FFS REFINERS (PTY) LTD

GROUNDWATER MONITORING REPORT ‐ DRY SEASON 2023 - EVANDER

REMEDIATION ORDER NO. 14/11/15/LR68/6

41104127
JULY 2023

CONFIDENTIAL

FFS REFINERS (PTY) LTD

GROUNDWATER MONITORING REPORT – DRY SEASON 2023 - EVANDER

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1 INTRODUCTION

1.1 AUTHORISATION

WSP Group Africa (Pty) Ltd (WSP) was commissioned by FFS Refiners (Pty) Ltd (FFS) to conduct groundwater monitoring and laboratory analysis during the 2023 dry season at its Evander Facility located in Mpumalanga.

The offer to conduct the works was contained at the WSP Proposal for Groundwater Monitoring at Portfolio Facilities, 2022–2023, dated 29 June 2022 and accepted by FFS under the Purchase Order Number 602431 - NOKB246, dated 05 May 2023.

1.2 BACKGROUND

A groundwater monitoring network was established at FFS's Evander site in 2007 in accordance with a Record of Decision (RoD) issued by the Mpumalanga Department of Agriculture and Land Administration (MDALA). Biannual groundwater monitoring/sampling is a requirement under the RoD, as well as FFS Evander's ISO14001 management system. Groundwater monitoring at the site has been undertaken since around this time.

A Site Assessment Report (SAR)[1] was prepared for Evander in November 2014 in accordance with Part 8 of the National Environmental Management: Waste Act of 2008 (NEM: WA), and submitted by FFS to the Department of Forestry, Fisheries and the Environment (DFFE) [then Department of Environmental Affairs (DEA)]. Based on the findings of the SAR, FFS was issued Remediation Order No. 14/11/15/LR68/6, dated 10 September 2019, and a Remediation Action Plan (RAP)[2] was prepared by WSP in December 2019, which was based around a biannual monitoring programme with allowance for the installation of additional wells.

1.3 PREVIOUS REPORTING

WSP, and other third-parties, have undertaken environmental monitoring works at the site since circa 2007. A list of reports previously completed works and known to WSP, specifically associated with groundwater is provided in the **Report Library** towards the end of this document. It should be noted that the most recent monitoring event conducted by WSP was in June 2021; WSP is unaware of any other events in the interim period.

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[1] WSP Report No. 45793 - FFS Contaminated Land Assessments Report, Evander, Mpumalanga, November 2014

[2] WSP Report No. 41102284 – Remediation Action Plan, FFS Evander, December 2019

1.4 AIMS AND OBJECTIVES

The objectives of this report are to:

- Summarise the findings of the recent groundwater monitoring undertaken in the 2023 dry season
- Interpret the significance of any groundwater contamination
- Provide recommendations as to any additional works that may be required to manage possible environmental liabilities associated with any groundwater contamination encountered

The current document is intended to provide an account of conditions at the site, based on fieldworks undertaken on **31 May 2023**. This report comprises factual and interpretative reporting based on the findings of the recent groundwater monitoring/sampling exercise and laboratory analysis of samples obtained, whilst taking cognisance of relevant previous data.

2 SITE SETTING

2.1 GEOGRAPHIC SUMMARY

Table 2-1 – Site Summary

Geographic Setting	
Site Name	FFS Evander
Address	3 Brunel Road, Evander, Mpumalanga
ERF Number	2527, Evander Ext 3, Mpumalanga Deeds Office
Coordinates	26.486606° South; 29.096983° East (approximate centre of the site)
District Municipality	Gert Sibande
Local Municipality	Govan Mbeki
Site Owner / Operator	FFS Refiners (Pty) Ltd
Size	Approximately 3.3 ha
Location Summary	The site is located within a predominantly mixed industrial area approximately 1.75 km southwest of Evander, immediately north of Brunel Road and roughly 200 m west of the R546
Site Use Summary	The site handles bulk oils, and consists of process plants and bunded Above-ground Storage Tanks (ASTs) which enables the site to process a variety of coal-tar derived products. Such products include Coal Tar Fuel (CTF) and creosote-type wood preservatives . The facility also houses workshops, a laboratory and administration buildings
Surrounding Land-Use Summary	The site is within an industrial area with other facilities bordering the north, south and east. Whilst absent prior to 2017, a slimes dam is located approximately 250 m west of the site boundary. From a review of historical aerial imagery, the use of the dam appears to have commenced circa December 2018 and was built on from the tailings facility located towards the north-northwest.

2.2 ENVIRONMENTAL SUMMARY

TOPOGRAPHY

The site is located at an elevation of approximately 1 630 m above mean sea level (amsl). The site is roughly oriented east-west and the oldest infrastructure of the plant is predominantly located down-gradient on the western portion. The surface topography slopes downwards towards the west.

HYDROLOGY

Evander is located on the primary drainage regional boundary between the Olifants (B11D) and Waterval (C12D) River Catchments to the north and south respectively. The Olifants River catchment drains to the north whilst the Waterval River catchment drains to the west and south. The site is located below a watershed as the topography falls moderately towards the west and northwest; the eastern side of the watershed runs east. The topography to the north and west of the site is disturbed by the presence of the tailings facility, approximately 250 m from the site and which extends roughly 2 km to the northwest.

The site's stormwater flows to the western boundary after which it enters a stormwater system associated with the adjacent Bradford Road.

GEOLOGY

FFS Evander is founded on Jurassic dolerite at depths of 1–3 metres below ground level (bgl) which underlies silty clay colluvium or gravelly fill from site construction activities. The lower silty clay is generally stiffer than the upper transported colluvium, and likely comprises residually weathered doleritic material.

The upper 1–4 m of the dolerite profile is generally weathered to varying degrees, this overlies the Vryheid Formation of the Late Carboniferous to Early Jurassic Karoo Supergroup comprising fine to coarse grained sandstone, shale and coal seams followed by increasingly fresh rock which extends from approximately 4–30 m bgl.

HYDROGEOLOGY

The underlying natural geology is considered to represent a minor aquifer with a mean annual recharge of 25–37 mm and is classified as intergranular and fractured (geological unit dependent). Regionally, the groundwater is anticipated to provide a mean annual baseflow contribution of 0–10 mm. Regionally the groundwater chemistry is classified as Type B dominated by calcium, magnesium and bicarbonate ions. The concentration of total dissolved solids is typically less than 300mg/l, and electrical conductivity ranges between 70–150 mS/m. The aquifer is considered as moderately vulnerable with low susceptibility to anthropogenic contamination.

Notwithstanding, the hydrogeological conditions of the area, as well as associated groundwater quality, are suspected to be heavily influenced by the tailings facility that has expanded to the west of the site.

2.3 EXISTING MONITORING NETWORK

A groundwater monitoring network was initially established at the site in 2007 and comprised of six wells. Based on the loss of MW2S during earlier site expansion works and in accordance with previous recommendations, an additional shallow monitoring well (MW7) was installed to the northwest of the site in October 2012.

Subsequently, MW4 was destroyed during further site expansion in 2014. Aligned with consequent recommendations, FFS commissioned the installation of four supplementary shallow monitoring wells in September 2016; however, one (NMW4) was later destroyed during bund construction.

The network currently comprises of eight groundwater monitoring wells. The positions are summarised in **Table 2-2** and illustrated on **Figure 2-1**.

Table 2-2 – Summary of Monitoring Network

Well ID	Coordinates		Installation Depth (m bgl)	Comments
	Latitude	Longitude		
Deep Wells				
MW1	26.485531°S	29.097044°E	28	Off-site perceived down-hydraulic gradient, approximately 8 m north of ASTs
MW2-D	26.485691°S	29.096863°E	30	Perceived down-hydraulic gradient, northwest of the site adjacent to tar AST
MW3	26.485488°S	29.097737°E	30	Off-site perceived down-hydraulic gradient, approximately 8 m north of ASTs and water tank
MW5	26.485846°S	29.096595°E	25	Off-site perceived down-hydraulic gradient, approximately 23 m west of the water tank
MW1	26.485531°S	29.097044°E	28	Off-site perceived down-hydraulic gradient, approximately 8 m north of ASTs
Shallow Wells				
MW7	26.485669°S	29.096717°E	4.5	Off-site perceived down-hydraulic gradient, approximately 15 m north-west of the water tank
NMW2-S	26.485867°S	29.096700°E	6	On-site along the north-western corner of the property down-gradient of the ASTs
MW8	26.485533°S	29.096733°E	7	Off-site roughly 15 m north of MW7, perceived down-hydraulic gradient of 2006 spill
MW9	26.485600°S	29.096367°E	6	Off-site approximately 30 m down-gradient of MW5 and perceived down-hydraulic gradient of the 2006 spill

Figure 2-1 – Existing Monitoring Network

2.4 CONTAMINATION AND SITE DEVELOPMENT

Previous FFS operations have resulted in subsurface impacts related to a historical spill, occasional minor product spillages and possible influence from wash-bay sumps. The initial groundwater assessment (WSP, 2007) identified phenols to represent the most substantial component of subsurface contamination, with notable contributions of Polycyclic Aromatic Hydrocarbons (PAHs), petroleum hydrocarbons and various other Volatile and Semi-Volatile Organic Compounds (VOCs and SVOCs). The findings of the initial assessment provided the impetus for the establishment of the on-going monitoring programme, as well as additional support works.

