

Peel Environmental Ltd

## Update to building layout: air quality analysis

Powerhouse Energy Protos

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### 1 Introduction

The planning application for the Protos Powerhouse Energy Recovery and Hydrogen Production Facility (the Proposed Development) was submitted to Cheshire West and Chester Council (CWACC) on 18 September 2019 (ref. 19/03489/FUL). This was supported by the air quality assessment and recommended stack heights by Fichtner Consulting Engineers (S2729-0030-0001SMN, referred to as the 'original AQA'). The original AQA was later accompanied by a technical note (S2729-0030-0003SMN) in response to Natural England's (NE) consultation response. Both these documents should be referred to when reading this technical note.

In May 2021, a new building layout and design was finalised. This included a change in layout and increase in elevation of the buildings. The purpose of this technical note is to confirm if the consented stack heights are still appropriate. The proposed changes will not have any impact on the transport emissions. Therefore, this analysis has only focussed on the emissions from the gasification facility and syngas engines.

The Proposed Development has two emission points to air; the stack from the gasification facility and the combined stack from the syngas engines. The interrelation between the gasification process and the syngas engine process means that it is expected that emissions from both stacks would occur simultaneously. For the purpose of this assessment, no availability has been taken into consideration and it has been assumed that both facilities are consistently running 24 hours a day, 365 days a year. This is a conservative assumption which does not account for periods the facilities will be closed for maintenance, etc.

The previously consented stack heights were 17 m for the gasification facility stack and 11 m for the syngas engines stack.

### 2 Discussion

#### 2.1 Model inputs

The model inputs remain the same as those used in the original AQA, with the exception of the new building layout, building heights, stack locations and updated meteorological data.

The new building layouts which have been used in the updated model are as in Table 1 below, and the stack location as in Table 1. This is also displayed on Figure 1.

The ground level on the site is not level; it slopes gently from the west to the east and from the south to the north. However, ADMS runs using a uniform ground level. Therefore, the heights of the buildings for the model have been calculated from AOD assuming that the uniform ground level is 7.5 m AOD, which is the lowest ground level on which any of the modelled buildings sit. This

means that the increase in ground level is incorporated into the total building height above this point.

Table 1: Building Details

Buildings	Centre Point		Height (m)	Width (m)	Length (m)	Angle (°)
	X (m)	Y (m)				
Gasification building	346410.2	376542.4	11.02	13.68	25.55	99
Feedstock building 1*	346381.1	376553.9	11.92	23.43	17.5	99
Feedstock building 2*	346392.9	376559.6	11.92	8.5	4.17	99
Silo 1	346394.2	376551.4	13.5		5.2	-
Silo 2	346393.2	376545.5	13.5		5.2	-
Silo 3	346392.2	376539.7	13.5		2.5	-

\*There is one feedstock building, but due to the requirement of ADMS to have only either rectangular or circular shaped buildings, for the purpose of the model this has been entered as two buildings.

Table 2: Stack locations

Stack	Centre Point	
	X (m)	Y (m)
Gasification facility	346409.5	376550.7
Syngas engines	346418.6	376578.3

The original AQA used meteorological data from the Liverpool John Lennon Airport meteorological recording station for the years 2013 – 2017. This assessment has used the most recent five years data from the same location; 2016-2020. Wind roses for the latest 5 years are provided in Figure 2. All other surface characteristics data and terrain are as in the original AQA.

## 2.2 Impact on human health

The results of the dispersion modelling for the revised building layout, but with the same stack heights for the gasification facility and syngas engines, are displayed and compared to the original AQA results in Table 3 and Table 4 found within Appendix B. As part of this analysis a review of the baseline air quality has been undertaken and updates made to accommodate the updated national modelling mapped background data for 2018 and more recent automatic monitoring. The updated baseline values are provided in the detailed results tables.

The results in Table 3 and Table 4 show that at the point of maximum impact, all impacts have increased from those presented in the original AQA. However, in some cases the PEC has decreased, due to a decrease in background concentrations. Table 3 and Table 4 present the results at the point of maximum impact. At this location, close to the site boundary, there are no areas of relevant exposure with regard to the AQALs, so consideration has been made to the plot files of annual mean and short term impacts to determine the difference in the distribution of emissions in the wider area.

Figure 3 shows the annual mean nitrogen dioxide impact from the Proposed Development. As shown, there is an increase at the point of maximum impact, but further away, where there are areas of relevant exposure, the impact is similar to those set out in the original AQA. Analysis of the annual mean impact at the identified receptors shows that the change in impact is extremely small

(less than 0.03% of the AQAL for annual mean nitrogen dioxide impacts). This is also the case for the annual mean impacts of other pollutants.

Figure 4 shows the 99.79<sup>th</sup> percentile of 1-hour mean nitrogen dioxide impact from the Proposed Development. A plot file showing the 99.79<sup>th</sup> percentile of 1-hour mean nitrogen dioxide impact was not included in the original AQA as the impact screened out as negligible. However, it has been produced to allow a comparison between the results of the original AQA and those associated with the proposed change in layout. As shown, there is an increase at the point of maximum impact, but further away from this area the impacts are similar to those presented in the original AQA.

