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Assessment of the impact of emissions from Port Talbot sinter plant dedust stack

Ref. Source number:	202423
Project number:	93030
Date of issue:	23 November 2021
Security Code:	Restricted
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Security Code: Restricted

Summary

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Author: Dr Neil Haines
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This report describes a dispersion modelling exercise to assess the impact on local air quality of emissions from the sinter plant secondary dedusting system at Tata Steel's Port Talbot site. Two scenarios are included in this study – emissions from the existing stack and emissions from a proposed new stack, which would be the same height as the existing one, but would be approximately 160 metres further west. It is also proposed to replace the existing electrostatic precipitator with a more efficient bag filter, which would reduce emissions of dust from the dedusting system.

The impact of the sinter plant dedusting emissions would be reduced by the installation of a bag filter, and even taking a number of worst-case assumptions, the predicted impact of emissions from the proposed new stack would contribute only a small proportion of the relevant air quality standards. The overall Predicted Environmental Concentrations, taking background levels into account, would be well within the standards, and would be lower than the current measured concentrations.

Assessment of the impact of emissions from Port Talbot sinter plant dedust stack

1. Introduction

This report describes a dispersion modelling exercise to assess the impact on local air quality of emissions from the sinter plant secondary dedusting system at Tata Steel's Port Talbot site. Two scenarios are included in this study – emissions from the existing stack and emissions from a proposed new stack, which would be the same height as the existing one, but would be approximately 160 metres further west. It is also proposed to replace the existing electrostatic precipitator with a more efficient bag filter, which would reduce emissions of dust from the dedusting system.

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.

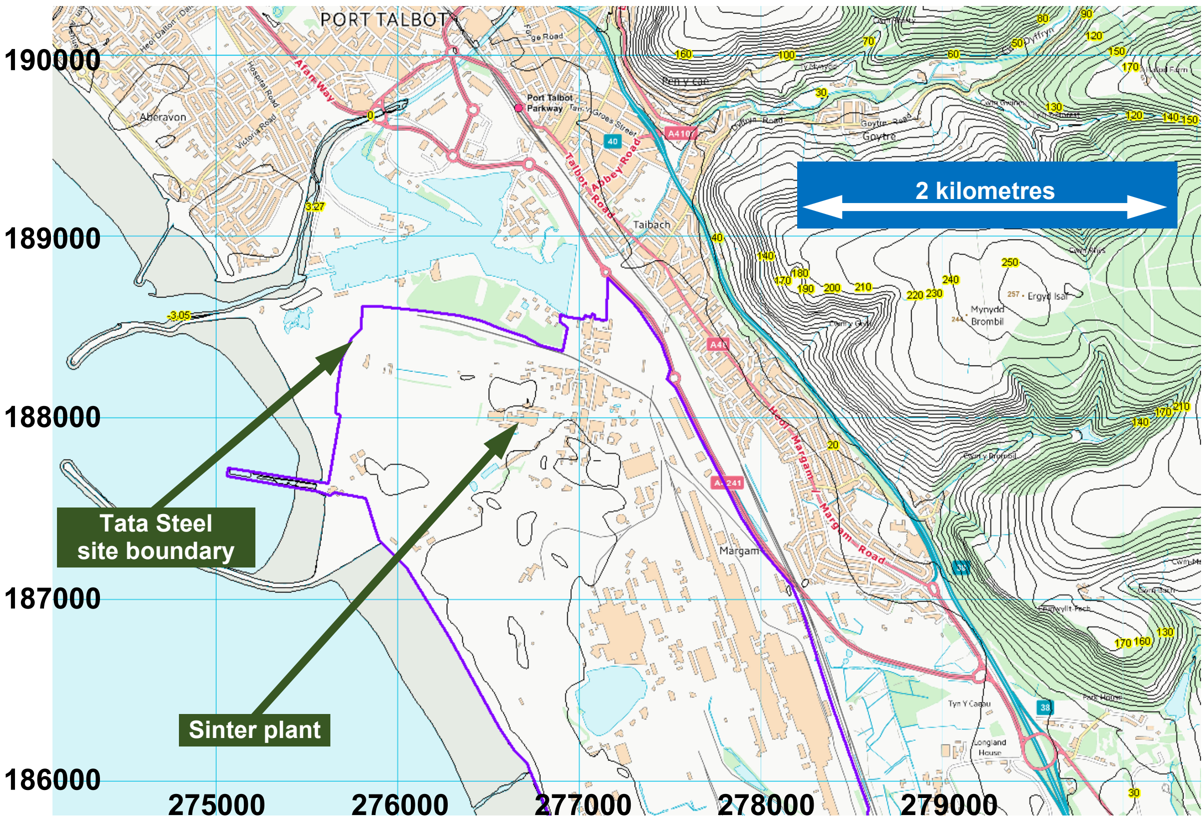

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Figure 1: Location map with National Grid references and 10 m contour intervals

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.

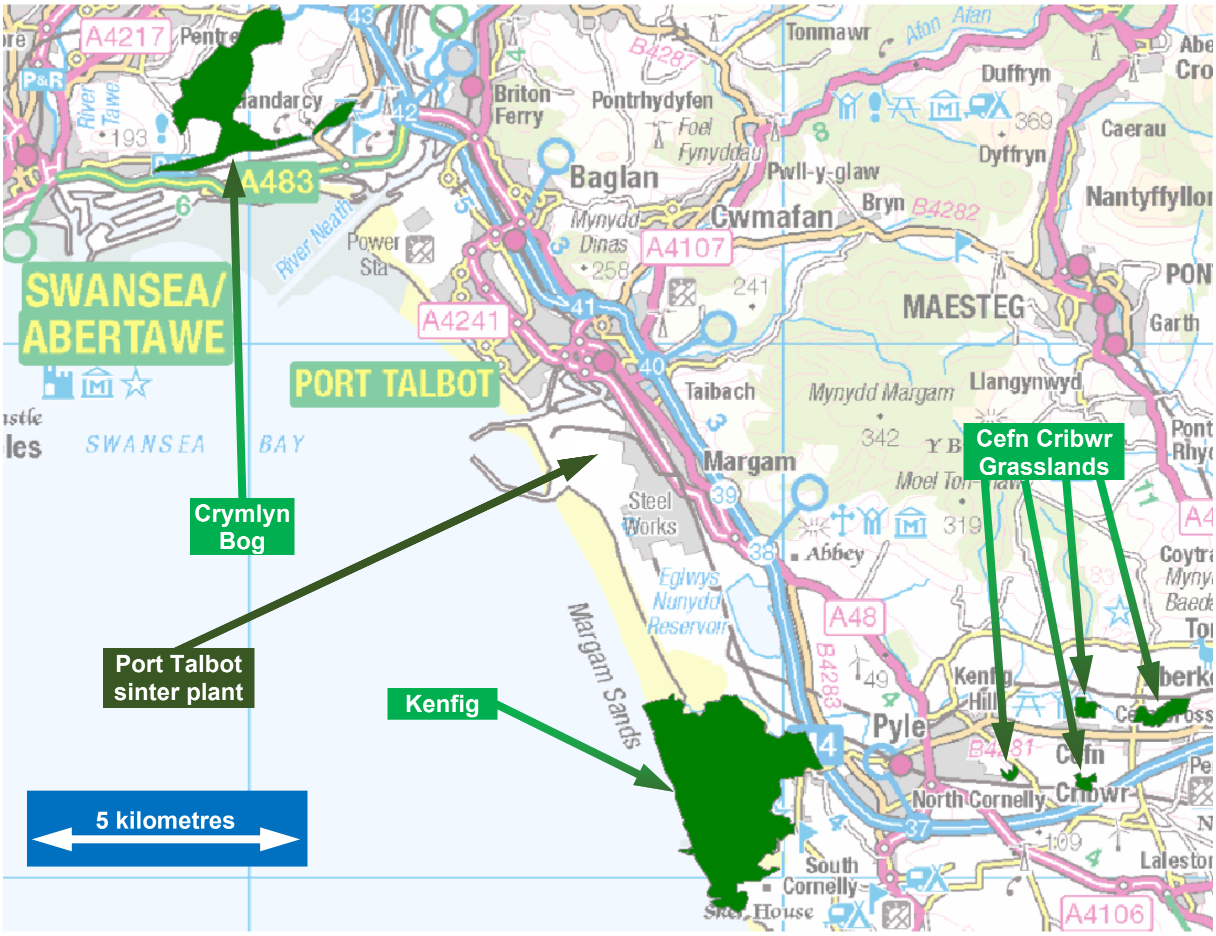

Figure 2: Special Areas of Conservation within 10 km of Tata Steel's Port Talbot site

3. Emissions and standards for assessment

This assessment focusses on emissions of particulate matter from the sinter plant dedust stack, emission point A2 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 emissions from the existing dedust system.

