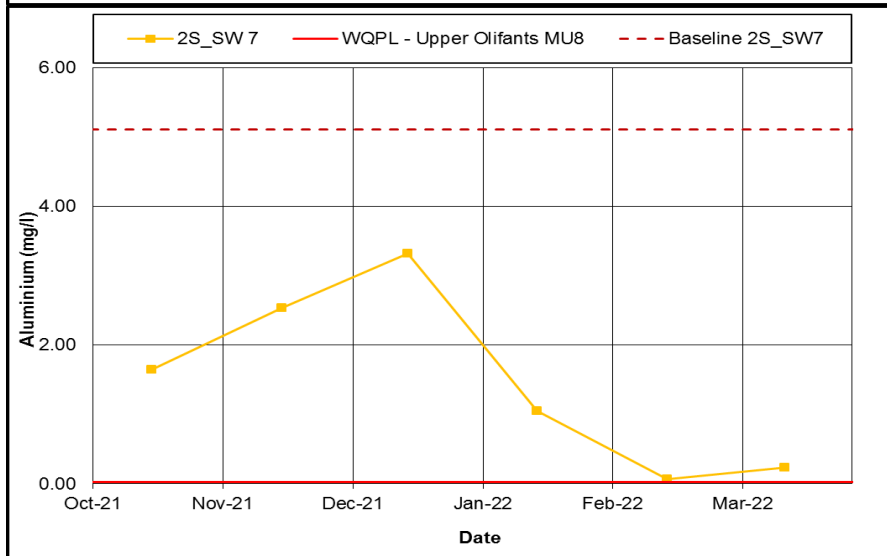
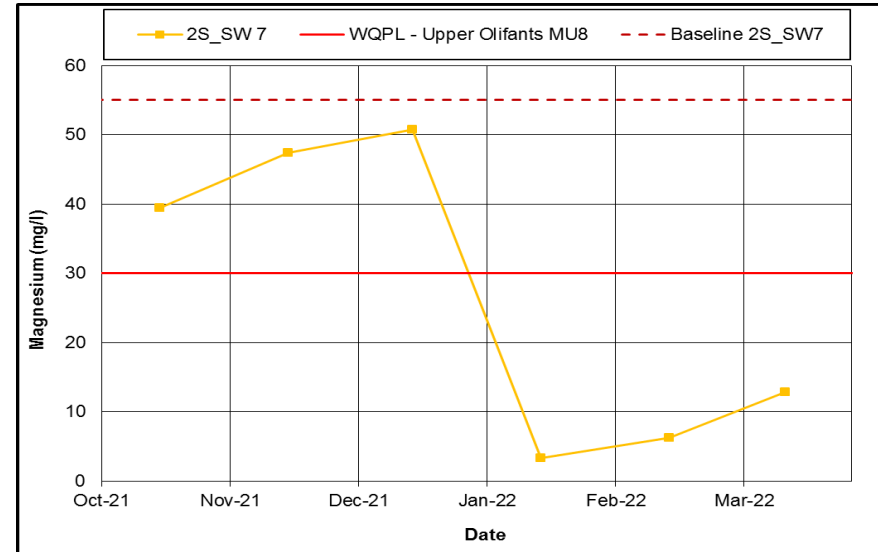
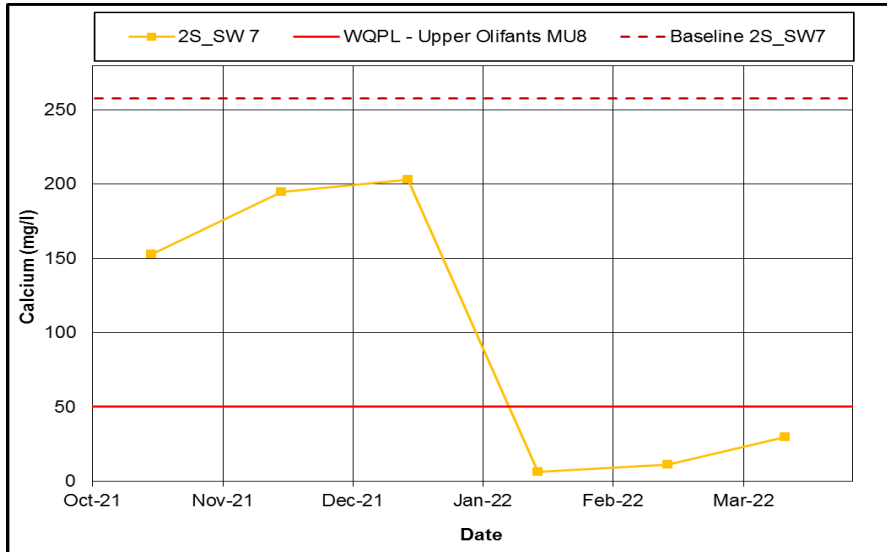
Table 18: 2S_SW 7 Analysis Results

Sample Date	Parameters														
	pH	EC (mS/m)	TDS (mg/l)	Alk (mg/l)	N (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	F (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
Non-Compliance	<6,5	>90	>350	>120	>0,5	>40	>150	>0,75	>50	>25	>50	>30	>0,02	>0,3	>0,05
	>8,4														
Average	6.46	20.87	154.00	40.33	0.10	5.80	72.07	0.52	7.63	6.75	15.85	7.52	0.45	2.12	0.70
Jan-22	6.65	11.70	64.00	23.00	0.10	5.88	22.40	0.37	5.57	6.19	6.44	3.38	1.05	0.93	0.01
Feb-22	7.14	16.70	104.00	32.00	0.10	5.54	38.80	0.36	7.42	6.47	11.40	6.28	0.07	0.70	0.04
Mar-22	5.60	34.20	294.00	66.00	0.10	5.98	155.00	0.84	9.89	7.60	29.70	12.90	0.23	4.72	2.05









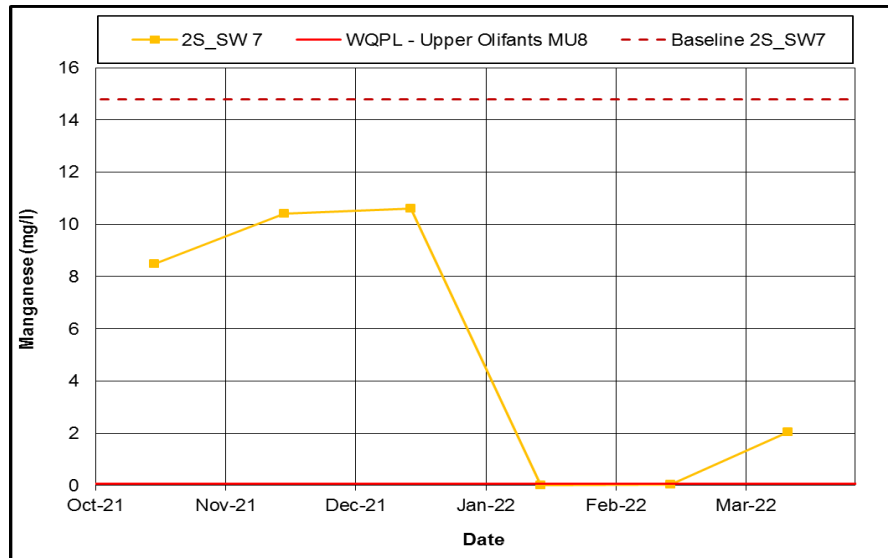


Figure 8: 2S_SW 7 Compliance Graphs



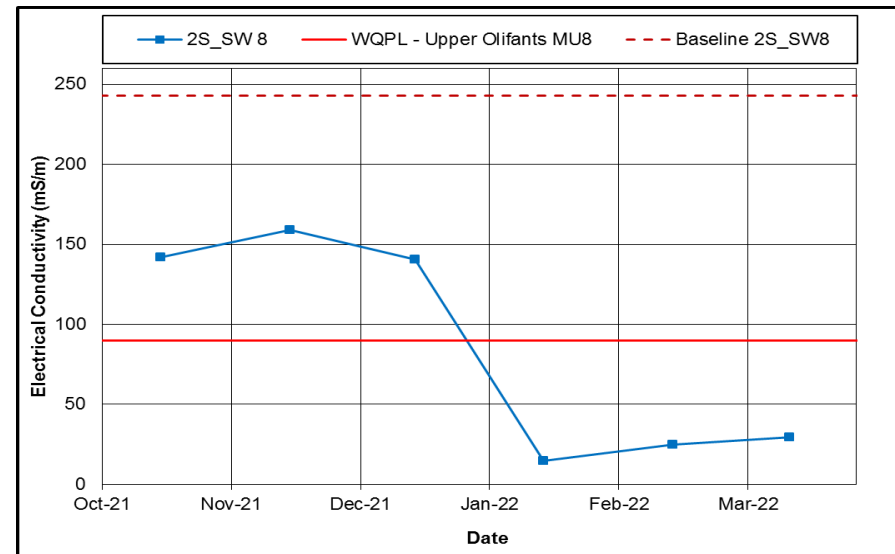
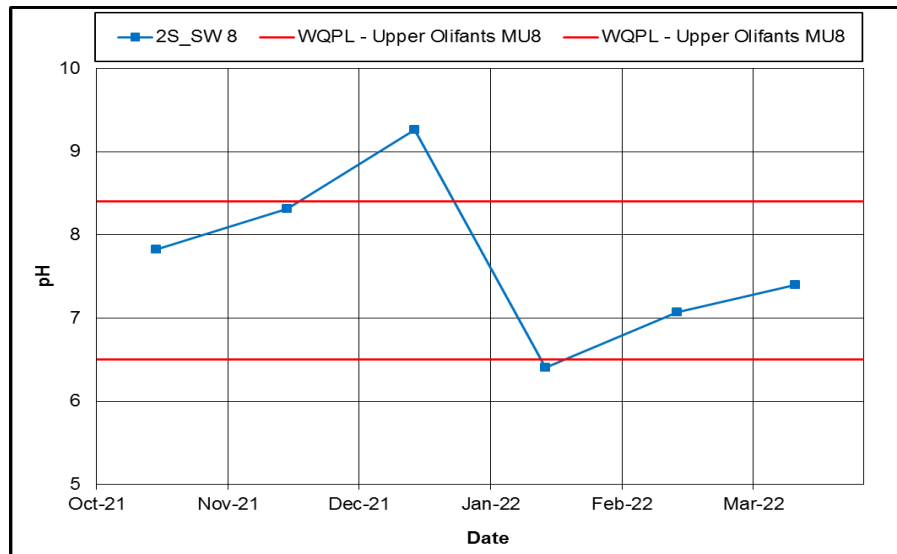
5.1.6. 2S_SW 8

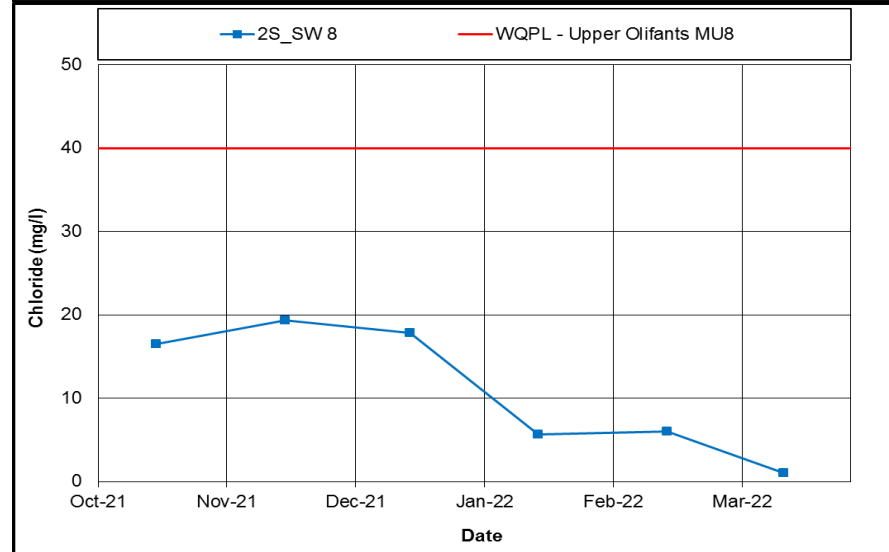
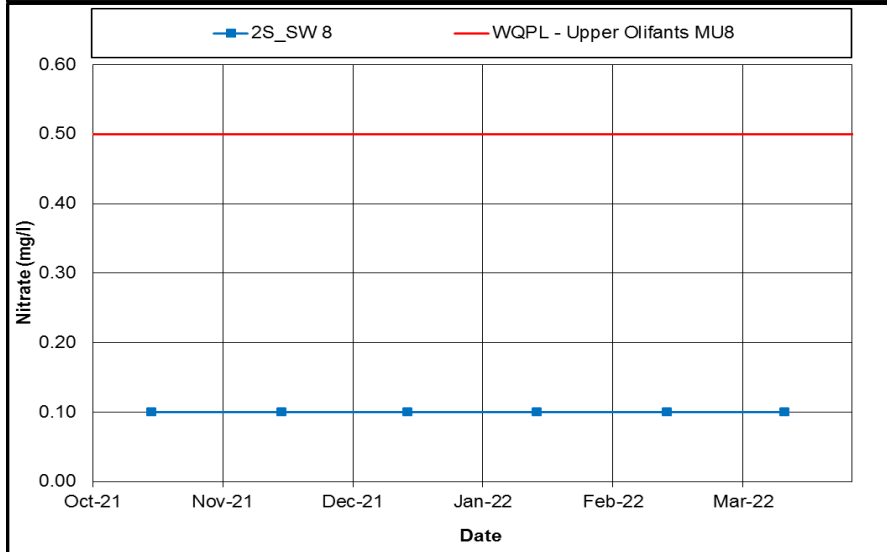
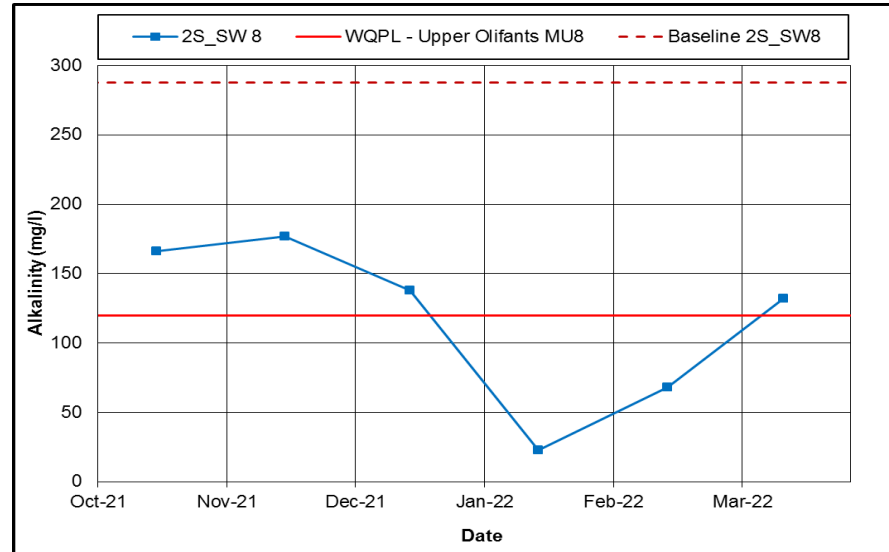
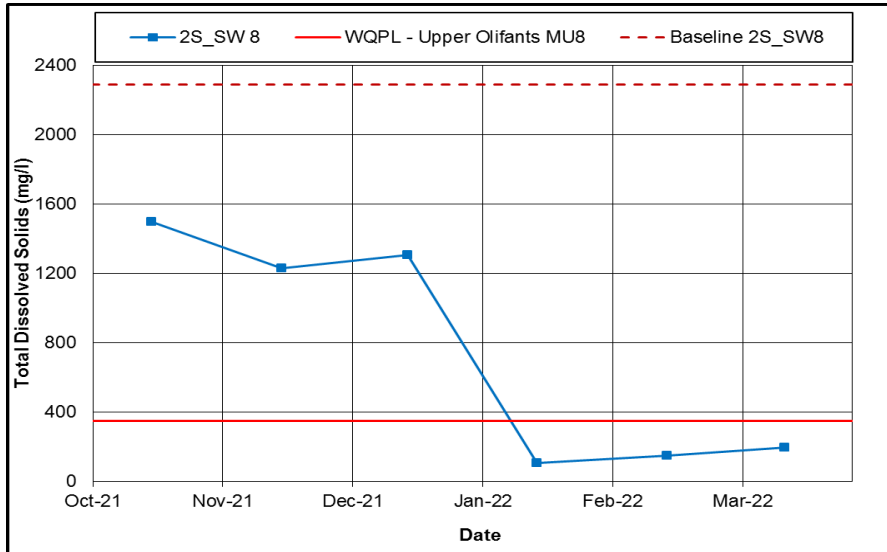
The compliance is indicated in **Table 19** and the visual representation of the data can be seen in **Figure 9**. Most of the parameters are compliant. Majority of the parameters comply with the WQLP, except for Aluminium and Iron.

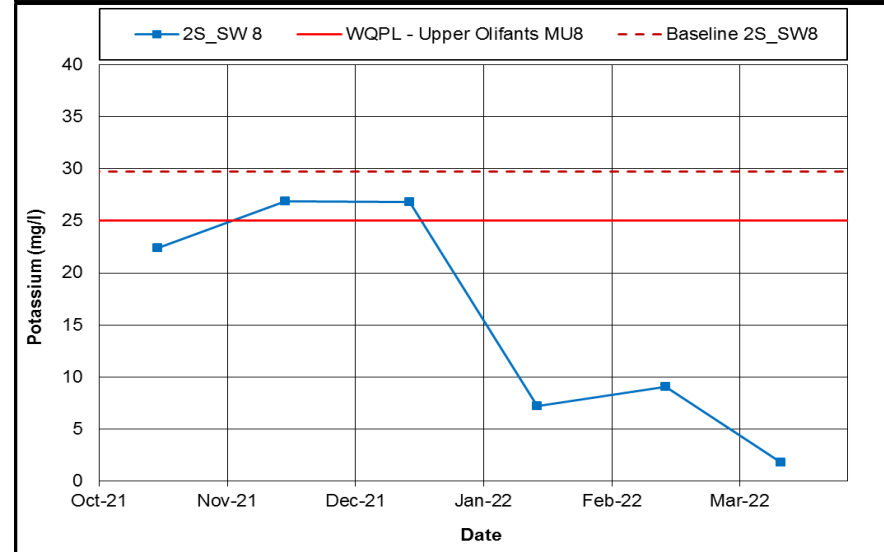
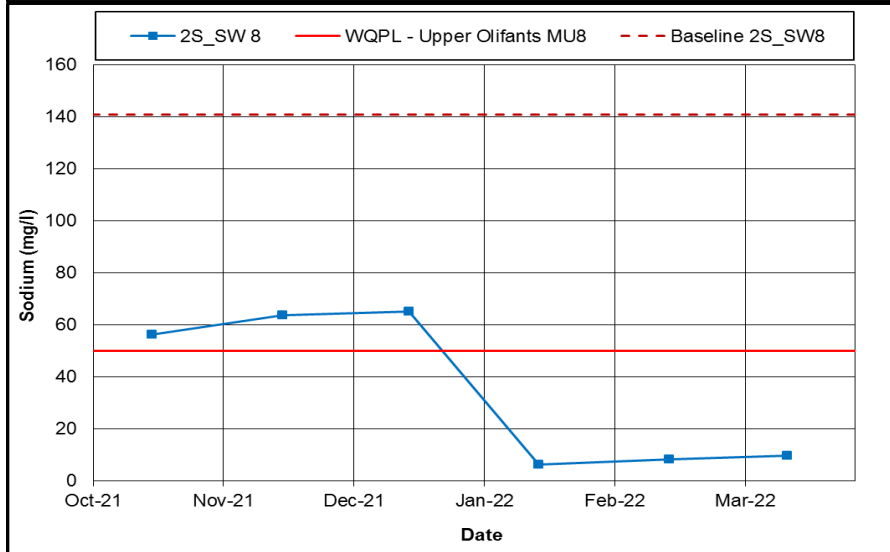
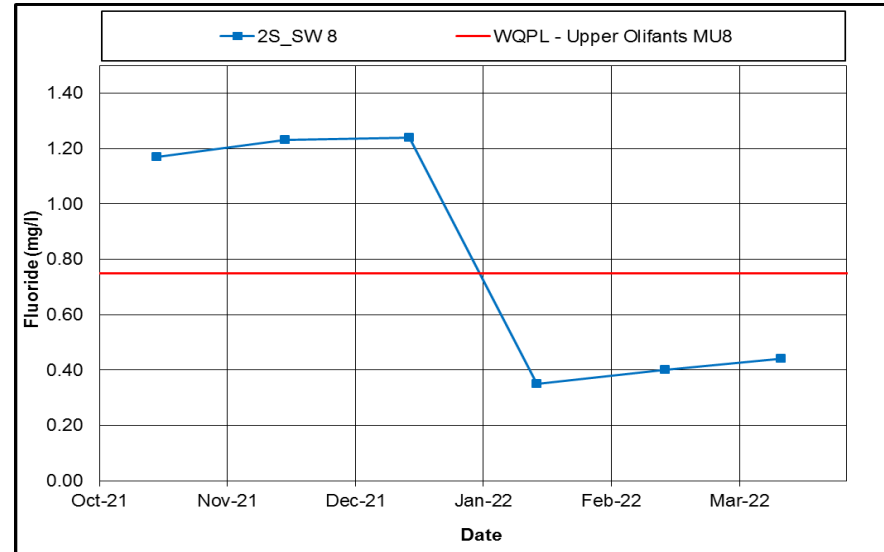
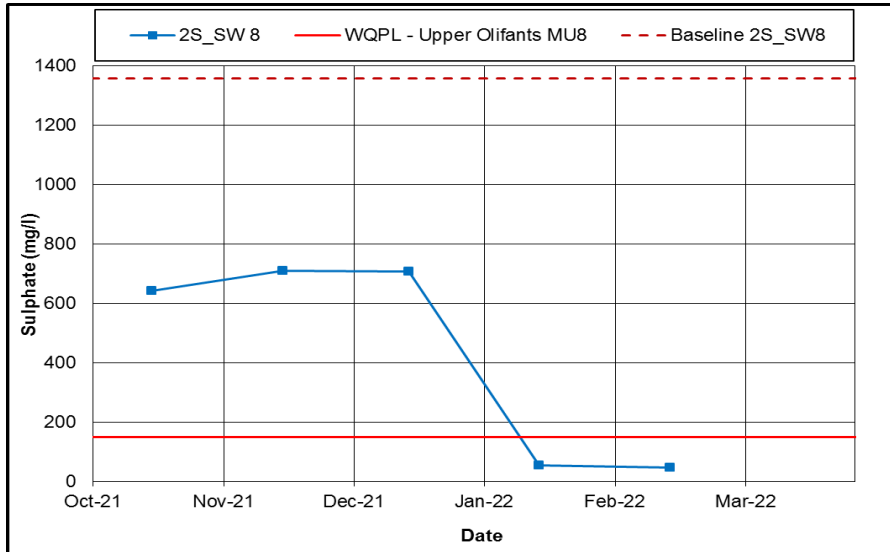


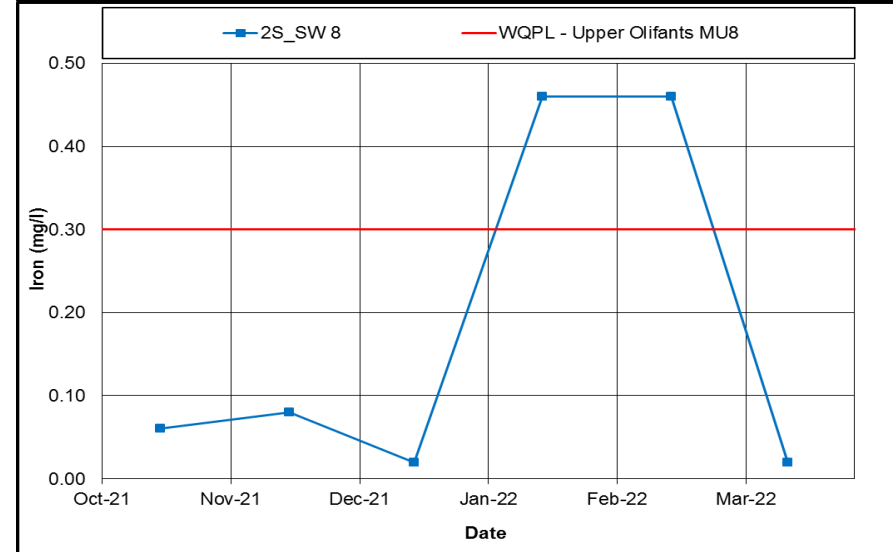
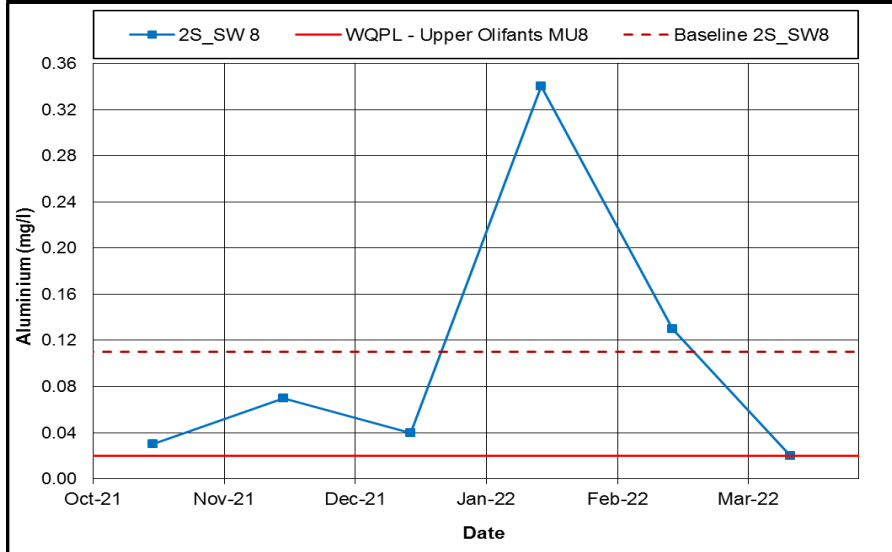
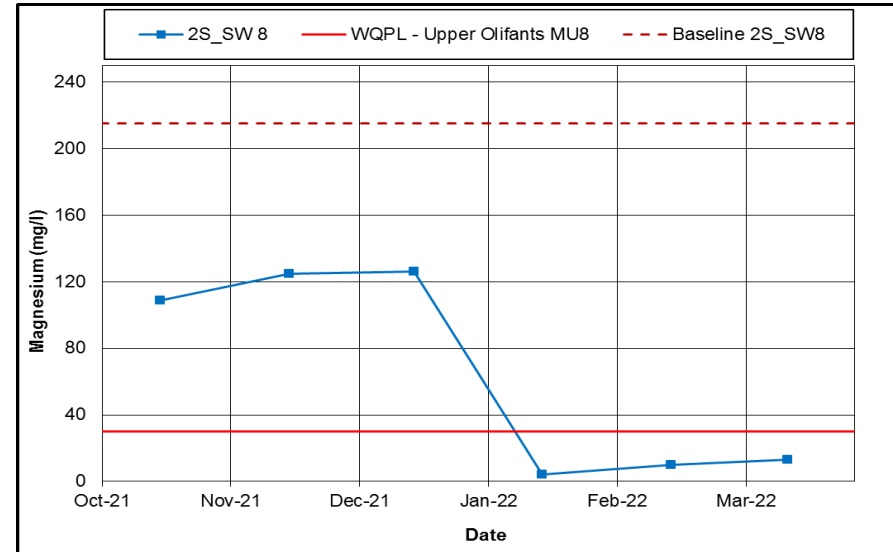
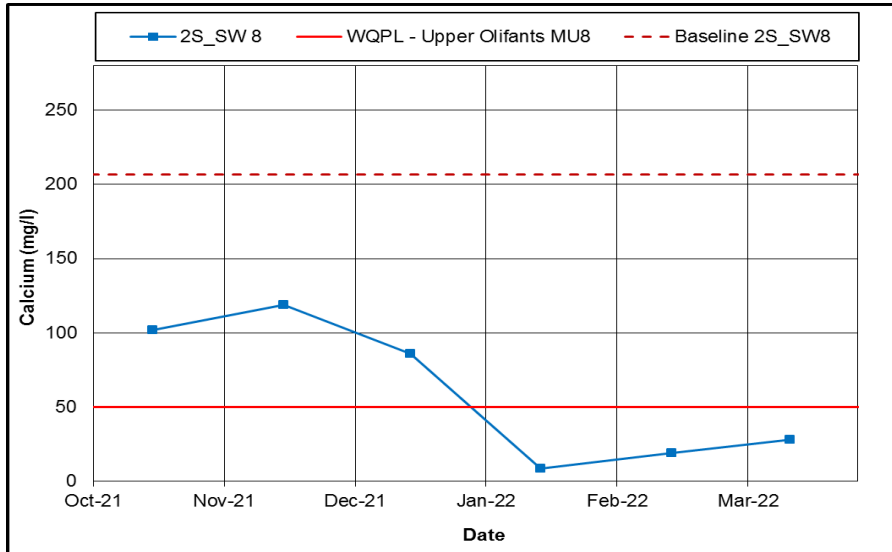
Table 19: 2S_SW 8 Analysis Results

Sample Date	Parameters														
	pH	EC (mS/m)	TDS (mg/l)	Alk (mg/l)	N (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	F (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
Non-Compliance	<6,5	>90	>350	>120	>0,5	>40	>150	>0,75	>50	>25	>50	>30	>0,02	>0,3	>0,05
	>8,4														
Average	6.96	22.87	150.00	74.33	0.10	4.21	43.73	0.40	8.05	6.03	18.61	9.13	0.16	0.31	0.03
Jan-22	6.41	14.50	106.00	23.00	0.10	5.64	53.20	0.35	6.30	7.24	8.62	4.34	0.34	0.46	0.01
Feb-22	7.07	24.80	150.00	68.00	0.10	5.98	47.40	0.40	8.17	9.06	19.00	9.86	0.13	0.46	0.08
Mar-22	7.40	29.30	194.00	132.00	0.10	1.00	30.60	0.44	9.68	1.78	28.20	13.20	0.02	0.02	0.01









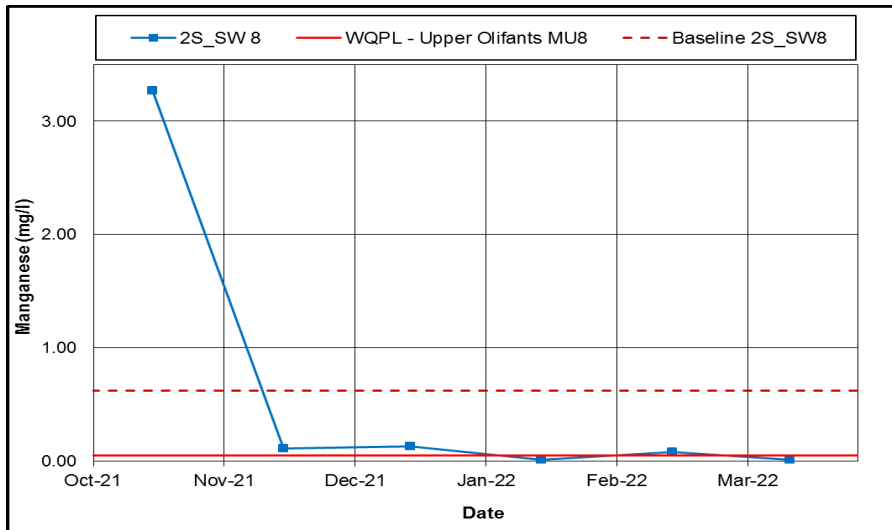


Figure 9: 2S_SW 8 Compliance Graphs



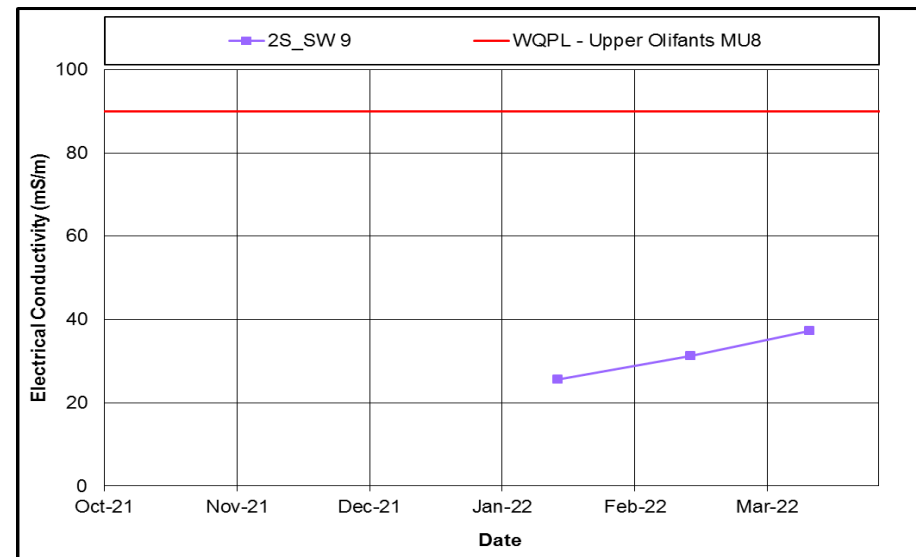
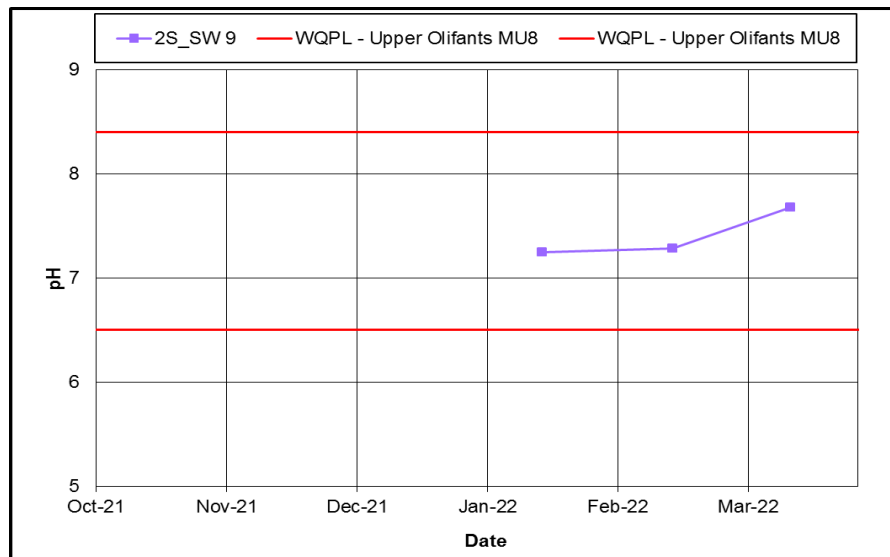
5.1.7. 2S_SW 9

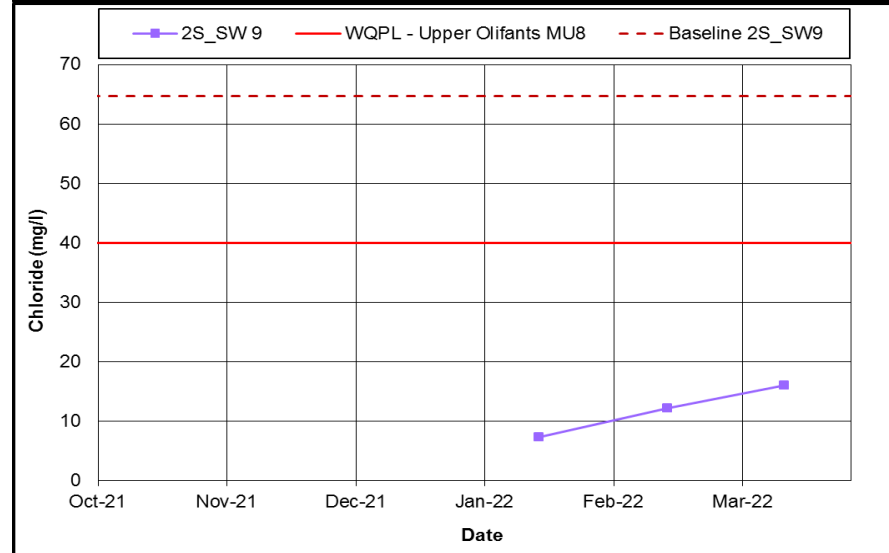
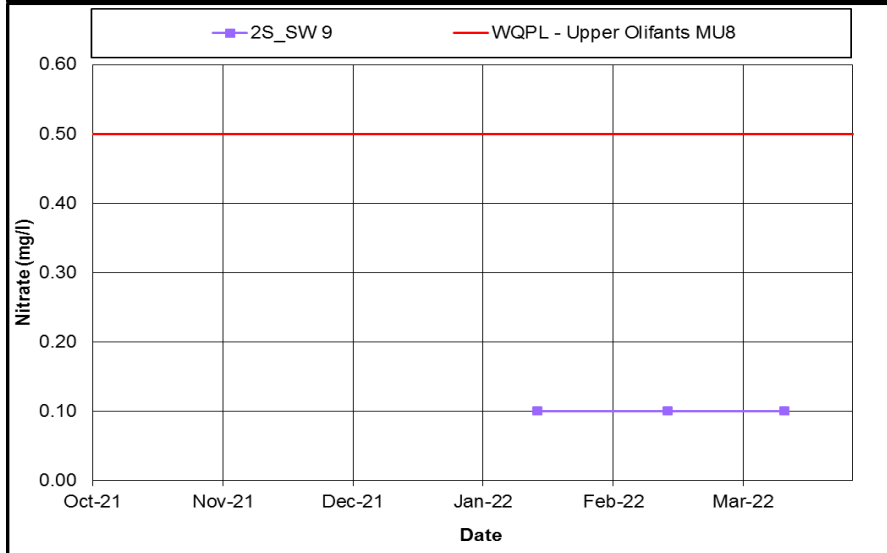
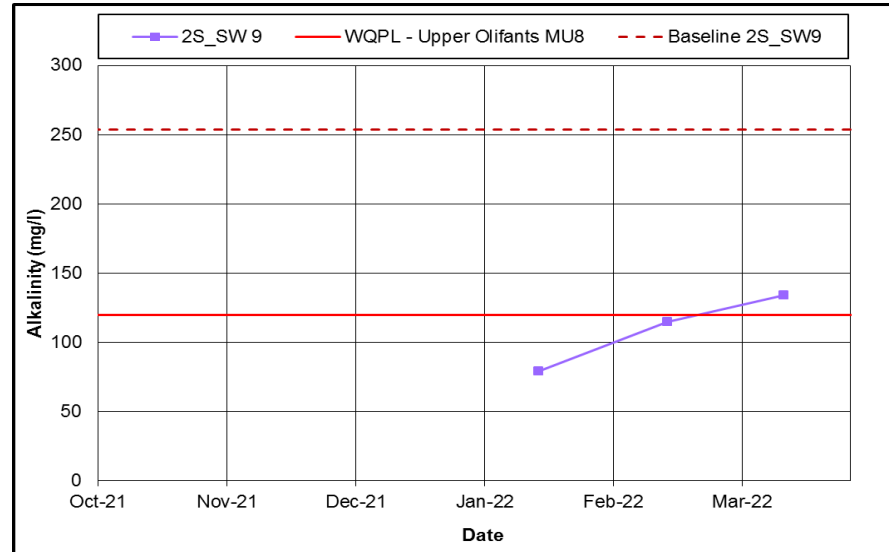
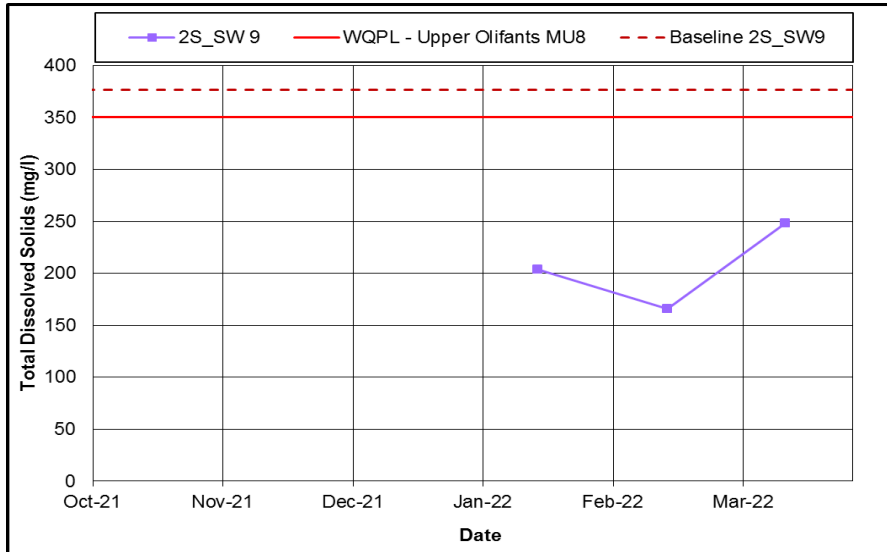
The 2S_SW 9 analysis for each parameter is tabulated in **Table 20** below. It can be seen from the table that Aluminium did not comply with the WQPL. Refer to **Figure 10** for a visual representation of the data

