



Health Risk Assessment of air quality monitoring results from March to April 2021: Walley's Quarry Landfill Site, 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 have recently installed four air quality Mobile Monitoring Facility (MMF) units which are to remain in place till at least August 2021 to collect monitoring data to continuously assess air quality.

It is important to make a distinction between concerns about odour and any toxicological effect from exposure to airborne chemicals. The aim of this risk assessment is to interpret the available data in relation to potential toxicological effects.

The data provided to Public Health England (PHE), by the Environment Agency (EA) have been compared to available health-based air quality guidelines and standards or assessment levels for hydrogen sulphide, particulate matter, nitrogen dioxide, and methane. Where the concentrations in air are shown to be lower than appropriate health based standards or guidelines, it may be assessed that the risk to health is minimal. The 24-hour average guideline value for hydrogen sulphide was exceeded at MMF9 on two days during the monitoring period: 7 & 8 March 2021, the highest of which was 202 $\mu\text{g}/\text{m}^3$. 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.

It is important however, to note public concerns in relation to odours. The human nose is very sensitive to odours, and substances that are perceived as odorous are commonly present at levels below which there is a direct toxicological effect. Odours can cause nuisance amongst the population possibly leading to stress and anxiety. Some people may experience symptoms such as nausea, headaches or dizziness, as a response to odours even when the substances that cause those smells are themselves not harmful to physical health.

Scope

The EA has recently shared with PHE, an Air Quality report based on monitoring data from MMF Stations MMF2 and MMF 9 from which there is data from the 4 March – 30 April 2021 (58 days).

In April two additional monitors were deployed MMF1 from which there is data from the 14 - 30 April and MMF 6 from which there is data from the 24 – 30 April 2021.

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

MMF 1 Location – Silverdale cemetery

MMF2 Location – Silverdale road, Newcastle under Lyme

MMF 6 Location – Newcastle community Fire Station

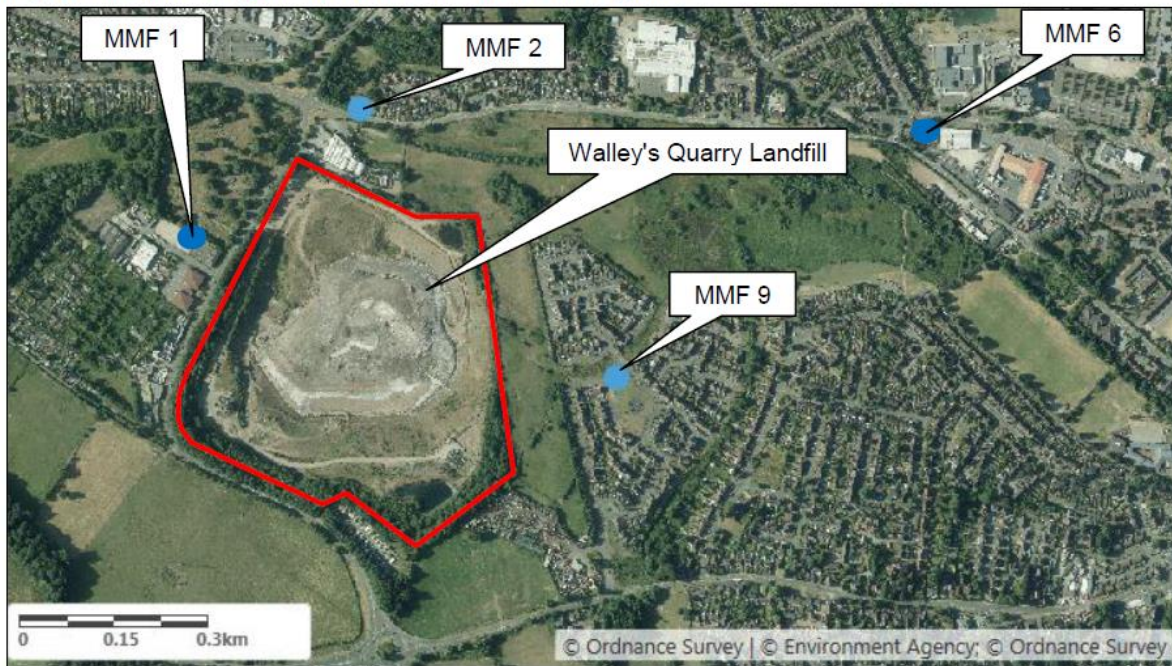
MMF9 Location - Severn Trent Pumping Station off Galingale View, Newcastle under Lyme

Table 1 Monitoring stations and the contaminants they are monitoring

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

*The EA is also monitoring for benzene, toluene, ethylbenzene and xylene, however this 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)

Air quality monitoring results and discussion

The health based guidance values considered for the risk assessment for acute, intermediate and lifetime exposure are summarised in Table 2.

