TATA STEEL

Assessment of the impact of emissions from Port Talbot sinter plant main stack during single-fan operation

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Summary

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Suction to the strand at Port Talbot sinter plant is generally provided by two waste gas fans in parallel, each with a separate electrostatic precipitator (ESP) to remove dust before exhausting to atmosphere through the main stack. Depending on production levels, the sinter plant can on occasion operate with just a single fan and ESP, but in this case the flow through the ESP is greater than would be the case in normal operation and the efficiency of dust abatement may be reduced. This report describes a dispersion modelling exercise to assess the impact on local air quality of emissions from the sinter plant primary dedusting system if the Emission Limit Value were to be increased during single-fan operation and compares this to the impact of the plant in normal operation.

Increasing the Emission Limit Value to 60 mg/m³ when the plant is operating with just one fan would lead to a small increase in impact at such times, but the impact on ambient air quality, even in the worst case of single-fan operation continuously throughout the year, would be less than a 1% increase in long-term PM_{10} or $PM_{2.5}$ concentrations at the Fire Station monitoring site and it is unlikely that the number of daily mean PM_{10} concentrations exceeding 50 µg/m³ would increase by more than one per year.

Assessment of the impact of emissions from Port Talbot sinter plant main stack during single-fan operation

1. Introduction

Suction to the strand at Port Talbot sinter plant is generally provided by two waste gas fans in parallel, each with a separate electrostatic precipitator (ESP) to remove dust before exhausting to atmosphere through the main stack. Depending on production levels, the sinter plant can on occasion operate with just a single fan and ESP, but in this case the flow through the ESP is greater than would be the case in normal operation and the efficiency of dust abatement may be reduced. This report describes a dispersion modelling exercise to assess the impact on local air quality of emissions from the sinter plant primary dedusting system if the Emission Limit Value were to be increased during single-fan operation and compares this to the impact of the plant in normal operation.

The structure of this document is based on guidelines[1] for air dispersion modelling reports published by the Environment Agency and Defra – this guidance is stated to apply to England, but in the absence of alternative guidance specific to Wales it has also been used in this instance.

2. Location

The steelworks is located along a flat strip of land between the town of Port Talbot and the coast of Swansea Bay. In the immediate vicinity of the sinter plant are other process areas on the Tata Steel site and there are residential areas within 1 to 1½ km in an arc clockwise from NW to SE of the sinter plant, as shown in Figure 1. Within 3 km to the east of the sinter plant, the terrain rises to over 250 metres above sea level.

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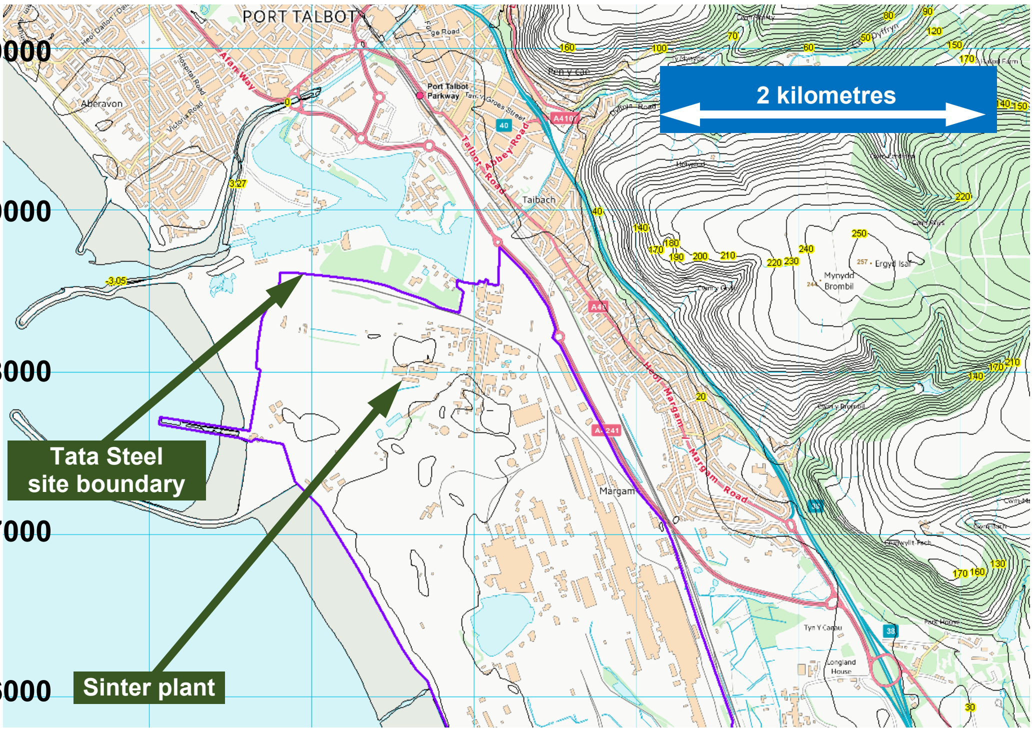
189000
188000
187000
186000



275000 276000 277000 278000 279000 280000

Figure 1: Location map with National Grid references and 10 m contour intervals

2.1. Protected conservation sites

Guidelines[2] for undertaking air quality risk assessments for environmental permits published by the Environment Agency and Defra include a requirement to assess the impacts on:

- Special Areas of Conservation, Special Protection Areas and Ramsar sites within 10 km of the site
- Sites of Special Scientific Interest and local nature sites (ancient woods, local wildlife sites and national and local nature reserves) within 2 km

This guidance is stated to apply to England, but in the absence of alternative guidance specific to Wales it has also been used in this instance. The only protected sites within the relevant distances from the sinter plant are three Special Areas of Conservation and their locations are shown on Figure 2.

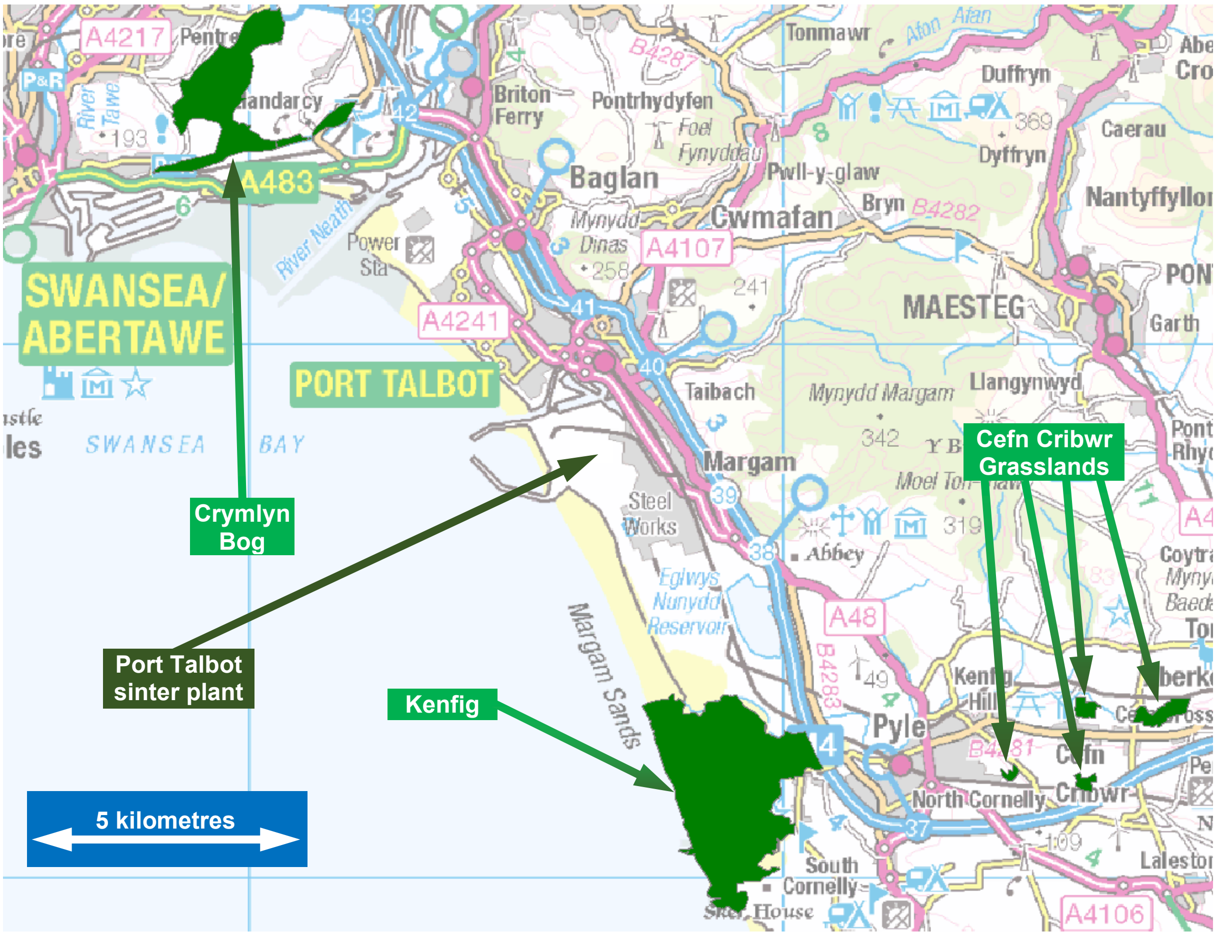


Figure 2: Special Areas of Conservation within 10 km of Tata Steel's Port Talbot site

3. Emissions and standards for assessment

This assessment focusses on emissions of particulate matter from the sinter plant main stack, emission point A1 in the Environmental Permit[3] for the Tata Steel site. There are no air quality standards for total particulate matter but standards for specific size fractions (PM_{10} and $PM_{2.5}$) are defined in the Air Quality Standards (Wales) Regulations[4] and are shown in Table 1 below.

