

# Annual Data Report

2020

## Cheltenham Borough Council

**Period covered:** 01/01/2020 – 31/12/2020

**Report number:** 131

**Report issue date:** 20/05/2021

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## Cheltenham 1150100 - Site Information

The Cheltenham monitoring station is located in a roadside cabin near A40 Gloucester road.

**UK-AIR ID:** None

**EU Site ID:** None

**Environment Type:** Urban Traffic

**Altitude (metres):** None

**Site Address:** 18 Gloucester Road, Cheltenham

**Government Region:** Cheltenham

**Easting/Northing:** 560963.89, 5749904.91

**Latitude/Longitude:** 51.896565, -2.114000

**Site location URL:** <https://goo.gl/maps/196QLfK1iYj5AjDd9>

## AQMesh devices in Cheltenham

9 AQMesh devices have been installed at various locations after co-location study, scaling factors (slope and offset) generated by co-location study during first quarter 2021 have been retrospectively applied to each AQMesh device's historical data channels from 01 January 2020 to present. The following AQMesh and reference station data summary is using scaled data at raw data rate exported from [www.airmonitors.net](http://www.airmonitors.net). Gaseous pollutant mass units are at 20 °C and 1013mb. Particulate matter concentrations are reported at ambient temperature and pressure.

## AQMesh statement

AQMesh is a multi-parameter small sensor system. When operated according to manufacturer's guidance and best practice the devices should provide reasonably accurate results "out of the box". Accuracy can be further improved by either physical co-location with Reference (or Equivalence) grade monitors or Acoem's network smart calibration methods and subsequent adjustment of calibration parameters. AQMesh devices, once calibrated, can provide accuracy close to that of a Reference for Equivalence monitor, but we recommend

that AQMesh data alone should not be relied upon for compliance with EU or UK air quality directives.

### AQMesh status flags

Flag	Description of when the status flag appears
Below Level Of Detection	The AQMesh reading is under the level of detection listed in the <a href="#">specification sheet</a> .
Stabilising	AQMesh is running automatic self stabilising which is usually 2 days in duration. This occurs when AQMesh is switched on for the first time and after gas sensor replacement.
Rebasing	AQMesh is running automatic self rebasing on gas sensors which usually lasts 2-5 days. This occurs when AQMesh is switched on for the first time and after gas sensor replacement. There is no data when this flag is present.
Rebased	This status flag replaces the rebasing status flag once AQMesh finishes rebasing, the readings during the rebasing process are retrospectively populated with the rebased status flag.
Optimising	Occurs when a pod is power-cycled for more than an hour i.e. Maintenance or power failure.
Communication Error	AQMesh is unable to upload data successfully. This status will require investigation.
Failed Sensor	AQMesh gas sensor has been determined as failed and requires a replacement sensor to be installed.
Cross Gas Error	This status flag appears when a sensor fails which is relied upon for the removal or interferences on another sensor, e.g. NO <sub>2</sub> sensor failure will affect O <sub>3</sub> reading. O <sub>3</sub> readings are then marked with the Cross Gas Error status flag.
Destabilised	The system has detected that the sensor may be compromised due to odd fluctuations in temperature and pressure.
Extreme Environment	This status flag appears when the manufacturer determines the combination of extremes in climate in which the electrochemical sensors do not provide consistent outputs. As such precise and accurate measurements are not possible.
Condensation	The NDIR sensor is affected by condensation on the detector. This flag is exclusive to CO <sub>2</sub> data.

Deliquescence	This status flag appears when not using the heated inlet option. Outlying data points caused by hygroscopic particle size growth will be flagged following analysis of the particle count distribution. This flag is exclusive to PM data.
Misread	Occurs when the particle counter misreads. It is exclusive to PM data.
Greater Than Upper Limit	Occurs when the reading is above the device measurement range.
Greater Than Concentration Limit	This status flag appears when data is above the concentration limit, set for ambient air measurement.
Less Than Concentration Limit	This status flag appears when data is lower than the device concentration limit, set for ambient air measurement.
Less Than Lower Limit	This status flag appears when reading is lower than the device measurement range.
PM <sub>1</sub> Greater Than PM <sub>2.5</sub>	Prescaled PM <sub>1</sub> readings are higher than PM <sub>2.5</sub> readings.
PM <sub>1</sub> Greater Than PM <sub>10</sub>	Prescaled PM <sub>1</sub> readings are higher than PM <sub>10</sub> readings.
PM <sub>2.5</sub> Greater Than PM <sub>10</sub>	Prescaled PM <sub>2.5</sub> readings are higher than PM <sub>10</sub> readings.
Depletion Event	This status flag appears when there is abundant NO <sub>x</sub> level in the air and AQMesh reports negative O <sub>3</sub> levels. O <sub>3</sub> readings should be considered and truncated to zero under this status flag.
Calibration	Device is under a calibration process.
Unknown Error	AQMesh encounters an unknown error. This is usually caused by a hardware related problem and requires further investigation.

## Upper limit, lower limit and concentration limit

This table shows the upper limit, lower limit and concentration limits that are set for AQMesh measured pollutants. The status flags “Greater Than Upper Limit”, “Greater Than Concentration Limit”, “Less Than Concentration Limit” and “Less Than Lower Limit” in the data summary are determined by values in this table.

<b>AQMesh channels</b>	<b>Upper limit</b>	<b>High concentration limit</b>	<b>Low concentration limit</b>	<b>Lower limit</b>	<b>Unit</b>
<b>NO</b>	1000	800	-5	-100	ppb
<b>NO<sub>2</sub></b>	1000	300	-5	-100	ppb
<b>PM<sub>10</sub></b>	3000	None	None	-100	µg m <sup>-3</sup>
<b>PM<sub>2.5</sub></b>	3000	None	None	-100	µg m <sup>-3</sup>
<b>PM<sub>1</sub></b>	1000	None	None	-100	µg m <sup>-3</sup>

## Glossary

**Data Capture Rate**- The amount of data captured as a percentage of the total possible in any period.

**Valid Data Rate** - The proportion of data considered valid after any invalid Status Flags have been considered and any Outliers have been removed.