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

WHO air quality guidelines	ATSDR- MRL **	US EPA RfC***	OEHHA Chronic REL ****
30-minute (average)* 7 µg/m ³ (5 ppb)	Intermediate (up to 1 year): 30 µg/m ³ (20 ppb)	For assessment of lifetime exposure	For assessment of lifetime exposure
24-hour (average) 150 µg/m ³ (107 ppb)	Based on lesions of the nasal olfactory epithelium in rats.	2 µg/m ³ (1 ppb)	10 µg/m ³ (7 ppb)
Based on eye irritation in humans.		Based on lesions of the nasal olfactory epithelium in rats.	Based on lesions of the nasal olfactory epithelium in rats.

*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.

**** The concentration level at or below which no adverse health effects are anticipated for a specified exposure duration is termed the reference exposure level (REL)⁴.

Hydrogen Sulphide (H₂S) acute 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 30/04/2021): 11%
 MMF2 (04/03/2021 to 30/04/2021): 14%
 MMF6 (24/04/2021 to 30/04/2021): 2%
 MMF9 (04/03/2021 to 30/04/2021): 36%

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

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 150µg/m³⁵.

However, at MMF9, the 24-hour average guideline value was exceeded on two days during the monitoring period: 7 & 8 March 2021, the highest of which was 202µg/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

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

[†] The level of the chemical in air at or above which the general population could experience notable discomfort.

†† 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 death⁶.

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 MMF 9 AEGL-1 was exceeded across the AEGL time frames 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.

Intermediate exposure

To assess intermediate exposure to hydrogen sulphide during 2021, the calculated average of the daily exposure concentrations from the March and April data have been compared against the Agency for Toxic Substances and Disease Registry (ATSDR) Intermediate Minimal Risk Level (MRL) of $30\mu\text{g}/\text{m}^3$, which applies to up to 1 year. The average daily hydrogen sulphide concentrations:

MMF1 (14/04/2021 to 30/04/2021): $3\mu\text{g}/\text{m}^3$

MMF2 (04/03/2021 to 30/04/2021): $4.2\mu\text{g}/\text{m}^3$

MMF6 (24/04/2021 to 30/04/2021): $1.4\mu\text{g}/\text{m}^3$

MMF9 (04/03/2021 to 30/04/2021): $27.2\mu\text{g}/\text{m}^3$

At all the monitoring stations the average daily hydrogen sulphide concentrations are below the ATSDR Intermediate MRL. As such, any risk to long-term physical health is likely to be small.

Hydrogen sulphide concentrations averaged across a 24-hour period

Figure 5 in the Appendix is a graph which shows average hydrogen sulphide concentrations against a 24-hour period. The complete data set from MMF9 has been averaged over a 24-hour period to illustrate trends in concentrations, peaks of hydrogen sulphide generally occur between 20:00 and 09:00.

Assessment of previous monitoring data

To assess long-term exposure to hydrogen sulphide the previous monitoring data from the 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) and the California Office of Environmental Health Hazard Assessment (OEHHA) Chronic Reference Exposure Level (REL) to assess long-term exposure to hydrogen sulphide. 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 and OEHHA values therefore they would not be expected to contribute to any significant effects on health.

Particulate matter UK air quality objectives

Table 4

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 30/04/2021): 37 µg/m³
 Average for MMF2 (04/03/2021 to 30/04/2021): 20 µg/m³
 Average for MMF6 (29/04/2021 to 30/04/2021): 11.2 µg/m³
 Average for MMF9 (04/03/2021 to 30/04/2021): 14.7 µg/m³

PM_{2.5}:

Average for MMF1 (14/04/2021 to 30/04/2021): 14.2 µg/m³
 Average for MMF2 (04/03/2021 to 30/04/2021): 10.5 µg/m³
 Average for MMF6 (24/04/2021 to 30/04/2021): 7 µg/m³
 Average for MMF9 (04/03/2021 to 30/04/2021): 9.4 µg/m³

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

Nitrogen dioxide UK air quality objectives

Table 5

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 30/04/2021): 15.8 µg/m³

Average for MMF9 (04/03/2021 to 30/04/2021): 12.4 µg/m³

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

Methane (CH₄)

Methane 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 maximum concentration of methane recorded were:

MMF1 (14/04/2021 to 30/04/2021): 44.48 mg/m³

MMF2 (04/03/2021 to 30/04/2021): 140.68 mg/m³

MMF6 (24/04/2021 to 30/04/2021): 78.88 mg/m³

MMF9 (04/03/2021 to 30/04/2021): 165.71 mg/m³

All of these maximum concentrations of methane were significantly less than the values discussed above.

