

Preston New Road – Continuous Monitoring Update
29th July 2019 to 11th August 2019



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Image from Google Maps 2018

Prepared for:

Cuadrilla Bowland Ltd.



For: Cuadrilla Bowland Ltd.
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Preston New Road – Continuous Monitoring Update
29th July 2019 to 11th August 2019

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1 Outline of Monitoring

Cuadrilla Bowland Ltd has appointed GGS to conduct continuous ambient air quality monitoring at the Preston New Road (PNR) wellsite before, during and after the hydraulic fracturing and well testing operations.

GGS has been undertaking continuous air quality monitoring at the PNR wellsite since early 2018. Continuous ambient methane monitoring commenced in February 2018. Continuous ambient monitoring of certain additional air quality parameters commenced in May 2018.

These monitoring requirements were codified in Cuadrilla Bowland's Environmental Management and Monitoring Plan (EMMP) (Version 5.1, May 2018) as required by pre-operational condition 2 of the site's environmental permit (EPR/AB3101MW/V004). The EMMP was approved by the Environment Agency on 18th May 2018 (CAR/UP3434VF/0306642).

A commitment to provide regular updates on the results gathered by this monitoring is included within the site's EMMP. This continuous monitoring update (CMU) report forms the latest regular update since the start of hydraulic fracturing operations, which commenced during week commencing 8th October 2018.

This CMU summarises the continuous monitoring results recorded between 29th July to 11th August 2019.

The parameters covered by this report are as detailed within the site's EMMP, and are summarised in Table 1 below.

Table 1. Required Continuous Ambient Air Quality Parameters.

Parameters	Monitoring frequency
Methane (CH ₄)	Continuous monitoring (10-minute average)
Nitrogen dioxide (NO ₂)	Continuous monitoring (10 minutely sampling)
PM ₁₀	Continuous monitoring (10 minutely sampling)
Total Volatile Organic Compounds (TVOC)	Continuous monitoring (10 minutely sampling)
Hydrogen sulphide (H ₂ S)	Continuous monitoring (10 minutely sampling)

A number of additional parameters are monitored using passive techniques at four locations surrounding the site. These parameters are detailed in Table 2 below.

Table 2. Required Passive Ambient Air Quality Parameters.

Parameters	Monitoring frequency
Hydrogen sulphide (H ₂ S)	Passive monitoring (Monthly – 4 locations)
BTEX (Benzene, toluene, ethylbenzene and xylene)	Passive monitoring (Monthly – 4 locations)

2 Site Monitoring Locations

A continuous monitoring station has been established at the site in order to capture the prevailing down-wind concentrations for the required air quality parameters. Figure 1 below illustrates the location of the monitoring station.

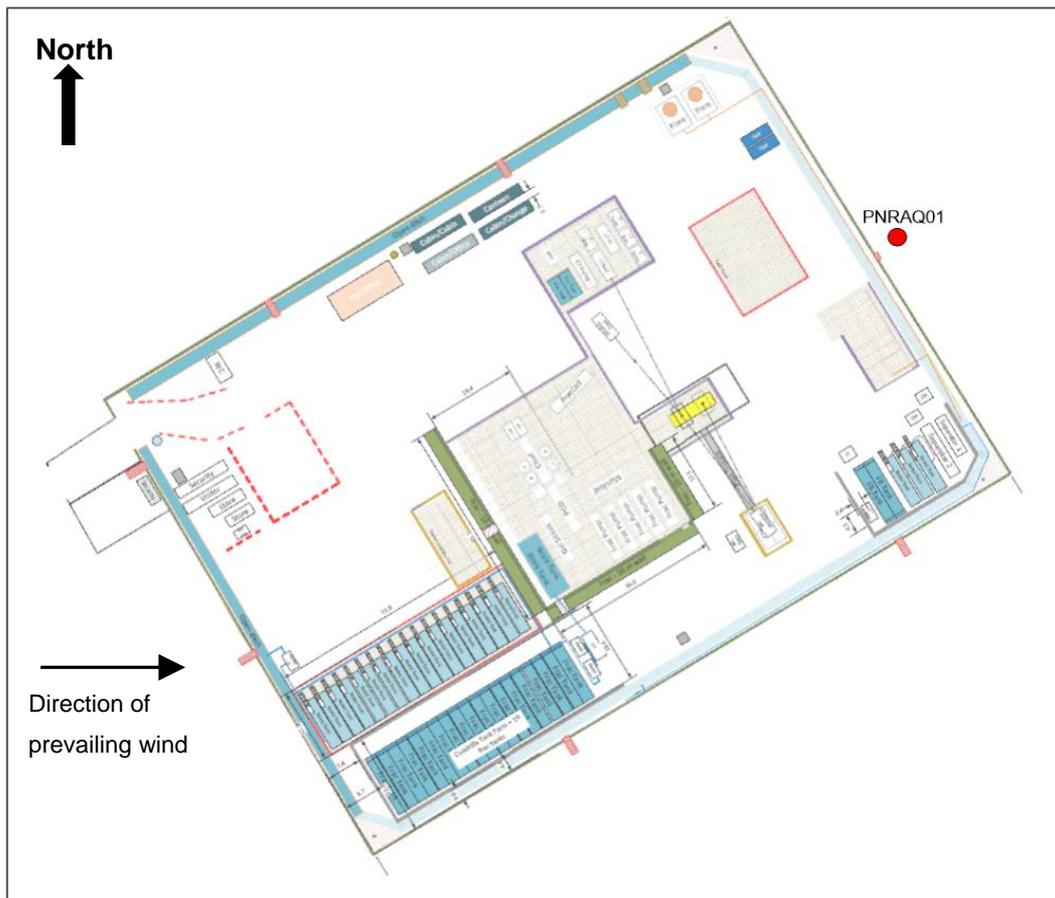


Figure 1. Location of prevailing down-wind ambient air quality monitoring station shown by red dot (PNRAQ01). Drawing adapted from the site 'as-built' plan (May 2018).