**Outliers** - Data points which have been removed from a data set other than by predetermined Status Flags by a manually applied ratification process.

**Status Flag** - A marker applied to each data point based on a number predetermined conditions which describe a condition which may render the data valid or invalid.

**Pre-Scaled Data** - Data which has not (yet) been subject to offset or slope adjustments as a result of a Calibration Process.

**Scaled Data** - Pre-Scaled data which has been subsequently adjusted by application of an offset and/or slope determined by a Calibration Process.

**Reference** - Data generated by a certified monitor complying with the requirements of an EU, UK or US Reference method.

**Equivalence** - A monitor which has been certified Equivalent to a EU, UK or US Reference Method according to the relevant Guidance on Equivalence Designation.

**Co-location Study** - A process of comparing data from a candidate sensor device with that of a Reference (or Equivalent) monitor for a period of time at a fixed location.

**Sensor Calibration Process** - A Co-location Study where a candidate sensor or sensor system is compared with a Reference (or Equivalence) grade monitor for a period of time and the candidate data is adjusted by application of an offset and/or slope in order to improve the level of agreement with the reference data source.

**Scale Separation** - A process of separating the local and regional concentration signals for an observed pollutant species within a network of sensors.

**Network Calibration process** - A Calibration Process applied to a group of sensors within a specified geographical area, using a common (regional) signal from ambient air as derived by a Scale Separation technique.

**Emissions Indices** - The amount of a criteria pollutant produced (or emitted) expressed as a percentage of the amount of fuel combusted. This is normally calculated as a ratio of the criteria pollutant concentration over that of CO<sub>2</sub>.

**Criteria Air Pollutant** - A gaseous, particulate matter, aerosol or vapour consisting of a material designated as a controlled air pollutant within an EU, UK or US Air Quality Directive.

**API (Application Program Interface)** - A protocol allowing manual or automated, third party queries of data within a database and returning a predetermined response format. e.g. (JSON, CSV etc)

**Relative Concentration** - The concentration of an airborne pollutant expressed as ppb, ppm, etc

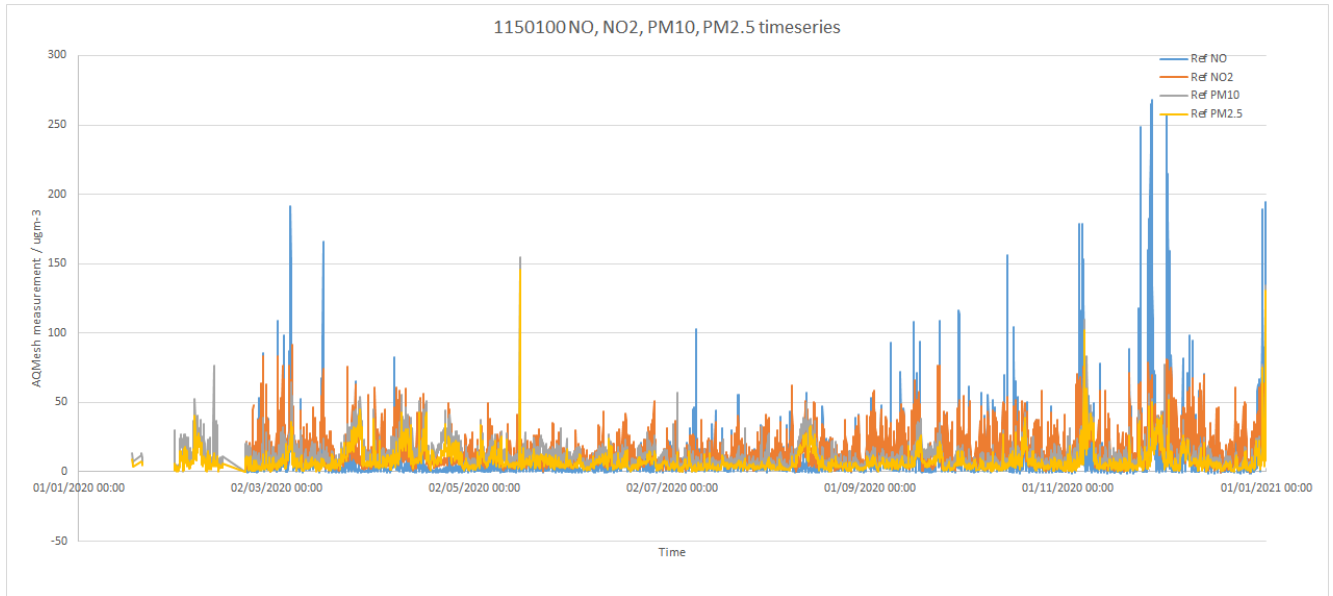
**Absolute Concentration** - The concentration of an airborne pollutant expressed in mg/m<sup>3</sup>, ug/m<sup>3</sup>, mole/m<sup>3</sup> etc.

**OpenAir** - A set of data analysis tools using advanced data processing in "R"

**"R"** - R is a programming language and free software environment for statistical computing and graphics supported by the R Foundation for Statistical Computing. The R language is widely used among statisticians and data miners for developing statistical software and data analysis.

## January 2020 - December 2020 Data summary

### 1150100 Cheltenham reference site - Data Summary



(Graph shows hourly averaged data)

This reference site has Thermo 42i NO<sub>x</sub> analyser and Palas Fidas PM analyser installed.