Benzene, Toluene, Ethylbenzene and Xylene (BTEX)

The EA is monitoring for BTEX contaminants, however this data has not yet been made available to PHE.

Conclusions

The monitoring results for particulate matter and nitrogen dioxide were below UK air quality objectives. Therefore, there would be minimal risks to health at these levels of exposure.

For the majority of the monitoring period the concentrations of hydrogen sulphide were below the WHO 24-hour health based-guideline value, AEGL values and for the full period below the ATSDR MRL. However, the WHO value and the AEGLs values were exceeded over a 2-day period on 7 and 8 March. 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.

Based on the current data up to the end of April, we would stress that 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. Short-term health effects may be experienced such as irritation to the eyes, nose and throat. Individuals with pre-existing respiratory conditions may be more susceptible to these effects.

The results for hydrogen sulphide continue to be above the odour threshold. Therefore, PHE recommends that all measures are taken to reduce the off-site

odours from the landfill site, as it is acknowledged that odours can affect an individual's wellbeing.

PHE understands that further air quality monitoring is being undertaken by the Environment Agency and this report will be updated as appropriate when more data is available. 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.

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 California Office of Environmental Health Hazard Assessment Chronic Reference Exposure Level for Hydrogen Sulphide. <https://oehha.ca.gov/chemicals/hydrogen-sulfide>
- 6 Hydrogen Sulphide Acute Exposure Guideline Levels (AEGs) [Acute Exposure Guideline Levels for Airborne Chemicals | US EPA](#)