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

A number of assumptions have been made to derive representative emission characteristics for the two scenarios modelled:

- For the current stack, the values of exit temperature and waste gas flowrate are taken as the average of the results from biannual spot samples over the past four years. Table 3 shows the measured values.
- The design operating temperature for the proposed bag filter plant is 100 °C. There will be some heat loss through the filter, outlet duct and stack and it is assumed that the stack exit temperature will be 75 °C.
- The design exit velocity for the proposed bag filter stack is 15.4 m/s, equivalent to 234 m³/s (actual conditions).
- The waste gas extracted from the dedust system is primarily air with low moisture levels (1 to 2%) and insignificant levels of other gases. The mean molecular weight has been assumed to be 28.8 kg/kmol (air with 1.5% moisture) for both scenarios.
- For both the current stack and the proposed new stack a conservative assumption has been made that the dust emissions would be continuously at the relevant Emission Limit Value (ELV). The environmental permit issued in June 2018[3] sets the ELV for the current stack at 50 mg/Nm³ until 31st October 2020 under a derogation under Article 15(4) of the Industrial Emissions Directive. After this date the BAT-associated emission levels (BAT-AELs) from the Iron and Steel BREF[8] will be applied, and for a bag filter plant this will be 10 mg/Nm³.
- Limited data are available on the size distribution of the dust emitted from the dedust stack and for the purposes of this assessment a 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.
- For the assessment of long-term impacts, a conservative assumption has been made that the plant operates continuously throughout the year.

Date	28/01/2016	21/09/2016	16/01/2017	13/07/2017	14/02/2018	17/08/2018	27/02/2019	03/07/2019	Average
Exit temperature (°C)	69.7	65.7	56.3	72.5	46.1	54.7	44.8	59.4	58.7
Stack pressure (mm Hg)	759	768	772	766	747	763	768	769	
Efflux velocity (m/s, actual)	17.9	16.2	13.5	12.3	16.6	15.2	16.9	16.8	15.7
Waste gas flowrate (m³/s, actual)	284	257	214	195	264	241	269	267	249
Waste gas flowrate (m³/s at reference conditions) [a]	225	209	181	155	223	202	229	223	206
Dust concentration (mg/m³ at reference conditions) [a]	12.6	26.2	36.8	67.3	27.2	35.5	20.5	55.4	35.2
Dust emission rate (g/s)	2.83	5.48	6.65	10.45	6.07	7.17	4.70	12.33	6.96

a Reference conditions for the sinter plant dedust stack are 0°C, 101.3 kPa with no correction for oxygen

Table 3: Results from monitoring the existing dedust stack

With the assumptions discussed above, the parameters input to the dispersion model for the two scenarios are shown in Table 4. It should be noted that the dust emission rate used for modelling the impacts of the existing ESP (10.3 g/s – see Table 4) is significantly greater than the average measured dust emission rate (7.0 g/s – see Table 3) and the calculated impacts are therefore likely to overestimate the true impacts. Similarly, the actual emissions from a new bag filter plant are likely to be lower than the ELV of 10 mg/Nm³ used in Table 4.

Scenario		Current stack	Proposed new stack
Abatement technology		Electrostatic precipitator	Bag filter
Stack location (National Grid reference)		276647,188037	276491,188071
Stack height (metres)		55	55
Exit diameter (metres)		4.5	4.4
Exit temperature (°C)		58.7	75.0
Mean molecular weight (kg/kmol)		28.8	28.8
Specific heat capacity (J/°C/kg)		1,012	1,012
Efflux velocity (m/s, actual)		15.7	15.4
Waste gas flowrate (m^3/s, actual)		249	234
Waste gas flowrate (m^3/s at reference conditions) [a]		206	184
Dust concentration (mg/m^3 at reference conditions) [a,b]		50	10
Pollutant emission rates (g/s):	PM_{10}	10.29	1.84
	$PM_{2.5}$	10.29	1.84

a Reference conditions for the sinter plant dedust stack are 0°C, 101.3 kPa with no correction for oxygen

b Assuming emissions at the respective ELVs

Table 4: Stack and emission parameters entered into dispersion model

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. Since the peak concentrations were found within the site boundary, a series of discrete receptors following the line of the boundary was subsequently entered into the dispersion model to assess the maximum impacts at the boundary.

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

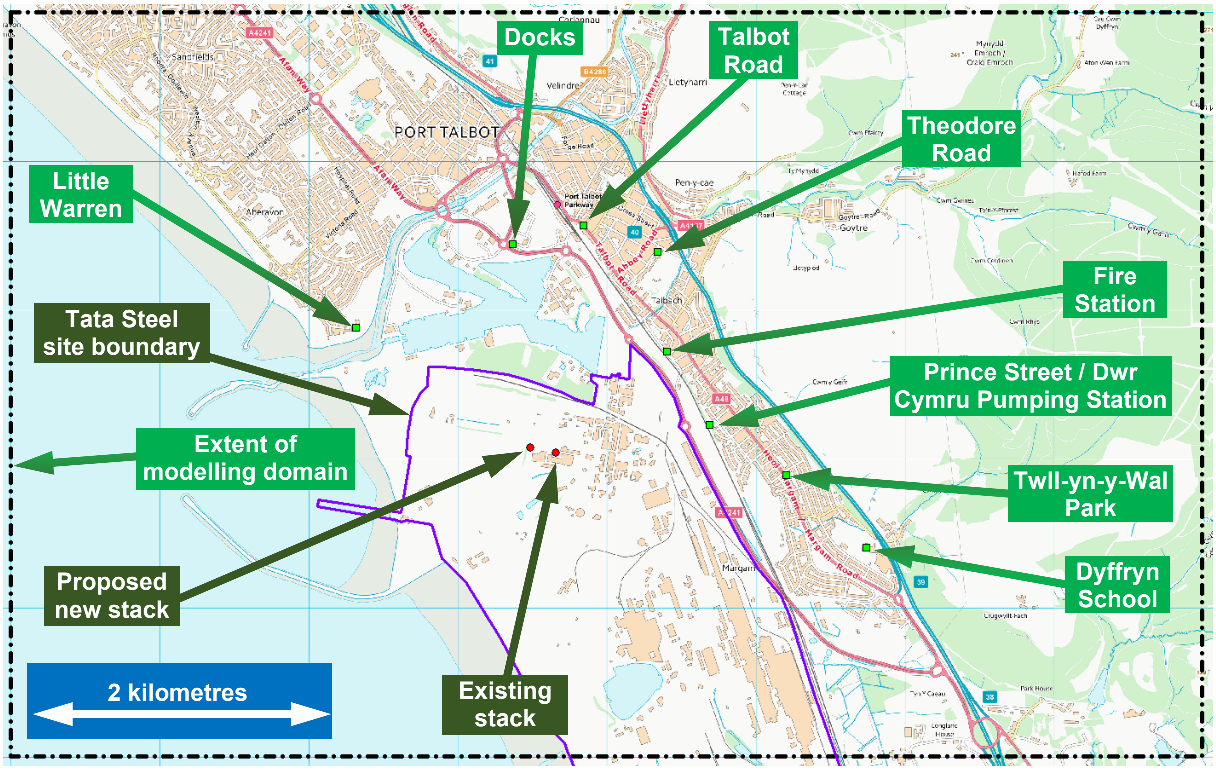

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Figure 3: Main modelling domain for impact assessment (excludes SAC receptors)

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.