Four passive monitoring locations have been established surrounding the site in order to capture the prevailing concentrations for the required air quality parameters from each wind direction quadrant. Figure 2 below illustrates these monitoring locations.

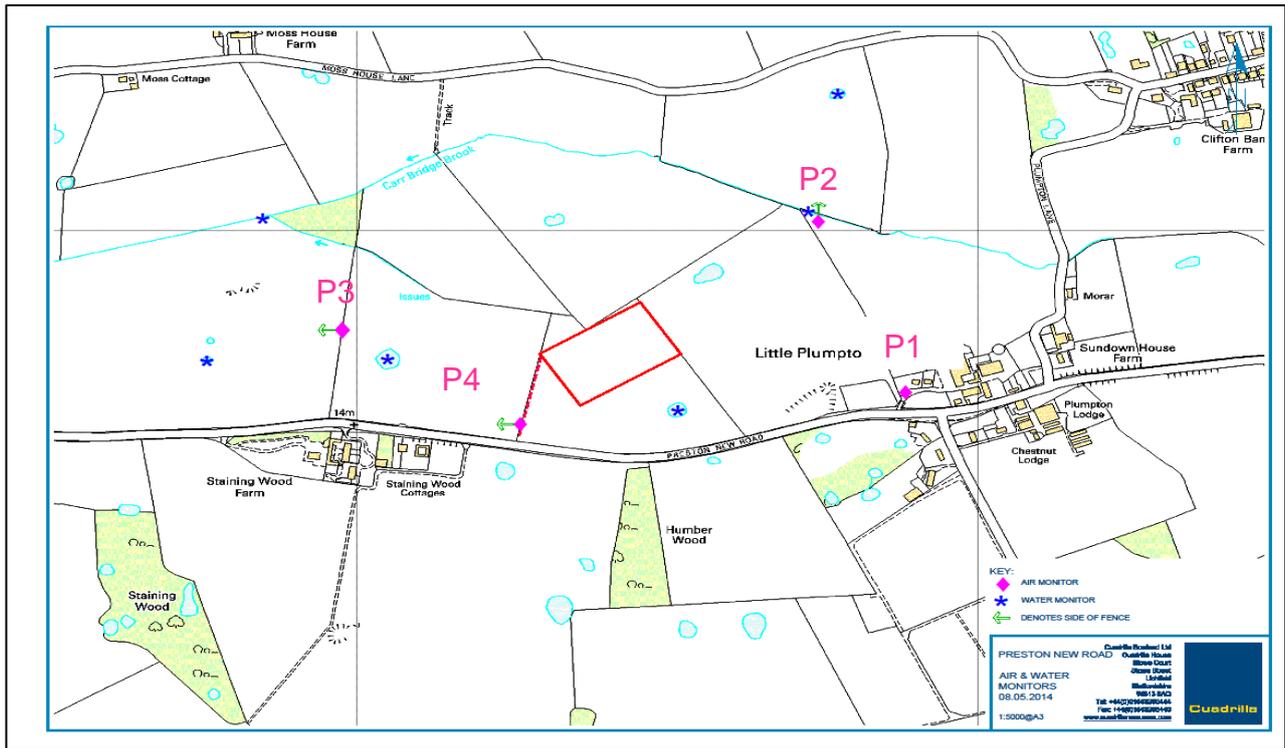


Figure 2. Location of four passive ambient air quality monitoring stations (P1 – P4) shown by pink diamonds. Drawing adapted from the site EMMP (V5.1, May 2018).

3 Continuous Monitoring Update

3.1 Background

GGs has been undertaking continuous air quality monitoring for all reported parameters at the PNR wellsite since mid-2018. The instruments used and monitoring specification are as detailed within the site's EMMP (Section 8).

Where available, the monitoring results have been compared against the applicable Daily Air Quality Index (DAQI) as defined by Defra¹. DAQIs exist for both nitrogen dioxide and particulate matter (specifically PM₁₀). DAQIs present the level of air pollution at a given location, along with actions to take where pollutant levels are elevated. Each set of monitoring results have been presented alongside the relevant DAQI bands to indicate the overall level of air quality at the monitoring location, which is immediately down prevailing wind of the onsite activities.

3.2 Methane (CH₄)

Methane is naturally occurring in the environment and arises from organic rich soils and ruminant cattle. It is typically present in the atmosphere at approximately 2 ppmv, but this can vary due to local influences. It is also the principle constituent of the target gas to be produced from the geological formations that are proposed to be hydraulically fractured.