It is notable that the site's AST facility was extended in 2010 and that the works involved the removal of an approximately 0.5 m thick layer of contaminated soil from an area in the northwest, and the importing of 'clean' soil as a fill media prior to the construction of concrete bunding. The AST facility was again extended in late 2014, into the north-eastern corner of the site, with associated concrete bunding and drainage infrastructure installed. The new ASTs were constructed on previously vacant land.

Previous reporting has indicated existing groundwater contamination in the deep aquifer which was thought to have been the result of a spill in 2006. Given the presence of contaminants within boundary monitoring wells, lateral off-site migration to the north and northwest is likely.

3 MONITORING & SAMPLING

3.1 STATIC WATER LEVELS

An electronic interface meter was used to measure the static groundwater level, and thickness of Light Non-Aqueous Phase Liquid (LNAPL), if present, in each monitoring well prior to well purging and sampling. The measured static groundwater levels are presented in **Table 3-1** for the current sampling event and temporal trends for the currently accessible positions since 2014 are illustrated on **Figure 3-1**.

Table 3-1 – Summary of Monitoring Data

Well ID	Depth (m bgl)		
	LNAPL Thickness	Groundwater	Base of Well
MW1	-	1.28	23.49
MW2-D		Not located	
NMW2-S	Sheen	1.94	6.79
MW3	-	1.63	29.65
MW5	-	1.47	23.93
MW7	-	0.75	4.24
MW8	-	1.53	8.41
MW9	-	1.20	7.01

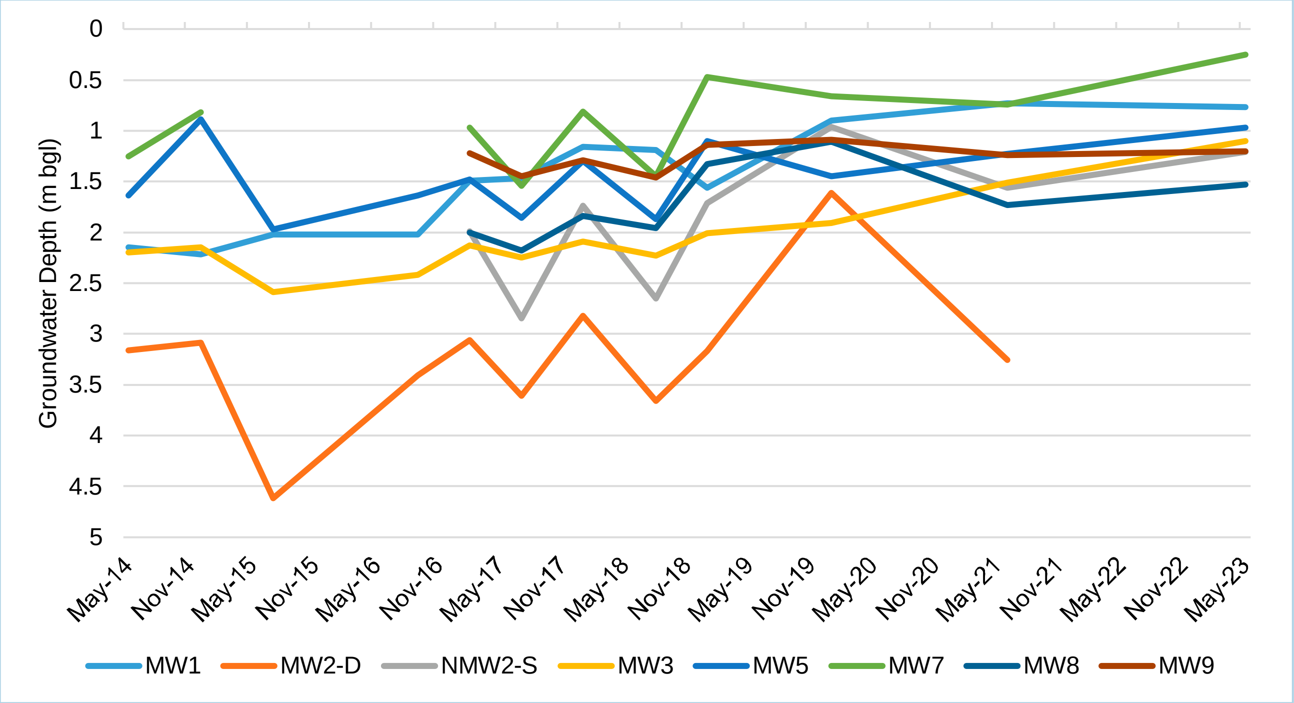


Figure 3-1 – Temporal Groundwater Depths (2014–2023)

KEY OBSERVATIONS

- A total of seven monitoring wells (MW1, NMW2-S, MW3, MW5, MW7, MW8 and MW9) were monitored
- Monitoring well MW2D could not be located due to the presence of rubble in its probable location
- No LNAPL was measured in any of the monitoring wells, although oily sheens (NMW2-S) and hydrocarbon odours (MW1, NMW2-S, MW3, MW7, MW9) were noted
- Except for substantial deepening at MW2D, groundwater levels are broadly consistent with previous events and in-line with typical fluctuations between wet and dry seasons
- A pattern of longer term, gradual shallowing of groundwater is suggested
- When compared to groundwater levels, the current bases of the wells appear to remain suitable for future monitoring events, although sedimentation has occurred at MW1

3.2 GROUNDWATER SAMPLING

Monitoring wells were purged until physicochemical stabilisation or of approximately three well-volumes using well-specific bailers and allowed to recharge where practicable prior to sample collection. Measurements of physicochemical parameters and observations made at the time of sampling are presented in **Table 3-2**.

Table 3-2 – Summary of In-Situ Monitoring Data

Well ID	Sampled (Yes/No)	Temp' (°C)	pH (Units)	EC (mS/m)	DO (mg/l)	ORP (mV)	Observations
MW1	Yes	18.66	8.02	152	0.32	-185.1	Clear with suspended black sediments, strong hydrocarbon odour
MW2D	No			Not located			
NMW2-S	Yes	20.25	6.87	137	0.33	-99.4	Grey-green, visible sheen and strong hydrocarbon odour
MW3	Yes	19.40	7.68	135	0.44	-155.8	Slightly clear with suspended black sediments, strong hydrocarbon odour
MW5	Yes	18.97	7.69	126	1.64	38.6	Clear with suspended brown sediments
MW7	Yes	18.90	7.02	115	0.02	-90.1	Clear with suspended black sediments, strong hydrocarbon odour
MW8	Yes	19.10	7.27	144	0.17	-92.3	Light grey with suspended fine sediments, overgrown
MW9	Yes	18.90	7.57	268	0.63	-74.5*	Light grey-green, strong hydrocarbon odour

** - Reading taken before stabilisation*

Sample containers were stored in a temperature-controlled environment for delivery to an accredited laboratory for analysis as summarised below. Clean, disposable gloves were used at all times during sampling and were changed between locations to minimise the potential for cross-contamination.

3.3 STORMWATER SAMPLING

The stormwater system was dry at the time of sampling and, therefore, no sample was recovered during the current event.

3.4 LABORATORY ANALYSIS

Samples were stored in a temperature-controlled environment and transferred for analysis as per below:

Analytical laboratory	Talbot Laboratories (Pty) Ltd
SANAS Accreditation	T0122
Analytical Suite	▪ Extractable Petroleum Hydrocarbons (EPH): C_{10}–C_{14} and C_{15}–C_{36} ▪ Gasoline Range Organics (GRO): C_7–C_9 ▪ Volatile Organic Compounds (VOC): including benzene, toluene, ethylbenzene, xylene and naphthalene (BTEX-N) ▪ Semi-Volatile Organic Compounds (SVOC): including Polycyclic Aromatic Hydrocarbons (PAHs) and phenols ▪ Electrical conductivity and pH
Certificate of Analysis	Test Report No. 004575/23, **Appendix A**

4 RESULTS AND ASSESSMENT

4.1 PHENOLS

The laboratory analytical results of phenolic compounds recorded above their laboratory limits of detection within any of the samples are summarised in **Table 4-1**.