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

Little Warren, April 2012 to December 2016 **NWP data, 2016 to 2020**

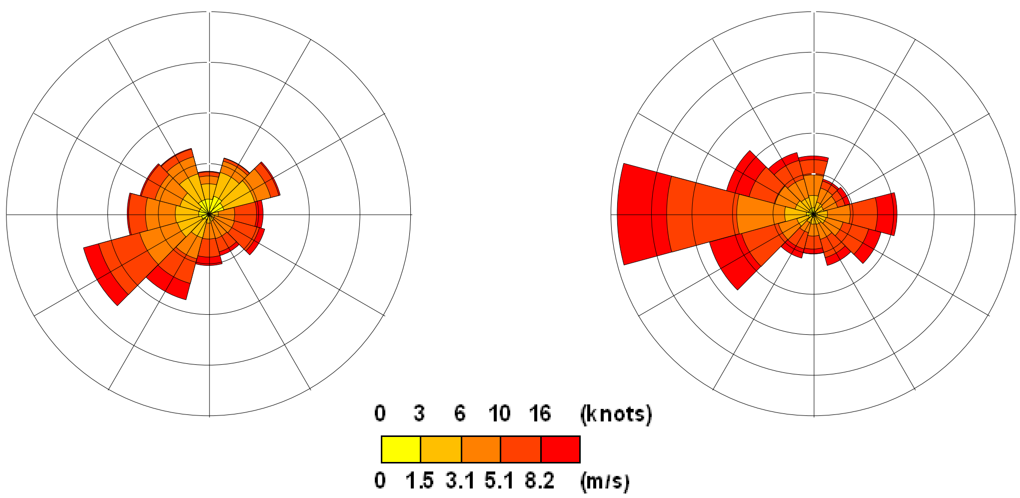

Figure 4: Wind roses – data from Little Warren and NWP data

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.

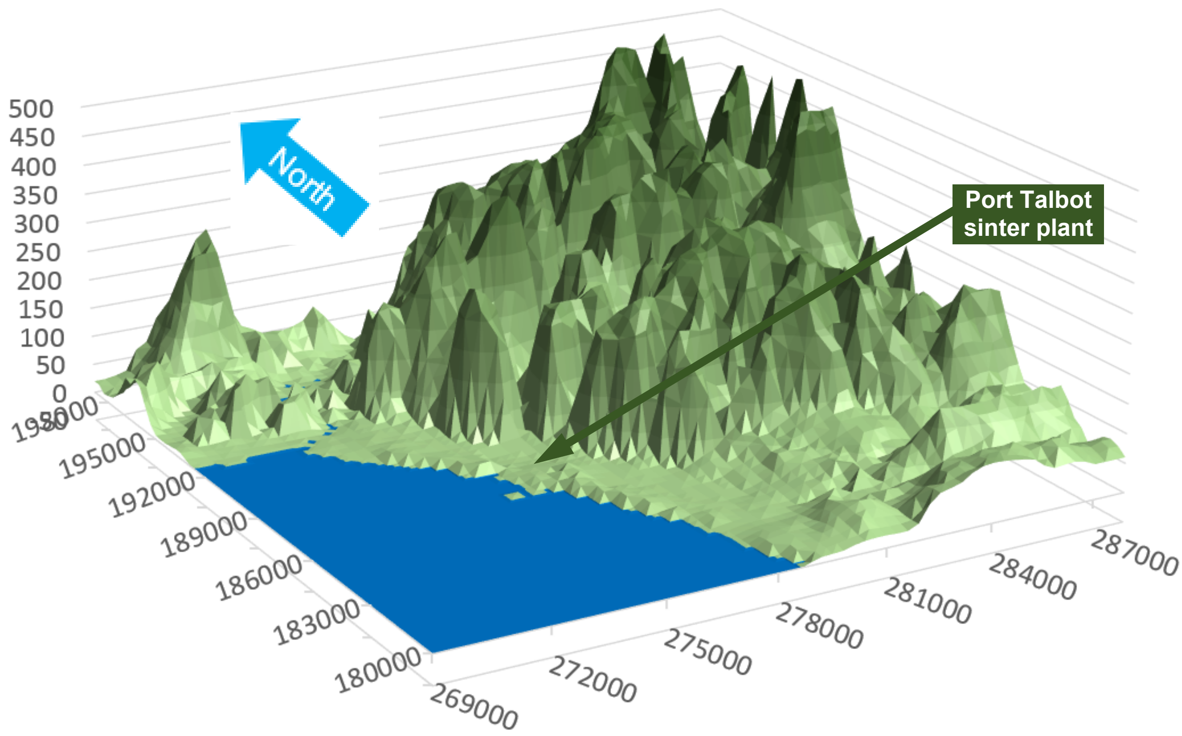

Figure 5: Complex terrain in the vicinity of the Tata Steel site

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. Figures 6 and 7 show the Port Talbot sinter plant, with heights of the main buildings and other structures marked. The stack heights for both the existing stack and the proposed new stack are 55 metres, which is less than 2½ times the height of the tallest part of the sinter plant and consequently the buildings module in ADMS has been used for this modelling exercise.

ADMS simplifies complex building layouts by combining all relevant structures into a single effective building for each wind direction, with a height determined by whichever building is deemed the main building for each source. Table 6 details the buildings entered, including the proposed new bag filter plant, and their locations and relative orientations are illustrated in Figure 8.