3.2.1 Methodology

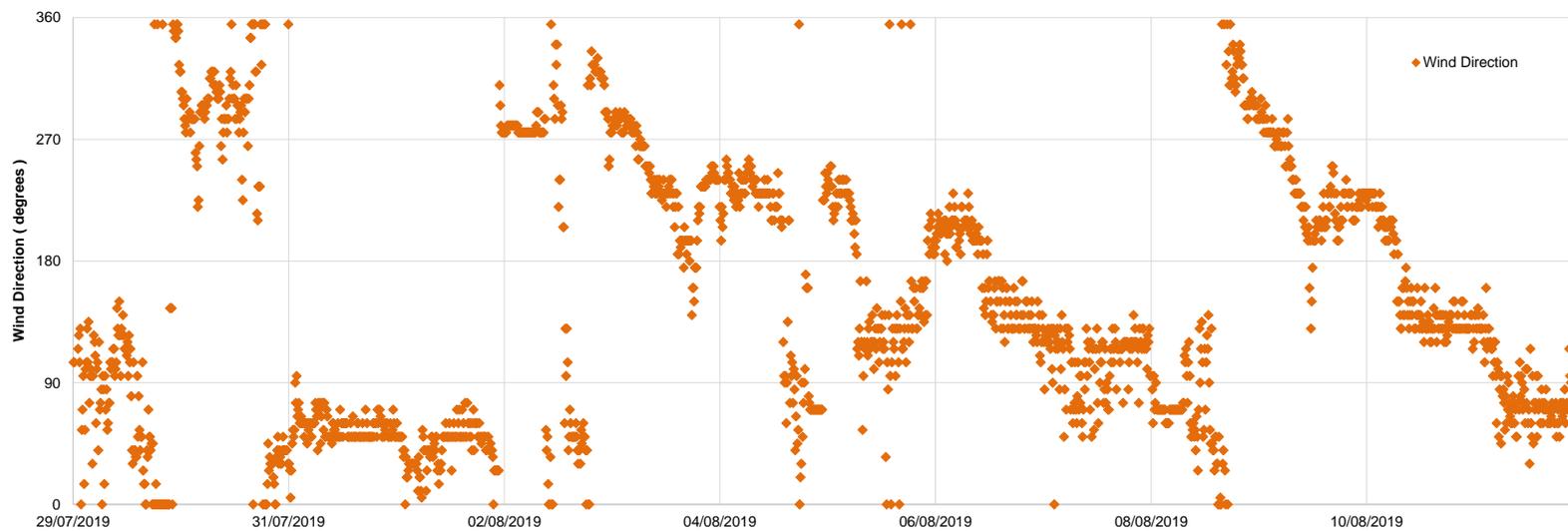
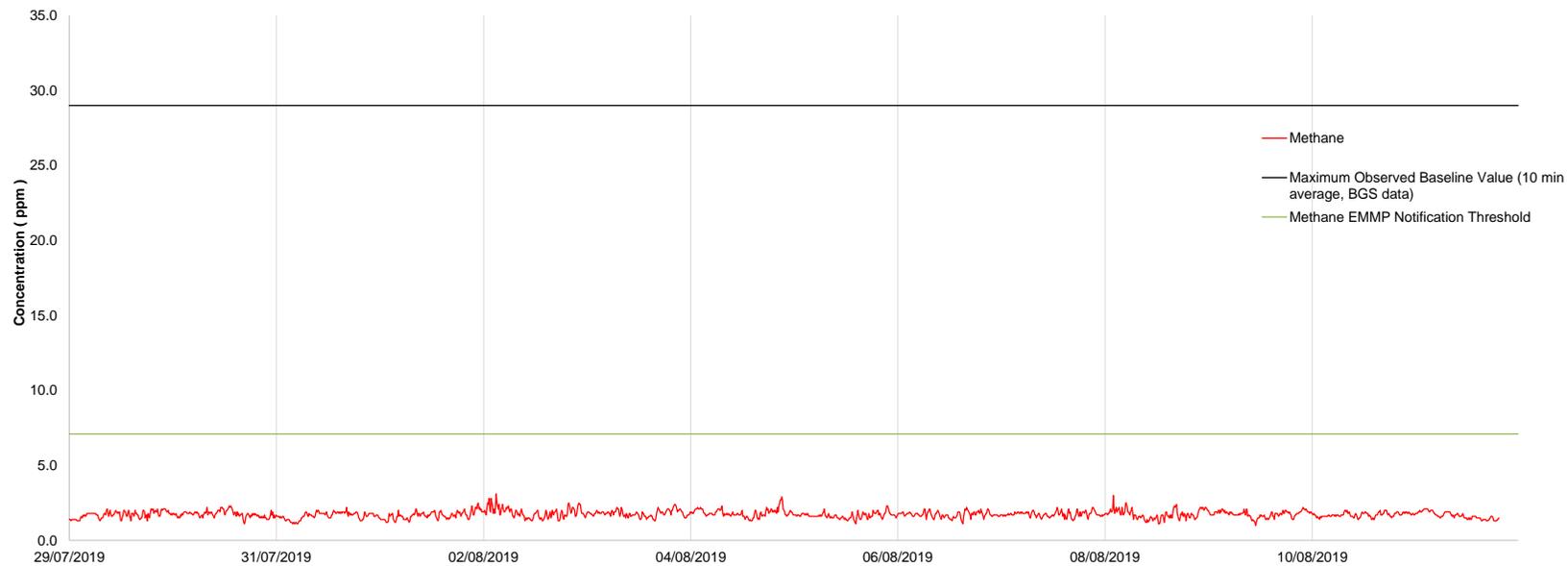
Continuous monitoring of methane at PNRAQ01 began in February 2018. Data is presented below from the 29th July to 11th August 2019. In line with the commitment within the site's EMMP the data is presented as a 10 minute average. No Daily Air Quality Index (DAQI) exists for methane.

