



UK Health
Security
Agency

Health Risk Assessment of air quality monitoring results from March to December 2021: Walleys Quarry Landfill Site, Silverdale Newcastle-under-Lyme

Regarding ongoing response to odours and health concerns associated with the site

On 1 October 2021, Public Health England (PHE) transitioned to the newly established UK Health Security Agency (UKHSA)^a. From 1 October, PHE's Category 1 functions under the Civil Contingencies Act 2004 transferred to the UKHSA. The UKHSA West Midlands Health Protection Team will continue to provide senior representation at Local Resilience Forum (LRF) meetings and events. They will provide the expert health protection advice to local authority Directors of Public Health, the local NHS and to LRF structures and programmes. UKHSA, as a Category 1 Responder, will be the point of contact for public health incidents and will be responsible for establishing Scientific and Technical Advisory Cells (STACs) during relevant responses.

Non-Technical Summary

The site is owned by Walleys Quarry Limited (formerly Red Industries RM Ltd), who operate the site as an active landfill which accepts non-hazardous waste. Their Environmental Permit also allows the acceptance of stable non-reactive hazardous waste such as gypsum and asbestos in a separate cell, however the company has chosen not to put the required infrastructure in place and therefore they cannot accept this material at this time.

In response to increased community concern of odours within Silverdale and the surrounding areas, from March 2021 the Environment Agency (EA) installed air quality Mobile Monitoring Facility (MMF) units, which are to remain in place until at least March 2022, to collect monitoring data to continuously assess air quality.

Data, provided to UKHSA by the EA up to the end of December 2021, have been compared to appropriate health-based air quality guidelines and standards or assessment levels for hydrogen sulphide, particulate matter, nitrogen dioxide, sulphur dioxide, methane and volatile organic compounds (VOCs comprising benzene, toluene, ethylbenzene and xylene (BTEX)). In addition, for hydrogen sulphide and toluene the concentrations have been compared to the odour annoyance guideline and odour detection thresholds respectively. Air concentrations of particulate matter, nitrogen dioxide, sulphur dioxide, methane and VOCs

^a All reference to Public Health England has now been changed to UKHSA in this report

are lower than appropriate health-based and odour standards, guidelines or assessment levels, and therefore, the risk to health from these substances is minimal.

The short-term 24-hour average guideline value for hydrogen sulphide was exceeded at MMF9 on two days at the beginning of the monitoring period: 7 and 8 March 2021. Exposure to concentrations of hydrogen sulphide above this guideline does not necessarily mean eye irritation or other health effects will occur, but it reduces the margin of safety that is considered desirable to protect health.

The hydrogen sulphide data up to the end of December 2021 shows continuing exposure to the population around the site. For three of the monitoring sites, concentrations are below the long-term (lifetime) health-based guidance value, as they have been since June/July 2021. At the fourth site, concentrations are slightly above the long-term (lifetime) health-based guidance value. The concentrations measured in December have plateaued and are broadly comparable to those levels observed since September. They remain lower than the levels seen from March to August 2021 (Figure 4). Currently any risk to long-term (lifetime) physical health is likely to be small, however, we cannot completely exclude a risk to health from pollutants in the area, where exposure continues above the long-term health-based guidance value. Short-term health effects may be experienced such as irritation to the eyes, nose and throat. People who have health conditions that affect breathing, such as asthma, may experience increased frequency and/or severity of symptoms. With continuing exposure, these effects may be prolonged but are not anticipated to continue long-term, once exposure has decreased to acceptable levels.

Hydrogen sulphide is an odorous chemical and the human nose is very sensitive to odours. While substances that are perceived as odorous are commonly present at levels below which there is a direct physical health effect of the substance itself, odours can cause nuisance and temporary symptoms. Such effects include headache, nausea, dizziness, watery eyes, stuffy nose, irritated throat, cough or wheeze, sleep problems and stress. The concentrations of hydrogen sulphide continue to be above the WHO odour annoyance guideline value for a considerable percentage of the time at one of the monitoring sites, which is undesirable due to the effects on people's wellbeing and the symptoms they are experiencing. Even at hydrogen sulphide concentrations below the WHO odour annoyance guideline value odour may still be present, however as concentrations fall to even lower levels it is anticipated that the strength of any odour should also reduce.

Therefore, UKHSA continues to strongly recommend that all appropriate measures are taken to reduce the off-site odours from the landfill site.

Scope

The EA has shared with UKHSA monitoring data from MMF units MMF2 and MMF9 from which there is rectified^b data from the 5 March – 31 December 2021 (303 days) and 6 March

^b Rectified data - Data is collected by the Environment Agency (EA) from four of the EA's Mobile Monitoring Facilities (MMF) located adjacent to the Walleys Quarry and Landfill Site in Newcastle-under-Lyme. There may be gaps in data as a result of power supply failure, hardware failure, communication loss or software updates. In some cases, it may be possible to retrospectively include this information. The EA call this data, 'rectified data' as it has undergone a basic quality assurance check and has been subjected to calibration where possible. However, as the calibration dates don't directly match the data collection period, this is not 'final data' and it is likely that this rectified data set may be updated following further quality assurance.

– 31 December 2021 (302 days) respectively. In April, two additional MMF units were deployed: MMF1 from which there is rectified data from the 14 April – 31 December 2021 (262 days) and MMF6 from which there is rectified data from the 24 April – 31 December 2021 (252 days).

UKHSA has reviewed the available data from the MMF units, listed below, and shown on a map in Figure 1:

MMF1 Location – Silverdale Cemetery, Newcastle-under-Lyme

MMF2 Location – Silverdale Road, Newcastle-under-Lyme

MMF6 Location – Newcastle Community Fire Station, Newcastle-under-Lyme

MMF9 Location – Severn Trent Pumping Station off Galingale View, Newcastle-under-Lyme

The contaminants monitored at each MMF are provided in Table 1.

Table 1 Monitoring stations and the contaminants they are monitoring

Monitoring station	Hydrogen sulphide (H ₂ S)	Methane (CH ₄)	Nitrogen dioxide (NO ₂)	Sulphur dioxide (SO ₂)	Particulate matter (PM ₁₀ , PM _{2.5})	Benzene, toluene, ethylbenzene and xylene
MMF1	✓	✓		✓	✓	
MMF2	✓	✓	✓		✓	✓
MMF6	✓	✓		✓	✓	
MMF9	✓	✓	✓	✓	✓	✓

Figure 1 Map showing the location of the four monitoring sites



Map courtesy of the Environment Agency

Methodology

Air quality guidelines, standards and assessment levels

The data provided to UKHSA have been compared to appropriate health-based air quality guidelines, standards or assessment levels. There are a variety of health-based standards and assessment levels that have been derived by a number of organisations shown below:

- UK health-based guidance values
- UK air quality standards
- World Health Organization (WHO) air quality guidelines
- Other UK air quality assessment levels
- National air quality assessment levels or health-based guidance values (other than UK)

Hydrogen sulphide

The health-based guidance values used by UKHSA for the risk assessment for acute, intermediate and lifetime exposure to hydrogen sulphide are summarised in Table 2.

Table 2: Health based guidance values used for this risk assessment

WHO air quality guidelines	ATSDR- MRL**	US EPA RfC***
30-minute (average)* 7 µg/m ³ (5 ppb) Based on odour annoyance	Intermediate (up to 1 year) 30 µg/m ³ (20 ppb) Based on lesions of the nasal olfactory epithelium in rats.	For assessment of lifetime exposure 2 µg/m ³ (1 ppb) Based on lesions of the nasal olfactory epithelium in rats.
24-hour (average) 150 µg/m ³ (107 ppb) Based on eye irritation in humans.		

*The WHO guideline value of 7 µg/m³ (5 ppb) over a 30-minute averaging period is a short-term odour value protective of odour annoyance¹.

** An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure. They are derived for acute (>1, ≤14 days), intermediate (>14, <364 days), and chronic (365 days and longer) exposure durations².

*** An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime³.

Hydrogen sulphide acute (short-term) exposure

WHO 30-minute (average) guideline

The EA monitoring data were used to identify the percentage of time across the whole monitoring period when hydrogen sulphide concentrations were above the WHO odour annoyance guideline level (7 µg/m³, 30-minute average) (see Table 3). When exposures are above the WHO odour annoyance guideline level, there is potential for significant odour complaints.

Table 3: Cumulative percentage of time that each monitoring station location has recorded hydrogen sulphide concentrations above WHO odour annoyance guideline level (7 µg/m³)

Monitoring Station	Cumulative percentage time above 7 µg/m ³	Monitoring dates
MMF1	4 %	14/04/2021 to 31/12/2021
MMF2	4 %	05/03/2021 to 31/12/2021
MMF6	3 %	24/04/2021 to 31/12/2021
MMF9	17 %	06/03/2021 to 31/12/2021

The percentage of time on a monthly basis when hydrogen sulphide concentrations were above the WHO odour annoyance guideline level have also been identified (see Table 4 and Figure 2).