Species	Averaging period	Limit Value
PM_{10}	One day	50 µg/m³, not to be exceeded more than 35 times a calendar year
	Calendar year	40 µg/m³
$PM_{2.5}$	Calendar year	25 µg/m³

Table 1: Relevant air quality standards

4. Background levels

Concentrations of PM_{10} in ambient air are measured by the local authority at a number of locations close to the Tata Steel site. $PM_{2.5}$ is also measured at one of those sites and since this monitoring station, at the Fire Station, just over 1 km from the sinter plant, is part of the UK Automatic Urban and Rural Network (AURN), with the highest QA/QC standards, results from this site have been used as representative levels for this assessment. Table 2 shows the measured concentrations[5] for the last six years.

Species	**Parameter**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Air quality standard**
PM_{10}	Number of daily means > 50 µg/m³	28	8	17	11	12	10	≤ 35 times
	Annual mean	27	22	23	23	21	21	≤ 40 µg/m³
$PM_{2.5}$	Annual mean	10	9	10	11	11	9	≤ 25 µg/m³

Table 2: PM concentrations in ambient air, Port Talbot Fire Station AURN site

It should be noted that the measured dust levels already include the impact of existing emissions from the sinter plant.

5. Dispersion model

Dispersion modelling was undertaken using the commercially available ADMS software[6] (version 5.2.1.0, February 2017), supplied by Cambridge Environmental Research Consultants. ADMS is a short-range, new generation, Gaussian plume air dispersion model, in which the atmospheric boundary layer properties are characterised by the boundary layer depth and the Monin-Obukhov length. Dispersion under convective meteorological conditions uses a skewed Gaussian concentration distribution (shown by validation studies to be a better representation than a symmetrical Gaussian distribution).

ADMS has been used in previous studies to model the air quality impact of existing and proposed industrial installations in the UK and abroad and is fit for the purposes of this assessment. The model has been extensively validated and a list of references[7] is available on the supplier's web site.

6. Emission parameters

Table 3 shows the stack and waste gas parameters that do not depend on whether the plant is running with two fans or a single fan and Table 4 shows the flowrates and dust mass emission rates for two different scenarios. It is assumed that dust emissions during normal operation with two fans in service will be continuously at the current Emission Limit Value of 40 mg/Nm³ and for single-fan operation emissions will be at a new ELV of 60 mg/Nm³.

Stack location (National Grid reference)	276499,188017
Stack height (metres)	133
Exit diameter (metres)	6.3
Waste gas moisture (%)	7.5
Waste gas oxygen (%, dry)	16
Mean molecular weight (kg/kmol)	29.4
Specific heat capacity (J/°C/kg)	1,012

Table 3: Emission parameters that are the same for both scenarios

Scenario	Two fans	Single fan
Flowrate through each ESP (m³/hr, actual)	1,170,000	1,566,000
Pressure in ESP (mbar)	-145	-100
Temperature in ESP (°C)	160	130
Flowrate through each ESP (m³/hr, 0 °C, 1 atm, actual O_2 and H_2O)	632,104	956,142
Total flowrate through stack (m³/hr, 0 °C, 1 atm, actual O_2 and H_2O)	1,264,209	956,142
Efflux velocity (m/s, 1 atm, actual temperature, O_2 and H_2O)	17.9	12.6
Waste gas flowrate (m³/s at reference conditions) [a]	259	196
Dust concentration (mg/m³ at reference conditions) [a,b]	40	60
Total dust emission rates (g/s):	10.34	11.73

a Reference conditions for the sinter plant main stack are 0°C, 101.3 kPa, dry, 17% oxygen

b Assuming emissions at the respective ELVs

Table 4: Emission parameters that depend on the number of fans in operation

For the assessment of long-term impacts, a conservative assumption has been made that the plant operates continuously throughout the year. Since there is limited data available on the size distribution of the dust emitted from the stack, for the purposes of this assessment a further conservative assumption has been made that all the particulate matter emitted will be below 2.5 µm aerodynamic diameter so that $PM_{2.5}$ = PM_{10} = total PM.

7. Modelled domain and grid resolution

An initial modelling run was undertaken over an 8 km x 5 km modelling domain as shown in Figure 3, with a grid spacing of 50 metres. The results (see Figures A3.1 to A3.4 in Annex 3) demonstrated that this grid extent was sufficient to identify the areas where the peak ground level concentrations occurred. Further runs using a finer grid spacing were undertaken covering just the area of peak impact to investigate the sensitivity of the peak results to the grid resolution and this is discussed in Section 12.2.

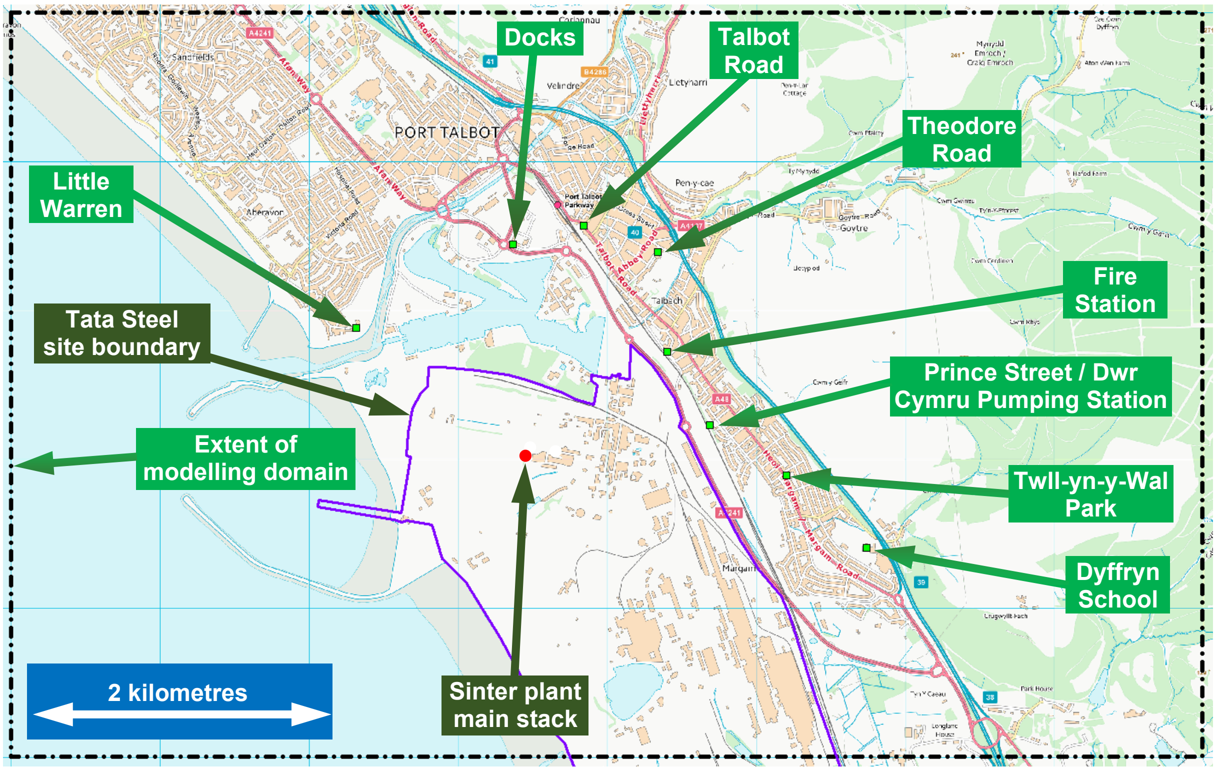


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Figure 3: Main modelling domain for impact assessment (excludes SAC receptors)

Also shown in Figure 3 are the locations of eight PM_{10} monitoring stations in Port Talbot, which have been entered into the model as discrete receptors. Three further receptors outside the main modelling domain were added at the closest points of the nearby Special Areas of Conservation (see Figure 2). The grid references for all these locations are listed in Table 5.