The short term AQAL applies where members of the public may be reasonably expected to have exposure for an hour period. As shown on Figure 4, there is a very small area just outside the site boundary where the impact is predicted to be greater than 10% of the AQAL. However, it is not likely that members of the public would spend periods of an hour in this location. Therefore, at areas of relevant exposure, the impact would be less than 10% of the AQAL and described as negligible.

The above analysis conservatively assumes that both the gasification facility and syngas engines operate continually at the daily ELVs as set in the Industrial Emissions Directive. The original AQA also included analysis which assumed that both the gasification facility and syngas engines operate continually at the half-hourly ELVs as set out in the Industrial Emissions Directive. This is an extremely conservative assumption as it is unlikely that both plants would need to operate at this level at the same time and that this would occur during the worst-case weather conditions for dispersion. Table 4 presents the results assuming operation of both plants concurrently at the half-hourly ELVs. As shown, at the point of maximum impact there is an increase from the results presented in the original AQA. For 99.79<sup>th</sup> percentile of hourly means of nitrogen dioxide and 99.9<sup>th</sup> percentile of 15 minute means of sulphur dioxide, this increase would cause magnitude of change to increase from 'slight adverse' to 'moderate adverse' compared to the results set out in the original AQA. However, contour plots show that the extent of the area which would be 'moderate adverse' is limited to the areas closely surrounding the site, where it is not expected for members of the public to be for over an hour. Furthermore, as set out in the original AQA, this impact is only predicted to occur under the conservative assumptions that the Proposed Development will operate at the short-term ELVs during worst-case meteorological conditions for dispersion and the worst-case assumption for the conversion of NO<sub>x</sub> to nitrogen dioxide has been applied. The impacts of sulphur dioxide are also an overly conservative assumption as they are based on the emission limits of a waste incinerator, designed to process a wide range of wastes. At the Proposed Development, the wastes are purely plastics, and are not expected to contain sulphur. Therefore, it is highly unlikely that actual concentrations will be as high as those presented within this analysis.

The IAQM 2017 guidance states that the significance of effect *"will be governed by the long-term exposure experienced by receptors and it will not be a necessity to define the significance of effects by reference to short-term impact"*. Therefore, taking into consideration the fact that impacts at the areas of relevant exposure remain extremely similar, it can be concluded that the overall impacts of Proposed Development with the revised layout and building heights but same stack heights of 17 m and 11 m for the gasification and syngas stacks respectively, will remain unchanged from the conclusions of the original AQA and are considered 'not significant'.

## 2.3 Impact at ecological sites

Consideration has also been made to the impact at the ecological sites, the results of which are displayed and compared in Appendix C. This has shown that the impacts with the revised layout but same stack heights are very similar at all ecological sites to the those presented in the original AQA, excluding Frodsham and Helsby and Ince Marshes.

Frodsham and Helsby and Ince Marshes is a local wildlife site of which part is contained within the wider Protos site and the point of maximum impact occurs within the ecological site. However, as part of the development of the Protos site, provision of ecological mitigation areas was made to compensate the loss of the sections of the local wildlife site. The predicted impact of emissions in these areas is similar to the original AQA.

As part of the previous application, NE requested an assessment of the impacts on neutral grassland habitats that are functionally linked to the Mersey Estuary SPA/ Ramsar. In order to carry out this analysis the impact of emissions at ecological mitigation area A was calculated. The maximum impact at ecological mitigation area A is very similar to that set out in the response to NE. Therefore, the conclusions set out in the response to NE remain the same that emissions associated with the Proposed Development are not predicted to have a significant effect on any ecological feature.

## 2.4 Cumulative assessment

The preceding analysis has shown that the impacts at sensitive receptors are very similar to the results set out in the original AQA. Therefore, it is not anticipated for the cumulative impact with other Facilities to change from previously assessed.

# 3 Conclusions and recommendations

This technical note provides an update to the original AQA and the associated response note to NE undertaken by Fichtner in 2019. The update has accommodated for changes to building layout, increase in building height, and updates to background concentrations and meteorological data. This technical note has demonstrated that the currently consented stack heights of 17 m and 11 m for the gasification facility and syngas engines stacks respectively remain suitable.