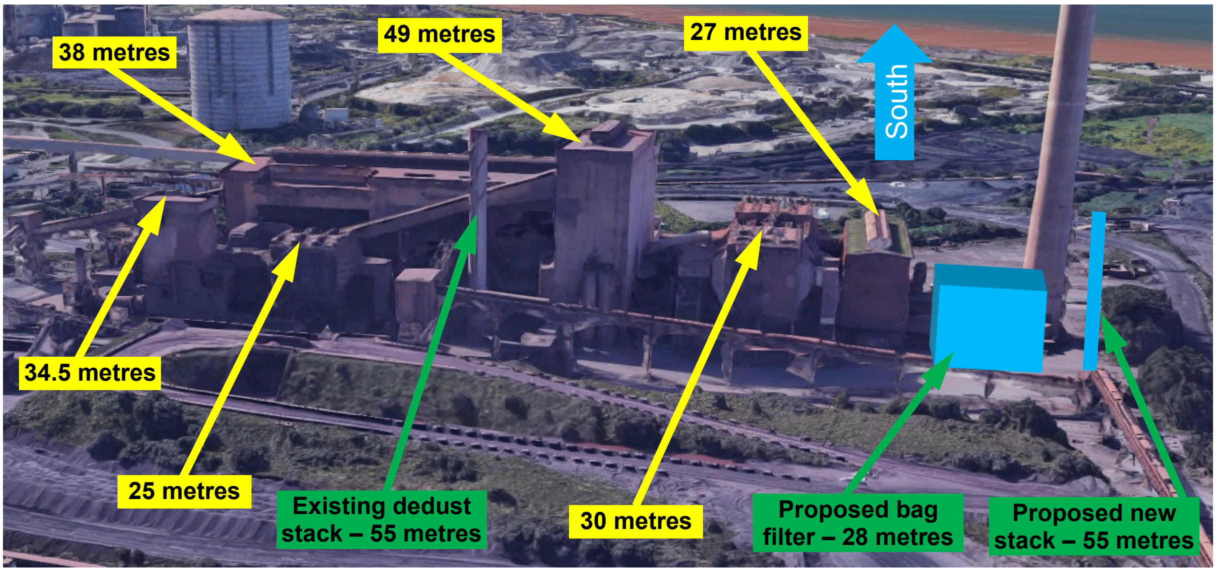

Figure 6: Port Talbot sinter plant – view from North

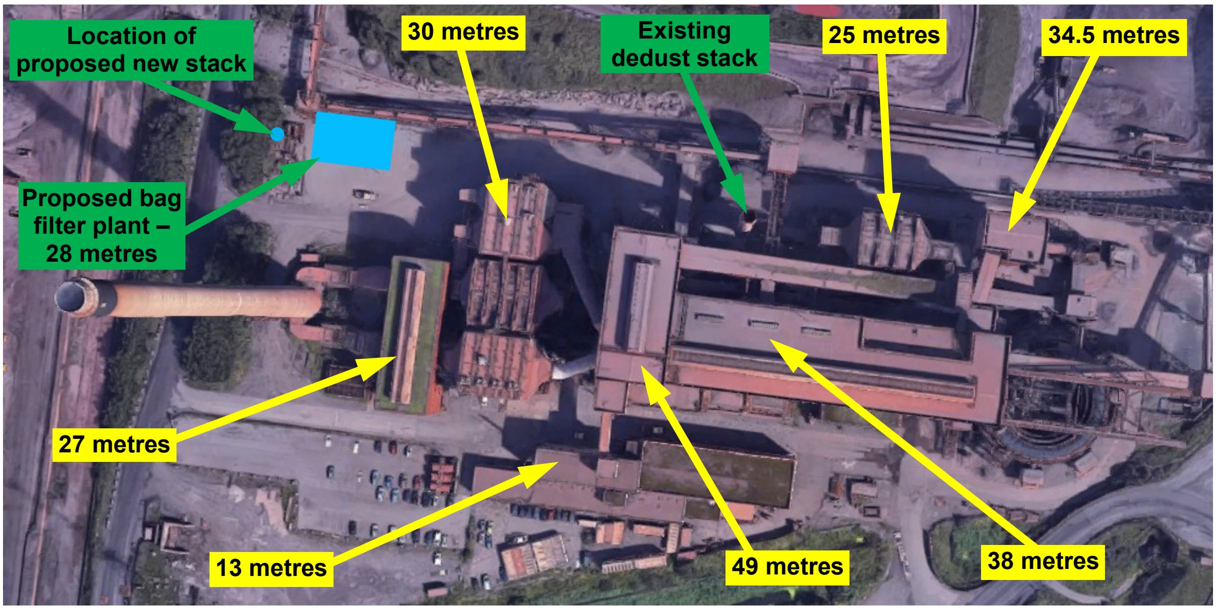

Figure 7: Port Talbot sinter plant – overhead view

Building	National Grid Reference of centre of building	Height metres	Length metres	Width metres	Angle between longest side and North
A Sinter plant, west end	276615,188013	49	42	21	9
B Sinter plant, main building	276672,187996	38	96	27	99
C ESPs for process waste gas and fan house	276559,188022	30	68	48	9
D Proposed new bag filter for dedusting waste gas	276525,188067	28	26	14	99

Table 6: Details of buildings entered into dispersion model

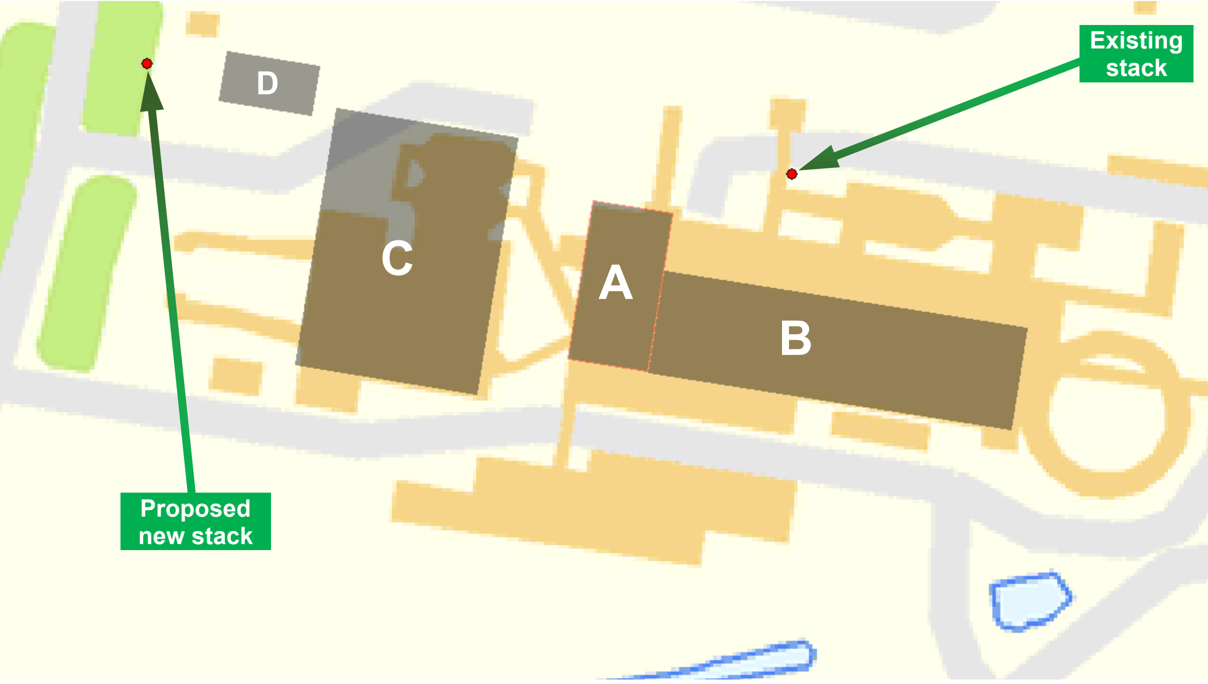

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Figure 8: Buildings entered into dispersion model (see Table 6 for details)

Building A has been set as the main building for the existing dedust stack and Building D for the proposed new stack.

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 and buildings modules discussed above, no other specialised model treatments have been included in this study.

10. Model uncertainty

Two validation studies have been published[10,11] in which both the complex terrain and buildings modules have been used. 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 a period of twelve months. For hourly average concentrations, this ratio was 0.79 in the first paper and 0.65 in the second and for 24-hour averages the ratios were 0.65 and 0.62 respectively. Hence in these studies ADMS 5.2 underestimated the short-term peak concentration by up to 38%, 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 none of the alternative models have better overall performance than ADMS 5.2. It should be noted that for the Baldwin power plant experiments[10], the surrounding hills were lower than the stack height whereas at Martins Creek Steam Electric Station[11] the terrain rose above the stacks, hence the second situation is more similar to that of Port Talbot.

	Ratio modelled:observed robust highest concentration for different models					
Data set	ADMS 5.2	AERMOD	ISCST3	CTDMPLUS	HPDM	RTDM
Baldwin	0.65	1.04	1.13		1.02	
Martins Creek	0.62	1.65	8.88	5.56		3.56

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 using 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. 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 dedusting system over the whole period from April 2012 to December 2016. The results in this table are likely to overestimate the true impacts of the existing and proposed new stack 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)
- All the particulate matter emitted will be below 2.5 μm aerodynamic diameter
- The sinter plant will operate continuously throughout the year

	Concentration of PM_{10} or $PM_{2.5}$ (µg/m³)			
Scenario	Existing stack		Proposed new stack	
Averaging period	Long-term average	Highest 24-hour average	Long-term average	Highest 24-hour average
PM_{10} monitoring stations				
Little Warren	0.38	9.6	0.07	1.8
Port Talbot Docks	0.34	5.4	0.06	1.1
Talbot Road	0.37	6.0	0.06	0.8
Theodore Road	0.52	6.9	0.09	1.2
Margam Fire Station	1.38	9.7	0.18	1.3
Prince Street	0.98	9.1	0.10	1.4
Twll-yn-y-Wal Park	0.46	5.1	0.05	0.8
Dyffryn School	0.27	3.1	0.04	0.4
Maximum value at monitoring station	**1.4**	**9.7**	**0.18**	**1.8**
Special Areas of Conservation				
Crymlyn Bog	0.047	0.91	0.008	0.15
Cefn Cribwr Grasslands	0.067	0.76	0.011	0.11
Kenfig	0.103	1.78	0.017	0.27
Maximum value at SAC	**0.10**	**1.8**	**0.017**	**0.27**
Peak at site boundary	3.2	38.9	0.27	3.3
Grid reference of peak location	276910,188368	276843,188385	276922,188428	275798,188495
Peak within site boundary	6.5	85.4	0.28	6.7
Grid reference of peak location	276650,188050	276650,188050	277000,188450	276250,188200

Table 8: Ambient PM_{10} and $PM_{2.5}$ concentrations attributable to dedust stack emissions

Dust concentrations at all receptors would be significantly reduced if the proposed bag filter plant and new stack were to be installed. Much of the reduction is attributable to the more efficient abatement system, but at most receptors the decrease in predicted concentration is greater than can be accounted for just by the lower mass emission rate, showing that the proposed new stack has better dispersion characteristics than the existing one. This will be partly due to reduced entrainment of the plume into the building wake as a result of the new stack location being further from the sinter plant buildings, partly due to slightly greater plume rise as a result of the increased buoyancy from the new stack, and partly due to the new stack location being further from the main residential areas to the east of the Tata Steel site.