Table 4: Monthly percentage of time that each monitoring station location has recorded hydrogen sulphide concentrations above WHO odour annoyance guideline level (7 µg/m³)

Dates	Monitoring Station			
	MMF1 (%)	MMF2 (%)	MMF6 (%)	MMF9 (%)
March 2021	NS	22*	NS	38**
April 2021	10***	8	2****	34
May 2021	9	13	8	36
June 2021	8	4	5	17
July 2021	2	6	3	17
August 2021	0.6	2.5	1.4	11
September 2021	0.7	0.8	1.7	10
October 2021	0	0.1	0.5	4.2
November 2021	0.6	0.2	0.8	8.9
December 2021	0.2	0	0.9	6.9

NS = hydrogen sulphide not sampled (monitoring station not deployed at this stage)

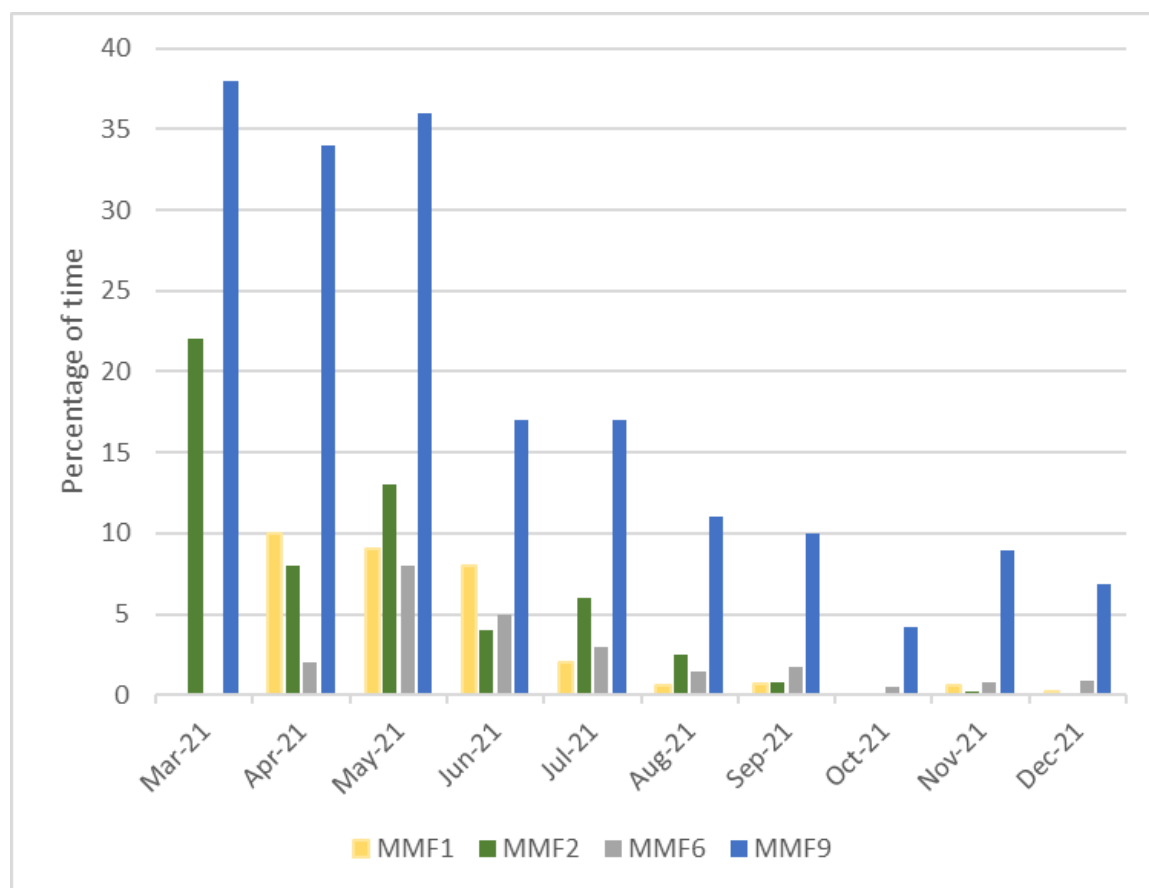
*Data from 5th March 2021 to 31st March 2021

**Data from 6th March 2021 to 31st March 2021

***Data from 14th April 2021 to 30th April 2021

****Data from 24th April 2021 to 30th April 2021

Figure 2: Monthly percentage of time that each monitoring station location has recorded hydrogen sulphide concentrations above WHO odour annoyance level ($7 \mu\text{g}/\text{m}^3$)



Odours can become a nuisance and start to affect people, causing temporary symptoms including headache, nausea, dizziness, watery eyes, stuffy nose, irritated throat, cough or wheeze particularly if a person has a pre-existing respiratory condition, sleep problems and stress. Individuals will react differently to the odour of hydrogen sulphide. Some people may be more sensitive to hydrogen sulphide odour than others. As the hydrogen sulphide concentration increases more people would be expected to have symptoms, particularly when the concentration exceeds the WHO 30-minute odour annoyance level of $7 \mu\text{g}/\text{m}^3$ on a regular basis.

The concentrations of hydrogen sulphide continue to be above the WHO odour annoyance guideline value for a considerable percentage of the time at one of the monitoring sites, which is undesirable due to the effects on people's wellbeing and the symptoms they are experiencing. This is reflected in the impacts on the effects on people's wellbeing and the symptoms they are experiencing, as reported to Staffordshire County Council's Smell and Symptom Tracker ([link](#)).

Even at hydrogen sulphide concentrations below the WHO odour annoyance guideline value odour may still be present, however as concentrations fall to even lower levels it is anticipated that the strength of any odour should also reduce.

UKHSA continues to strongly recommend that all appropriate measures are taken to reduce the off-site odours from the landfill site.

WHO 24-hour (average) guideline

The monitoring data has been converted to 24-hour averages for each of the monitoring days. At MMF1, MMF2 and MMF6 24-hour average values were significantly below the WHO 24-hour average guideline value of 150 µg/m³.

At MMF9, the 24-hour average guideline value has been exceeded on two days at the beginning of the monitoring period: 7 and 8 March 2021, with 24-hour average concentrations of 163 µg/m³ (7 March 2021) and 202 µg/m³ (8 March 2021). No further exceedances have occurred to date, and subsequent 24-hour average values have been significantly below the WHO 24-hour average guideline value of 150 µg/m³.

Exposure to concentrations of hydrogen sulphide above the WHO 24-hour guideline value does not necessarily mean eye irritation or other health effects will occur, but it reduces the margin of safety that is considered desirable to protect health.

Peak exposures

Short-term peaks in hydrogen sulphide concentration have been compared against the US Environmental Protection Agency (US EPA) Acute Exposure Guideline Levels (AEGLs) (see Table 5).

Table 5: US Environmental Protection Agency (US EPA) Acute Exposure Guideline Levels (AEGLs) for hydrogen sulphide

	10 min	30 min	60 min	4 hour	8 hour
AEGL-1[†]					
ppb	750	600	510	360	330
µg/m ³	(1045)	(836)	(711)	(502)	(460)
AEGL-2^{††}					
ppb	41000	32000	27000	20000	17000
µg/m ³	(57150)	(44600)	(37660)	(27880)	(23700)
AEGL-3^{†††}					
ppb	76000	59000	50000	37000	31000
µg/m ³	(105900)	(82240)	(69690)	(51570)	(43210)

[†] The level of the chemical in air at or above which the general population could experience notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

^{††} The level of the chemical in air at or above which there may be irreversible or other serious long-lasting effects or impaired ability to escape.

^{†††} The level of the chemical in air at or above which the general population could experience life-threatening health effects or death⁴.

AEGLs are expressed as specific concentrations of airborne chemicals at which health effects may occur and used to assess peaks of exposure. They are designed to protect the elderly and children, and other individuals who may be susceptible.

The monitoring data from MMF1, MMF2, MMF6 and MMF9 were compared with AEGL-1 10-minute, 30-minute, 60-minute, 4-hour and 8-hour levels for hydrogen sulphide (Figures 1-4 in the Appendix). At MMF1, MMF2 and MMF6, all concentrations were significantly below the AEGL-1 values.

At MMF9, the AEGL-1 level was exceeded across the AEGL timeframes between the 7 and 8 of March 2021 as set out in Table 6. No further exceedances have occurred, and all later concentrations were significantly below the AEGL-1 values.

Exposure to concentrations above the AEGL-1 values may cause notable discomfort, irritation or certain asymptomatic, non-sensory effects. However, the effects are not disabling, and are transient and reversible upon cessation of exposure.

Table 6: AEGL-1 timeframes

	Acute Exposure Guideline Levels (AEGLs)				
	10 min	30 min	60 min	4 hour	8 hour
Timeframe of exceedances of AEGL-1 at MMF9	0615 - 0650 hrs (8 th March)	0550 - 0655 hrs (8 th March)	0415 - 0650 hrs (8 th March)	0210 - 0550hrs (8 th March)	2245 hrs (7 th March) - 0230 hrs (8 th March)

Note that exceedances of AEGLs occur when rolling-average concentrations over a given AEGL duration (ie, 10 min, 30min, 60min, 4 hour and 8hour) exceed the corresponding AEGL concentration.

Hydrogen sulphide medium-term exposure

To assess medium-term exposure to hydrogen sulphide during 2021, the calculated average concentrations from March to December have been compared against the Agency for Toxic Substances and Disease Registry (ATSDR) Intermediate Minimal Risk Level (MRL) of 30 µg/m³, which applies cumulatively to up to 1 year. The average hydrogen sulphide concentrations across the whole monitoring period are given in Table 7:

Table 7: Cumulative average concentrations for hydrogen sulphide

Monitoring Station	Cumulative concentration (µg/m ³)	Monitoring dates
MMF1	1.4	14/04/2021 to 31/12/2021
MMF2	1.9	05/03/2021 to 31/12/2021
MMF6	1.8	24/04/2021 to 31/12/2021
MMF9	9.2	06/03/2021 to 31/12/2021

At all the monitoring stations, the average hydrogen sulphide concentrations over the period March to December 2021 are below the ATSDR Intermediate MRL. This means that the concentrations experienced in 2021 are unlikely to cause a lasting impact to physical health, and as such, any risk to long-term (lifetime) physical health is likely to be small.

The monthly average and cumulative-monthly average hydrogen sulphide concentrations for MMF9 (the monitoring station with the highest recorded concentrations of hydrogen sulphide) are shown in Figure 3 below.

Monthly average hydrogen sulphide concentrations are provided in Table 8 and Figure 4 below.