	National Grid Reference
PM_{10} monitoring stations	
Little Warren	275313,188879
Port Talbot Docks	276368,189443
Talbot Road	276846,189570
Theodore Road	277340,189387
Margam Fire Station	277406,188719
Prince Street	277690,188227
Twll-yn-y-Wal Park	278205,187890
Dyffryn School	278742,187405
Special Areas of Conservation	
Crymlyn Bog	271821,194171
Cefn Cribwr Grasslands	284085,182027
Kenfig	277913,183424

Table 5: Locations of discrete receptors entered into dispersion model

8. Weather data and surface characteristics

8.1. Weather data

For the purposes of this assessment, wind speed, wind direction and temperature from a weather station at Little Warren, 1.5 km NW of the sinter plant, have been combined with rainfall, cloud cover and relative humidity data from St Athan, 30 km SE. The composite data set contains hourly sequential data from 10/04/12 to 31/12/16 (four years and nine months). Within this period, valid meteorological data were available for 40,068 hours (96.7% of the time). For sensitivity analysis, a second set of data derived from the Meteorological Office's weather forecasting models (NWP data) has also been used. Figure 4 shows wind roses for the two data sets. Annex 2 gives more details relating to the choice of weather data.

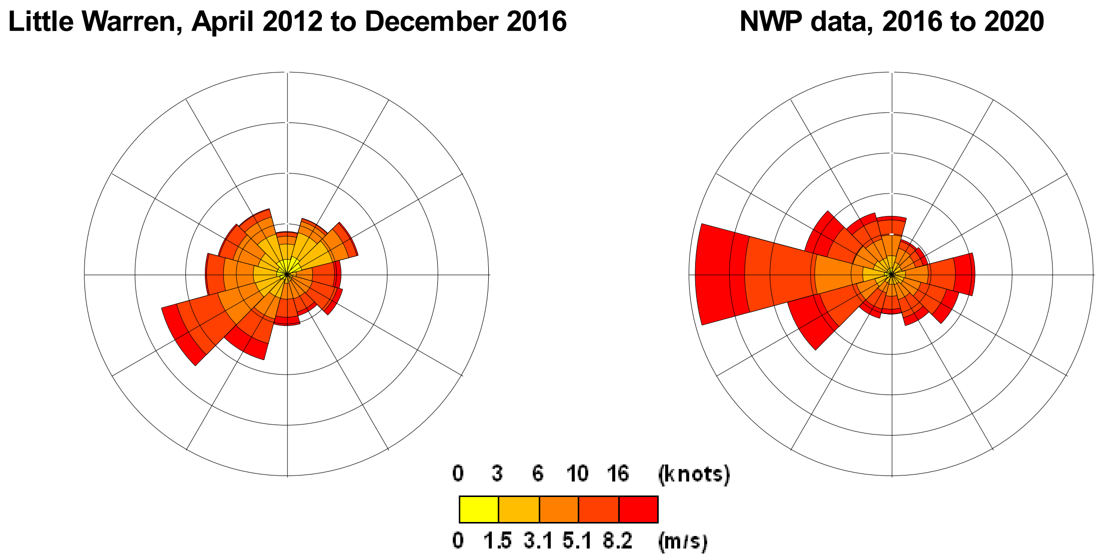


Figure 4: Wind roses – data from Little Warren and NWP data

8.2. Other meteorological characteristics

As well as the hourly sequential data discussed in section 8.1, the ADMS model also uses some other parameters to further define the meteorological conditions. Some of these are entered for both the dispersion site (i.e. the area shown in Figure 3) and the meteorological measurement site. Since the main meteorological data are a mixture of measurements from two sites, the site for which these parameters are defined will vary. The main impact of surface roughness is on the wind profile (the variation of wind speed with height) and since the wind speed data are taken from Little Warren, this is the most appropriate meteorological site for which to enter the roughness. The minimum Monin-Obukhov length relates to the atmospheric stability and since the relevant parameters for this are taken from St Athan airfield, this is the most appropriate meteorological site for which to enter this parameter. For sensitivity analysis, NWP data for a grid square centred within the steelworks boundary have been used and in this case the surface roughness and minimum Monin-Obukhov length for that location have been used instead.

The other parameters entered into the dispersion model are:

- Latitude of Port Talbot steelworks = 51.6°N
- Surface roughness:
    - At meteorological site (Little Warren and NWP) = 0.5 metres
    - At dispersion site – variable (see Section 9.1)
- Minimum Monin-Obukhov length:
    - At meteorological site (St Athan) = 1 metre (representative of rural areas)
    - At meteorological site (NWP) and at dispersion site = 30 metres (representative of mixed urban/industrial areas)
- The following parameters were left at the ADMS default values for both the dispersion site and the meteorological site:
    - Surface albedo = 0.23
    - Priestley-Taylor parameter = 1

9. Specialised modelling treatments

The ADMS dispersion model includes a number of specialised modules to take into account the impacts of, for instance, hills within the modelling domain or buildings close to the source. The following sections describe the modelling treatments used in this study.

9.1. Complex terrain

The hills to the east of the sinter plant have slopes greater than 10% (see Figure 1) and so the complex terrain module in ADMS has been used for this modelling exercise. A digital terrain file covering all the receptors (64 grid points in each direction, with a spacing of 300 metres) was created from Ordnance Survey Landform Panorama data using the “Create terrain file” utility within the ADMS model. The data are illustrated in Figure 5.

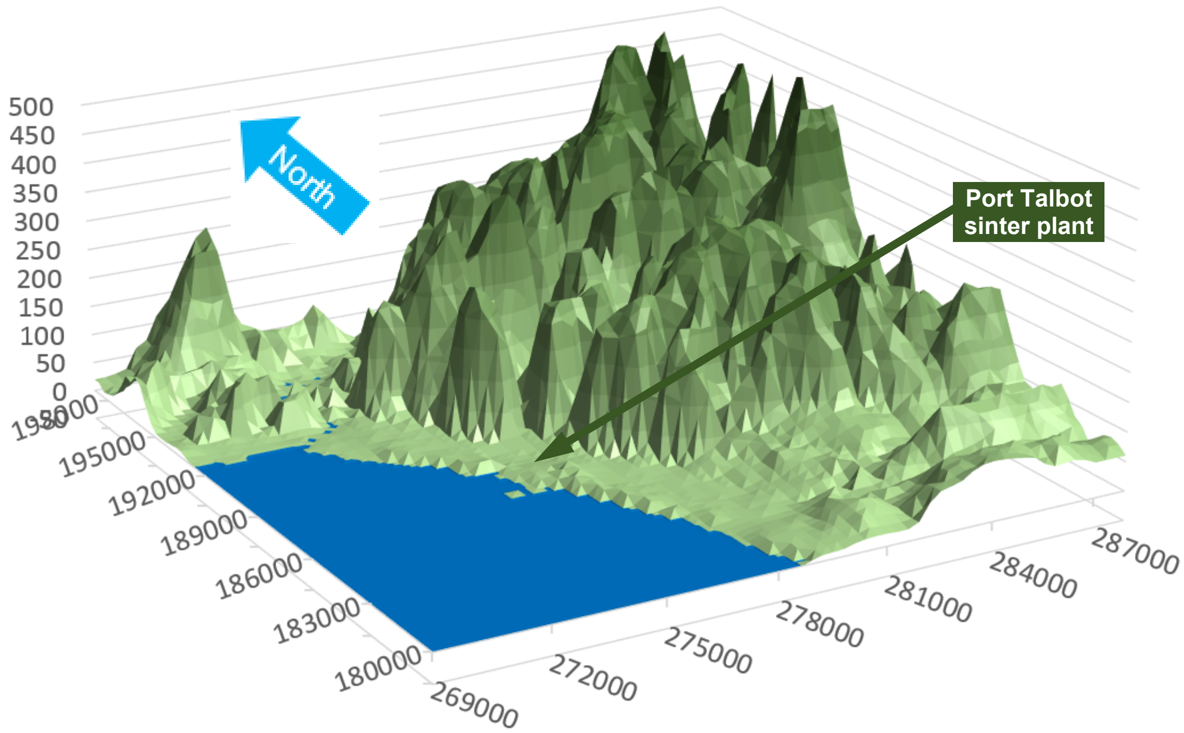


Figure 5: Complex terrain in the vicinity of the Tata Steel site

Furthermore, there are significant spatial variations in the surface roughness over the modelled domain – from less than 0.001 metres over the sea to greater than 1 metre over parts of the Tata Steel site. ADMS allows the use of variable roughness files, but the User Guide[9] states that "an order of magnitude variation in the surface roughness length is allowable", hence some compromise is necessary to comply with this limitation. For the purposes of this assessment, a surface roughness of 0.05 metres has been used for the sea and 0.5 metres for all areas of land, including the Tata Steel site, urban and suburban areas, woods and grassland.

9.2. Buildings

Buildings that exceed 40% of the stack height may affect dispersion from nearby stacks, mainly by entrainment of pollutants into the cavity region in the immediate leeward side of the building, bringing the plume down to ground level more rapidly than would be the case in the absence of a building. The maximum height of any of the buildings at the sinter plant is 49 metres, which is less than 40% of the stack height and so the building effects module has not been used in this modelling exercise.

9.3. Coastline

ADMS includes a coastline module to model the development of a convective boundary layer in the situation where there is a stable boundary layer over the sea and the land is warmer than the sea. However, the coastline module cannot be combined with either the complex terrain module or the buildings module. Furthermore, the coastline module requires hourly sequential data on sea temperature in the area, which are not available, and for these reasons the coastline module has not been used in this modelling exercise.