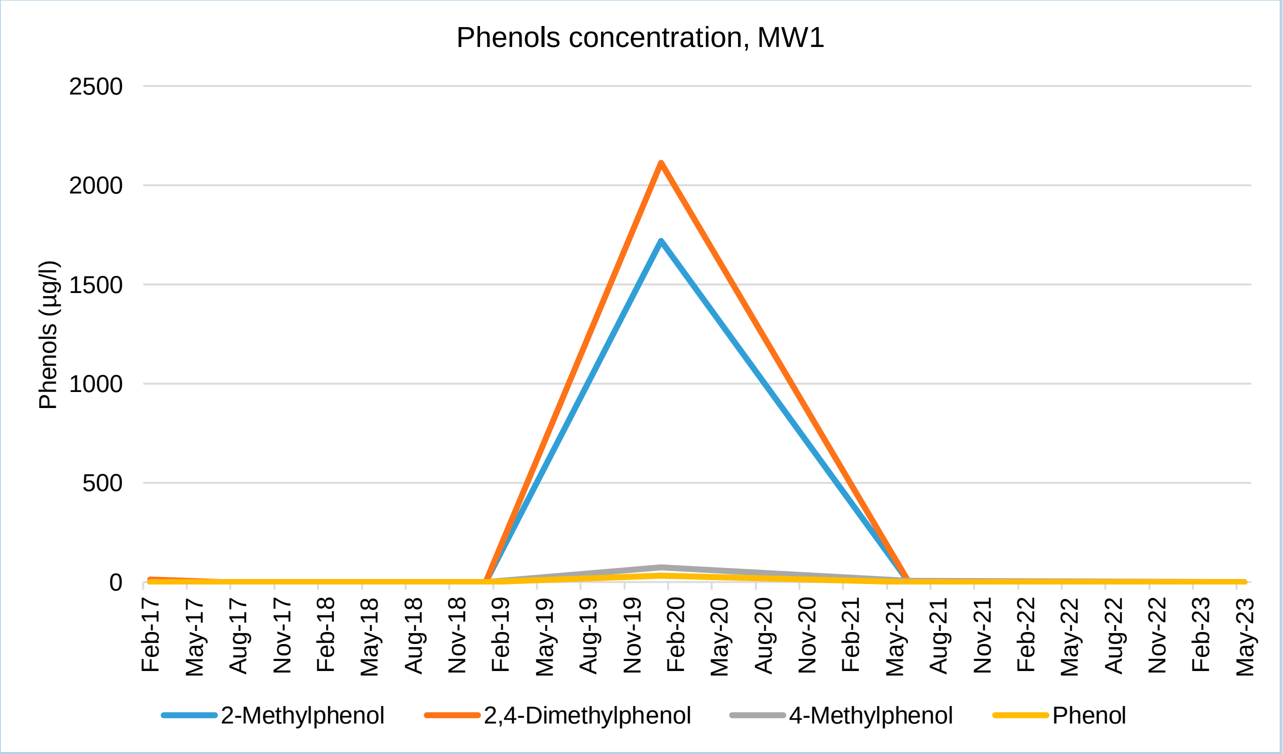
Table 4-1 – Summary of Phenol Concentrations

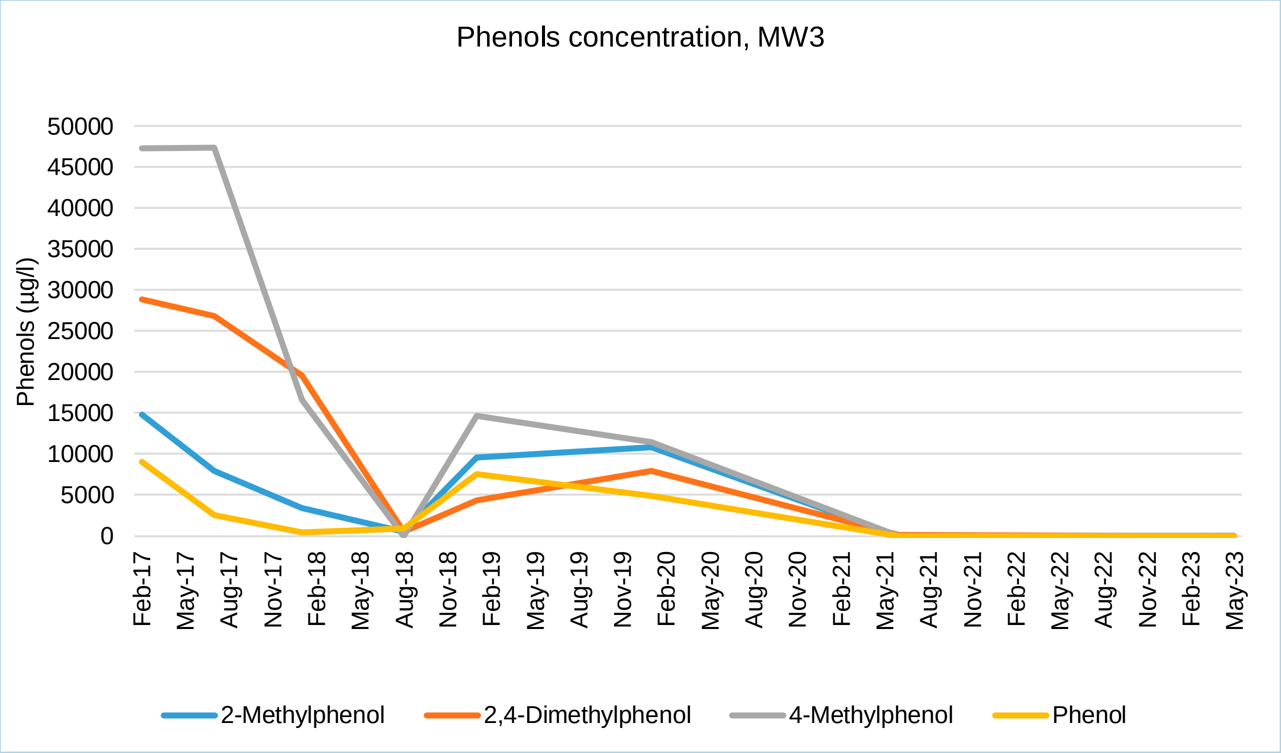
Compounds	**Concentration (µg/l)**						
	MW1	**NMW2-S**	**MW3**	**MW5**	**MW7**	**MW8**	**MW9**
2-Methylphenol	*<1*	440	1	*<1*	*<1*	*<1*	*<1*
2,4-Dimethylphenol	2	1 800	*<1*	*<1*	3	*<1*	*<1*
4-Methylphenol	4	19 000	1	2	*<1*	*<1*	2
Phenol	*<2*	100	*<2*	*<2*	*<2*	*<2*	*<2*

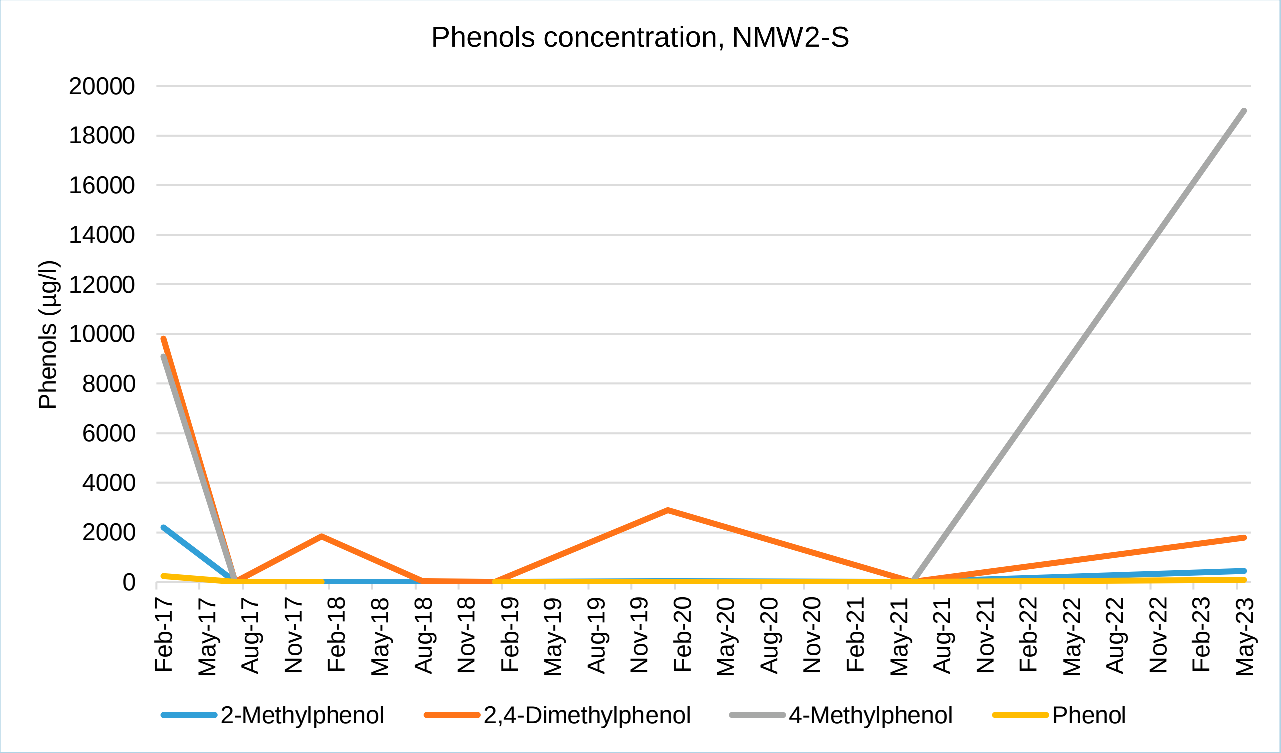
Whilst there are no published guideline values for individual phenolic compounds within South Africa, the South African Water Quality Guidelines (SAWQG) Volume 7: Aquatic Ecosystems, First Edition, dated 1996 provides a target water quality for phenol of <30 µg/l, with chronic and acute effect values of 60 µg/l and 500 µg/l, respectively.

