



Public Health
England

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

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

Non-Technical Summary

The site is owned by Walley's Quarry Limited (formerly Red industries), who operate the site as an active landfill which accepts non-hazardous waste, and a cell which accepts stable non-reactive hazardous waste (gypsum and asbestos). Activities at the site are regulated by the Environment Agency (EA) under an Environmental Permit first issued in 2016.

In response to increased community concern of odours within Silverdale and the surrounding areas, the EA installed four 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.

The data provided to Public Health England (PHE) by the EA, have been compared to available health-based air quality guidelines and standards or assessment levels for hydrogen sulphide, particulate matter, nitrogen dioxide, sulphur dioxide and methane. In addition, for hydrogen sulphide the concentrations have been compared to the odour annoyance guideline.

Air concentrations of particulate matter, nitrogen dioxide, sulphur dioxide and methane are lower than appropriate health-based standards or guidelines, 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 during 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 July 2021 shows continuing exposure to the population around the site, albeit concentrations in July are lower than those seen from March to June. Currently any risk to long term (lifetime) physical health is likely to be small, however, we would stress that we cannot completely exclude a risk to health from pollutants in the area, especially if exposure continues at these levels. 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, which is undesirable due to the effects on people’s wellbeing and the symptoms they are experiencing.

Therefore, PHE strongly recommends that all measures are taken to reduce the off-site odours from the landfill site.

Scope

The EA has shared with PHE, an Air Quality report based on monitoring data from MMF Stations MMF2 and MMF9 from which there is ratified data from the 5 March – 30 July 2021 (150 days) and 6 March – 30 July 2021 (149 days) respectively).

In April two additional monitors were deployed MMF1 from which there is data from the 14 April - 30 July 2021 (109 days) and MMF 6 from which there is ratified data from the 24 April – 30 July 2021 (99 days).

PHE has reviewed the available data from the MMF stations, listed below:

MMF 1 Location – Silverdale cemetery

MMF 2 Location – Silverdale Road, Newcastle under Lyme

MMF 6 Location – Newcastle community Fire Station

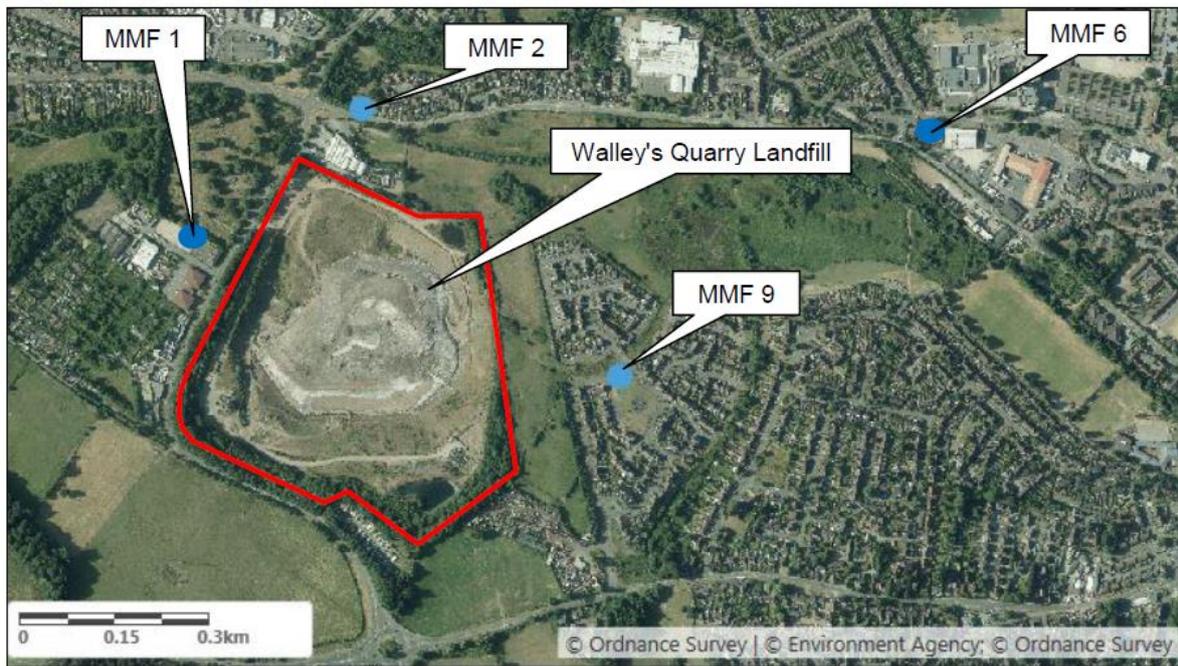
MMF 9 Location - Severn Trent Pumping Station off Galingale View, Newcastle under Lyme

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	✓	✓	✓	✓	✓	✓

*The EA is monitoring for benzene, toluene, ethylbenzene and xylene, however ratified data is not yet available for PHE to review.