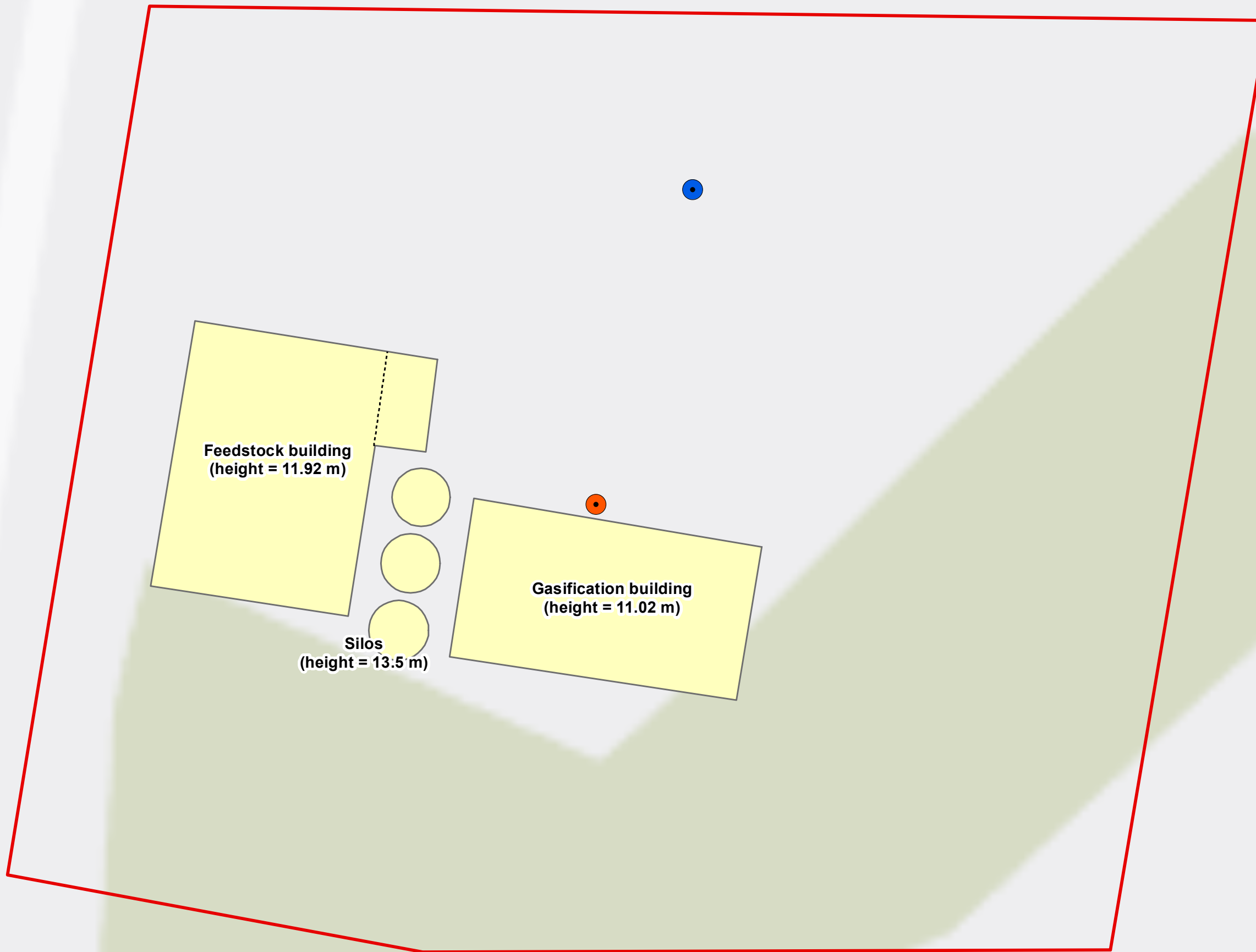
The results for human health impacts are comparable to the impacts of the original AQA. Although there are predicted increases in process contribution at the point of maximum impact, at sensitive receptors the impacts are very similar to those of the original AQA and impacts remain negligible irrespective of the total concentrations.

The impacts at ecological sites are also similar to the results of the original AQA. Therefore, the conclusions set out in the original AQA and follow up response to NE remain the same; that emissions associated with the Proposed Development are not predicted to have a significant effect on any ecological feature.





In conclusion, this analysis has shown that with stack heights of 17 m and 11 m for the gasification facility and syngas engines stacks respectively, the impacts to air quality in terms of both human health and ecological sites will be unchanged from the conclusions of the original AQA submitted with the planning application, in that the impact of the Proposed Development would not be significant.

# Appendices

# A Figures



**Legend**

-  Gasification stack
-  Syngas stack
-  Plot 10b site boundary
-  Modelled buildings

Client:	Peel
Site:	Protos
Project:	Plot 10b P2H
Title:	