¹ Daily Air Quality Index, Defra 2018[<https://uk-air.defra.gov.uk/air-pollution/daqj>], accessed October 2018.

3.2.2 Results

A summary of the continuous monitoring results are presented in the graph on the following page. A maximum and minimum table is also presented. The observed results are graphed against both the threshold at which the site's EMMP requires the Environment Agency to be notified, and the maximum 10 minute average level observed during baseline conditions, that is, prior to site construction. The baseline data is based on results collected by the British Geological Survey (BGS) at a monitoring location approximately 450m from the site. The BGS data was originally collected at one minute intervals. To allow direct comparison with the continuous monitoring results observed at site, the one minute baseline data has been converted to ten minute averages, the maximum of which are presented on the graph below. The highest individual baseline results are higher than the threshold indicated.

The latest methane monitoring results are in line with the baseline results observed at the site.



Title:

Preston New Road Methane - 29th July to 11th August 2019

Project:

GG51628 Preston New Road

Client:

Cuadrilla Bowland Ltd

Minimum / Maximum Table		
Parameter	Minimum	Maximum
CH ₄ (ppm)	1.0	3.1

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3.3 Nitrogen Dioxide (NO₂)

Trace concentrations of nitrogen dioxide occur naturally in the atmosphere from volcanic sources and lightning strikes. It is also a product of combustion and is present in vehicle exhaust fumes and cigarette smoke. Nitrogen dioxide concentrations in the atmosphere are highly variable, both temporally and spatially.

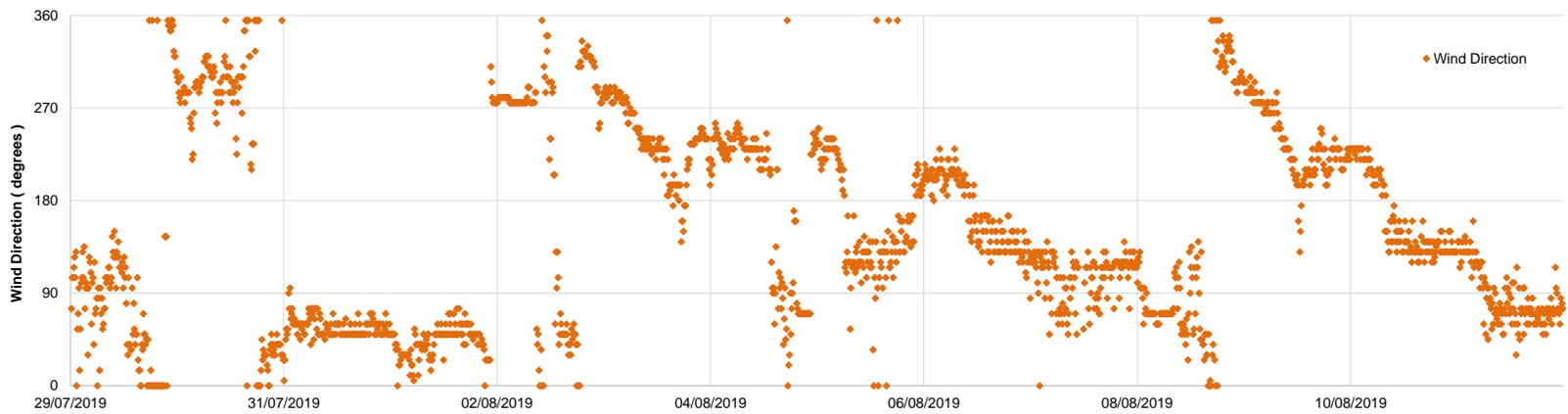
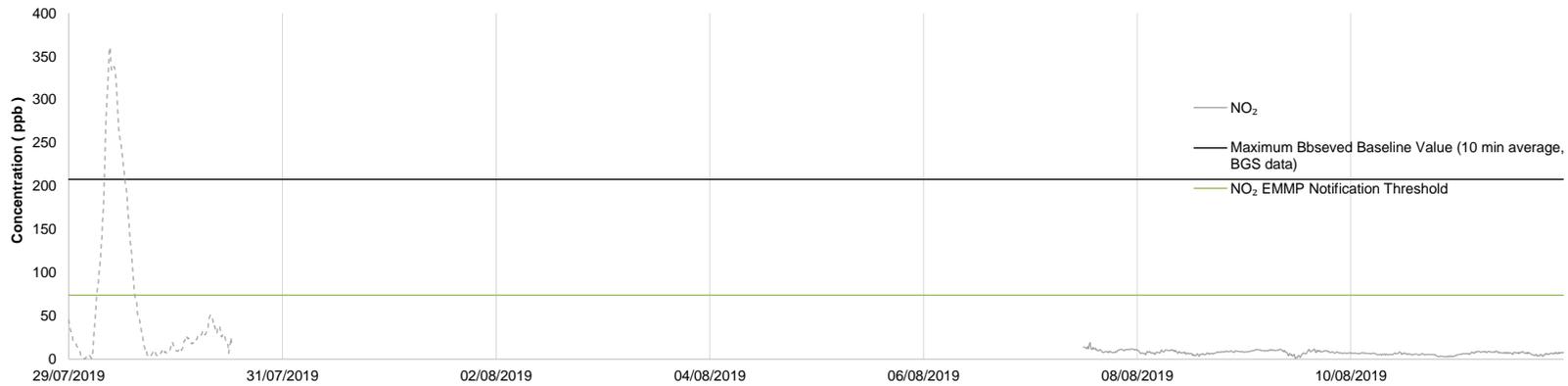
3.3.1 Methodology