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. In all cases, the peak impact is found within the boundary of the Tata Steel site.

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 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: Little Warren and St Athan	Apr 2012 - Dec 2016	1.4	9.7	0.18	1.3
		Calendar year 2013	1.2	8.0	0.15	1.3
		Calendar year 2014	1.3	8.1	0.16	1.0
		Calendar year 2015	1.6	9.7	0.21	1.3
		Calendar year 2016	1.5	8.6	0.18	1.2
	NWP	Jan 2016 - Dec 2020	0.5	7.3	0.08	1.2
Prince Street	Combined: Little Warren and St Athan	Apr 2012 - Dec 2016	1.0	9.1	0.10	1.4
		Calendar year 2013	0.8	7.5	0.08	1.0
		Calendar year 2014	0.9	7.5	0.09	0.8
		Calendar year 2015	1.0	6.5	0.10	0.9
		Calendar year 2016	1.0	7.6	0.10	1.0
	NWP	Jan 2016 - Dec 2020	1.5	11.2	0.18	1.5
Peak at site boundary	Combined: Little Warren and St Athan	Apr 2012 - Dec 2016	3.2	38.9	0.27	3.3
		Calendar year 2013	3.2	38.9	0.24	2.5
		Calendar year 2014	3.0	26.8	0.24	2.4
		Calendar year 2015	3.6	26.4	0.31	2.7
		Calendar year 2016	3.3	22.3	0.27	3.3
	NWP	Jan 2016 - Dec 2020	2.1	27.9	0.25	3.5
Peak within site boundary	Combined: Little Warren and St Athan	Apr 2012 - Dec 2016	6.5	85.4	0.28	6.7
		Calendar year 2013	6.8	85.4	0.24	5.0
		Calendar year 2014	7.2	76.2	0.26	6.3
		Calendar year 2015	7.1	70.5	0.32	6.7
		Calendar year 2016	6.0	48.7	0.28	5.4
	NWP	Jan 2016 - Dec 2020	8.4	75.4	0.35	9.0

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 15% 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 Prince Street 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 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 and in all cases, these peaks fell within the site boundary. Although the magnitude of the on-site peak may be affected by the grid resolution, the peak concentrations at the boundary or at other specific receptors, which are those which are relevant for the assessment of the potential impact on human health, do not depend on the grid spacing.

12.3. Comparison to standards

Table 10 compares the peak modelled dust concentrations at the site boundary and the levels at the Fire Station attributable to emissions from the proposed new stack with the relevant air quality standards.

			At site boundary		At Fire Station	
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
PM_{10}	One day	50	3.3	6.5%	1.3	2.6%
	Calendar year	40	0.27	0.7%	0.18	0.4%
$PM_{2.5}$	Calendar year	25	0.27	1.1%	0.18	0.7%

Table 10: Comparison of modelled results and air quality standards

The Process Contribution beyond the site boundary is predicted to be much lower than the air quality standards.

12.4. Predicted Environmental Concentration

Since emissions from the proposed bag filter plant would replace those from the existing stack, the overall Predicted Environmental Concentration (PEC) for the future situation will be lower than current ambient levels. If the long-term impact at the Fire Station PM_{10} monitor of emissions from the existing stack (see Table 8) is subtracted from the average measured concentration at that site (see Table 2) and the impact of the proposed new stack is then added, this gives an indication of the future ambient levels at the Fire Station. Table 11 details these estimates.

	Long-term average concentration (µg/m³)				
	Measured	Modelled contribution		Predicted Enviromental Concentration	Air Quality Standard
Species	(2015 to 2019)	Existing stack	Proposed new stack		
PM_{10}	23.2	1.38	0.18	22.0	≤ 40
$PM_{2.5}$	10.2	1.38	0.18	9.0	≤ 25

Table 11: Potential long-term PEC at Port Talbot Fire Station AURN site

The actual improvement in air quality as a result of replacing the existing sinter plant dedust system is likely to be less than shown in Table 12, as this is based on worst-case impacts.

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 stacks under consideration coincides with the highest ambient levels. It is, however, certain that the proposed new bag filter plant would not lead to more exceedances than the current situation. To estimate the possible impact on PM_{10} exceedances, daily mean contributions at the Fire Station monitor from the existing and proposed new sinter plant dedusting system were modelled for each day during 2015 when the measured level was greater than 50 µg/m³ (2015 was chosen as the example as it is the year with the highest number of exceedances in the last five – see Table 2).

Table 12 shows the corresponding PECs and demonstrates that there would have potentially been four fewer days on which the mean PM_{10} concentration would have exceeded 50 µg/m³ had the new dedusting system been in operation during 2015 – i.e. there would have been 24 exceedances, rather than the 28 actually measured. The impact of the sinter plant dedusting emissions is still only a minor contributor to the overall daily mean PM_{10} values, but in some instances, highlighted in the table, the lower emissions from the proposed new stack would have been sufficient to reduce a level of just above 50 µg/m³ to just below that value.

	Daily mean PM_{10} concentration (µg/m³)					
		Modelled contribution				
Date	Measured at Fire Station	Existing stack	Proposed new stack	Predicted Environmental Concentration		
07/01/2015	56.2	3.4	0.30	53.2		
18/02/2015	70.6	0.0	0.00	70.6		
19/02/2015	71.3	0.0	0.00	71.3		
28/02/2015	50.6	0.5	0.01	50.1		
06/03/2015	55.7	0.0	0.00	55.7		
07/03/2015	63.5	1.7	0.19	62.0		
18/03/2015	54.0	2.3	0.23	51.9		
19/03/2015	76.2	1.8	0.19	74.5		
20/03/2015	60.2	1.2	0.11	59.1		
06/04/2015	51.4	1.8	0.17	49.8		
10/04/2015	52.7	0.9	0.12	51.9		
24/04/2015	59.6	3.9	0.27	56.0		
01/06/2015	61.7	2.9	0.32	59.1		
06/06/2015	53.4	1.5	0.44	52.4		
07/07/2015	50.9	3.6	0.53	47.8		
11/07/2015	60.2	5.4	0.68	55.4		
03/08/2015	87.3	6.0	0.36	81.7		
04/08/2015	78.4	7.0	0.81	72.3		
26/08/2015	51.4	5.8	0.49	46.1		
18/11/2015	54.8	3.3	0.43	51.9		
01/12/2015	61.9	5.6	0.40	56.6		
04/12/2015	54.3	4.7	0.61	50.3		
05/12/2015	146.4	4.4	0.25	142.2		
06/12/2015	79.6	8.3	0.87	72.2		
17/12/2015	54.7	3.8	0.13	51.0		
20/12/2015	53.3	4.7	0.27	48.9		
26/12/2015	58.5	0.8	0.02	57.6		
27/12/2015	66.6	1.7	0.09	64.9		
Total exceedances as measured	**28**	Total exceedances with new dedusting system		**24**	Air Quality Standard	**≤ 35**

Table 12: Potential short-term PEC at Port Talbot Fire Station AURN site, 2015

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 improvement in air quality as a result of replacing the existing sinter plant dedust system is likely to be less than shown above.

12.5. Overall assessment

Replacing the existing electrostatic precipitators with a more efficient bag filter plant would reduce the impact of emissions from the sinter plant dedusting system at Tata Steel's Port Talbot site. Even taking a number of worst-case assumptions, the predicted impact of emissions from the proposed new stack would contribute only a small proportion of the relevant air quality standards. The overall Predicted Environmental Concentrations would be well within the standards, and would be lower than the current measured concentrations.

13. References

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2. "Air emissions risk assessment for your environmental permit", August 2016, *www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit*
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9. "ADMS 5 User Guide", version 5.2, November 2016, page 354
10. "ADMS 5 Buildings and Complex Terrain Validation: Baldwin Power Plant", Cambridge Environmental Research Consultants, November 2016, *www.cerc.co.uk/environmental-software/assets/data/doc_validation/CERC_ADMS5_Study_Validation_Baldwin_5.2_vs_5.1.pdf*
11. "ADMS 5 Buildings and Complex Terrain Validation: Martins Creek Steam Electric Station", 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.