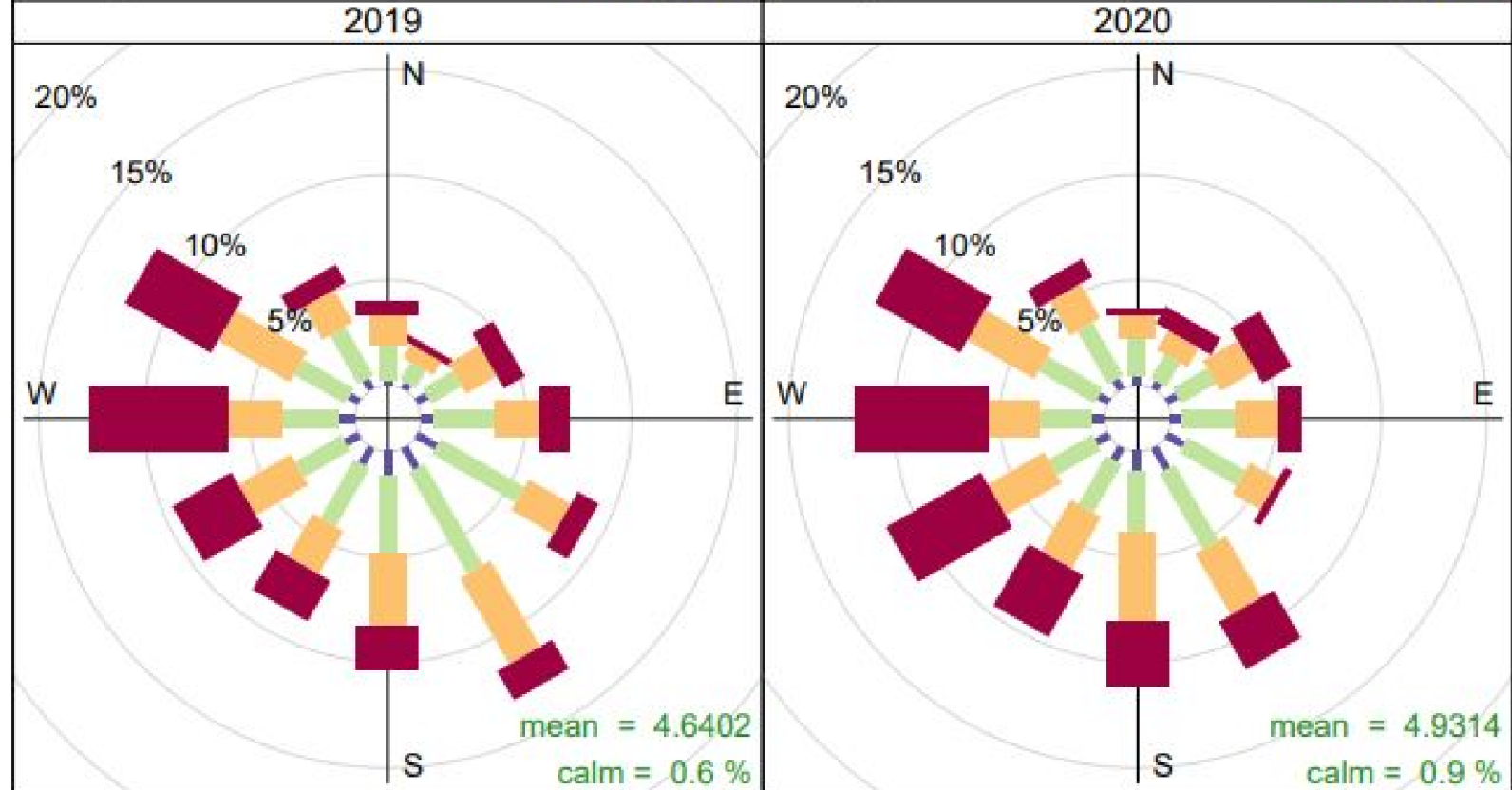
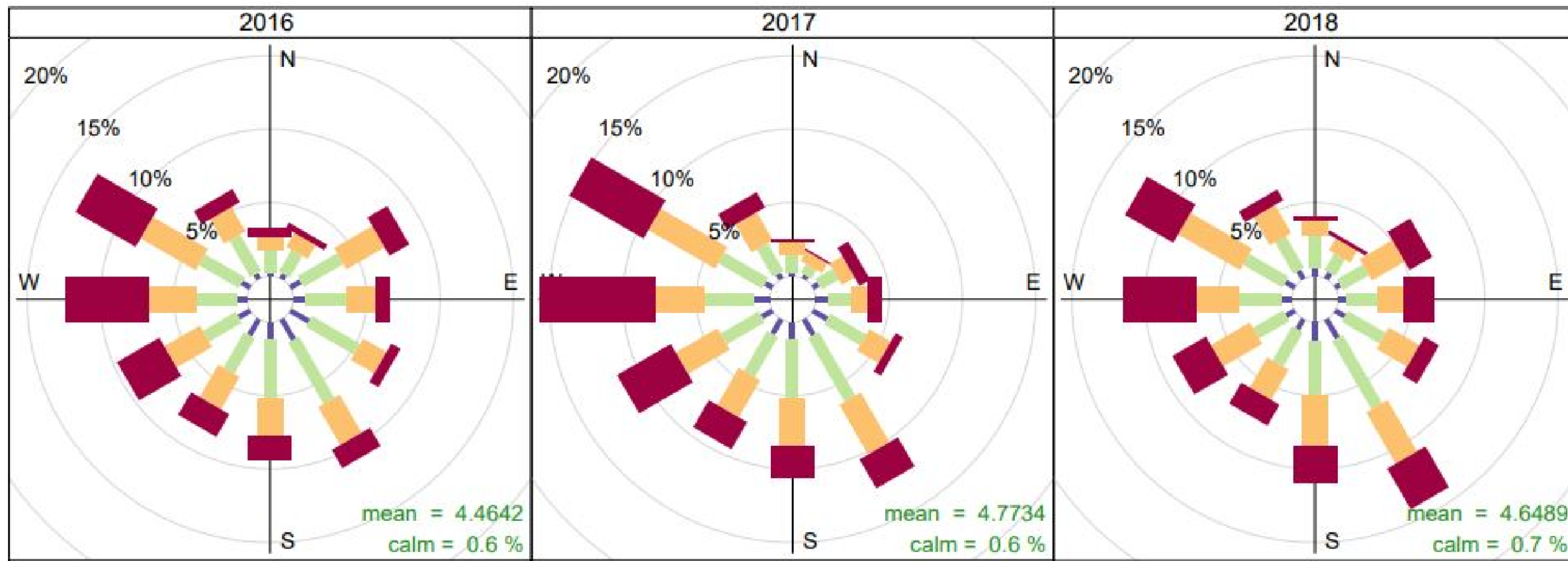
Figure 1 - Modelled buildings