Figure 1. Map showing the location of the four monitoring sites



Methodology

Air quality standards and assessment levels

The data provided to PHE have been compared to available health-based air quality guidelines and 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
- European air quality standards
- Other UK air quality assessment levels
- National air quality assessment levels (other than UK)

Hydrogen sulphide

The health-based guidance values considered 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 hydrogen sulphide concentrations were above the World Health Organization's odour annoyance guideline level (7 µg/m³, 30-minute average):

MMF1 (14/04/2021 to 31/07/2021): 8%
 MMF2 (05/03/2021 to 31/07/2021): 11%
 MMF6 (24/04/2021 to 31/07/2021): 5%
 MMF9 (06/03/2021 to 31/07/2021): 27%

As such, there was potential for significant odour complaints to occur over these periods.

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 µg/m³ on a regular basis. 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](#)).

PHE strongly recommends that all 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/m³.⁵

However, at MMF9, the 24-hour average guideline value was exceeded on two days during 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).

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

Table 3 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.

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 3).

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 time frames between the 7 and 8 of March as set out in Table 1 in the Appendix.

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.

Hydrogen sulphide medium term exposure

To assess medium term exposure to hydrogen sulphide during 2021, the calculated average of the daily exposure concentrations from the March - July data 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 daily hydrogen sulphide concentrations were:

MMF1 (14/04/2021 to 31/07/2021): 2.0 µg/m³
 MMF2 (05/03/2021 to 31/07/2021): 3.0 µg/m³
 MMF6 (24/04/2021 to 31/07/2021): 2.4 µg/m³
 MMF9 (06/03/2021 to 31/07/2021): 15.9 µg/m³

At all the monitoring stations, the average daily hydrogen sulphide concentrations over the period March to June 2021 are below the ATSDR Intermediate MRL. This means that the concentrations experienced so far 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.

Monthly mean hydrogen sulphide concentrations for complete months data is represented in the Table 4 below.

Table 4 - Monthly mean concentrations for hydrogen sulphide

Monitoring Station	March (µg/m ³)	April 2021 (µg/m ³)	May 2021 (µg/m ³)	June 2021 (µg/m ³)	July 2021 (µg/m ³)
MMF1	NS	3.0 ^{***}	2.4	1.9	1.3
MMF2	5.8 [*]	2.7	3.1	2.0	1.9
MMF6	NS	1.4 ^{****}	3.6	2.4	1.5
MMF9	27.9 ^{**}	26.5	15.1	7.2	5.7

NS = hydrogen sulphide not sampled

*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

Assessment of previous monitoring data for hydrogen sulphide

To assess long term exposure to hydrogen sulphide, the previous monitoring data from 6/7/2017 to 14/2/2018 and 15/1/2019 to 25/6/2019 monitoring periods 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.

For the 2017/18 monitoring period the average 24-hour concentration was 0.85 µg/m³ and for the 2019 the average 24-hour concentration was 0.95 µg/m³. These previous concentrations are below the US EPA value, therefore they would not be expected to contribute to any significant effects on health.

Particulate matter

Table 5 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

PM₁₀:

Average for MMF1 (12/04/2021 to 31/07/2021): 19.2 µg/m³

Average for MMF2 (04/03/2021 to 31/07/2021): 16.8 µg/m³

Average for MMF6 (29/04/2021 to 31/07/2021): 12.5 µg/m³

Average for MMF9 (05/03/2021 to 31/07/2021): 12.9 µg/m³

PM_{2.5}:

Average for MMF1 (14/04/2021 to 31/07/2021): 6.5 µg/m³

Average for MMF2 (04/03/2021 to 31/07/2021): 9.1 µg/m³

Average for MMF6 (24/04/2021 to 31/07/2021): 8.1 µg/m³

Average for MMF9 (05/03/2021 to 31/07/2021): 8.2 µg/m³

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

Nitrogen dioxide

Table 6 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

Average for MMF2 (04/03/2021 to 31/07/2021): 14.2 µg/m³

Average for MMF9 (04/03/2021 to 31/07/2021): 9.3 µg/m³

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

Sulphur dioxide

Table 7 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

Average for MMF1 (24/06/2021 to 31/07/2021): 1.1 µg/m³

Average for MMF6 (24/06/2021 to 31/07/2021): 1.1 µg/m³

Average for MMF9 (28/05/2021 to 31/07/2021): 4.6 µg/m³

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 were:

MMF1 (14/04/2021 to 31/07/2021): 2.5 mg/m³

MMF2 (05/03/2021 to 31/07/2021): 2.6 mg/m³

MMF6 (24/04/2021 to 31/07/2021): 1.8 mg/m³

MMF9 (06/03/2021 to 31/07/2021): 4.4 mg/m³

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

Benzene, toluene, ethylbenzene and xylene (BTEX)

The EA is monitoring for benzene, toluene, ethylbenzene and xylene, however ratified data is not yet available for PHE to review.

Conclusions

The monitoring results for particulate matter, nitrogen dioxide and sulphur dioxide were below UK air quality objectives. 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, which is undesirable due to the effects on people's wellbeing and the symptoms they are experiencing.

For the majority of the monitoring period from March to July 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 July 2021 shows continuing exposure to the population around the site, above levels acceptable for long term (lifetime) exposure. To assess the risk from the increased concentrations in 2021, the concentrations 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 would stress that we cannot completely exclude a risk to health from pollutants in the area, especially if exposure continues at these levels. 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 Environment Agency and multi-agency partners will also be assessing additional factors such as meteorological conditions, complaints, and distance to receptors from the monitoring stations. PHE will continue supporting the other agencies with this work.

Overall, PHE strongly recommends that all 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](#)