Building parameters:

Building	National Grid Reference of centre of building	Height metres	Length metres	Width metres	Angle between longest side and North
A Sinter plant, west end	276615,188013	49	42	21	9
B Sinter plant, main building	276672,187996	38	96	27	99
C ESPs for process waste gas and fan house	276559,188022	30	68	48	9
D Proposed new bag filter for dedusting waste gas	276525,188067	28	26	14	99

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

Source parameters:

	Scenario	Current stack	Proposed new stack
Abatement technology		Electrostatic precipitator	Bag filter
Stack location (National Grid reference)		276647,188037	276491,188071
Stack height (metres)		55	55
Exit diameter (metres)		4.5	4.4
Exit temperature (°C)		58.7	75.0
Mean molecular weight (kg/kmol)		28.8	28.8
Specific heat capacity (J/°C/kg)		1,012	1,012
Efflux velocity (m/s, actual)		15.7	15.4
Waste gas flowrate (m³/s, actual)		249	234
Waste gas flowrate (m³/s at reference conditions) [a]		206	184
Dust concentration (mg/m³ at reference conditions) [a,b]		50	10
Pollutant emission rates (g/s):	PM_{10}	10.29	1.84
	$PM_{2.5}$	10.29	1.84

Building A has been set as the main building for the current stack and Building D for the proposed new stack.

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

Additional specified receptors were used along the boundary of the Tata Steel site and these are provided separately in the file *Port Talbot Boundary.asp*.

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.

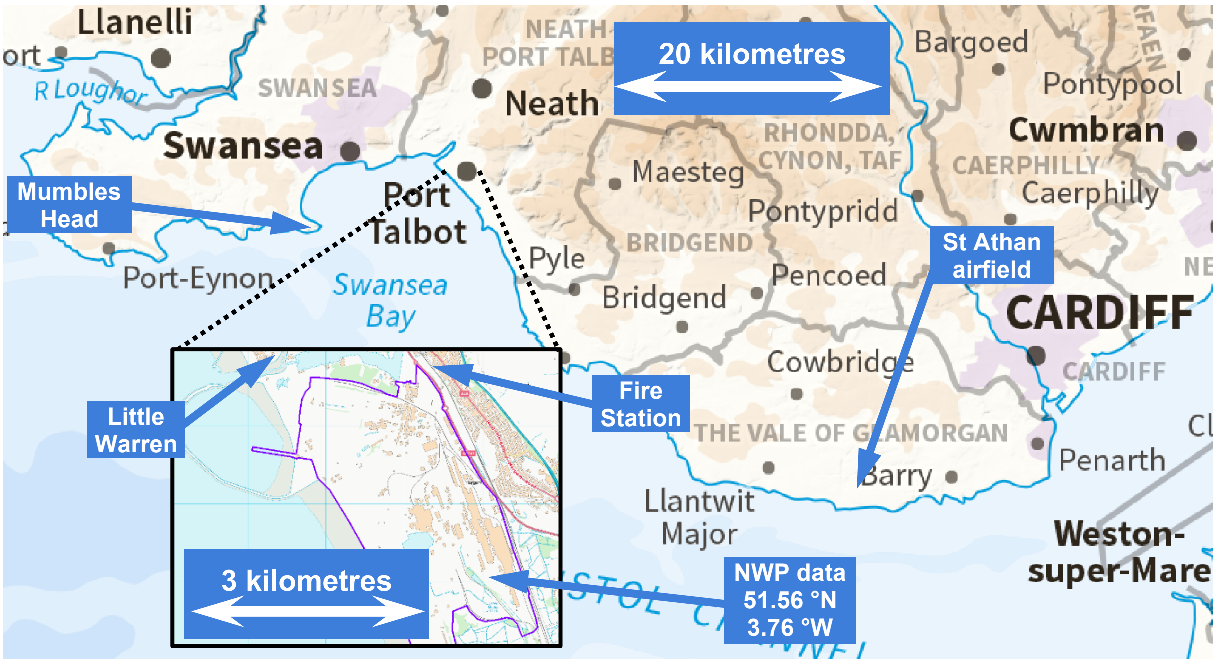

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Figure A2.1: Location of meteorological stations

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.

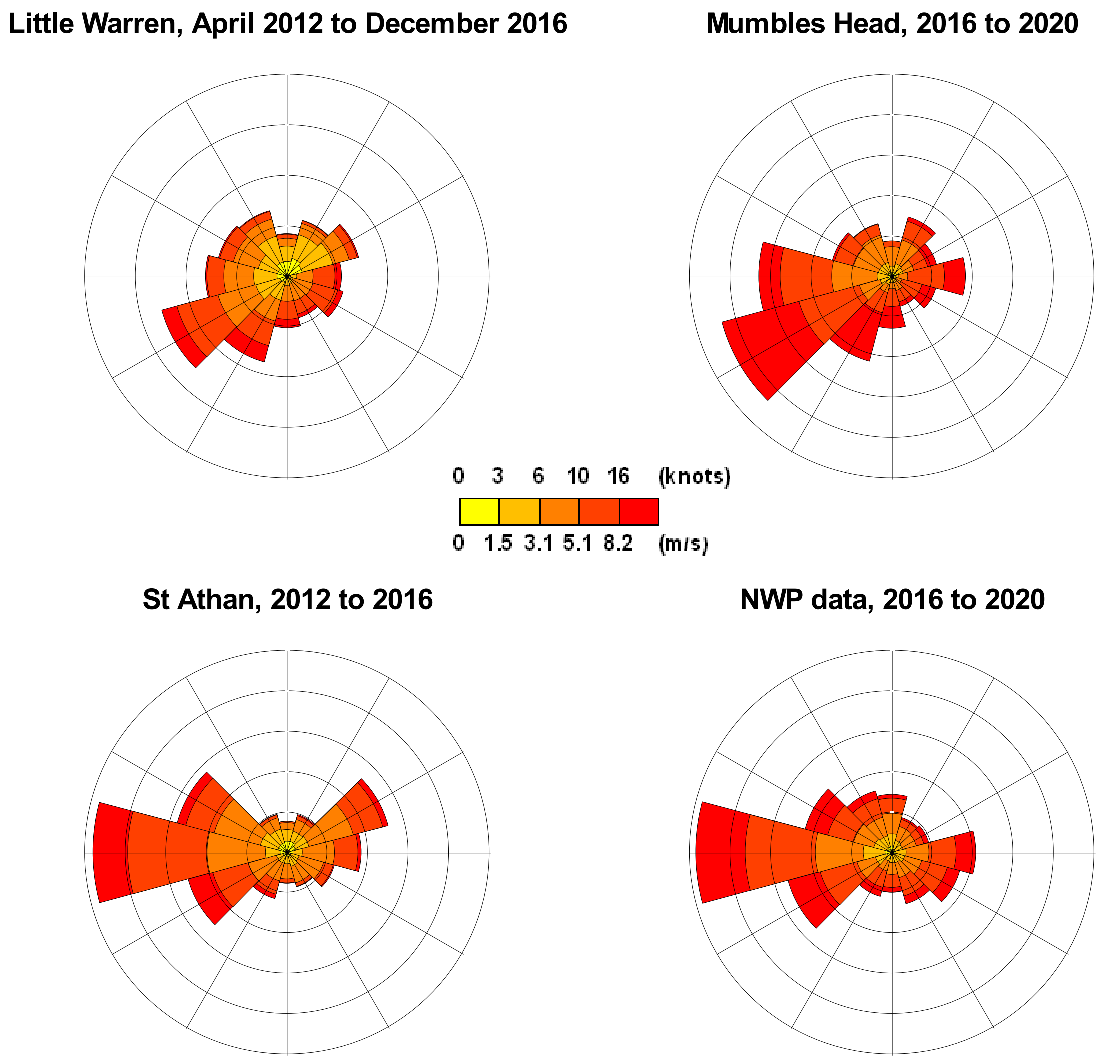

Figure A2.2: Wind roses – outer ring corresponds to 10,000 occurrences

References

A2.1 "ADMS 5 User Guide", version 5.2, November 2016, page 43

A2.2 Air Quality Expert Group, "Understanding PM_{10} in Port Talbot", April 2011, *www.gov.uk/government/publications/understanding-pm10-in-port-talbot*