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Frequency of counts by wind direction (%)

Client:	Peel
Site:	Protos
Project:	Plot 10b P2H
Title:	

Figure 2 - Liverpool wind roses 2016-2020

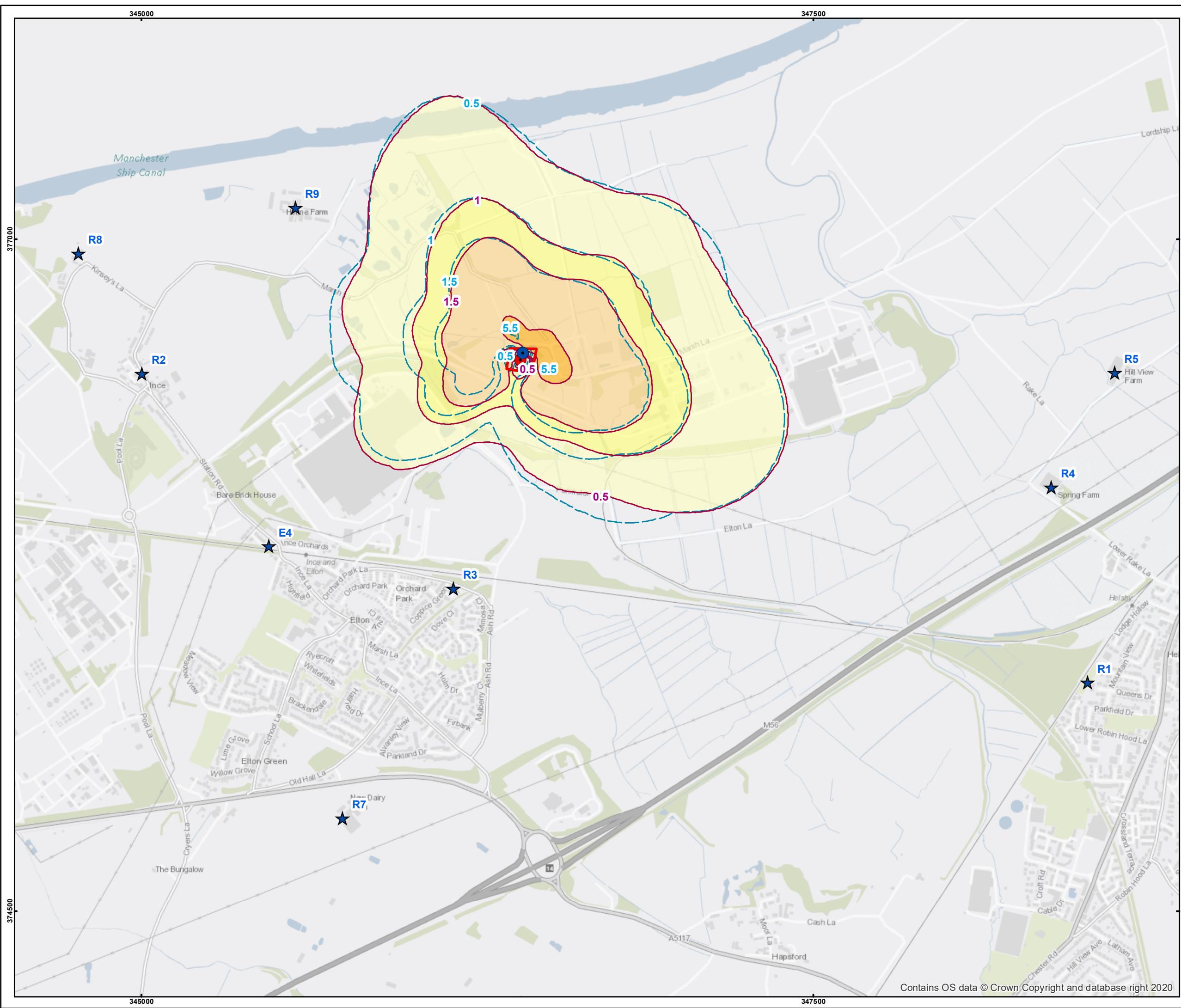
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**Legend**