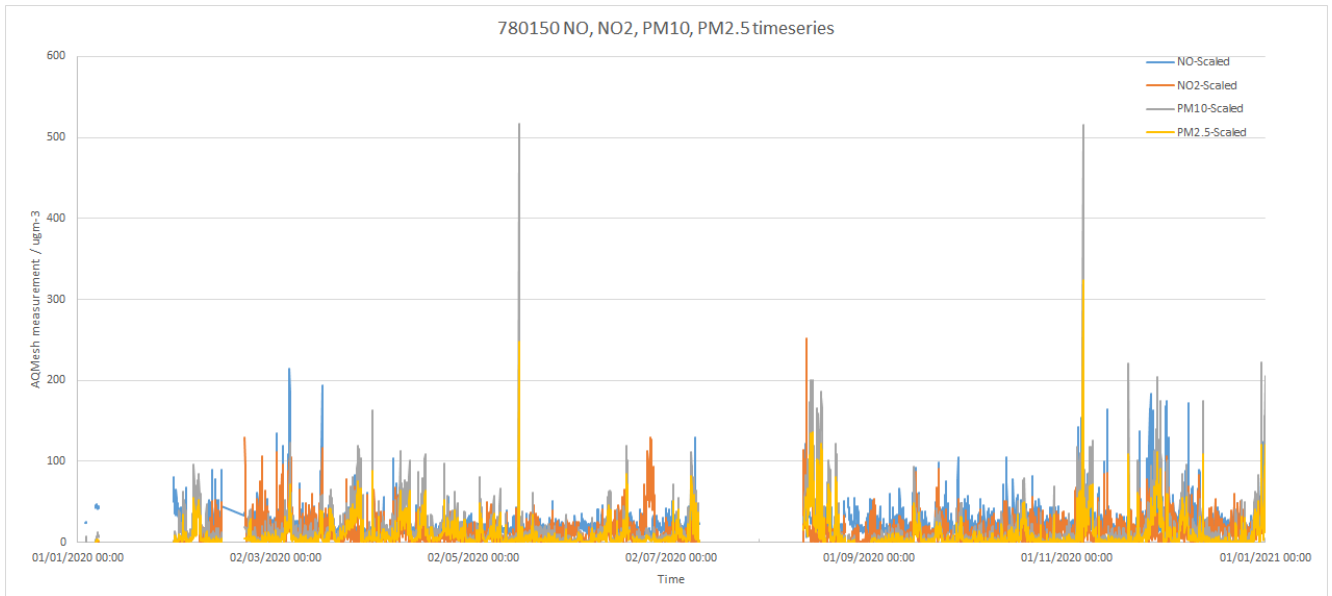
Reference Valid data	NO Scaled data	NO <sub>2</sub> Scaled data	PM <sub>10</sub> Scaled data	PM <sub>2.5</sub> Scaled data	Unit
<b>Data capture rate</b>	74.94%	79.05%	65.44%	65.44%	None
<b>Max</b>	267.80	91.80	154.94	145.88	µg m <sup>-3</sup>
<b>Min</b>	-0.60	0.00	0.00	0.00	µg m <sup>-3</sup>
<b>Median</b>	4.80	12.40	9.84	5.42	µg m <sup>-3</sup>
<b>Monthly mean</b>	10.52	15.98	12.23	7.66	µg m <sup>-3</sup>
<b>Invalid data status flag</b>					
	Communication Error	Communication Error	Communication Error	Communication Error	

(Min, Max & Median based on hourly data)



NOTE: Negative reading shown in the above tables are genuine data from the reference instrument. Negative values could be the noise readings when ambient pollution level is very low.

### 780150 AQMesh - Data Summary

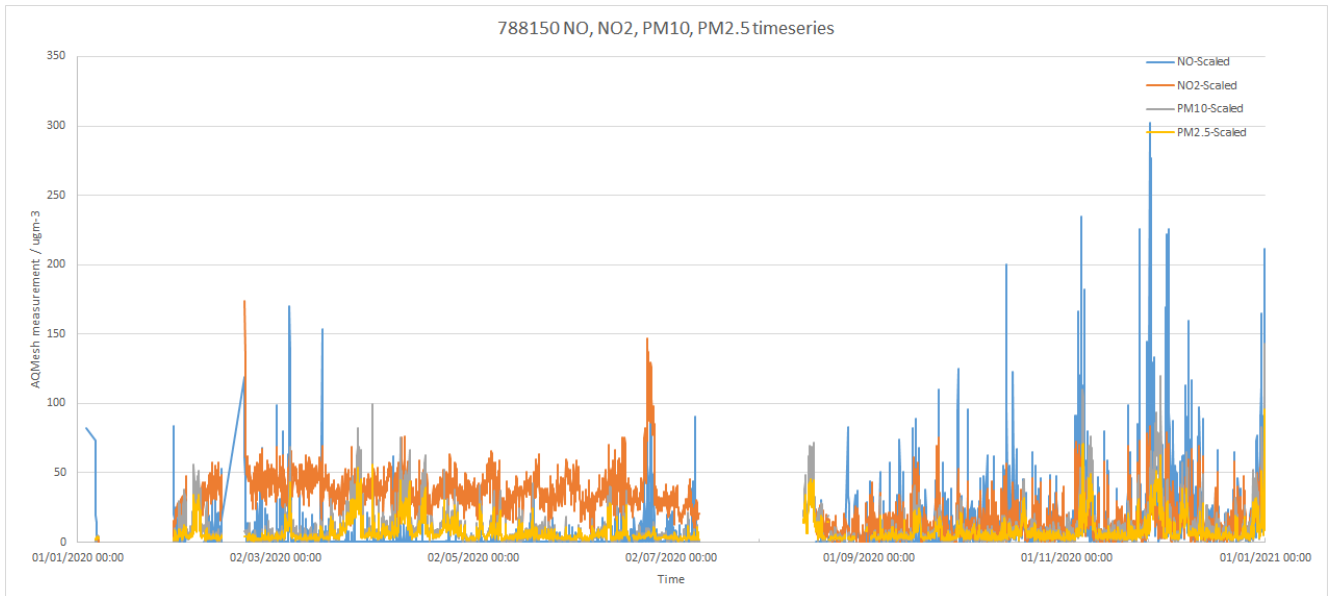


(Graph shows hourly averaged data)