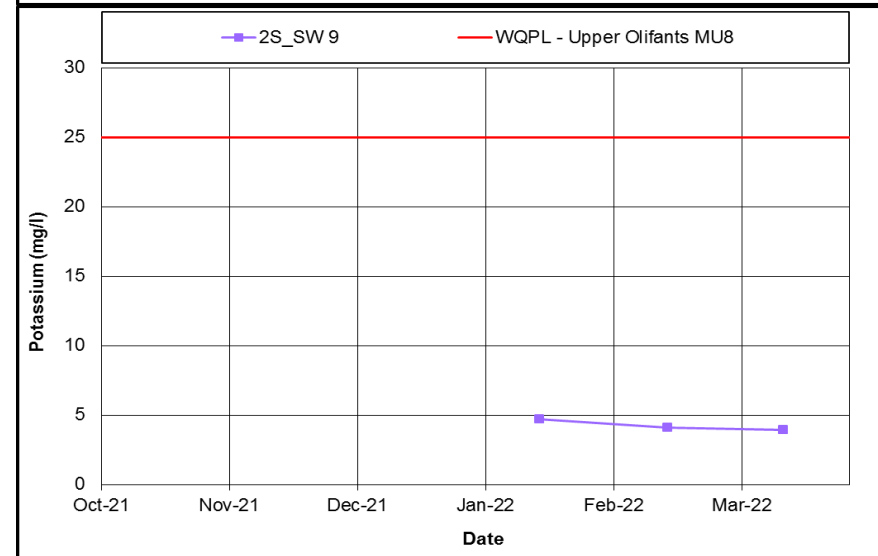
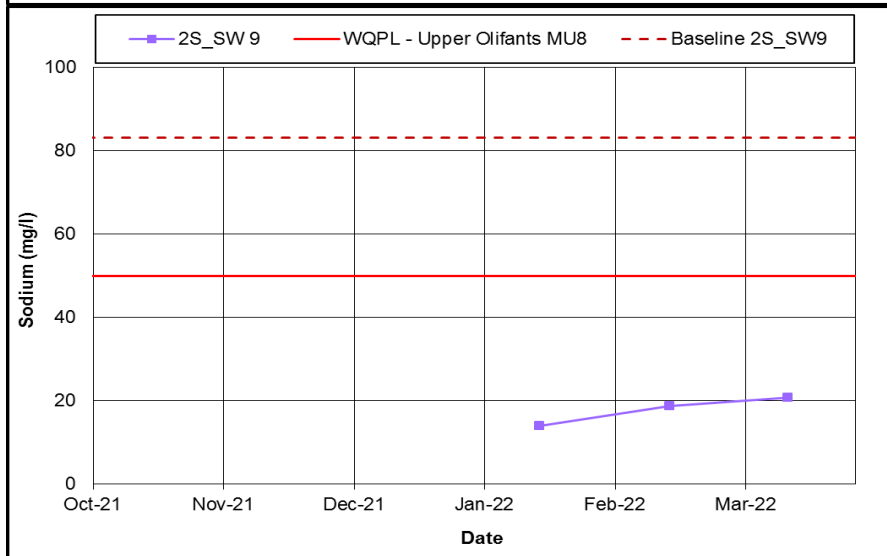
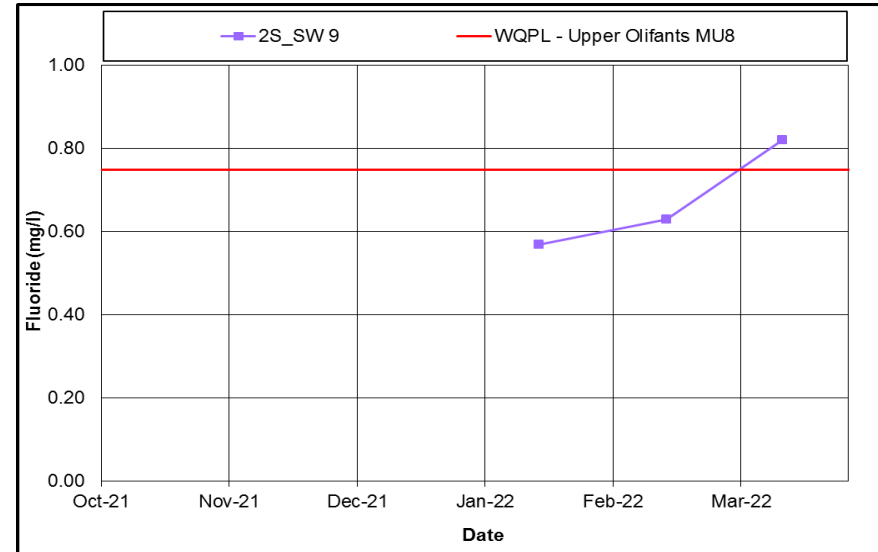
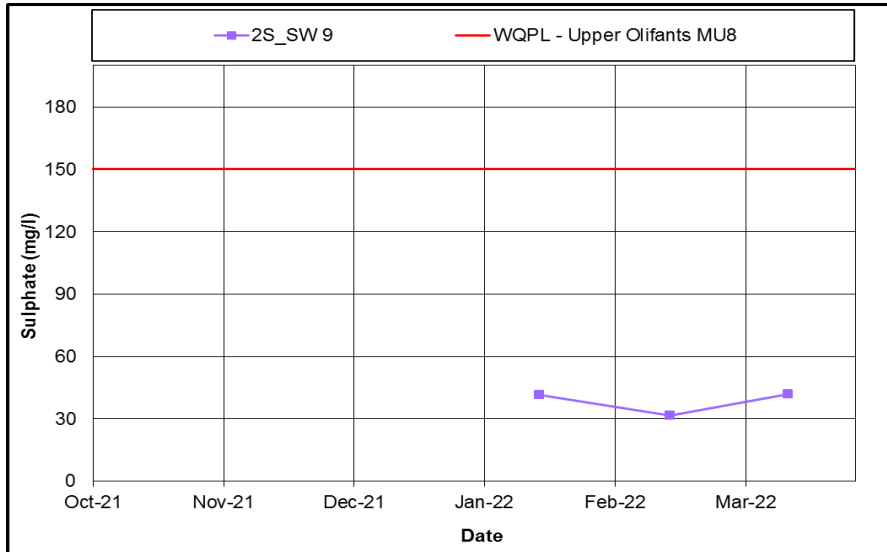


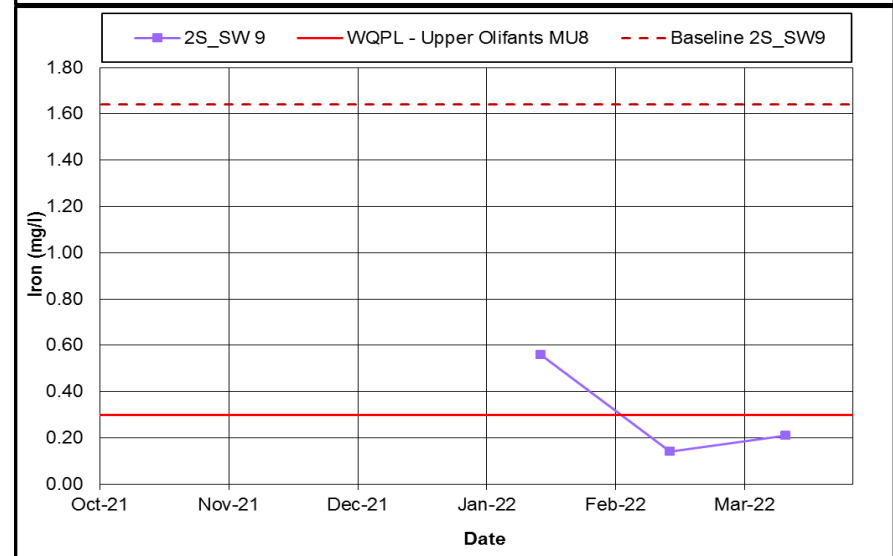
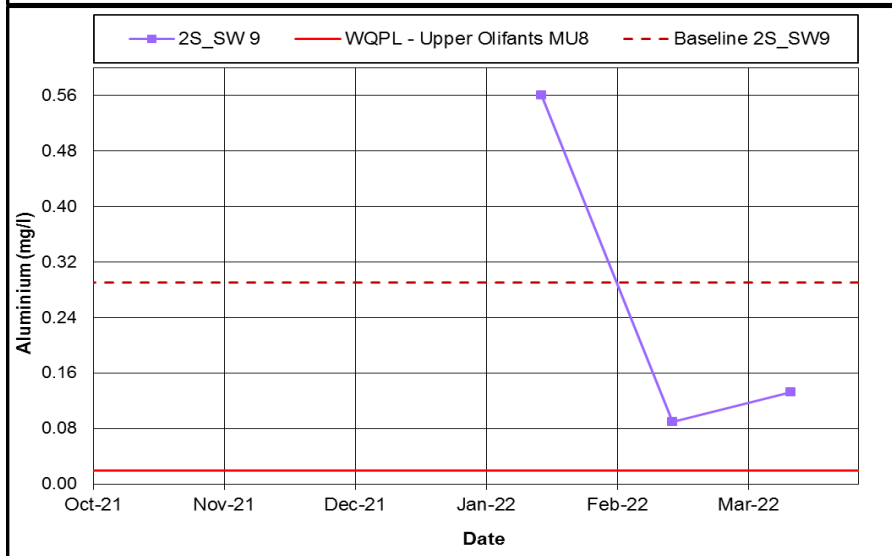
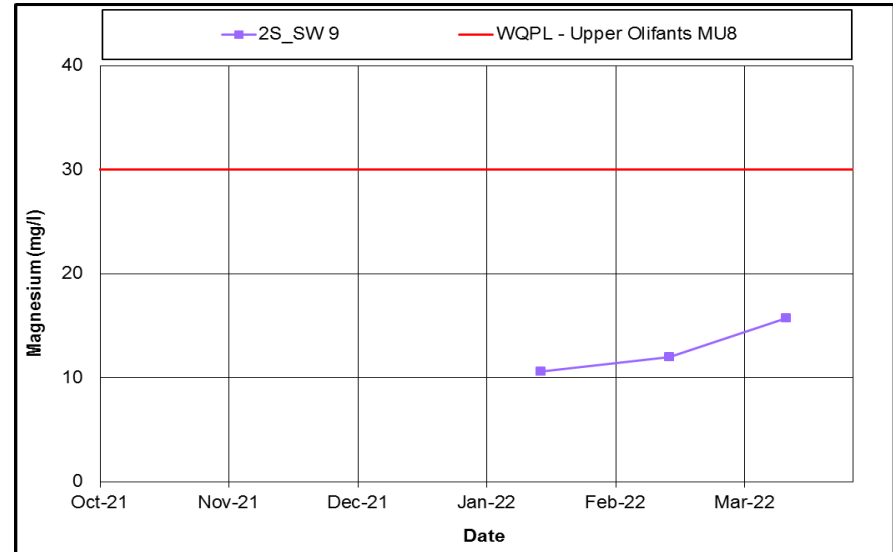
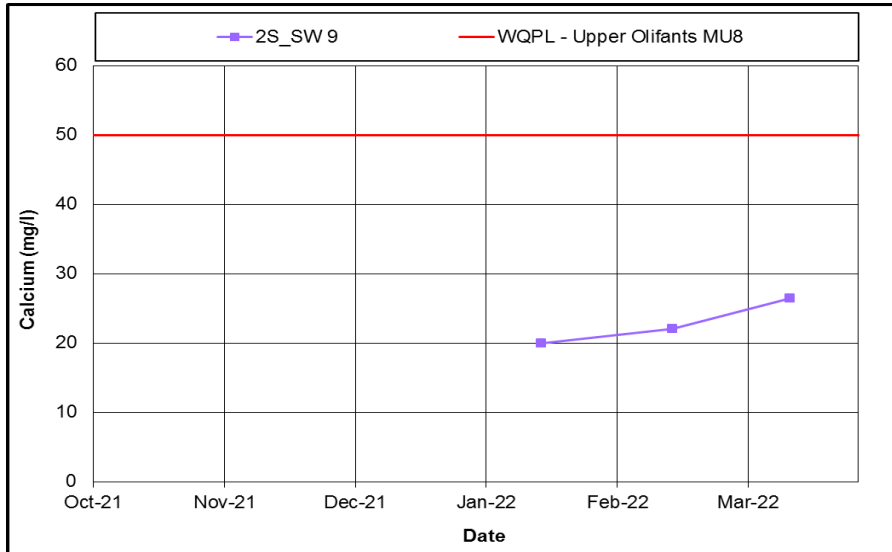
Table 20: 2S_SW 9 Analysis Results

Sample Date	Parameters														
	pH	EC (mS/m)	TDS (mg/l)	Alk (mg/l)	N (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	F (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
Non-Compliance	<6,5	>90	>350	>120	>0,5	>40	>150	>0,75	>50	>25	>50	>30	>0,02	>0,3	>0,05
	>8,4														
Average	7.40	31.33	206.00	109.33	0.10	11.89	38.33	0.67	17.83	4.26	22.83	12.77	0.26	0.30	0.01
Jan-22	7.25	25.50	204.00	79.00	0.10	7.38	41.60	0.57	14.00	4.73	20.00	10.60	0.56	0.56	0.01
Feb-22	7.28	31.20	166.00	115.00	0.10	12.20	31.40	0.63	18.70	4.09	22.10	12.00	0.09	0.14	0.01
Mar-22	7.68	37.30	248.00	134.00	0.10	16.10	42.00	0.82	20.80	3.97	26.40	15.70	0.13	0.21	0.01









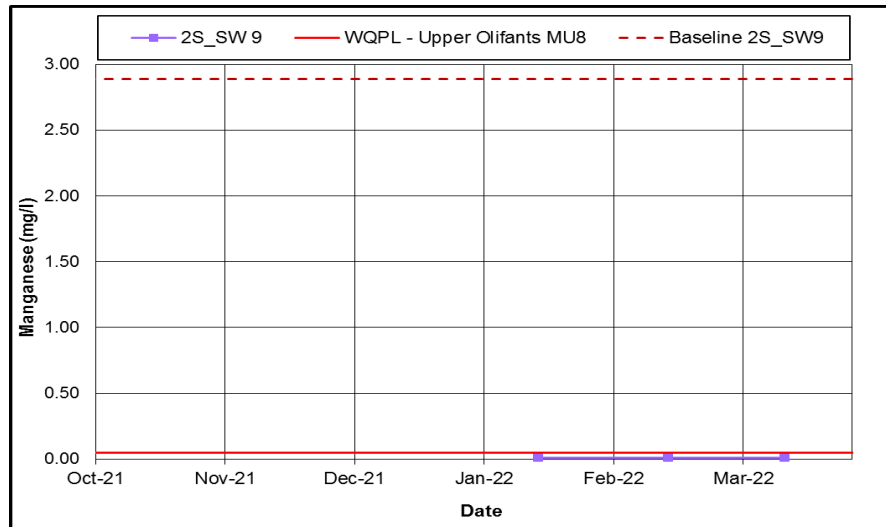


Figure 10: 2S_SW 9 Compliance Graphs



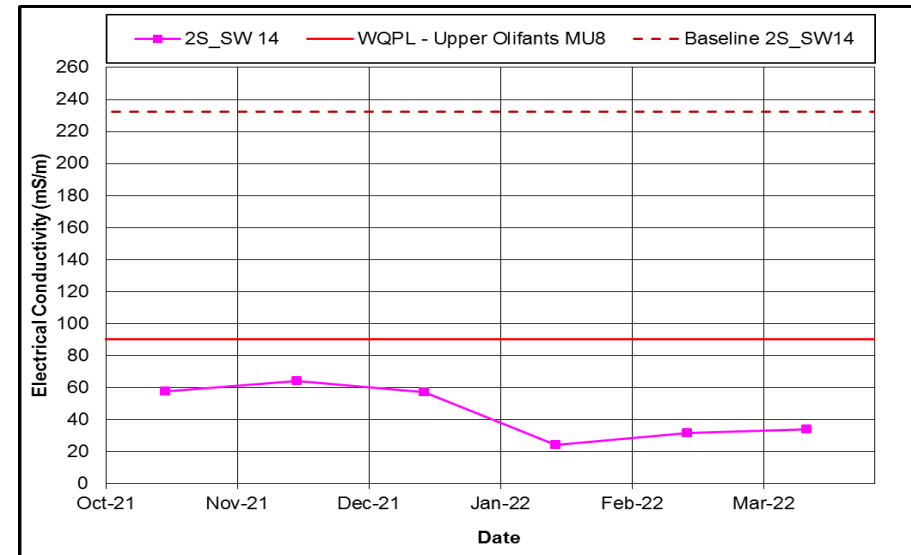
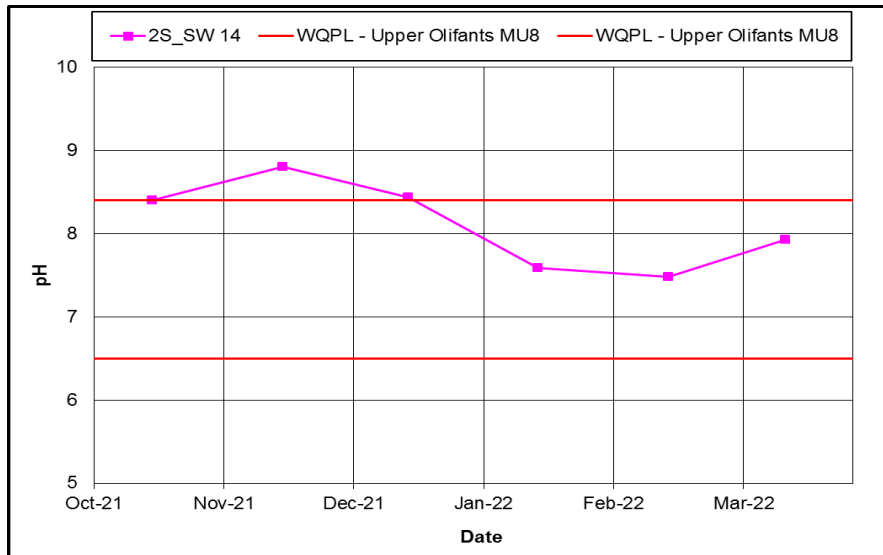
5.1.8. 2S_SW 14

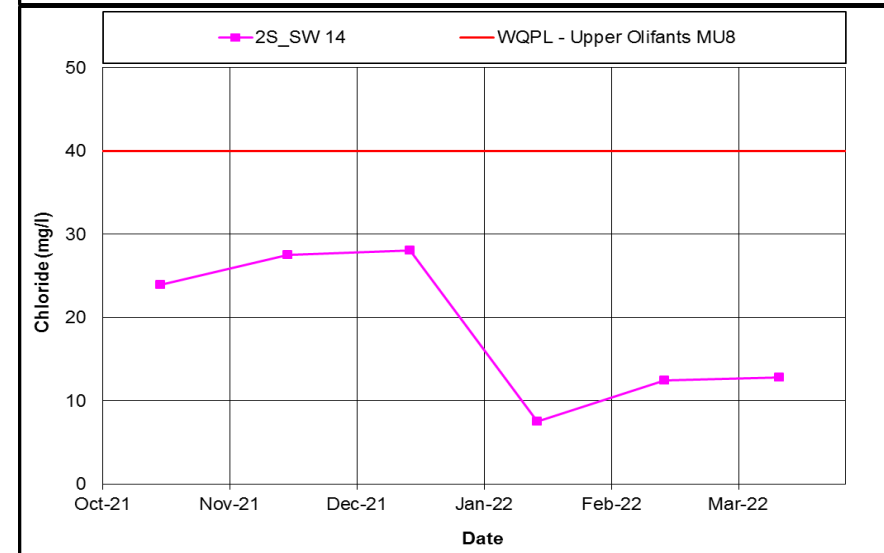
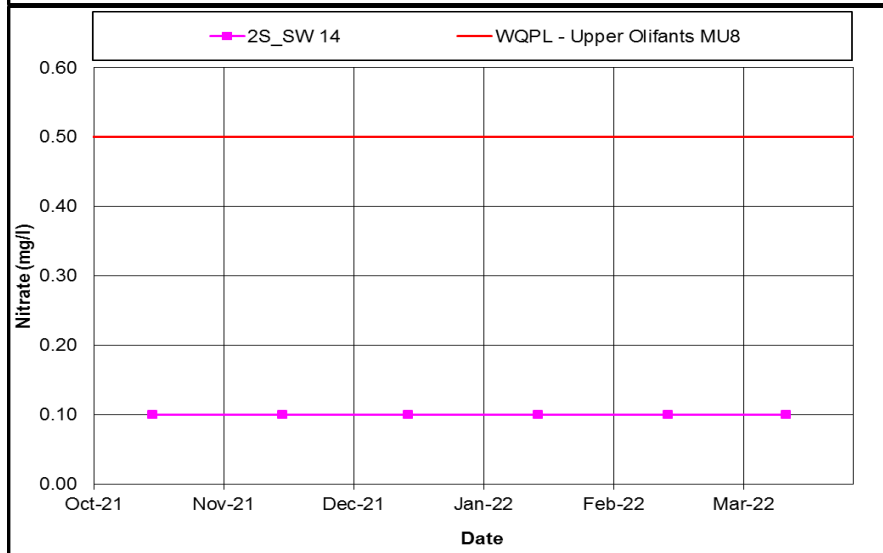
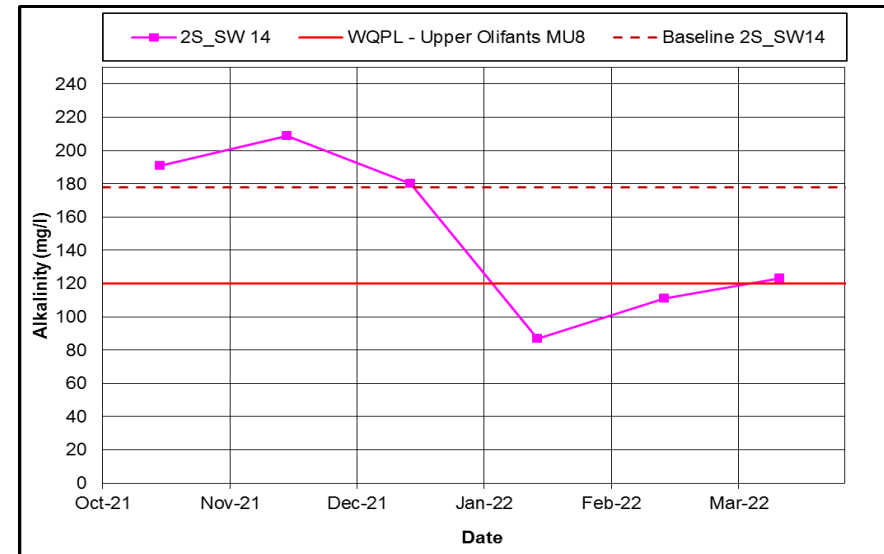
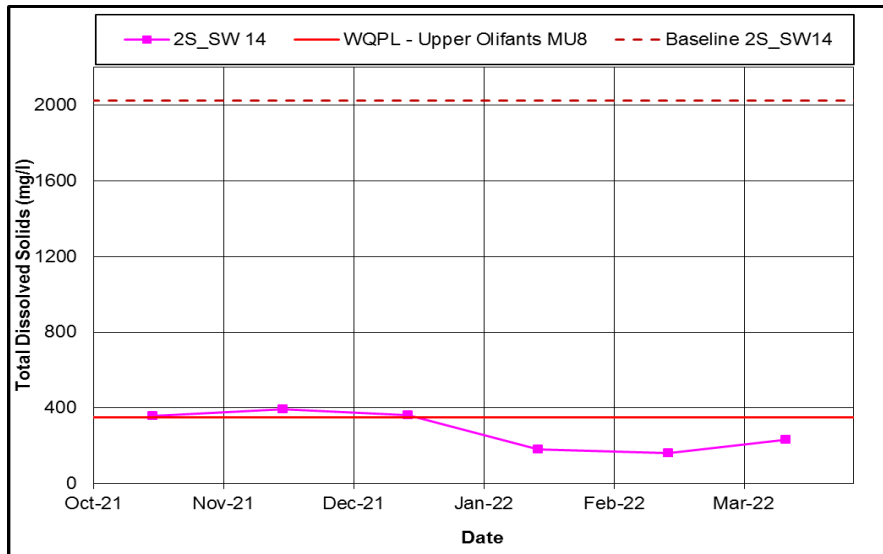
The 2S_SW 14 analysis for each parameter is tabulated in **Table 21** below. It can be seen from the table that Aluminium did not comply with the WQPL. Refer to **Figure 11** for a visual representation of the data.

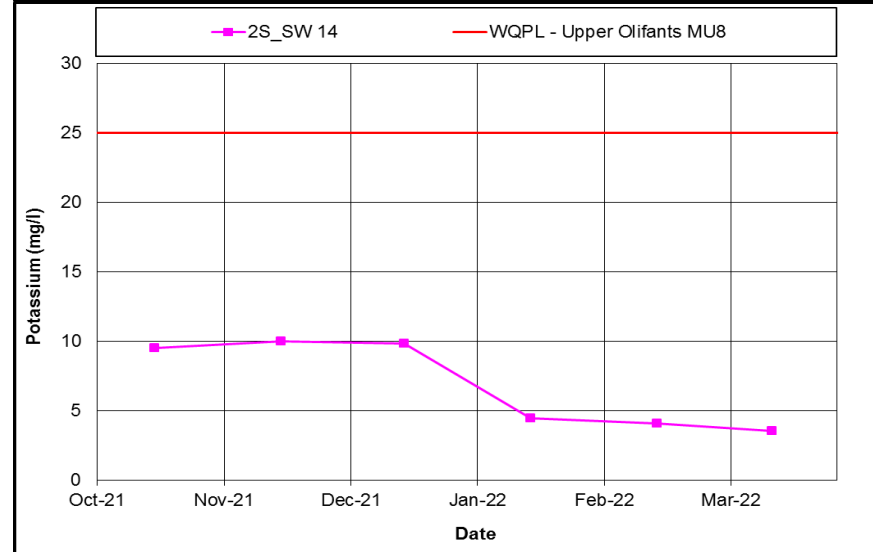
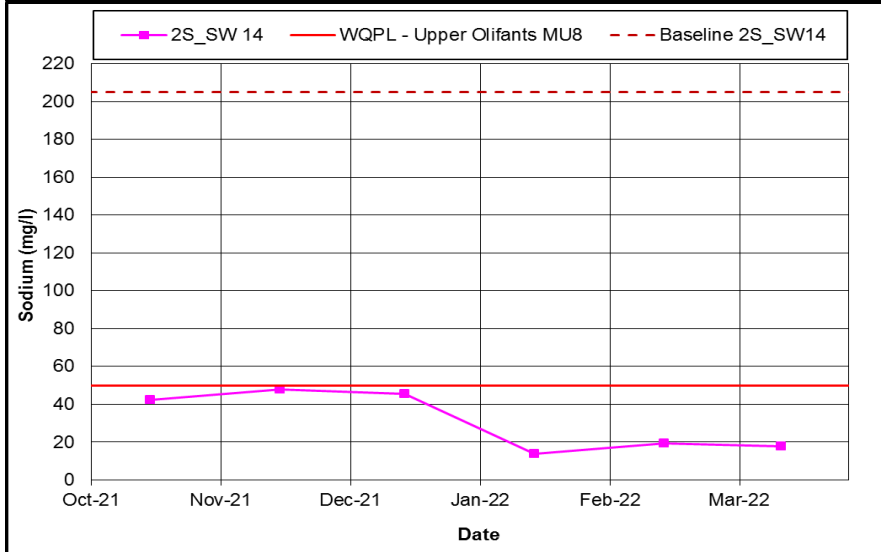
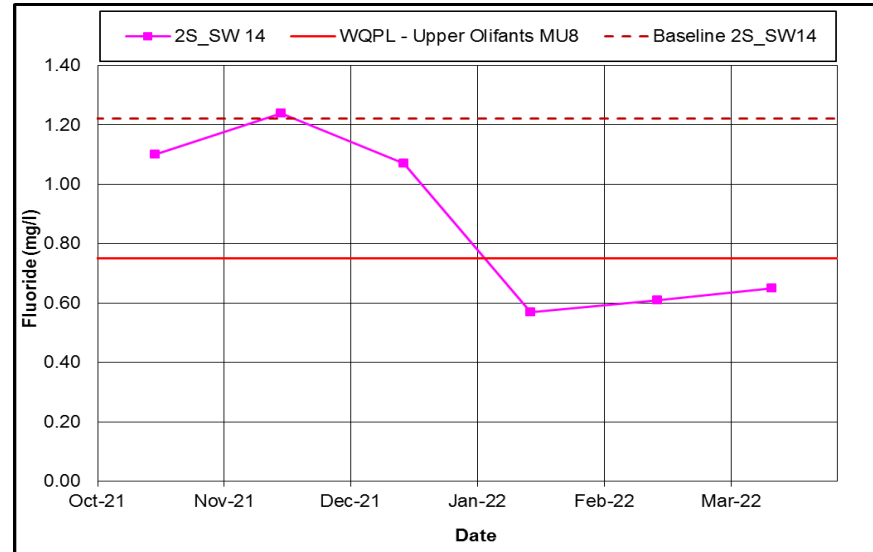
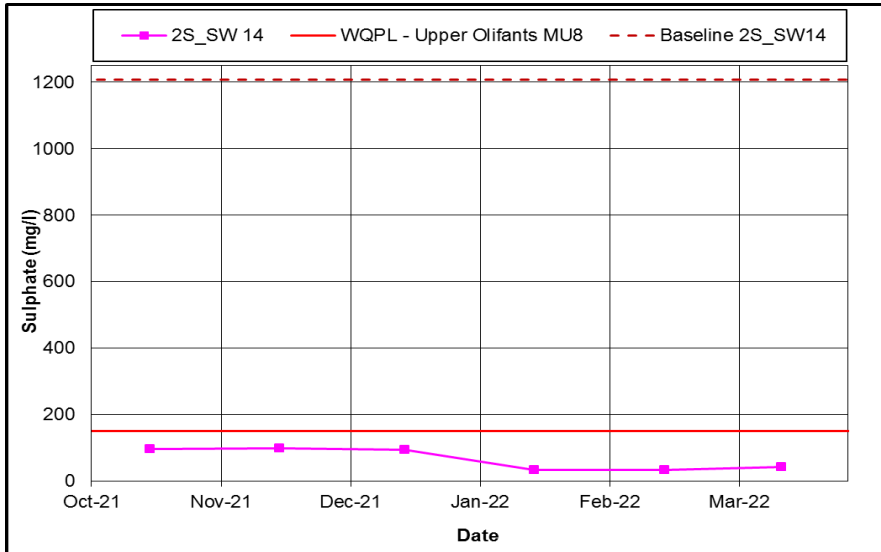


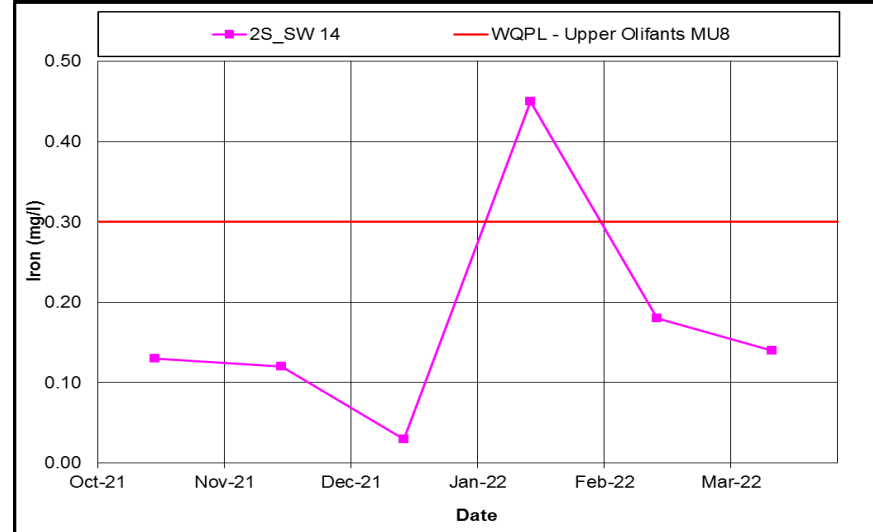
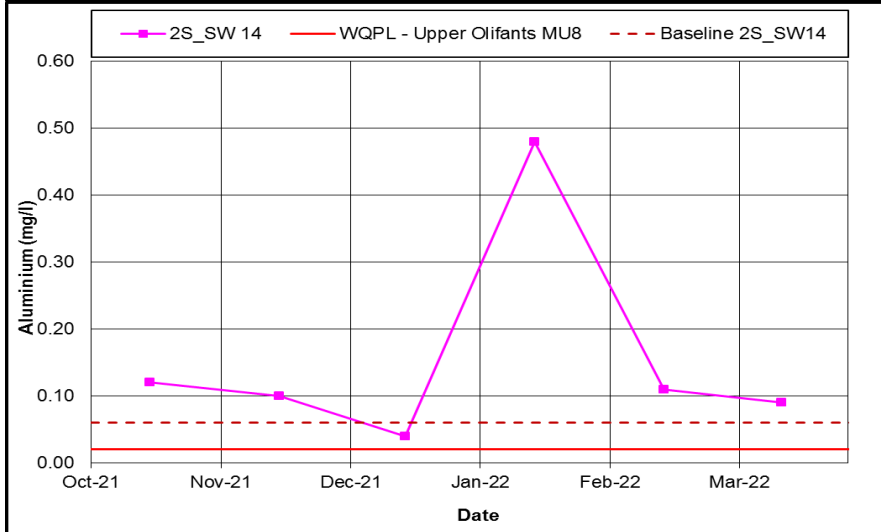
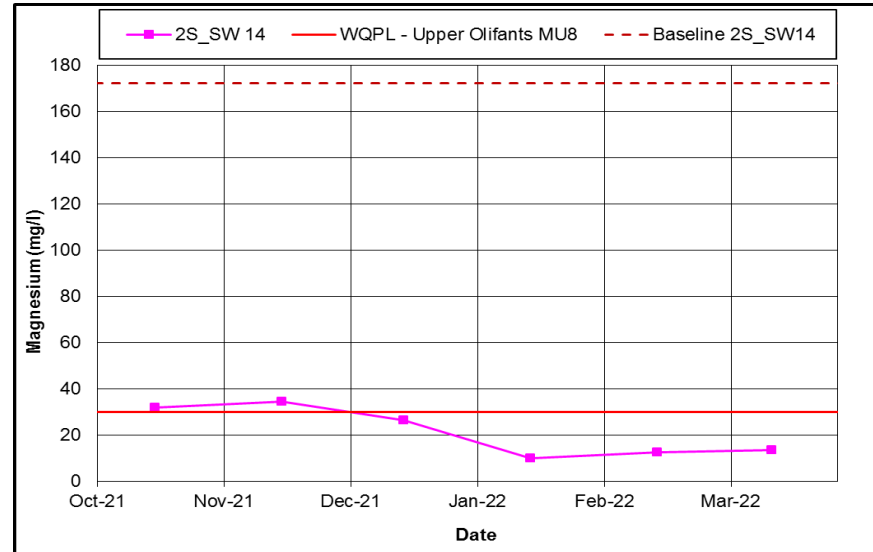
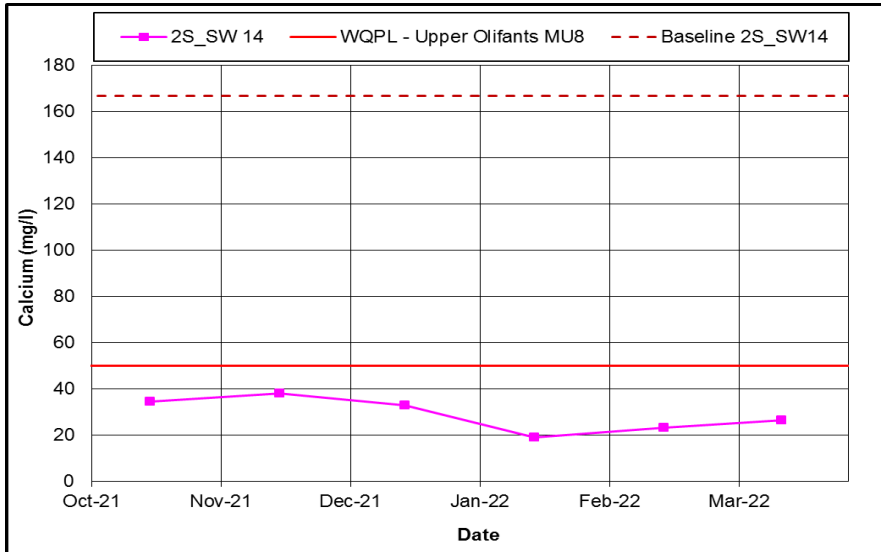
Table 21: 2S_SW 14 Analysis Results

Sample Date	Parameters														
	pH	EC (mS/m)	TDS (mg/l)	Alk (mg/l)	N (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	F (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
Non-Compliance	<6,5	>90	>350	>120	>0,5	>40	>150	>0,75	>50	>25	>50	>30	>0,02	>0,3	>0,05
	>8,4														
Average	7.67	30.07	192.00	107.00	0.10	10.90	36.40	0.61	16.90	4.02	22.80	12.03	0.23	0.26	0.01
Jan-22	7.59	24.30	180.00	87.00	0.10	7.51	32.50	0.57	13.70	4.47	19.00	10.00	0.48	0.45	0.01
Feb-22	7.48	31.70	162.00	111.00	0.10	12.40	34.00	0.61	19.30	4.07	23.10	12.50	0.11	0.18	0.01
Mar-22	7.93	34.20	234.00	123.00	0.10	12.80	42.70	0.65	17.70	3.52	26.30	13.60	0.09	0.14	0.01









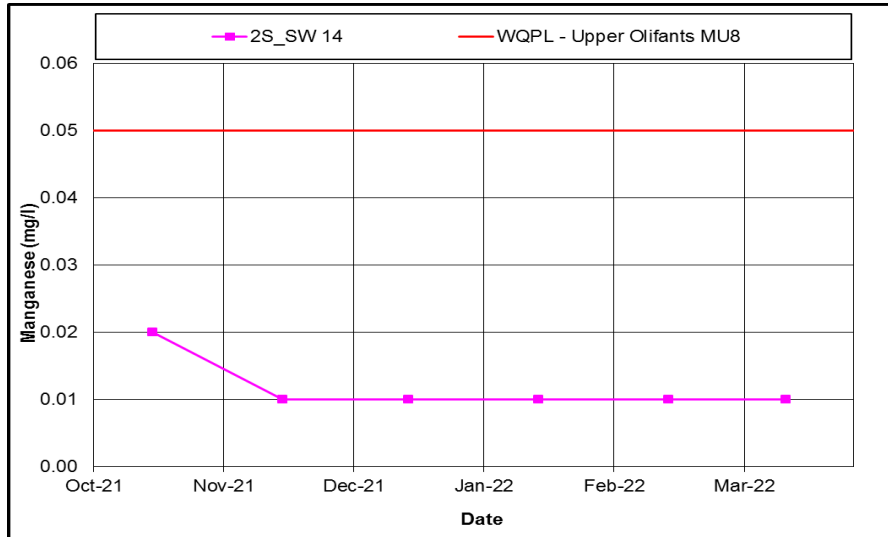


Figure 11: 2S_SW 14 Compliance Graphs



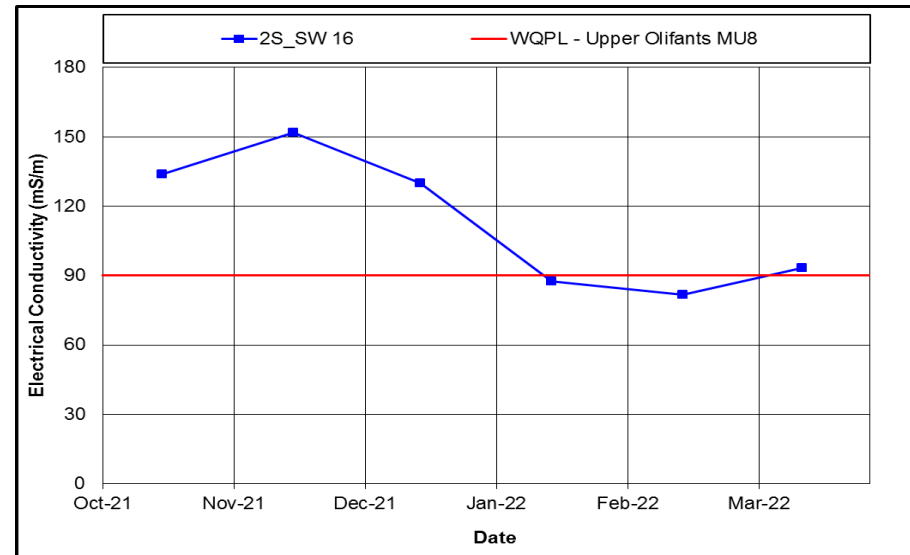
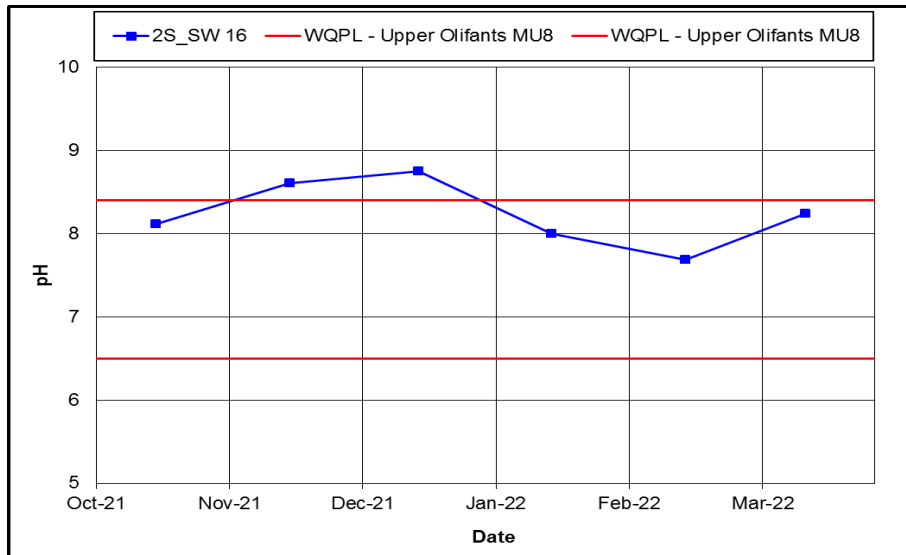
5.1.9. 2S_SW 16

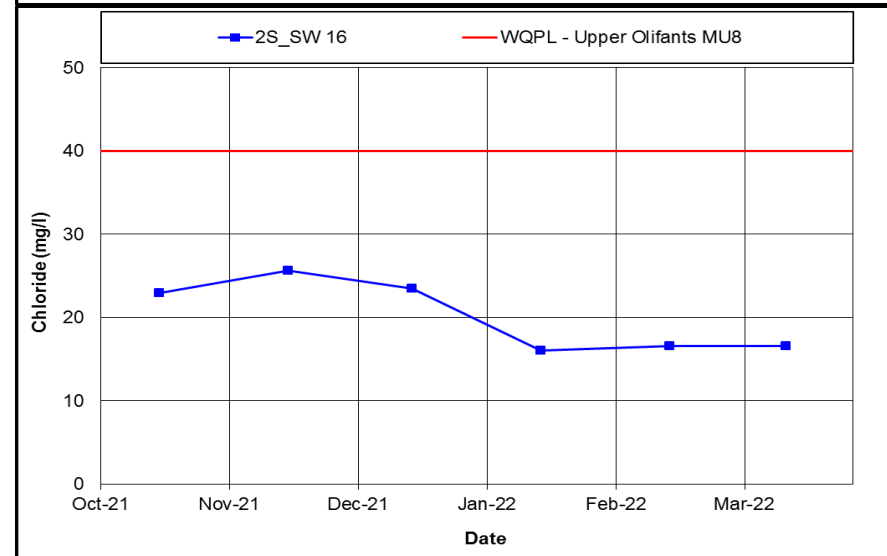
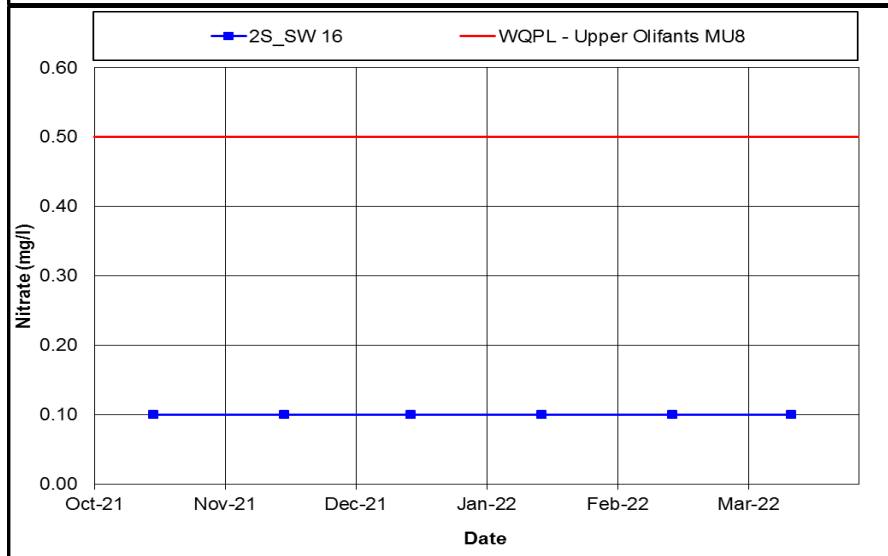
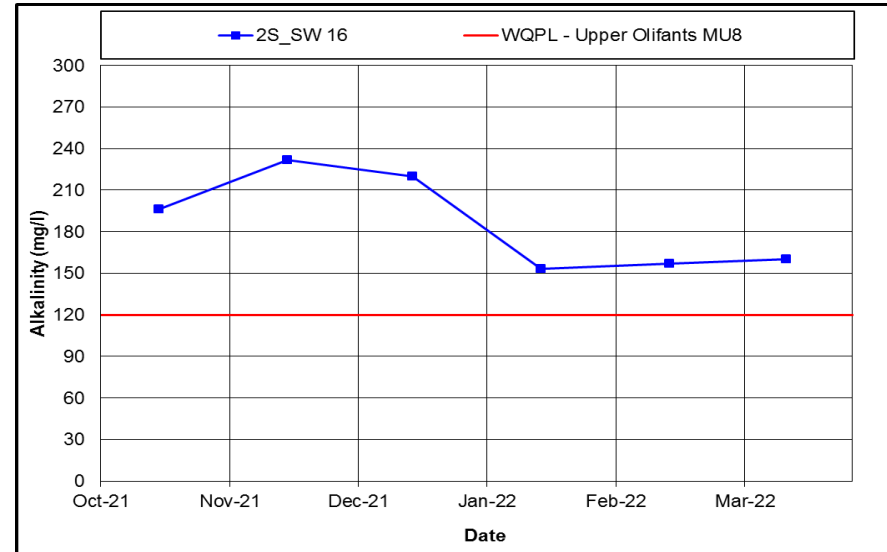
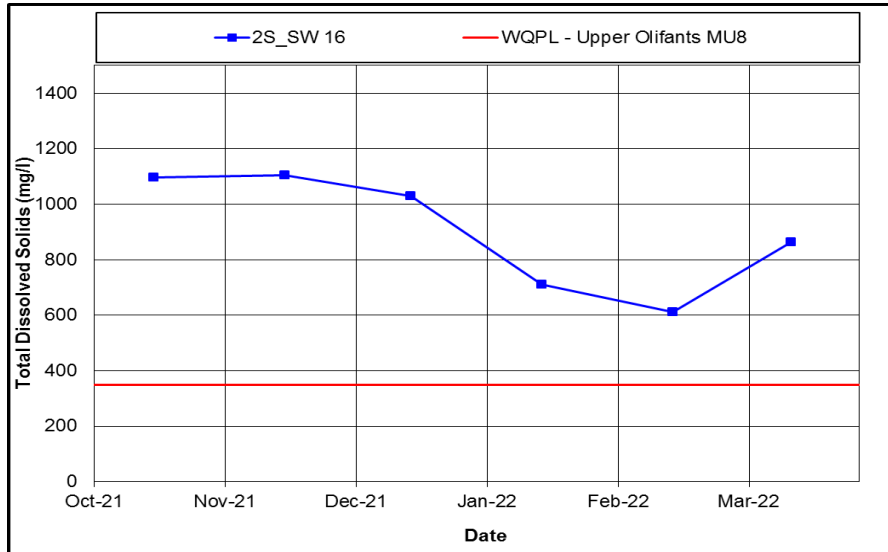
Various exceedances can be noted for this point, but the majority of the parameters were compliant. Refer to **Table 22** for the data and **Figure 12** for the graphical representation.