The trends in phenol concentrations for the three wells which have consistently shown impact are shown below. It is, however, notable that a previous report (Aquatico, July 2019) did not include any analytical data for phenols and, therefore, concentrations for this period are unknown.

Of some concern is that phenols, which were previously not detected at NMW2-S (WSP, 2021) and have largely shown decreasing trends across pertinent wells, were detected during the current monitoring event at substantially elevated concentrations, some three orders of magnitude above the target water quality guideline for acute health effects in the case of 4-methylphenol.


Phenols concentration, MW1
Phenols (µg/l)
2500
2000
1500
1000
500
0
Feb-17
May-17
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
May-20
Aug-20
Nov-20
Feb-21
May-21
Aug-21
Nov-21
Feb-22
May-22
Aug-22
Nov-22
Feb-23
May-23
2-Methylphenol
2,4-Dimethylphenol
4-Methylphenol
Phenol


Phenols concentration, MW3
Phenols (µg/l)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Feb-17
May-17
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
May-20
Aug-20
Nov-20
Feb-21
May-21
Aug-21
Nov-21
Feb-22
May-22
Aug-22
Nov-22
Feb-23
May-23
2-Methylphenol
2,4-Dimethylphenol
4-Methylphenol
Phenol



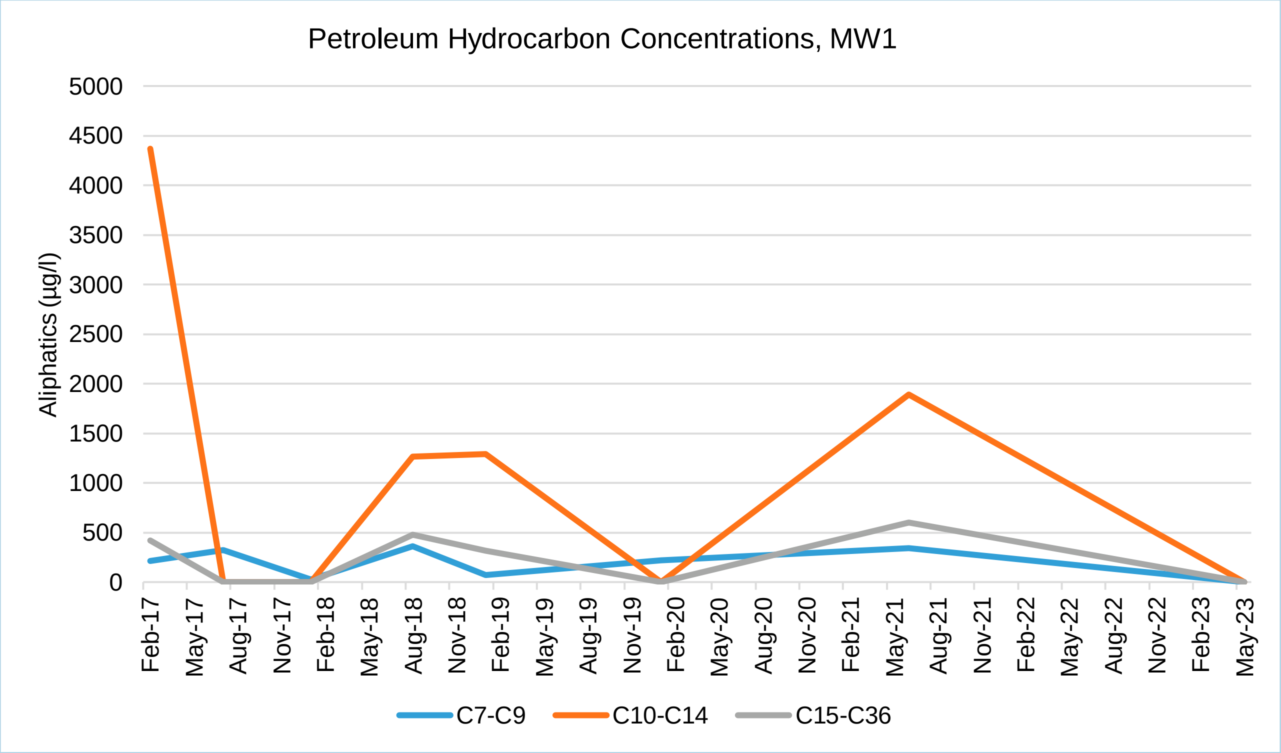
4.2 PETROLEUM HYDROCARBONS

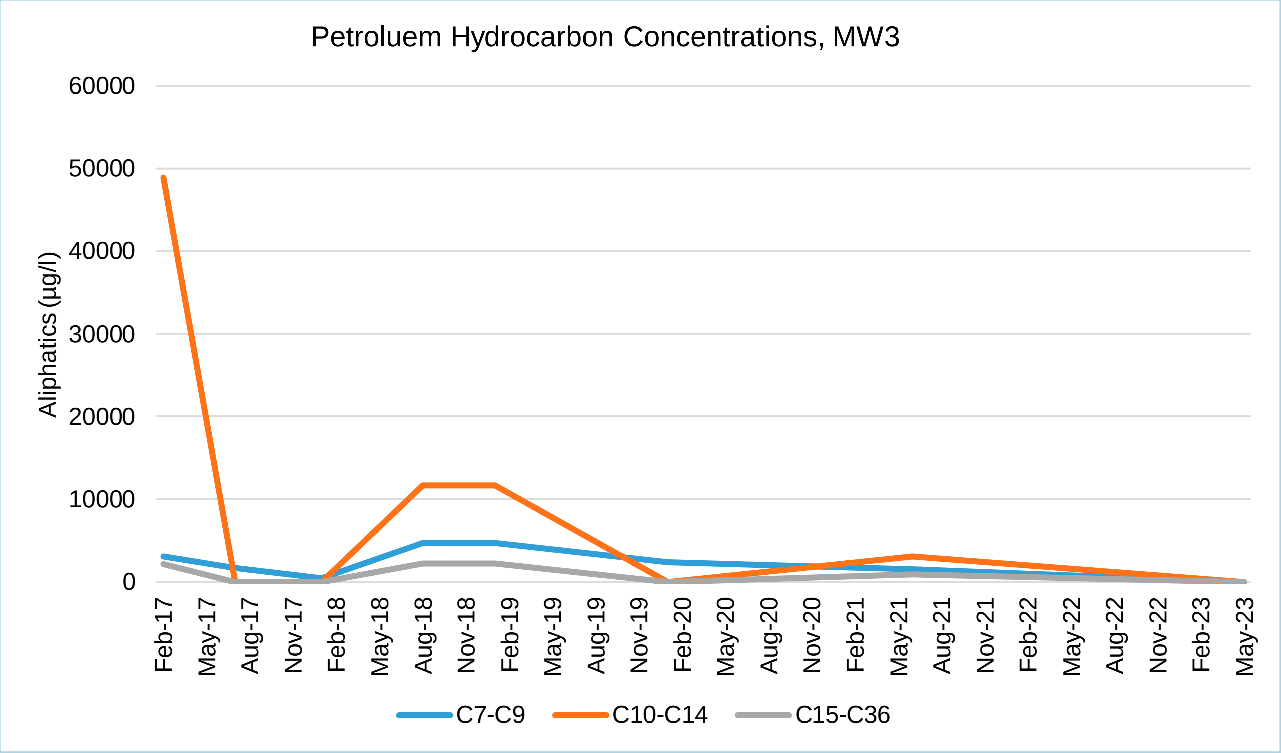
The laboratory analytical results for petroleum hydrocarbons (including GRO and EPH) are summarised in **Table 4-2**.