<b>AQMesh Valid data</b>	<b>NO Scaled data</b>	<b>NO<sub>2</sub> Scaled data</b>	<b>PM<sub>10</sub> Scaled data</b>	<b>PM<sub>2.5</sub> Scaled data</b>	<b>Unit</b>
<b>Valid data rate</b>	97.85%	98.47%	97.05%	97.05%	None
<b>Max</b>	214.90	252.30	517.23	324.23	µg m <sup>-3</sup>
<b>Min</b>	7.30	0.00	0.00	0.00	µg m <sup>-3</sup>
<b>Median</b>	18.70	9.90	8.28	3.24	µg m <sup>-3</sup>
<b>Monthly mean</b>	23.45	14.10	17.31	9.54	µg m <sup>-3</sup>
<b>Invalid data status flag</b>					
	Stabilising	Stabilising Less Than Lower Limit Optimising Truncation	Deliquescence Truncation	Deliquescence Truncation	

(Min, Max & Median based on hourly data)

## 788150 AQMesh - Data Summary

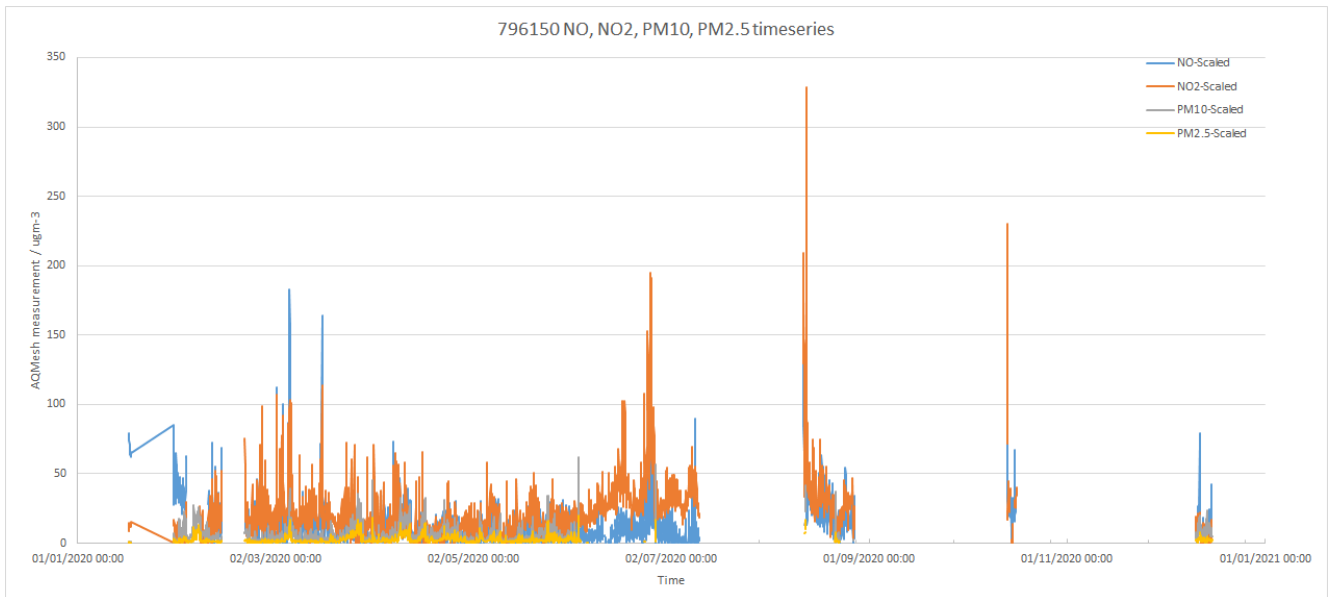


(Graph shows hourly averaged data)

<b>AQMesh Valid data</b>	<b>NO Scaled data</b>	<b>NO<sub>2</sub> Scaled data</b>	<b>PM<sub>10</sub> Scaled data</b>	<b>PM<sub>2.5</sub> Scaled data</b>	<b>Unit</b>
<b>Valid data rate</b>	96.74%	97.19%	97.41%	97.41%	None
<b>Max</b>	302.20	174.20	143.17	95.79	$\mu\text{g m}^{-3}$
<b>Min</b>	0.00	0.00	0.00	1.38	$\mu\text{g m}^{-3}$
<b>Median</b>	0.00	25.90	5.74	4.45	$\mu\text{g m}^{-3}$
<b>Monthly mean</b>	9.39	26.32	10.16	7.44	$\mu\text{g m}^{-3}$
<b>Invalid data status flag</b>					
	Stabilising Truncation	Optimising Stabilising Truncation	Delinquescence Misread Truncation	Delinquescence Misread	

(Min, Max & Median based on hourly data)