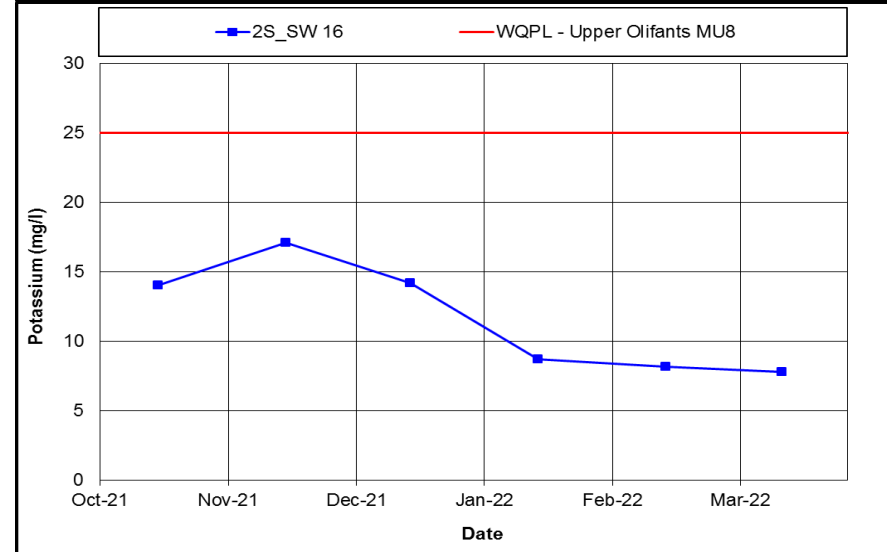
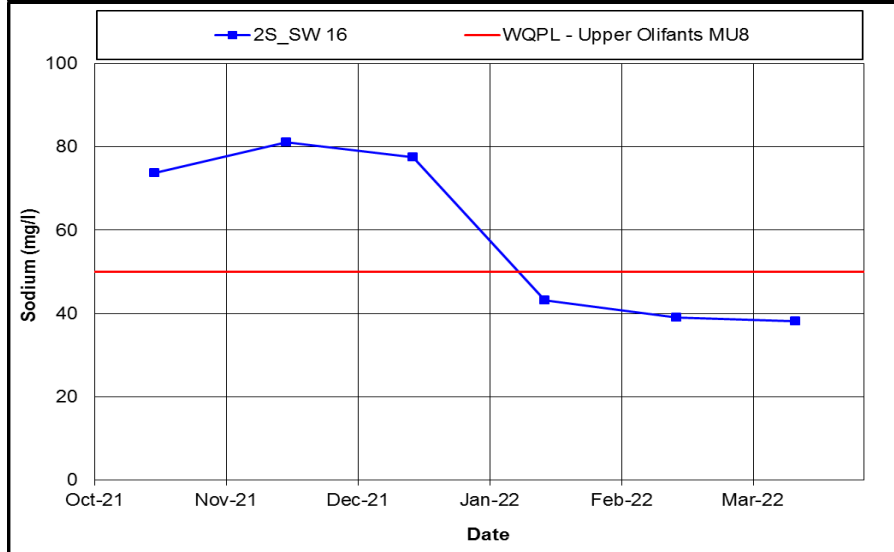
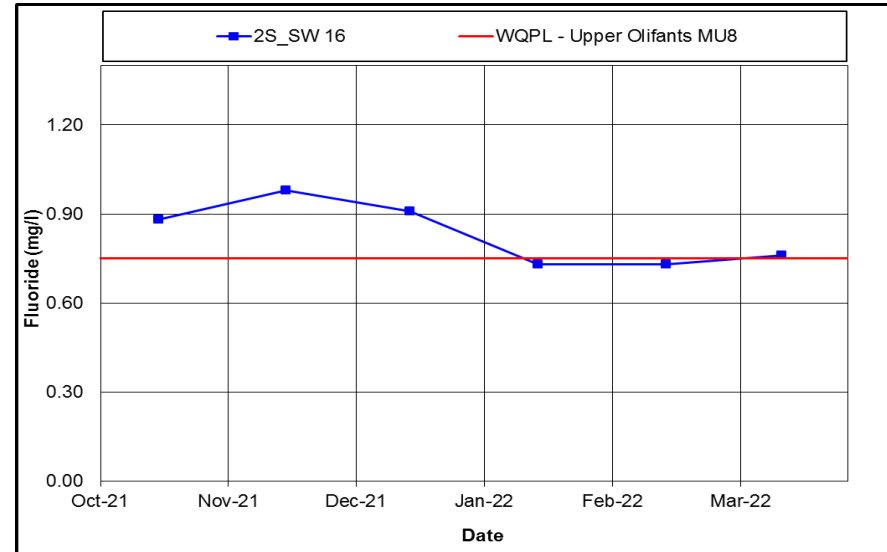
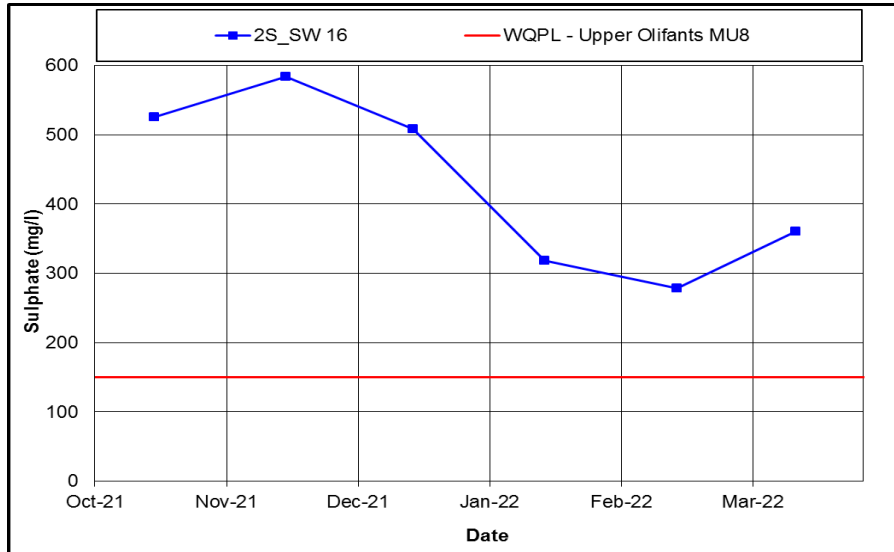


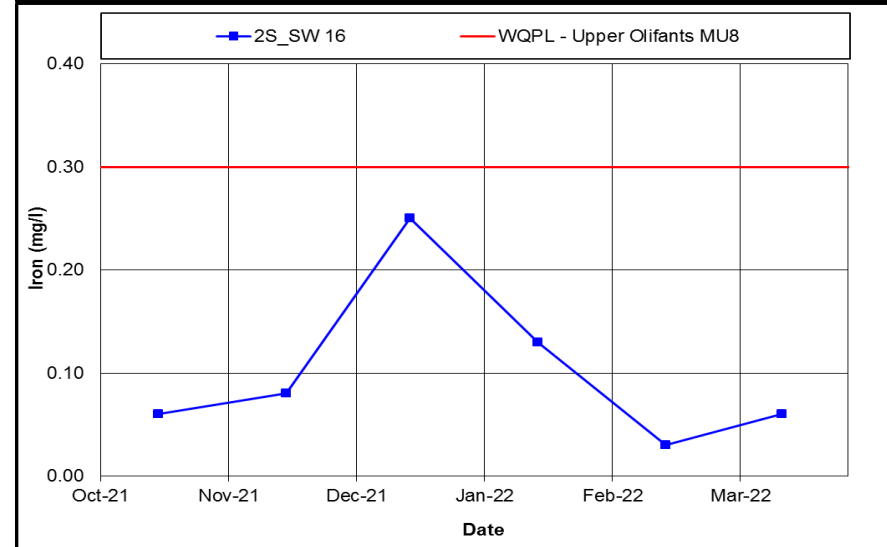
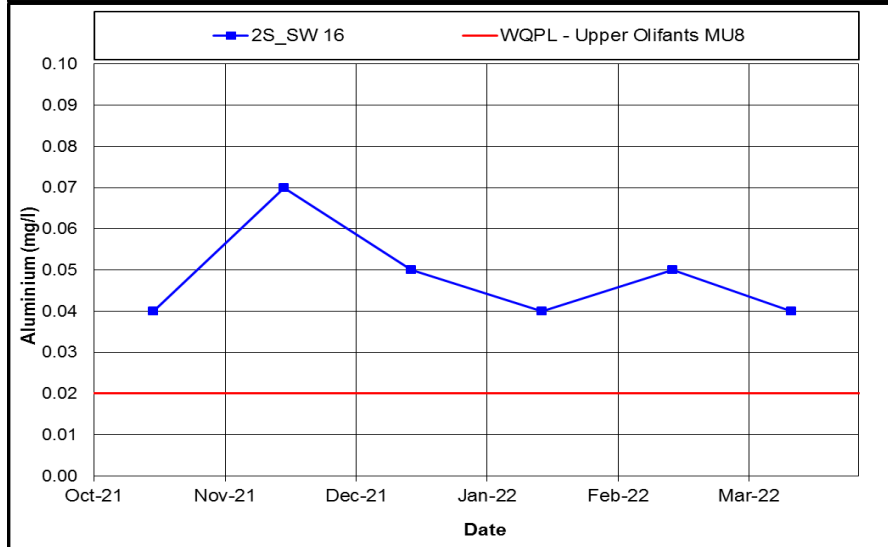
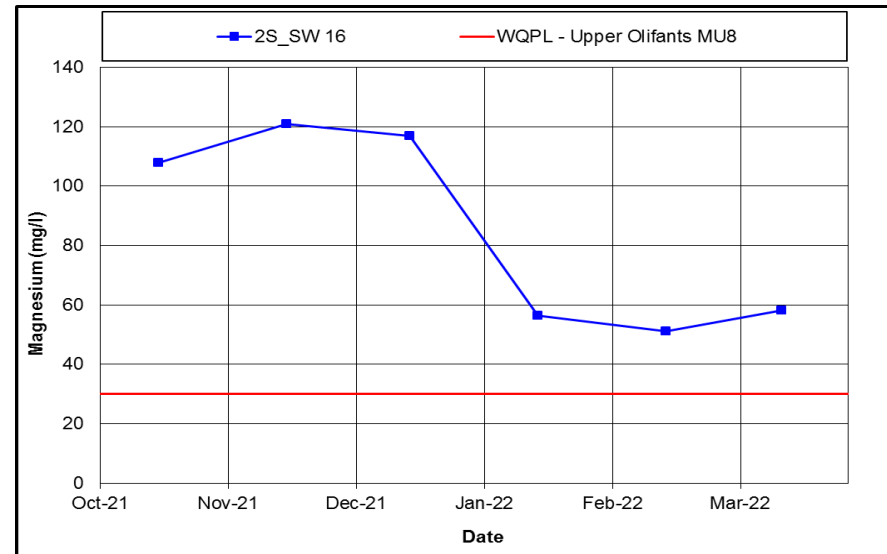
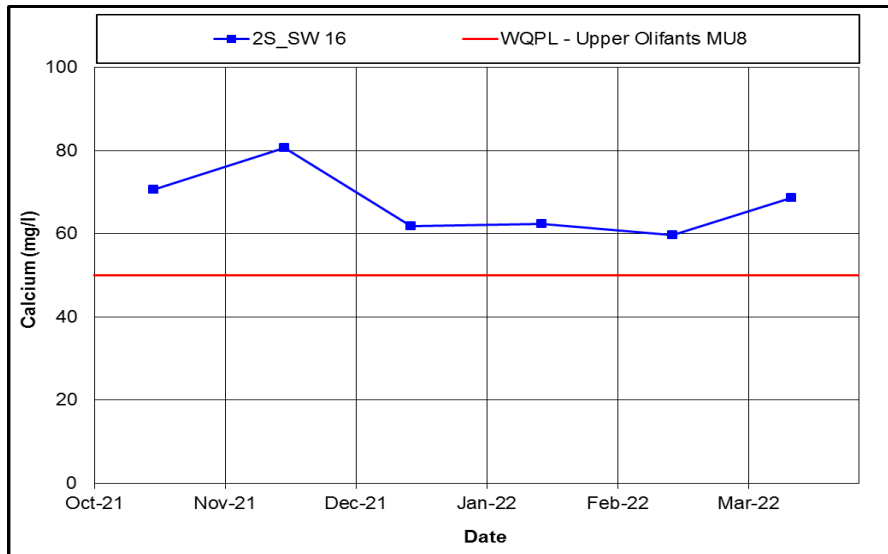
Table 22: 2S_SW 16 Analysis Results

Sample Date	Parameters														
	pH	EC (mS/m)	TDS (mg/l)	Alk (mg/l)	N (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	F (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
Non-Compliance	<6,5	>90	>350	>120	>0,5	>40	>150	>0,75	>50	>25	>50	>30	>0,02	>0,3	>0,05
	>8,4														
Average	7.98	87.60	729.33	156.67	0.10	16.40	318.67	0.74	40.13	8.22	63.53	55.30	0.04	0.07	0.01
Jan-22	8.00	87.50	712.00	153.00	0.10	16.00	318.00	0.73	43.20	8.71	62.40	56.50	0.04	0.13	0.01
Feb-22	7.69	81.90	612.00	157.00	0.10	16.60	278.00	0.73	39.00	8.16	59.60	51.20	0.05	0.03	0.01
Mar-22	8.24	93.40	864.00	160.00	0.10	16.60	360.00	0.76	38.20	7.78	68.60	58.20	0.04	0.06	0.01









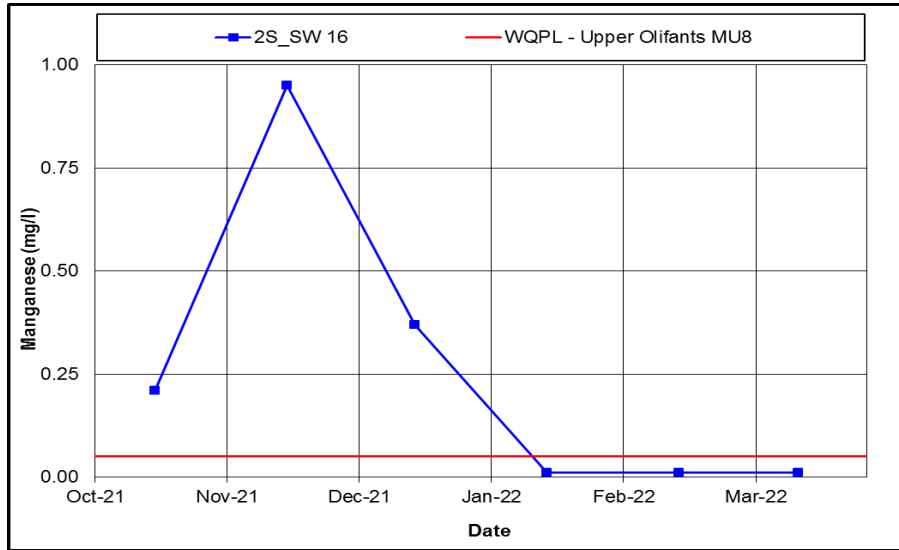


Figure 12: 2S_SW 16 Compliance Graphs



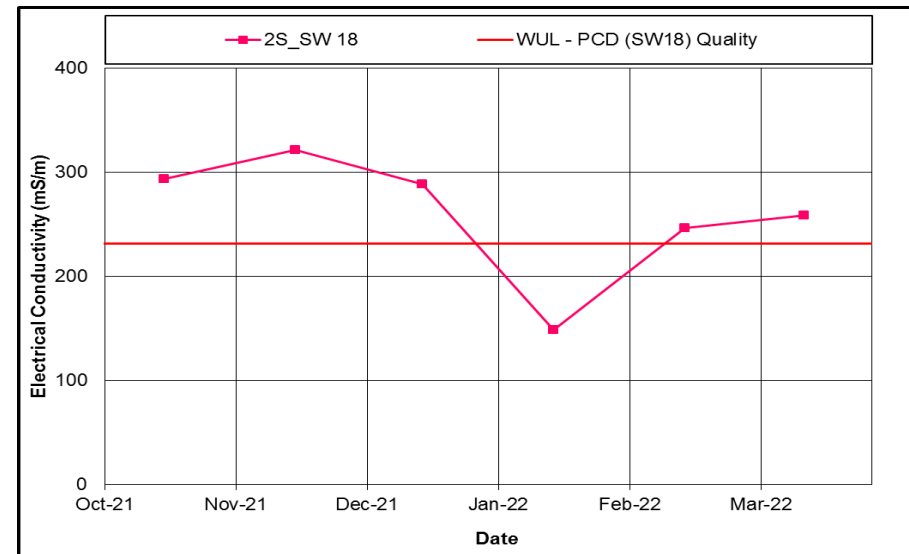
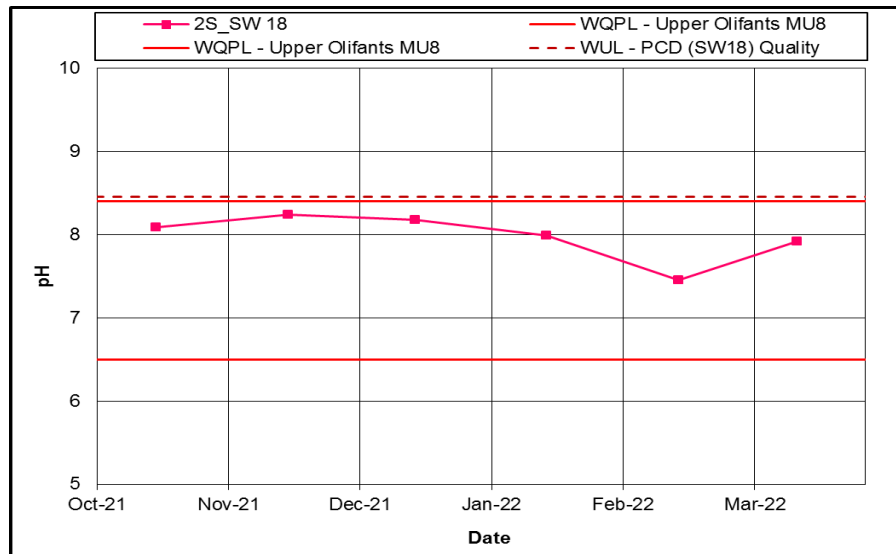
5.1.10. 2S_SW 18

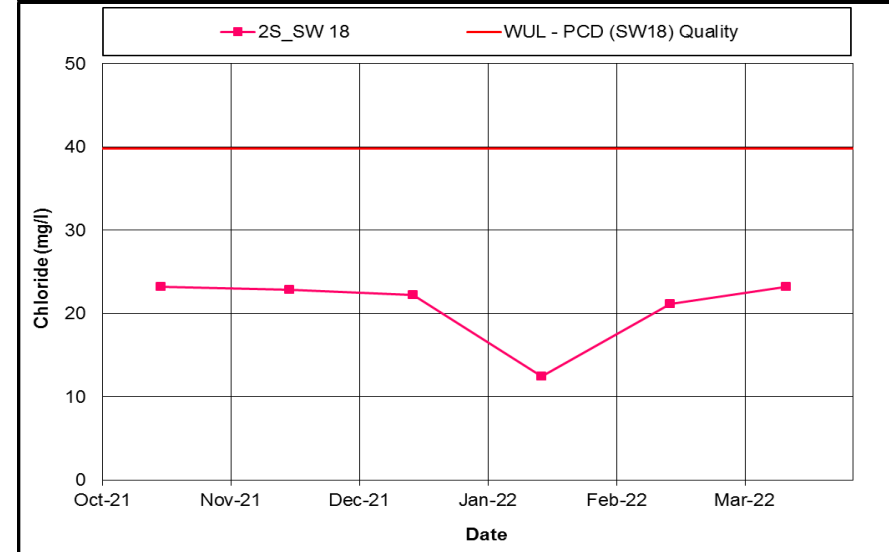
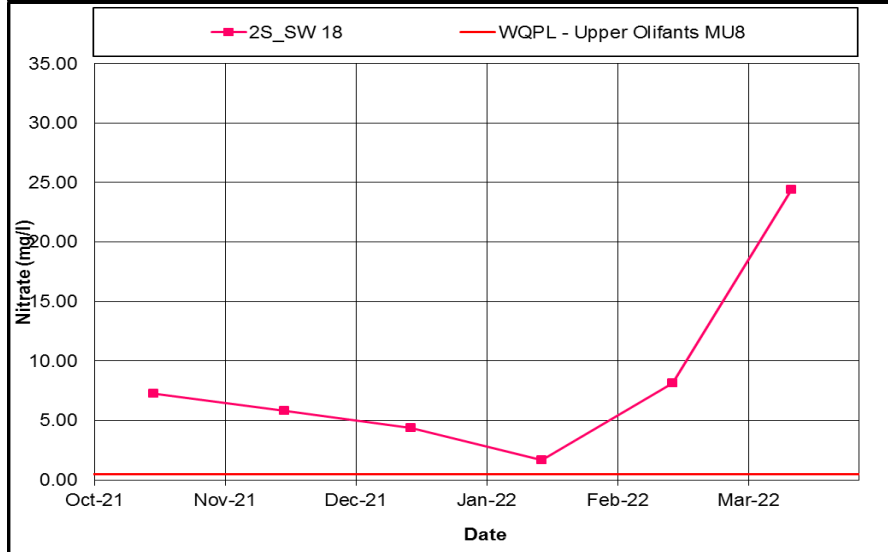
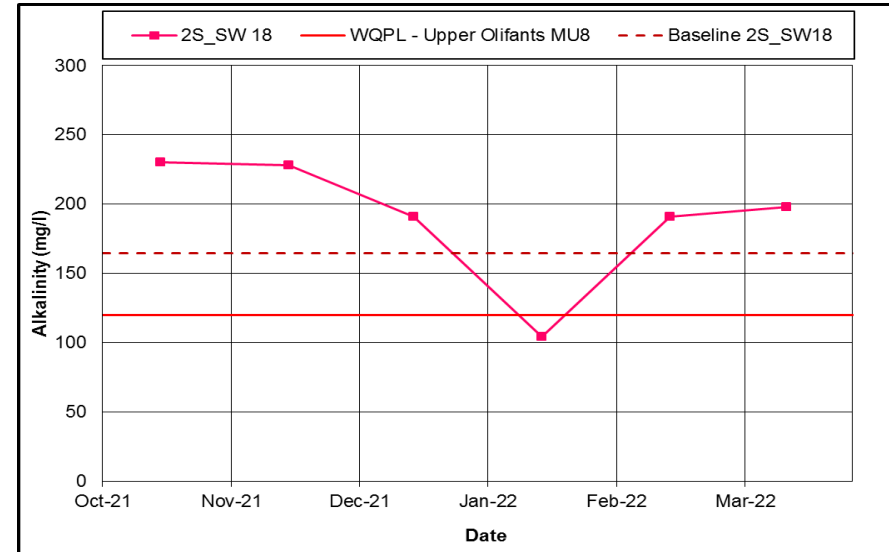
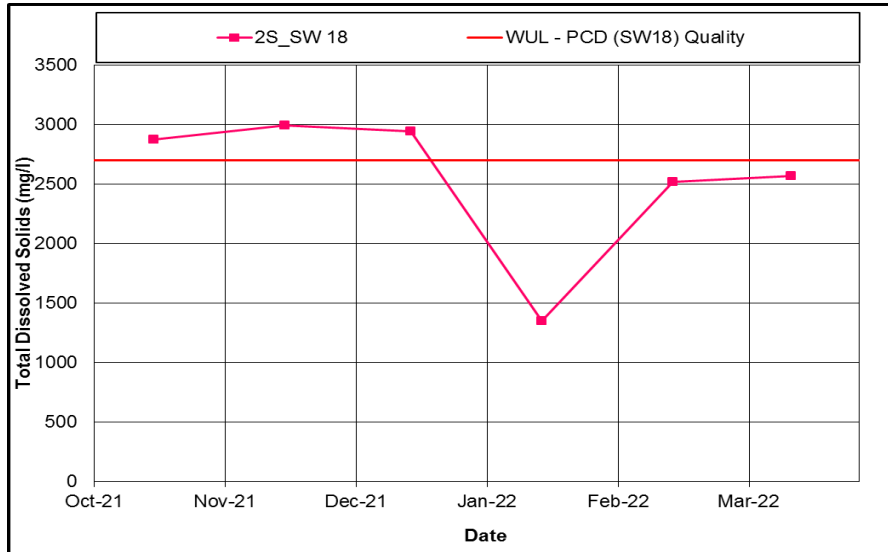
Only half of the parameters comply with the standards specified in the WUL/WQPL. Refer to **Table 23**. The compliance graphs are represented in **Figure 13**.

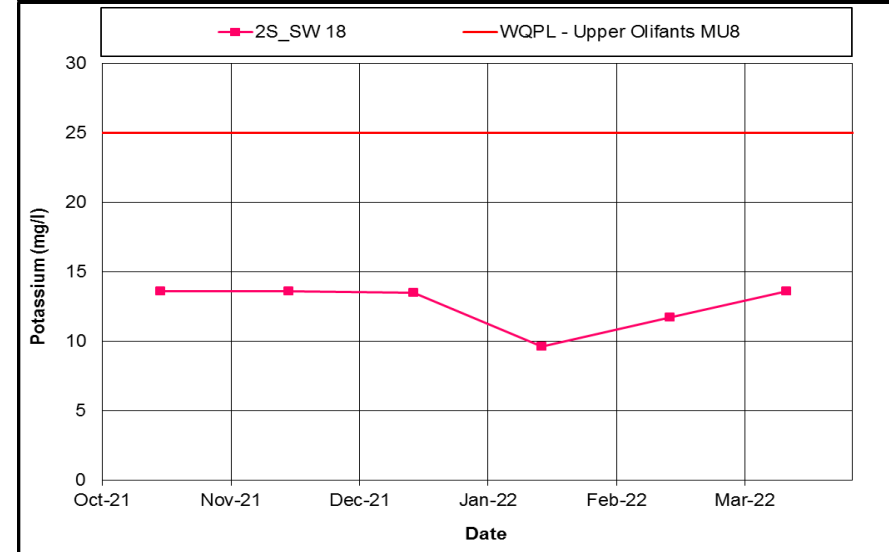
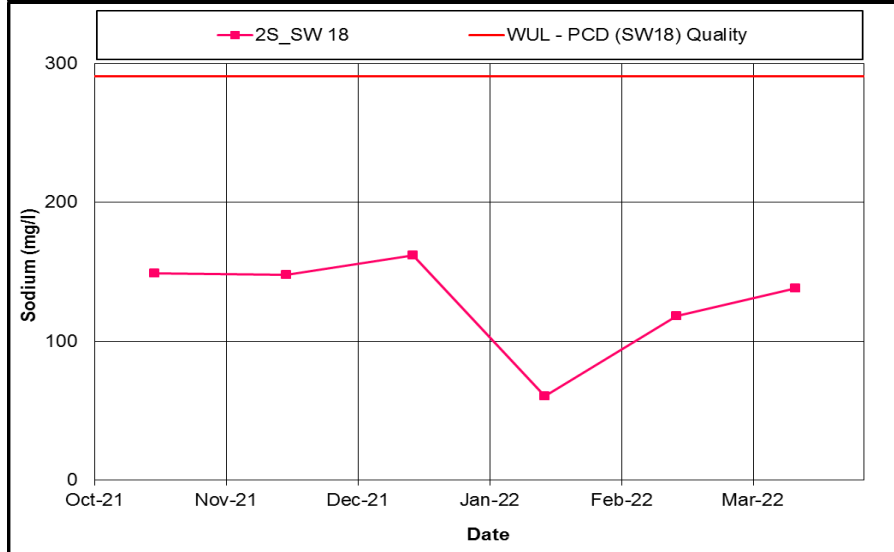
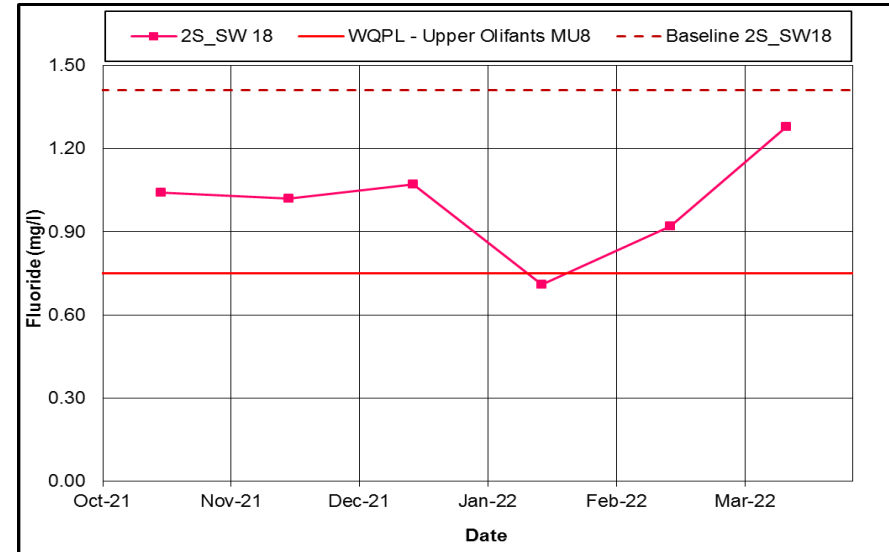
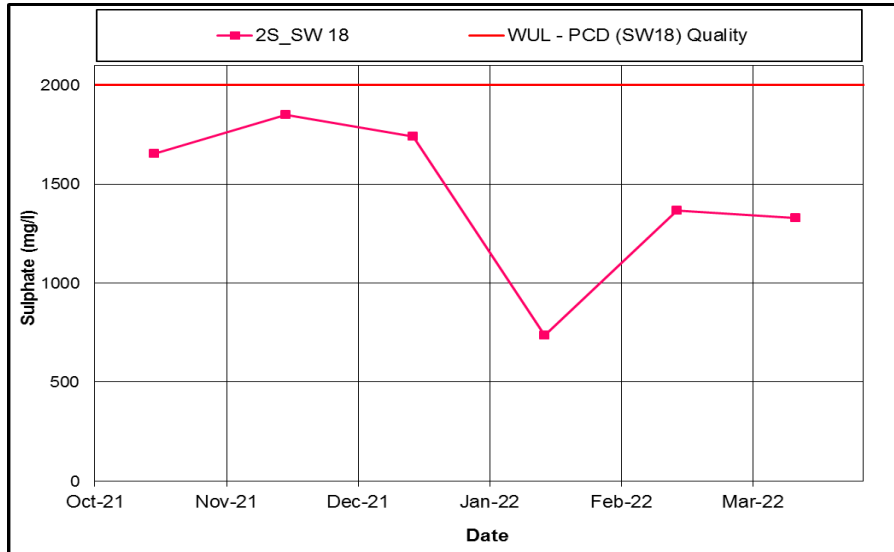


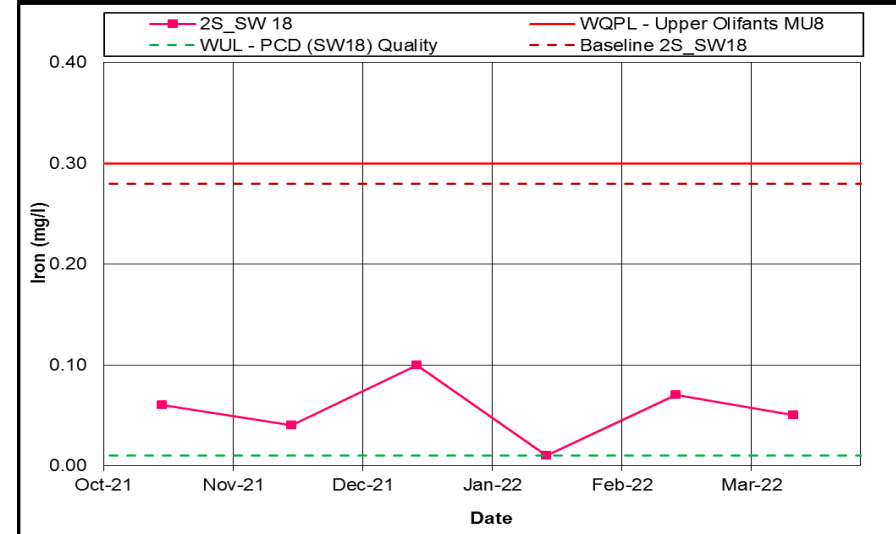
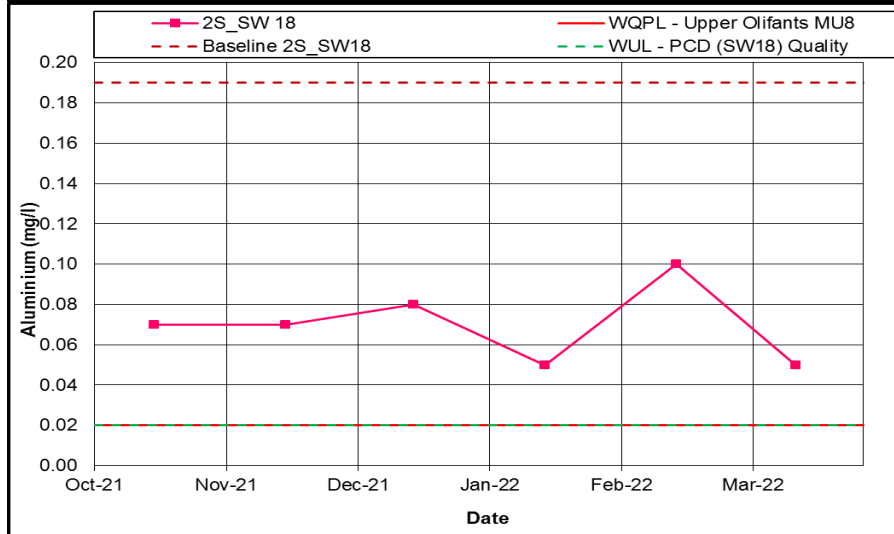
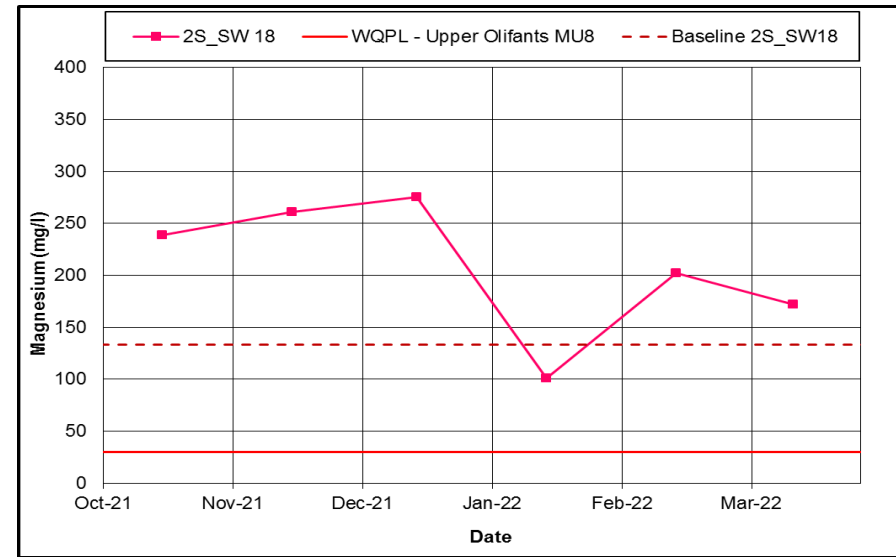
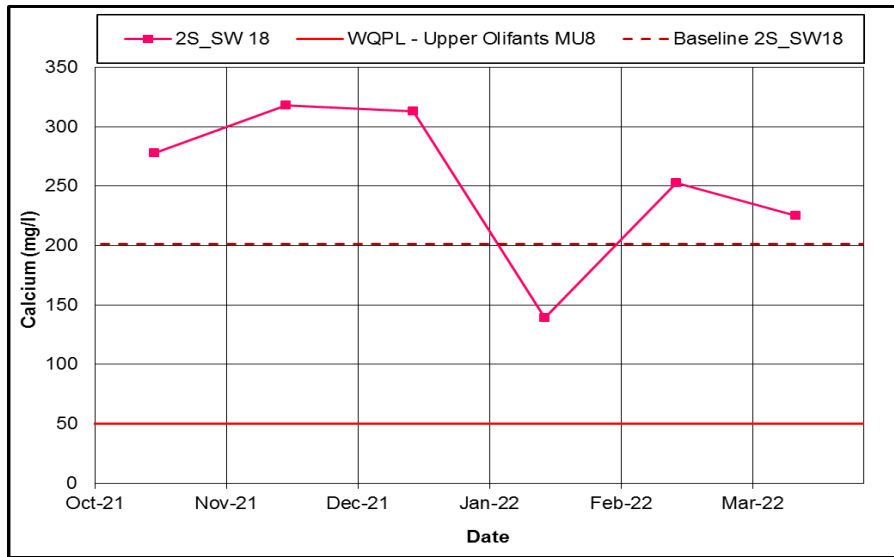
Table 23: 2S_SW 18 Analysis Results