- Syngas stack
- Gasification stack
- Plot 10b site boundary
- ★ Sensitive receptors
- Updated analysis PC as a % of AQAL
- Original AQA PC as a % of AQAL

**Updated analysis PC**

- 0- 0.5% of AQAL
- 0.5 - 1% of AQAL
- 1 - 1.5% of AQAL
- 1.5 - 5.5% of AQAL
- 5.5 - 10% of AQAL
- >10 % of AQAL

Client:	Peel
Site:	Protos
Project:	Plot 10b P2H
Title:	

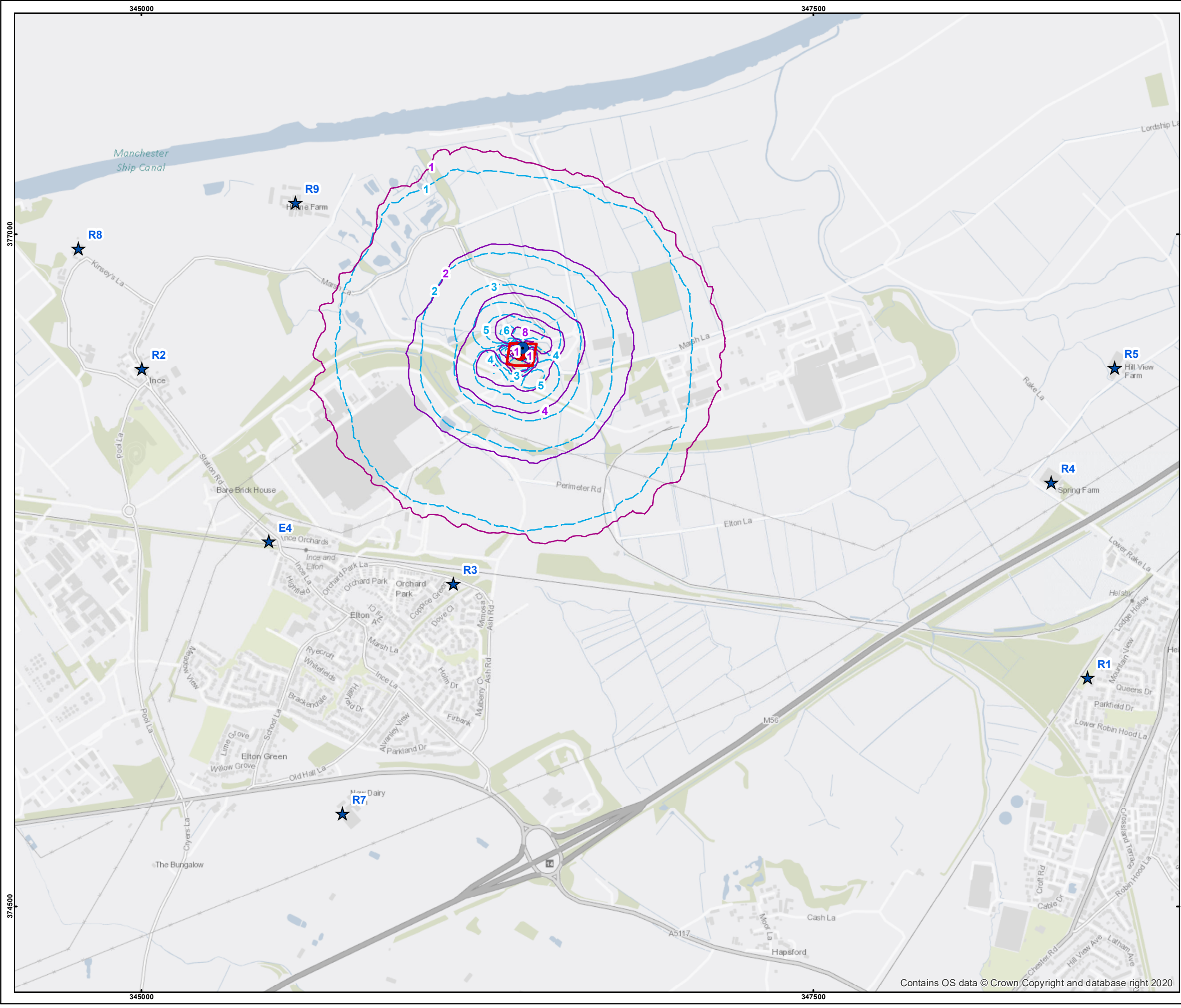
Figure 3 - Annual mean nitrogen dioxide

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- Legend**
- Syngas stack
  - Gasification stack
  - Plot 10b site boundary
  - ★ Sensitive receptors
  - Updated analysis PC as a % of AQAL
  - Original AQA PC as a % AQAL

Client:	Peel
Site:	Protos
Project:	Plot 10b P2H
Title:	

Figure 4 - 99.79th %ile of hourly means of nitrogen dioxide

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## B Dispersion modelling results and comparison