## 796150 AQMesh - Data Summary

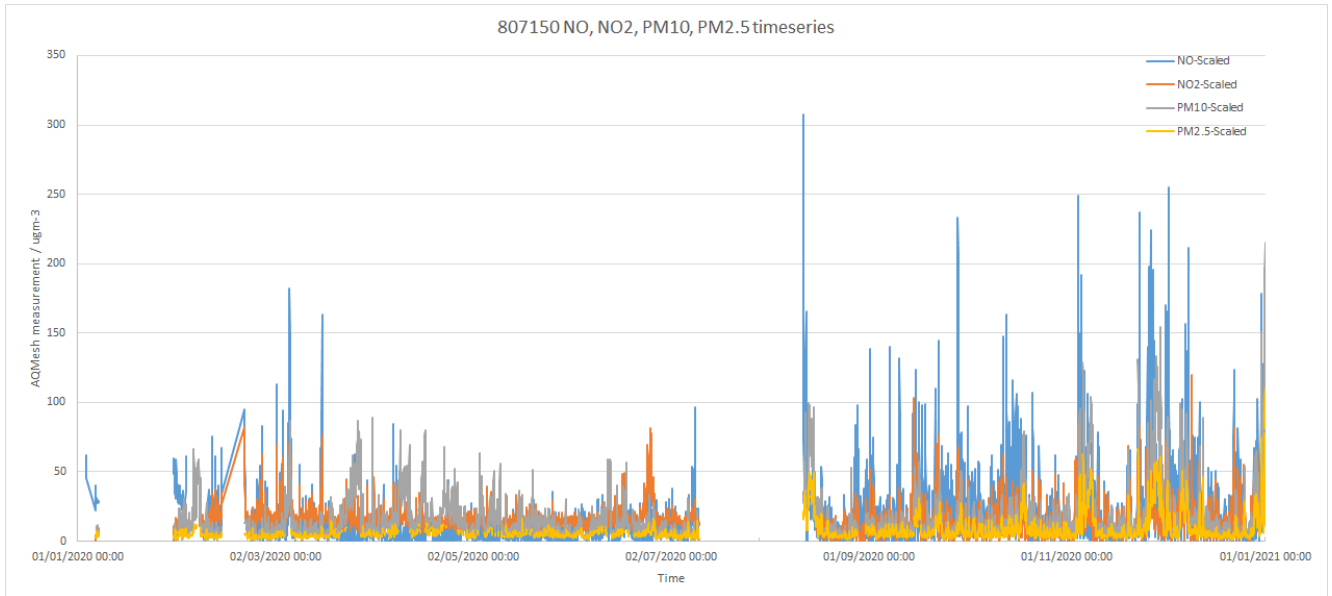


(Graph shows hourly averaged data)

<b>AQMesh Valid data</b>	<b>NO Scaled data</b>	<b>NO<sub>2</sub> Scaled data</b>	<b>PM<sub>10</sub> Scaled data</b>	<b>PM<sub>2.5</sub> Scaled data</b>	<b>Unit</b>
<b>Valid data rate</b>	86.83%	97.01%	69.95%	69.95%	None
<b>Max</b>	183.20	328.30	61.78	19.78	µg m <sup>-3</sup>
<b>Min</b>	0.00	0.00	0.00	0.18	µg m <sup>-3</sup>
<b>Median</b>	11.10	18.40	4.24	1.73	µg m <sup>-3</sup>
<b>Monthly mean</b>	15.18	22.34	5.95	2.55	µg m <sup>-3</sup>
<b>Invalid data status flag</b>					
	Stabilising Less Than Concentration Limit Less Than Lower Limit Communication error Truncation	Less Than Lower Limit Optimising Stabilising Greater Than Concentration Limit Greater Than Upper Limit Communication Error Truncation	Delinquency Misread Unknown error Truncation	Delinquency Misread Unknown error	

(Min, Max & Median based on hourly data)

### 807150 AQMesh - Data Summary

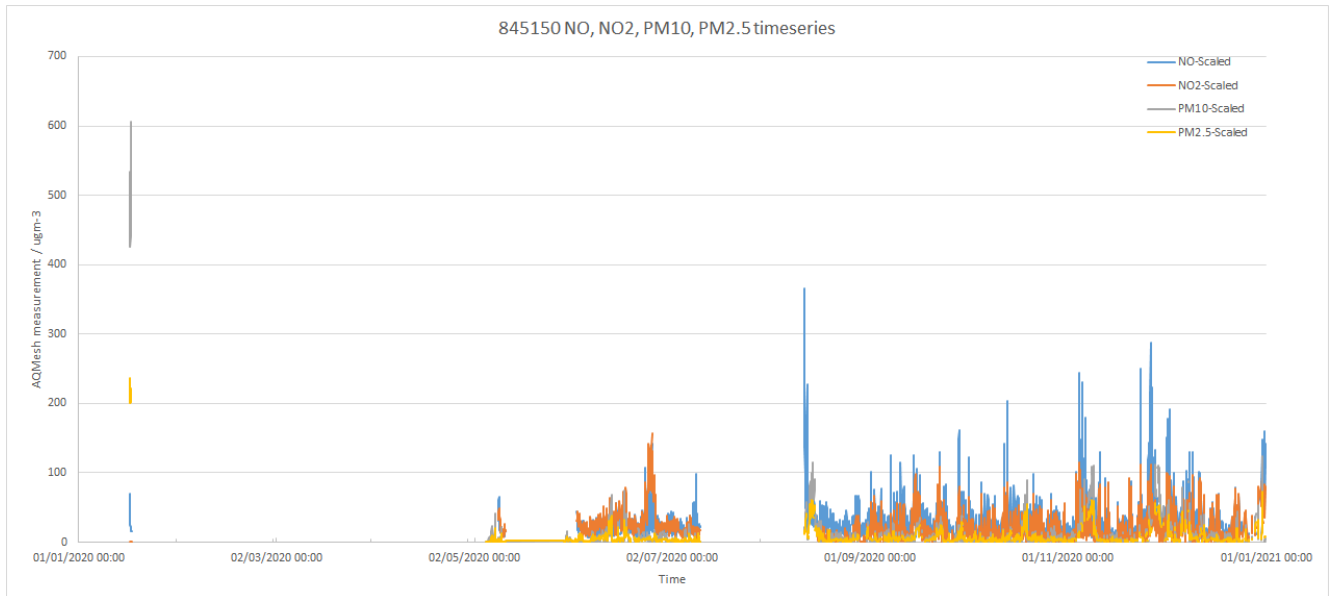


(Graph shows hourly averaged data)