9.4. Other specialised modelling treatments

Other than the use of the complex terrain module discussed above, no other specialised model treatments have been included in this study.

10. Model uncertainty

In 2016 the ADMS developers published five validation studies relating to modelling in complex terrain. This discussion focusses on the studies at Lovett power plant[10] and a pulp and paper mill[11], which were long-term studies where the terrain height was greater than the stack height, since this is similar to the situation at Port Talbot. In these papers, ADMS 5.2 has been tested against short-term measured ground level concentrations from field data sets – long-term model performance was not assessed due to issues with the detection limits of the SO_2 monitors used and the lack of reliable background data.

There is no single statistic that gives a complete measure of the performance of a dispersion model and the studies compare observed and modelled concentrations in a number of different ways. One statistic that gives an indication of the short-term model uncertainty is the ratio between the modelled "robust highest concentration" and the corresponding observed level over the period of the studies (twelve months in both cases). For hourly average concentrations, this ratio was 1.04 in the first paper and 0.64 in the second and for 24-hour averages the ratios were 1.01 and 0.47 respectively. Hence in these studies ADMS 5.2 underestimated the short-term peak concentration by up to 53%, though some of this may be attributable to the fact that the measured concentrations included background levels from sources not included in the model.

A comparison of the performance of other dispersion models[12] against the same two field data sets (see Table 7) shows that ADMS performs better than two of the alternative models tested is not dissimilar to AERMOD.

	Ratio modelled:observed robust highest concentration for different models			
Data set	ADMS 5.2	AERMOD	ISCST3	CTDMPLUS
Lovett power plant	1.04	*	9.11	2.01
Westvaco Corporation	0.47	1.14	8.74	1.54

* Excluded because the Lovett power plant data set was used to "tune" some components of AERMOD

Table 7: Dispersion model performance against field data sets – 24-hour average concentrations

The model uncertainty is not explicitly stated in these validation studies.

11. Sensitivity analysis

In Section 12.1 the impact of different sets of meteorological data is investigated to indicate the likely inter-annual variation and the influence of using NWP data compared to the combined data set used for the main results. In Section 12.2 the sensitivity of the peak ground-level concentration and the location of the peak to changes in the grid resolution is discussed. No other sensitivity analysis has been included in this assessment.

12. Impact assessment

Table 8 shows the modelled long-term and short-term impacts of emissions from the sinter plant main stack over the whole period from April 2012 to December 2016 using a combined meteorological dataset from Little Warren and St Athan.

	Concentration of PM_{10} or $PM_{2.5}$ (µg/m³)			
Scenario	Two-fan operation		Single fan operation	
Averaging period	Long-term average	Highest 24-hour average	Long-term average	Highest 24-hour average
PM_{10} monitoring stations				
Margam Fire Station	0.066	0.73	0.140	1.24
Twll-yn-y-Wal Park	0.034	0.82	0.066	1.31
Little Warren	0.033	1.01	0.061	1.55
Port Talbot Docks	0.028	0.70	0.053	1.08
Talbot Road	0.037	0.89	0.070	1.30
Theodore Road	0.060	0.92	0.114	1.68
Dyffryn School	0.032	0.60	0.056	0.91
Prince Street	0.036	0.59	0.077	1.16
Maximum value at monitoring station	**0.066**	**1.01**	**0.140**	**1.68**
Special Areas of Conservation				
Crymlyn Bog SAC	0.014	0.27	0.021	0.37
Cefn Cribwr SAC	0.021	0.27	0.030	0.45
Kenfig SAC	0.015	0.39	0.023	0.53
Maximum value at SAC	**0.021**	**0.39**	**0.030**	**0.53**
Peak concentration across output grid	0.16	2.1	0.25	3.0
Grid reference of peak location	278150,189050	277900,190250	278150,189050	277800,190150

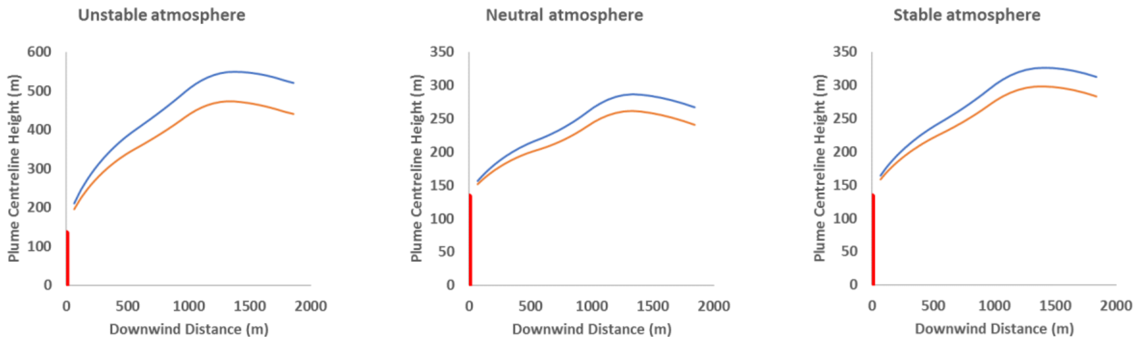
Table 8: Ambient dust concentrations attributable to sinter plant main stack emissions

These results are likely to overestimate the true impacts of the emissions as a number of worst-case assumptions have been made in the modelling study:

- Dust emissions will always be at the relevant Emission Limit Value (ELV)
- The sinter plant will operate continuously throughout the year
- All the particulate matter emitted will be below 2.5 µm aerodynamic diameter

Although, in relative terms, operation with a single fan and a higher ELV would increase the ambient dust concentrations attributable to emissions from the sinter plant, in absolute terms the environmental impact of this increase is small, as discussed in Sections 12.3 and 12.4.

The increased ground level concentrations are partly due to the increased mass emission rates of dust (see Table 4) and partly to the reduced plume rise during single fan operation as a result of lower momentum and buoyancy at the stack exit. Figure 6 shows how the mean plume height varies between two-fan and single-fan operation under different weather conditions. Since ground level dust concentrations are approximately proportional to the inverse of the <u>square</u> of the plume height, even a small difference in plume rise can significantly affect the results.



Atmosphere type	Wind speed (m/s)	Surface sensible heat flux (W/m²)	Boundary layer height (m)
Unstable	2	105	900
Neutral	5	0	800
Stable	3	-12	400

Figure 6: Variation of stack height with downwind distance

Figures A3.1 to A3.4 in Annex 3 illustrate the patterns of dispersion for the long-term average dust concentrations and the highest daily means for the two scenarios.

12.1. Year-on-year variation and impact of different meteorological data

The modelling results in Table 8 are based on Little Warren/St Athan meteorological data for the whole period from April 2012 to December 2016. Further model runs using data for the four separate complete years (2013 to 2016) were subsequently undertaken and Table 9 shows how concentrations varied from one year to another. In addition, a further model run was undertaken using NWP meteorological data and these results are also shown in Table 9.

	Meteorological data		Concentration of PM_{10} or $PM_{2.5}$ (µg/m³)			
		Scenario	Existing stack		Proposed new stack	
	Source	Period	Long-term average	Highest 24-hour average	Long-term average	Highest 24-hour average
Fire Station	Combined:	Apr 2012 - Dec 2016	0.066	0.73	0.140	1.24
		Calendar year 2013	0.060	0.61	0.132	1.14
	Little Warren and St Athan	Calendar year 2014	0.059	0.50	0.128	1.04
		Calendar year 2015	0.077	0.73	0.155	1.24
		Calendar year 2016	0.062	0.59	0.134	1.14
	NWP	Jan 2016 - Dec 2020	0.023	0.47	0.046	0.84
Little Warren	Combined:	Apr 2012 - Dec 2016	0.033	1.01	0.061	1.55
		Calendar year 2013	0.035	0.70	0.063	1.11
	Little Warren and St Athan	Calendar year 2014	0.038	0.88	0.068	1.49
		Calendar year 2015	0.029	1.01	0.054	1.55
		Calendar year 2016	0.026	0.58	0.051	1.21
	NWP	Jan 2016 - Dec 2020	0.039	1.20	0.068	1.66
Peak across output grid	Combined:	Apr 2012 - Dec 2016	0.16	2.1	0.25	3.0
		Calendar year 2013	0.12	2.1	0.20	3.0
	Little Warren and St Athan	Calendar year 2014	0.15	1.7	0.23	2.4
		Calendar year 2015	0.19	1.6	0.28	2.2
		Calendar year 2016	0.15	1.2	0.24	1.9
	NWP	Jan 2016 - Dec 2020	0.15	2.0	0.23	2.9

Table 9: Year-on-year variation and impact of different meteorological data

Comparing the results for the combined Little Warren/St Athan meteorological data for different years, the annual average concentration for the “worst” individual year was no more than 20% greater than the average for the whole 4¾ year period. The peak short-term impacts (maximum daily average for each calendar year) show a greater variation from one year to another but the values in Table 8 already represent the worst case.