Appendix

Figure 1

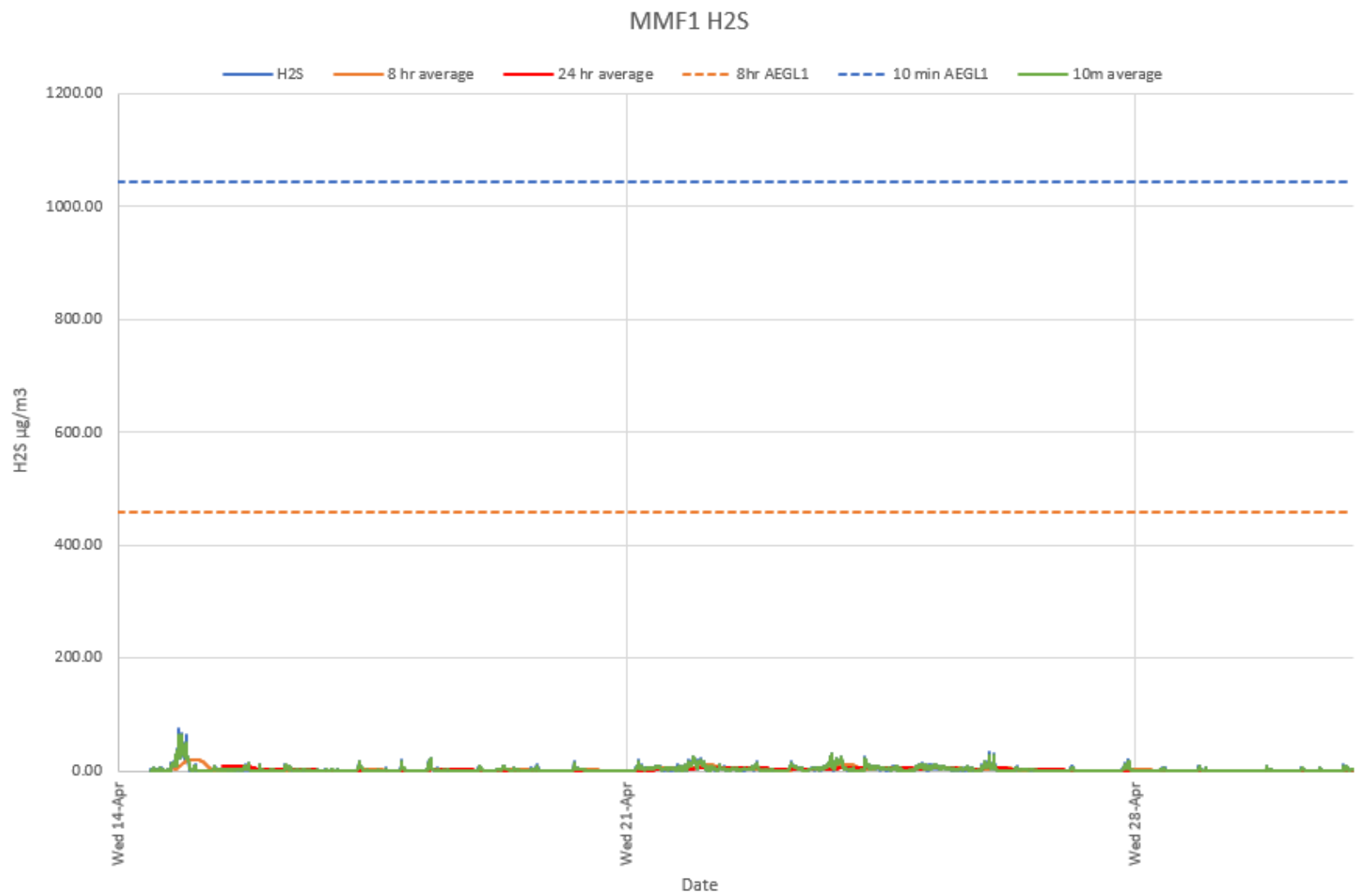


Figure 2

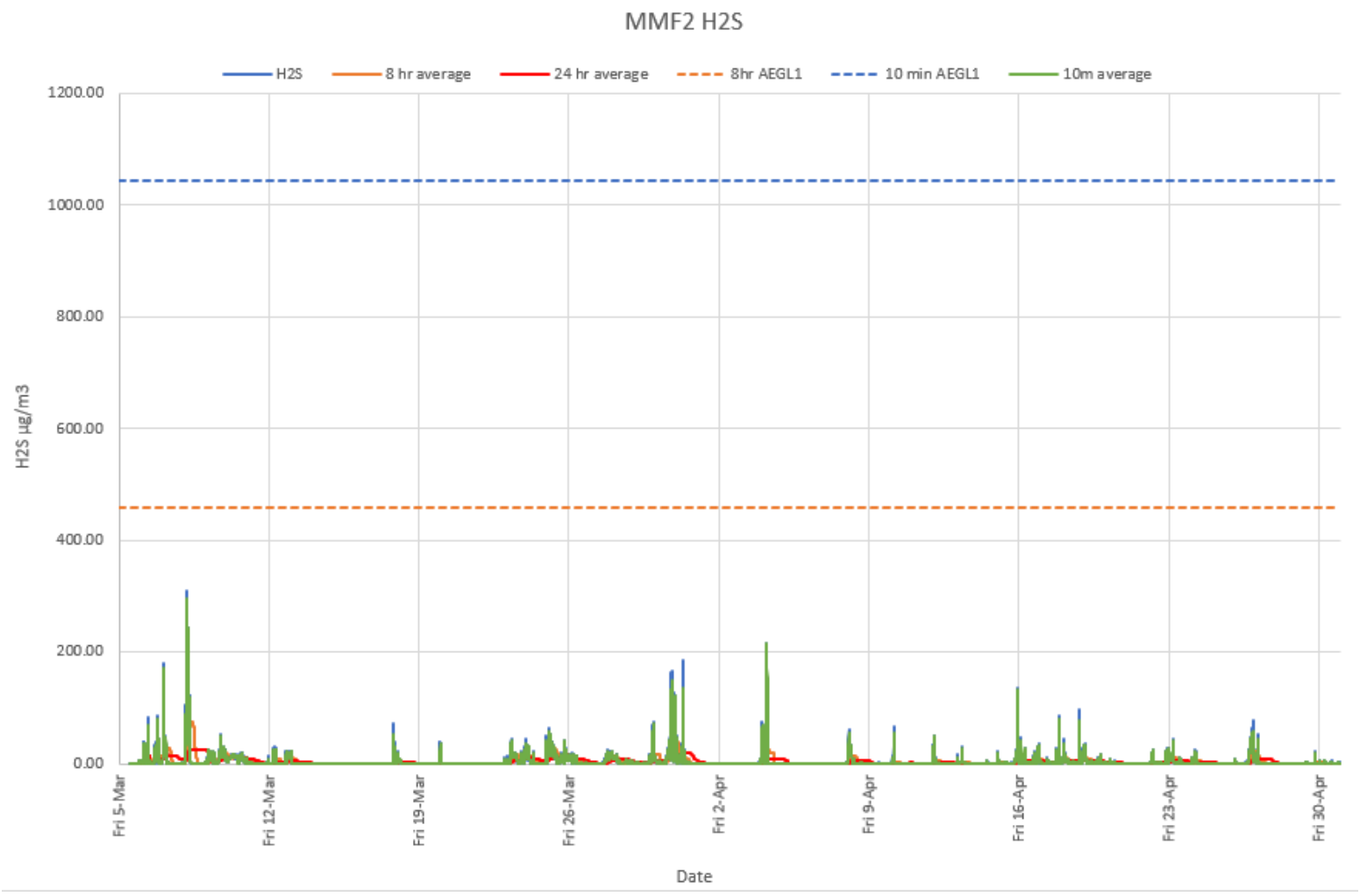