Appendix

Figure 1

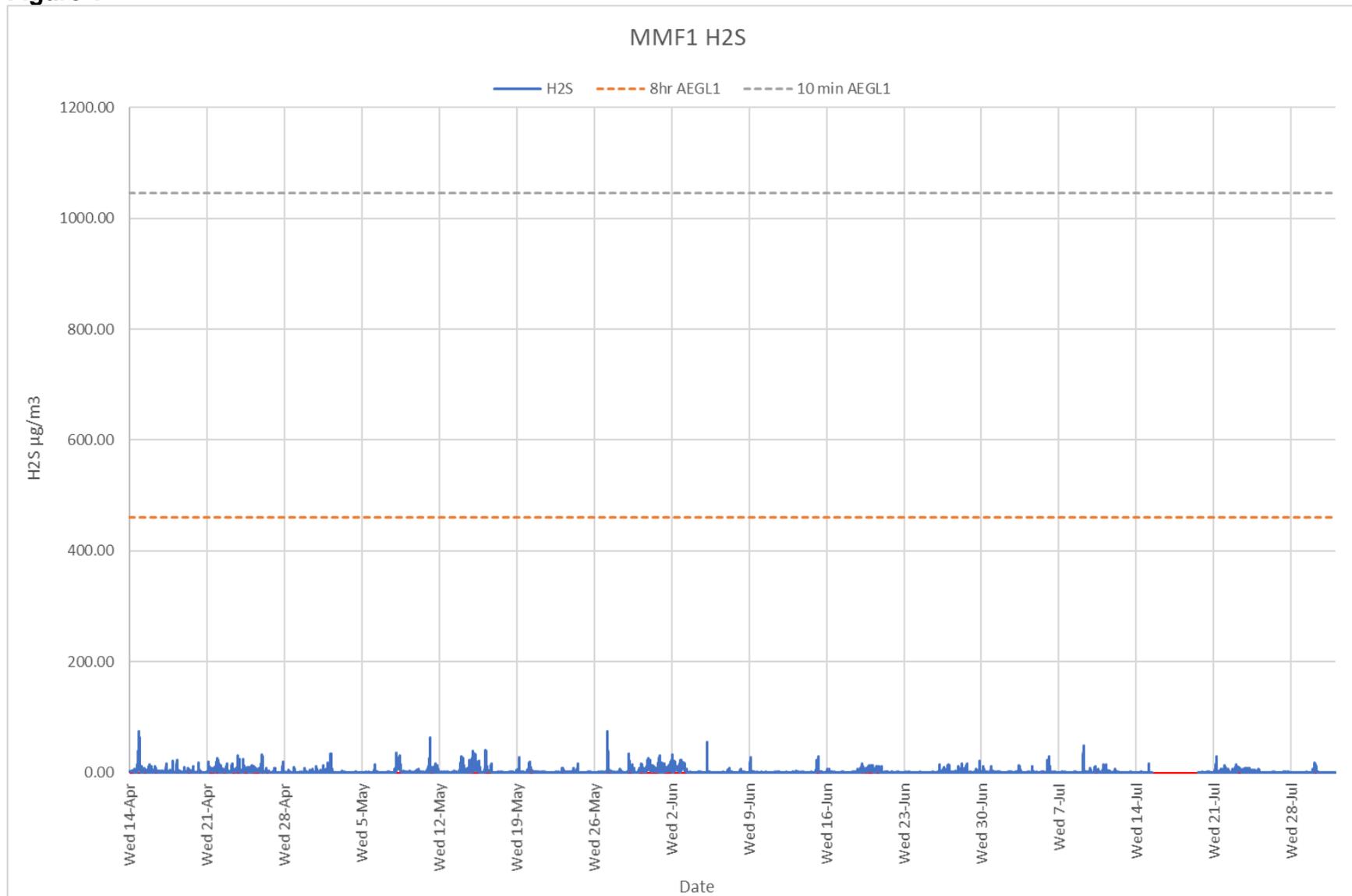


Figure 2

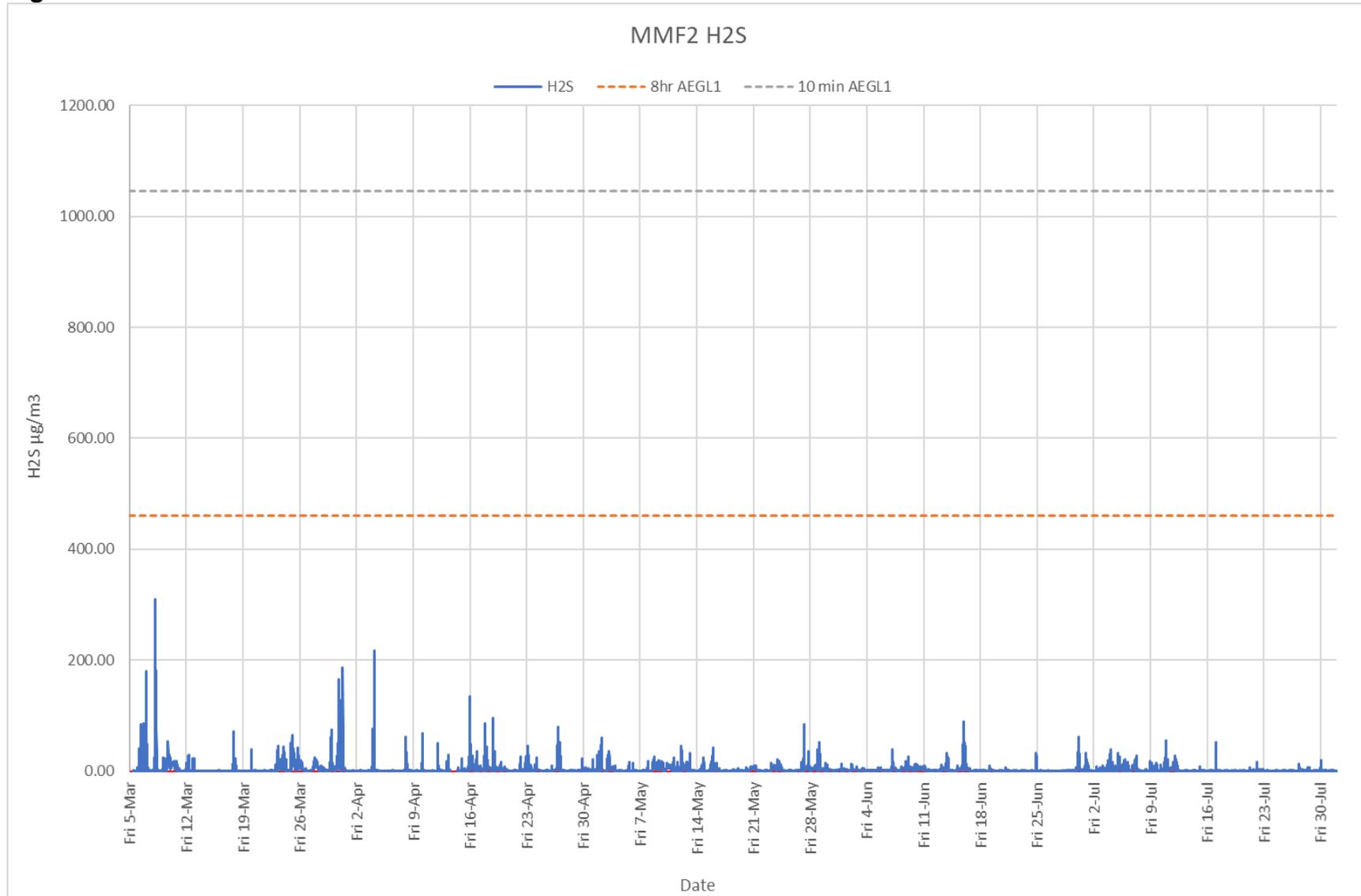