<b>AQMesh Valid data</b>	<b>NO Scaled data</b>	<b>NO<sub>2</sub> Scaled data</b>	<b>PM<sub>10</sub> Scaled data</b>	<b>PM<sub>2.5</sub> Scaled data</b>	<b>Unit</b>
<b>Valid data rate</b>	97.98%	97.14%	97.95%	97.95%	None
<b>Max</b>	307.30	119.70	215.25	110.08	µg m <sup>-3</sup>
<b>Min</b>	0.00	0.00	0.00	1.67	µg m <sup>-3</sup>
<b>Median</b>	9.50	15.00	10.14	4.99	µg m <sup>-3</sup>
<b>Monthly mean</b>	17.07	15.74	16.04	7.72	µg m <sup>-3</sup>
<b>Invalid data status flag</b>					
	Stabilising Less Than Concentration Limit Truncation	Optimising Stabilising Less Than Concentration Limit Truncation	Deliquescence Misread Truncation	Deliquescence Misread	

(Min, Max & Median based on hourly data)

## 845150 AQMesh - Data Summary



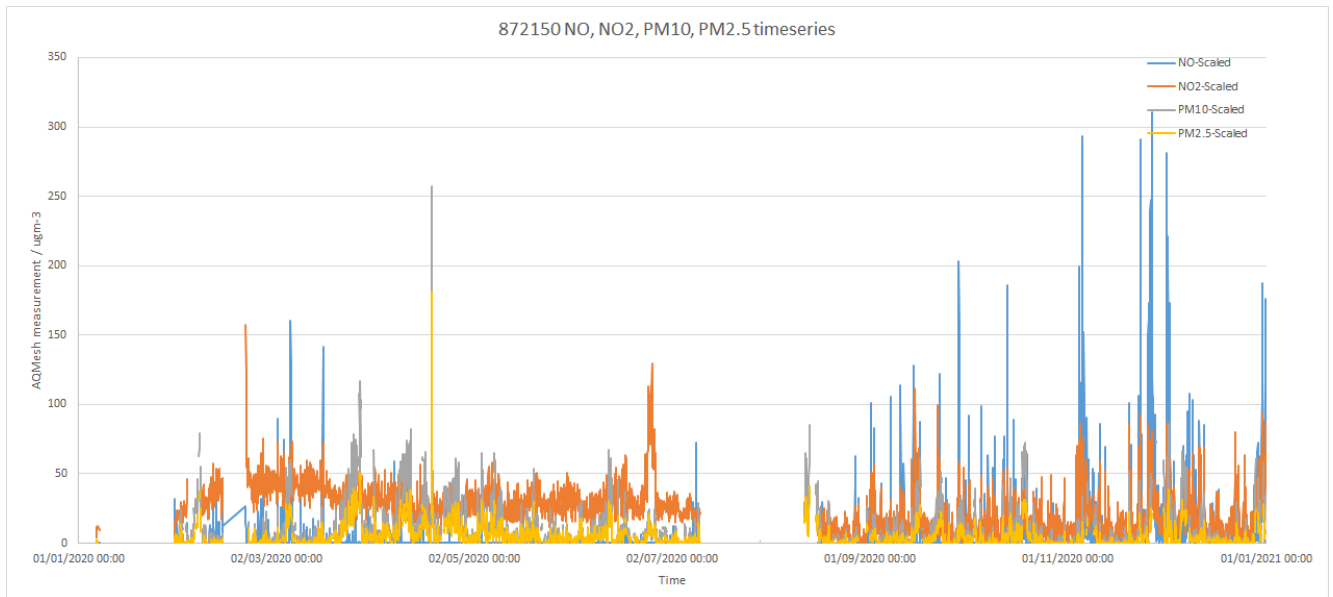
(Graph shows hourly averaged data)

<b>AQMesh Valid data</b>	<b>NO Scaled data</b>	<b>NO<sub>2</sub> Scaled data</b>	<b>PM<sub>10</sub> Scaled data</b>	<b>PM<sub>2.5</sub> Scaled data</b>	<b>Unit</b>
<b>Valid data rate</b>	80.13%	93.05%	75.82%	75.82%	None
<b>Max</b>	365.00	157.10	606.00	237.25	µg m <sup>-3</sup>
<b>Min</b>	6.10	0.00	0.00	0.00	µg m <sup>-3</sup>
<b>Median</b>	25.60	15.00	1.71	3.70	µg m <sup>-3</sup>
<b>Monthly mean</b>	32.90	19.57	9.15	7.28	µg m <sup>-3</sup>
<b>Invalid data status flag</b>					
	Stabilising Less Than Concentration Limit Less Than Lower Limit Communication Error	Optimising Stabilising Communication Error Extreme Environment Truncation	Delinquescence Misread Unknown error Truncation	Delinquescence Misread Unknown error Truncation	

	Extreme Environment				
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(Min, Max & Median based on hourly data)