Continuous monitoring of nitrogen dioxide at PNRAQ01 began in May 2018 and results are recorded every 10 minutes. Data is presented below from the 29th July to 11th August 2019. The graph on the following page presents the observed results in comparison to the DAQI air quality bands set out by DEFRA, where results are reported as an hourly mean concentration.

3.3.2 Results

A summary of the continuous monitoring results are presented in the graph on the following page. A maximum and minimum table is also presented. The observed results are graphed against both the threshold at which the site's EMMP requires the Environment Agency to be notified, and the maximum 10 minute average level observed during baseline conditions, that is, prior to site construction. The baseline data is based on results collected by the British Geological Survey (BGS) at a monitoring location approximately 450m from the site. The BGS data was originally collected at one minute intervals. To allow direct comparison with the continuous monitoring results observed at site, the one minute baseline data has been converted to ten minute averages, the maximum of which are presented on the graph below. The highest individual baseline results are higher than the threshold indicated.

A technical issue previously affecting the reliability of the nitrogen dioxide results obtained at the site was resolved during this reporting period. From this point onwards, observed results were consistently low, and in line with expected values for the monitoring location.



* Boundaries are set by the DEFRA Daily Air Quality Index (DAQI) for Nitrogen Dioxide using a hourly mean concentration. Boundary limit concentrations are converted from $\mu\text{g}/\text{m}^3$ using a conversion factor of 1 ppb : 1.9125 $\mu\text{g}/\text{m}^3$



Title:
Preston New Road NO₂ - 28th July to 11th August 2019

Project:
GGs1628 Preston New Road

Client:
Cuadrilla Bowland Ltd

Minimum / Maximum Table		
Parameter	Minimum	Maximum
NO ₂ (ppb)	0.0	360.8

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3.4 Particulate Matter 10 (PM₁₀)

Airborne particulate matter is made up of a collection of materials of various sizes that range from a few nanometres in diameter to around 100 microns (100 µm). It consists of a wide range of material from both natural and anthropogenic sources and includes sea salt, soil dust and the products of combustion. PM₁₀ is defined as particulate matter 10 micrometres or less in diameter. PM₁₀ concentrations in the atmosphere are highly variable, both temporally and spatially.