Figure 3: MMF9 monthly average and cumulative-monthly average hydrogen sulphide concentrations

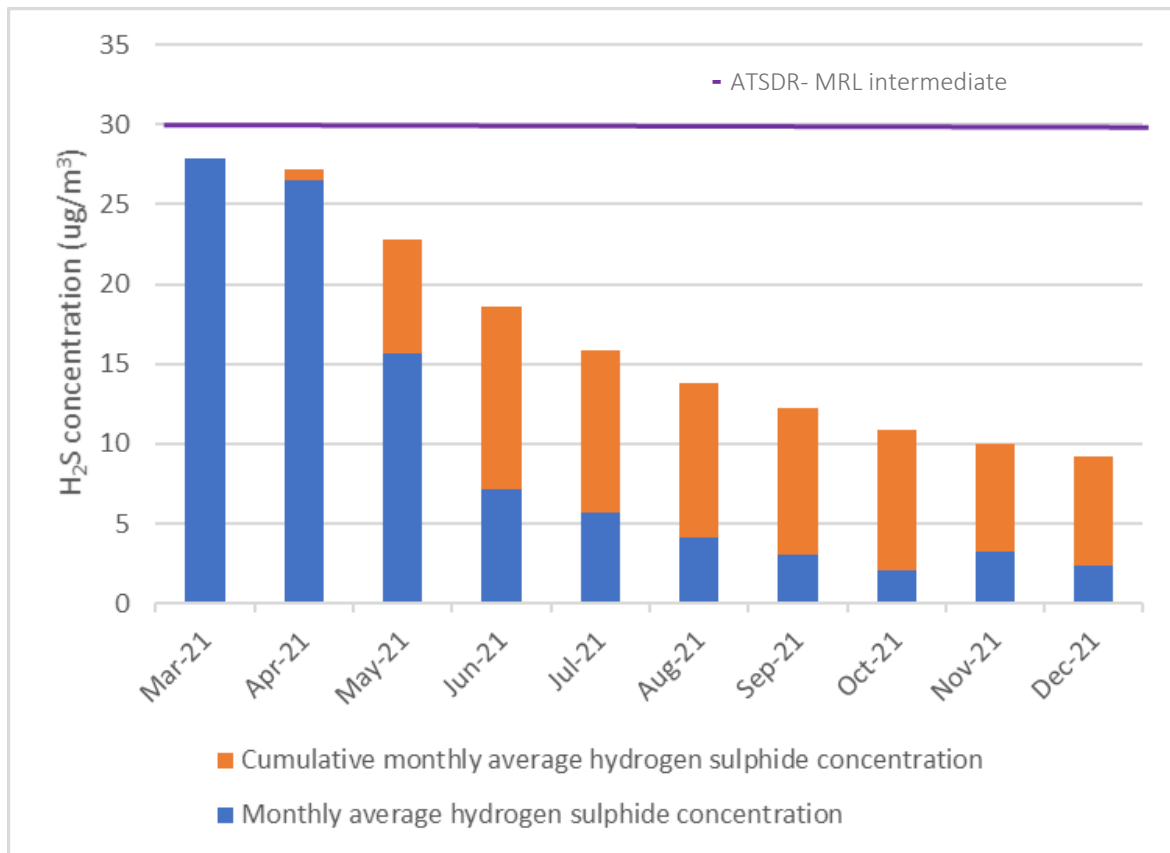


Table 8: Monthly average concentrations for hydrogen sulphide

Dates	Monitoring Station			
	MMF1 (µg/m³)	MMF2 (µg/m³)	MMF6 (µg/m³)	MMF9 (µg/m³)
March 2021	NS	5.8*	NS	27.9**
April 2021	3.0***	2.7	1.4****	26.5
May 2021	2.4	3.1	3.6	15.7
June 2021	1.9	2.0	2.4	7.2
July 2021	1.3	1.9	1.5	5.7
August 2021	0.8	1.3	1.2	4.1
September 2021	1.2	0.9	1.3	3.1
October 2021	0.9	0.9	1.2	2.1
November 2021	0.7	0.6	1.4	3.3
December 2021	1.1	0.7	1.5	2.4

NS = hydrogen sulphide not sampled (monitoring station not deployed at this stage)

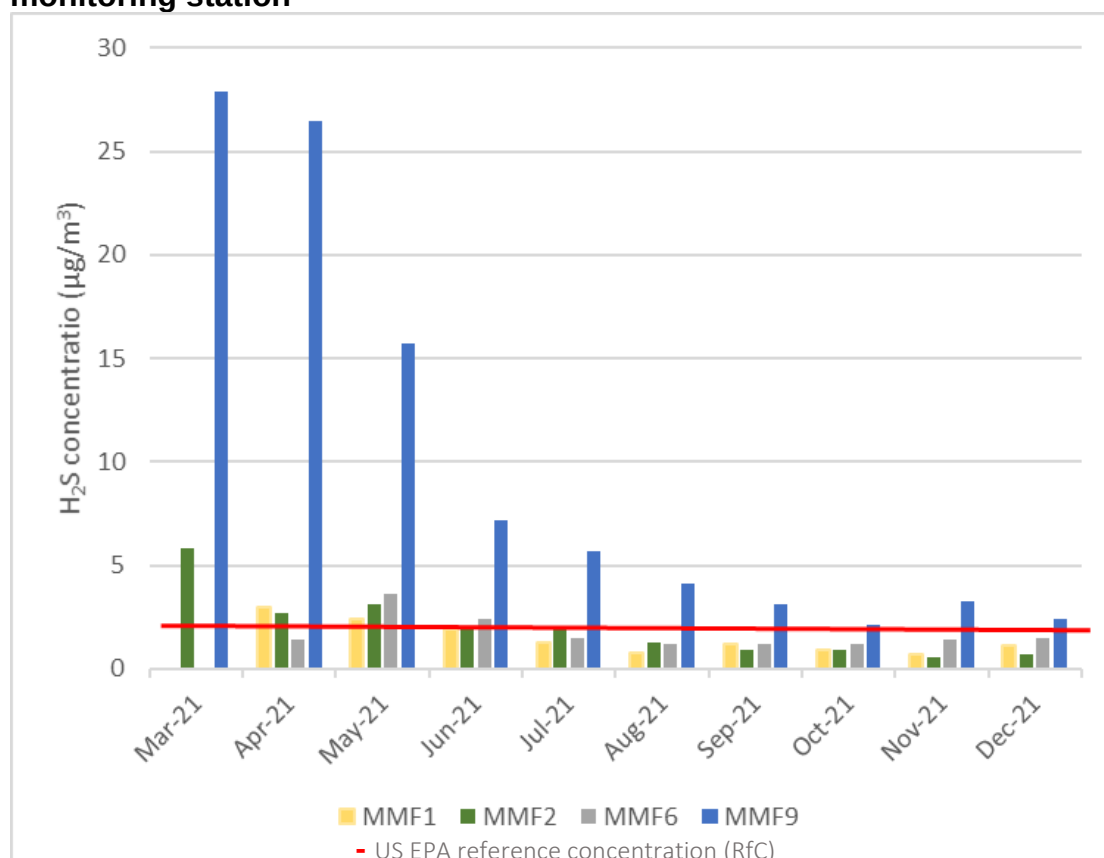
*Data from 5th March 2021 to 31st March 2021

**Data from 6th March 2021 to 31st March 2021

***Data from 14th April 2021 to 30th April 2021

****Data from 24th April 2021 to 30th April 2021

Figure 4: Monthly average hydrogen sulphide concentrations at each monitoring station



Hydrogen sulphide long-term exposure

To assess long-term exposure to hydrogen sulphide, data has been compared against the US EPA Reference Concentration (RfC) shown in Table 2. The RfC is an estimate of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Exposure to concentrations of hydrogen sulphide above the US EPA RfC does not necessarily mean health effects will occur, but it reduces the margin of safety^c that is considered desirable to protect health.

At MMF1, the monthly average concentrations since June 2021 have been below the US EPA RfC of 2 µg/m³. At MMF2 and MMF6, the monthly average concentrations since July 2021 have been below the US EPA RfC of 2 µg/m³ (Figure 4). If these concentrations continue, the risk to long-term (lifetime) health would be minimal.

At MMF9, the monthly average concentration for December is slightly lower to that for November. Prior to November, monthly average concentrations indicated a downward trend, although remaining above the US EPA RfC (Figure 4). Currently, as the cumulative and monthly concentrations are below the ATSDR Intermediate MRL (see above), the risk to long-term (lifetime) health is likely to be small, but it cannot be completely excluded if the

^c Health-based guidance values are derived from animal or human data with a margin of safety applied to account for uncertainties in the data including potential differences in human response compared to that of an animal species and the variability in response in the human population due to factors such as genetic profile, age, and health status.

monthly average concentrations continue to be above the US EPA RfC. The lower the concentrations become, the smaller any risk will be.

Assessment of previous monitoring data for hydrogen sulphide

In considering long-term exposure to hydrogen sulphide, the previous monitoring data from 6 July 2017 to 14 February 2018 and 15 January 2019 to 25 June 2019 monitoring periods should also be taken into account in the assessment against the US EPA RfC shown in Table 2.

For the 2017/18 monitoring period the average concentration was $0.85 \mu\text{g}/\text{m}^3$ and for the 2019 monitoring period the average concentration was $0.95 \mu\text{g}/\text{m}^3$. These previous concentrations are below the US EPA RfC, therefore they would not be expected to contribute to any significant effects on health.

Particulate matter

Table 9: Particulate matter UK Air Quality Objectives

Substance	UK limit values
PM ₁₀	50 µg/m ³ not to be exceeded more than 35 times a year 24 hour mean
	40 µg/m ³ Annual mean
PM _{2.5}	25 µg/m ³ Annual mean

Table 10: Average particulate matter concentrations

Monitoring Station	50 µg/m ³ not to be exceeded more than 35 times a year (count)	Monitoring dates
MMF1	7	12/04/2021 to 31/12/2021
MMF2	1	04/03/2021 to 31/12/2021
MMF6	0	29/04/2021 to 31/12/2021
MMF9	0	05/03/2021 to 31/12/2021
Monitoring Station	Average PM ₁₀ concentration (µg/m ³)	Monitoring dates
MMF1	15.2	12/04/2021 to 31/12/2021
MMF2	14.1	04/03/2021 to 31/12/2021
MMF6	11.4	29/04/2021 to 31/12/2021
MMF9	11.5	05/03/2021 to 31/12/2021
Monitoring Station	Average PM _{2.5} concentration (µg/m ³)	Monitoring dates
MMF1	7.9	14/04/2021 to 31/12/2021
MMF2	8.1	04/03/2021 to 31/12/2021
MMF6	7.5	24/04/2021 to 31/12/2021
MMF9	7.5	05/03/2021 to 31/12/2021

These results are all below the relevant annual air quality objectives.

Nitrogen dioxide

Table 11: Nitrogen dioxide (NO₂) UK Air Quality Objectives

Substance	UK limit values
NO ₂	200 µg/m ³ not to be exceeded more than 18 times a year 24-hour mean
	40 µg/m ³ Annual mean

Table 12: Average NO₂ concentrations

Monitoring Station	Average concentration (µg/m ³)	Monitoring dates
MMF2	13.8	04/03/2021 to 31/12/2021
MMF9	10.4	04/03/2021 to 31/12/2021

These results are all well below the relevant annual air quality objectives in the UK Air Quality Strategy.

Sulphur dioxide

Table 13: Sulphur dioxide (SO₂) UK Air Quality Objectives

Substance	UK limit values
SO ₂	266 µg/m ³ not to be exceeded more than 35 times a year 15 min mean
	350 µg/m ³ not to be exceeded more than 24 times a year 1 hour mean
	125 µg/m ³ not to be exceeded more than 3 times a year 24 hour mean

Table 14: Average SO₂ concentrations

Monitoring Station	Average concentration (µg/m ³)	Monitoring dates
MMF1	1.2	24/06/2021 to 31/12/2021
MMF6	1.4	24/06/2021 to 31/12/2021
MMF9	3.7	28/05/2021 to 31/12/2021

The SO₂ data for the period averaged are all well below the respective limit values for SO₂ in the UK Air Quality Strategy. Therefore, no significant risks to health from SO₂ are expected during this monitoring period.