Comparing the results for the NWP meteorological data with the Little Warren/St Athan results, the values for the Fire Station are lower when using the NWP data, which reflects the reduced frequency of winds blowing from the sinter plant towards the Fire Station (see Figure 4). Conversely, results for Little Warren are higher using the NWP data and the frequency of winds blowing towards this receptor is also higher. Although there will be significant differences at some individual receptors, the overall modelled impacts and the peaks across the whole output grid are similar whether the combined Little Warren/St Athan dataset or the NWP dataset derived from weather forecasting models is used and the overall conclusions do not depend on the choice of weather data.

12.2. Effect of grid resolution

The initial model run used a grid spacing of 50 metres to identify the areas where the peak ground-level concentrations occurred. A further model run using a 25 metre grid spacing was subsequently undertaken and Table 10 shows how this affected the peak concentration and the location of the peak.

	Scenario	Two-fan operation		Single fan operation	
	Grid resolution	Long-term average	Highest 24-hour average	Long-term average	Highest 24-hour average
Peak PM_{10} or $PM_{2.5}$ concentration across output grid (µg/m³)	50 metres	0.1593	2.068	0.2468	2.998
	25 metres	0.1593	2.068	0.2468	3.000
Grid reference of peak location	50 metres	278150,189050	277900,190250	278150,189050	277800,190150
	25 metres	278150,189050	277875,190250	278150,189050	277825,190150

Table 10: Effect of grid resolution

Since halving the grid spacing made no more than 0.1% difference to the magnitude of the peak concentrations, the grid resolution has not been further investigated.

12.3. Comparison to standards

Table 11 compares the peak modelled dust concentrations attributable to emissions from the sinter plant main stack with the relevant air quality standards, based on the combined Little Warren/St Athan meteorological data.

			Scenario	**Two-fan operation**		**Single fan operation**	
	Species	**Averaging period**	**Air Quality Standard (µg/m³)**	**Peak concentration (µg/m³)**	**Percentage of Air Quality Standard**	**Peak concentration (µg/m³)**	**Percentage of Air Quality Standard**
Fire Station	PM_{10}	One day	50	0.73	1.5%	1.24	2.5%
		Calendar year	40	0.066	0.2%	0.140	0.4%
	$PM_{2.5}$	Calendar year	25	0.066	0.3%	0.140	0.6%
Little Warren	PM_{10}	One day	50	1.01	2.0%	1.55	3.1%
		Calendar year	40	0.033	0.1%	0.061	0.2%
	$PM_{2.5}$	Calendar year	25	0.033	0.1%	0.061	0.2%
Peak across output grid	PM_{10}	One day	50	2.1	4.1%	3.0	6.0%
		Calendar year	40	0.16	0.4%	0.25	0.6%
	$PM_{2.5}$	Calendar year	25	0.16	0.6%	0.25	1.0%

Table 11: Comparison of modelled results and air quality standards

The Process Contribution is predicted to be much lower than the air quality standards, even with a series of worst-case assumptions.

12.4. Predicted Environmental Concentration

Since the measured dust concentrations in Table 2 already include the impact of emissions from the sinter plant (assumed to be largely during two-fan operation), the Predicted Environmental Concentration (PEC) for single-fan operation can be estimated by adding the difference in impacts between the two scenarios to the measured levels. Table 12 shows the potential long-term impact of operating with just one fan.

	Long-term average concentration (µg/m³)				
	Measured	Modelled contribution		Predicted Enviromental	Air Quality
Species	(2015 to 2020)	Two-fan operation	Single-fan operation	Concentration for single-fan operation	Standard
PM_{10}	22.8	0.07	0.14	22.9	≤ 40
$PM_{2.5}$	10.0	0.07	0.14	10.1	≤ 25

Table 12: Potential long-term PEC at Port Talbot Fire Station – single fan operation

The increase in the long-term average PM_{10} concentration would be no more than 0.4% and for $PM_{2.5}$ the increase would be no more than 0.8% (assuming as a worst-case that the sinter plant would operate with a single fan for the whole of a year). The actual change in air quality is likely to be less than shown in Table 12, as this is based on worst-case impacts and it would not be expected that single-fan operation would be used for periods as long as a year.

It is less easy to determine the potential impact on the number of days on which the mean PM_{10} concentration may exceed 50 µg/m³, since it may not be the case that the greatest impact from the sinter plant main stack coincides with the highest ambient levels. The daily mean ground-level concentration at the Fire Station monitoring station attributable to the sinter plant emissions during single-fan operation is no more than 0.51 µg/m³ greater than that during two-fan operation. Hence the number of exceedances would only increase if the measured level was already between 49.5 and 50 µg/m³ and this coincided with a high impact from the sinter plant main stack. Taking 2015 as an example, as it is the year with the highest number of exceedances in the last six (see Table 2), there was only one such occasion – on 1st January the measured PM_{10} concentration was 49.9 µg/m³, the predicted impact of two-fan operation was 0.2 µg/m³ and the predicted impact of single-fan operation was 0.3 µg/m³. If the sinter plant had been operating with a single fan on this day, then the difference between two-fan and single-fan operation would be just enough to push the daily mean PM_{10} concentration to 50 µg/m³ and the total number of exceedances in that year might have been 29 rather than the 28 actually measured.

As for the case of the long-term impacts, the fact that the modelled contributions are based on a number of worst-case assumptions means that the actual change in air quality as a result of increasing the ELV during single fan operation is likely to be less than discussed above.

12.5. Overall assessment

Increasing the Emission Limit Value for the sinter plant main stack to 60 mg/m³ when the plant is operating with just one fan would lead to a small increase in impact at such times, but the impact on ambient air quality would be less than a 1% increase in long-term PM_{10} or $PM_{2.5}$ concentrations at the Fire Station monitoring site and it is unlikely that the number of daily mean PM_{10} concentrations exceeding 50 µg/m³ would increase by more than one per year.

13. References

1. "Environmental permitting: air dispersion modelling reports", November 2014, *www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports*
2. "Air emissions risk assessment for your environmental permit", August 2016, *www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit*

3. Environmental Permit number EPR/BL7108IM, dated 26/06/18
4. "The Air Quality Standards (Wales) Regulations 2010", May 2010, *www.legislation.gov.uk/wsi/2010/1433/contents/made*
5. "Annual and Exceedence Statistics", *https://uk-air.defra.gov.uk/data/exceedence*
6. "ADMS 5", *www.cerc.co.uk/environmental-software/ADMS-model.html*
7. "Model validation", *www.cerc.co.uk/environmental-software/model-validation.html*
8. "Commission Implementing Decision of 28 February 2012 establishing the best available techniques (BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions for iron and steel production"
9. "ADMS 5 User Guide", version 5.2, November 2016, page 354
10. "ADMS 5 Complex Terrain Validation: Lovett Power Plant", Cambridge Environmental Research Consultants, November 2016, *www.cerc.co.uk/environmental-software/assets/data/doc_validation/CERC_ADMS5_Study_Validation_Lovett_5.2_vs_5.1.pdf*
11. "ADMS 5 Complex Terrain Validation: Tracy power plant", Cambridge Environmental Research Consultants, November 2016, *www.cerc.co.uk/environmental-software/assets/data/doc_validation/CERC_ADMS5_Study_Validation_MartinsCreek_5.2_vs_5.1.pdf*
12. Perry, S.G. *et al.*, "AERMOD: A Dispersion Model for Industrial Source Applications. Part II: Model Performance against 17 Field Study Databases", *Journal of Applied Meteorology*, Volume 44(5), May 2005, pages 694-708

Annex 1 – Input parameters

This document is based on guidelines for air dispersion modelling reports published by the Environment Agency and Defra. Since January 2021 a requirement has been added that a separate annex with a table of all the input parameters used should be provided. Much of this is included in the main body of the report, but is reproduced here for clarity. In some cases where the volume of data is large, such as terrain data files or lists of additional specified receptors, these have instead been provided electronically.

Terrain parameters:
See files *Port Talbot.ter* and *Port Talbot.ruf* provided separately.

Source parameters:

Stack location (National Grid reference)	276499,188017	
Stack height (metres)	133	
Exit diameter (metres)	6.3	
Mean molecular weight (kg/kmol)	29.4	
Specific heat capacity (J/°C/kg)	1,012	
Scenario	**Two fans**	**Single fan**
Exit temperature (°C)	160	130
Efflux velocity (m/s, actual conditions)	17.9	12.6
Total dust emission rates (g/s):	10.34	11.73

Meteorological parameters:

Dispersion site parameters	Latitude (°N)	51.6	
	Surface roughness (m)	Variable - see *Port Talbot.ruf*	
	Surface albedo	0.23	
	Priestley-Taylor parameter	1	
	Minimum Monin-Obukhov length (m)	30	
Meteorological site parameters	Data source	Little Warren/St Athan	NWP
	Surface roughness (m)	0.5	0.5
	Surface albedo	0.23	0.23
	Priestley-Taylor parameter	1	1
	Minimum Monin-Obukhov length (m)	1	30
	Wind directions grouped into sectors ?	N	N
	Data hourly sequential?	Y	Y

Receptor parameters:

A regular receptor grid was used with all receptors at ground level:

Direction	Start	Finish	Distance (km)	Grid spacing (m)	Number of grids
W to E (x)	273000	281000	8	50	161
S to N (y)	186000	191000	5	50	101

Specified receptors were also added at current and former PM_{10} monitoring stations in Port Talbot and at the closest points of the nearby Special Areas of Conservation:

	National Grid Reference
PM_{10} monitoring stations	
Little Warren	275313,188879
Port Talbot Docks	276368,189443
Talbot Road	276846,189570
Theodore Road	277340,189387
Margam Fire Station	277406,188719
Prince Street	277690,188227
Twll-yn-y-Wal Park	278205,187890
Dyffryn School	278742,187405
Special Areas of Conservation	
Crymlyn Bog	271821,194171
Cefn Cribwr Grasslands	284085,182027
Kenfig	277913,183424

Output parameters:

Long-term average and maximum daily average PM_{10} concentrations were output; $PM_{2.5}$ concentrations were assumed to be the same as the PM_{10} levels.