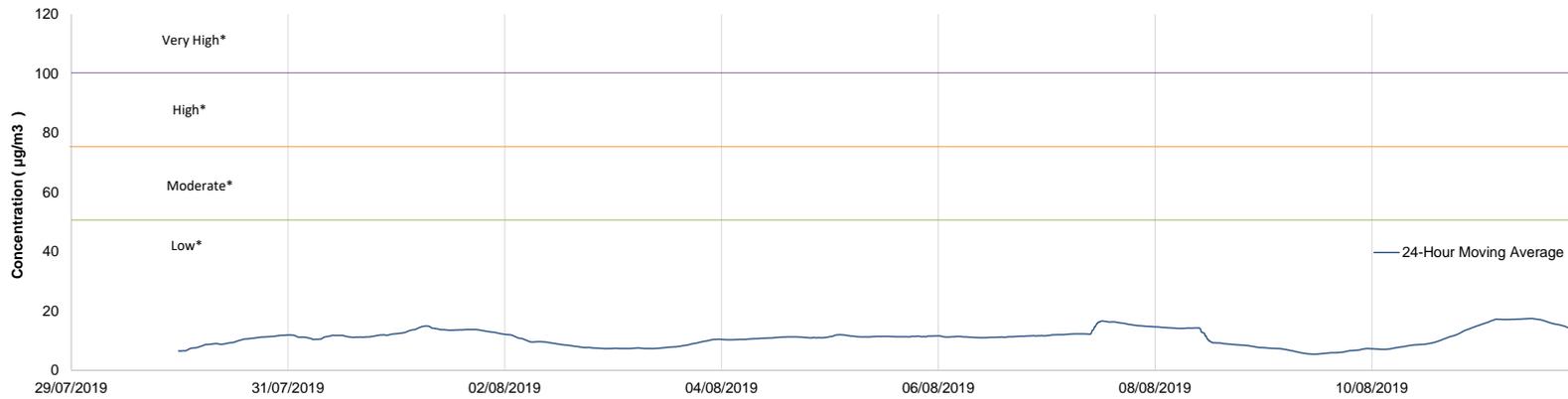
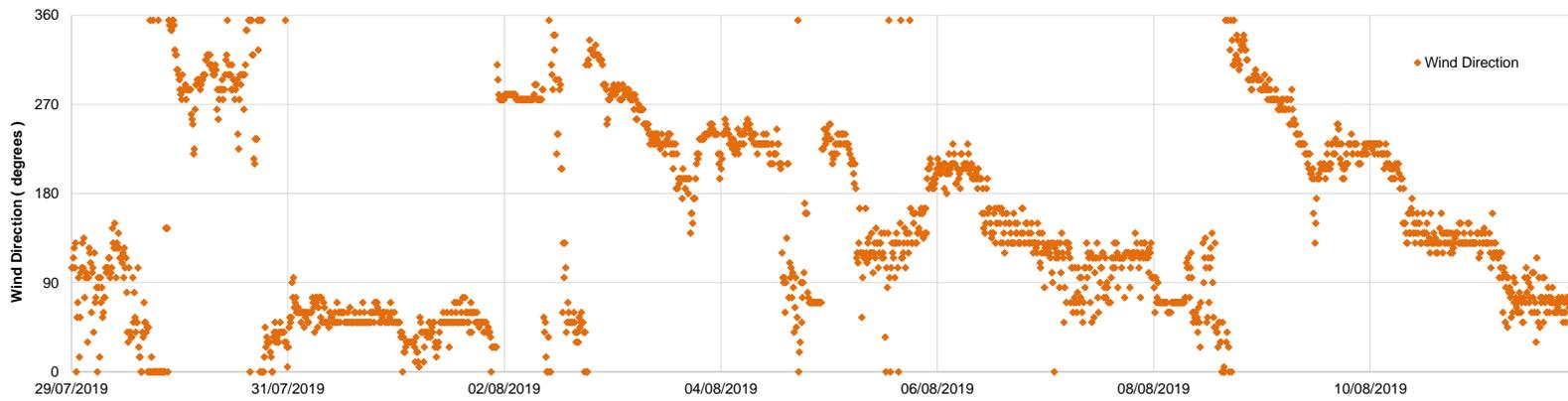
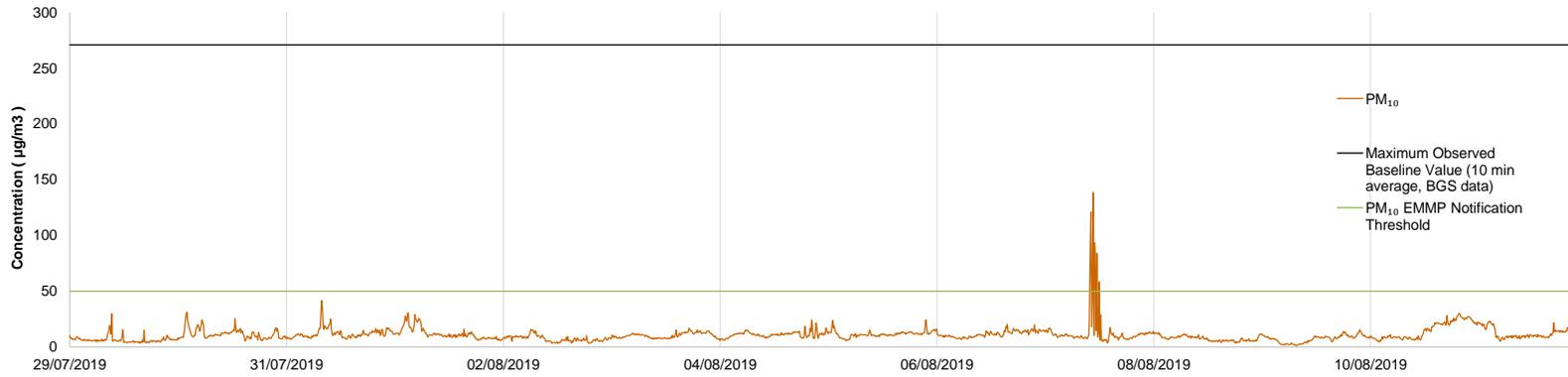
3.4.1 Methodology

Continuous monitoring of particulate matter at PNRAQ01 began in May 2018 and results are recorded every 10 minutes. Data is presented below from the 29th July to 11th August 2019. The graph on the following page presents the observed results in comparison to the Daily Air Quality Index (DAQI) air quality bands set out by DEFRA, where results are reported as a 24 hourly mean concentration.

3.4.2 Results

A summary of the continuous monitoring results are presented in the graph on the following page. A maximum and minimum table is also presented. The observed results are graphed against both the threshold at which the site's EMMP requires the Environment Agency to be notified, and the maximum 10 minute average level observed during baseline conditions, that is, prior to site construction. The baseline data is based on results collected by the British Geological Survey (BGS) at a monitoring location approximately 450m from the site. The BGS data was originally collected at one minute intervals. To allow direct comparison with the continuous monitoring results observed at site, the one minute baseline data has been converted to ten minute averages, the maximum of which are presented on the graph below. The highest individual baseline results are higher than the threshold indicated.

The latest particulate matter results are in line with expected results for the activity undertaken at the site and the surrounding environment. However, a single elevation above the notification threshold occurred on 7th August.



* Boundaries are set by the DEFRA Daily Air Quality Index (DAQI) for PM10 using a moving average over 24 hours.