Methane

Methane (CH₄) is generally considered to be an asphyxiant rather than a toxic gas. It is typically only a risk to health in high concentrations in enclosed spaces. There are no ambient air quality standards. However, levels greater than 80% methane may cause asphyxia (1% methane is equivalent to 6,556 mg/m³) and the Lower Explosive Limit is 32,781 mg/m³.

The average concentration of methane recorded are given in Table 15.

Table 15: Average methane concentrations

Monitoring Station	Average concentration (mg/m ³)	Monitoring dates
MMF1	2.3	14/04/2021 to 31/12/2021
MMF2	2.4	05/03/2021 to 31/12/2021
MMF6	1.7	24/04/2021 to 31/12/2021
MMF9	3.6	06/03/2021 to 31/12/2021

All the maximum concentrations of methane were significantly below the values discussed above.

Benzene, toluene, ethylbenzene and xylene (BTEX)

Benzene

Table 16: Benzene UK Air Quality Objective and health-based guidance value

Substance	UK Air Quality Objective and health-based guidance value
Benzene	UK Air Quality Objective: 5 µg/m ³ (annual mean)
	Short-term Environmental Assessment Level (EAL)*: 30 µg/m ³ (24-hour mean)

* EALs represent a pollutant concentration in ambient air at which no significant risks to public health are expected⁵.

Table 17: Average and maximum 30-minute benzene concentrations

Monitoring Station	Average concentration (µg/m ³)	Monitoring dates
MMF2	0.26	10/03/2021 to 05/01/2022
MMF9	0.30	10/03/2021 to 05/01/2022
Monitoring Station	Maximum 30-minute concentration (µg/m ³)	Monitoring dates
MMF2	9.21	10/03/2021 to 05/01/2022
MMF9	5.58	10/03/2021 to 05/01/2022

The calculated averages for the monitoring period are below the UK Air Quality Objective and the maximum 30-minute concentrations are below the short-term EAL therefore there would not be expected to be any significant risks to health at these levels of exposure.

Toluene

Table 18: Toluene health-based guidance values

Substance	Health-based guidance values
Toluene	PHE indoor air quality guideline (long-term)*: 2300 µg/m ³ (24-hour average)
	PHE indoor air quality guideline value (short-term)*: 15,000 µg/m ³ (8-hour average)
	WHO odour detection threshold level**: 1000 µg/m ³ (30-minute average)

*An estimate of a level human exposure to a chemical in air at which no significant risks to health are expected. Whilst these values have been set to assess indoor exposure, they are also relevant for assessment of outdoor exposure⁶.

** The WHO recommends that the peak concentrations of toluene in air should be kept below the odour detection threshold level of 1000 µg/m³ as a 30-minute average⁷.

Table 19: Average and maximum 30-minute toluene concentrations

Monitoring Station	Average concentration (µg/m ³)	Monitoring dates
MMF2	1.89	10/03/2021 to 05/01/2022
MMF9	2.78	10/03/2021 to 05/01/2022
Monitoring Station	Maximum 30-minute concentration (µg/m ³)	Monitoring dates
MMF2	51.45	10/03/2021 to 05/01/2022
MMF9	40.72	10/03/2021 to 05/01/2022

The calculated averages and maximum 30-minute concentrations are below the health-based guidance values. Therefore, there would not be expected to be any significant risk to health at these levels of exposure.

Ethylbenzene

Table 20: Ethylbenzene health-based guidance values

Substance	Health-based guidance values
Ethylbenzene	ATSDR chronic MRL*: 260 µg/m ³
	ATSDR acute MRL*: 27,700 µg/m ³

*An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure. They are derived for acute (>1, ≤14 days), intermediate (>14, <364 days), and chronic (365 days and longer) exposure durations⁸.

Table 21: Average and maximum 30-minute ethylbenzene concentrations

Monitoring Station	Average concentration (µg/m ³)	Monitoring dates
MMF2	0.67	10/03/2021 to 05/01/2022
MMF9	0.51	10/03/2021 to 05/01/2022
Monitoring Station	Maximum 30-minute concentration (µg/m ³)	Monitoring dates
MMF2	121.56	10/03/2021 to 05/01/2022
MMF9	88.58	10/03/2021 to 05/01/2022

The calculated averages and maximum 30-minute concentrations are below the health-based guidance values. Therefore, there would not be expected to be any significant risk to health at these levels of exposure.

Xylene

Table 22: Xylene health-based guidance values

Substance	Health-based guidance values
Xylene	PHE indoor air quality guideline value (long-term)*: 100 µg/m ³
	ATSDR acute MRL**: 9000 µg/m ³

*An estimate of a level human exposure to a chemical in air at which no significant risks to health are expected. Whilst these values have been set to assess indoor exposure, they are also relevant for assessment of outdoor exposure⁶.

**An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure. They are derived for acute (>1, ≤14 days), intermediate (>14, <364 days), and chronic (365 days and longer) exposure durations⁹

Table 23: Average and maximum 30-minute xylene concentrations

Monitoring Station	Average concentration (µg/m ³)	Monitoring dates
MMF2	2.19	10/03/2021 to 05/01/2022
MMF9	1.42	10/03/2021 to 05/01/2022
Monitoring Station	Maximum 30-minute concentration (µg/m ³)	Monitoring dates
MMF2	58.59	10/03/2021 to 05/01/2022
MMF9	140.28	10/03/2021 to 05/01/2022

The calculated averages for the monitoring period are below the PHE indoor air quality guideline value and the maximum 30-minute concentrations are below the ATSDR acute MRL therefore there would not be expected to be any significant risks to health at these levels of exposure.

Conclusions

The monitoring results for particulate matter, nitrogen dioxide and sulphur dioxide were below UK air quality objectives. Levels of benzene, toluene, ethylbenzene and xylene were below health-based guidance values. Therefore, there would be minimal risks to health at these levels of exposure.

The results for hydrogen sulphide continue to be above the WHO odour annoyance guideline value for a considerable percentage of the time at one of the monitoring sites, which is undesirable due to the effects on people's wellbeing and the symptoms they are experiencing.

For the vast majority of the monitoring period from March to December 2021, the concentrations of hydrogen sulphide were below the short-term WHO 24-hour health-based guideline value and AEGL values. The WHO 24-hour value and the AEGLs values were exceeded over a 2-day period on 7 and 8 March 2021. Exposure to concentrations above these values could potentially cause notable discomfort and irritation. Exceedances of these values does not necessarily mean health effects will occur, but it reduces the margin of safety that is generally considered to be desirable to protect health.

The hydrogen sulphide data up to the end of December 2021 shows continuing exposure to the population around the site. At three of the monitoring sites, concentrations are below the US EPA RfC long-term (lifetime) health-based guidance value, as they have been since June/July 2021. At the fourth site, concentrations are slightly above the long-term (lifetime) health-based guidance value. The concentrations measured in December have plateaued and are broadly comparable to those levels observed since September, although they remain lower than the levels seen from March to August 2021 (Figure 4).

To assess the risk from the monitored concentrations in 2021, the data have been compared to the ATSDR intermediate MRL for exposure between 14 - 364 days, and the MRL has not been exceeded. As a result, currently any risk to long-term physical health is likely to be small, however we cannot completely exclude a risk to health from pollutants in the area, where exposure continues above the long-term health-based guidance values.

Short-term transient health effects may be experienced such as irritation to the eyes, nose and throat, in addition to effects resulting from odour such as headache, nausea, dizziness, watery eyes, stuffy nose, irritated throat, cough or wheeze, sleep problems and stress. Individuals with pre-existing respiratory conditions may be more susceptible to these effects. With continuing exposure these effects may be prolonged but are not anticipated to continue long-term once exposure has decreased to acceptable levels.

The EA and multi-agency partners will also be assessing additional factors such as meteorological conditions, complaints, and distance to receptors from the monitoring units. UKHSA will continue supporting the other agencies with this work.

Overall, UKHSA continues to strongly recommend that all appropriate measures are taken to reduce the off-site odours from the landfill site as early as possible, and reduce the concentrations in the local area to levels below those health-based guidance values used to assess long-term exposure.

References

- 1 World Health Organization (WHO) air quality guideline [Microsoft Word - 6.6-hydrogen sulfide.doc \(who.int\)](#)
- 2 U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological profile for Hydrogen Sulphide, 2006.
<http://www.atsdr.cdc.gov/ToxProfiles/tp114.pdf>
- 3 U.S. Environmental Protection Agency Reference Concentration for Hydrogen Sulphide.
https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=61
- 4 Hydrogen Sulphide Acute Exposure Guideline Levels (AEGLs) [Acute Exposure Guideline Levels for Airborne Chemicals | US EPA](#)
- 5 Environment Agency Environmental Assessment Levels (EALs)
<https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit>
- 6 Public Health England. Indoor Air Quality Guidelines for selected Volatile Organic Compounds (VOCs) in the UK, 2019.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/831319/VO_statement_Final_12092019_CS_1.pdf
- 7 World Health Organization (WHO) air quality guideline, Toluene.
https://www.euro.who.int/data/assets/pdf_file/0005/74732/E71922.pdf
- 8 U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological profile for ethylbenzene, 2010.
<https://www.atsdr.cdc.gov/ToxProfiles/tp110.pdf>
- 9 U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological profile for xylene, 2007.
<https://www.atsdr.cdc.gov/toxprofiles/tp71.pdf>