Annex 2 – Choice of weather data

Dispersion models predict pollutant concentrations in ambient air attributable to emissions from a source or group of sources under particular weather conditions. The most basic meteorological data required for these calculations are wind direction, wind speed and some measure of turbulence, which governs mixing in the lower layers of the atmosphere. Turbulence may result from friction as the wind passes over the earth's surface or from surface heat flux (warming from the sun, or cooling at night). Friction is a function of wind speed and surface roughness and heat flux is a function of the time of year, time of day, latitude and cloud cover. The ADMS 5 model specifies a number of different sets of minimum meteorological data requirements, the most commonly available of which[A2.1] is wind speed, wind direction, time of year, time of day and cloud cover, with latitude also defined elsewhere in the modelling input files.

A range of weather data has been measured at Port Talbot Fire Station, NE of the steelworks, since August 2007. However, a study by the UK Air Quality Expert Group[A2.2] (AQEG) in 2011 found that it was unclear whether meteorological data from this weather station adequately characterised the air flows over the steelworks and the surrounding area and data from this site have not been considered in this modelling exercise. Following the AQEG recommendations, a more representative meteorological site was identified and in 2012 a weather station was installed by the local authority at Little Warren Playing Fields, NW of the steelworks. Wind speed, wind direction and temperature were routinely measured at Little Warren from April 2012 to December 2017, but no cloud cover data or any other data suitable for the assessment of atmospheric stability/turbulence were measured there.

The nearest Meteorological Office station to Port Talbot is at Mumbles Head, 13 km W of the steelworks, but again no cloud cover data are collected there. The nearest site where cloud cover data are recorded is the Meteorological Office station at St Athan airfield, 30 km SE of the site. The Meteorological Office can also generate data derived from weather forecasting models[A2.3] as a proxy data set where no suitable measured data are available (Numerical Weather Prediction, or NWP). NWP data have been obtained for the grid square centred at 51.555 °N, 3.761°W, which is within the steelworks boundary.

Figure A2.1 shows the locations of the various meteorological data sources discussed above relative to the steelworks.

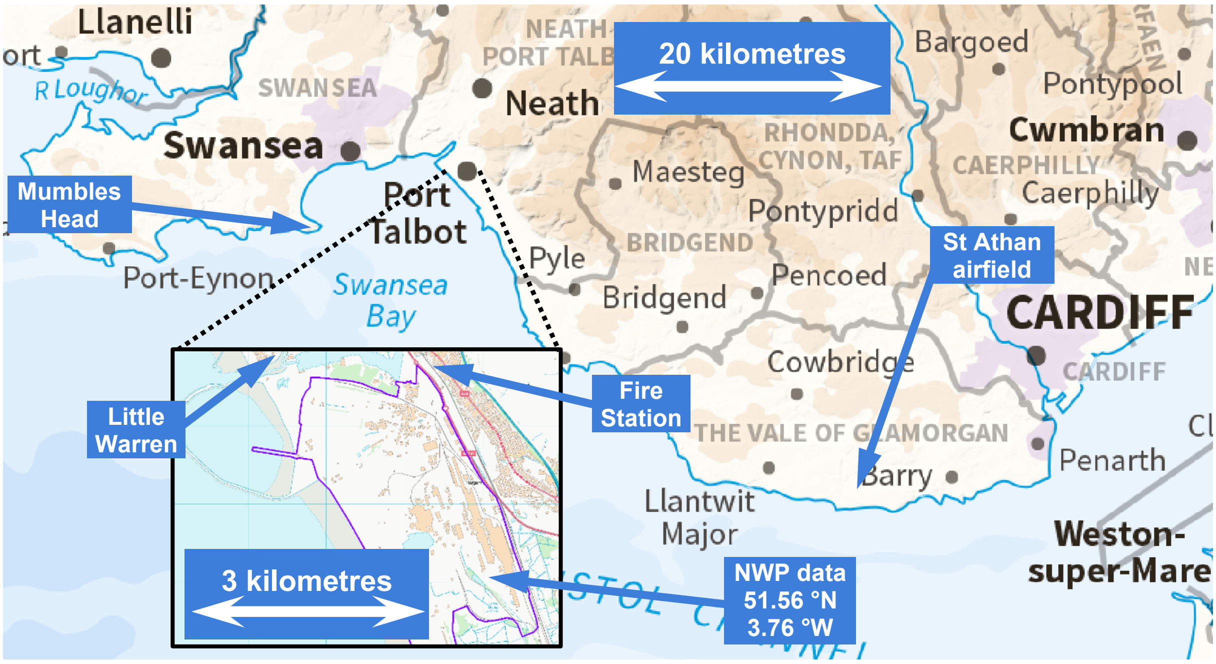


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Figure A2.1: Location of meteorological stations

Figure A2.2 shows five-year wind roses for Little Warren, Mumbles Head, St Athan and the NWP data. The pattern of different wind directions is similar for Little Warren and Mumbles Head, but wind speeds are higher at the latter. The NWP data is also similar to Mumbles Head, but the most frequent wind direction is from 270° for the NWP data and 240° for Little Warren and Mumbles Head. The St Athan wind rose is similar to that for the NWP data, but with more frequent winds blowing from 60°.

Although the NWP and St Athan data are the most complete, they may not be the most representative of the local conditions across the steelworks due to the difference in the most frequent wind direction between these and the measured data at Little Warren and Mumbles Head. For the purposes of this assessment, a composite data set has been created using data measured at Little Warren where available (wind speed, wind direction and temperature), and for parameters not measured at Little Warren (rainfall, cloud cover and relative humidity), contemporaneous data from St Athan have been used instead. The combined data set comprises hourly sequential data from 10/04/12 to 31/12/16 and within this period, valid meteorological data were available for 40,068 hours (96.7% of the time).

For sensitivity analysis, the modelling was also run using the NWP data to determine whether this had a significant impact on the final results.