Sample Date	Parameters														
	pH	EC (mS/m)	TDS (mg/l)	Alk (mg/l)	N (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	F (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
Non-Compliance	<6,5	>232	>2 700	>120	>0,5	>39,78	>2 000	>0,75	>290,8	>25	>50	>30	>0,02	>0,01	>0,02
	>8,4														
Average	7.79	218.33	2 149.33	164.33	11.39	18.90	1 144.33	0.97	105.50	11.64	205.67	158.33	0.07	0.04	0.42
Jan-22	7.99	149.00	1 350.00	104.00	1.67	12.40	737.00	0.71	60.50	9.62	139.00	101.00	0.05	0.01	0.33
Feb-22	7.46	247.00	2 524.00	191.00	8.11	21.10	1 368.00	0.92	118.00	11.70	253.00	202.00	0.10	0.07	0.92
Mar-22	7.92	259.00	2 574.00	198.00	24.40	23.20	1 328.00	1.28	138.00	13.60	225.00	172.00	0.05	0.05	0.01









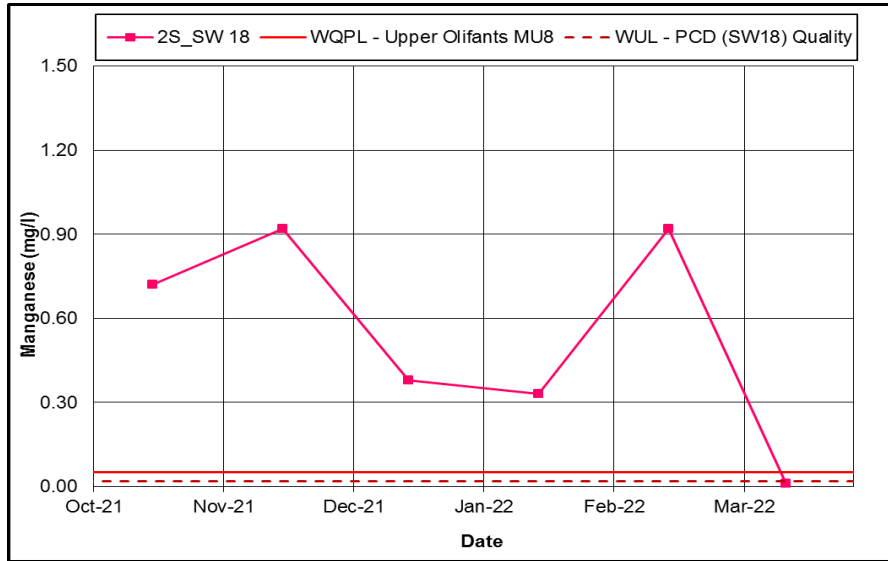


Figure 13: 2S_SW 18 Compliance Graphs



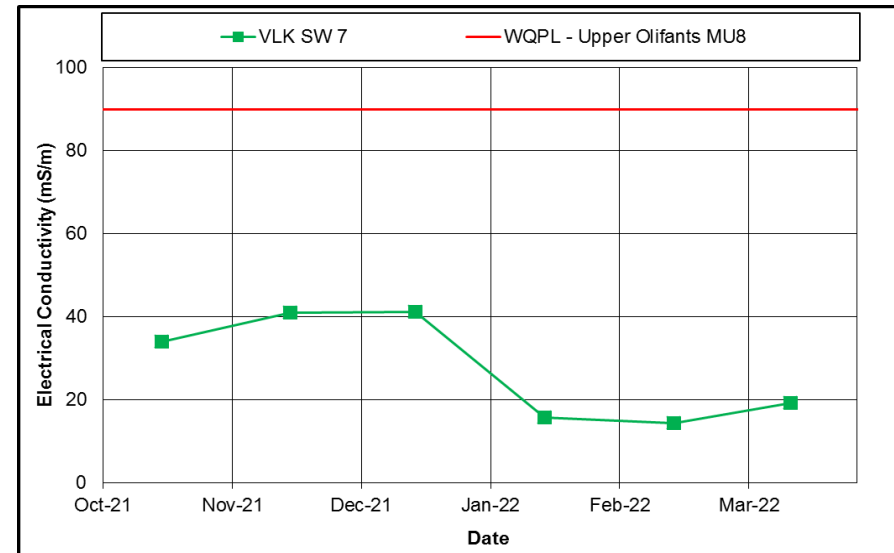
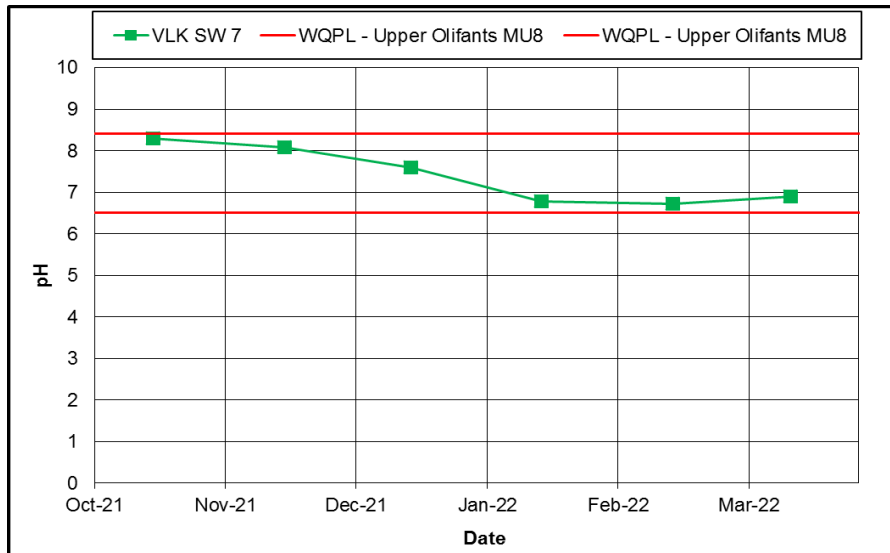
5.1.11. VLK SW 7

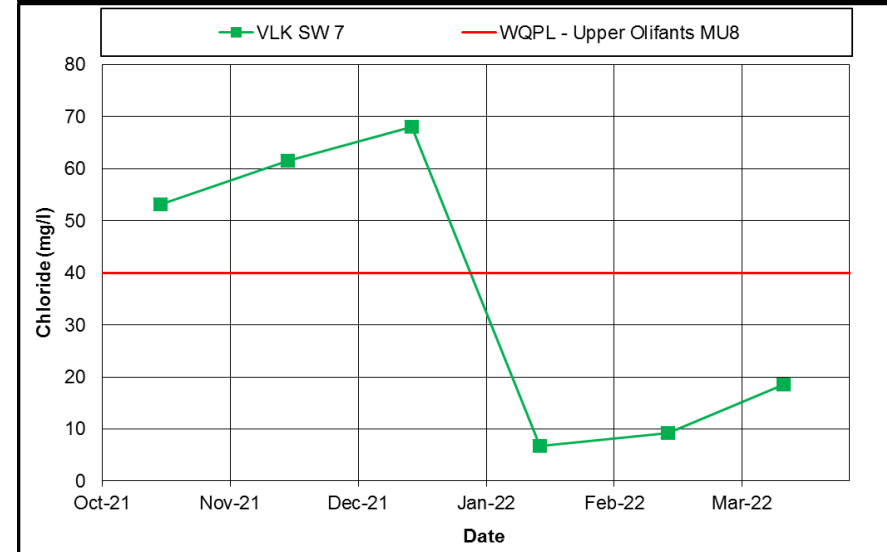
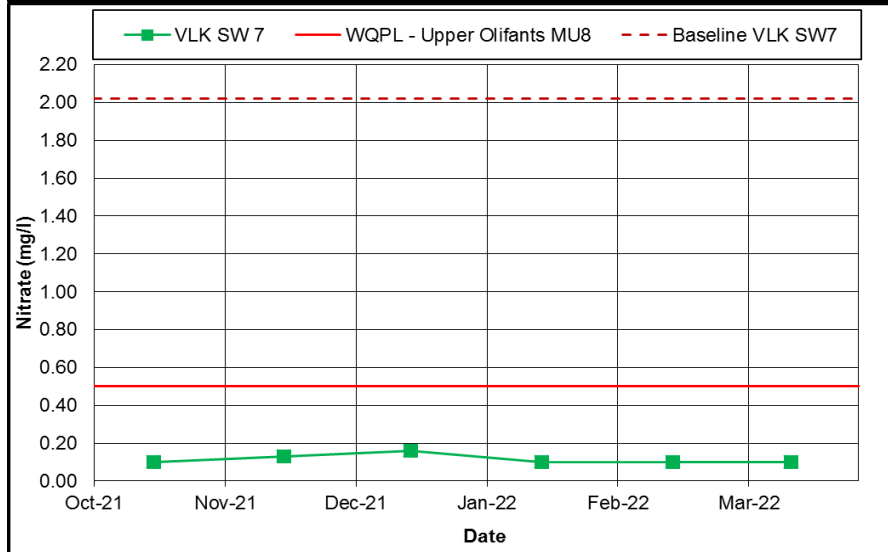
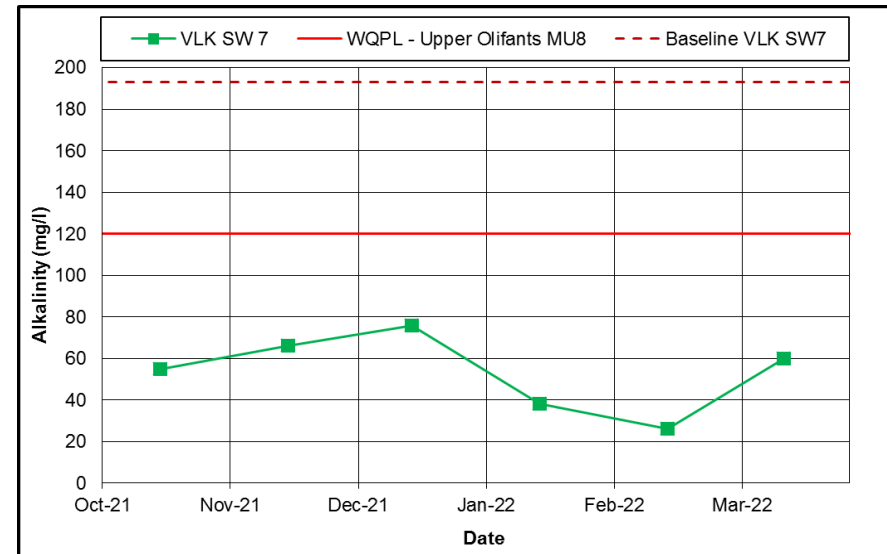
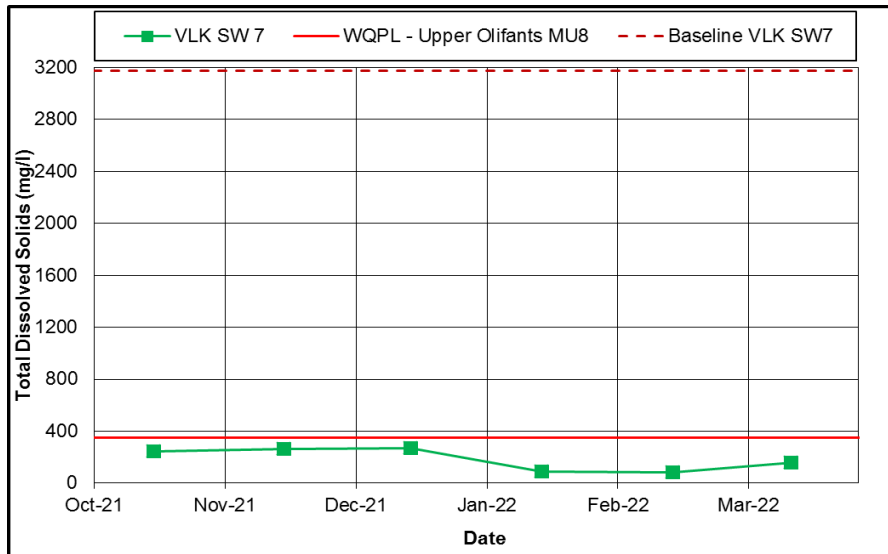
Almost all of the parameters were compliant in terms of the standards found in the WQPL, except for Aluminium and Iron. Refer to **Table 24** for the data. **Figure 14** represents the data trends for VLK_SW 7 for the duration of this monitoring period.

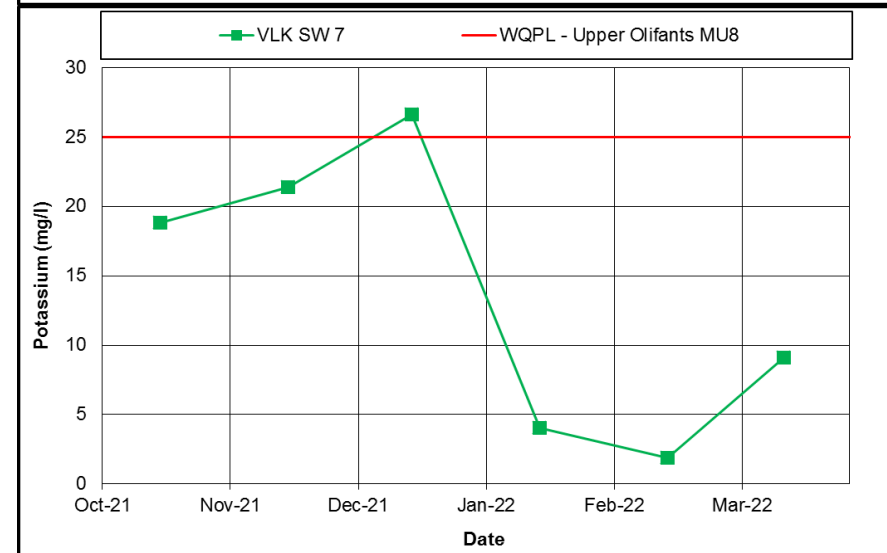
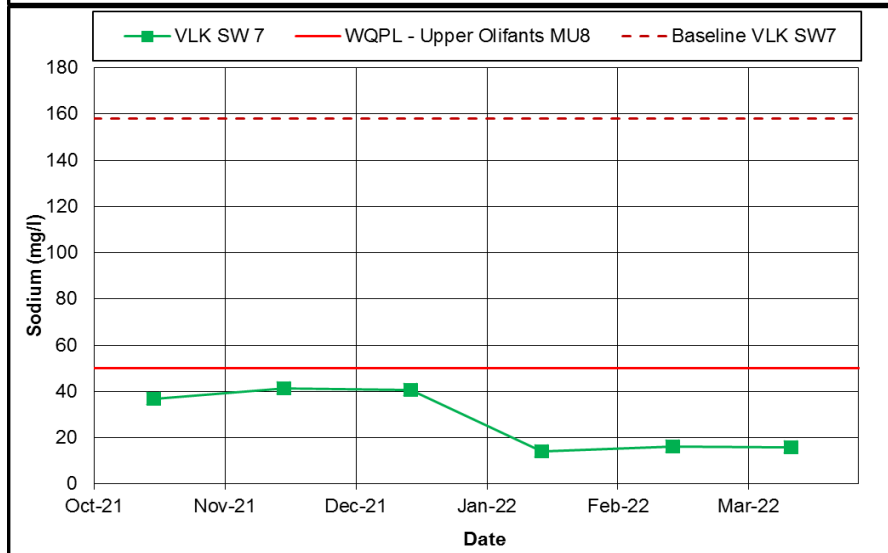
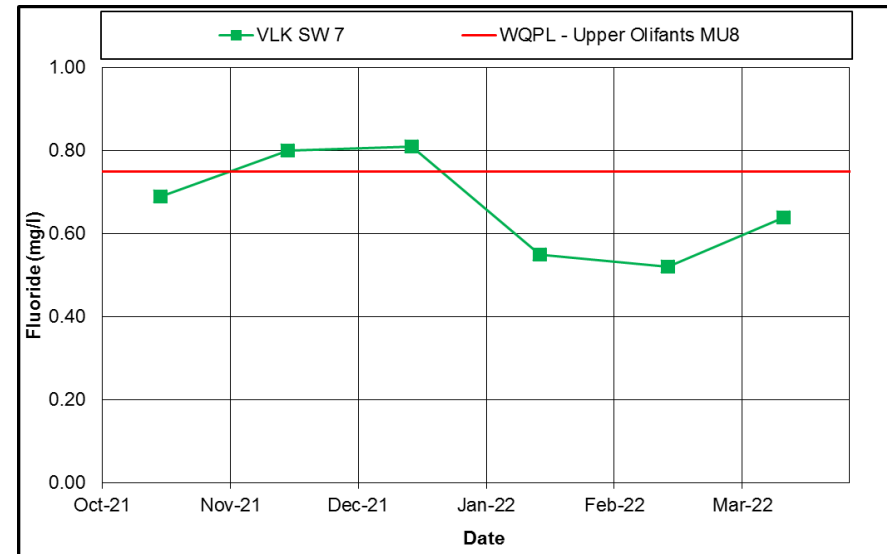
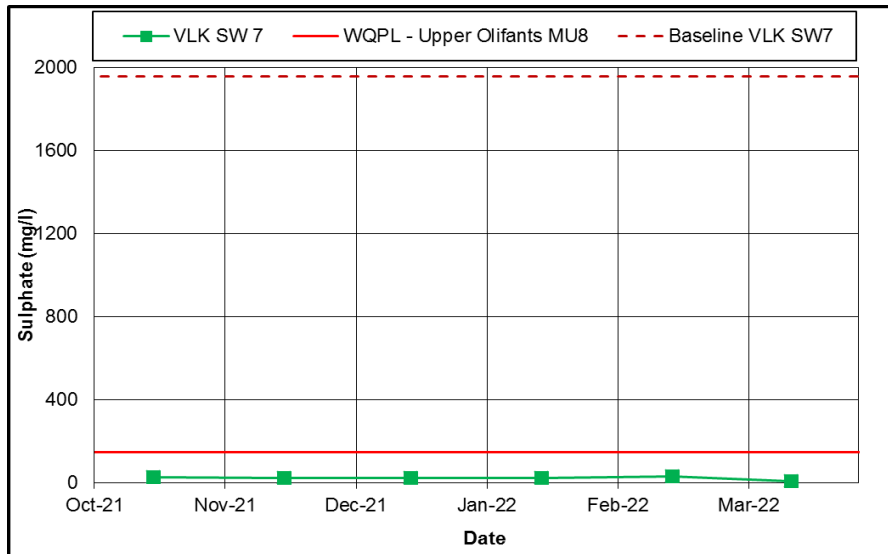


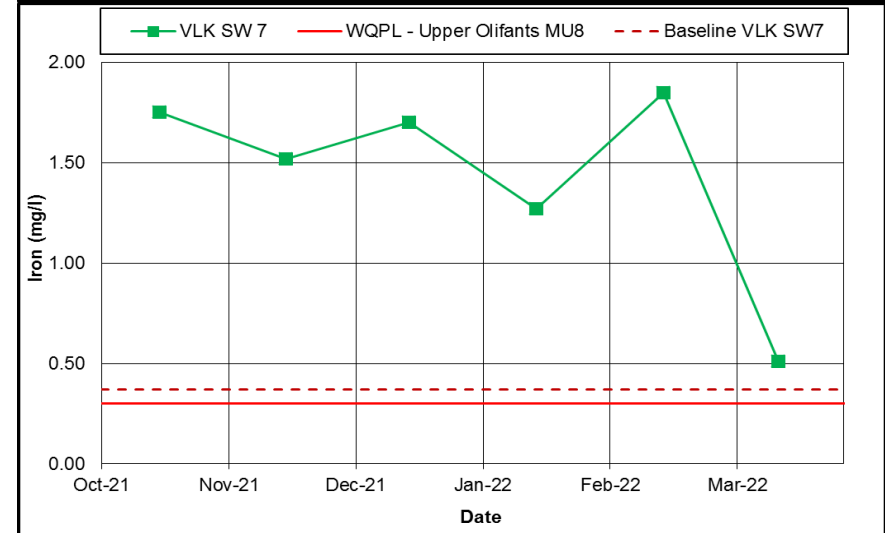
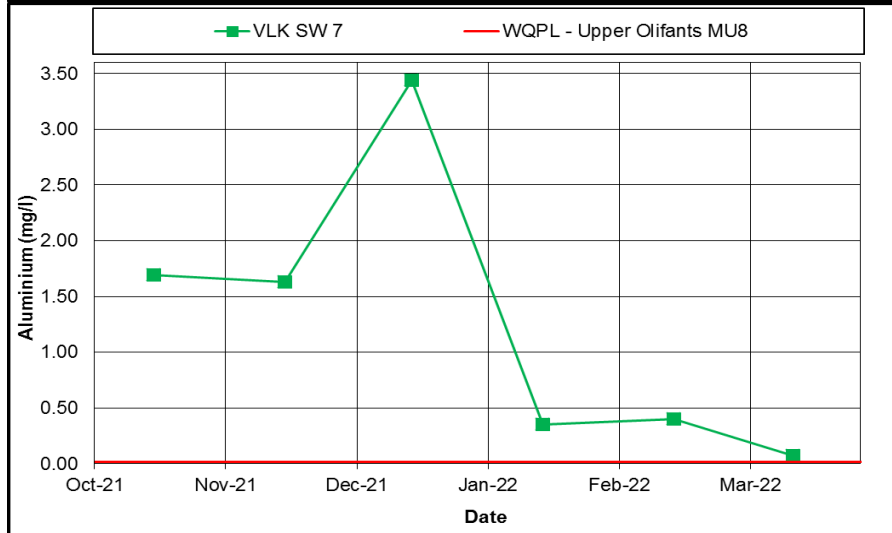
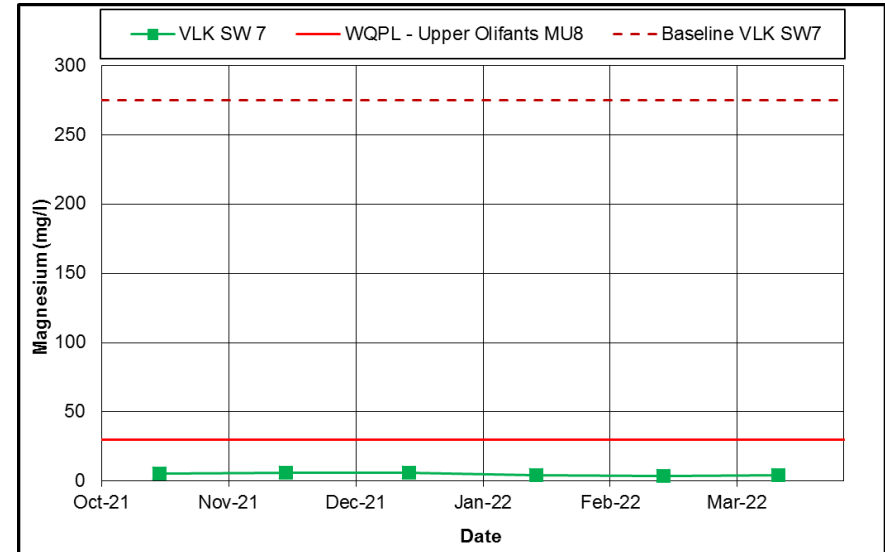
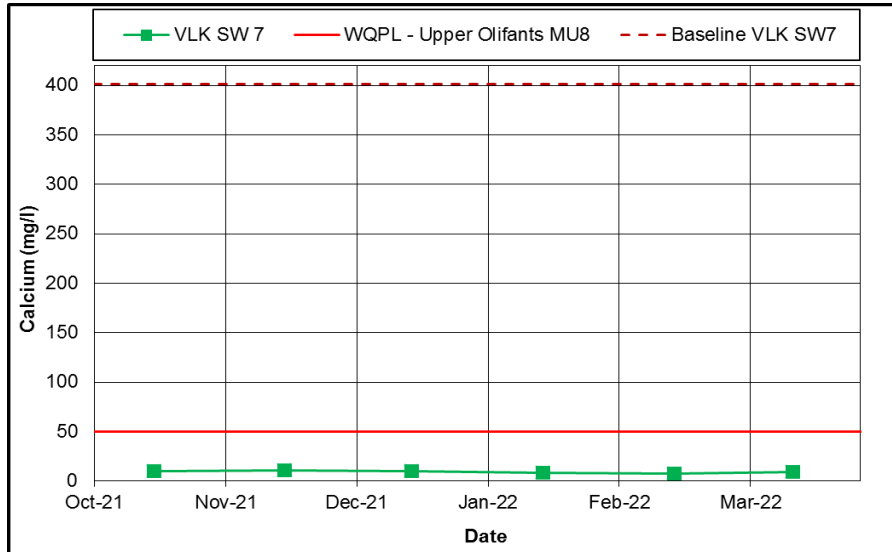
Table 24: VLK SW 7 Analysis Results

Sample Date	Parameters														
	pH	EC (mS/m)	TDS (mg/l)	Alk (mg/l)	N (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	F (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
Non-Compliance	<6,5	>90	>350	>120	>0,5	>40	>150	>0,75	>50	>25	>50	>30	>0,02	>0,3	>0,05
	>8,4														
Average	6.80	16.47	110.33	41.33	0.10	11.45	22.12	0.57	15.43	5.01	8.58	4.00	0.27	1.21	0.05
Jan-22	6.78	15.80	87.00	38.00	0.10	6.71	25.70	0.55	14.20	4.05	8.62	4.06	0.35	1.27	0.01
Feb-22	6.72	14.40	86.00	26.00	0.10	9.15	30.70	0.52	16.30	1.91	7.95	3.52	0.40	1.85	0.01
Mar-22	6.90	19.20	158.00	60.00	0.10	18.50	9.97	0.64	15.80	9.08	9.17	4.42	0.07	0.51	0.13









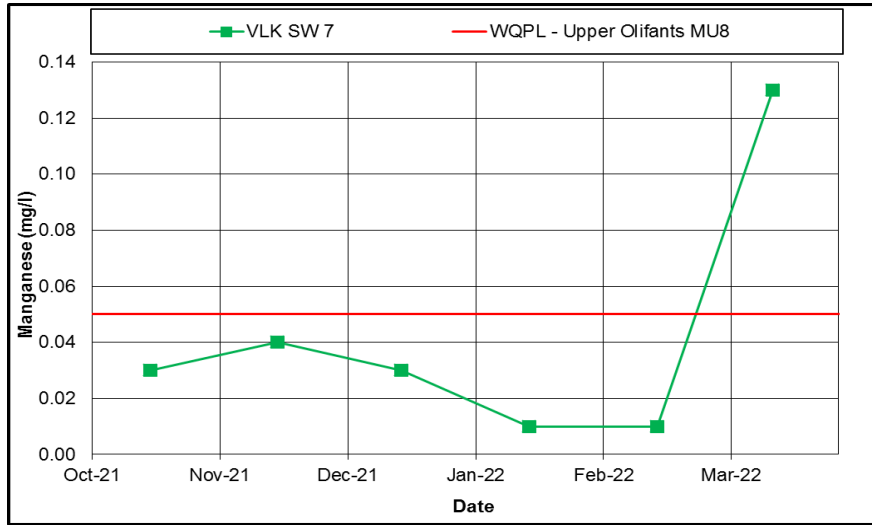


Figure 14: VLK SW 7 Compliance Graphs



5.1.12. Average Surface Water Sulphate and pH compliance

The data summarised in **Table 25** depicts the average SO₄ values for this monitoring period of 2022. One can see that almost all the averages measured compliant. The compliance for SO₄ for each monitoring point can be seen in **Figure 15**.

Table 25: Average SO₄

Site name	SO ₄ concentrations	
	Average Previous Reporting Period	Average Current Reporting Period
2S_SW1	269.00	114.83
2S_SW2	141.00	72.37
2S_SW3	256.33	104.40
2S_SW4	712.50	750.00
2S_SW7	511.33	72.02
2S_SW8	547.33	43.73
2S_SW9	Dry	38.33
2S_SW14	82.33	36.40
2S_SW16	479.00	318.67
2S_SW18	1 568.33	1 144.33
VLK SW7	21.67	22.12

As mentioned previously, pH is used as a contaminant of concern. The average pH concentration levels for the monthly surface water monitoring points are represented in **Table 26** below. The compliance of the monitoring points is visually represented in **Figure 16**.

From the table, it can be seen that the average pH level for monitoring point 2S_SW7 was non-compliant for the duration of the January - March 2022 monitoring period.

Table 26: Average pH

Site name	Average pH	
	Average Previous Reporting Period	Average Current Reporting Period
2S_SW1	7.91	7.56
2S_SW2	7.77	7.55
2S_SW3	7.89	7.53
2S_SW4	7.79	7.05
2S_SW7	3.59	6.46
2S_SW8	8.67	6.96



Site name	Average pH	
	Average Previous Reporting Period	Average Current Reporting Period
2S_SW9	Dry	7.40
2S_SW14	8.16	7.67
2S_SW16	8.35	7.98
2S_SW18	8.04	7.79
VLK SW7	7.88	6.80



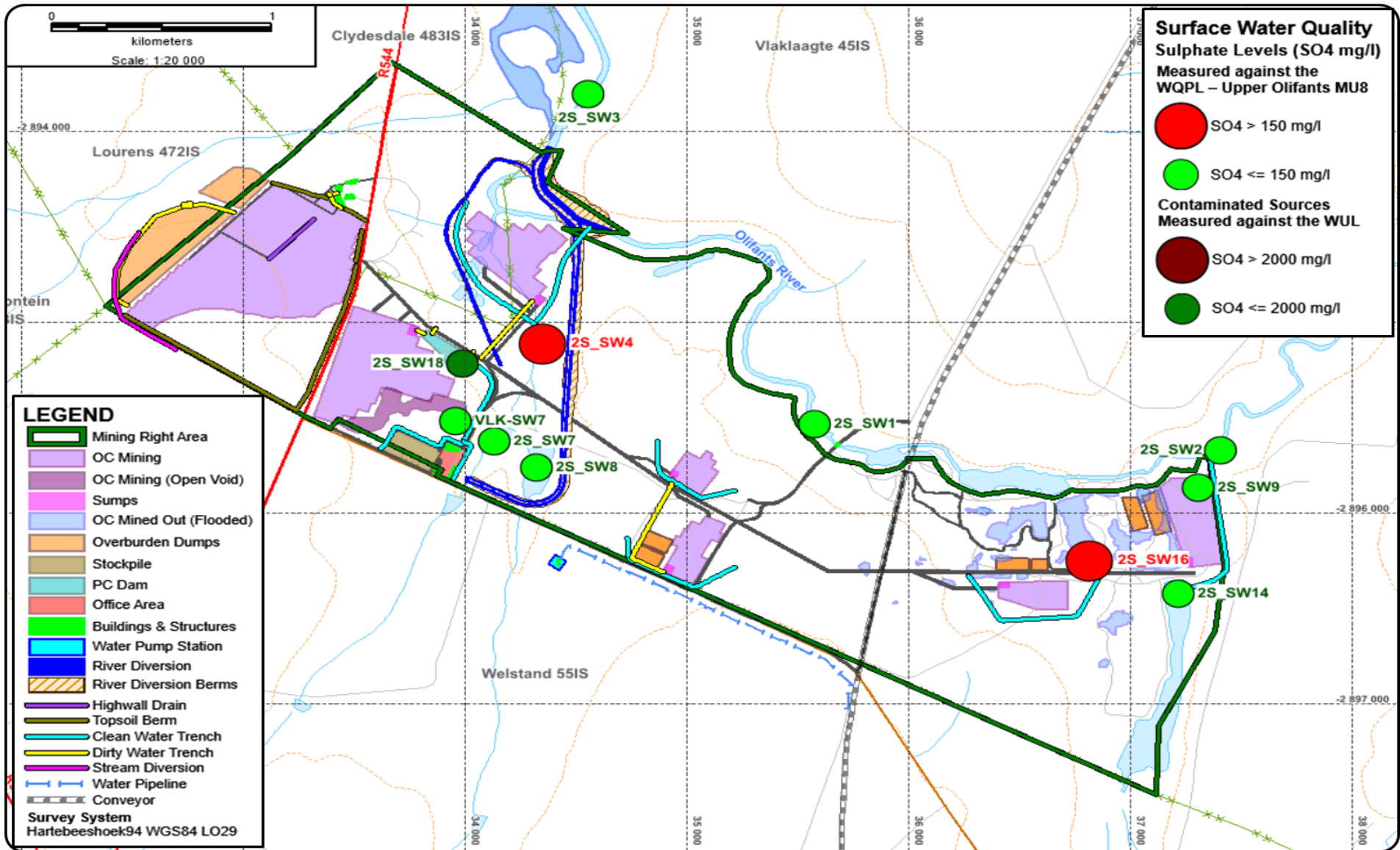


Figure 15: Surface water Sulphate Compliance Map



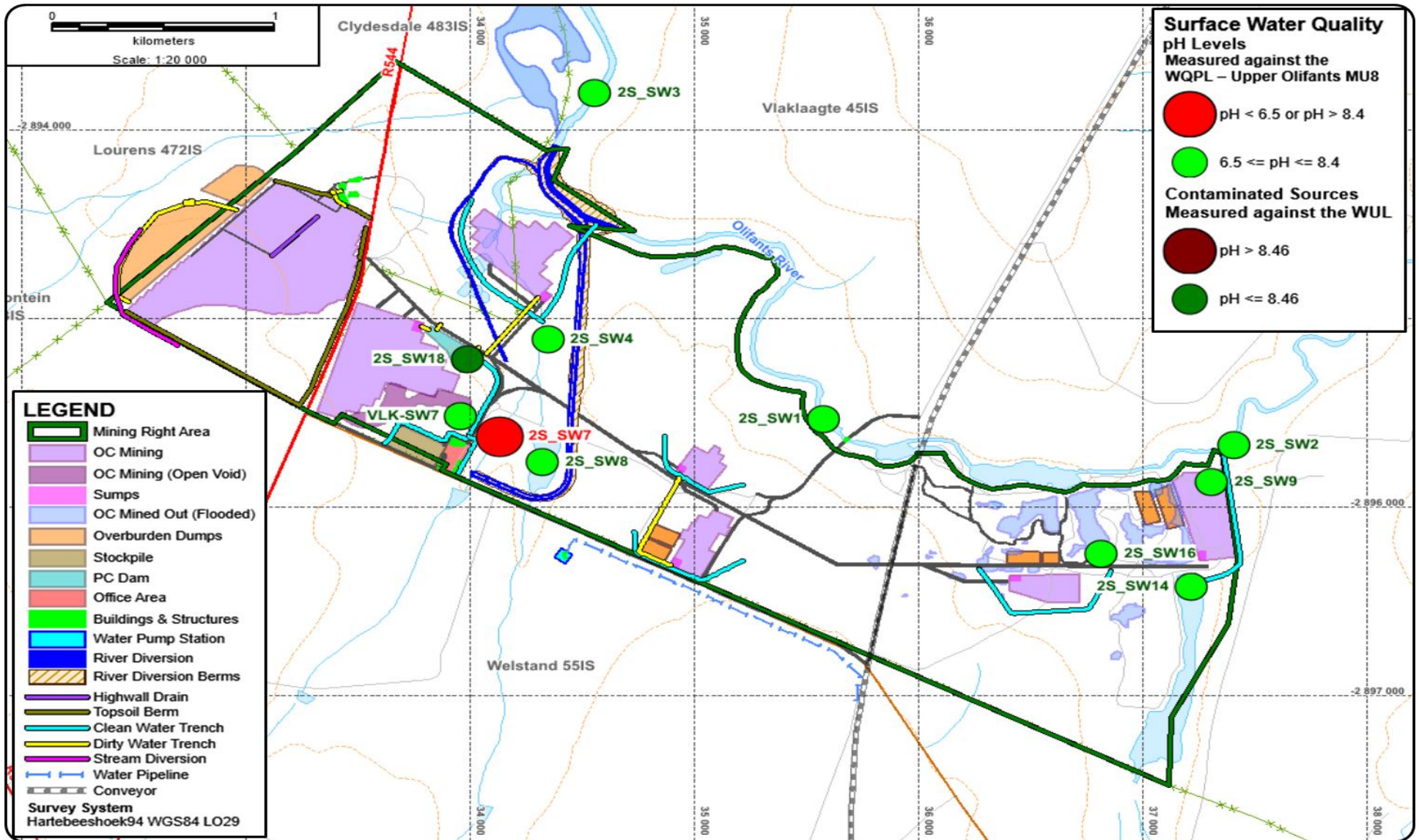


Figure 16: Surface water pH Compliance Map



5.1.13. Piper, Wilcox and Schoeller Diagrams for Surface Water

Refer to **Figure 17** to **Figure 20** for the Diagrams.