Appendix

Figure 1a: MMF1 Hydrogen sulphide

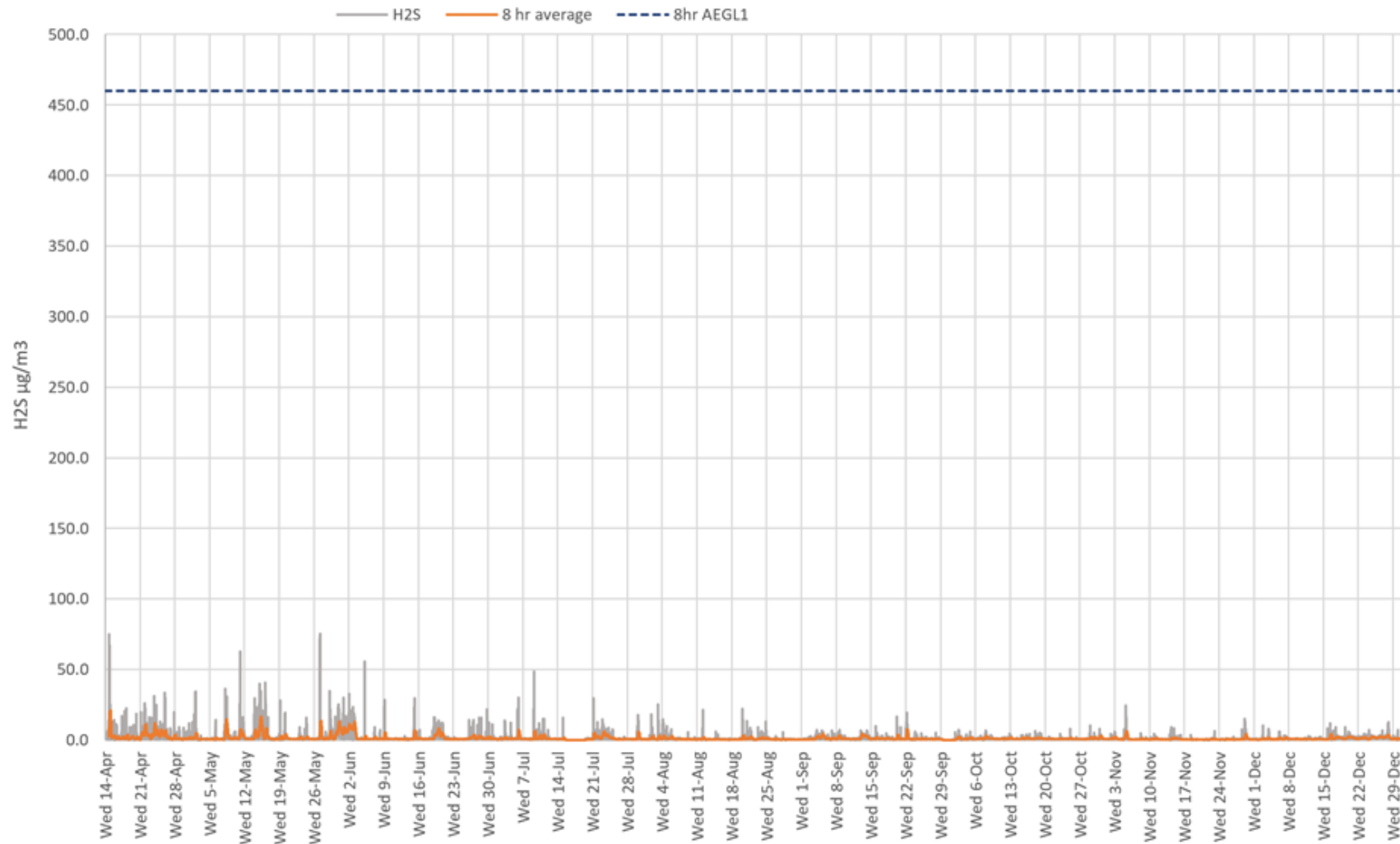


Figure 1b: MMF1 Hydrogen sulphide

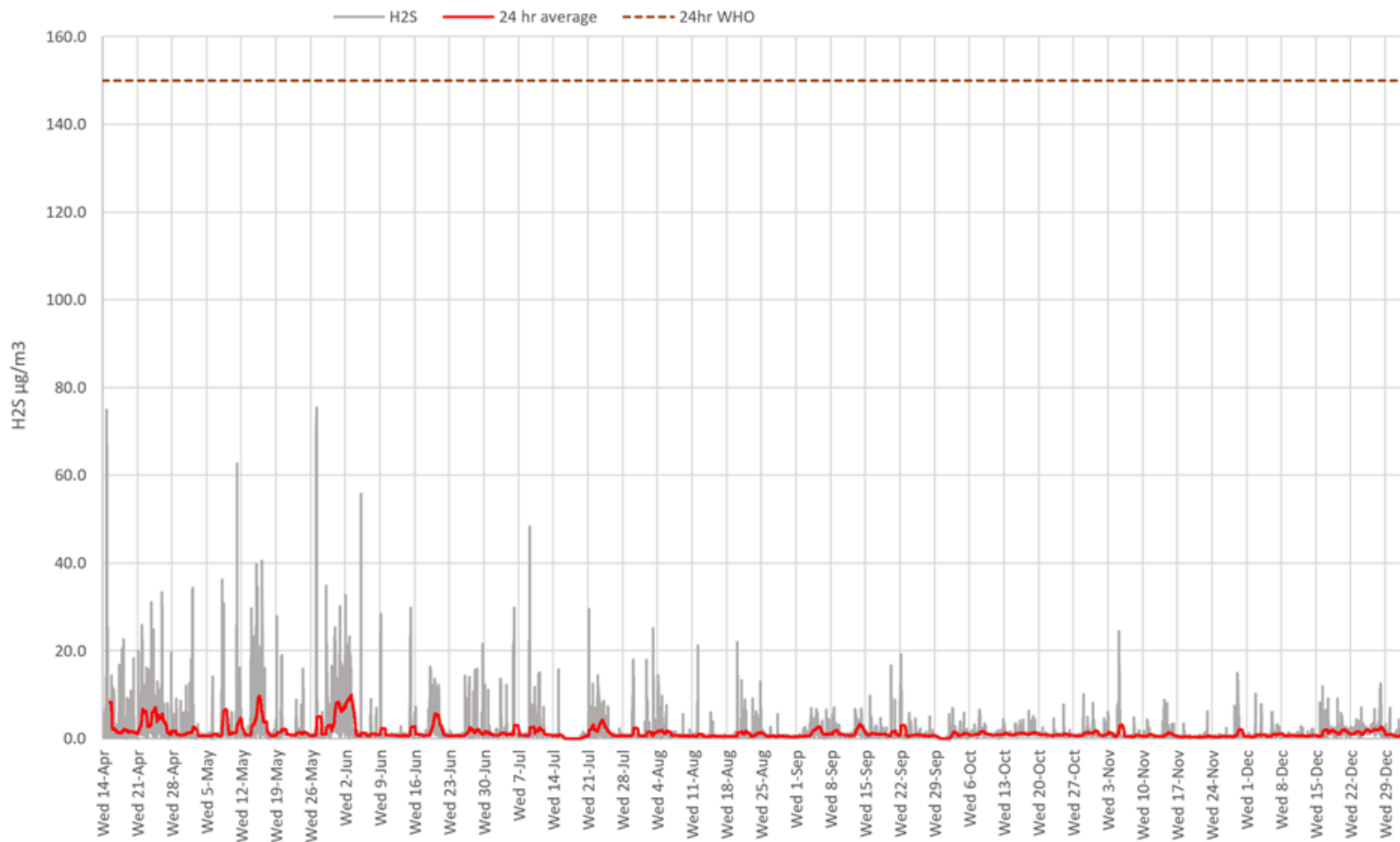


Figure 1c: MMF1 Hydrogen sulphide

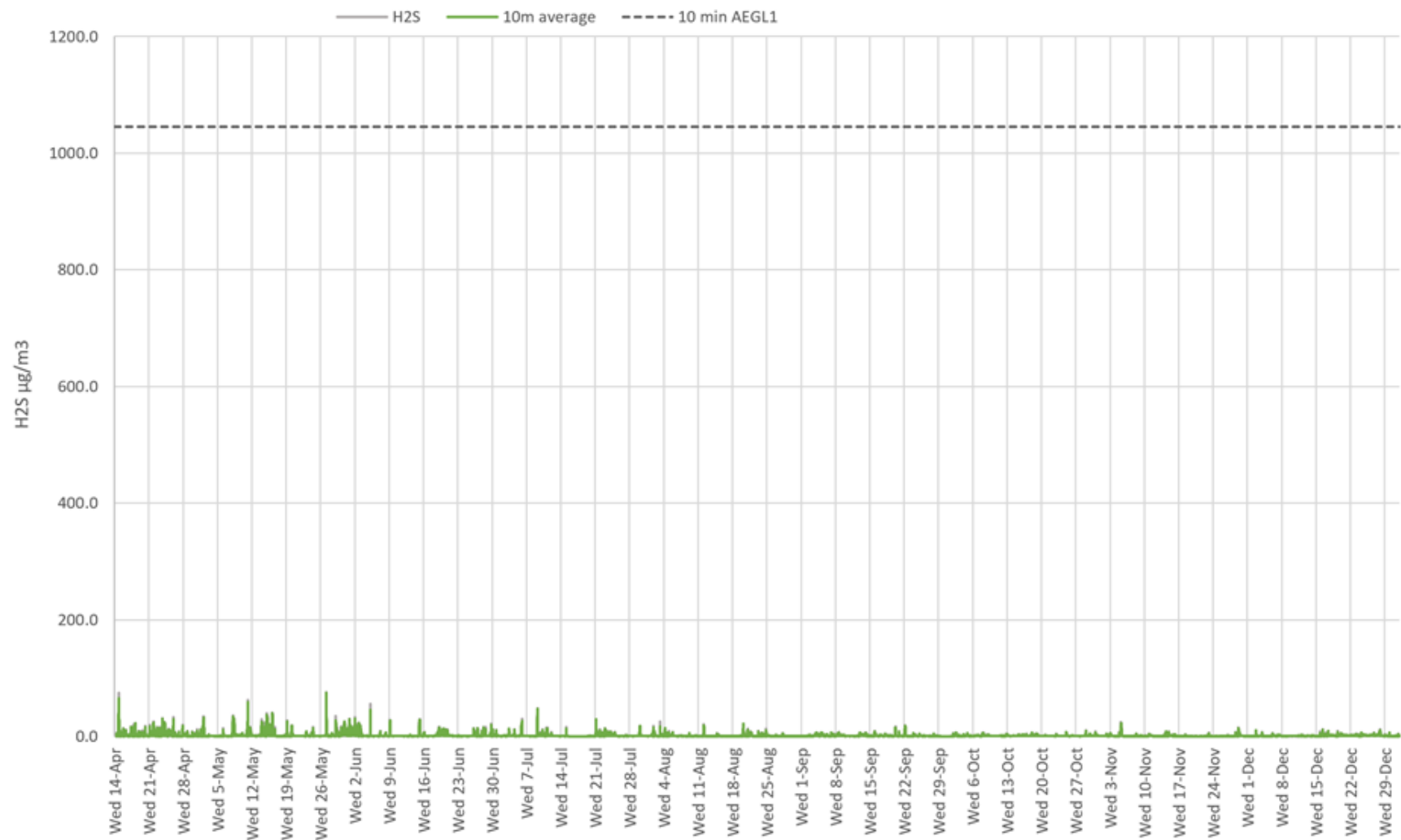