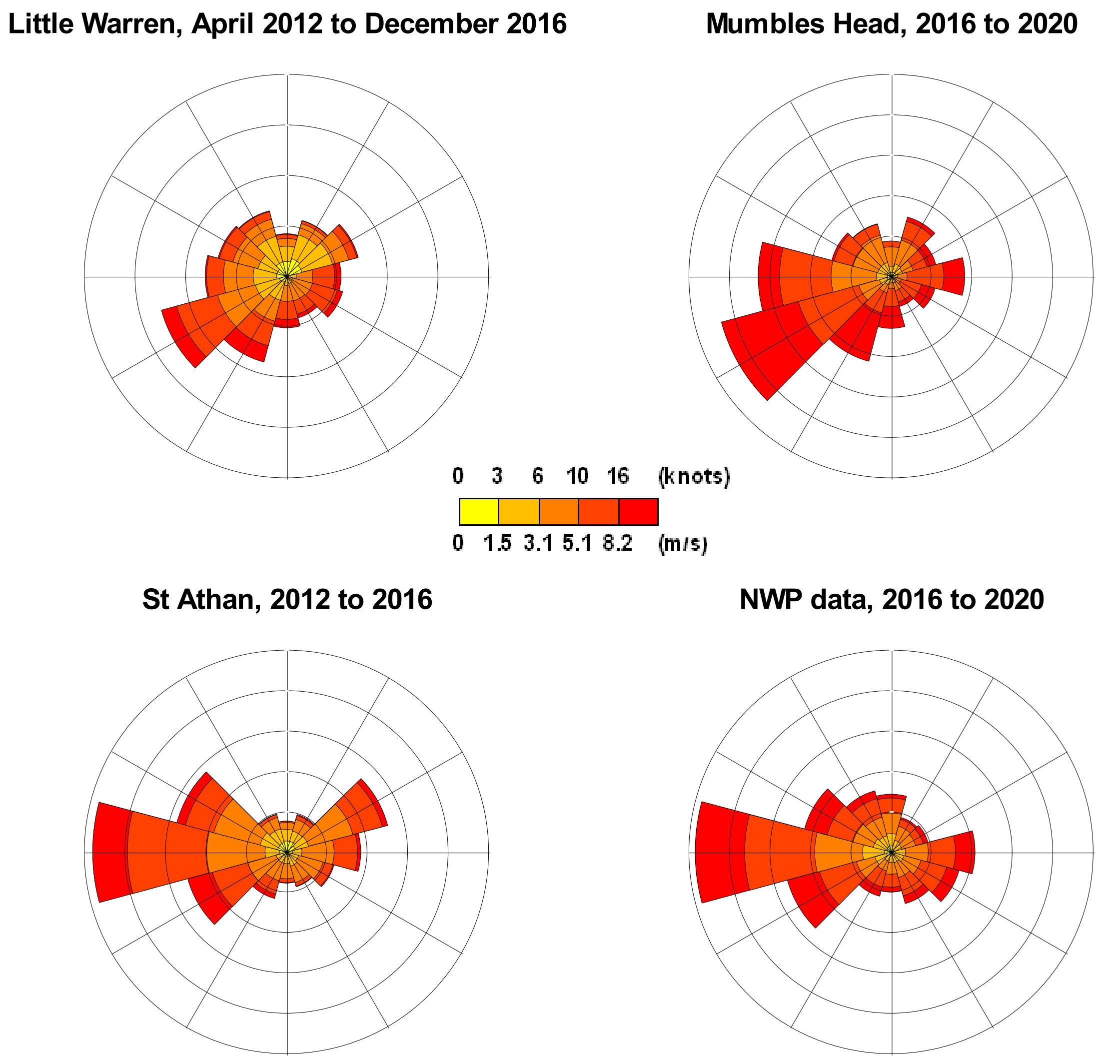

Figure A2.2: Wind roses – outer ring corresponds to 10,000 occurrences

References

A1.1 "ADMS 5 User Guide", version 5.2, November 2016, page 43

A1.2 Air Quality Expert Group, "Understanding PM_{10} in Port Talbot", April 2011, *www.gov.uk/government/publications/understanding-pm10-in-port-talbot*

A1.3 Numerical Weather Prediction Meteorological Data, *https://www.airpollutionservices.co.uk/meteorological-nwp-data/*

Annex 3 – Patterns of dispersion

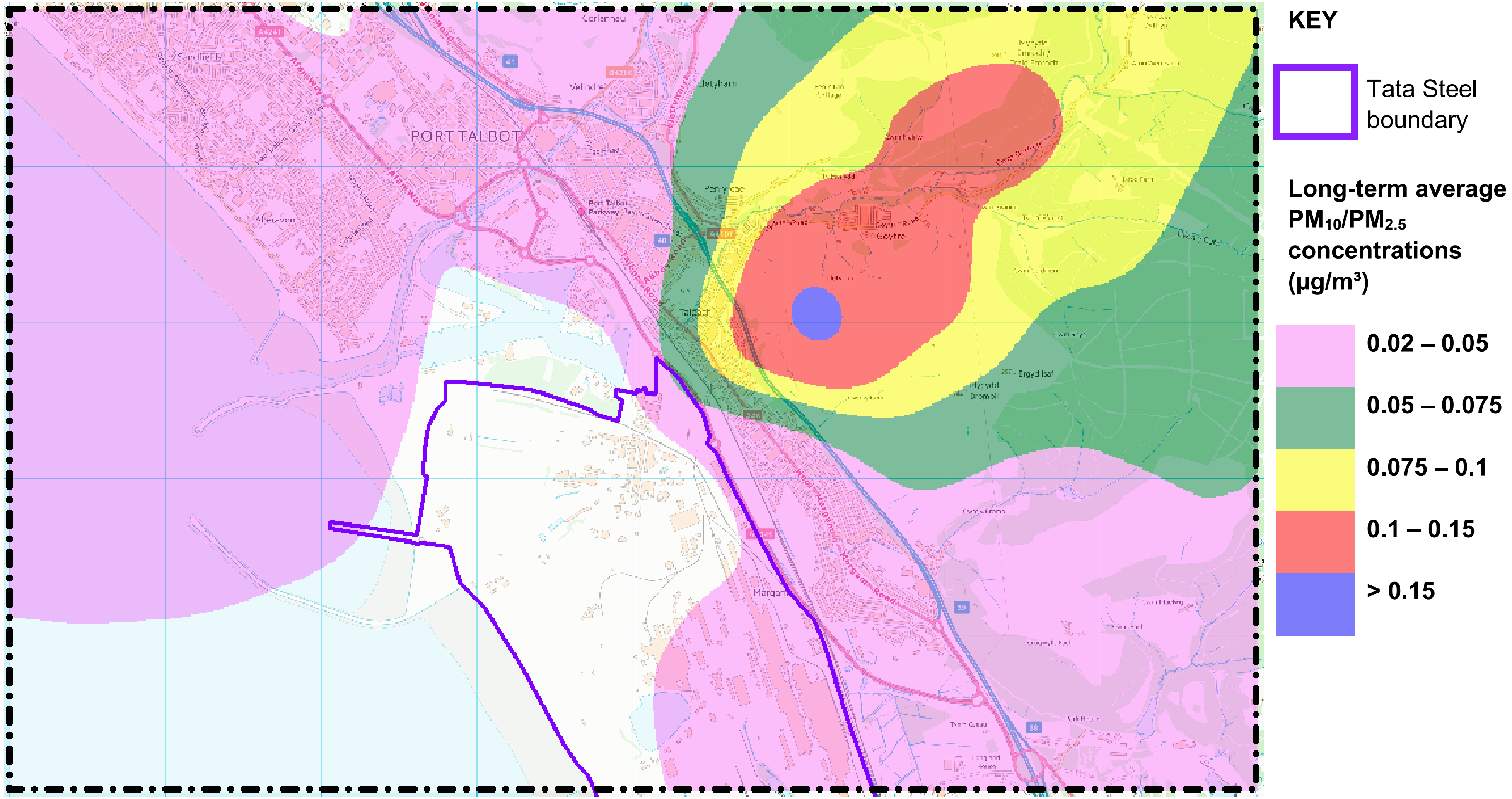

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Figure A3.1: Process Contribution to long-term average concentrations (two-fan operation, 2012 – 2016 meteorological data)