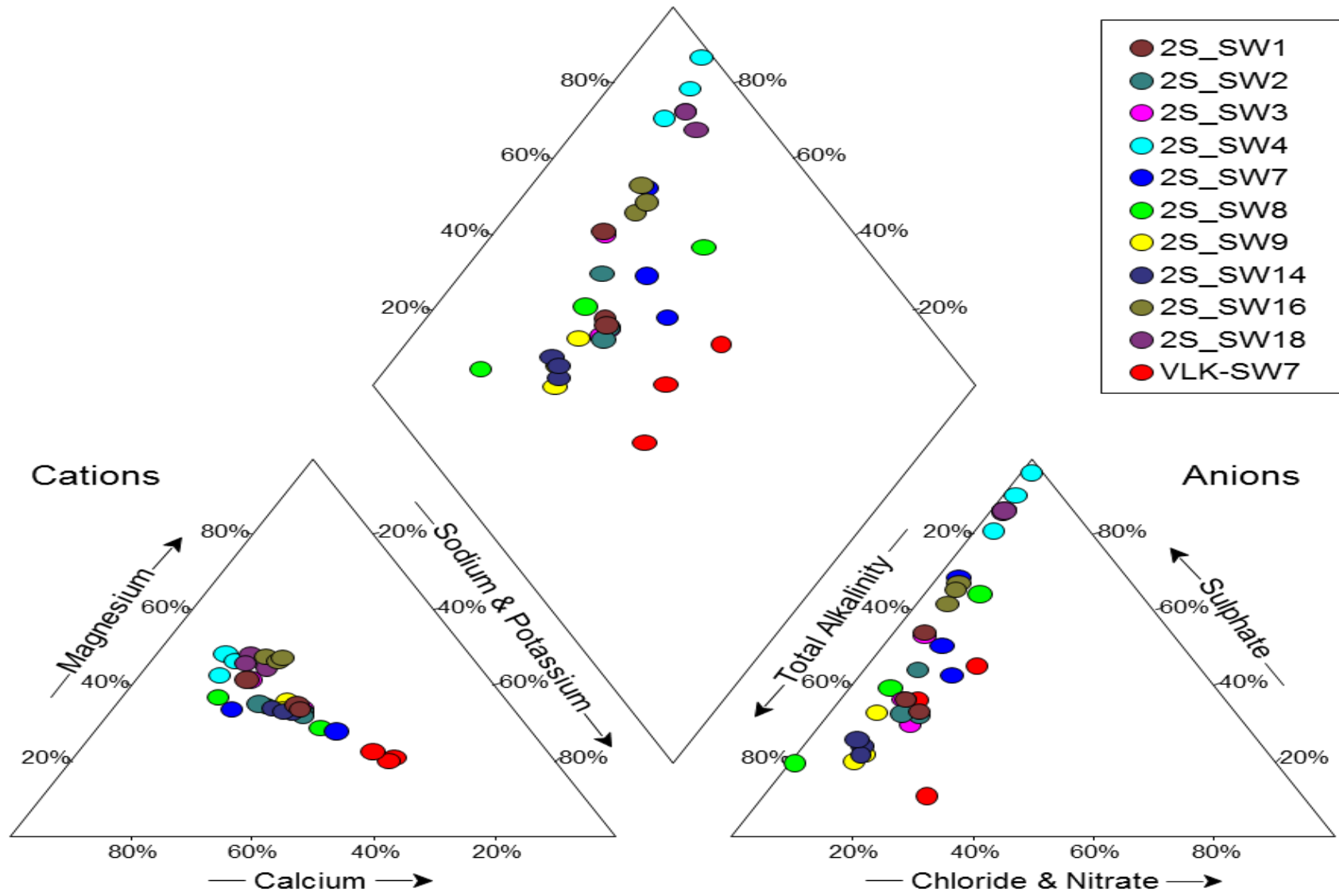


Figure 17: Surface Water Piper Diagram



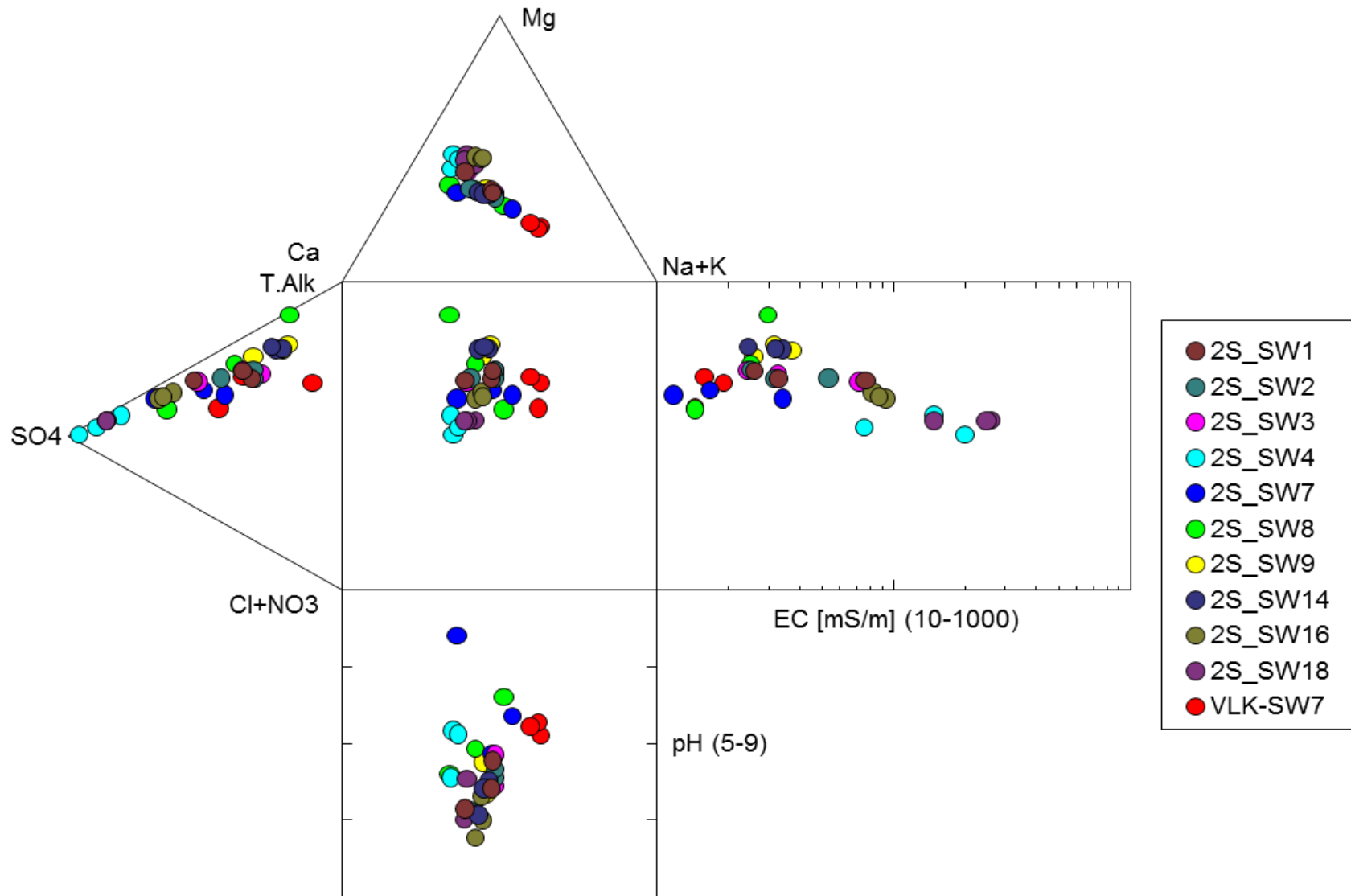


Figure 18: Surface Water Durov Diagram



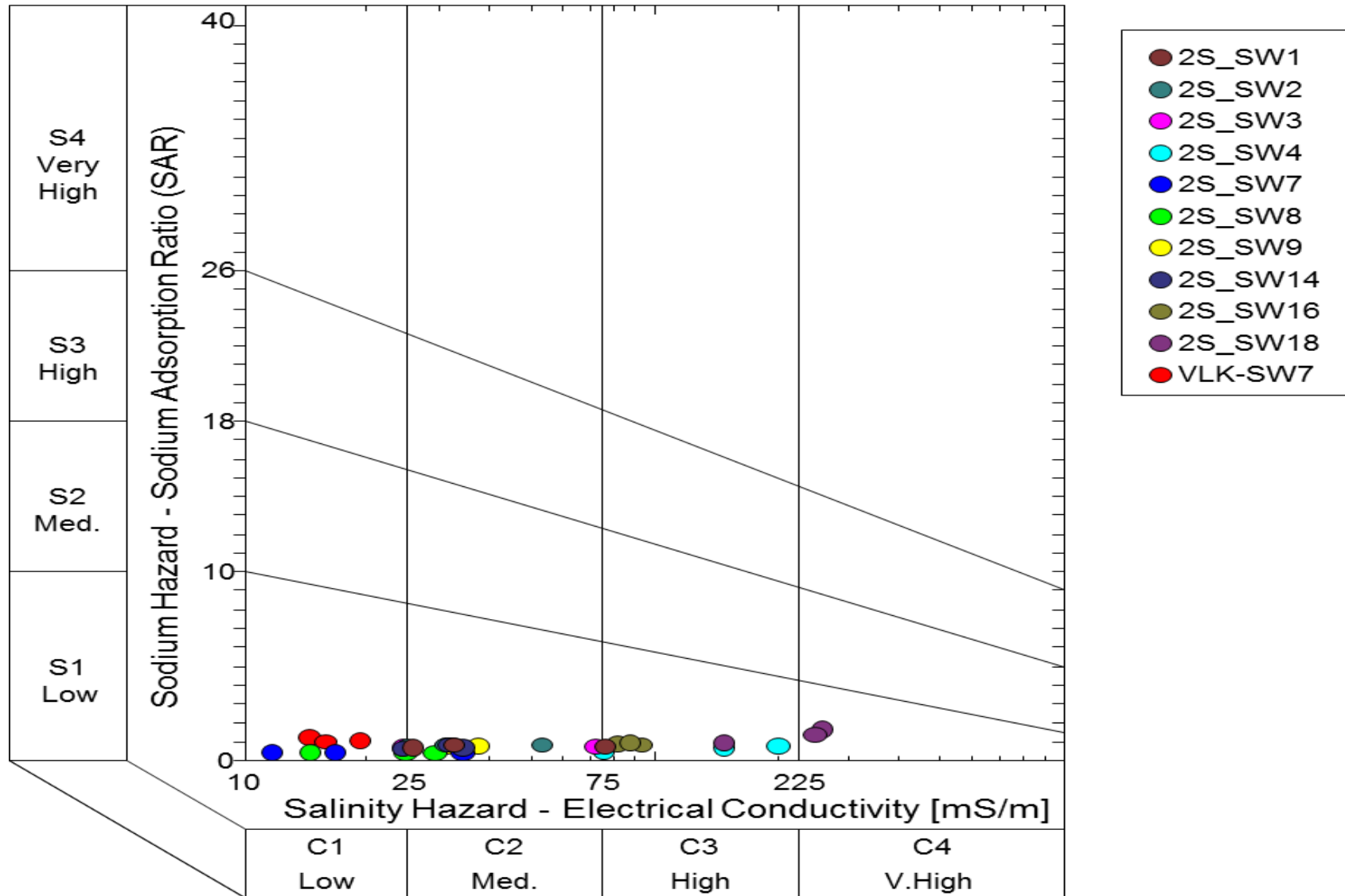


Figure 19: Surface Water S.A.R Diagram



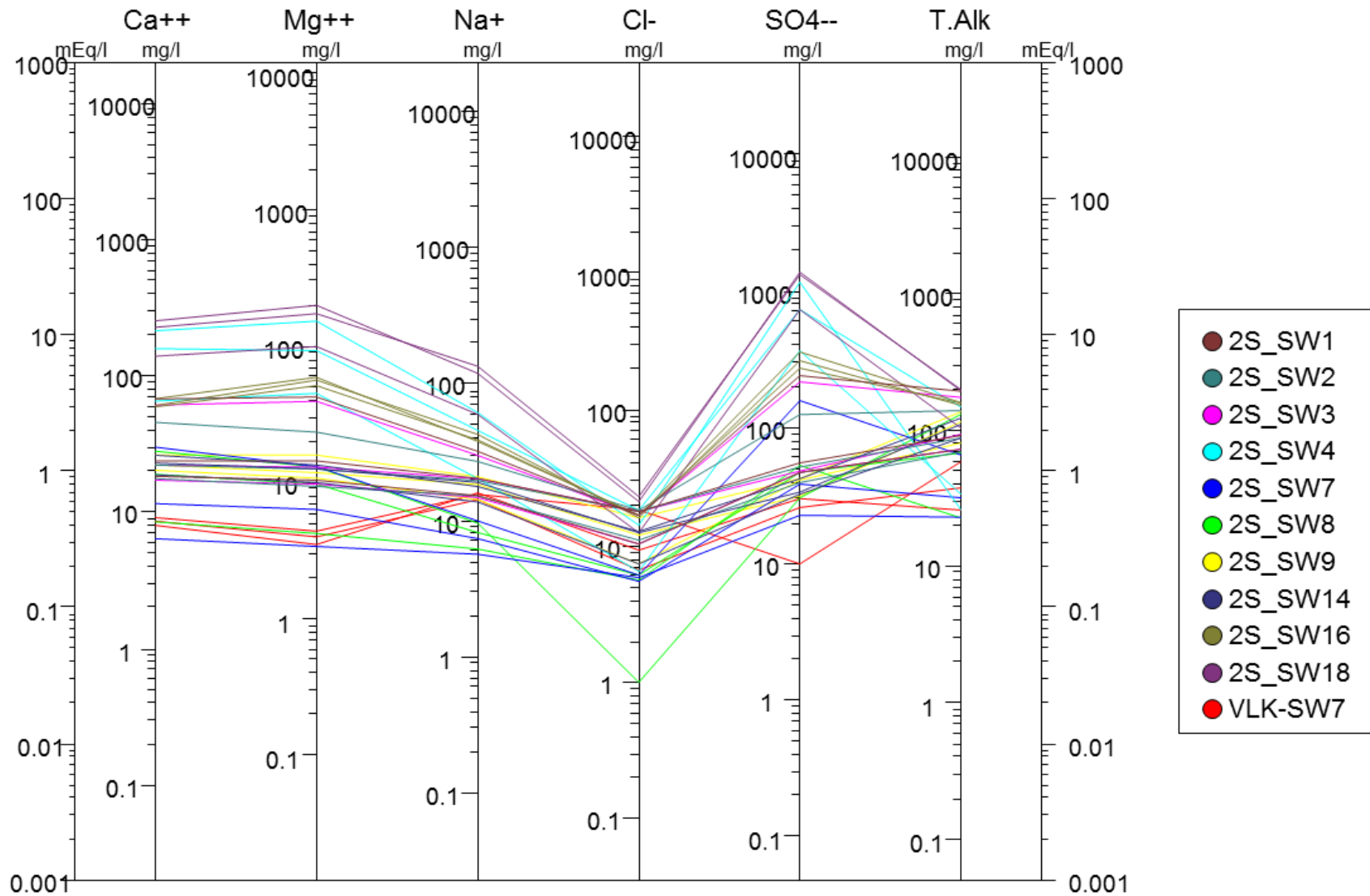


Figure 20: Surface Water Schoeller Diagram



5.2 Vlaklaagte Groundwater Compliance

The analyses of the groundwater results are discussed per individual monitoring point below and compared against SANS 241: 2015 and SAWQG. Refer to **Annexure 2** for the full laboratory analysis. As mentioned previously, Sulphate (SO_4) ions and pH were used as the contaminants of concern.

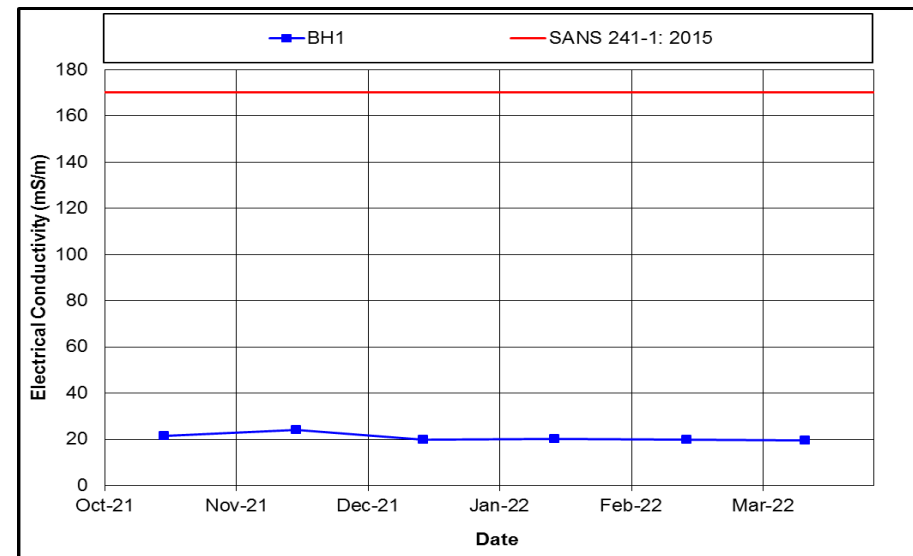
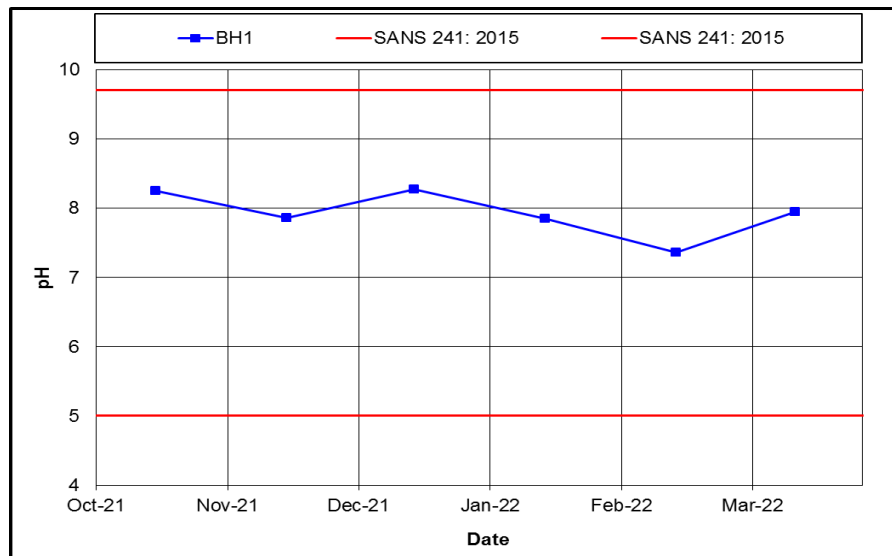
5.2.1. BH1

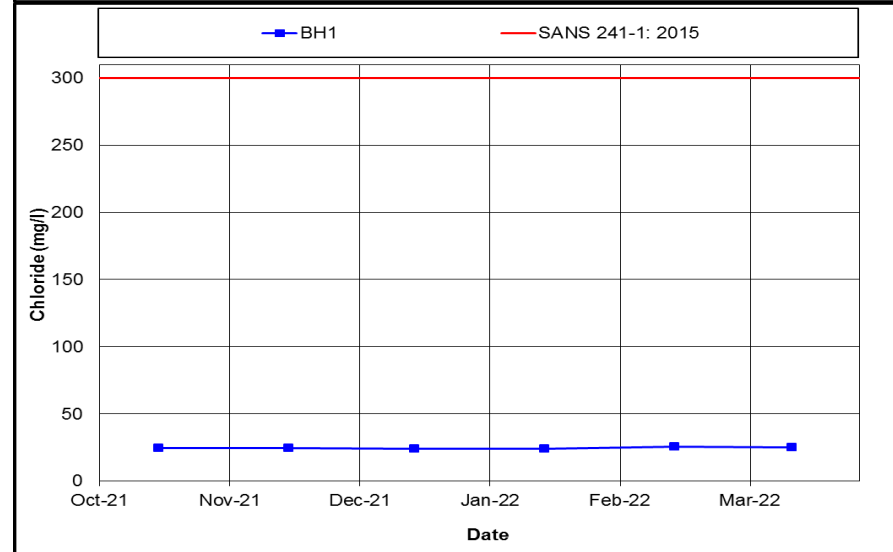
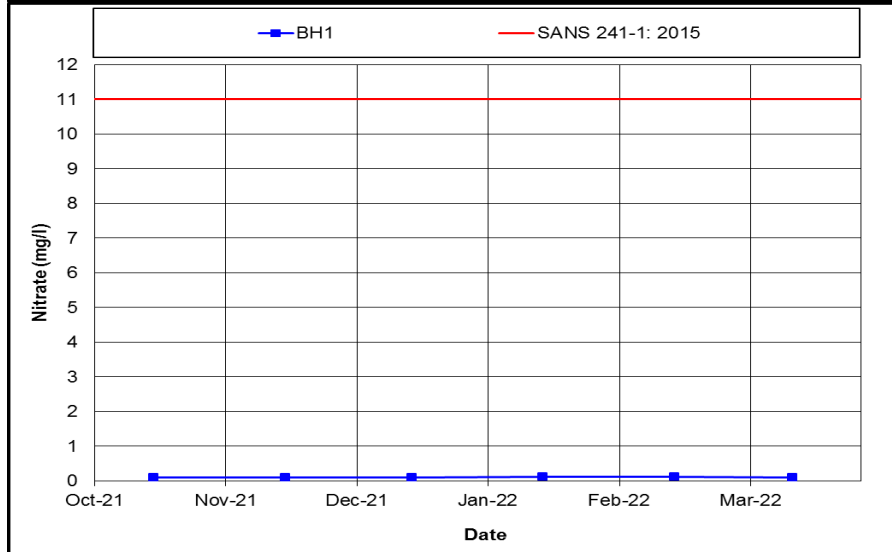
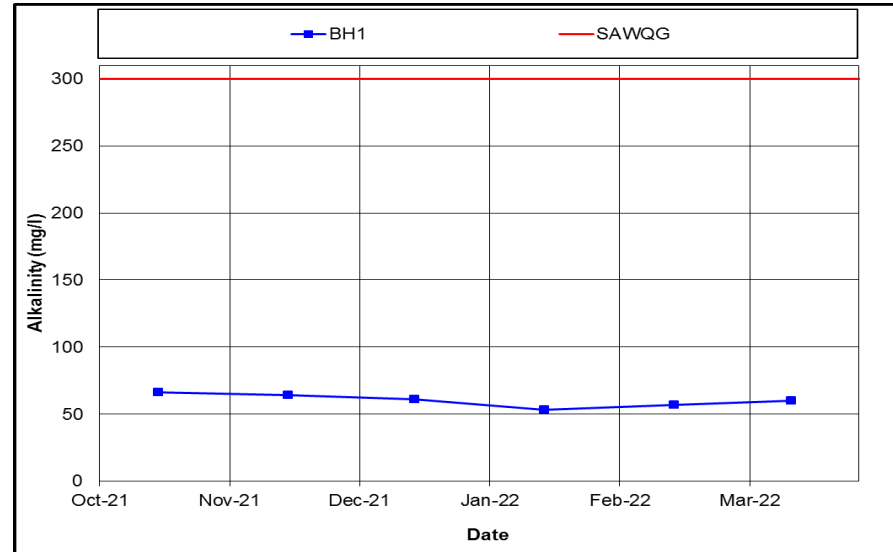
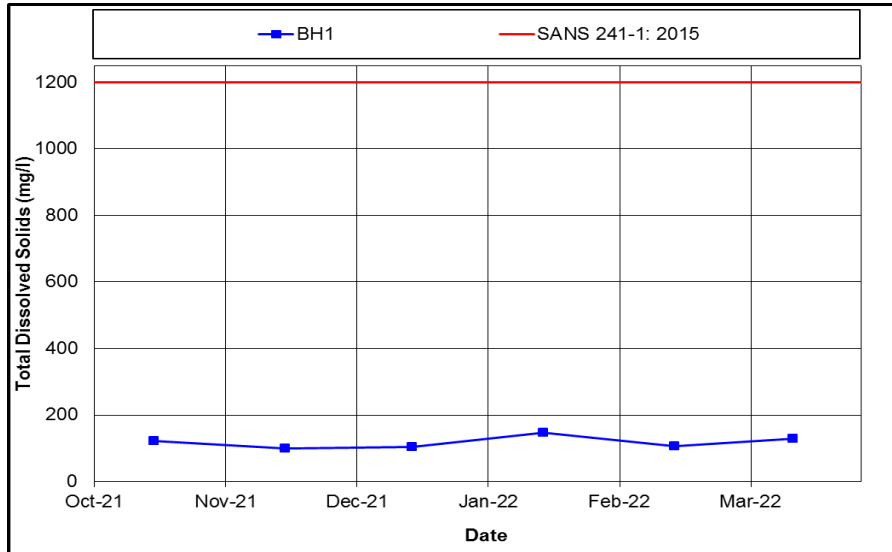
BH1 recorded no exceedances in parameters for this monitoring quarter as depicted in **Table 27** below. Refer to **Figure 21** for the compliance graphs.

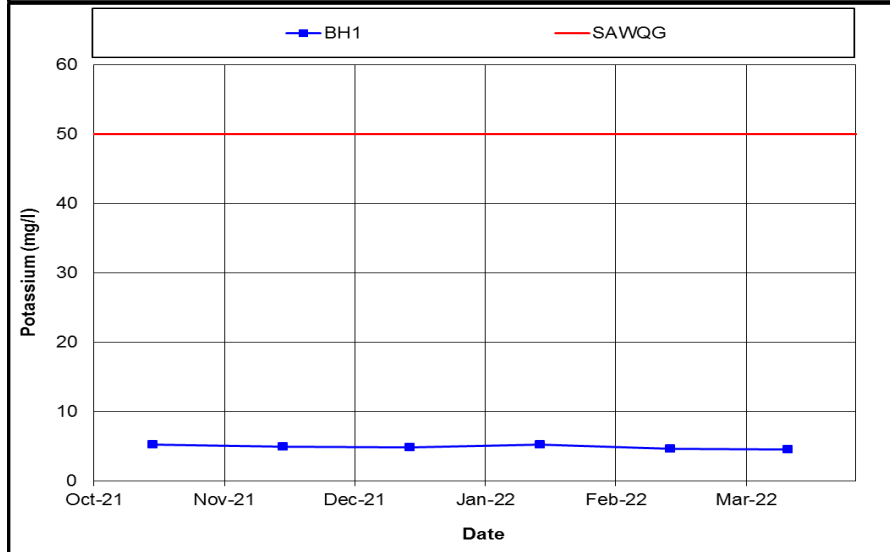
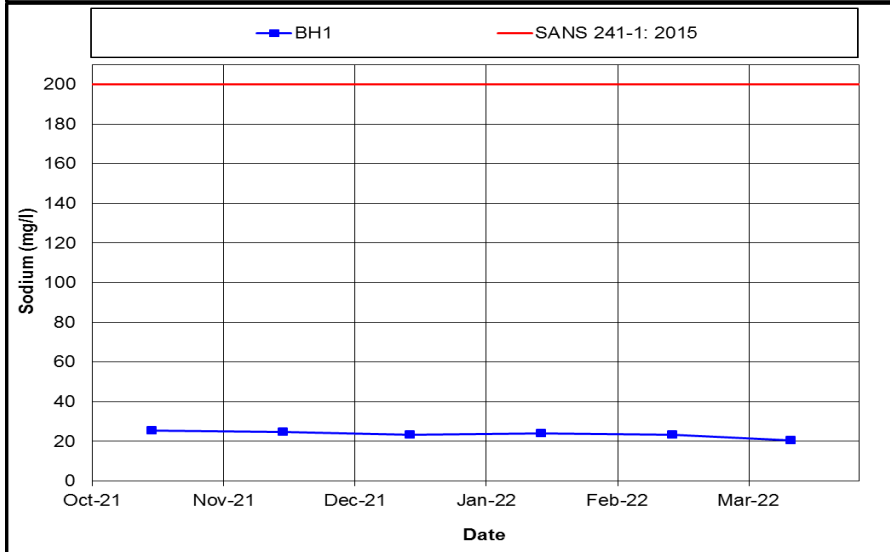
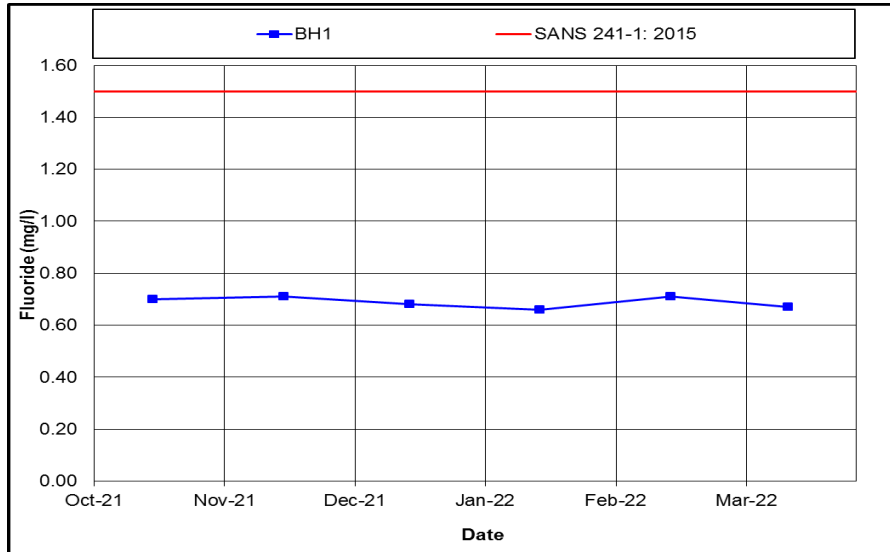
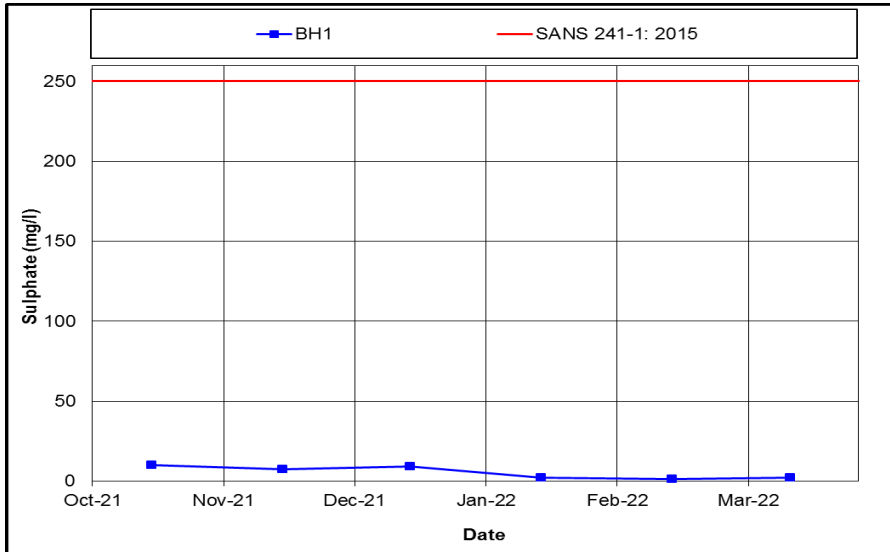


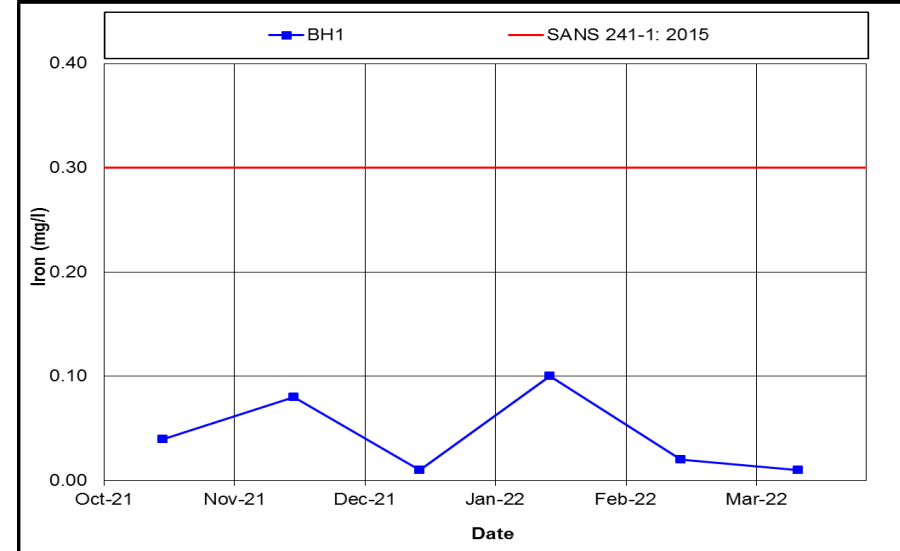
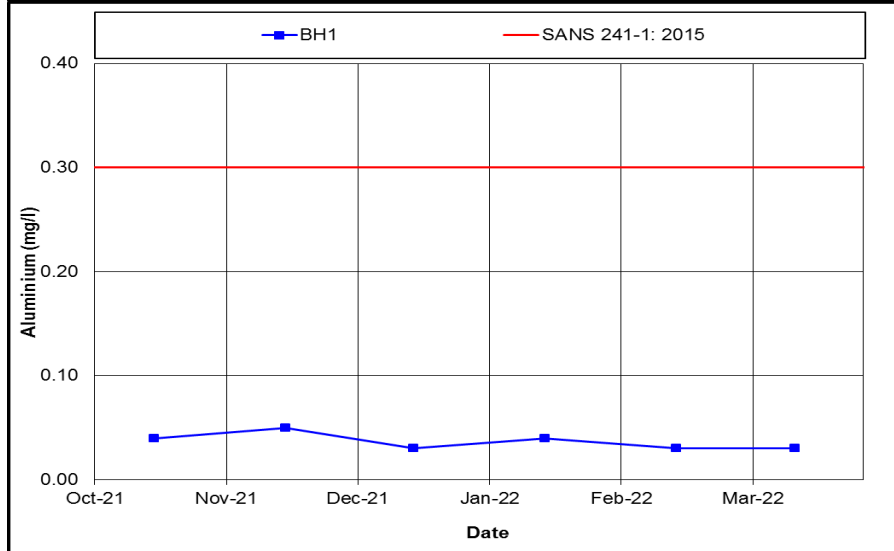
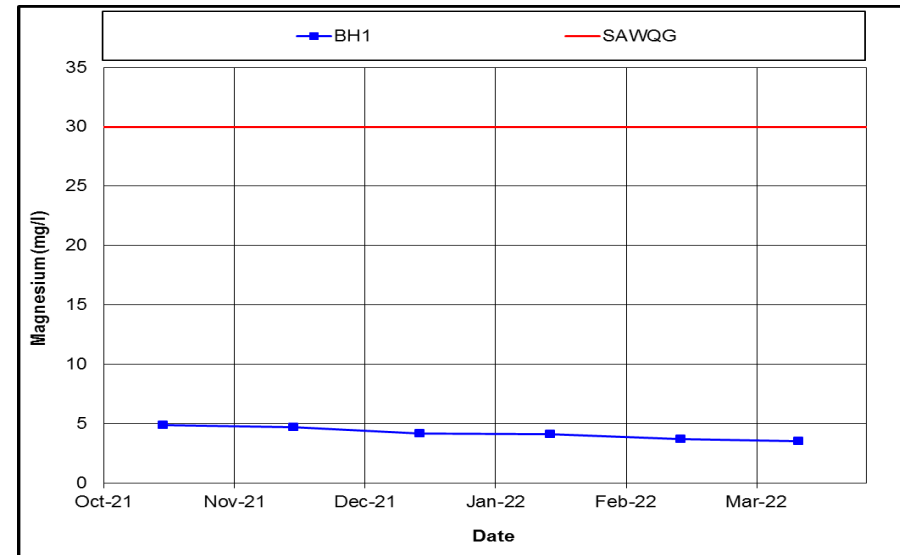
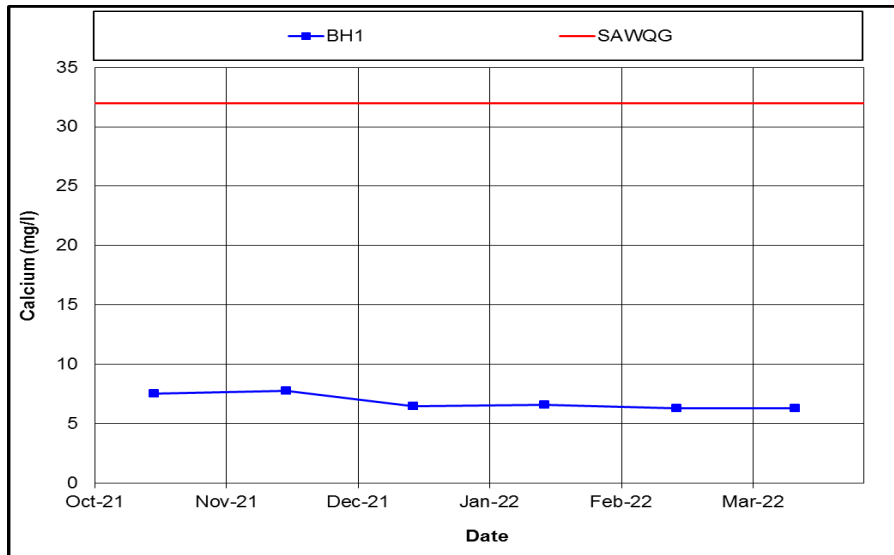
Table 27: BH1 Analysis Results

Sample Date	Parameters														
	pH	EC (mS/m)	TDS (mg/l)	Alk (mg/l)	N (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	F (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
Non-Compliance	<5	>170	>1 200	>300	>11	>300	>250	>1,5	>200	>50	>32	>30	>0,3	>0,3	>0,1
	>9,7														
Average	7.72	19.77	127.33	56.67	0.11	24.80	1.83	0.68	22.60	4.80	6.39	3.78	0.03	0.04	0.01
Jan-22	7.85	20.10	148.00	53.00	0.12	23.80	2.10	0.66	24.00	5.20	6.59	4.13	0.04	0.10	0.01
Feb-22	7.36	19.80	106.00	57.00	0.12	25.40	1.40	0.71	23.20	4.65	6.31	3.69	0.03	0.02	0.01
Mar-22	7.94	19.40	128.00	60.00	0.10	25.20	2.00	0.67	20.60	4.56	6.28	3.52	0.03	0.01	0.01









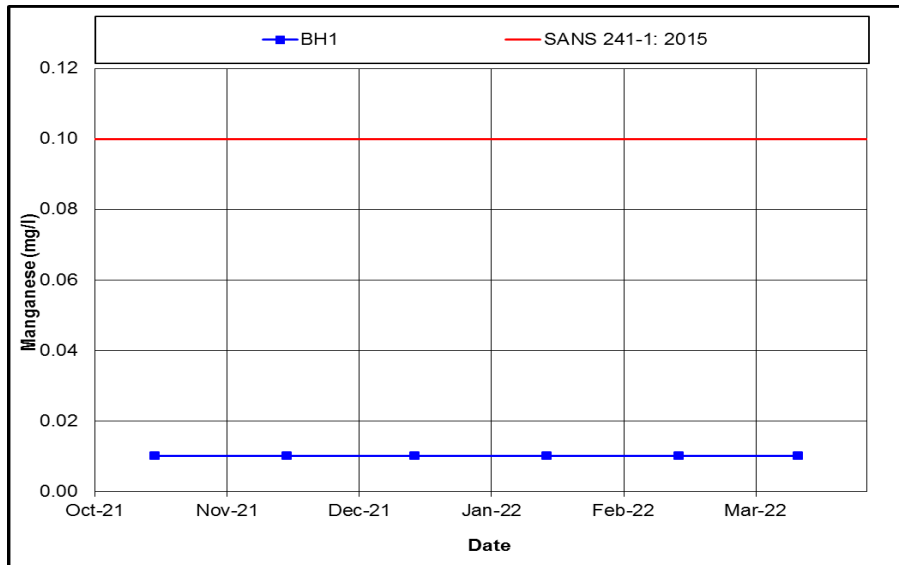


Figure 21: BH1 Compliance Graphs



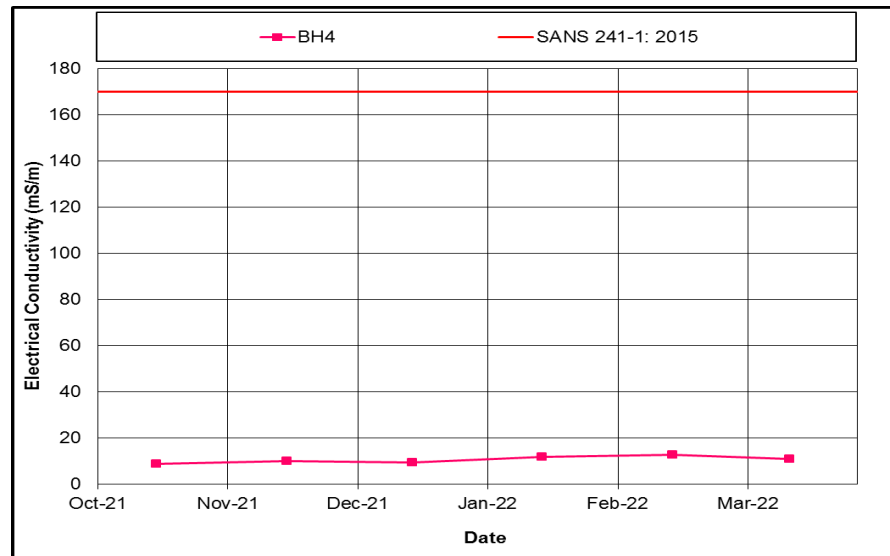
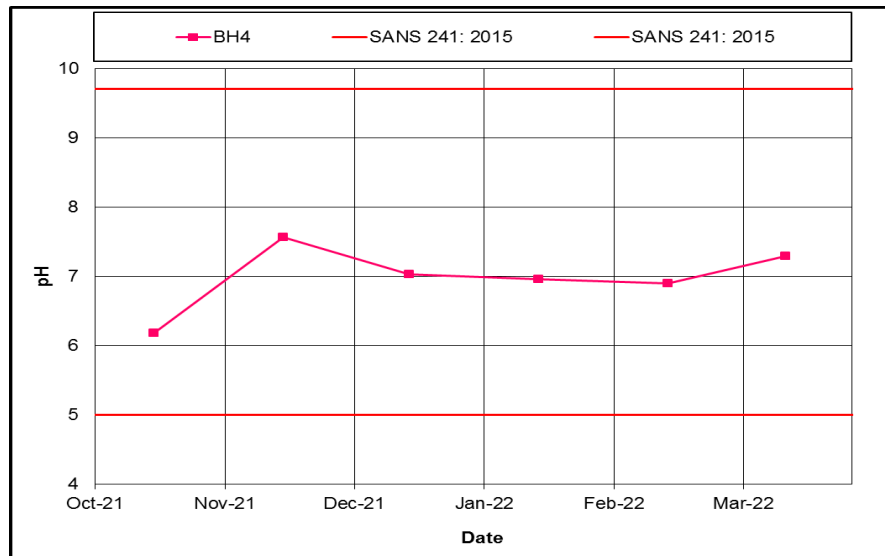
5.2.2. BH4

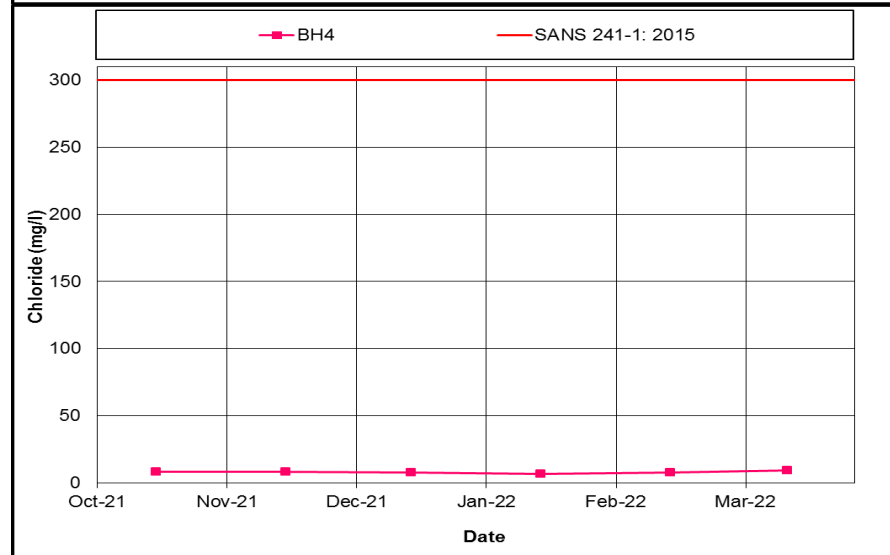
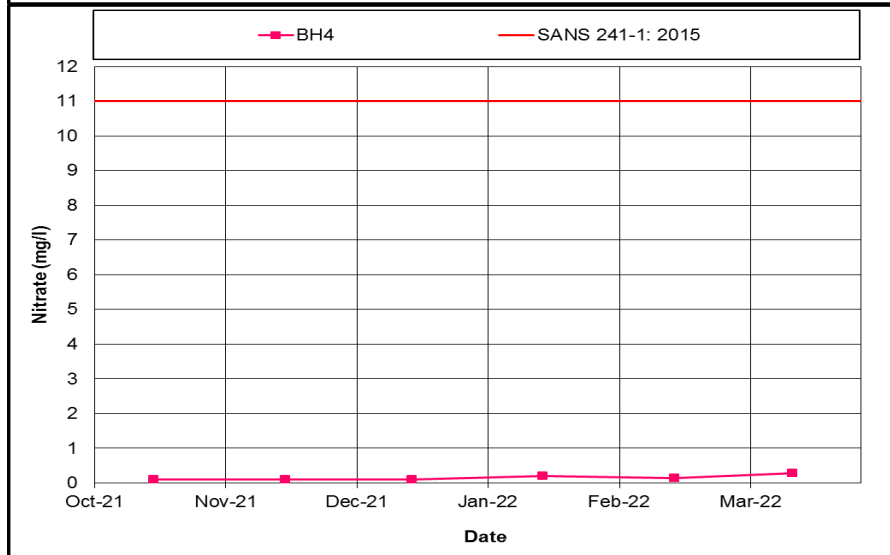
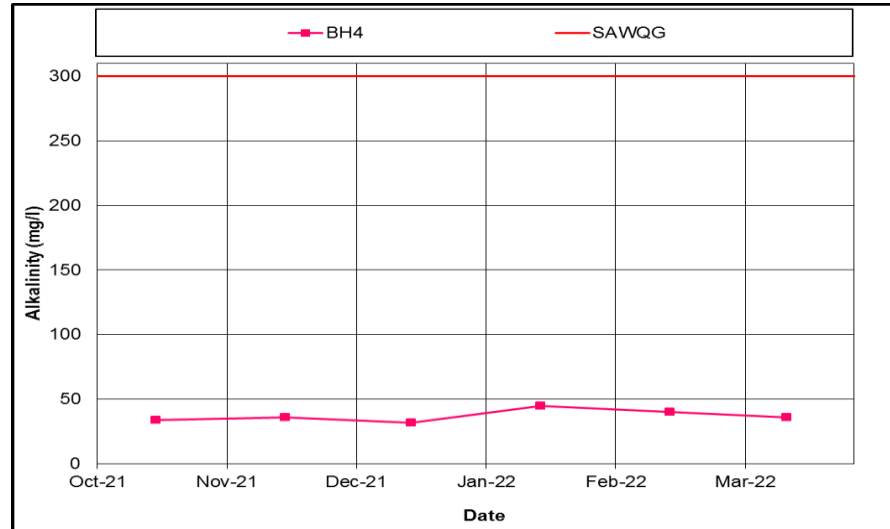
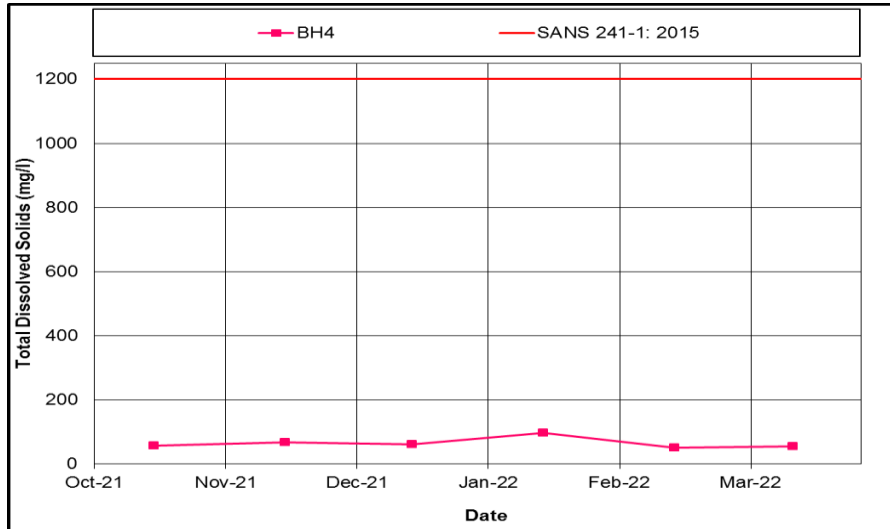
Table 28 indicates that BH4 only exceeded the Manganese parameter during January 2022 and that all the other points were compliant. Refer to **Figure 22** for the compliance graphs.