A2.3 Numerical Weather Prediction Meteorological Data, *https://www.airpollutionservices.co.uk/meteorological-nwp-data/*

Annex 3 – Patterns of dispersion

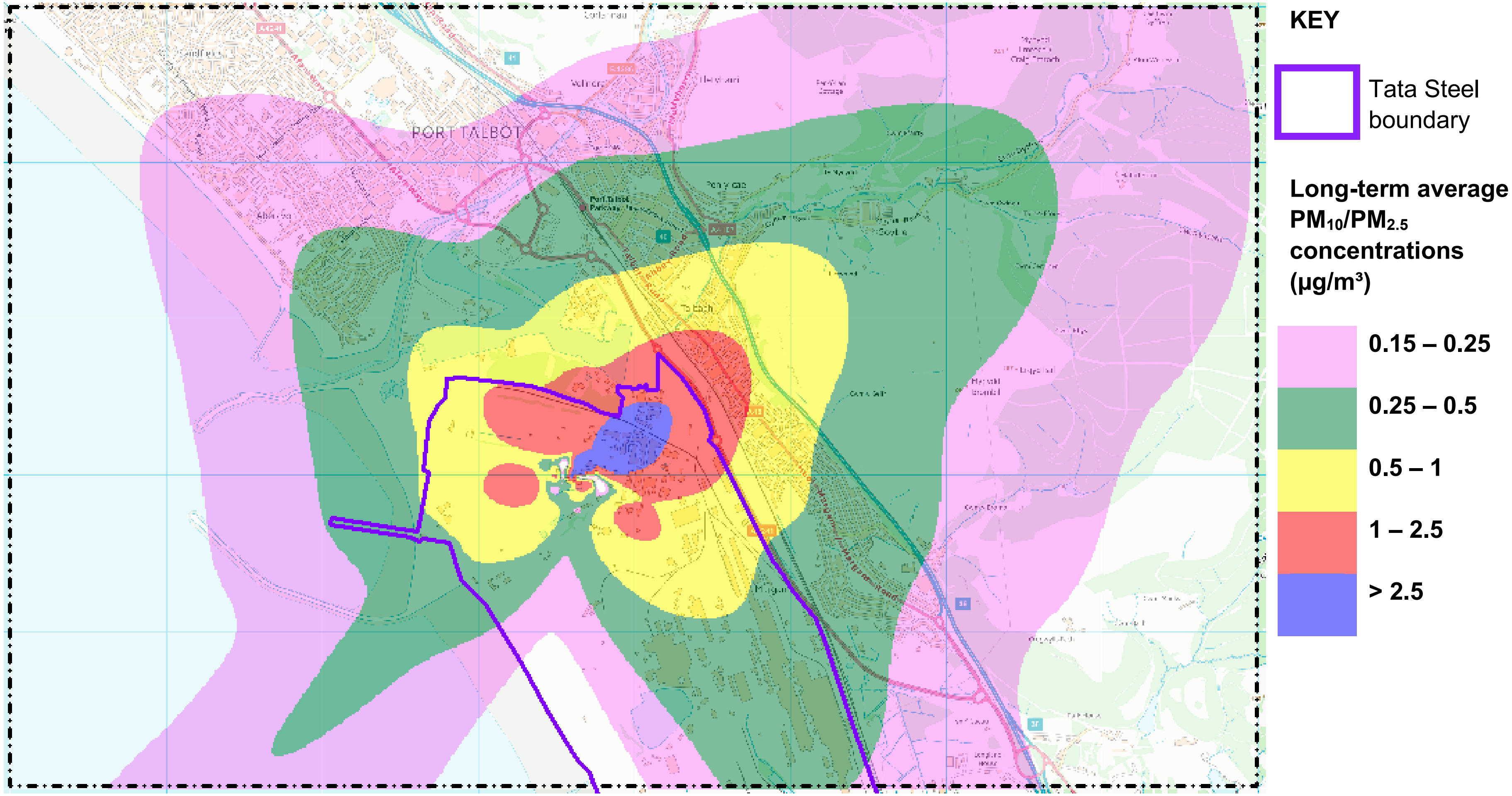

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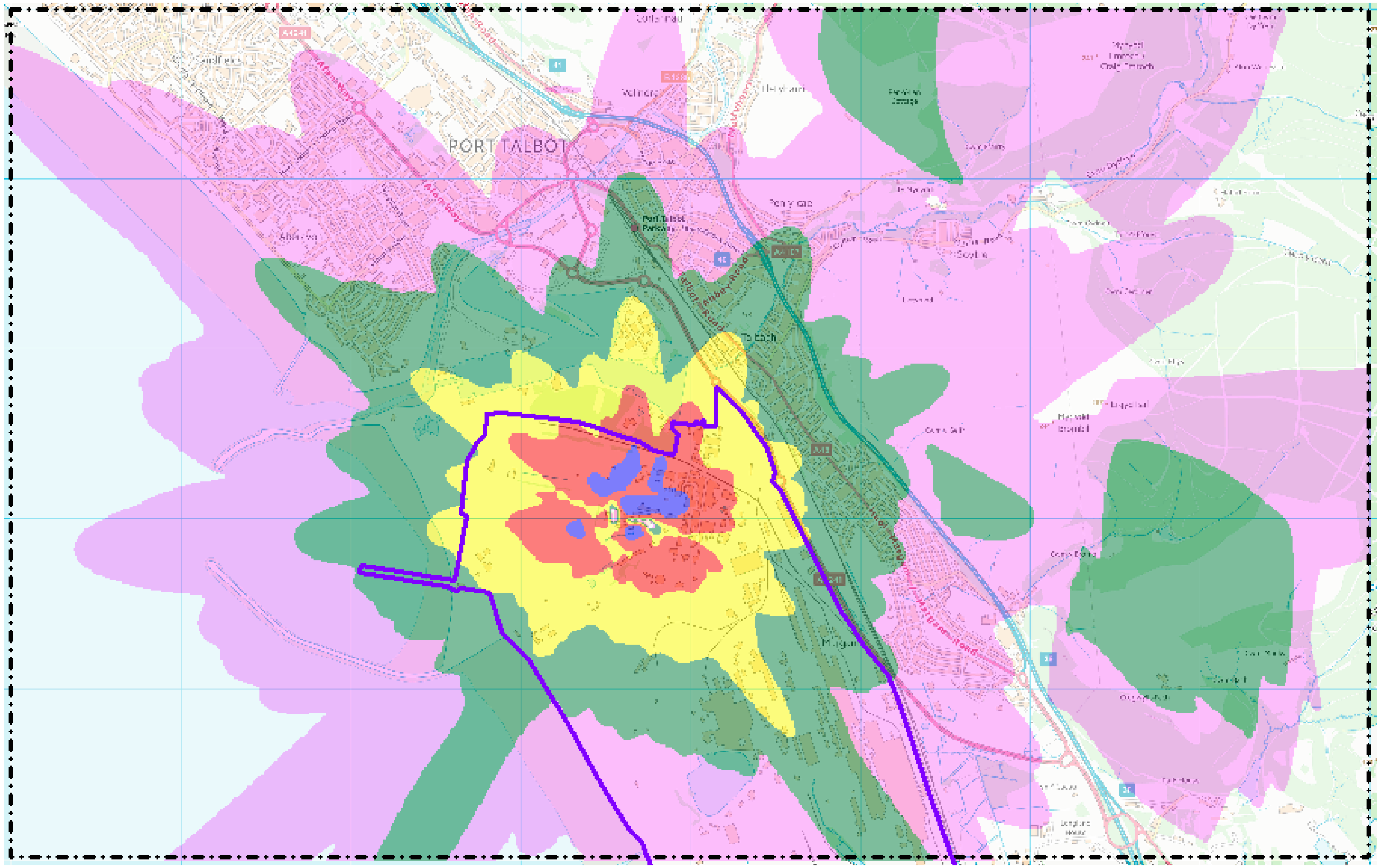
Figure A3.1: Process Contribution to long-term average concentrations (existing stack, 2012 – 2016 meteorological data)



KEY

Tata Steel boundary

Maximum daily average $PM_{10}/PM_{2.5}$ concentrations ($\mu g/m^3$)