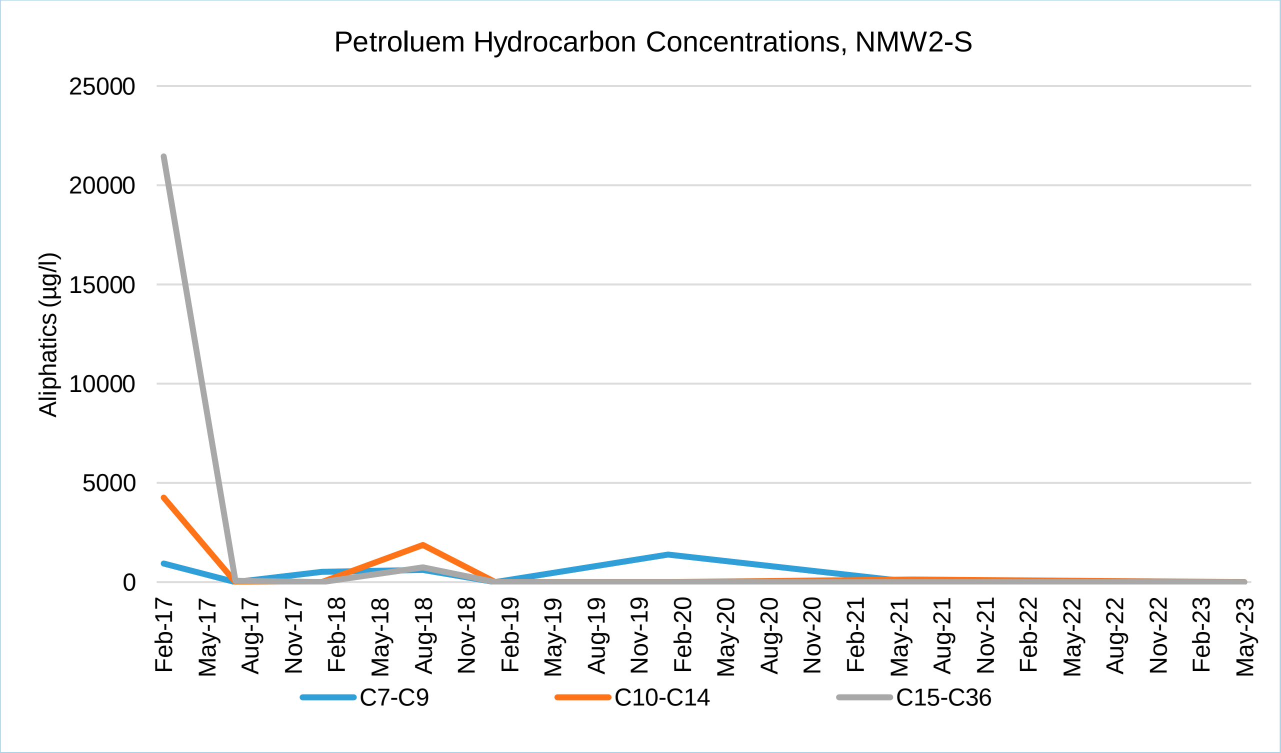
Table 4-2 – Summary of Petroleum Concentrations

Band	Concentration (µg/l)						
	MW1	NMW2-S	MW3	MW5	MW7	MW8	MW9
GRO >C_7–C_9	*<0.08*	*<0.08*	*<0.08*	*<0.08*	*<0.08*	*<0.08*	*<0.08*
EPH >C_{10}–C_{14}	*<0.68*	*<0.68*	*<0.68*	*<0.68*	*<0.68*	*<0.68*	*<0.68*
EPH >C_{15}–C_{36}	*<0.68*	*<0.68*	*<0.68*	*<0.68*	*<0.68*	*<0.68*	*<0.68*

There are no published guidelines within South Africa for petroleum hydrocarbons in respect of the protection of aquatic systems. Petroleum hydrocarbons concentrations were below detection limit for the current monitoring event.


Petroleum Hydrocarbon Concentrations, MW1
Aliphatics (µg/l)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Feb-17
May-17
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
May-20
Aug-20
Nov-20
Feb-21
May-21
Aug-21
Nov-21
Feb-22
May-22
Aug-22
Nov-22
Feb-23
May-23
C7-C9
C10-C14
C15-C36


Petroluem Hydrocarbon Concentrations, MW3
Aliphatics (µg/l)
60000
50000
40000
30000
20000
10000
0
Feb-17
May-17
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
May-20
Aug-20
Nov-20
Feb-21
May-21
Aug-21
Nov-21
Feb-22
May-22
Aug-22
Nov-22
Feb-23
May-23
C7-C9
C10-C14
C15-C36



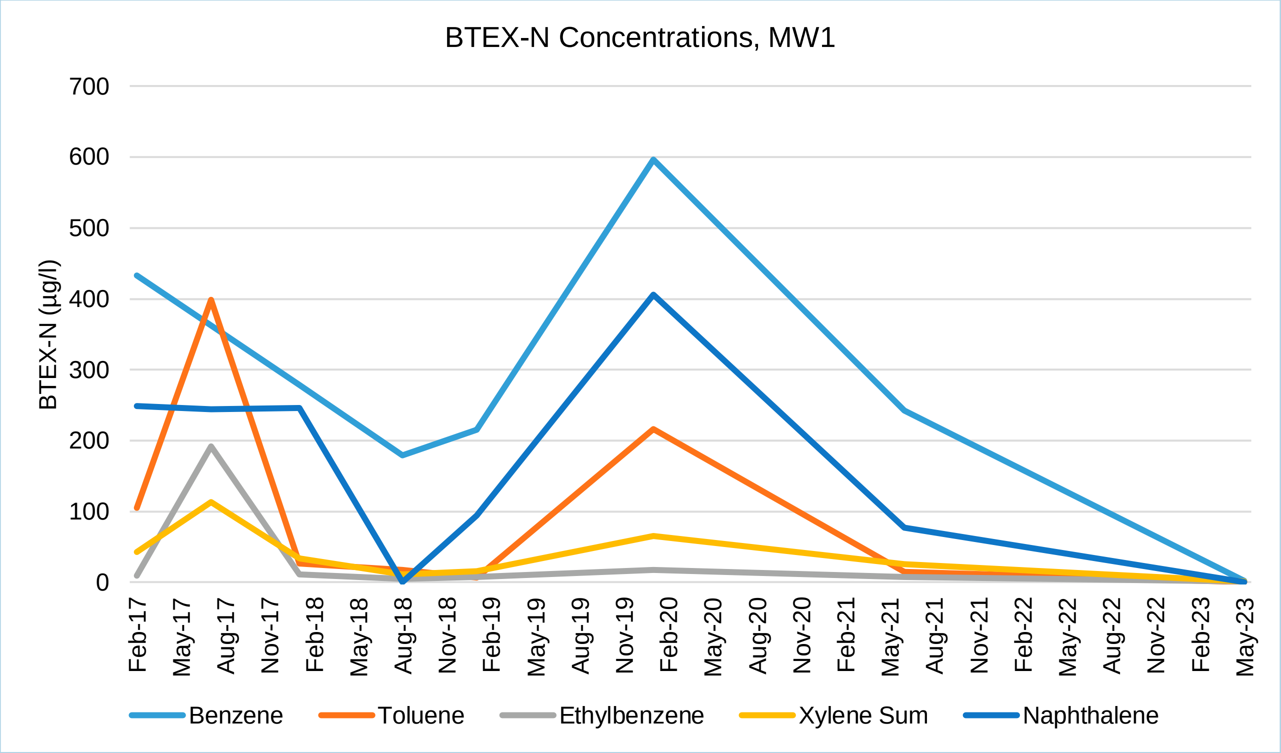
4.3 VOLATILE ORGANIC COMPOUNDS

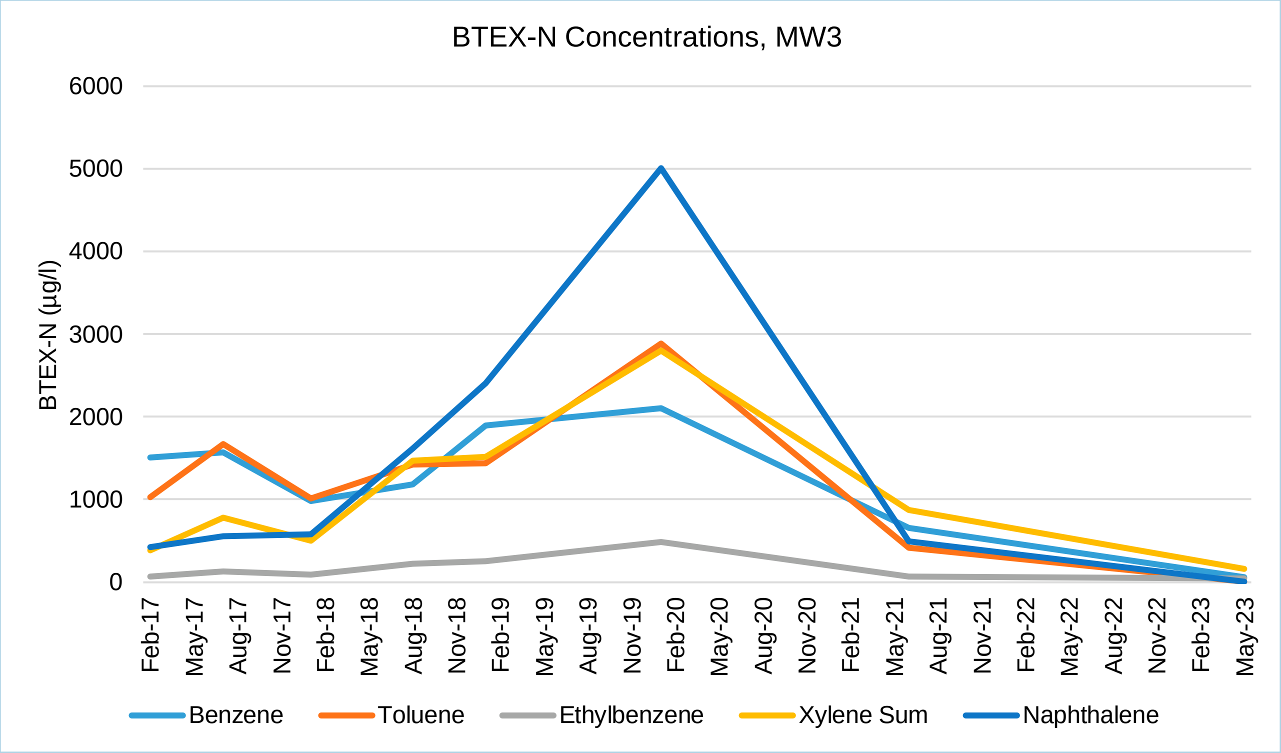
The laboratory analytical results of VOCs recorded above their respective laboratory limits of detection are summarised in **Table 4-3**.