Table 3: Point of Maximum Impact – Daily ELVs

Pollutant	Averaging period	Units	AQAL	Original AQA				Updated analysis				Change in PC (as % of Original AQA)	Change in PEC (as % of Original AQA)
				Background Conc.	PC	PC as % of AQAL	PEC as % of AQAL	Background Conc.	PC	PC as % of AQAL	PEC as % of AQAL		
Nitrogen dioxide	Annual mean	µg/m <sup>3</sup>	40	26.05	2.30	<b>5.75%</b>	70.88%	20.17	4.36	<b>10.91%</b>	61.34%	5.16%	-9.54%
	99.79th %ile of hourly means	µg/m <sup>3</sup>	200	52.10	12.74	6.37%	32.42%	40.34	23.89	<b>11.94%</b>	32.11%	5.58%	-0.30%
Sulphur dioxide	99.18th %ile of daily means	µg/m <sup>3</sup>	125	12.60	5.87	4.70%	14.78%	16.18	9.17	7.34%	20.28%	2.64%	5.50%
	99.73rd %ile of hourly means	µg/m <sup>3</sup>	350	12.60	9.01	2.57%	6.17%	16.18	16.55	4.73%	9.35%	2.16%	3.18%
	99.9th %ile of 15 min. means	µg/m <sup>3</sup>	266	12.60	9.78	3.68%	8.42%	16.18	20.40	7.67%	13.75%	3.99%	5.34%
Particulates (PM <sub>10</sub> )	Annual mean	µg/m <sup>3</sup>	40	16.21	0.16	0.41%	40.94%	12.47	0.31	<b>0.78%</b>	31.95%	0.37%	-8.98%
	90.4th %ile of daily means	µg/m <sup>3</sup>	50	32.42	0.55	1.09%	65.93%	24.94	1.01	2.02%	51.90%	0.93%	-14.03%
Particulates (PM <sub>2.5</sub> )	Annual mean	µg/m <sup>3</sup>	20	10.25	0.16	<b>0.66%</b>	41.66%	8.67	0.31	<b>1.56%</b>	44.91%	0.90%	3.25%
Carbon monoxide	8 hour running mean	µg/m <sup>3</sup>	10,000	732.00	8.54	0.09%	7.41%	826.00	13.66	0.14%	8.40%	0.05%	0.99%
	Hourly mean	µg/m <sup>3</sup>	30,000	732.00	10.00	0.03%	2.47%	826.00	21.74	0.07%	2.83%	0.04%	0.35%
Hydrogen chloride	Hourly mean	µg/m <sup>3</sup>	750	1.42	2.00	0.27%	0.46%	1.42	4.35	0.58%	0.77%	0.31%	0.31%
Hydrogen fluoride	Annual mean	µg/m <sup>3</sup>	16	2.35	0.02	0.10%	14.79%	2.35	0.03	0.19%	14.88%	0.09%	0.09%
	Hourly mean	µg/m <sup>3</sup>	160	4.70	0.20	0.13%	3.06%	4.70	0.43	0.27%	3.21%	0.15%	0.15%
Ammonia	Annual mean	µg/m <sup>3</sup>	180	1.36	0.16	0.09%	0.85%	2.08	0.31	0.17%	1.33%	0.08%	0.48%
	Hourly mean	µg/m <sup>3</sup>	2,500	2.72	2.00	0.08%	0.19%	4.16	4.35	0.17%	0.34%	0.09%	0.15%
VOCs (as benzene)	Annual mean	µg/m <sup>3</sup>	5	0.97	0.16	<b>3.29%</b>	22.69%	0.79	0.31	<b>6.24%</b>	22.04%	2.95%	-0.65%
	Hourly mean	µg/m <sup>3</sup>	195	1.94	2.00	1.03%	2.02%	1.58	4.35	2.23%	3.04%	1.20%	1.02%
VOCs (as 1,3-butadiene)	Annual mean	µg/m <sup>3</sup>	2.25	0.23	0.16	<b>7.31%</b>	17.53%	0.31	0.31	<b>13.86%</b>	27.63%	6.55%	10.11%
Mercury	Annual mean	µg/m <sup>3</sup>	250	20.01	0.82	0.33%	8.33%	19.00	1.56	<b>0.62%</b>	8.22%	0.29%	-0.11%
	Hourly mean	µg/m <sup>3</sup>	7,500	40.02	10.00	0.13%	0.67%	38.00	21.74	0.29%	0.80%	0.16%	0.13%
Cadmium	Annual mean	µg/m <sup>3</sup>	5	0.13	0.82	<b>16.44%</b>	19.04%	0.12	1.56	<b>31.18%</b>	33.58%	14.74%	14.54%
	Hourly mean	µg/m <sup>3</sup>	-	0.26	10.00	-	-	0.24	21.74	-	-	-	-
PaHs	Annual mean	µg/m <sup>3</sup>	250	190.00	1.73	<b>0.69%</b>	76.69%	270.00	3.27	<b>1.31%</b>	109.31%	0.62%	32.62%
Dioxins and Furans	Annual mean	µg/m <sup>3</sup>	-	20.37	1.64	-	-	20.37	3.12	-	-	-	-
PCBs	Annual mean	µg/m <sup>3</sup>	200	0.13	0.08	0.04%	0.10%	0.13	0.16	0.08%	0.14%	0.04%	0.04%
	Hourly mean	µg/m <sup>3</sup>	6,000	0.25	1.00	0.02%	0.02%	0.26	2.17	0.04%	0.04%	0.02%	0.02%