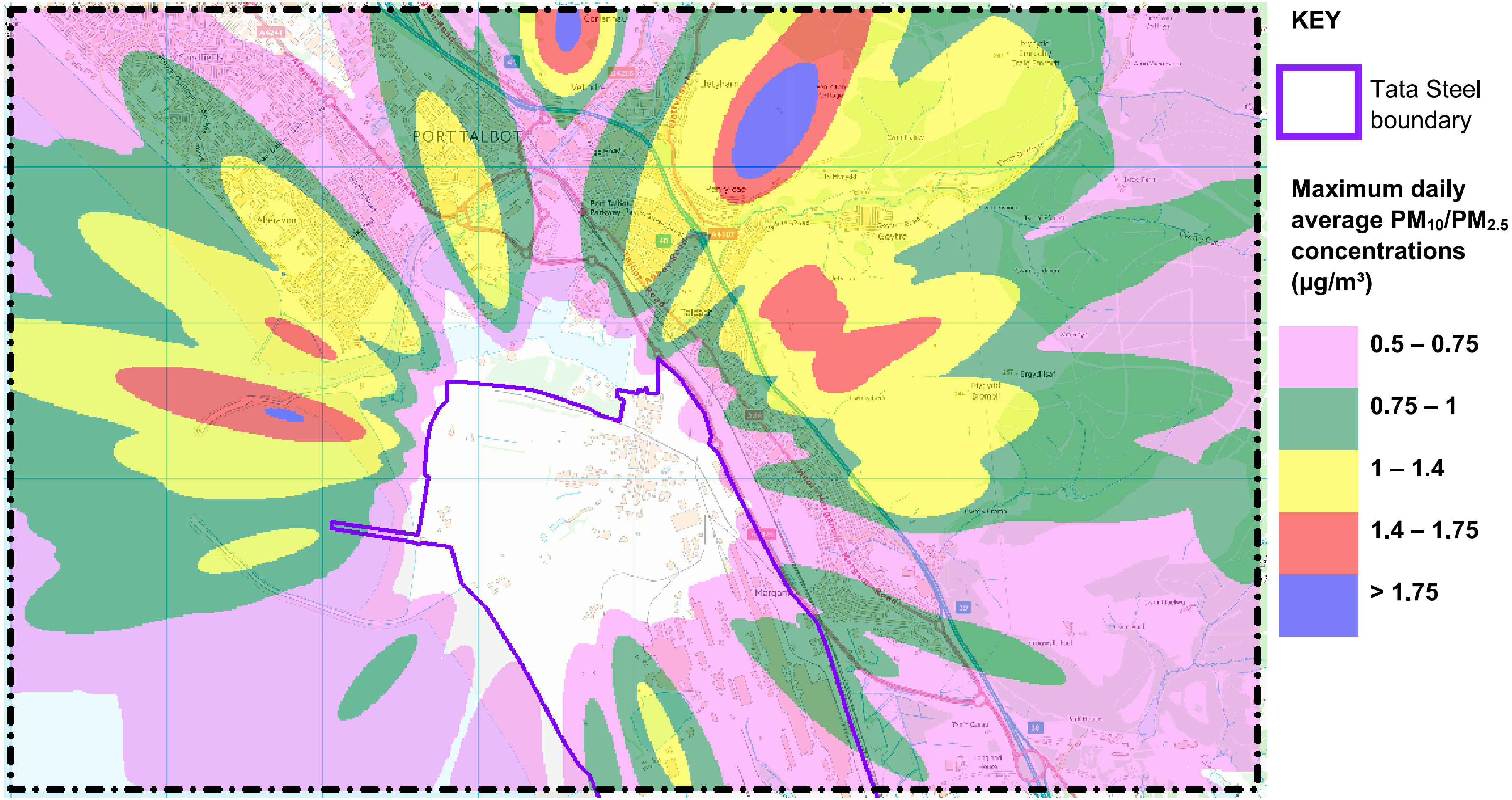
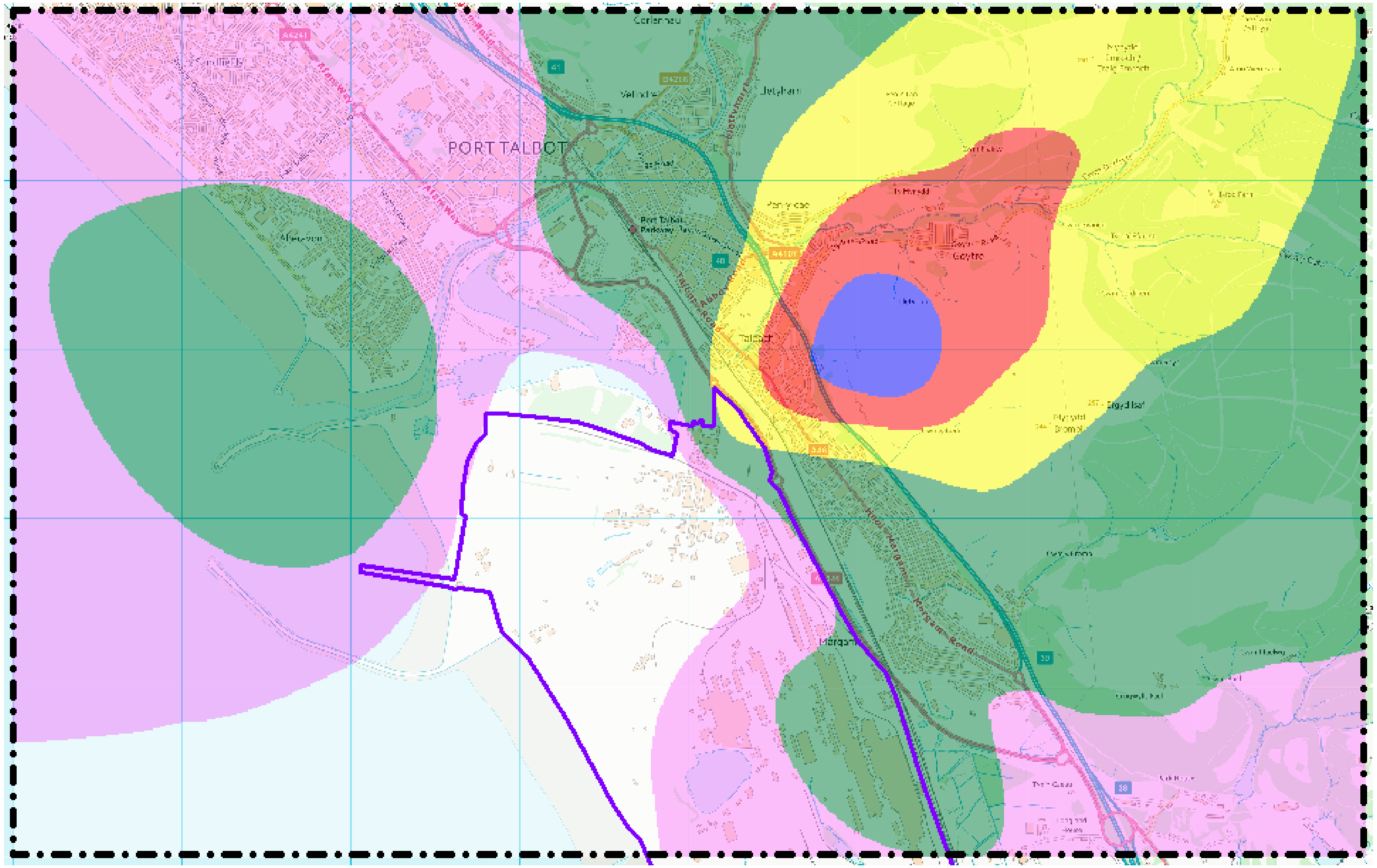


Figure A3.2: Maximum daily average concentrations (two-fan operation, 2012 – 2016 meteorological data)



KEY

Tata Steel boundary

Long-term average $PM_{10}/PM_{2.5}$ concentrations (µg/m³)

0.025 – 0.05

0.05 – 0.1

0.1 – 0.15

0.15 – 0.2

> 0.2

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Figure A3.3: Process Contribution to long-term average concentrations (single-fan operation, 2012 – 2016 meteorological data)

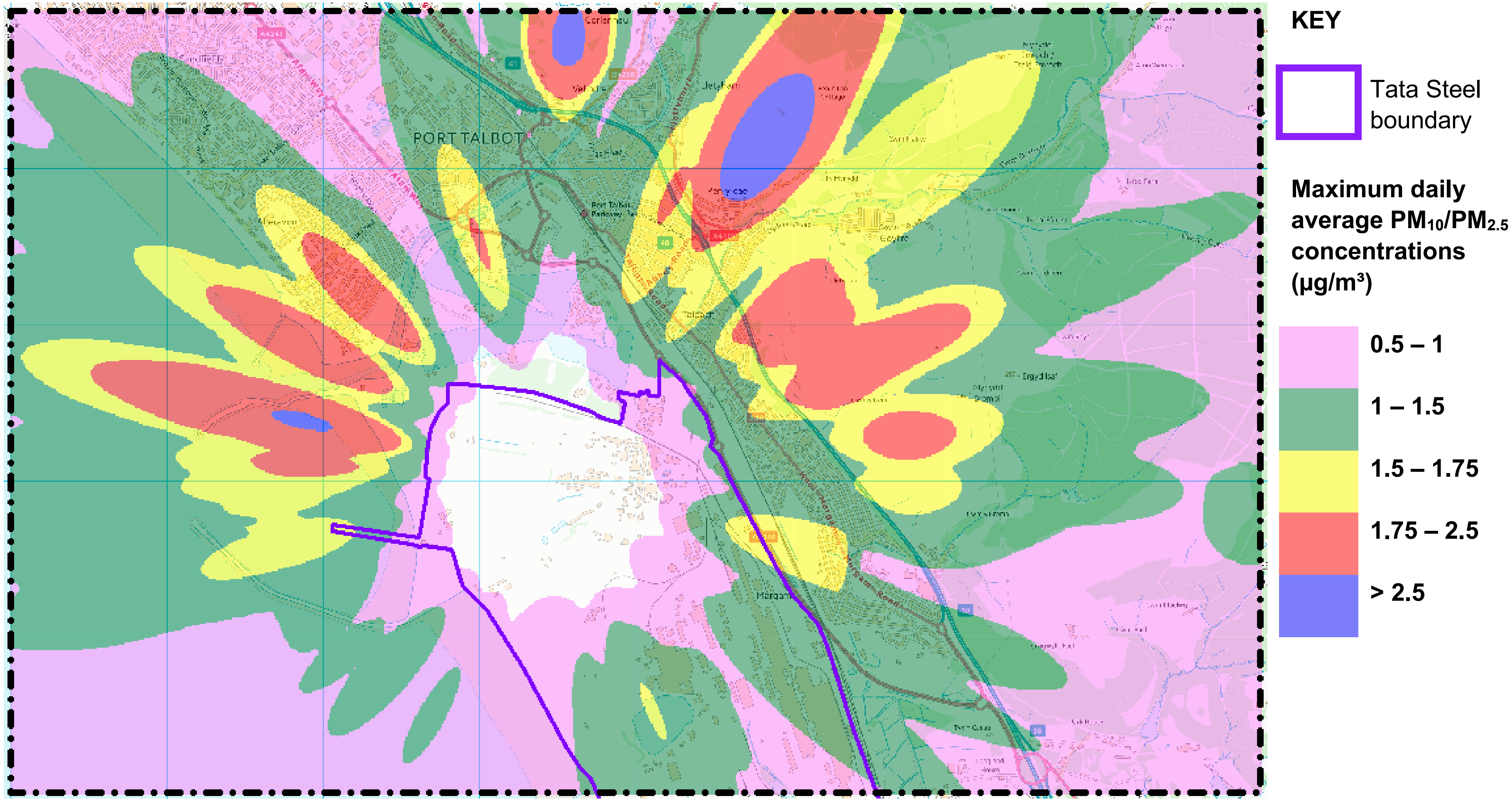

Figure A3.4: Maximum daily average concentrations (single-fan operation, 2012 – 2016 meteorological data)