Table 4-3 – Summary of VOC Concentrations

Compound	**Concentration (µg/l)**						
	MW1	**NMW2-S**	**MW3**	**MW5**	**MW7**	**MW8**	**MW9**
BTEX-N Compounds							
Benzene	2.00	55	56	*<0.62*	24	*<0.62*	*<0.62*
Toluene	*<0.62*	6.82	5.15	*<0.62*	1.09	*<0.62*	*<0.62*
Ethylbenzene	1.18	3.34	42	*<0.62*	*<0.62*	*<0.62*	*<0.62*
Xylenes (sum)		10.07	162	*<0.62*	4.81	*<0.62*	*<0.62*
Naphthalene	*<0.62*	*31*	2.17	*<0.62*	*<0.62*	*<0.62*	*<0.62*

There are no published guideline values within South Africa for these compounds in respect of the protection of aquatic systems. Nevertheless, their spatial distribution is consistent with the presence of the phenolic compounds. The trends in BTEX-N concentrations for the three pertinent wells are shown below.


BTEX-N Concentrations, MW1
BTEX-N (µg/l)
0
100
200
300
400
500
600
700
Feb-17
May-17
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
May-20
Aug-20
Nov-20
Feb-21
May-21
Aug-21
Nov-21
Feb-22
May-22
Aug-22
Nov-22
Feb-23
May-23
Benzene
Toluene
Ethylbenzene
Xylene Sum
Naphthalene


BTEX-N Concentrations, MW3
BTEX-N (µg/l)
0
1000
2000
3000
4000
5000
6000
Feb-17
May-17
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
May-20
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Nov-20
Feb-21
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Aug-21
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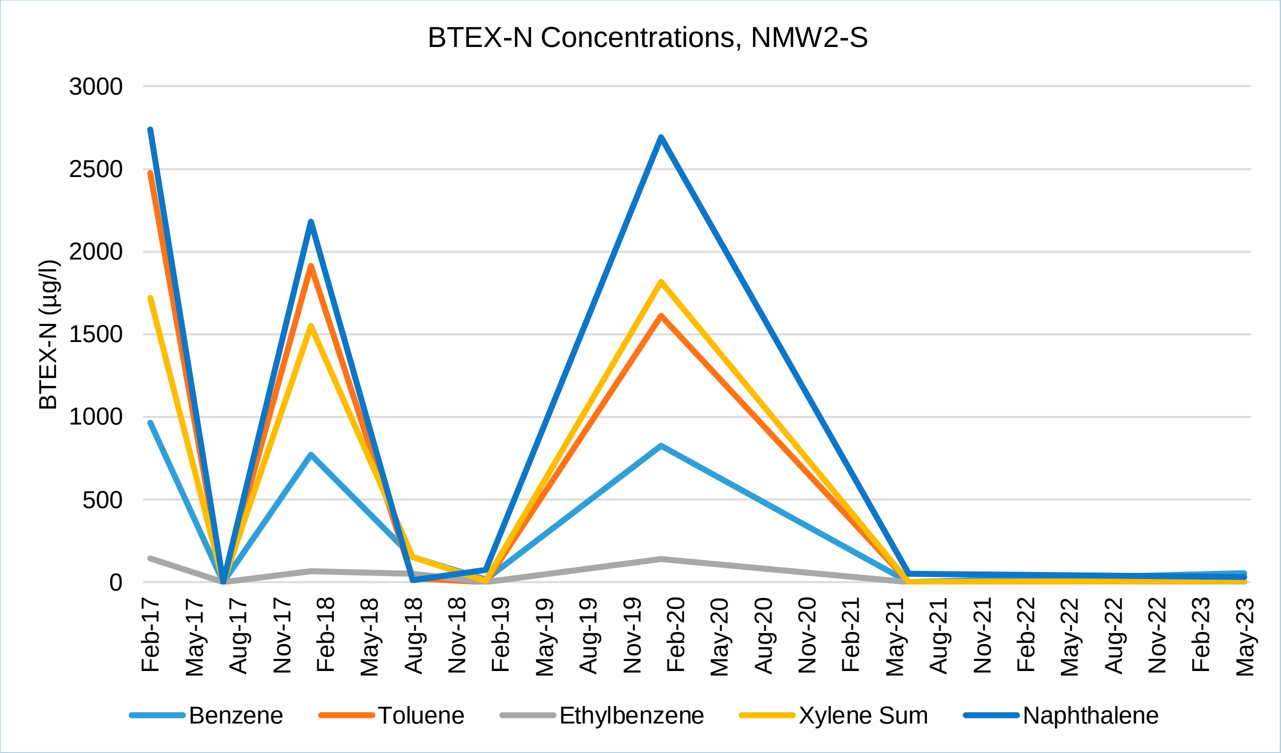

4.4 SEMI-VOLATILE ORGANIC COMPOUNDS

The laboratory analytical results of SVOCs recorded above their respective laboratory limits of detection are summarised in **Table 4-4**.

Table 4-4 – Summary of SVOC Concentrations

Compound	**Concentration (µg/l)**						
	MW1	**NMW2-S**	**MW3**	**MW5**	**MW7**	**MW8**	**MW9**
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	2.33	3.56	*<0.5*	*<0.5*	1.16	*<0.5*	*<0.5*

Previous monitoring undertaken by WSP in 2021 found ten SVOCs, including acenaphthene, above the limits of detection, whereas in the current event only acenaphthene has been recorded at concentrations above detection, in three wells. The concentrations of acenaphthene are low and unlikely to pose a significant source of risk to the aquatic environment. Nonetheless, its presence should continue to be monitored taking cognisance of the evidence of its fluctuating presence.

Whilst it is considered likely that this compound is either derived from site activities or the breakdown/interactions of various products, its sporadic appearance is not conducive to trend analysis and, therefore, not considered to represent a key contaminant of concern given the predominance of other compounds, at this stage.

5 CONCLUSIONS

Existing groundwater contamination that has been detected in the deep aquifer is thought to be primarily the result of a historical spill that reportedly occurred in 2006. Over the intervening period, the contaminants that were released have migrated vertically to the underlying deep aquifer and, given their continued presence within boundary monitoring wells (particularly MW1 and MW3), have likely migrated laterally off-site to the north and northwest. The migration of hydrocarbon contamination off-site within the shallow groundwater was previously indicated by the presence of petroleum hydrocarbons within MW9; however, the current monitoring event indicated nearly all hydrocarbon concentrations below the limits of laboratory detection (3- and 4- methylphenol detected at 2 µg/l).

The Groundwater Contamination Risk Assessment detailed in the WSP (June 2013) report concluded that existing dissolved-phase contamination within both the shallow and deep groundwater underlying the north of the site is unlikely to represent a significant source of risk with respect to its off-site migration to the, then present, nearby dam. This is supported by the general absence of contaminants of concern within MW5, MW8 and MW9, which are anticipated to be generally down-hydraulic-gradient of the original contamination source. Nonetheless, as reported previously (WSP, 2021), a tailings facility has encroached onto the area previously occupied by the dam, and will be expected to have a substantial impact on the local hydrogeological regime.

The elevated concentrations recorded within the samples obtained from MW1, MW3, NMW2-S and to a lesser extent MW7, when compared to the rest of the samples are of concern, indicating the deeper aquifer is more substantially impacted than the shallow aquifer. However, and whilst most contaminants of concern have shown a general reduction in concentration over time, the apparently recent substantial increase in phenols within NMW2-S is of some concern, as this is within the shallow aquifer and is thus suggestive of a relatively recent impact.