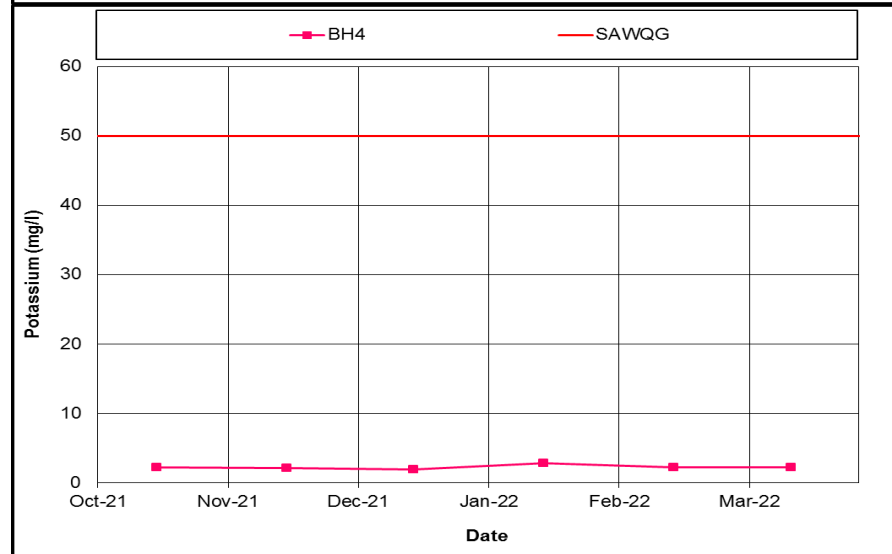
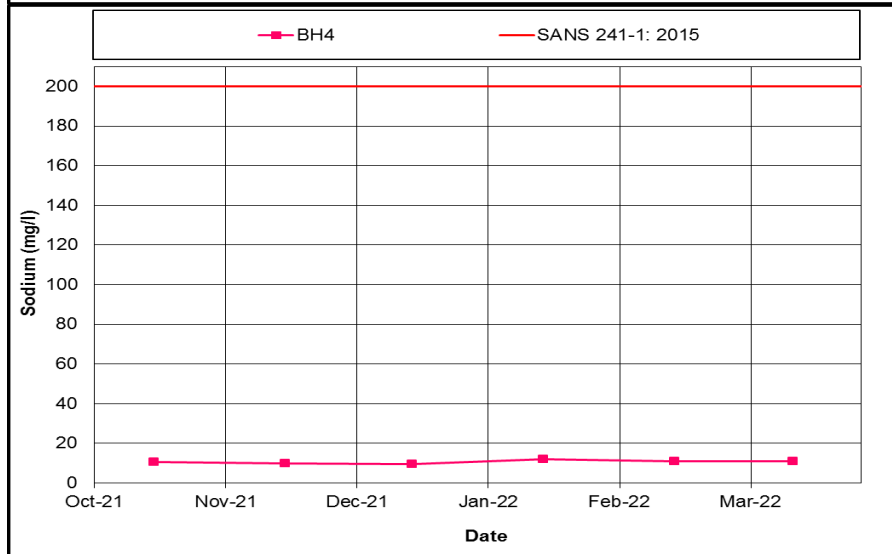
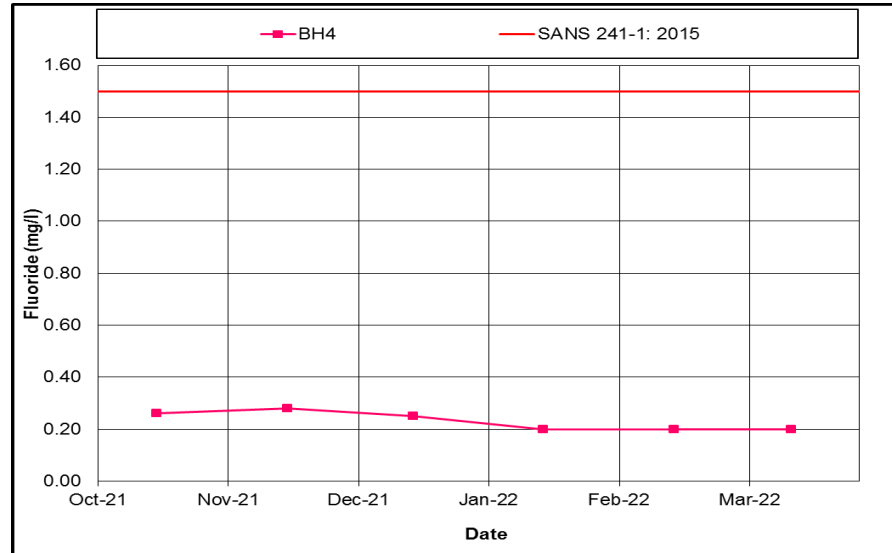
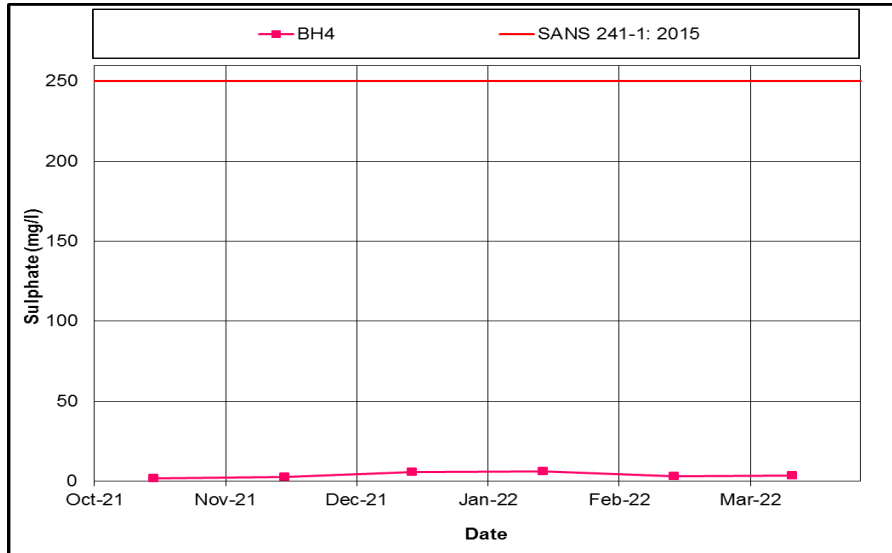


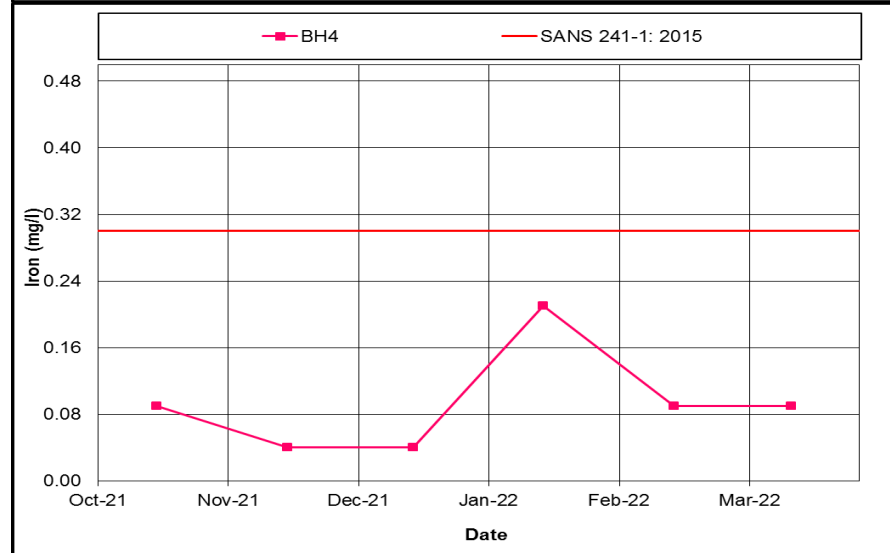
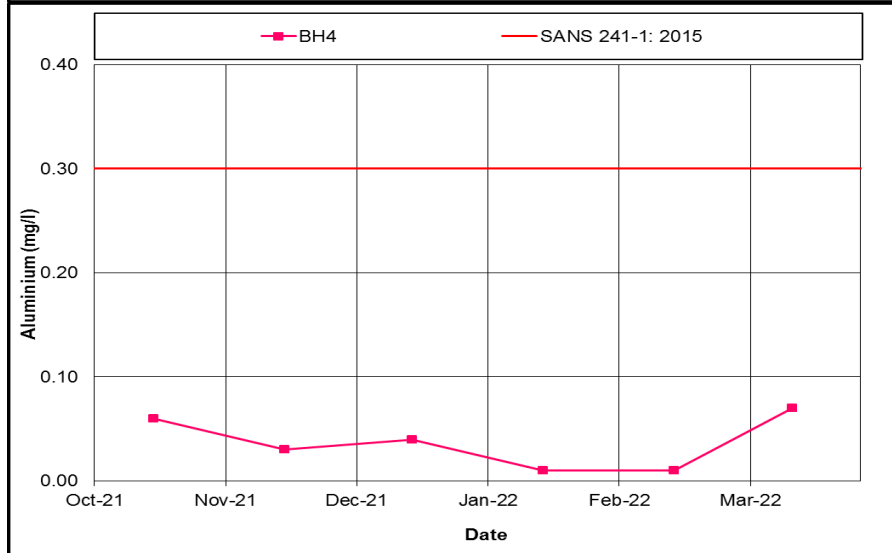
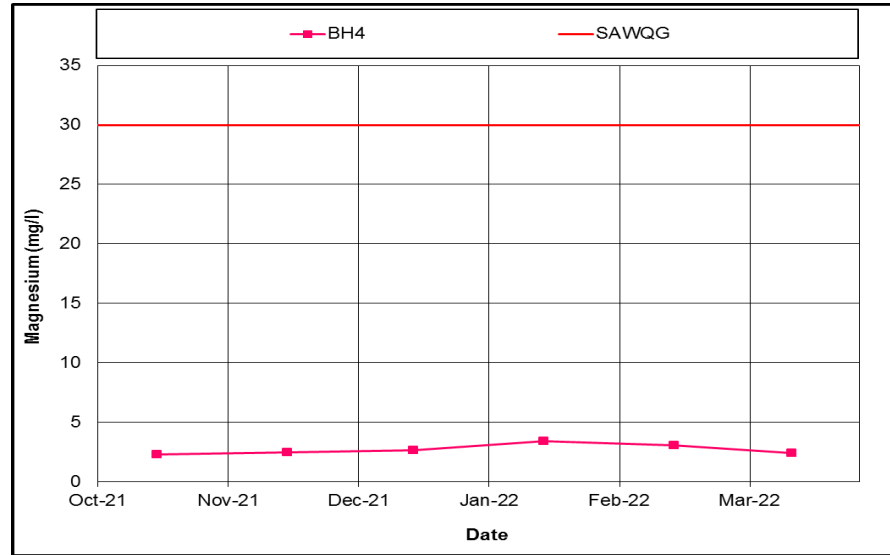
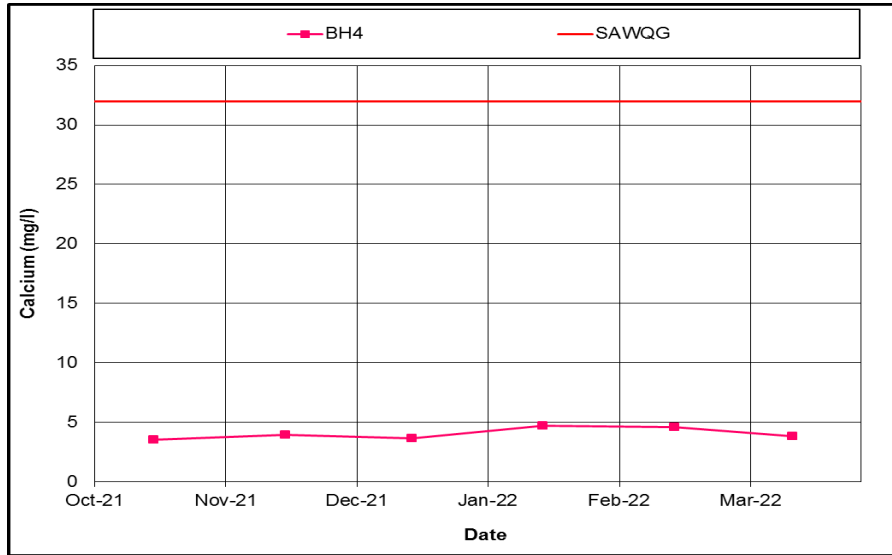
Table 28: BH4 Analysis Results

Sample Date	Parameters														
	pH	EC (mS/m)	TDS (mg/l)	Alk (mg/l)	N (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	F (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
Non-Compliance	<5	>170	>1 200	>300	>11	>300	>250	>1,5	>200	>50	>32	>30	>0,3	>0,3	>0,1
	>9,7														
Average	7.05	11.97	68.67	40.33	0.21	7.84	4.22	0.20	11.23	2.42	4.38	2.98	0.03	0.13	0.09
Jan-22	6.96	12.00	98.00	45.00	0.21	6.54	5.98	0.20	12.00	2.81	4.71	3.44	0.01	0.21	0.12
Feb-22	6.90	12.80	52.00	40.00	0.14	7.65	3.00	0.20	10.90	2.26	4.62	3.07	0.01	0.09	0.10
Mar-22	7.29	11.10	56.00	36.00	0.29	9.34	3.69	0.20	10.80	2.19	3.81	2.42	0.07	0.09	0.06









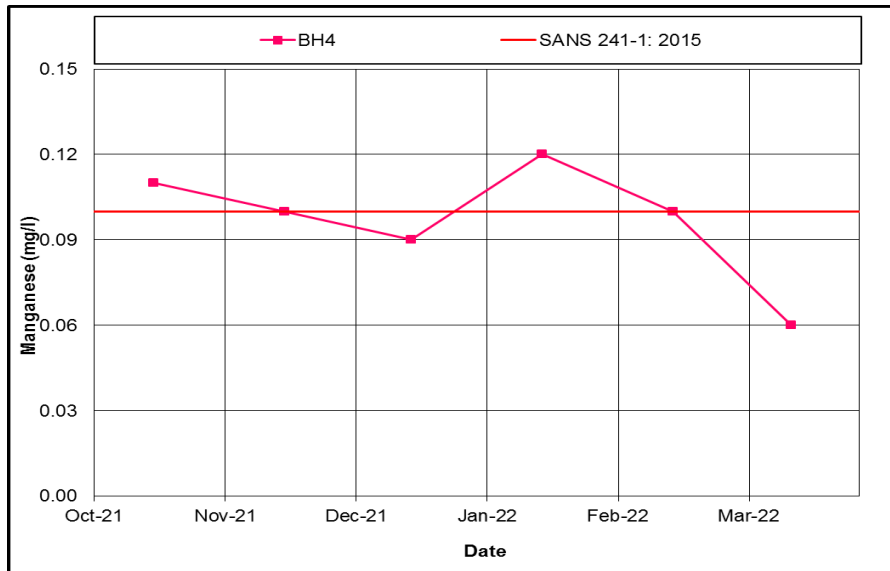


Figure 22: BH4 Compliance Graphs



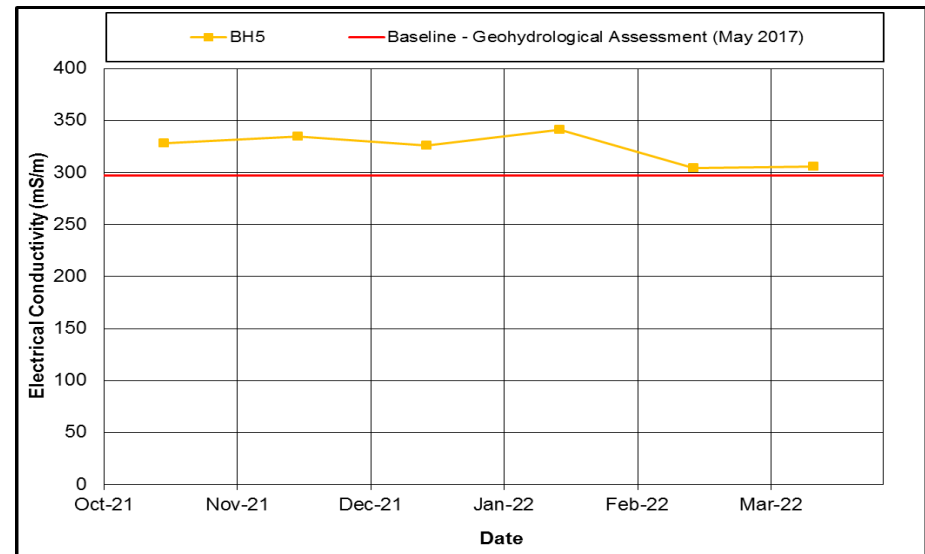
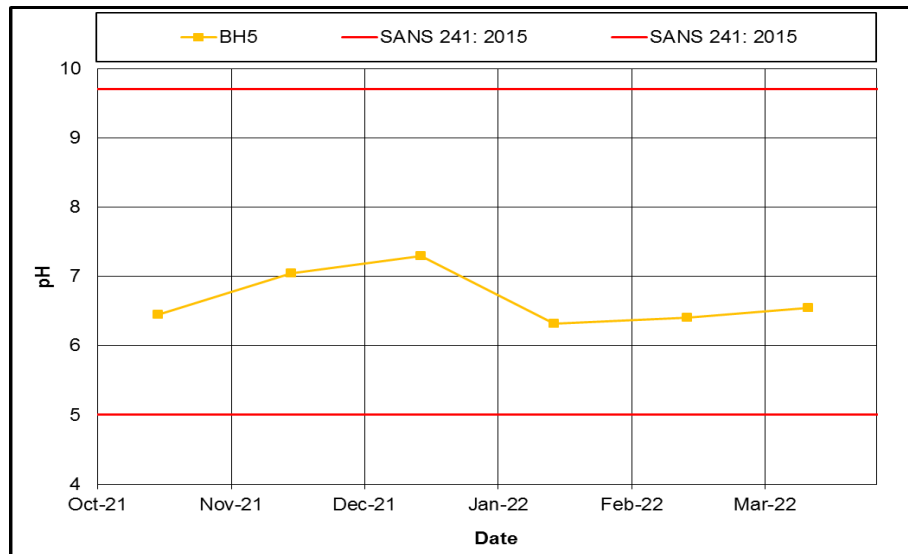
5.2.3. BH5

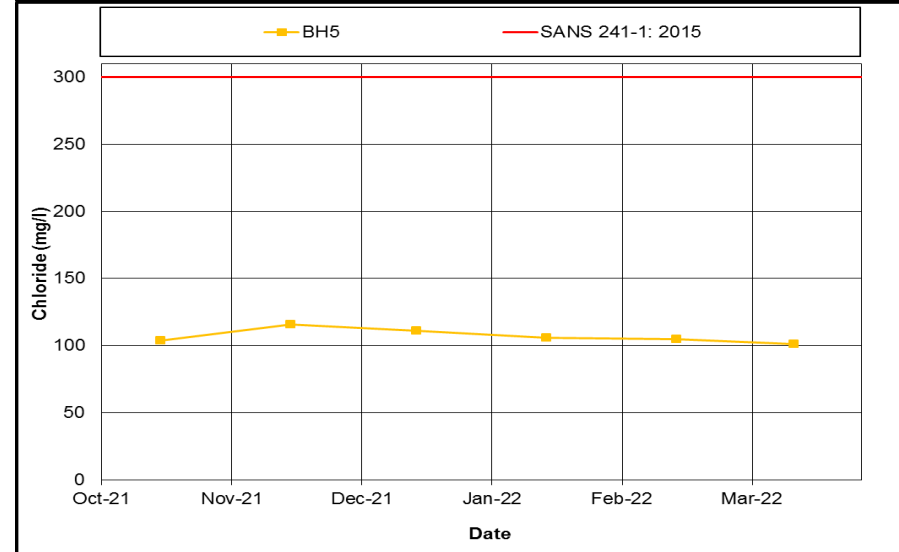
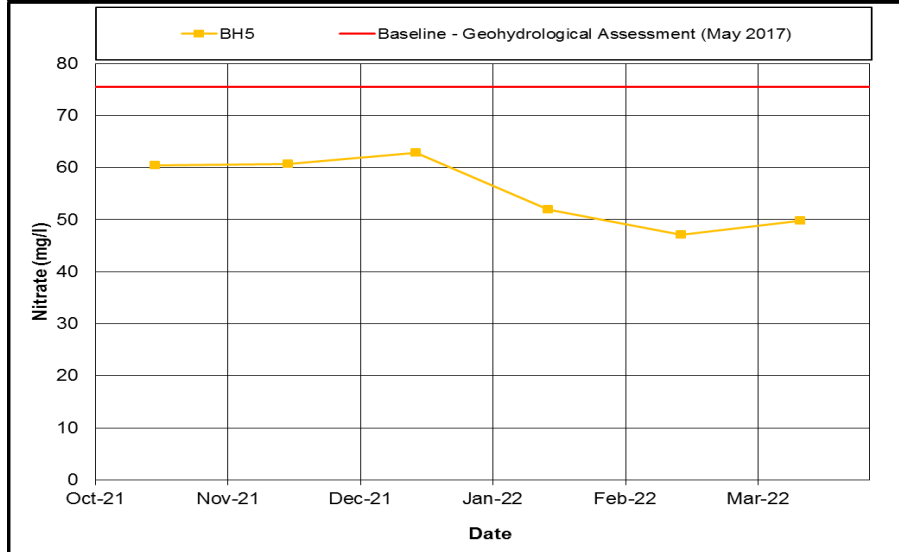
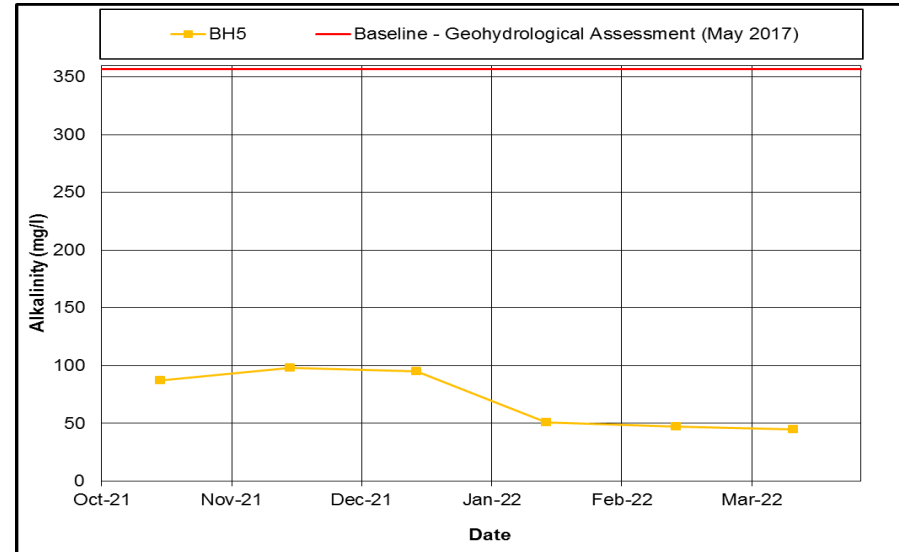
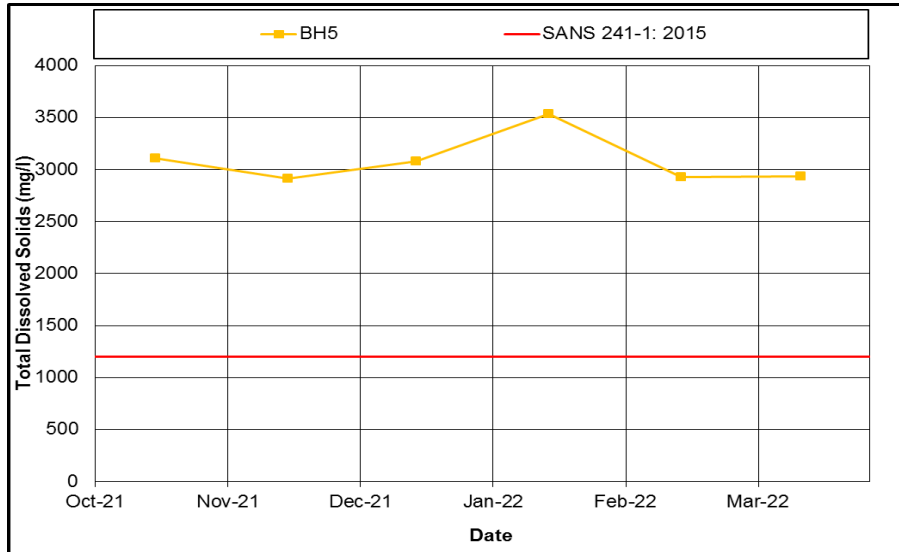
BH5 exceeded five of the tested parameters namely; EC, TDS, Sulphate, Sodium and Magnesium, refer to **Table 29**. These exceedances could be attributed to decant from historical underground mining. Refer to **Figure 23** for the compliance graphs.

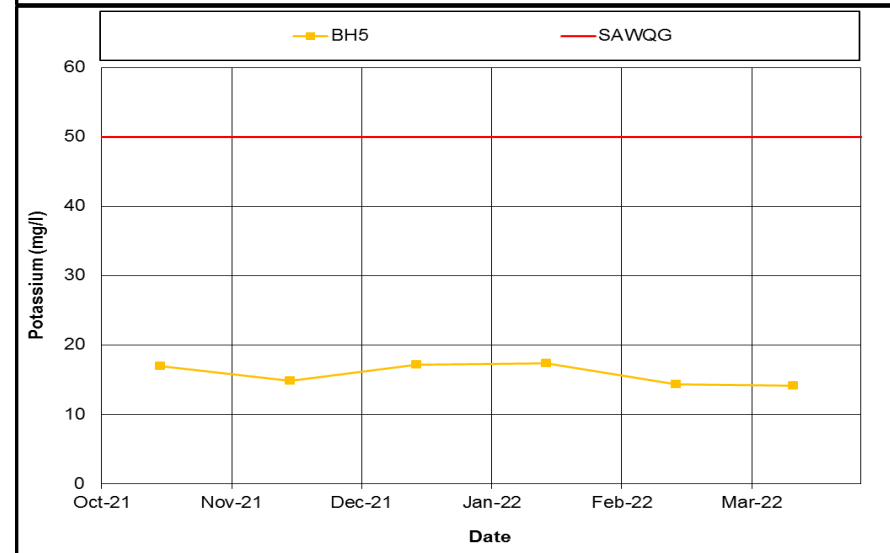
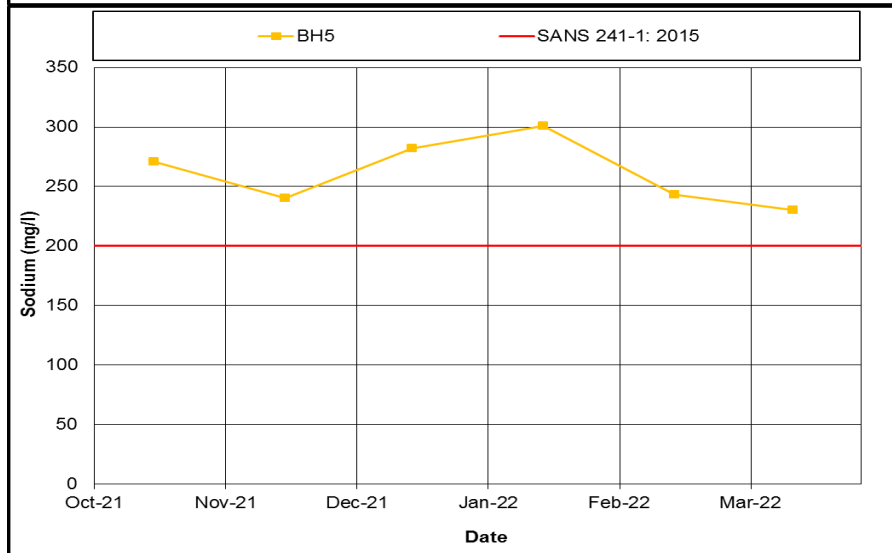
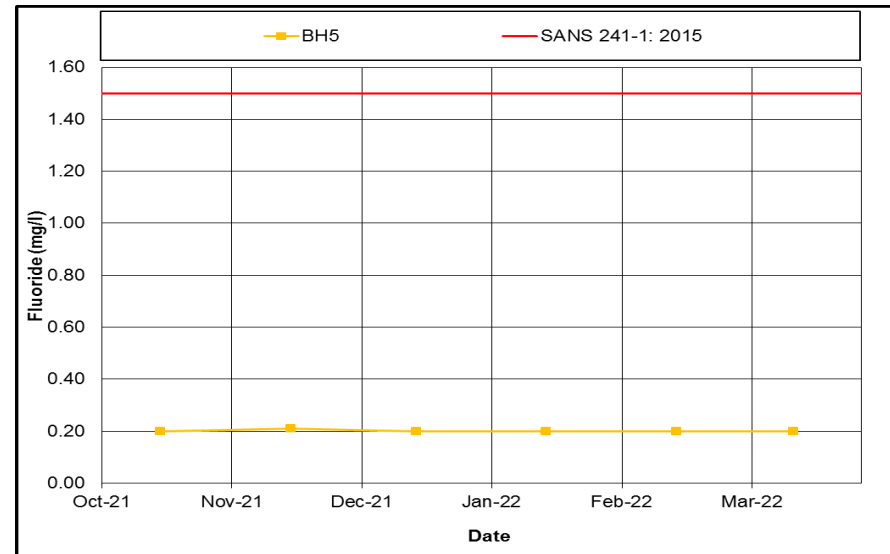
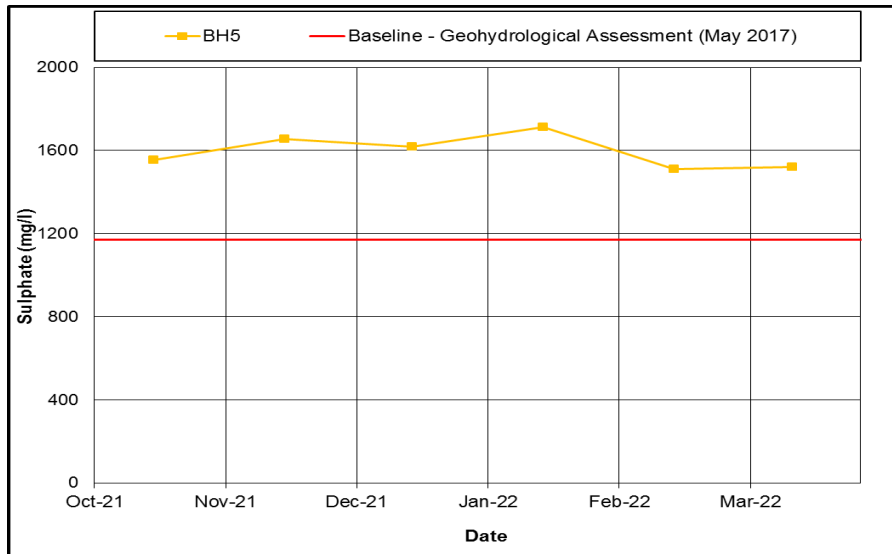


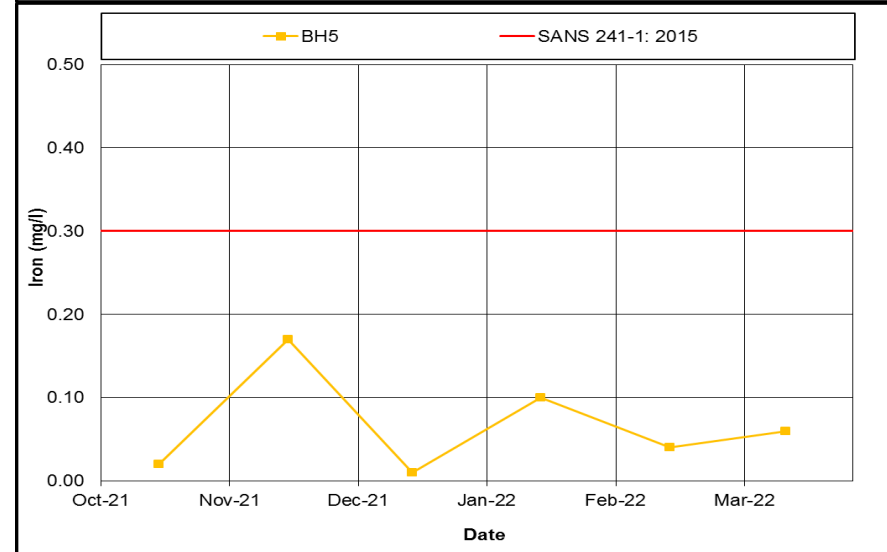
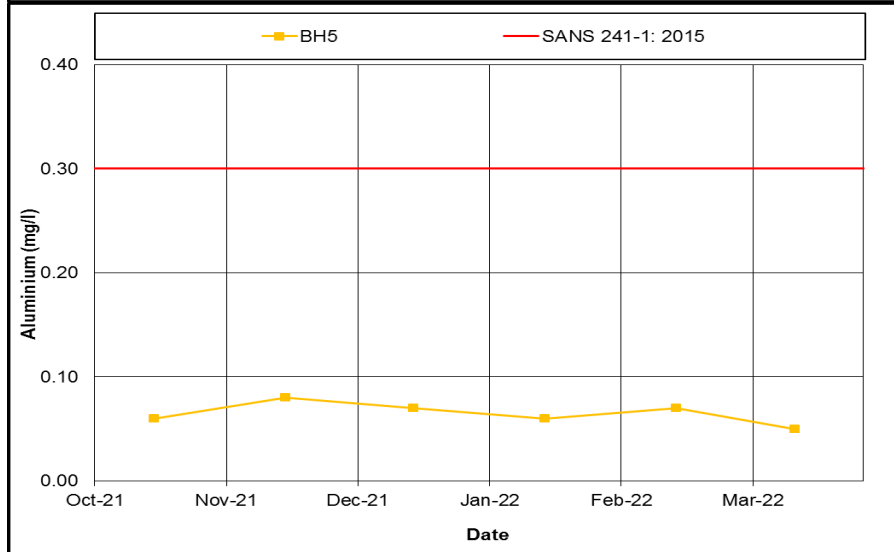
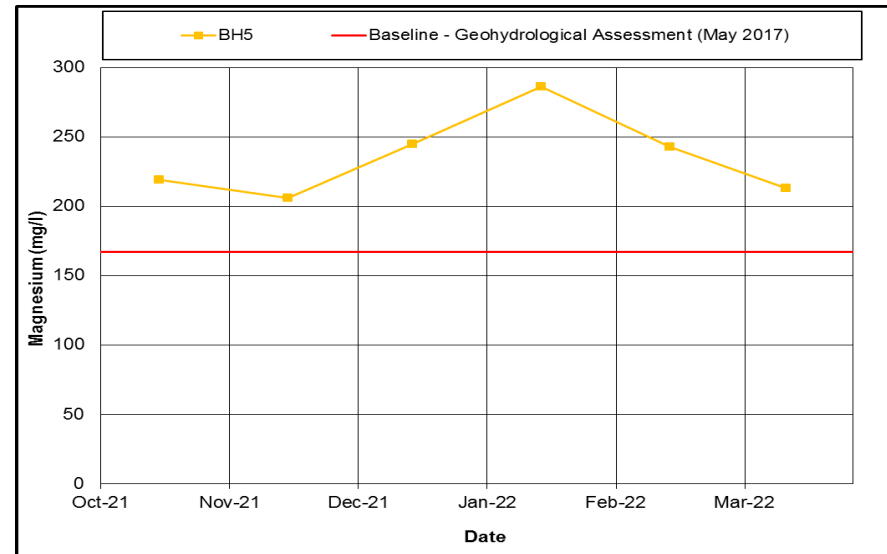
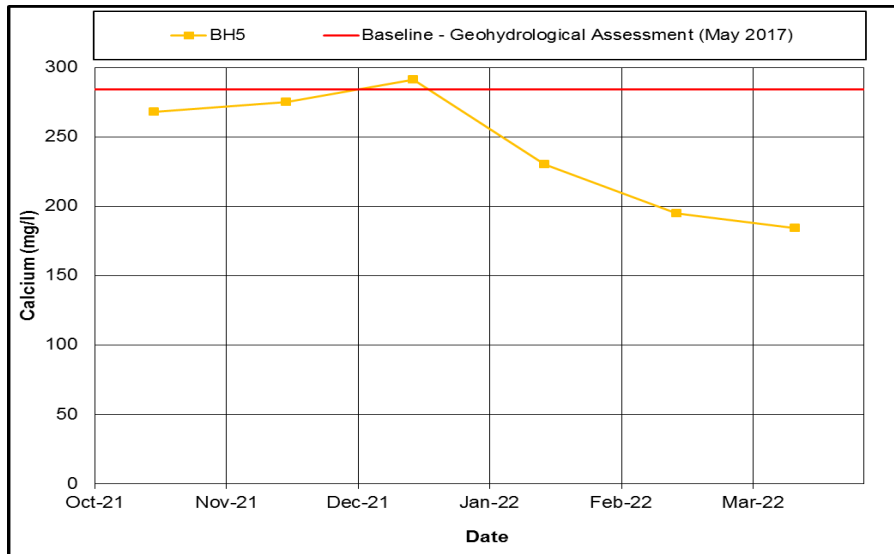
Table 29: BH5 Analysis Results

Sample Date	Parameters														
	pH	EC (mS/m)	TDS (mg/l)	Alk (mg/l)	N (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	F (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
Non-Compliance	<5 >9,7	>297	>1 200	>357	>75,5	>300	>1 172	>1,5	>200	>50	>282	>30	>0,3	>0,3	>0,352
Average	6.42	317.00	3 131.33	47.67	49.60	104.00	1 581.67	0.20	258.00	15.27	203.00	247.33	0.06	0.07	0.30
Jan-22	6.32	341.00	3 534.00	51.00	51.90	106.00	1 714.00	0.20	301.00	17.40	230.00	286.00	0.06	0.10	0.29
Feb-22	6.40	304.00	2 928.00	47.00	47.10	105.00	1 511.00	0.20	243.00	14.30	195.00	243.00	0.07	0.04	0.34
Mar-22	6.55	306.00	2 932.00	45.00	49.80	101.00	1 520.00	0.20	230.00	14.10	184.00	213.00	0.05	0.06	0.28









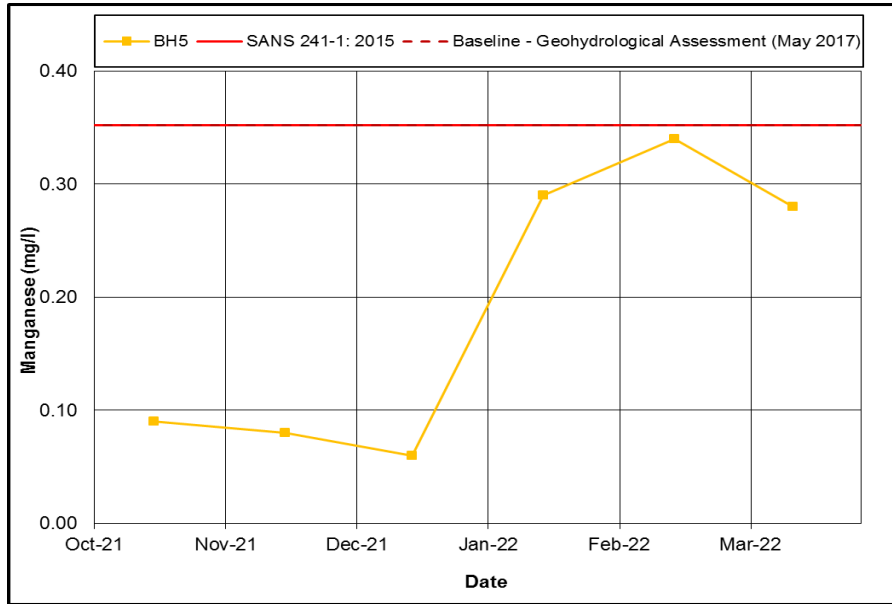


Figure 23: BH5 Compliance Graphs



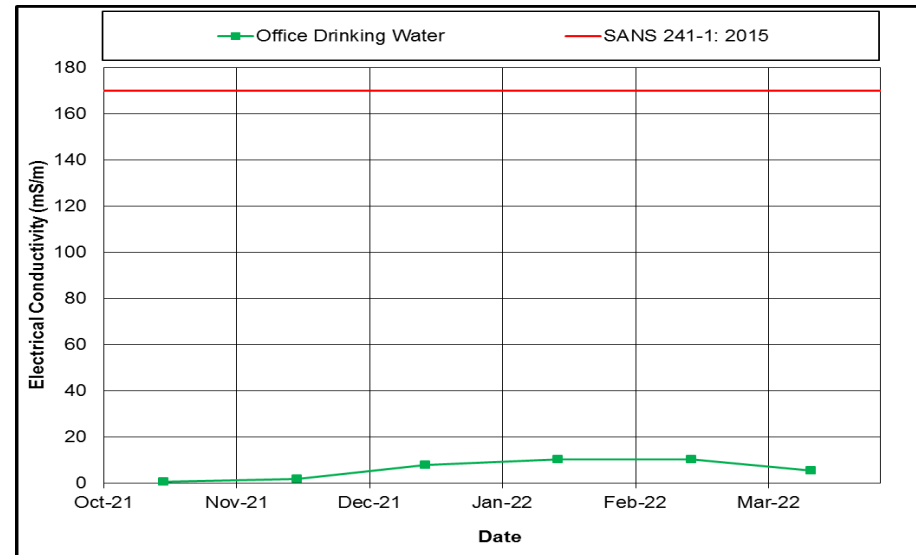
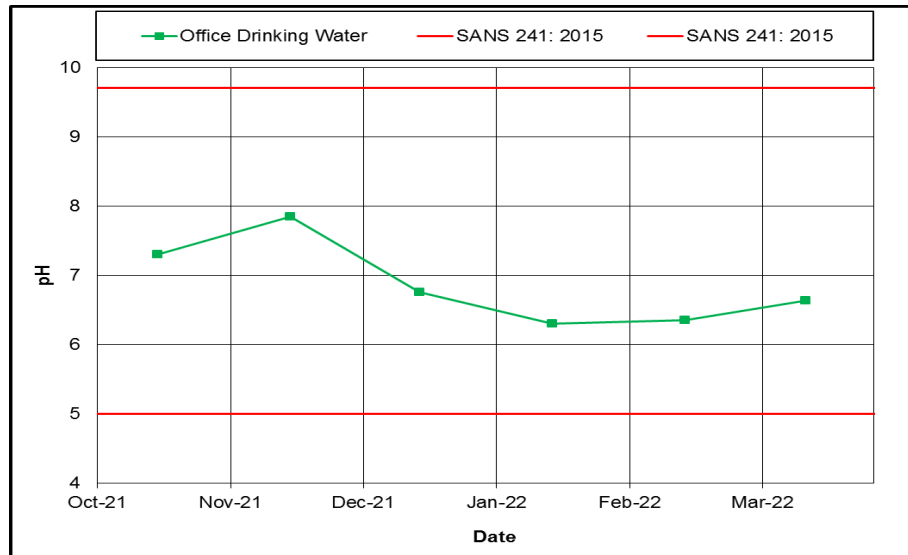
5.2.4. Office Drinking Water