Figure 2a: MMF2 Hydrogen sulphide

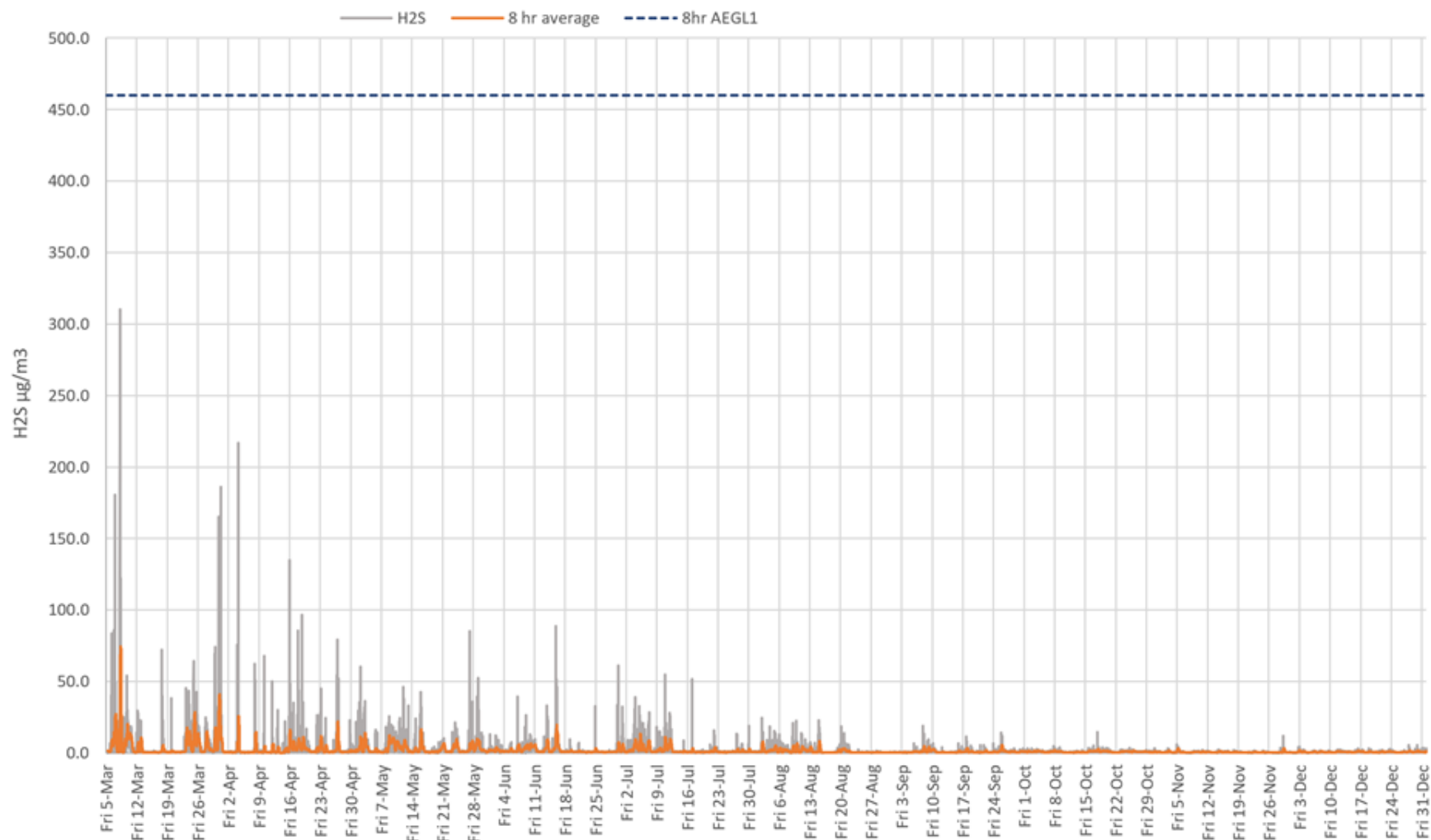


Figure 2b: MMF2 Hydrogen sulphide

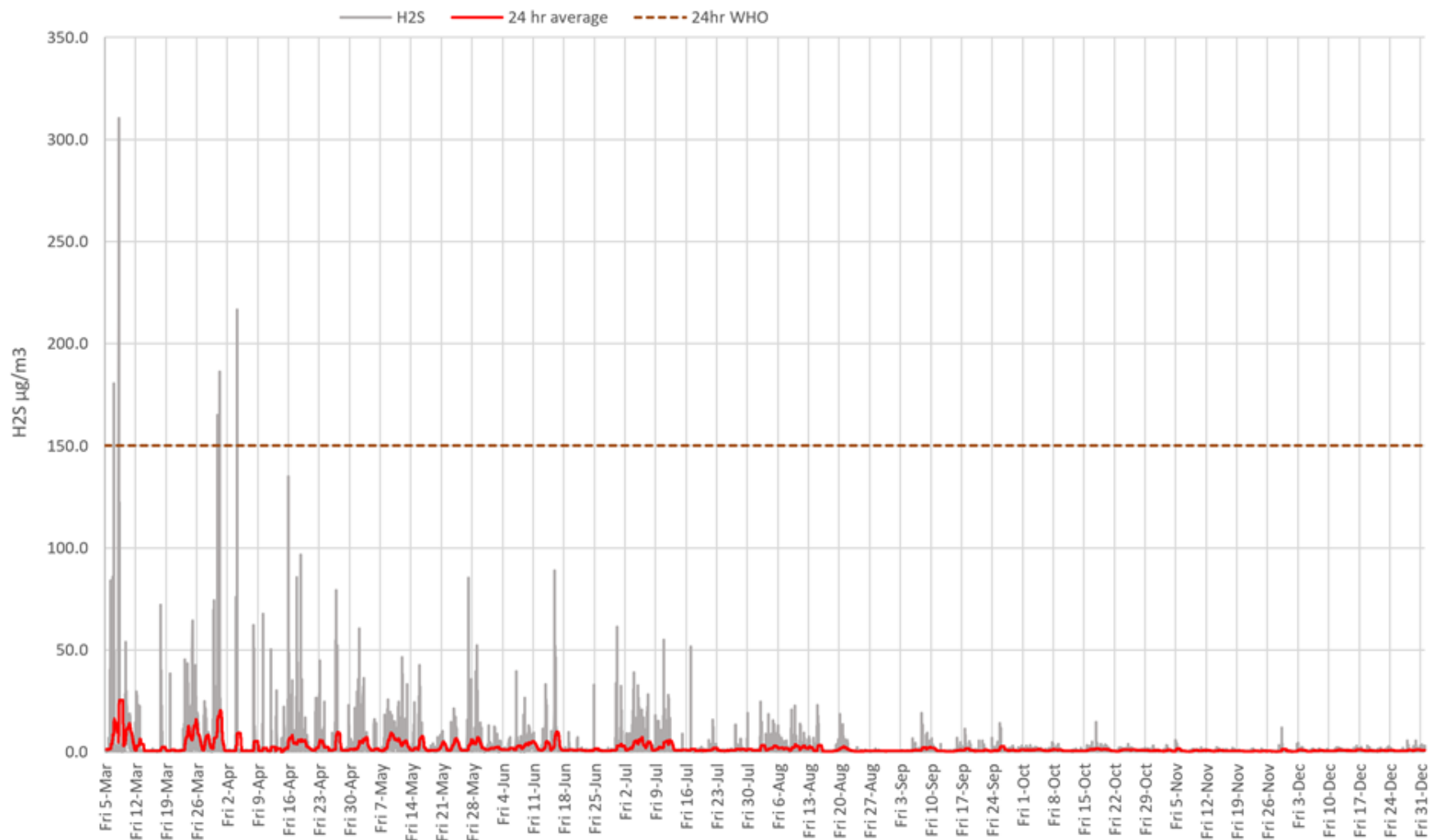


Figure 2c: MMF2 Hydrogen sulphide