6 RECOMMENDATIONS

In conjunction with routine biannual groundwater monitoring (in compliance with the Remediation Order), WSP recommends:

- Advancement of two (shallow and deep) monitoring wells up-gradient, replacing the destroyed monitoring wells (MW4 and NMW4) to provide background groundwater conditions
- Accurately survey all monitoring well positions, to update the understanding of groundwater flow, particularly relating to direction/s and gradient
- Investigation of the region where NMW2-S is located to evaluate the possible cause of the apparently recent substantial increase in phenol concentrations

REPORT LIBRARY

Date	Author	Report Ref.	Title
July 2021	WSP	41103519	FFS Evander Groundwater Monitoring Report: Dry Season
March 2020	WSP	41102256	FFS Evander Groundwater Monitoring Report: Wet Season
December 2019	WSP	41102284	FFS Evander Remediation Action Plan, FFS Evander
July 2019	Aquatico Science (Pty) Ltd		FFS Evander Annual Water Quality Report
February 2019	WSP	41101585	FFS Evander Groundwater Monitoring Report: Wet Season
October 2018	WSP	41101107	FFS Evander Groundwater Monitoring Report: Dry Season
February 2018	WSP	41100702	FFS Evander Groundwater Monitoring Report: Wet Season
August 2017	WSP	48960/1	FFS Evander Groundwater Monitoring Report: Dry Season
February 2017	WSP	48532/1	FFS Evander Groundwater Monitoring Report: Wet Season
October 2016	WSP	48163/1	FFS Evander Groundwater Monitoring Report: Dry Season
October 2016	WSP	48163/2	FFS Evander Monitoring Well Installation Report
March 2016	WSP	47874/1	FFS Evander Groundwater Monitoring Report: Wet Season
August 2015	WSP	46950/1	FFS Evander Groundwater Monitoring report: Dry Season
February 2015	WSP	44365/6	FFS Evander Groundwater Monitoring Report: Wet Season
June 2014	WSP	44365/1	FFS Evander Groundwater Monitoring Report: Dry Season 2014
February 2014	WSP	37400/3	FFS Evander Groundwater Monitoring Report: Wet Season 2013
September 2013	WSP	37400/2	FFS Evander Groundwater Monitoring Report: Dry Season 2013
June 2013	WSP	37401/1	FFS Evander Groundwater Contamination Risk Assessment
February 2013	WSP	28394/6	FFS Evander Groundwater Monitoring Wet Season Report
August 2012	WSP	28394/5	FFS Evander Groundwater Monitoring Dry Season Report
January 2012	WSP	23661	FFS Evander Groundwater Monitoring Wet Season Report
November 2011	WSP	23661	FFS Evander Groundwater Monitoring Dry Season Report
May 2011	WSP	101032CL	FFS Evander Groundwater Monitoring Wet Season Report
July 2010	WSP	100614CL	FFS Evander Groundwater Monitoring Report

Date	Author	Report Ref.	Title
March 2010	WSP	90212CL	FFS Evander Groundwater Monitoring Report
October 2007	WSP	1654CL	FFS Evander Groundwater Investigation

Appendix A

LABORATORY CERTIFICATE OF ANALYSIS

Certificate of Analysis

Project details

Customer Details

Customer reference:	FFS EVANDER (41104127-D07)
Quotation number:	Q2305-225_A
Order number:	20008942
Company name:	WSP ENVIRONMENTAL (PTY) LTD JHB
Contact address:	P O BOX 5384, RIVONIA, 2128
Contact person:	HASTIE WARWICK

Sampling Details

Sampled by:	CUSTOMER
Sampled date:	2023/05/31
Additional customer information:	014826/23- SAMPLED BY: BATANDE GETYENGANA & PONTSHO TSHABALALA, 014827/23- SAMPLED BY: BATANDE GETYENGANA & PONTSHO TSHABALALA, 014828/23- SAMPLED BY: BATANDE GETYENGANA & PONTSHO TSHABALALA, 014829/23- SAMPLED BY: BATANDE GETYENGANA & PONTSHO TSHABALALA, 014830/23- SAMPLED BY: BATANDE GETYENGANA & PONTSHO TSHABALALA, 014831/23- SAMPLED BY: BATANDE GETYENGANA & PONTSHO TSHABALALA, 014832/23- SAMPLED BY: BATANDE GETYENGANA & PONTSHO TSHABALALA

Sample Details

Sample type(s):	GROUNDWATER SAMPLES
Date received:	2023/06/06
Delivered by:	COURIER SERVICE
Additional customer information:	LOW EXPECTED CONTAMINATION , EXPECTED CONTAMINATION UNCERTAIN
Temperature at sample receipt (°C):	12.3

Report Details

Testing commenced:	2023/06/06
Testing completed:	2023/07/19
Report date:	2023/07/19
Our reference:	004575/23.R1
Amended report details:	REPORTED ADDITIONAL TPH RESULTS

Analytical Results

Methods	Determinands	Units	014826/23	014827/23
			FFS EVANDER SITE: MW1 31.05.2023	**FFS EVANDER SITE: NMW2-S 31.05.2023**
Chemical				
2A	Electrical Conductivity at 25°C	mS/m	154	101
1	pH at 25°C	pH units	8.0	7.4
Organics				
100	BTEX*	µg/ℓ	6.51	107
100	Benzene	µg/ℓ	2.00	55
100	Toluene	µg/ℓ	<0.62	6.82
100	Ethylbenzene	µg/ℓ	1.18	3.34
100	m+p-Xylene	µg/ℓ	<0.62	2.98
100	o-Xylene	µg/ℓ	1.46	7.09
100	Naphthalene	µg/ℓ	<0.62	31
102	Acenaphthene*	µg/ℓ	2.33	3.56
102	Acenaphthylene*	µg/ℓ	<0.5	<0.5
102	Anthracene*	µg/ℓ	<0.5	<0.5
102	Benzo[a]pyrene*	µg/ℓ	<0.5	<0.5
102	Chrysene*	µg/ℓ	<0.5	<0.5
102	Fluoranthene*	µg/ℓ	<0.5	<0.5
102	Flourene*	µg/ℓ	<0.5	<0.5
102	Phenanthrene*	µg/ℓ	<0.5	<0.5
102	Pyrene*	µg/ℓ	<0.5	<0.5
102	Dibenz[a,h]anthracene*	µg/ℓ	<0.5	<0.5
102	Benzo[g,h,i]perylene*	µg/ℓ	<0.5	<0.5
102	Indeno[123-c,d]pyrene*	µg/ℓ	<0.5	<0.5
-	Phenol*	µg/ℓ	<2#	100#
-	2,3,4,6 Tetrachlorophenol*	µg/ℓ	<1#	<10#
-	2,4 Dimethylphenol*	µg/ℓ	2#	1800#
-	2,4,5 Trichlorophenol*	µg/ℓ	<1#	<10#
-	2,4,6 Trichlorophenol*	µg/ℓ	<1#	<10#
-	2,4-Dichlorophenol*	µg/ℓ	<1#	<10#
-	2,6-Dichlorophenol*	µg/ℓ	<1#	<10#
-	2-Chlorophenol*	µg/ℓ	<1#	<10#

Methods	Determinands	Units	014826/23	014827/23
			FFS EVANDER SITE: MW1 31.05.2023	**FFS EVANDER SITE: NMW2-S 31.05.2023**
Organics				
-	2-Methylphenol (o-cresol)*	µg/ℓ	<1#	440#
-	2-Nitrophenol*	µg/ℓ	<1#	<10#
-	3- and 4-Methylphenol (m+p cresol)*	µg/ℓ	2#	19000#
-	4-Chloro-3-methylphenol*	µg/ℓ	<1#	<10#
-	Pentachlorophenol*	µg/ℓ	<1#	<10#
101	C7-C9	mg/ℓ	<0.08	<0.08
101	C10-C14	mg/ℓ	<0.68	<0.68
101	C15-C36	mg/ℓ	<0.68	<0.68
101	TPH C9-C36	µg/ℓ	<680	<680
101	TPH Gasoline Range Organics (GRO), C6-C10	µg/ℓ	<80	<80

Methods	Determinands	Units	014828/23	014829/23
			FFS EVANDER SITE: MW3 31.05.2023	FFS EVANDER SITE: MW5 31.05.2023
Chemical				
2A	Electrical Conductivity at 25°C	mS/m	126	114
1	pH at 25°C	pH units	7.6	7.7
Organics				
100	BTEX*	µg/ℓ	266	<3.75
100	Benzene	µg/ℓ	56	<0.62
100	Toluene	µg/ℓ	5.15	<0.62
100	Ethylbenzene	µg/ℓ	42	<0.62
100	m+p-Xylene	µg/ℓ	103	<0.62
100	o-Xylene	µg/ℓ	58	<0.62
100	Naphthalene	µg/ℓ	2.17	<0.62
102	Acenaphthene*	µg/ℓ	<0.5	<0.5
102	Acenaphthylene*	µg/ℓ	<0.5	<0.5
102	Anthracene*	µg/ℓ	<0.5	<0.5
102	Benzo[a]pyrene*	µg/ℓ	<0.5	<0.5
102	Chrysene*	µg/ℓ	<0.5	<0.5
102	Fluoranthene*	µg/ℓ	<0.5	<0.5
102	Flourene*	µg/ℓ	<0.5	<0.5
102	Phenanthrene*	µg/ℓ	<0.5	<0.5
102	Pyrene*	µg/ℓ	<0.5	<0.5
102	Dibenz[a,h]anthracene*	µg/ℓ	<0.5	<0.5
102	Benzo[g,h,i]perylene*	µg/ℓ	<0.5	<0.5
102	Indeno[123-c,d]pyrene*	µg/ℓ	<0.5	<0.5
-	Phenol*	µg/ℓ	<2#	<2#
-	2,3,4,6 Tetrachlorophenol*	µg/ℓ	<1#	<1#
-	2,4 Dimethylphenol*	µg/ℓ	<1#	<1#
-	2,4,5 Trichlorophenol*	µg/ℓ	<1#	<1#
-	2,4,6 Trichlorophenol*	µg/ℓ	<1#	<1#
-	2,4-Dichlorophenol*	µg/ℓ	<1#	<1#
-	2,6-Dichlorophenol*	µg/ℓ	<1#	<1#
-	2-Chlorophenol*	µg/ℓ	<1#	<1#
-	2-Methylphenol (o-cresol)*	µg/ℓ	1#	<1#