- **2.5 – 5**
- **5 – 10**
- **10 – 20**
- **20 – 40**
- **> 40**

Figure A3.2: Maximum daily average concentrations (existing stack, 2012 – 2016 meteorological data)

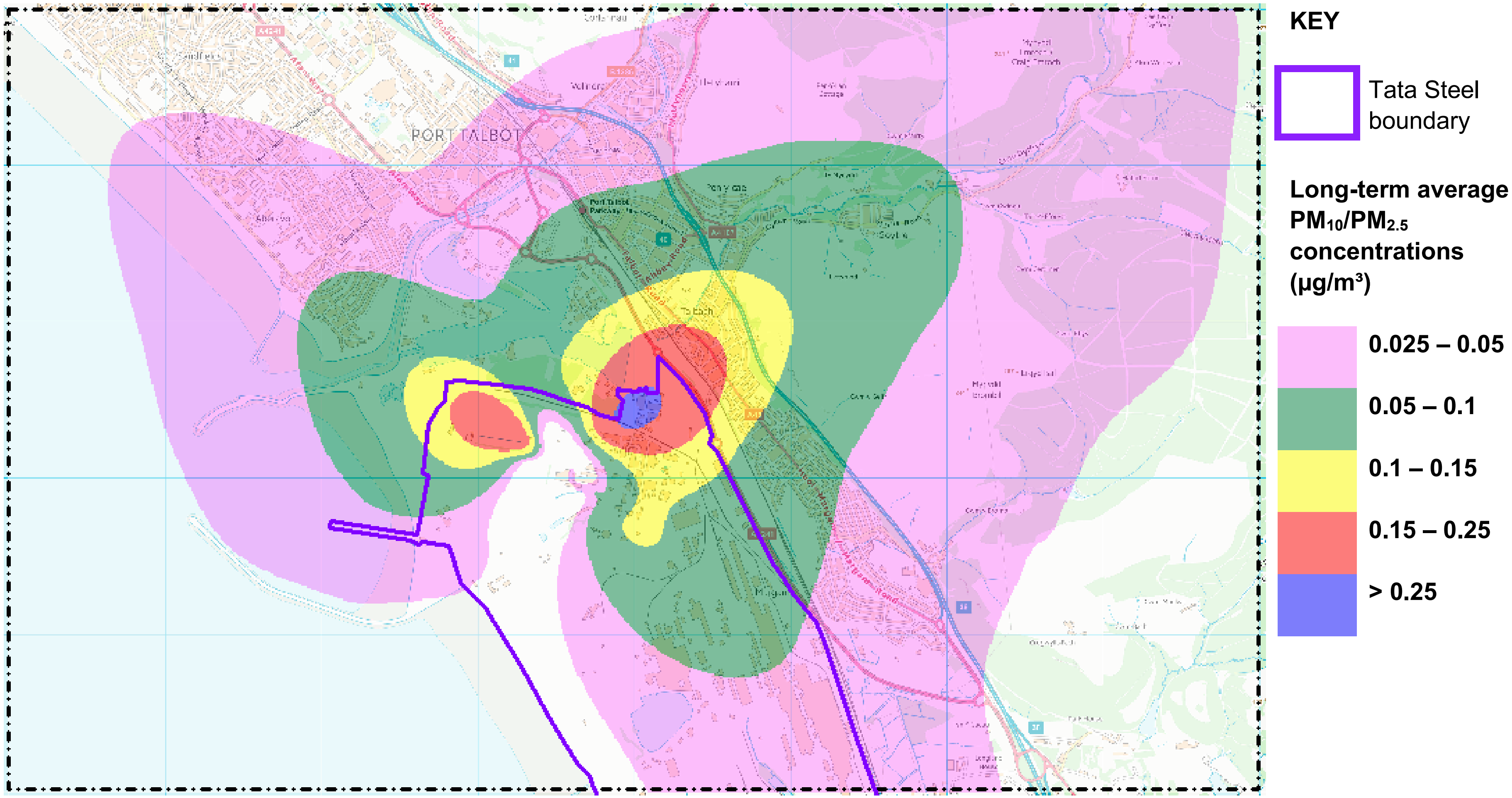


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Figure A3.3: Process Contribution to long-term average concentrations (proposed new stack, 2012 – 2016 meteorological data)

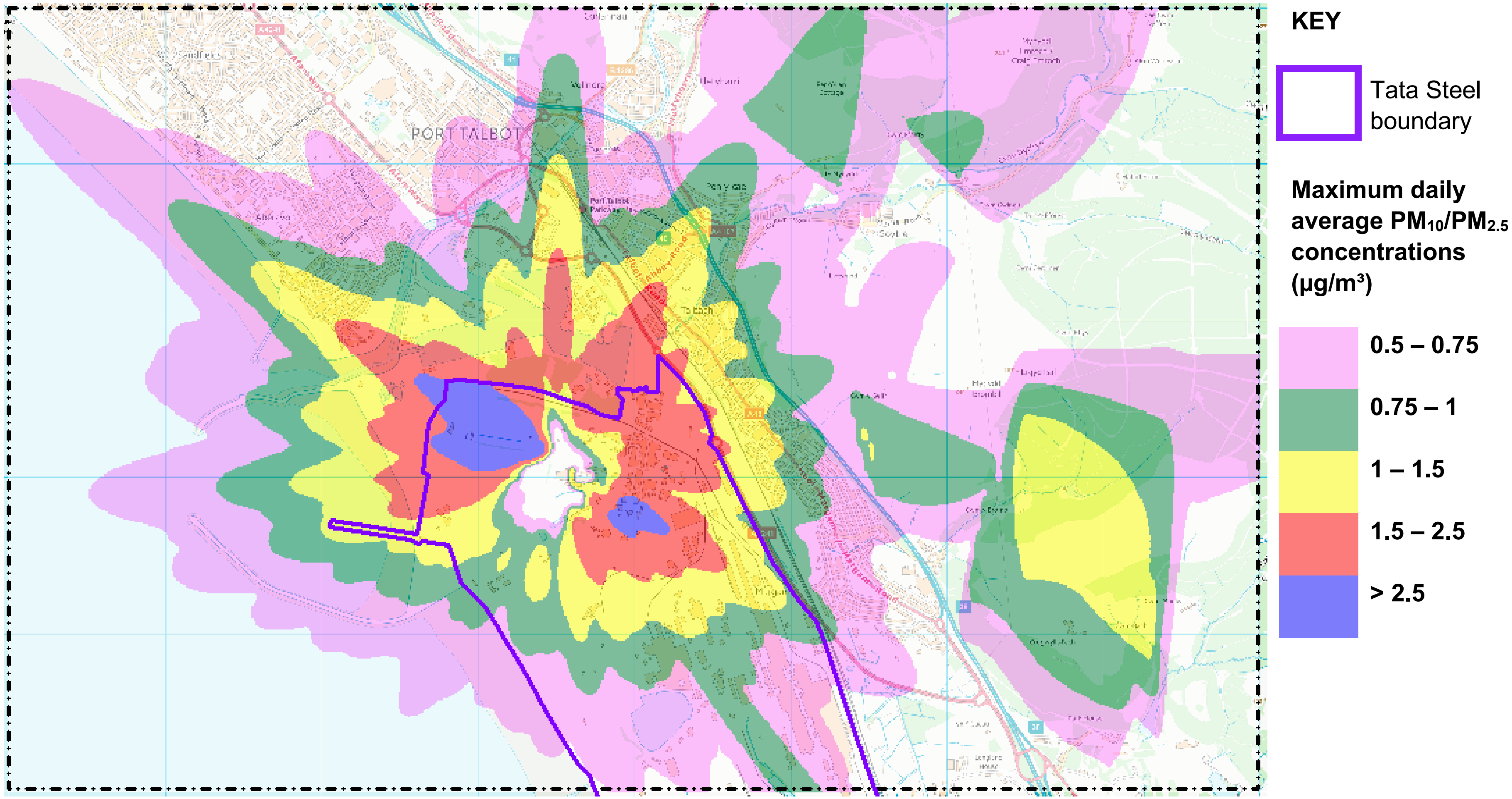

Figure A3.4: Maximum daily average concentrations (proposed new stack, 2012 – 2016 meteorological data)