## 872150 AQMesh - Data Summary



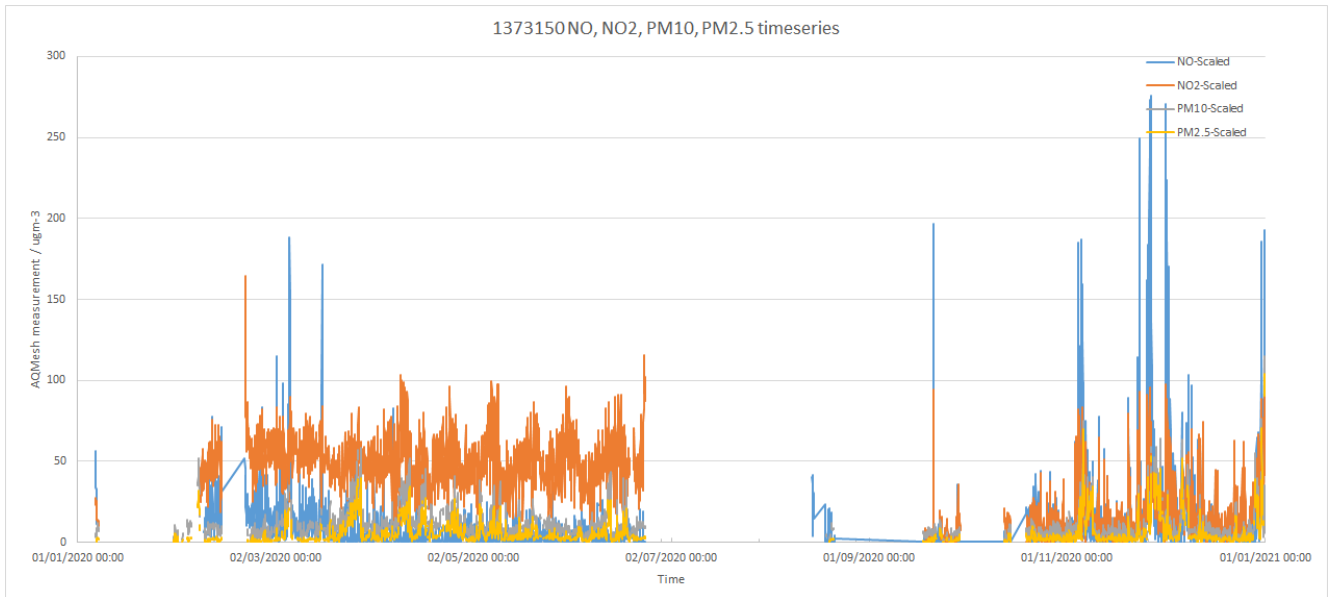
(Graph shows hourly averaged data)

<b>AQMesh Valid data</b>	<b>NO Scaled data</b>	<b>NO<sub>2</sub> Scaled data</b>	<b>PM<sub>10</sub> Scaled data</b>	<b>PM<sub>2.5</sub> Scaled data</b>	<b>Unit</b>
<b>Valid data rate</b>	92.10%	97.15%	80.41%	80.41%	None
<b>Max</b>	310.90	157.40	257.11	181.23	µg m <sup>-3</sup>
<b>Min</b>	0.00	0.00	0.00	0.00	µg m <sup>-3</sup>
<b>Median</b>	0.00	22.50	2.55	2.20	µg m <sup>-3</sup>
<b>Monthly mean</b>	6.73	24.23	8.75	4.87	µg m <sup>-3</sup>
<b>Invalid data status flag</b>					
	Stabilising Less Than Concentration Limit	Optimising Stabilising Communication Error	Delinquescence Misread Truncation	Delinquescence Misread Truncation	

	Less Than Lower Limit Communication Error Truncation	Truncation			
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(Min, Max & Median based on hourly data)

### 1373150 AQMesh - Data Summary



(Graph shows hourly averaged data)

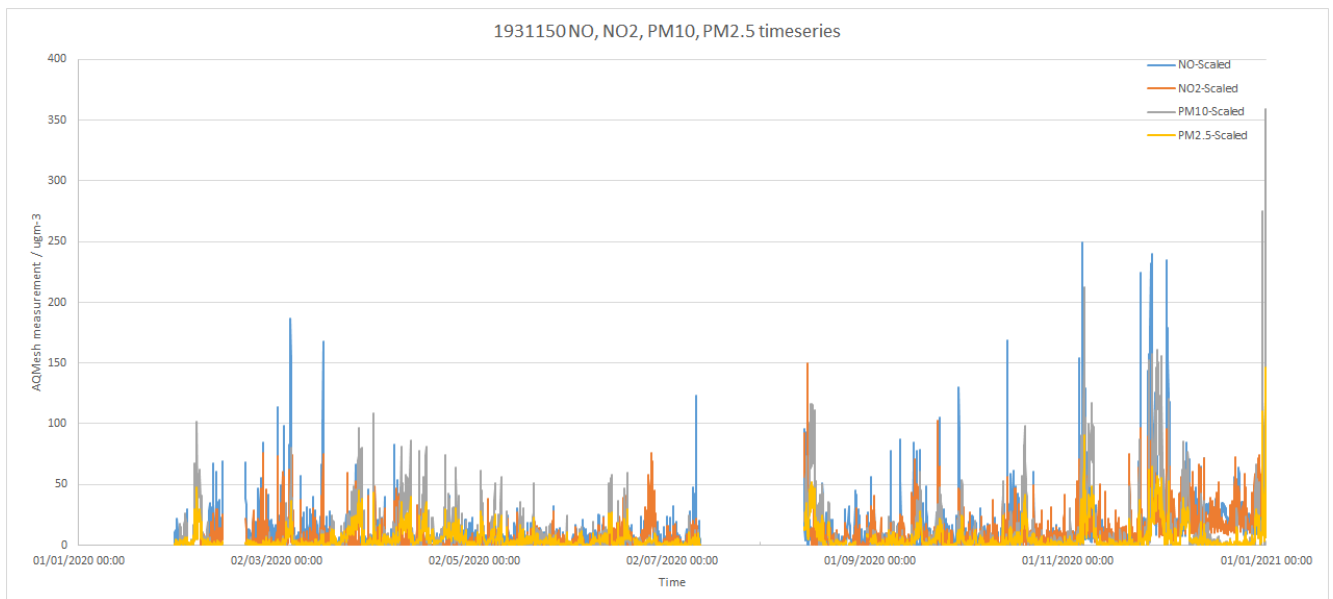
<b>AQMesh Valid data</b>	<b>NO Scaled data</b>	<b>NO<sub>2</sub> Scaled data</b>	<b>PM<sub>10</sub> Scaled data</b>	<b>PM<sub>2.5</sub> Scaled data</b>	<b>Unit</b>
<b>Valid data rate</b>	94.93%	94.36%	82.07%	82.07%	None
<b>Max</b>	275.80	290.40	115.13	109.78	$\mu\text{g m}^{-3}$
<b>Min</b>	0.00	0.00	0.19	0.00	$\mu\text{g m}^{-3}$
<b>Median</b>	4.40	38.30	7.73	2.73	$\mu\text{g m}^{-3}$
<b>Monthly mean</b>	11.59	36.57	10.42	5.40	$\mu\text{g m}^{-3}$
<b>Invalid data status flag</b>					
	Less Than Concentration Limit Less Than Lower Limit	Less Than Lower Limit Optimising Stabilising	Delinquescence Misread Unknown error	Delinquescence Misread Unknown error	