Methods	**Determinands**	**Units**	**014828/23**	**014829/23**
			FFS EVANDER SITE: MW3 31.05.2023	**FFS EVANDER SITE: MW5 31.05.2023**
Organics				
-	2-Nitrophenol*	µg/ℓ	<1#	<1#
-	3- and 4-Methylphenol (m+p cresol)*	µg/ℓ	4#	2#
-	4-Chloro-3-methylphenol*	µg/ℓ	<1#	<1#
-	Pentachlorophenol*	µg/ℓ	<1#	<1#
101	C7-C9	mg/ℓ	<0.08	<0.08
101	C10-C14	mg/ℓ	<0.68	<0.68
101	C15-C36	mg/ℓ	<0.68	<0.68
101	TPH C9-C36	µg/ℓ	<680	<680
101	TPH Gasoline Range Organics (GRO), C6-C10	µg/ℓ	<80	<80

Methods	**Determinands**	**Units**	**014830/23**	**014831/23**
			FFS EVANDER SITE: MW7 31.05.2023	**FFS EVANDER SITE: MW8 31.05.2023**
Chemical				
2A	Electrical Conductivity at 25°C	mS/m	92.9	119
1	pH at 25°C	pH units	7.4	7.4
Organics				
100	BTEX*	μg/ℓ	32	<3.75
100	Benzene	μg/ℓ	24	<0.62
100	Toluene	μg/ℓ	1.09	<0.62
100	Ethylbenzene	μg/ℓ	<0.62	<0.62
100	m+p-Xylene	μg/ℓ	2.23	<0.62
100	o-Xylene	μg/ℓ	2.58	<0.62
100	Naphthalene	μg/ℓ	<0.62	<0.62
102	Acenaphthene*	μg/ℓ	1.16	<0.5
102	Acenaphthylene*	μg/ℓ	<0.5	<0.5
102	Anthracene*	μg/ℓ	<0.5	<0.5
102	Benzo[a]pyrene*	μg/ℓ	<0.5	<0.5
102	Chrysene*	μg/ℓ	<0.5	<0.5
102	Fluoranthene*	μg/ℓ	<0.5	<0.5
102	Flourene*	μg/ℓ	<0.5	<0.5
102	Phenanthrene*	μg/ℓ	<0.5	<0.5
102	Pyrene*	μg/ℓ	<0.5	<0.5
102	Dibenz[a,h]anthracene*	μg/ℓ	<0.5	<0.5
102	Benzo[g,h,i]perylene*	μg/ℓ	<0.5	<0.5
102	Indeno[123-c,d]pyrene*	μg/ℓ	<0.5	<0.5
-	Phenol*	μg/ℓ	<2#	<2#
-	2,3,4,6 Tetrachlorophenol*	μg/ℓ	<1#	<1#
-	2,4 Dimethylphenol*	μg/ℓ	3#	<1#
-	2,4,5 Trichlorophenol*	μg/ℓ	<1#	<1#
-	2,4,6 Trichlorophenol*	μg/ℓ	<1#	<1#
-	2,4-Dichlorophenol*	μg/ℓ	<1#	<1#
-	2,6-Dichlorophenol*	μg/ℓ	<1#	<1#
-	2-Chlorophenol*	μg/ℓ	<1#	<1#
-	2-Methylphenol (o-cresol)*	μg/ℓ	<1#	<1#

Methods	**Determinands**	**Units**	**014830/23**	**014831/23**
			FFS EVANDER SITE: MW7 31.05.2023	**FFS EVANDER SITE: MW8 31.05.2023**
Organics				
-	2-Nitrophenol*	µg/ℓ	<1#	<1#
-	3- and 4-Methylphenol (m+p cresol)*	µg/ℓ	<1#	<1#
-	4-Chloro-3-methylphenol*	µg/ℓ	<1#	<1#
-	Pentachlorophenol*	µg/ℓ	<1#	<1#
101	C7-C9	mg/ℓ	<0.08	<0.08
101	C10-C14	mg/ℓ	<0.68	<0.68
101	C15-C36	mg/ℓ	<0.68	<0.68
101	TPH C9-C36	µg/ℓ	<680	<680
101	TPH Gasoline Range Organics (GRO), C6-C10	µg/ℓ	<80	<80

Methods	**Determinands**	**Units**	**014832/23**
			FFS EVANDER SITE: MW9 31.05.2023
Chemical			
2A	Electrical Conductivity at 25°C	mS/m	254
1	pH at 25°C	pH units	7.5
Organics			
100	BTEX*	µg/ℓ	<3.75
100	Benzene	µg/ℓ	<0.62
100	Toluene	µg/ℓ	<0.62
100	Ethylbenzene	µg/ℓ	<0.62
100	m+p-Xylene	µg/ℓ	<0.62
100	o-Xylene	µg/ℓ	<0.62
100	Naphthalene	µg/ℓ	<0.62
102	Acenaphthene*	µg/ℓ	<0.5
102	Acenaphthylene*	µg/ℓ	<0.5
102	Anthracene*	µg/ℓ	<0.5
102	Benzo[a]pyrene*	µg/ℓ	<0.5
102	Chrysene*	µg/ℓ	<0.5
102	Fluoranthene*	µg/ℓ	<0.5
102	Flourene*	µg/ℓ	<0.5
102	Phenanthrene*	µg/ℓ	<0.5
102	Pyrene*	µg/ℓ	<0.5
102	Dibenz[a,h]anthracene*	µg/ℓ	<0.5
102	Benzo[g,h,i]perylene*	µg/ℓ	<0.5
102	Indeno[123-c,d]pyrene*	µg/ℓ	<0.5
-	Phenol*	µg/ℓ	<2#
-	2,3,4,6 Tetrachlorophenol*	µg/ℓ	<1#
-	2,4 Dimethylphenol*	µg/ℓ	<1#
-	2,4,5 Trichlorophenol*	µg/ℓ	<1#
-	2,4,6 Trichlorophenol*	µg/ℓ	<1#
-	2,4-Dichlorophenol*	µg/ℓ	<1#
-	2,6-Dichlorophenol*	µg/ℓ	<1#
-	2-Chlorophenol*	µg/ℓ	<1#
-	2-Methylphenol (o-cresol)*	µg/ℓ	<1#

Methods	Determinands	Units	014832/23
			FFS EVANDER SITE: MW9 31.05.2023
Organics			
-	2-Nitrophenol*	µg/ℓ	<1#
-	3- and 4-Methylphenol (m+p cresol)*	µg/ℓ	2#
-	4-Chloro-3-methylphenol*	µg/ℓ	<1#
-	Pentachlorophenol*	µg/ℓ	<1#
101	C7-C9	mg/ℓ	<0.08
101	C10-C14	mg/ℓ	<0.68
101	C15-C36	mg/ℓ	<0.68
101	TPH C9-C36	µg/ℓ	<680
101	TPH Gasoline Range Organics (GRO), C6-C10	µg/ℓ	<80

Refer to the “Notes” section at the end of this report for further explanations.

Specific Observations

None

Quality Assurance

Technical signatories

Notes to this report

Limitations

This report shall not be reproduced except in full without prior written approval of the laboratory.
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Sample preparation may require filtration, dilution, digestion or similar. Final results are reported accordingly.
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Uncertainty of measurement

Talbot Laboratories’ Uncertainty of Measurement (UoM) values are:

- Identified for relevant tests.
- Calculated as a percentage of the respective results.
- Applicable to total, dissolved and acid soluble metals for ICP element analyses.
- Available upon request.

Analysis explanatory notes

Tests may be marked as follows:

^	Tests conducted at our Port Elizabeth satellite laboratory.
*	Tests not included in our Schedule of Accreditation and therefore that are not SANAS accredited.
#	Tests that have been sub-contracted to a peer laboratory.
NR	Not required -shown, for example, where the schedule of analysis varied between samples.
σ	Field sampling point on-site results.
a	Testing has deviated from Method.

End of Report

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