Table 4: Point of Maximum Impact – Short term ELVs

Pollutant	Averaging period	Units	AQAL	Original AQA				Updated analysis				Change in PC (as % of Original AQA)	Change in PEC (as % of Original AQA)
				Background Conc.	PC	PC as % of AQAL	PEC as % of AQAL	Background Conc.	PC	PC as % of AQAL	PEC as % of AQAL		
Nitrogen dioxide	99.79th %ile of hourly means	µg/m <sup>3</sup>	200	52.10	25.47	<b>12.74%</b>	38.79%	40.34	47.78	<b>23.89%</b>	44.06%	11.15%	5.27%
Sulphur dioxide	99.73rd %ile of hourly means	µg/m <sup>3</sup>	350	12.60	36.02	<b>10.29%</b>	13.89%	16.18	66.21	<b>18.92%</b>	23.54%	8.63%	9.65%
	99.9th %ile of 15 min. means	µg/m <sup>3</sup>	266	12.60	39.14	<b>14.71%</b>	19.45%	16.18	81.60	<b>30.68%</b>	36.76%	15.96%	17.31%
Carbon monoxide	8 hour running mean	µg/m <sup>3</sup>	10,000	732.00	25.62	0.26%	7.58%	826.00	40.99	0.41%	8.67%	0.15%	1.09%
	Hourly mean	µg/m <sup>3</sup>	30,000	732.00	30.00	0.10%	2.54%	826.00	65.22	0.22%	2.97%	0.12%	0.43%
Hydrogen chloride	Hourly mean	µg/m <sup>3</sup>	750	1.42	12.00	1.60%	1.79%	1.42	26.09	3.48%	3.67%	1.88%	1.88%
Hydrogen fluoride	Hourly mean	µg/m <sup>3</sup>	160	4.70	0.80	0.50%	3.44%	4.70	1.74	1.09%	4.02%	0.59%	0.59%
VOCs (as benzene)	Hourly mean	µg/m <sup>3</sup>	195	1.94	4.00	2.05%	3.05%	1.58	8.70	4.46%	5.27%	2.41%	2.22%

## NOTES:

Assumes operation of both the gasification facility and syngas engines at the half-hourly ELVs set in the Industrial Emissions Directive during the worst-case weather conditions for dispersion.

Results presented as the maximum predicted impact at any point using 5-years of weather data.

PEC has been calculated as the PC plus the background concentration.

## C Ecological sites results tables and comparison

Table 5: Atmospheric emissions at ecological sites

Site	Results of original AQA						Results of updated analysis					
	NOx		SO <sub>2</sub>	HF		NH <sub>3</sub>	NOx		SO <sub>2</sub>	HF		NH <sub>3</sub>
	Annual Mean	Daily Mean	Annual Mean	Weekly Mean	Daily Mean	Annual Mean	Annual Mean	Daily Mean	Annual Mean	Weekly Mean	Daily Mean	Annual Mean
<b>European designated sites (within 10km) and UK designated sites (within 2km)</b>												
Mersey Estuary SPA/SAC/Ramsar	1.03%	3.12%	0.39%	1.04%	0.23%	0.51%	1.03%	3.12%	0.38%	1.20%	0.26%	0.51%
Neutral grassland habitats functionally linked to Mersey Estuary <sup>(1)</sup>	-	-	-	-	-	-	1.87%	7.71%	0.70%	2.72%	0.58%	0.93%
Midland Meres and Mosses Phase 1 <sup>(2)</sup>	0.03%	0.12%	0.02%	0.03%	0.01%	0.05%	0.03%	0.35%	0.02%	0.03%	0.03%	0.05%
<b>Locally designated sites (within 2km)</b>												
Frodsham and Helsby and Ince Marshes SBI	10.96%	42.82%	4.11%	13.94%	3.21%	5.48%	20.78%	59.90%	7.79%	22.33%	4.49%	10.39%
Station Road Railway Site	0.40%	2.19%	0.15%	0.95%	0.16%	0.20%	0.42%	2.23%	0.16%	0.98%	0.17%	0.21%

## Notes:

(1) The values for this site were presented spatially rather than tabularly in the response to NE report, so the values cannot be directly compared.

(2) A review of the site citations indicates that lichens and bryophytes are an important feature at these sites and the lower critical levels for sulphur dioxide (10 µg/m<sup>3</sup>) and ammonia (1 µg/m<sup>3</sup>) for the protection of lichens and bryophytes have been applied.