Title:
Preston New Road PM₁₀ -29th July to 11th August 2019

Project:
GGS1628 Preston New Road

Client:
Cuadrilla Bowland Ltd

Minimum / Maximum Table		
Parameter	Minimum	Maximum
PM ₁₀ (µg/m ³)	1.3	138.5

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3.5 Total Volatile Organic Compounds (TVOCs)

Volatile organic compounds (VOCs) are a wide range of substances with low boiling points that evaporate from solids or liquids. They occur both naturally and as products used in industrial processes. VOCs are also released by combustion activities and hydrocarbon-based substances. VOCs are generally absent in ambient air unless in close proximity to a source. Benzene, toluene, ethyl-benzene and xylene (BTEX) are each VOC compounds.

3.5.1 Methodology

Continuous monitoring of total VOCs (TVOCs) began in May 2018 and results are recorded every 10 minutes. Data is presented below from the 29th July to 11th August 2019. No DAQI exists for the TVOC parameter.

Passive monitoring of BTEX compounds is also undertaken at four locations on a monthly basis. The most recently available results are detailed in Section 3.5.2 below.

3.5.2 Results

A summary of the continuous monitoring results are presented in the graph on the next page. A maximum and minimum table is also presented. The observed results are graphed against the threshold at which the site's EMMP requires Cuadrilla to investigate potential causes. No directly equivalent parameter was measured by the British Geological Survey during the baseline period.

The latest monitoring results are in line with results observed at the site prior to hydraulic fracturing commencing.

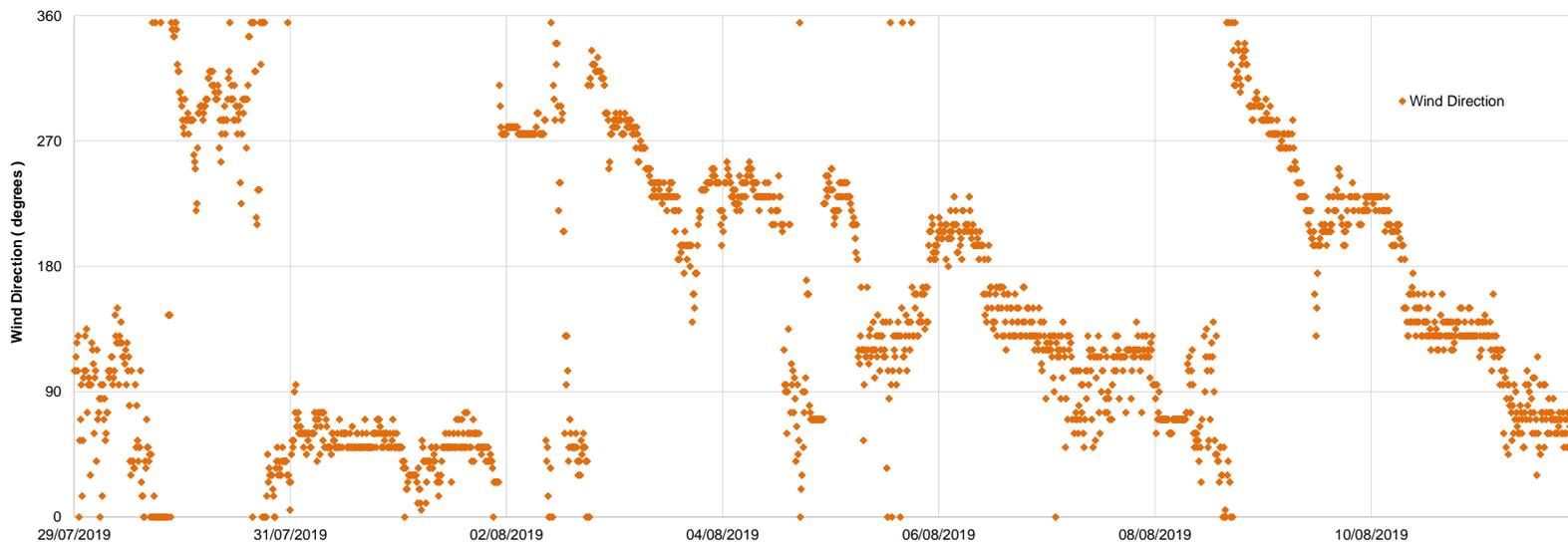
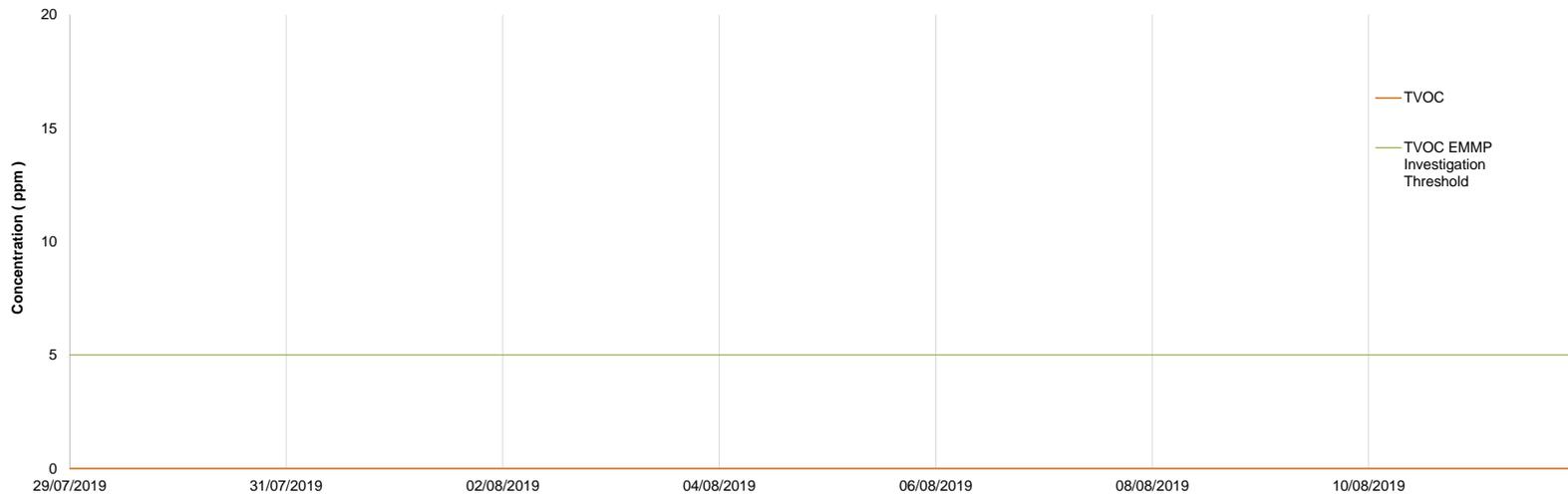
The most recently available passive BTEX monitoring results are included in Table 3 below.