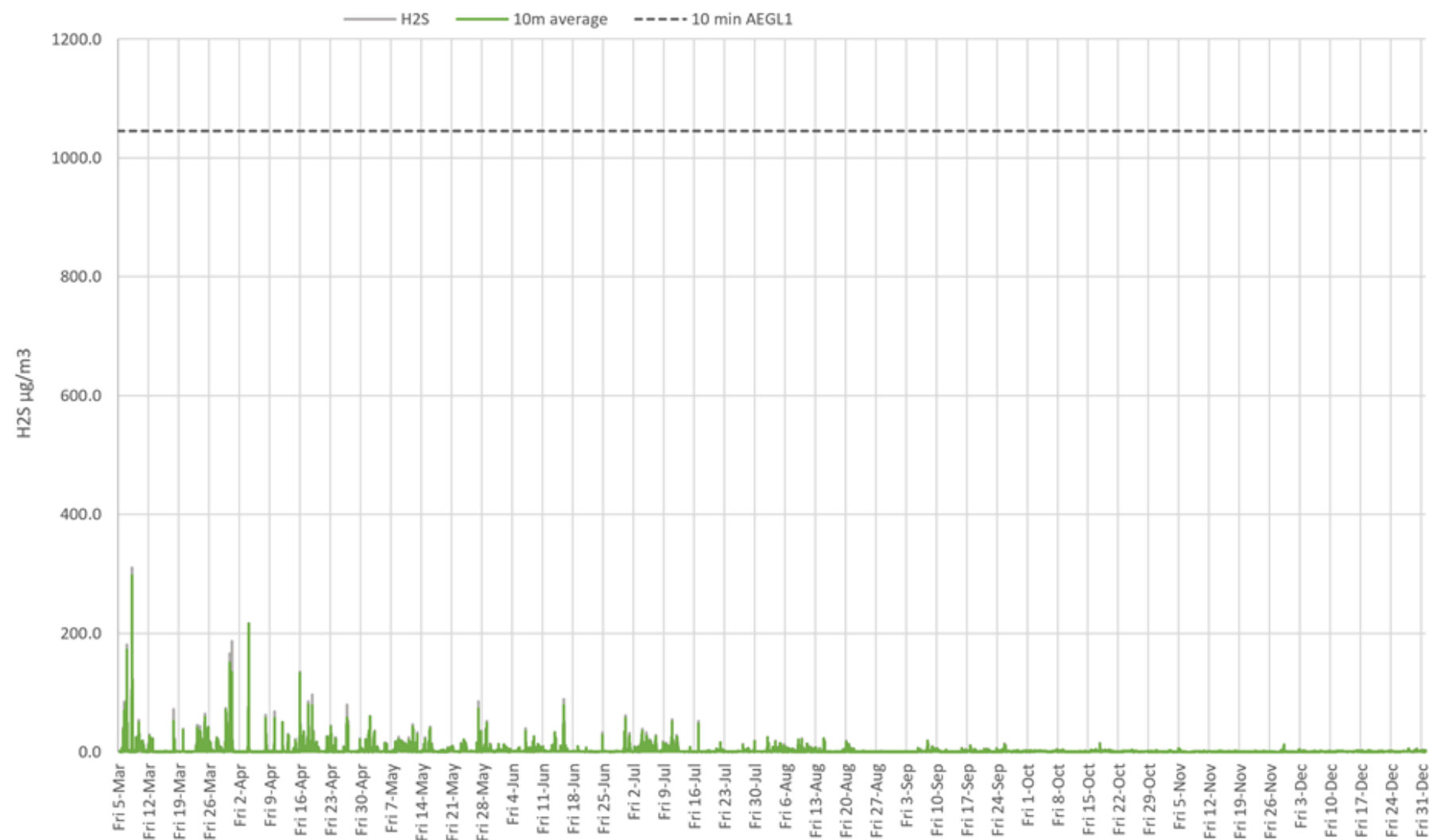


Figure 3a: MMF6 Hydrogen sulphide

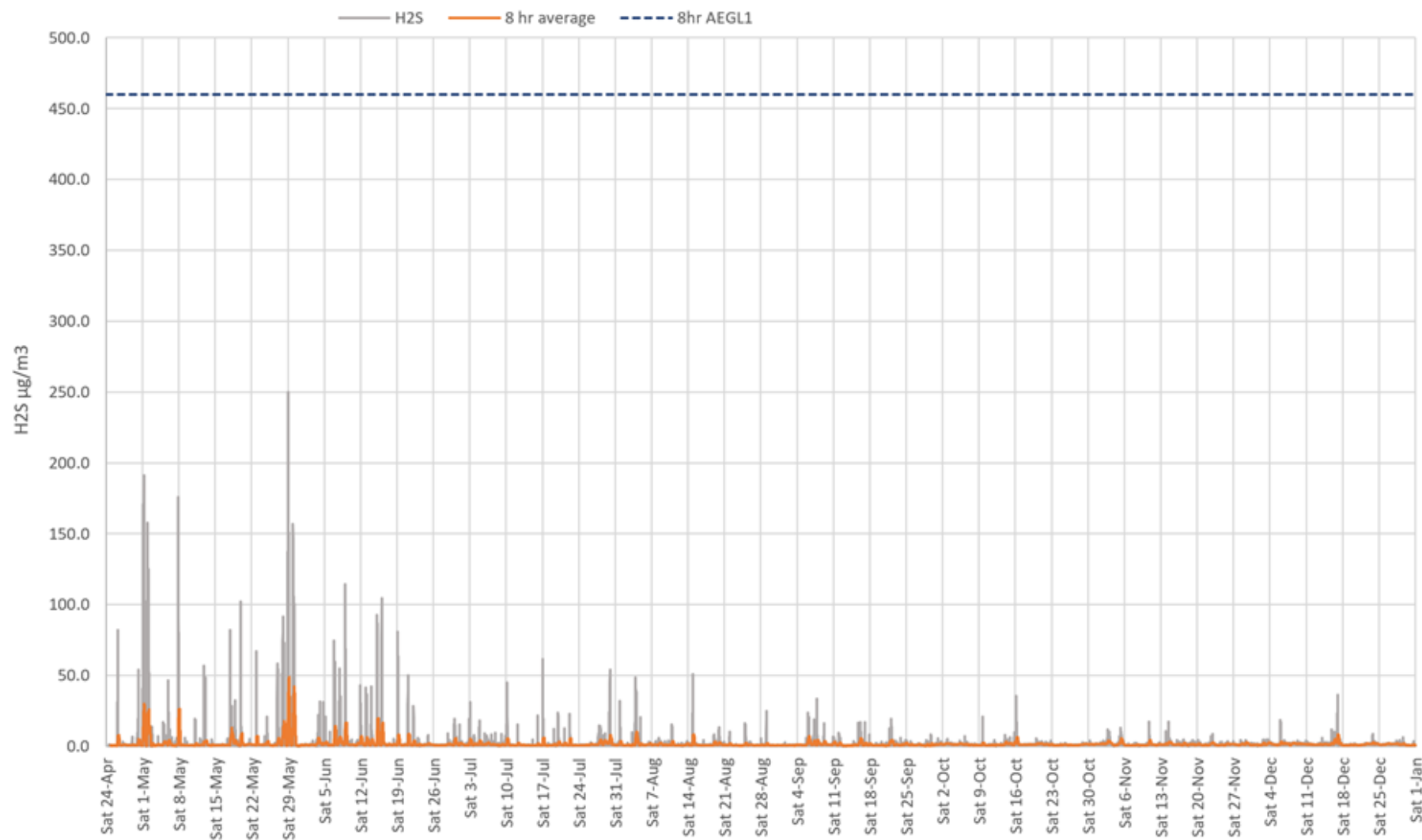


Figure 3b: MMF6 Hydrogen sulphide

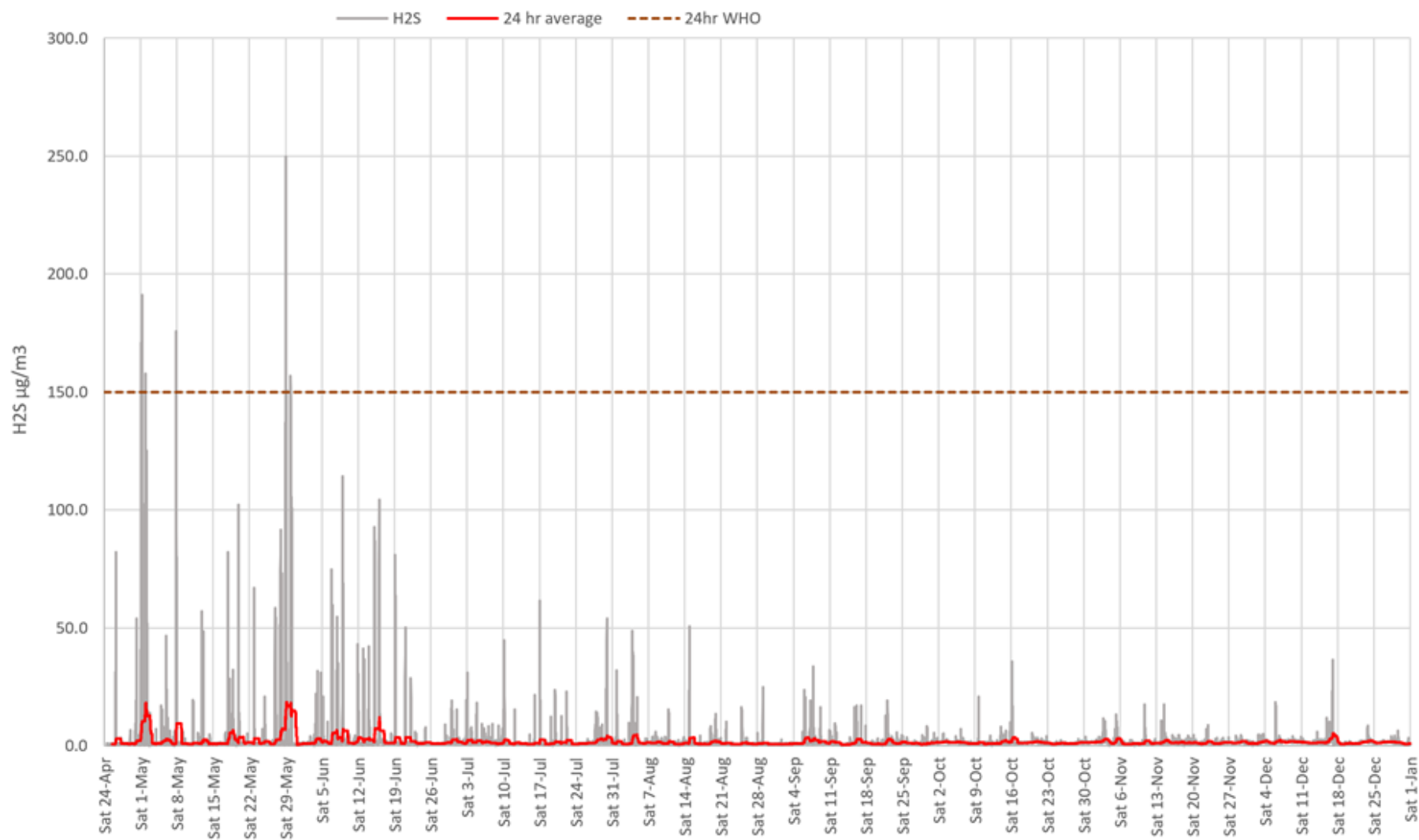


Figure 3c: MMF6 Hydrogen sulphide