Figure 3

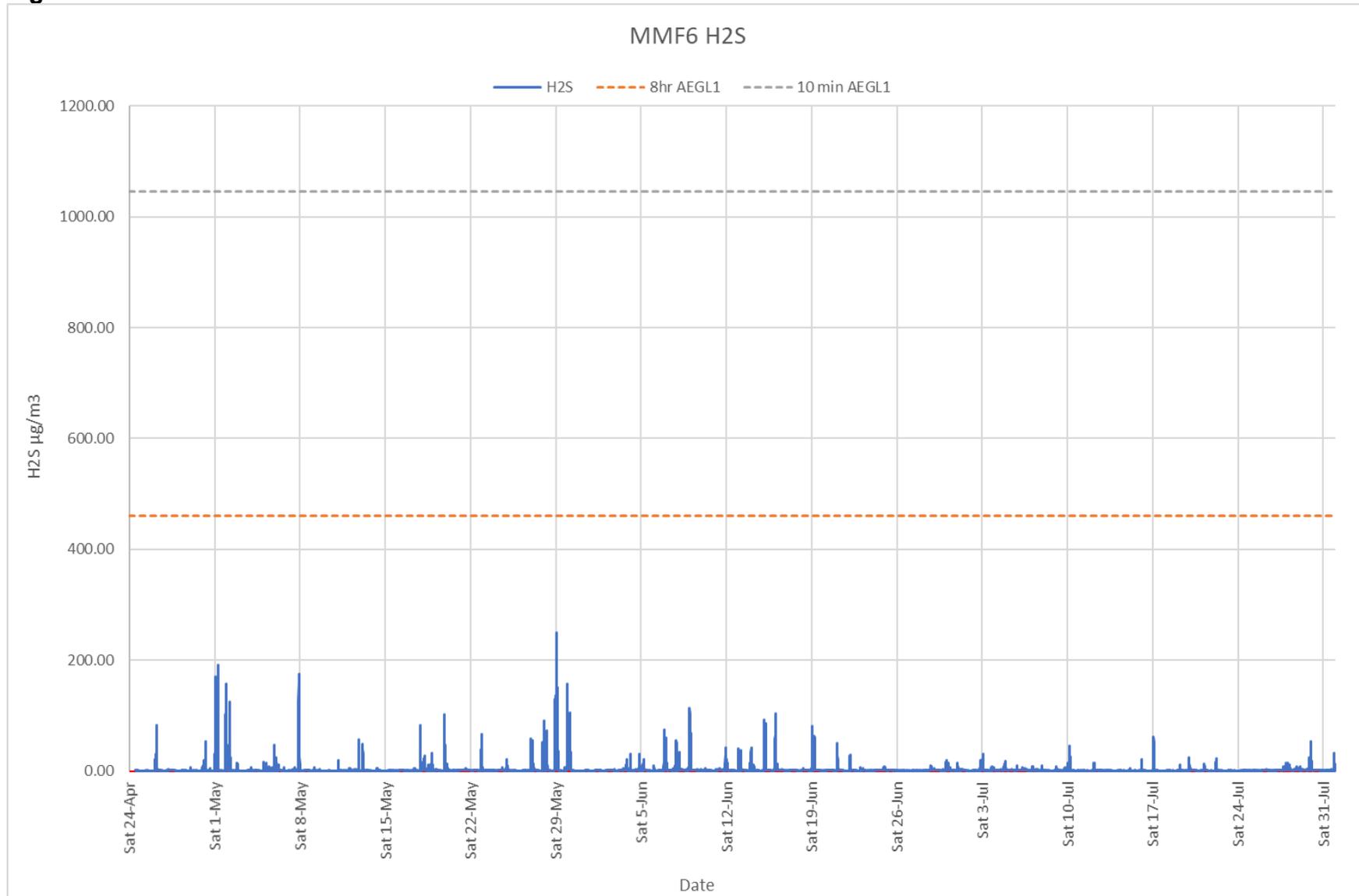


Figure 4

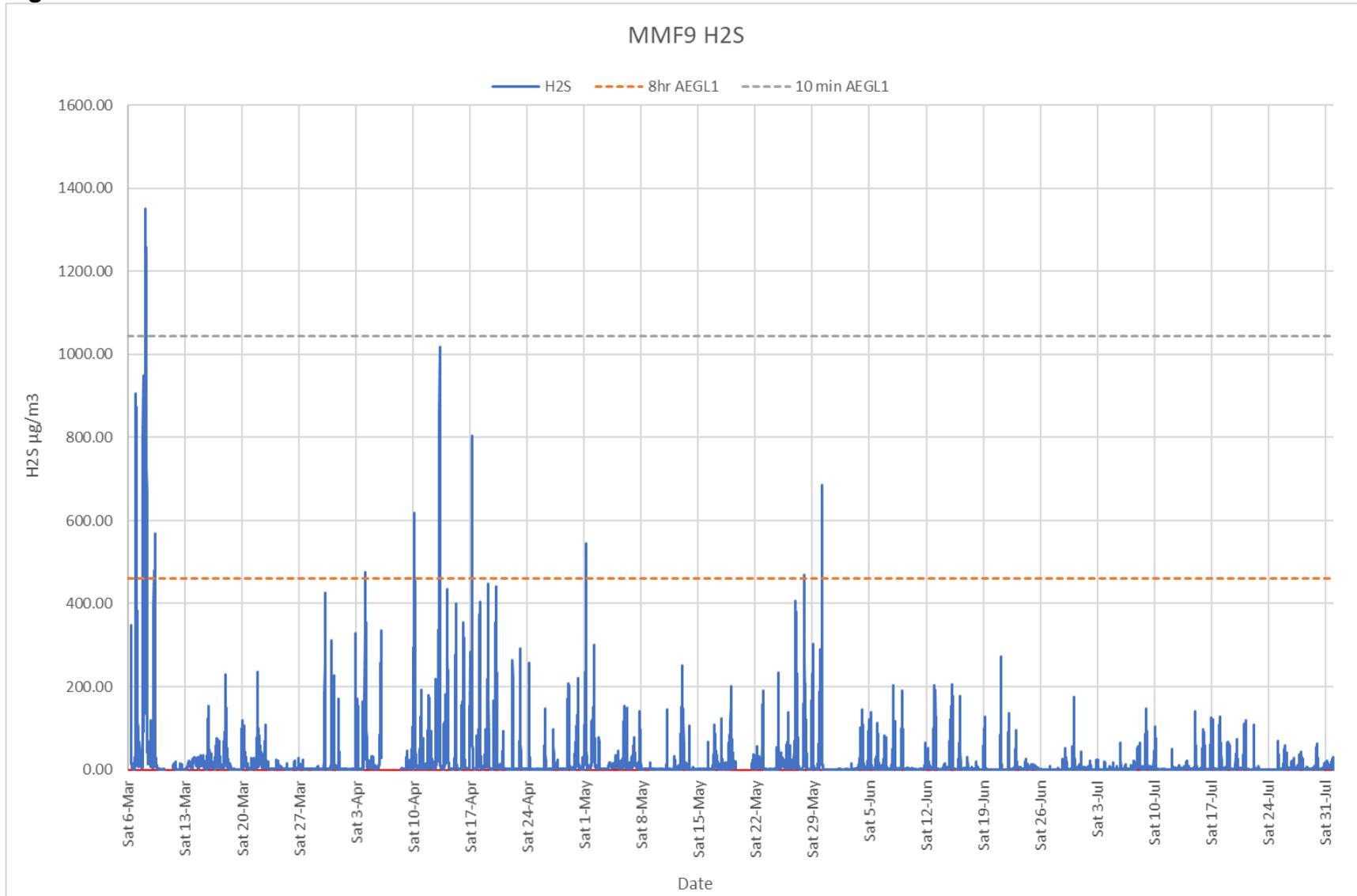


Table 1 AEGL-1 time frames

	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.