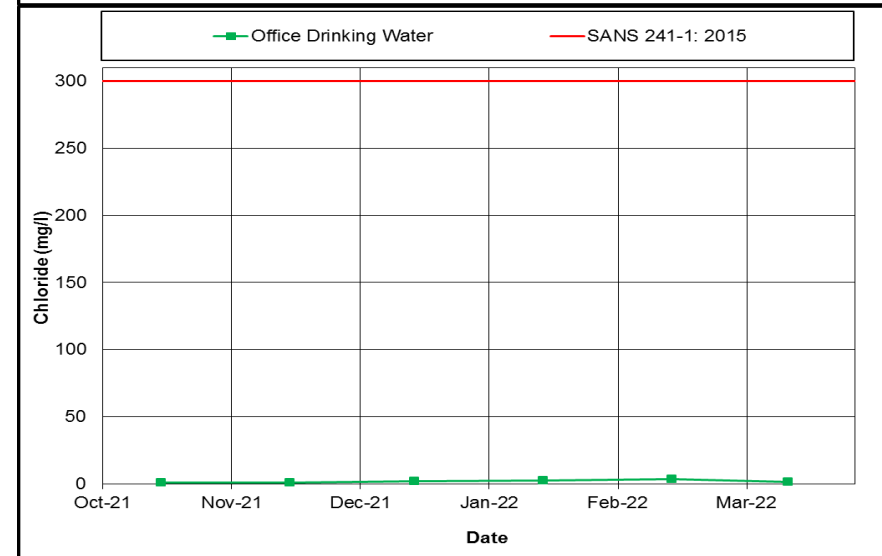
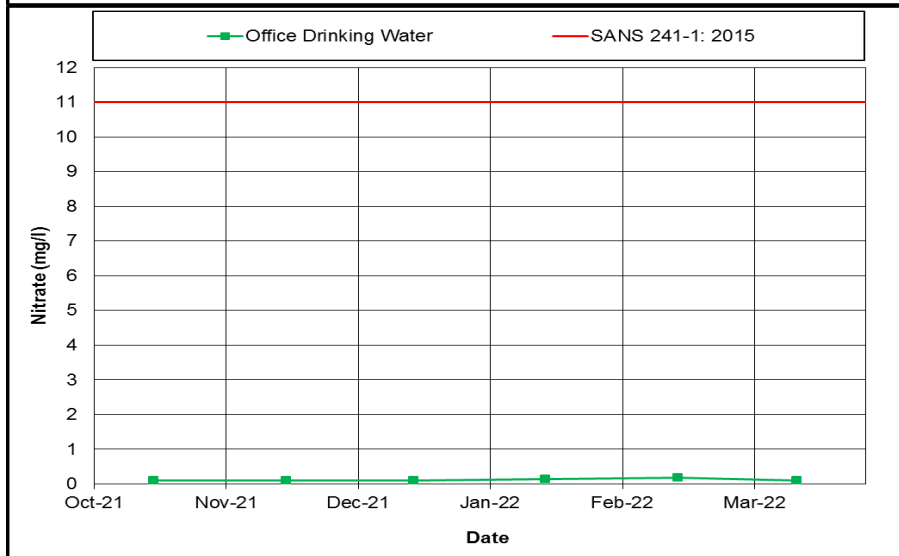
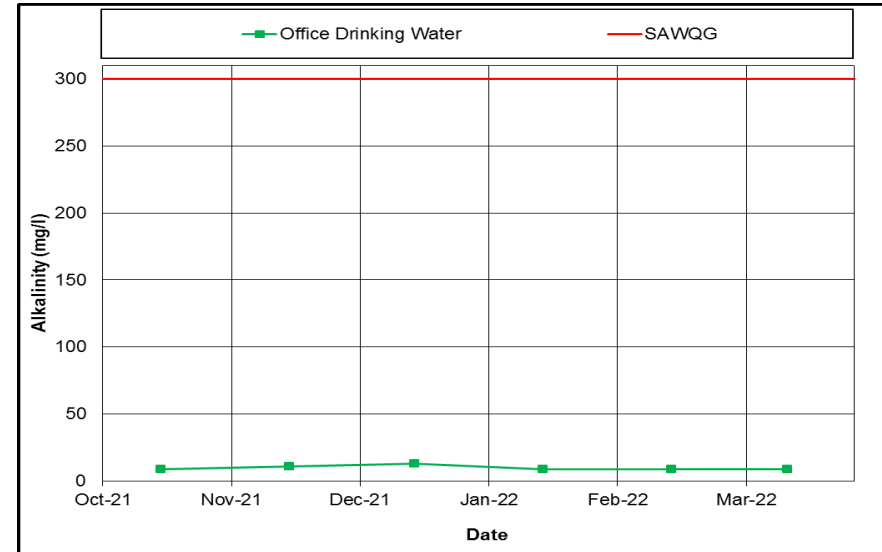
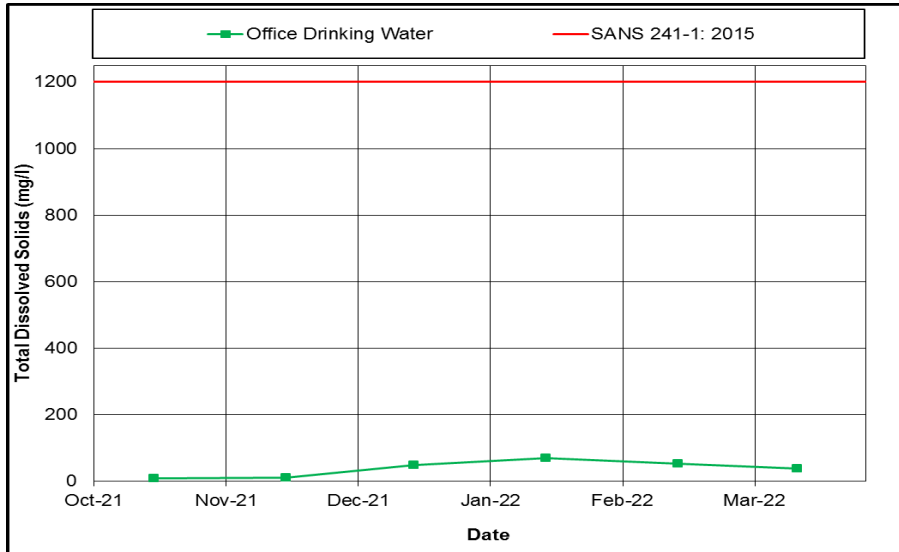
The data for ODW is presented in **Table 30** below. As mentioned in **Section 3**, the parameters for this monitoring point are measured against the standards set by SANS 241: 2015, except for elements; Alkalinity, Potassium, Calcium and Magnesium which are measured against SAWQG. From the table, it is evident that all of the parameters were recorded as compliant for the duration of this monitoring period. The compliance graphs represented in **Figure 24**, show that the parameters remained relatively constant throughout the monitoring period.

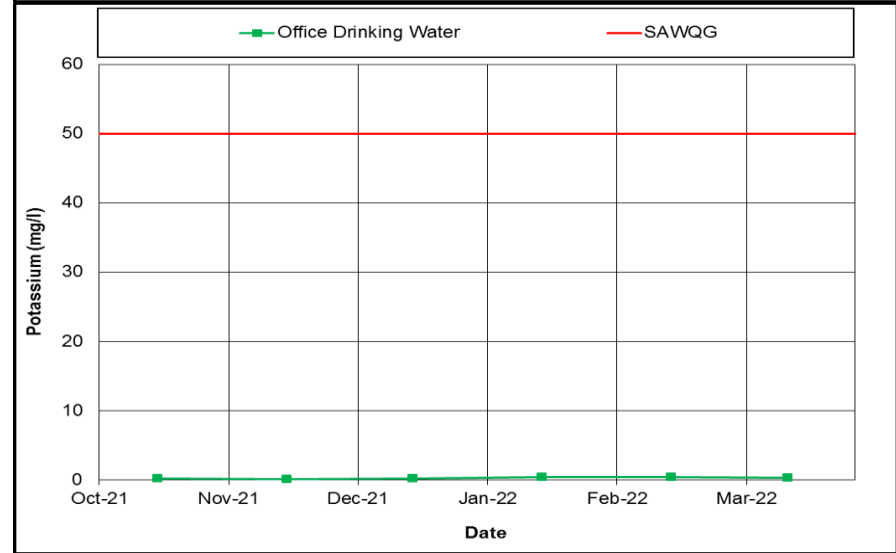
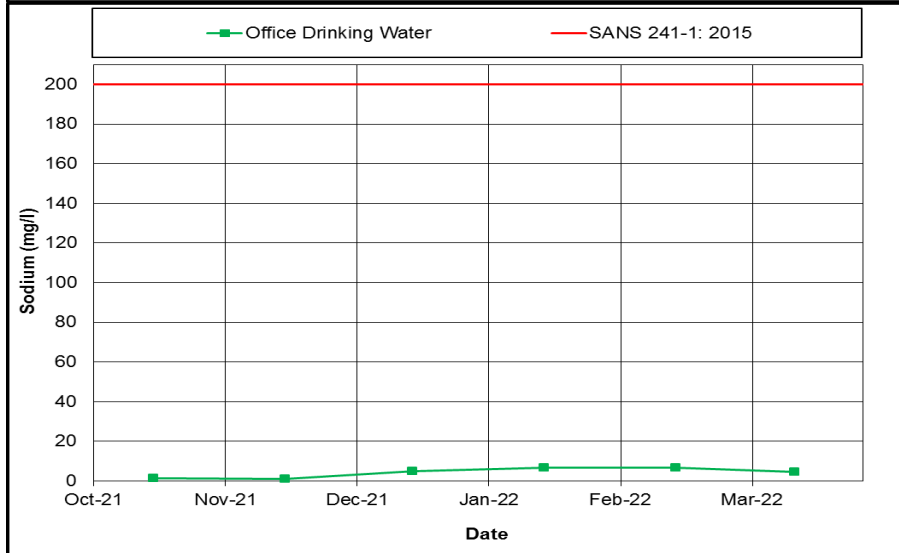
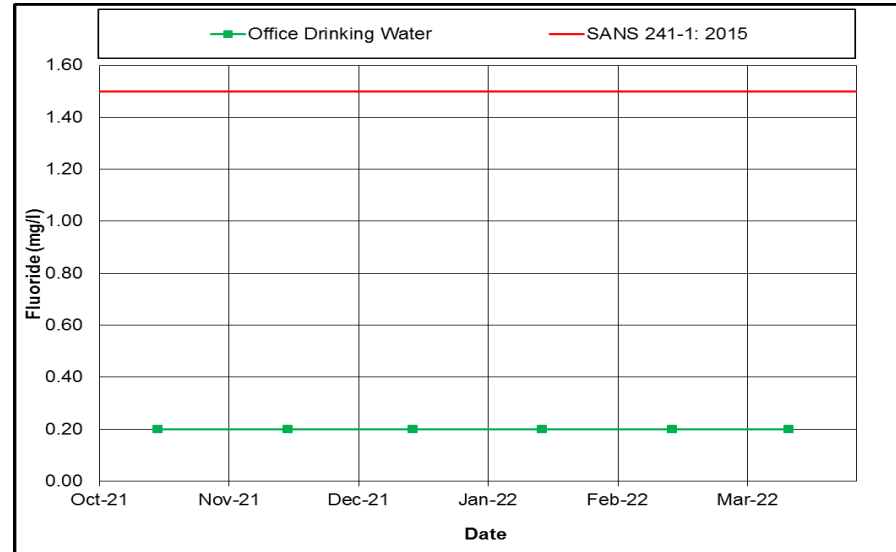
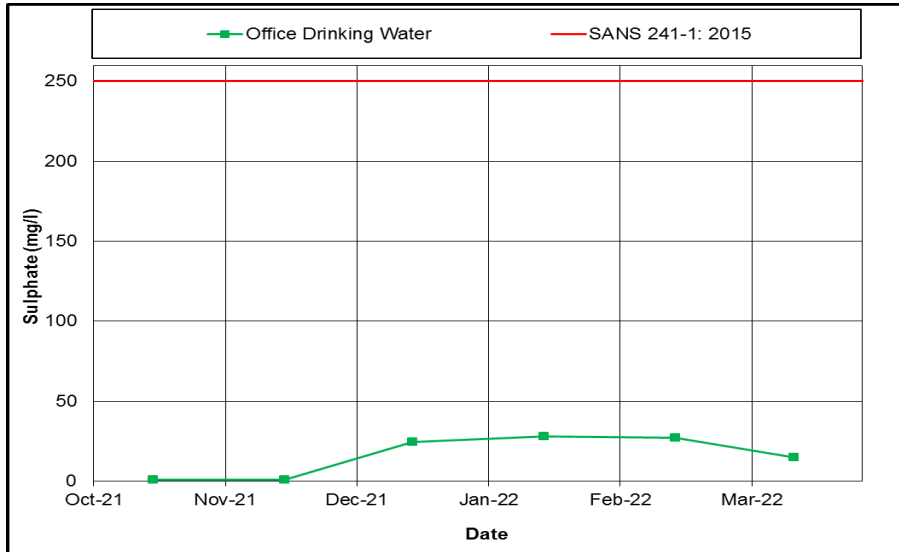


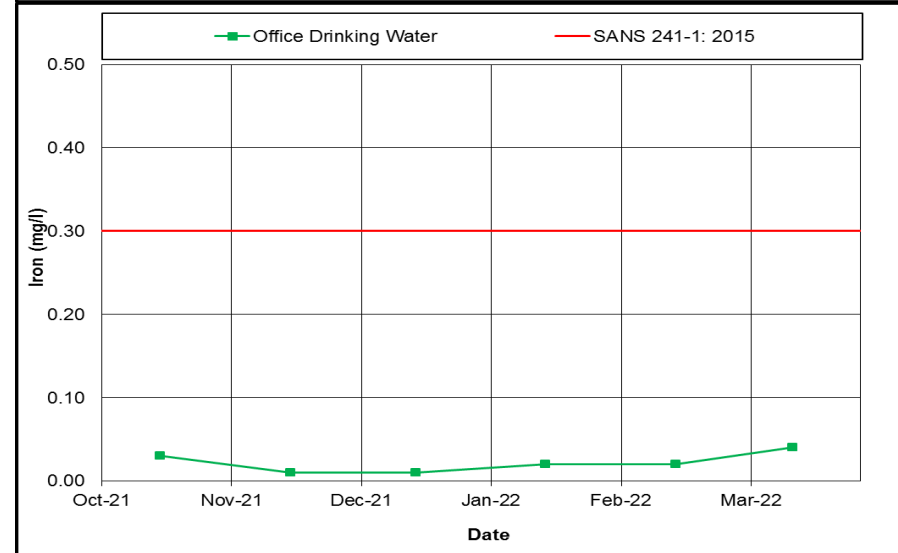
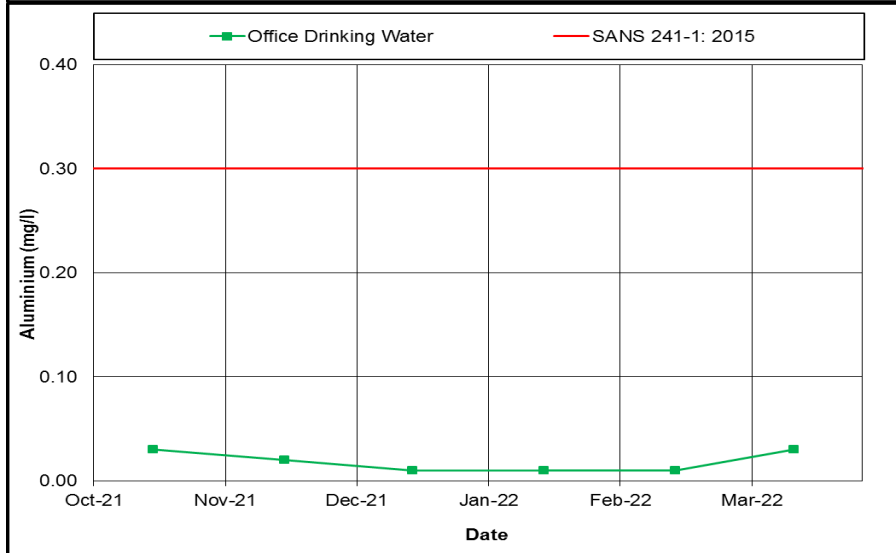
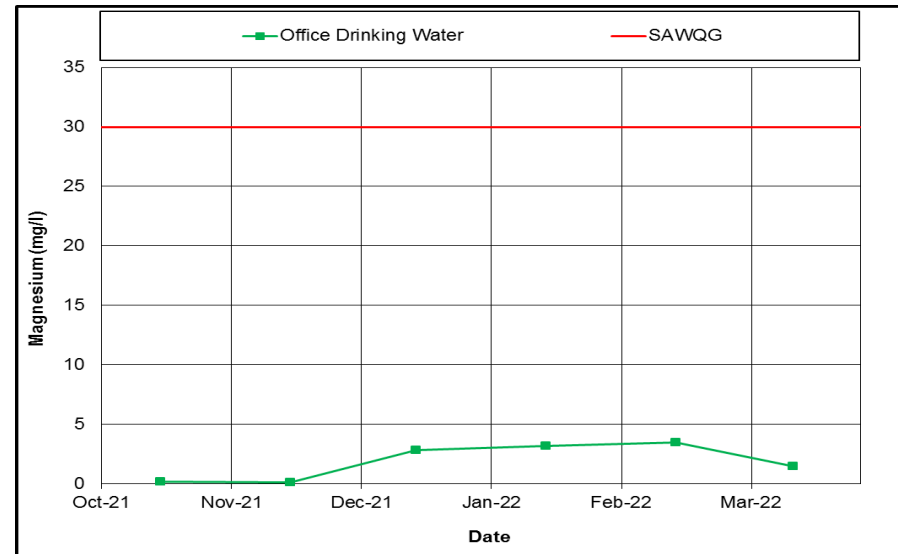
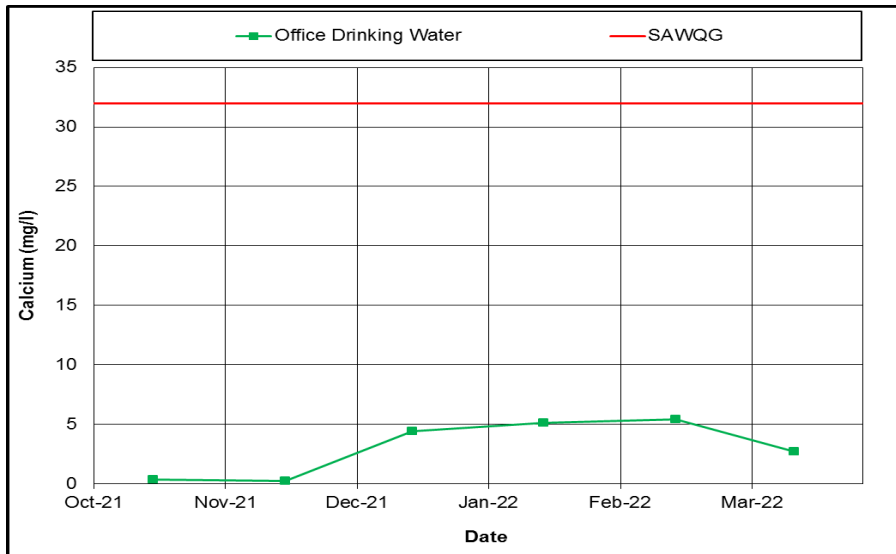
Table 30: Office Water Analysis Results

Sample Date	Parameters														
	pH	EC (mS/m)	TDS (mg/l)	Alk (mg/l)	N (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	F (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
Non-Compliance	<5 >9,7	>170	>1 200	>300	>11	>300	>250	>1,5	>200	>50	>32	>30	>0,3	>0,3	>0,1
Average	6.43	8.77	53.67	9.00	0.14	2.65	23.30	0.20	6.02	0.35	4.42	2.72	0.02	0.03	0.01
Jan-22	6.30	10.50	70.00	9.00	0.15	2.75	27.90	0.20	6.74	0.40	5.13	3.20	0.01	0.02	0.02
Feb-22	6.35	10.30	53.00	9.00	0.18	3.42	27.20	0.20	6.89	0.37	5.39	3.50	0.01	0.02	0.01
Mar-22	6.63	5.50	38.00	9.00	0.10	1.79	14.80	0.20	4.43	0.27	2.73	1.47	0.03	0.04	0.01









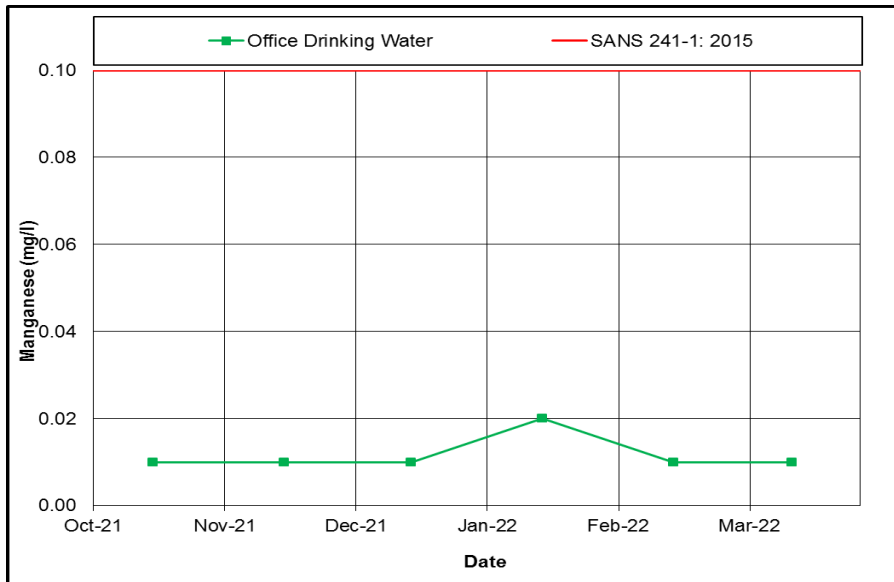


Figure 24: ODW Compliance Graphs



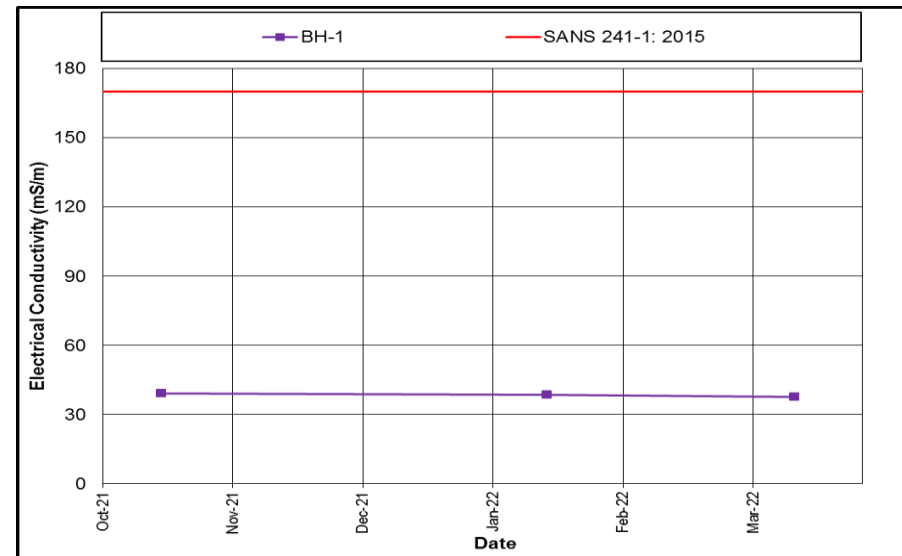
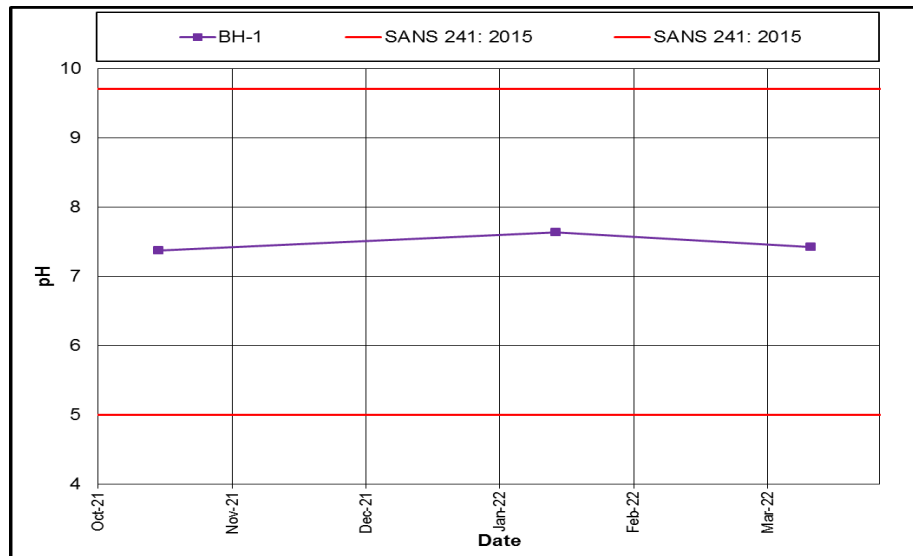
5.2.5. BH-1 (Quarterly)

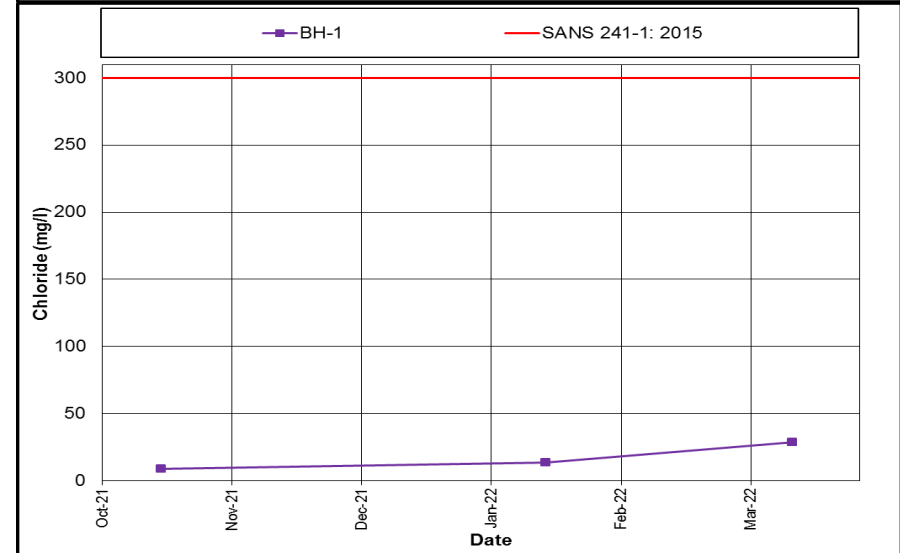
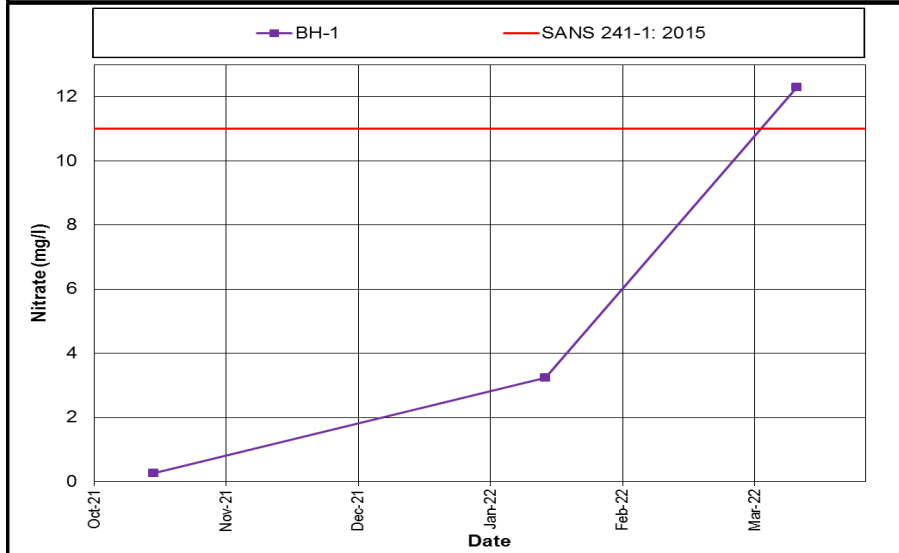
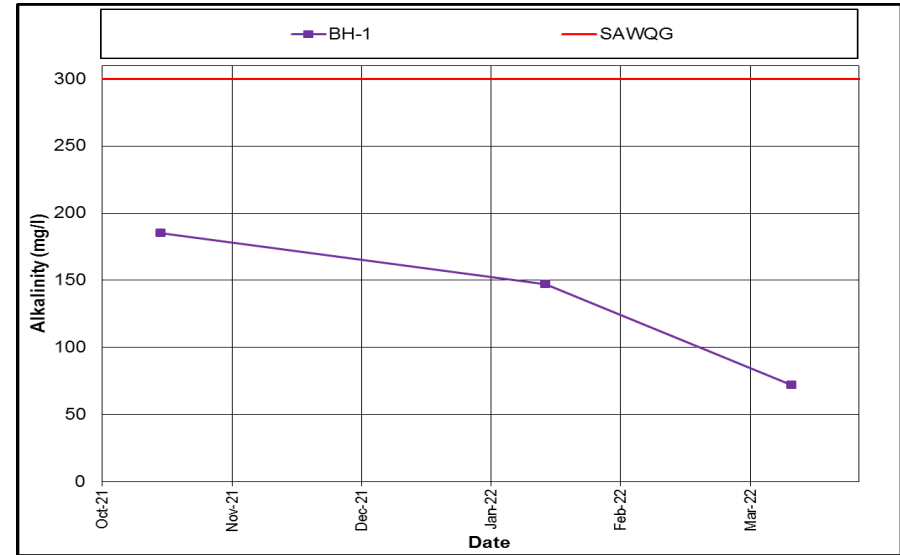
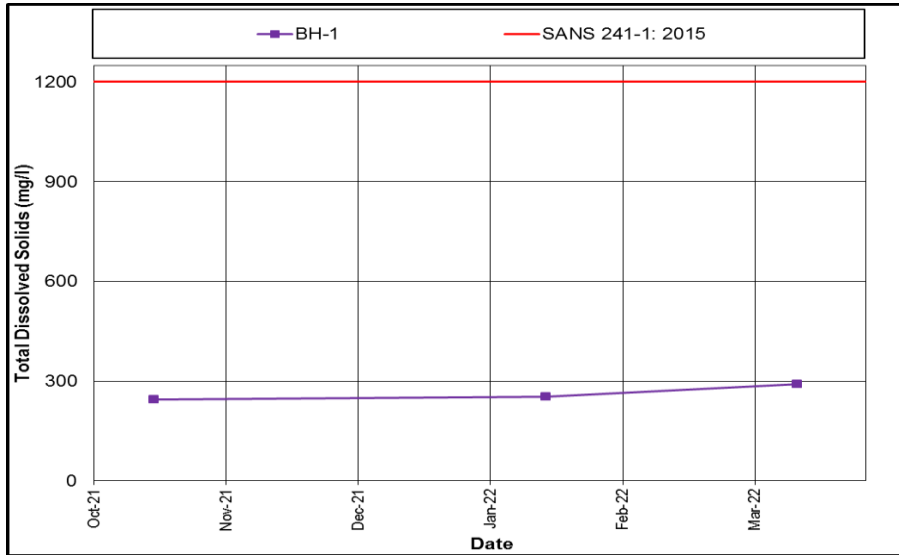
Table 31 below represents the data for BH-1. Refer to **Figure 25** for the compliance maps.

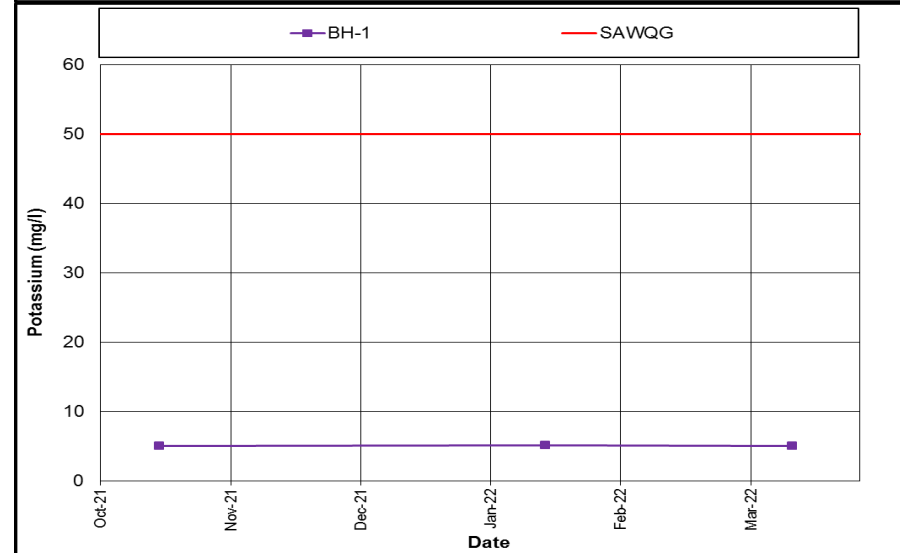
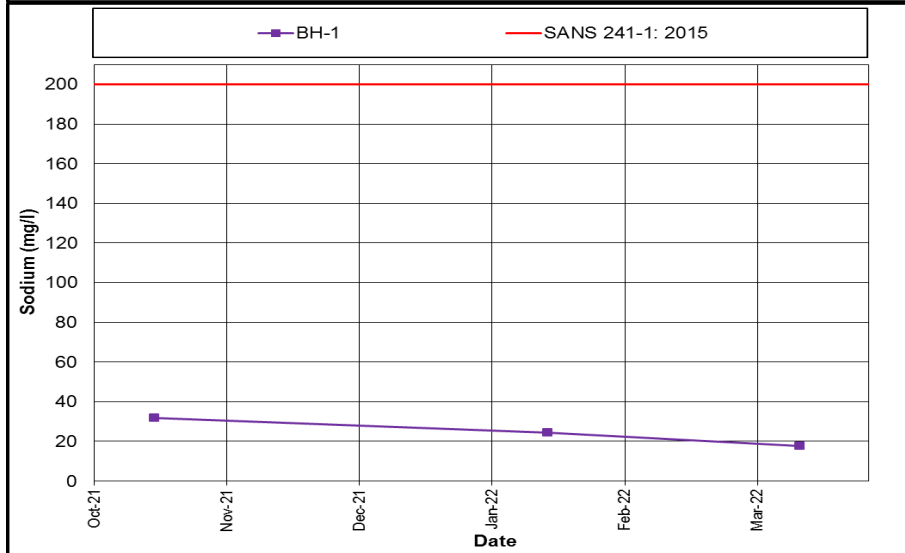
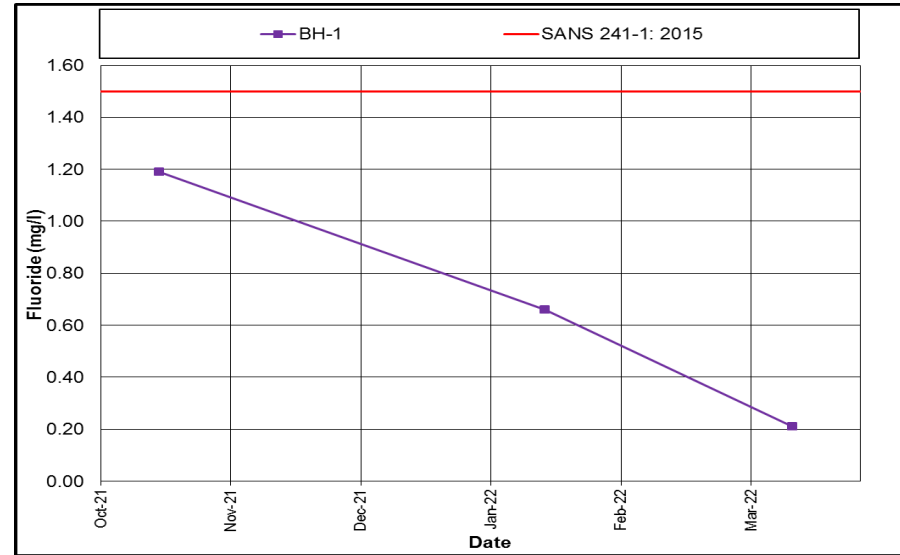
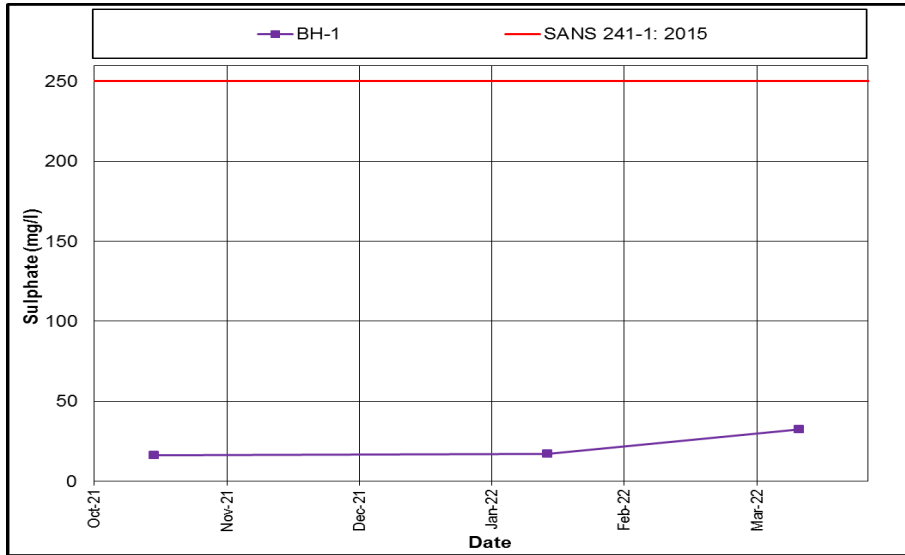