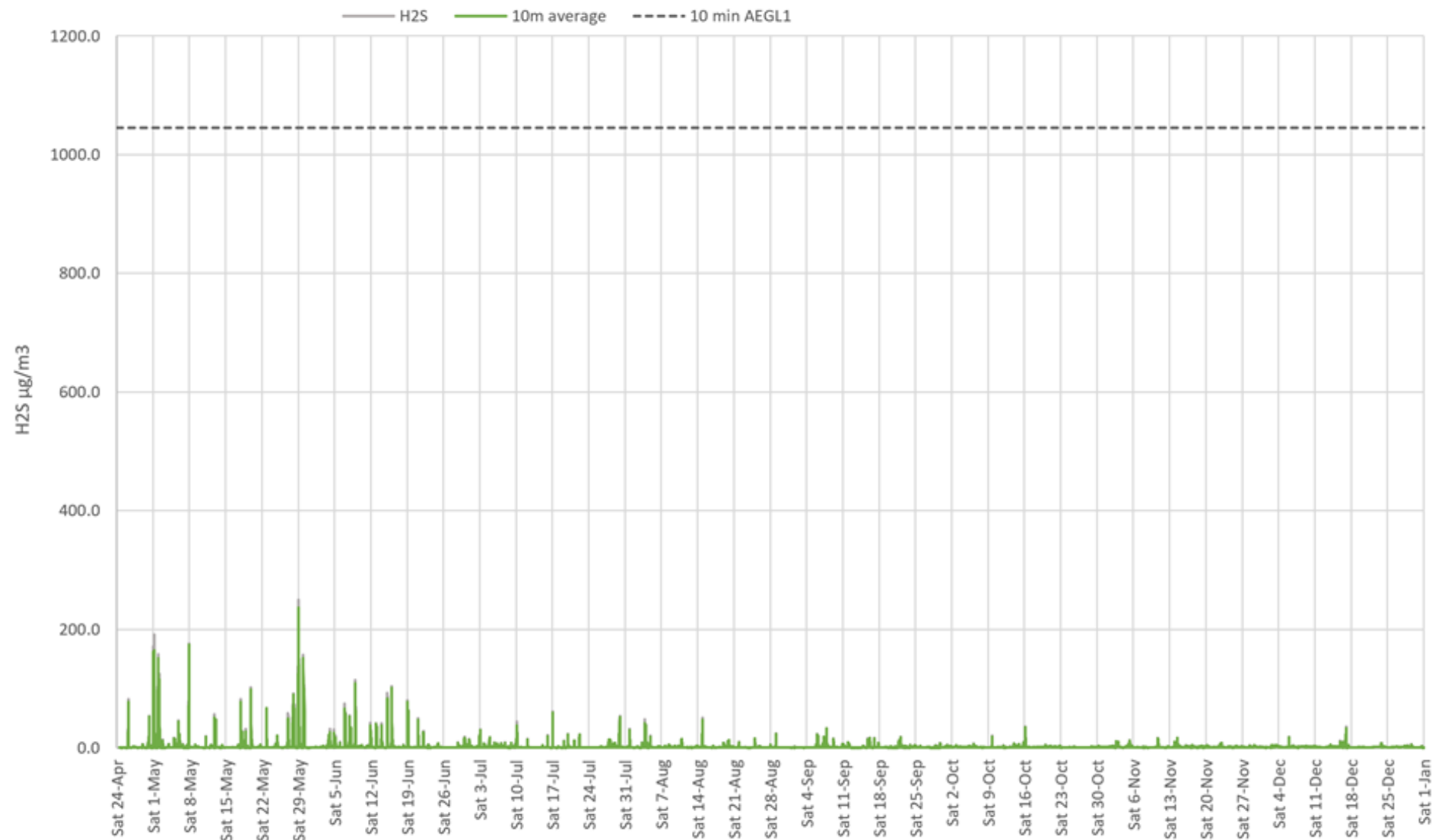


Figure 4a: MMF9 Hydrogen sulphide

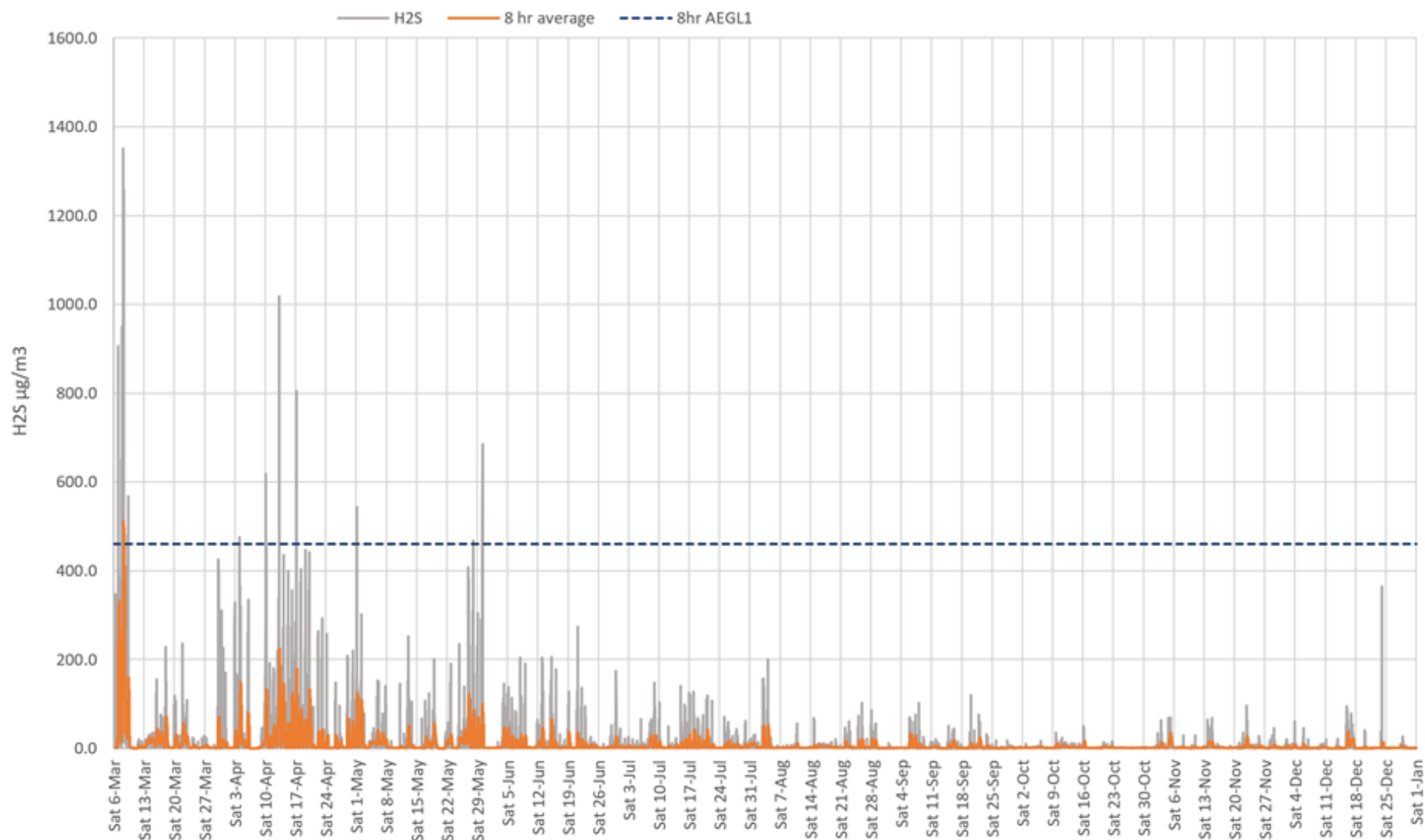


Figure 4b: MMF9 Hydrogen sulphide

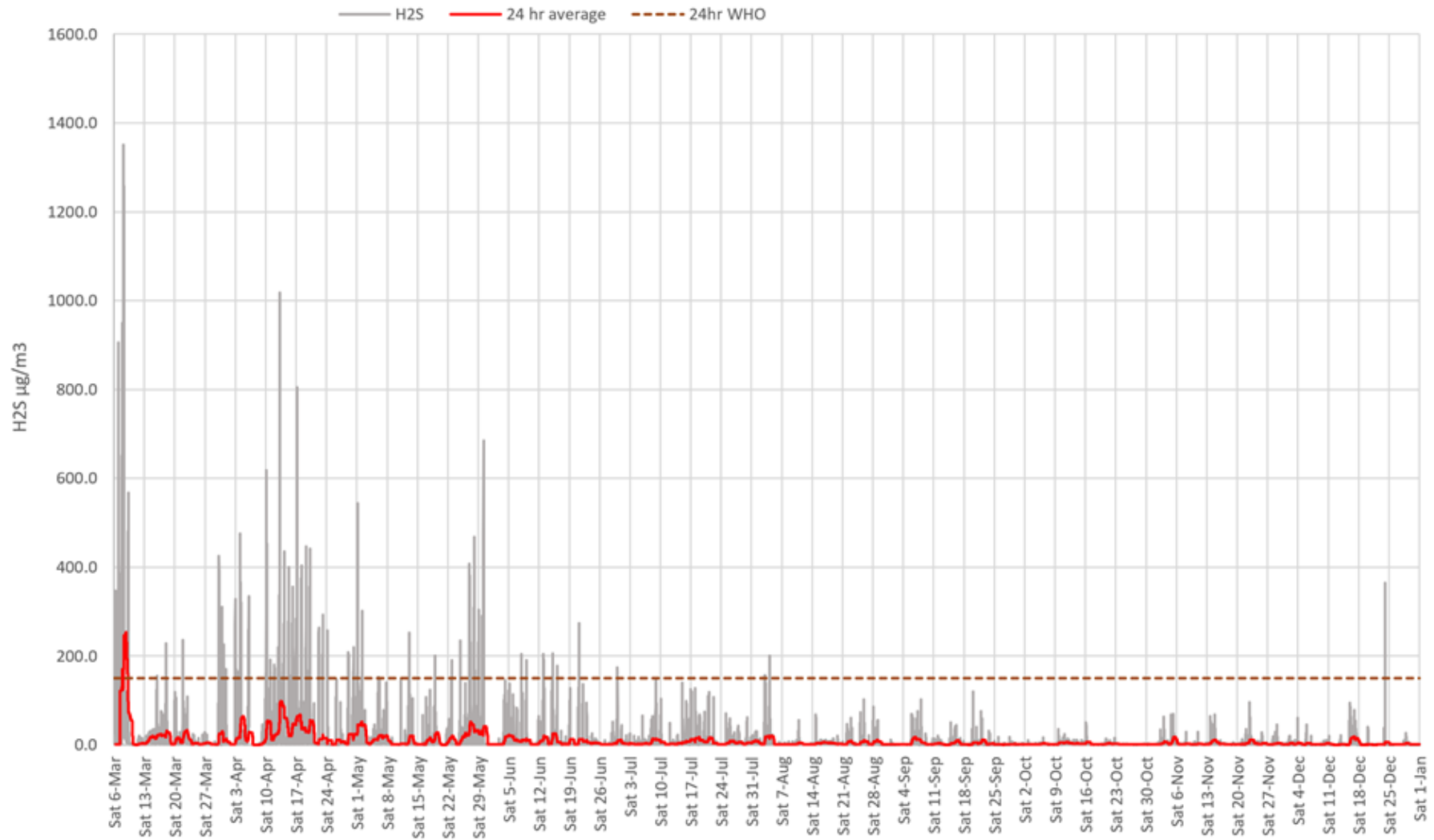


Figure 4c: MMF9 Hydrogen sulphide