Table 3. Passive BTEX Results from the period 4th June – 4th July 2019.

Location	P1	P2	P3	P4	UK AQO
Parameter	$\mu\text{g m}^{-3}$				
Benzene	<0.5	<0.5	0.5	0.5	5.0*
Toluene	1.9	0.4	0.4	0.6	N/a
Ethyl-benzene	0.5	<0.3	<0.3	<0.3	N/a
Xylene (m&p)	1.3	<0.3	<0.3	0.3	N/a
Xylene (o)	0.4	<0.3	<0.3	<0.3	N/a

*UK AQO for benzene is $5.0 \mu\text{g m}^{-3}$ as an annual mean. No UK AQO exists for toluene, ethyl-benzene or xylene.

Note: Locations P1 and P4 typically record higher BTEX results due to their proximity to traffic emissions on the A583, Preston New Road.



Title:
Preston New Road TVOC - 29th July to 11th August 2019

Project:
GGS1628 Preston New Road

Client:
Cuadrilla Bowland Ltd

Minimum / Maximum Table		
Parameter	Minimum	Maximum
TVOC (ppm)	0	0

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3.6 Hydrogen sulphide

Hydrogen sulphide is typically formed by the bacterial degradation of organic matter. It is a toxic and flammable gas which is typified by a strong rotten eggs odour. It is detectible as an odour at very low levels (parts per billion), and can cause chronic health effects where exposure is prolonged. Acute health impacts followed by unconsciousness and death can be caused by exposure to high concentrations (>100s ppm).

3.6.1 Methodology

Continuous monitoring of hydrogen sulphide (H₂S) began in May 2018 and results are recorded every 10 minutes. Continuous H₂S monitoring is undertaken to provide additional information retrospectively in the event that hydrogen sulphide is detected within the natural gas encountered at the site.

Passive monitoring of hydrogen sulphide is also undertaken at four locations on a monthly basis. The most recently available results are detailed in Section 3.6.2 below.

3.6.2 Results

No hydrogen sulphide was detected at PNRAQ01 during the period 29th July to 11th August 2019.

The most recently available passive hydrogen sulphide monitoring results are included in Table 4 below.

Table 4. Passive BTEX Results from the period 4th June – 4th July 2019.

Location	P1	P2	P3	P4	UK OEL
Parameter	µg m ⁻³				
Hydrogen sulphide	<0.03	<0.03	<0.03	<0.03	7000*

*The long term UK Occupational Exposure Level (OEL) for hydrogen sulphide is based on an 8 hour time-weighted average.

4 Quality Control & Assurance

All monitoring equipment operated by GGS is maintained in accordance with the manufacturer's guidelines. Annual services and calibrations are undertaken when required and routine visual inspections of the equipment are undertaken prior to deployment and during regular site visits by GGS staff.

GGS operates an Integrated Management System (IMS) that is accredited by QMS International plc as complying with the following international standards:

- BS EN ISO 9001:2015 (Quality Management System);
- ISO 14001:2015 (Environmental Management System), and;
- ISO 45001:2018 (Health and Safety Management System).

All of GGS' continuous monitoring and sampling is carried out to procedures that are subject to an annual audit.

5 Ongoing Monitoring Regime

Ambient air monitoring will continue throughout the duration of site operations as required by the EMMP.

In addition, if significant concentrations, as determined with reference to baseline monitoring carried out prior to well stimulation operations and as agreed with the Environment Agency, are observed then the Environment Agency will be notified and the source of the elevation will be investigated.

As agreed with the Environment Agency, these fortnightly reports were temporarily suspended during a period of reduced activity at the site. As agreed, reporting will commence at least two weeks prior to periods of increased onsite activity. Continuous monitoring of all parameters has continued throughout.