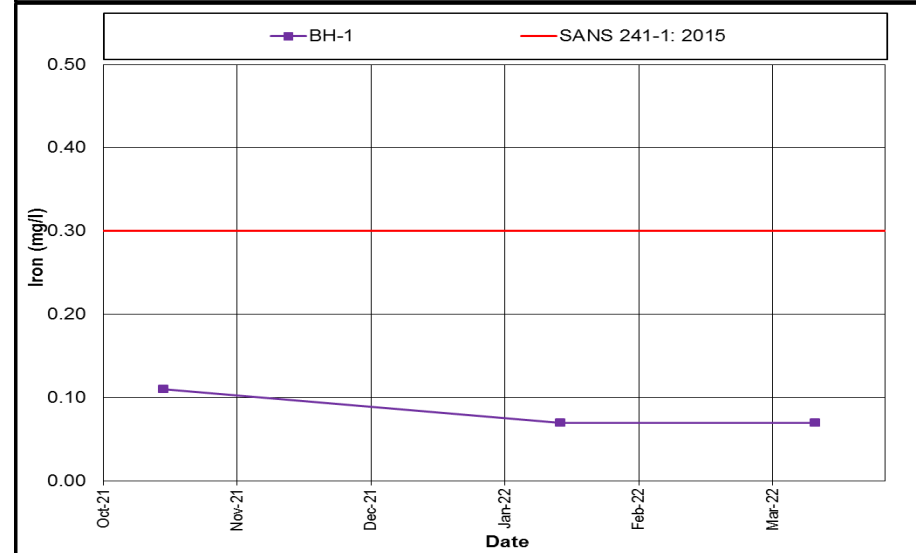
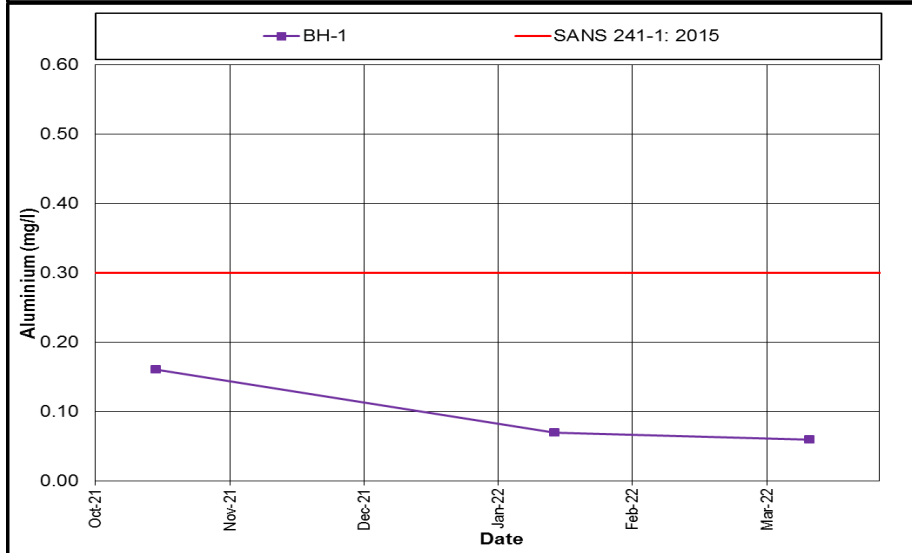
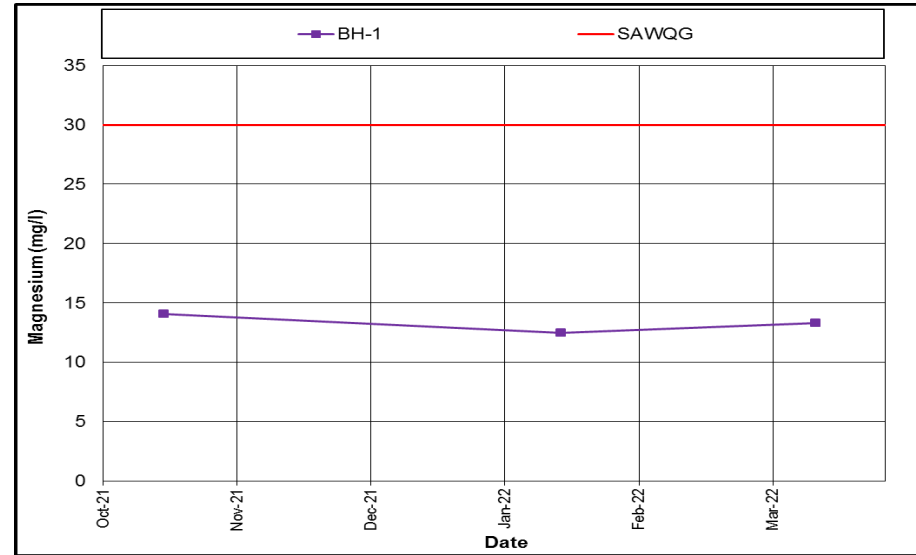
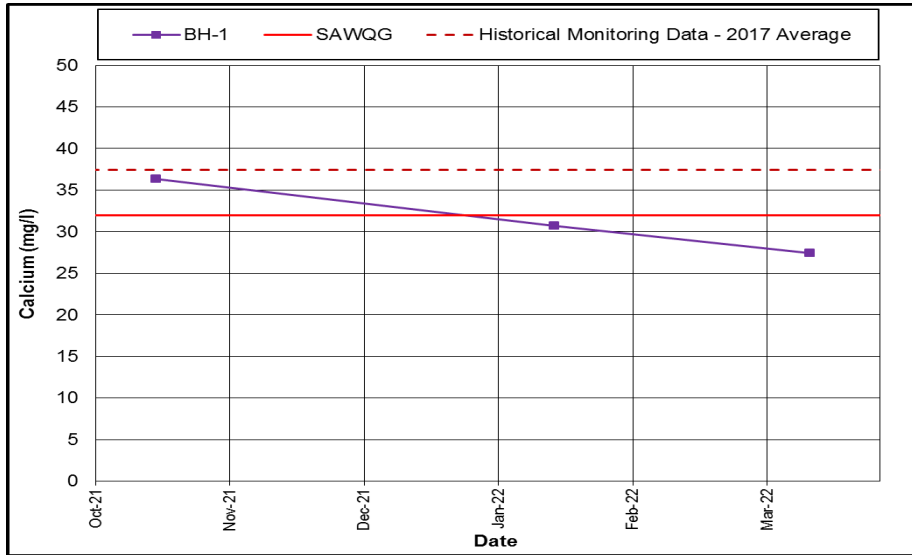
Table 31: BH-1 Analysis Results

Sample Date	Parameters														
	pH	EC (mS/m)	TDS (mg/l)	Alk (mg/l)	N (mg/l)	Cl (mg/l)	SO ₄ (mg/l)	F (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Al (mg/l)	Fe (mg/l)	Mn (mg/l)
Non-Compliance	<5	>170	>1 200	>300	>11	>300	>250	>1,5	>200	>50	>32	>30	>0,3	>0,3	>0,1
	>9,7														
Average	7.53	38.15	271.00	109.50	7.77	21.30	24.65	0.44	20.90	5.07	29.05	12.90	0.07	0.07	0.01
Jan-22	7.63	38.70	252.00	147.00	3.24	13.70	17.10	0.66	24.30	5.12	30.70	12.50	0.07	0.07	0.01
Feb-22	No Sampling Required														
Mar-22	7.42	37.60	290.00	72.00	12.30	28.90	32.20	0.21	17.50	5.02	27.40	13.30	0.06	0.07	0.01









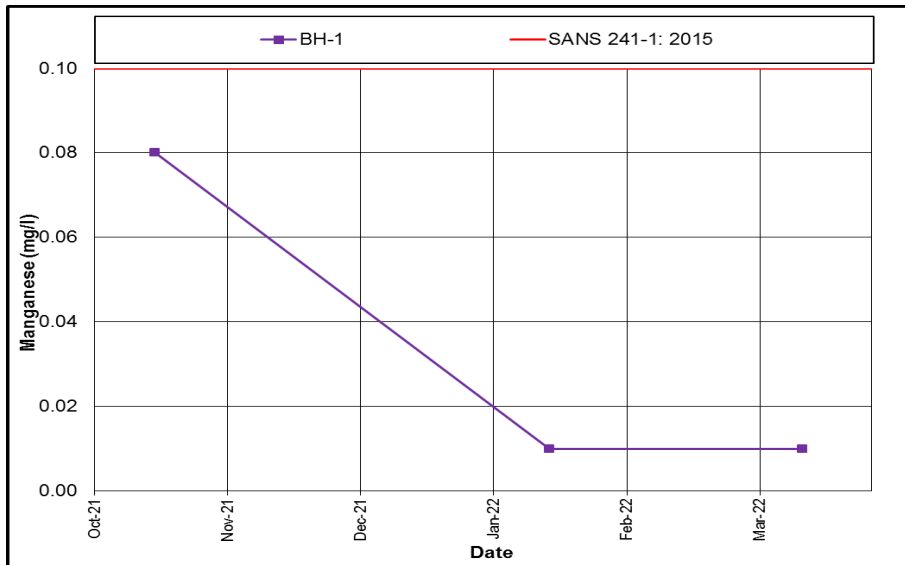


Figure 25: BH-1 Compliance Graphs



5.2.6. Average Groundwater Sulphate and pH compliance

The data summarized in **Table 32** depicts the average SO₄ values for January to March 2022. BH5 was the only point that was marked as non-compliant when compared against the baseline qualities determined in the Hydrogeological Assessment (GCS, 2017). For significance of this report, compliance was measured against the SANS, and BH5 is still marked as non-compliant. Refer to **Figure 26** for the compliance map.

Table 32: Groundwater chemical analyses: Average SO₄

Site name	SO ₄ concentrations		
	Average Previous Reporting Period	Baseline	Average Current Reporting Period
BH1	13.17	11.4	1.83
BH4	5.20	1.79	4.22
BH5	1 520.33	1 172	1 581.67
BH-1 (Quarterly)	2.27	14	24.65
ODW	15.37	N/A	23.30

The average pH concentration levels for the monthly and quarterly groundwater monitoring points are represented in **Table 33** below. Since the baseline data does not provide a range, the compliance was also measured against SANS 241-1: 2015. Please refer to **Figure 27** for a visual representation of the pH compliance.

Table 33: Groundwater chemical analyses: Average pH

Site name	Average pH			
	Average Previous Reporting Period SANS	Average Previous Reporting Period Baseline	Average Current Reporting Period SANS	Average Current Reporting Period Baseline
BH1	7.81	N/A	7.72	N/A
BH4	6.78	N/A	7.05	N/A
BH5	6.89	6.89	6.42	6.42
BH-1 (Quarterly)	7.33	N/A	7.53	N/A
ODW	8.03	N/A	6.43	N/A



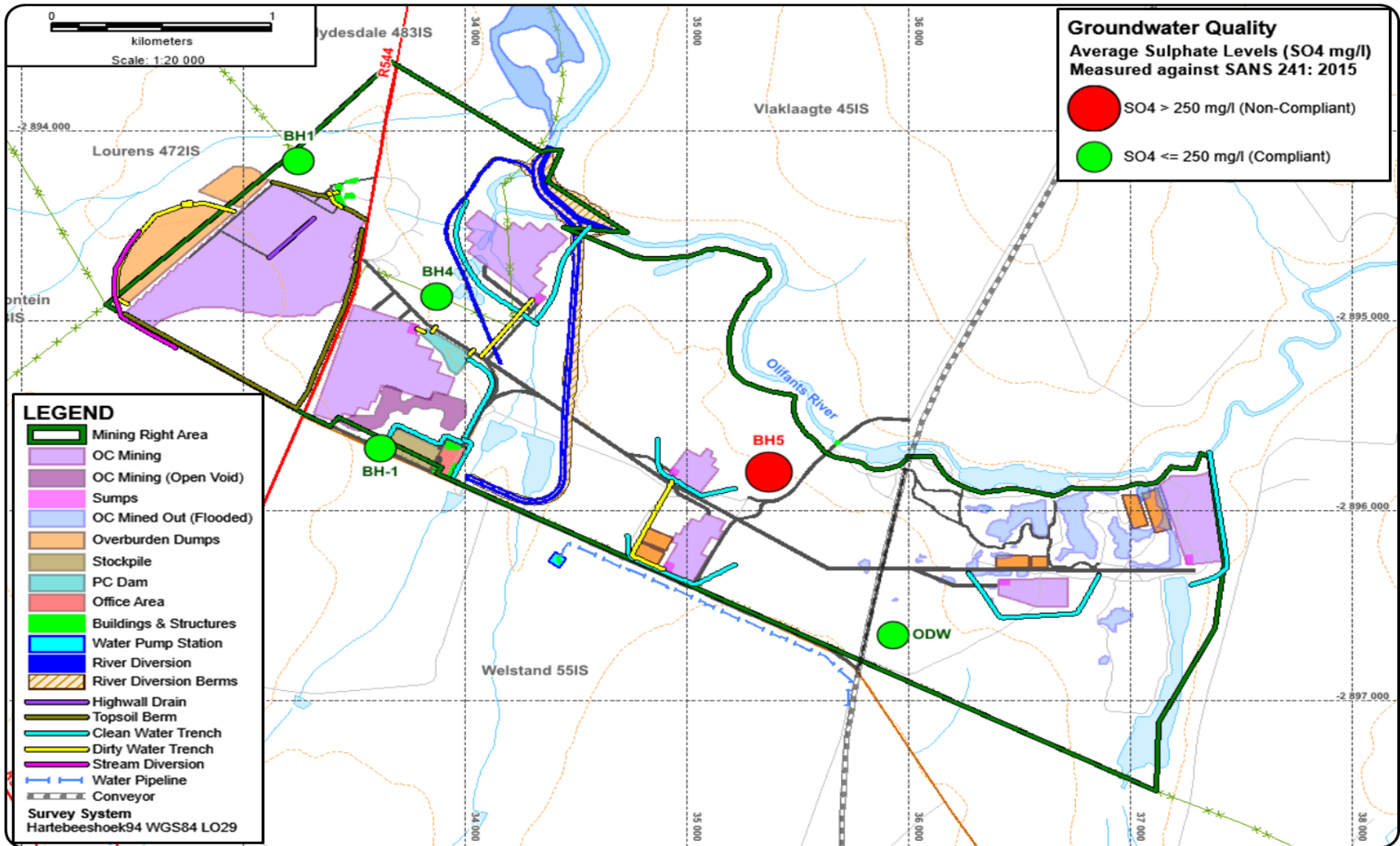


Figure 26: Groundwater SO₄ Compliance Map



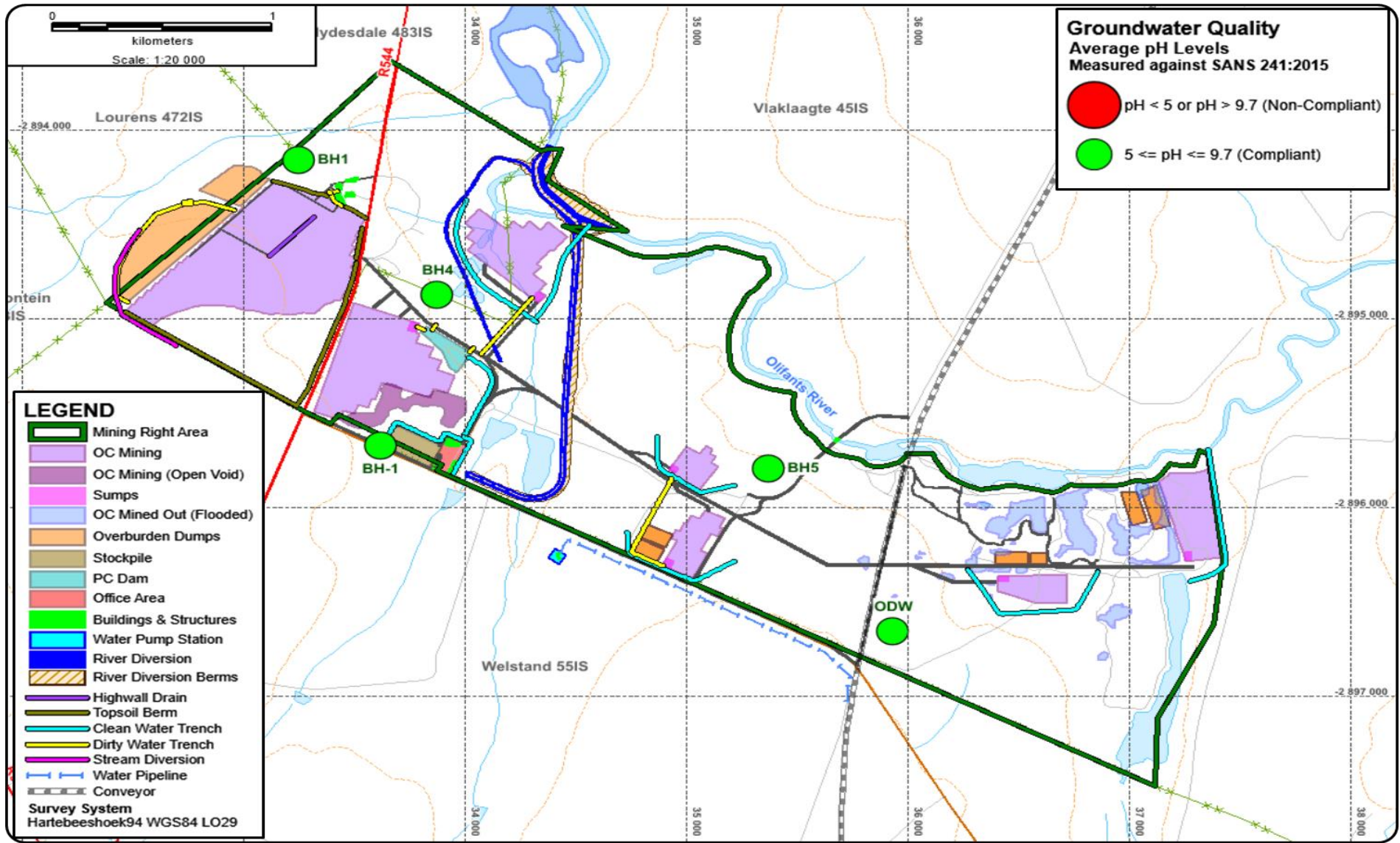


Figure 27: Groundwater pH Compliance Map



5.2.7. Piper, Wilcox and Schoeller Diagrams for Groundwater

Refer to **Figure 28** to **Figure 31** for the Diagrams.



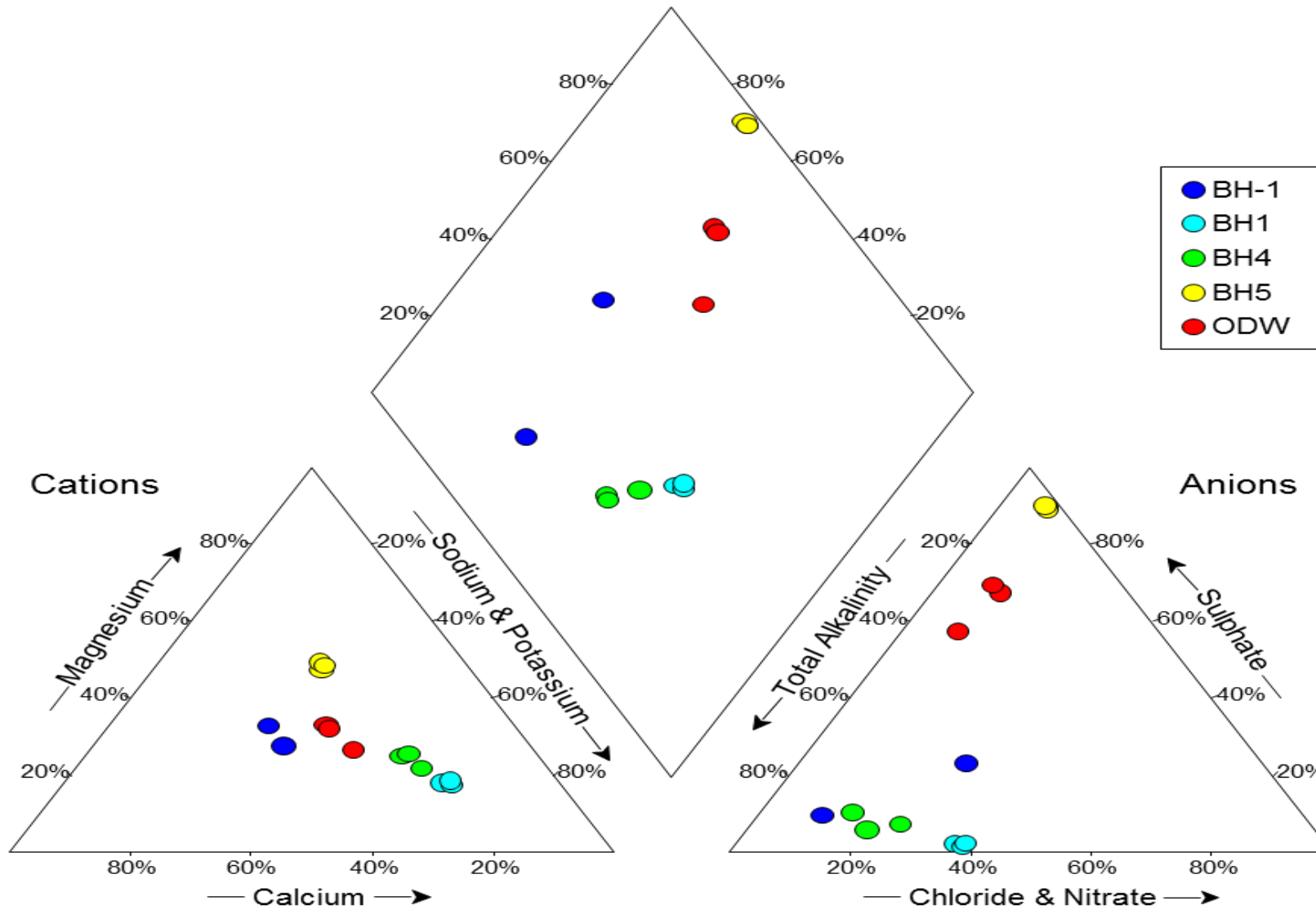


Figure 28: Groundwater Piper Diagram



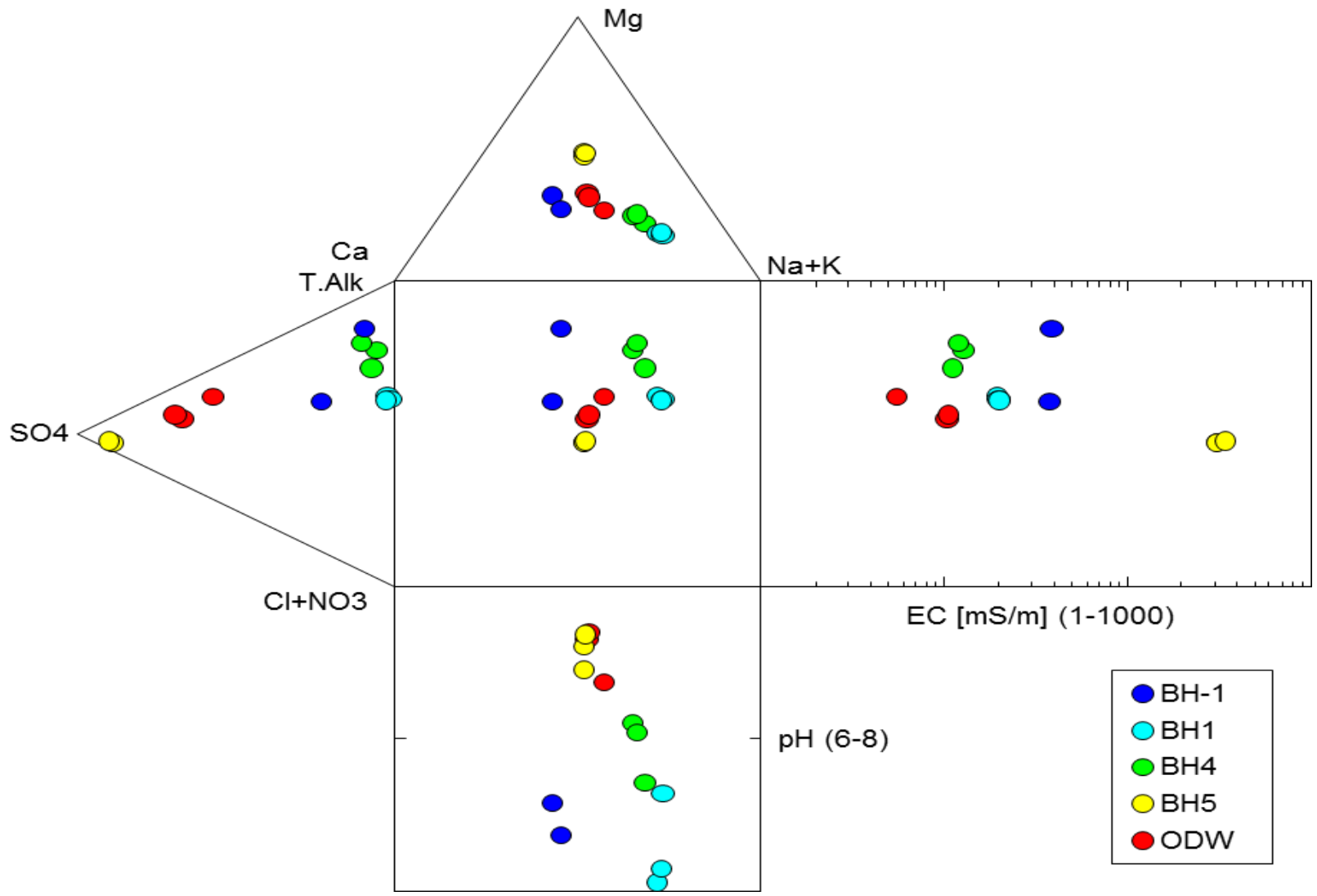


Figure 29: Groundwater Durov Diagram



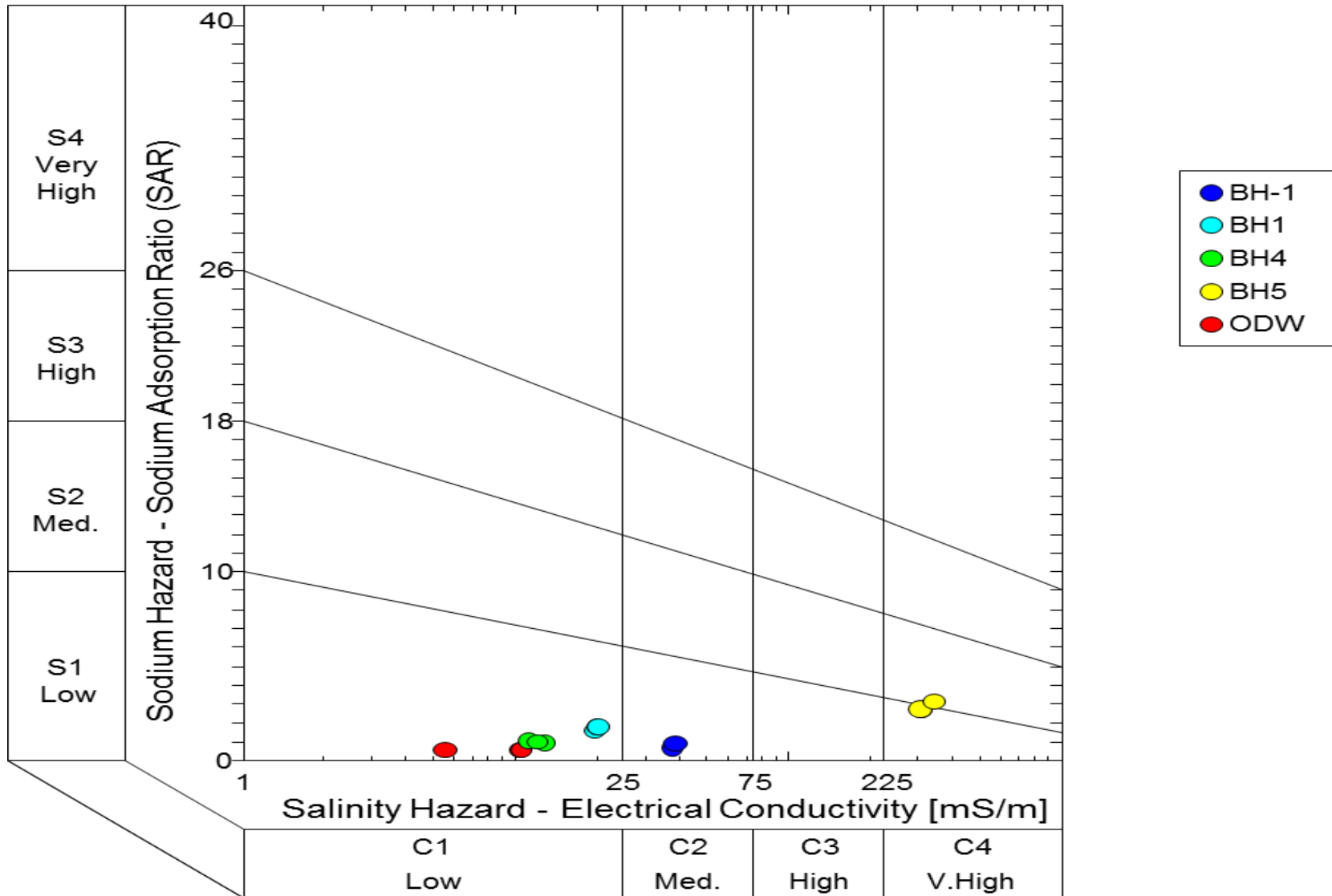


Figure 30: Groundwater S.A.R Diagram



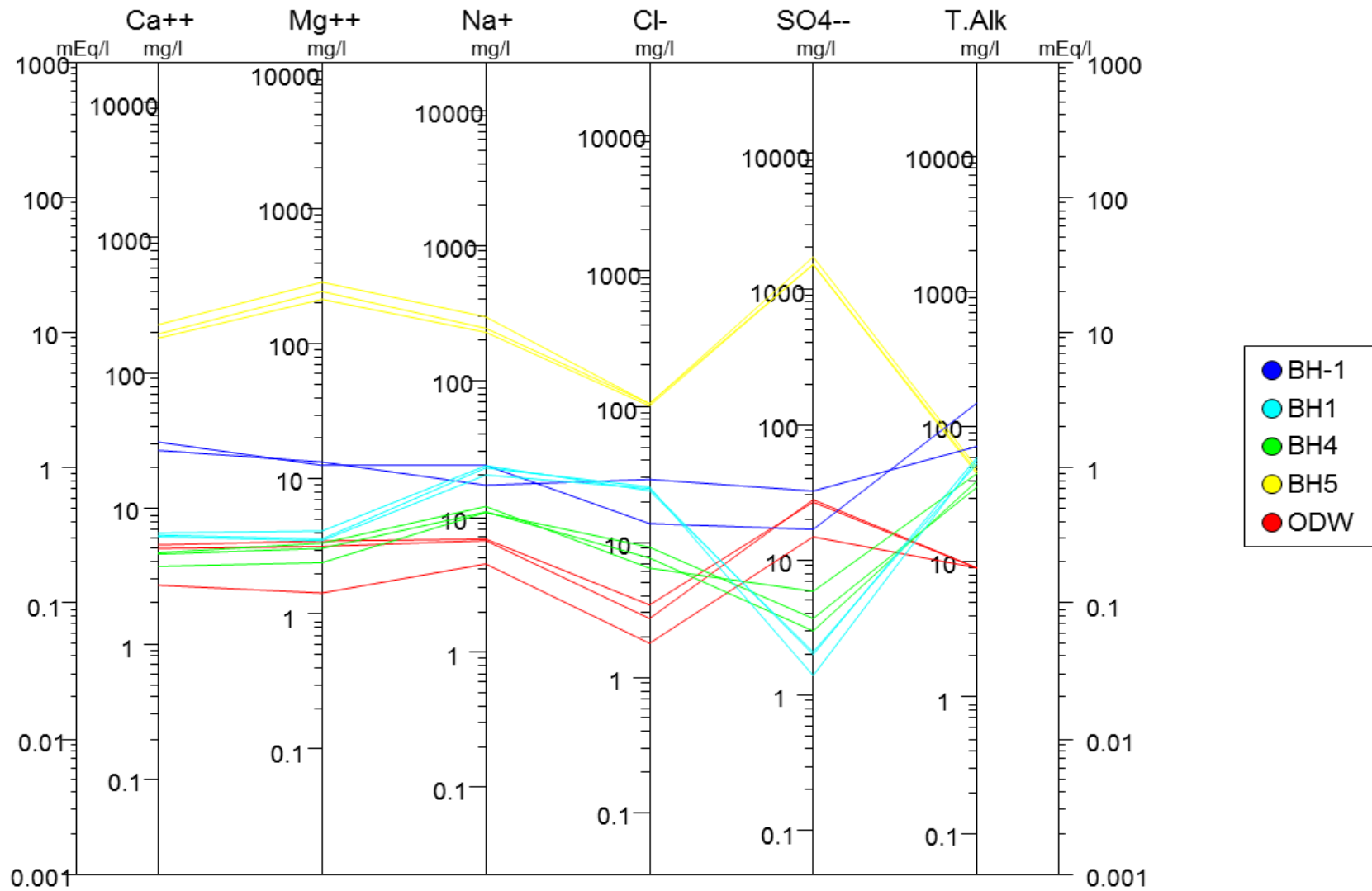


Figure 31: Groundwater Schoeller Diagram



6 WATER LEVEL STATUS

Water level measurements are conducted on a monthly basis on all boreholes except ODW. ODW is fitted with a pump making measurements impossible. The measurements for January to March 2022 are reflected in **Table 34** below as well as visually represented in **Figure 32**. Refer to **Annexure 2** for the results.

The water levels remained relatively stable during the monitoring period. It is important to note that only borehole BH5 is within the historical underground workings.

Table 34: Groundwater water levels (mbgl)

Site Label	January 2022	February 2022	March 2022
BH1	1.03	1.01	1.01
BH4	3.97	3.92	3.92
BH5	9.47	9.64	9.64
BH-1(Q)	21.75	21.82	21.82



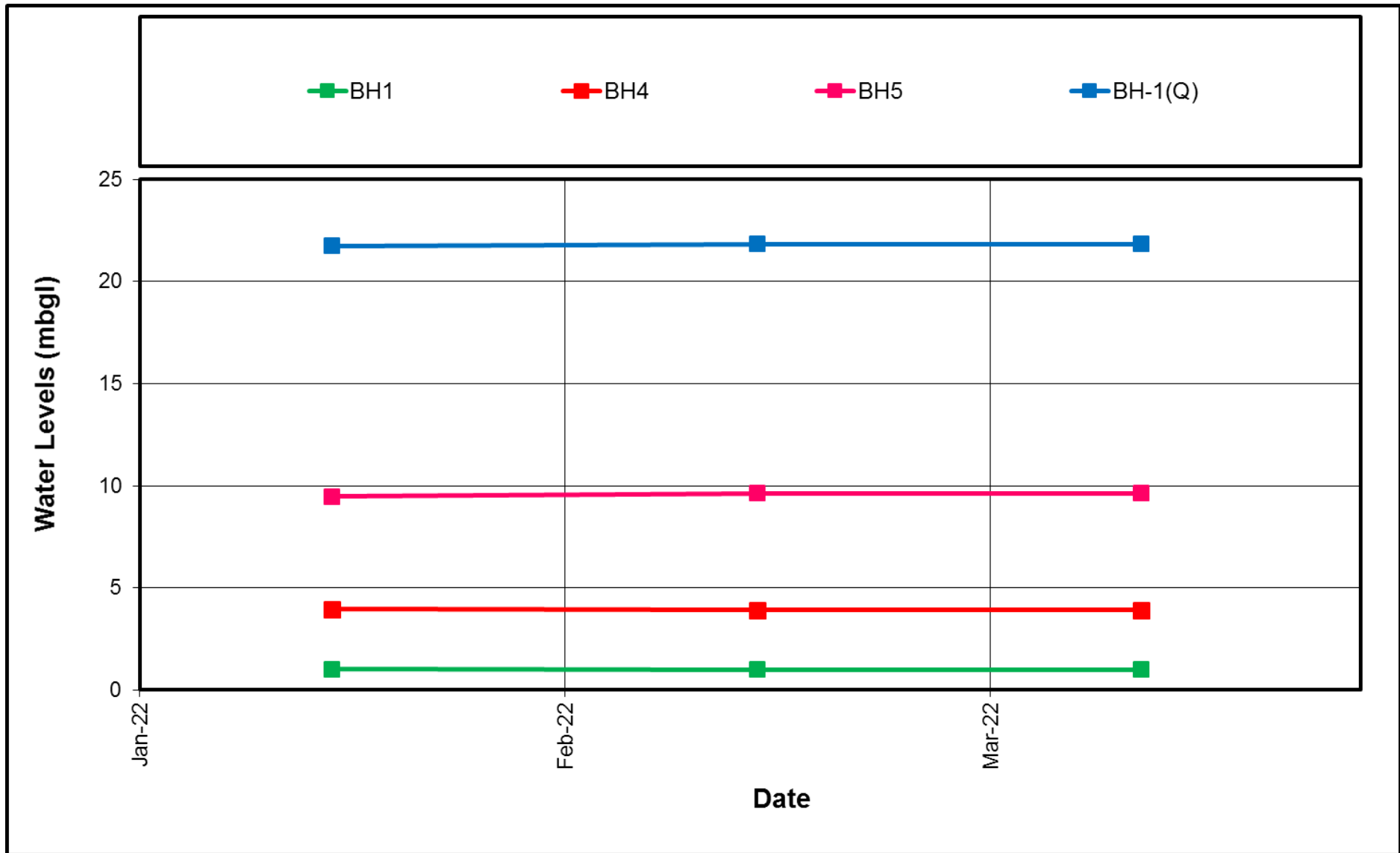


Figure 32: Groundwater Levels Graph



7 BACTERIOLOGICAL

A bacteriological analysis was conducted on the ODW monitoring point for the months of January, February and March 2022. **Table 35** below represents the results of the analysis, which concluded that the sampled point complied with the SANS 241:2015 microbiological drinking water standard for the tested parameters. Refer to **Annexure 4** for the full laboratory analysis.

A simple colour coding system has been used in **Table 35** below: Green = Compliant and Red = Non-compliant.

Table 35: Office Drinking Water Bacteriological Compliance

SANS 241:2015 Microbiological Drinking Water Standard		January 2022	February 2022	March 2022
Total Coliform Bacteria per 100 ml	≤ 10	Nil	Nil	Nil
Faecal Coliform per 100 ml	Nil	Nil	Nil	Nil
Escherichia Coliform per 100 ml	Nil	-	-	-
Heterotrophic Plate Count per 1 ml	≤ 1000	150	9	105



8 RECOMMENDATIONS

Table 36 below lists the non-compliant parameters found within each surface water monitoring point throughout the monitoring period of January 2022 to March 2022. It can be seen from this table that majority of the SW points have elevated levels of Calcium, Aluminium, Magnesium, Iron and Manganese.

The column representing *% Compliance* indicates the percentage of the total tested parameters which the monitoring points complied with during this monitoring period.

An improvement in water quality was observed for this monitoring period as compared to the previous period, it is recommended that the source of pollution at the non-compliant monitoring points be determined and measures be taken to improve the quality of water. Refer to **Table 36** for possible reasons as to why the parameters are non-compliant as well as recommendations for what can be done to improve the quality of the water in order for compliance to be achieved.

Table 37 lists the non-compliant parameters found within each groundwater monitoring point.

According to the *% Compliance* column all the monitoring points complied with more than 60%.

Refer to **Table 37** for possible reasons as to why the parameters might be non-compliant.



Table 36: Possible reasons and recommendations for exceedances occurring in the surface water monitoring points

Monitoring Point	Parameters Exceeded (Average)	% Compliance (Current Report)	% Compliance (Previous Report)	Possible Reasons for Exceedances and Recommendations
2S_SW1	Aluminium Iron	86.7%	33.3%	All three of these points are located within the Olifants River. The water quality did improve at all three points, but 2S_SW1 recorded a spike in Sulphate for March 2022. Mining could be a potential pollutant as well as decant from the historical underground mining. The cause of pollution should be investigated.
2S_SW2	Aluminium Iron	86.7%	73.3%	
2S_SW3	Aluminium Iron Manganese	80.0%	40.0%	
2S_SW4	EC TDS Nitrate Sulphate Calcium Magnesium Aluminium Manganese	46.7%	26.7%	This point has been mined out and has been moved to a suitable alternative location. The exceedances and fluctuations are of concern. Mining could be a potential pollutant as well as decant from the historical underground mining. The cause of pollution should be investigated.
2S_SW7	pH Aluminium Iron Manganese	73.3%	46.7%	<p>This point is located near an old OC Void (VLK-SW7) An upstream user can also impact the quality. Potential contaminant migration from the OC void can also contribute to the deteriorating water qualities. It is important to note that the baseline qualities of all the non-compliances were already high prior to mining. When compared to the baseline qualities, the point is compliant and some improvements are noted for the water quality.</p> <ul style="list-style-type: none"> • Investigations should be lodged to determine whether the void can be rehabilitated and what can be done with the water located within the void. • Ensure that water management structures are maintained and functional on-site.



Monitoring Point	Parameters Exceeded (Average)	% Compliance (Current Report)	% Compliance (Previous Report)	Possible Reasons for Exceedances and Recommendations
2S_SW8	Aluminium Iron	86.7%	46.7%	<p>This point is located near an old OC Void (VLK-SW7). Potential contaminant migration for the OC void or upstream contamination could contribute to the deteriorating water qualities.</p> <ul style="list-style-type: none"> Investigations should be lodged to determine whether the void can be rehabilitated and what can be done with the water located within the void. 2 Seam can identify the upstream water user and inform them of deteriorating surfaced water quality in the stream. Measures to improve water quality must be considered.
2S_SW9	Aluminium	93.3%	Dry	<p>2S_SW9 is located within a trench, northeast in the mining boundary. The baseline for Aluminium and Alkalinity already exceeded the guidelines prior to mining. The dry conditions noted for the point could have contributed to these exceedances and it is recommended that the point is closely monitoring in the upcoming months.</p>
2S_SW14	Aluminium	93.3%	80.0%	<p>2S_SW14 is located within close proximity to various OC voids. The quality is likely affected by seepage and contaminant migration from these voids.</p> <ul style="list-style-type: none"> Investigations should be lodged to determine whether the void can be rehabilitated and what can be done with the water located within the void. Measures to improve water quality must be considered.
2S_SW16	TDS Alkalinity Sulphate Calcium Magnesium Aluminium	60%	33.3%	<p>The monitoring point is located within an opencast void; therefore, poor water qualities can be expected.</p>
2S_SW18	Alkalinity Nitrate Fluoride Calcium	46.7%	40.0%	<p>The PCD is required to comply with the WUL conditions; however, the quality of water disposed into the PCD exceeds the guidelines in the WUL. It should be noted that some of the qualities did improve.</p> <ul style="list-style-type: none"> Maintenance and cleaning of PCD is required on a regular basis. If qualities cannot be achieved as set out in the WUL, a formal amendment must be applied for at DWS



Monitoring Point	Parameters Exceeded (Average)	% Compliance (Current Report)	% Compliance (Previous Report)	Possible Reasons for Exceedances and Recommendations
	Magnesium Aluminium Iron Manganese			with proper motivation.
VLK SW7	Aluminium Iron	86.7%	86.7%	The monitoring point is located within an opencast void; therefore, poor water qualities can be expected.

Table 37: Possible reasons and recommendations for exceedances in groundwater monitoring points

Monitoring Point	Parameters Exceeded (Average)	% Compliance (Current Report)	% Compliance (Previous Report)	Possible Reasons for Exceedances and Recommendations
BH1	None.	100%	100%	No exceedances recorded and no action is required.
BH4	None	100%	93.3%	No exceedances recorded and no action is required.
BH5	EC TDS Sulphate Sodium Magnesium	66.7%	66.7%	BH5 is located within historical underground mining areas and these activities resulted in poor water qualities. Mitigation for these impacts is complicated, however the borehole is not used for domestic or agricultural purposes, only monitoring.
BH-1	None	100%	93.3%	No exceedances recorded and no action is required.



Monitoring Point	Parameters Exceeded (Average)	% Compliance (Current Report)	% Compliance (Previous Report)	Possible Reasons for Exceedances and Recommendations
Office Drinking Water	None.	100%	100%	No exceedances recorded and no action is required.



9 CONCLUSIONS

It is proposed that the mine update and implement an EMSM or Environmental Management Systems Manual. An EMSM is a document containing all the monitoring points, sampling frequency, water quality parameters and other legislative requirements as stipulated in the WUL and EMPr of an operation. The EMSM can be used as a guide for monitoring actions required and should be regularly updated as monitoring points will be removed as they are destroyed or discontinued and others will be added as necessary.

The 2022 quarterly reports will be used as an accurate record if changes are made. It is also important that all future monitoring reports be taken into consideration, especially with regards to fluctuations of water quality. However, the recommended actions in the above section should be implemented to limit and prevent the adverse impacts of the operational activities on the water quality of the area.

The pH and Sulphate concentrations show a slight decrease for groundwater and surface water when compared to the previous reporting quarter. However, the recommended actions in the above section should be implemented to limit and prevent the adverse impacts of the operational activities on the water quality of the area.



10 REFERENCES

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