	Greater Than Upper Limit Truncation	Less Than Concentration Limit Truncation		Truncation	
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(Min, Max & Median based on hourly data)

## 1931150 AQMesh - Data Summary



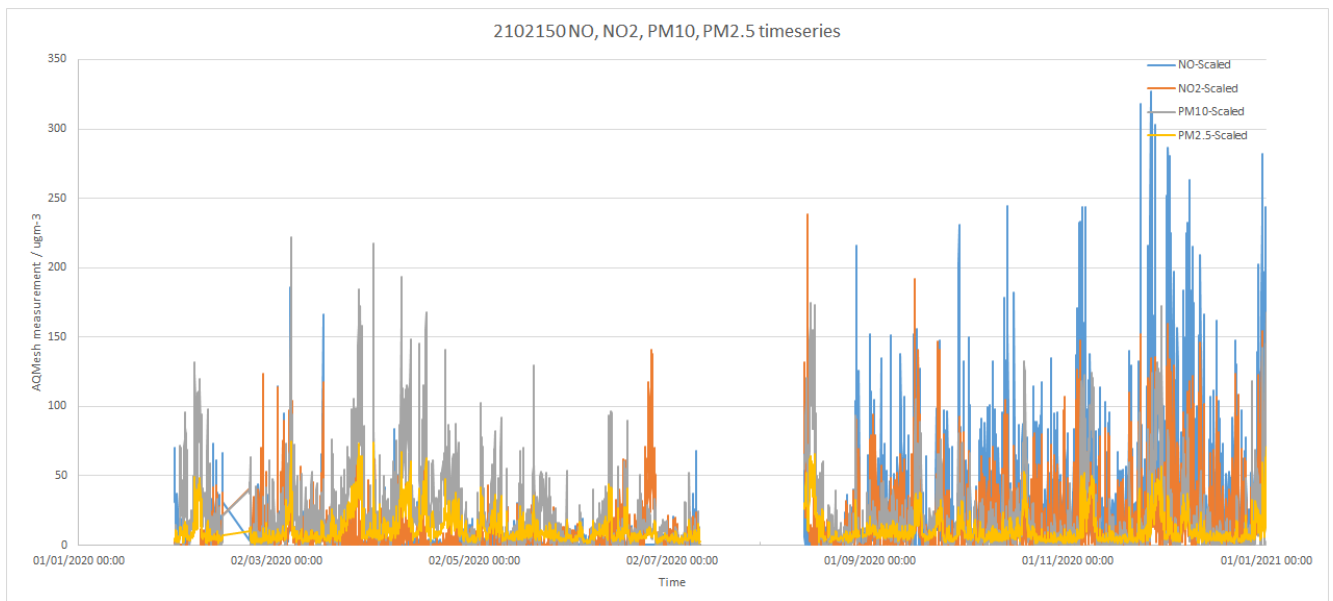
(Graph shows hourly averaged data)

<b>AQMesh Valid data</b>	<b>NO Scaled data</b>	<b>NO<sub>2</sub> Scaled data</b>	<b>PM<sub>10</sub> Scaled data</b>	<b>PM<sub>2.5</sub> Scaled data</b>	<b>Unit</b>
<b>Valid data rate</b>	97.50%	95.24%	97.74%	97.74%	None
<b>Max</b>	248.90	149.40	358.78	146.10	µg m <sup>-3</sup>
<b>Min</b>	0.00	0.00	0.00	0.00	µg m <sup>-3</sup>
<b>Median</b>	4.90	4.10	0.00	2.32	µg m <sup>-3</sup>
<b>Monthly mean</b>	10.85	9.24	9.43	5.77	µg m <sup>-3</sup>
<b>Invalid data status flag</b>					
	Stabilising Less Than	Less Than Lower Limit	Delinquency Misread	Delinquency Misread	

	Concentration Limit Less Than Lower Limit Truncation	Optimising Stabilising Less Than Concentration Limit Rebasing Truncation	Truncation	Truncation	
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(Min, Max & Median based on hourly data)

## 2102150 AQMesh - Data Summary



(Graph shows hourly averaged data)

<b>AQMesh Valid data</b>	<b>NO Scaled data</b>	<b>NO<sub>2</sub> Scaled data</b>	<b>PM<sub>10</sub> Scaled data</b>	<b>PM<sub>2.5</sub> Scaled data</b>	<b>Unit</b>
<b>Valid data rate</b>	97.88%	98.55%	99.16%	99.16%	None
<b>Max</b>	327.30	238.70	222.11	74.60	µg m <sup>-3</sup>
<b>Min</b>	0.00	0.00	0.00	1.39	µg m <sup>-3</sup>
<b>Median</b>	4.80	4.60	12.12	7.15	µg m <sup>-3</sup>
<b>Monthly mean</b>	20.99	14.46	21.03	10.81	µg m <sup>-3</sup>
<b>Invalid data status flag</b>					
	Stabilising	Stabilising	Deliquescence	Deliquescence	

	Truncation	Less Than Lower Limit Optimising Truncation	Misread Truncation	Misread	
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(Min, Max & Median based on hourly data)