Figure 3

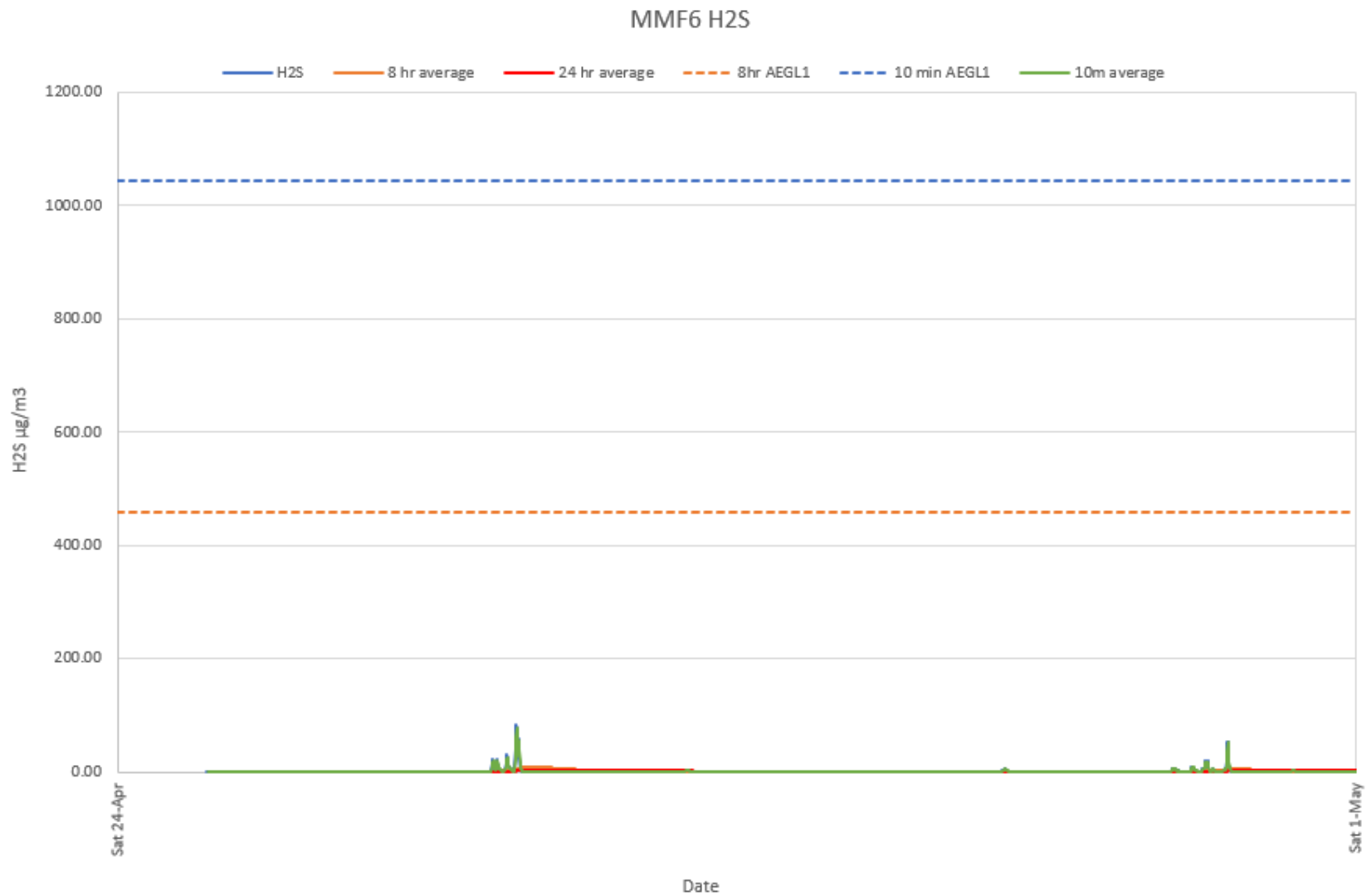


Figure 4

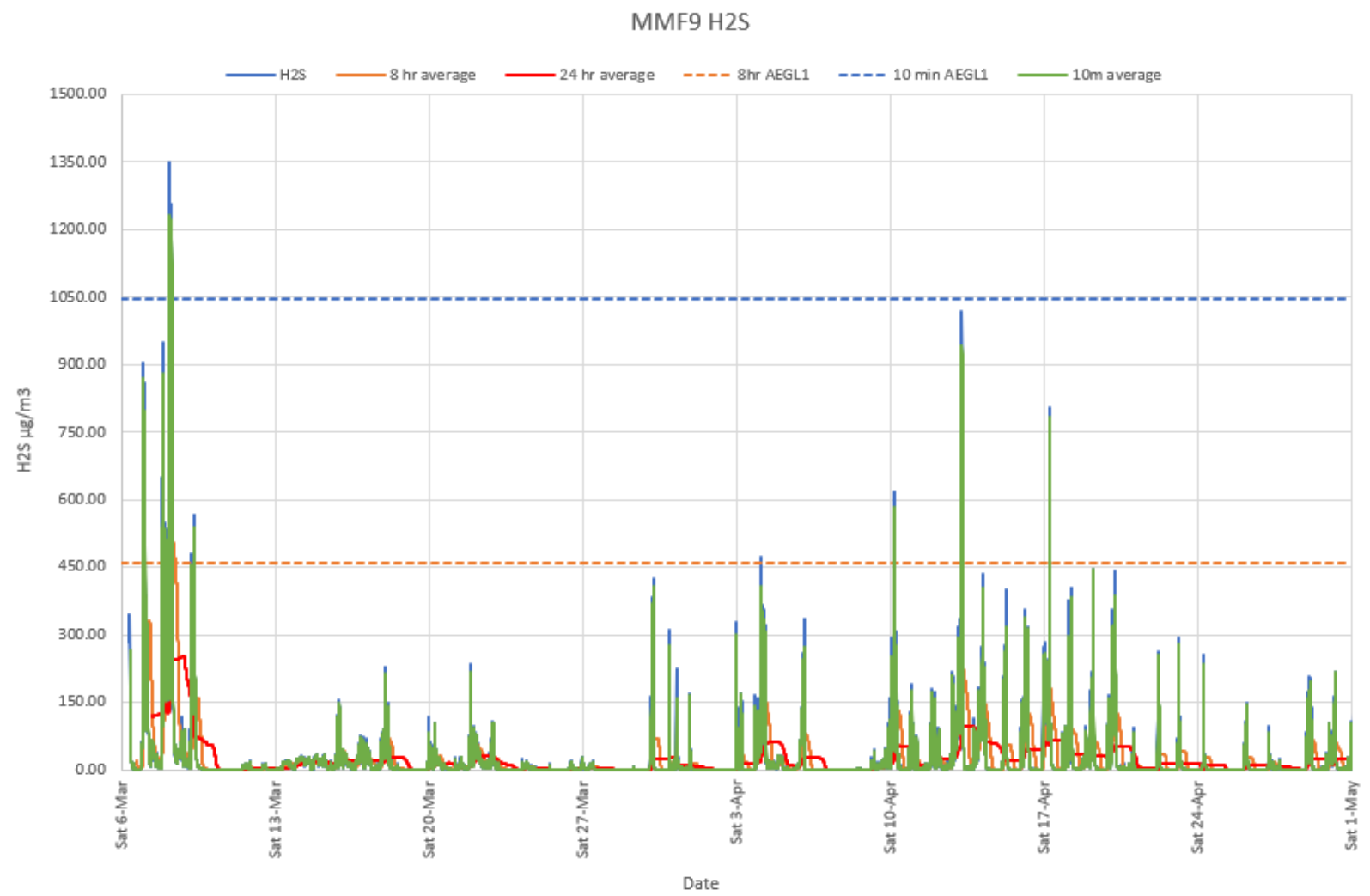


Table 1 AEGL time frames

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

Figure 5

