BIOGEN

BARRY GASIFICATION PLANT – DETAILED MODELLING

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SECTION 1

INTRODUCTION

1 INTRODUCTION

1.1.1 This report provides a detailed description of the Air Quality Assessment carried out in support of the Environmental Statement for the proposed Gasification Facility, Barry Docks, Vale of Glamorgan.

1.1.2 This report includes the following assessments:

- Pollutant concentrations due to process emissions;
- Determination of appropriate stack height;
- Nitrogen deposition for sensitive ecosystems; and
- Health risk assessment for dioxins

SECTION 2

ASSESSMENT METHODOLOGY

2 ASSESSMENT METHODOLOGY

2.1 Overview

2.1.1 The assessment uses the 'new generation' gaussian dispersion model ADMS (v4). This model has been sufficiently well validated[1] over a range of dispersion conditions to allow its use in modelling dispersion from the proposed facility.

2.1.2 The methodology used in the dispersion modelling follows the guidance of the Environment Agency (EA) as outlined in Appendix E of the Integrated Pollution Prevention and Control (IPPC) Horizontal Guidance Note H1[2]. This is considered to be an example of best practice in dispersion modelling. Model input parameters and set up details are provided in the following sections.

2.2 Location

2.2.1 The study area is shown in Figure 1-1. The site is currently disused and is situated at National Grid Reference 312810,167260 on Atlantic Way, within Barry Docks.

2.2.2 Surrounding land use comprises mixed industrial activities, including waste management activities (scrap yards, waste segregation, and landfill) and bulk materials storage and handling (including stockpiles of sand and other aggregates) and small industrial units.

2.2.3 Table 2-1 gives details of the sensitive receptors identified close to the site. The closest residential receptor is located over 500m north-east of the site. The town of Barry is approximately 800m to the north-west. The closest ecological receptor is approximately 300m south-west of the site.

Table 2-1 Receptors in the vicinity of the proposed facility

Receptor	Location	Height (m)	Distance to proposed facility (m)
Hayes Lane	313724,167300	1.5	955
Hayes Point hospital	314004,167398	1.5	1246
Bendrick Road	313410,167478	1.5	695
Hayes Road	313638,167674	1.5	987
Southleigh home	314905,168078	1.5	2306
Dock View Road	312397,167944	1.5	839
Dyfrig Street	312109,166908	1.5	725
Children's hospice	314331,167685	1.5	1631

[1] Cambridge Environmental Research Consultants, ADMS User Guide
[2] IPPC Horizontal Guidance Note, Environment Agency, Environmental Assessment and Appraisal of BAT, July 2003

Receptor	Location	Height (m)	Distance to proposed facility (m)
Bendrick Rock SSSI	313076, 167166	0	302
Barry Island SSSI	312226, 166870	0	944

2.3 Modelled domain/receptors

2.3.1 Ground level pollutant concentrations have been modelled over the domain, at a resolution of 50m out to 3 km, this is within the EAs recommended minimum grid spacing of 1.5 times the stack height (67.5m). A stack height of 45m metres has been used for the base case assessments based on a stack height determination assessment, details of which can be found in Section 3.5.

2.4 Assessment Pollutants

2.4.1 Part IV of the Environment Act 1995 required the Government to develop a National Air Quality Strategy (AQS) containing standards and objectives for ambient pollutant concentrations, and measures in order to achieve these objectives. The AQS published in 1997 and subsequently revised in 2000, 2003 and 2007[3] satisfies these requirements. The standards and objectives for air quality relating to the protection of human health are contained in the Air Quality Regulations. The objectives are set out in Table 2-2. In addition, the requirements of the EU 1996 Air Quality Framework Directive and subsequent Daughter Directives have been transcribed into UK law via the Air Quality Limit Values Regulations. These regulations place the Secretary of State under a duty to ensure that air quality limit values are not exceeded within specified zones by relevant dates. Where there is risk of limit values being exceeded, the Secretary of State is required to draw up and implement an action plan to ensure limit values will be met by the dates specified in the Directive.

2.4.2 Under Part III of the Environmental Protection Act (1990), Local Authorities have regulatory powers to control Statutory Nuisance, which can include emissions (including dust and odours) from construction activities. However, there are no UK legislated standards or objectives relating to dust deposition rates or dust nuisance and therefore the potential impacts of the facility have been assessed qualitatively.

[3] Department for Environment, Food and Rural Affairs in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland, 2007,The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 1).

Table 2-2 Air quality objectives and EU limit values for the protection of human health relevant to the assessment of the Barry Gasification Plant

Pollutant	AQS Objective	EU Limit Value	Measured as	To be Achieved by
Carbon Monoxide	10 mg/m^3	-	Max daily running 8hr mean	31/12/2003
	-	10 mg/m^3	Max daily running 8hr mean	01/01/2005
Nitrogen Dioxide	200 µg/m^3	-	1 hr mean; not to be exceeded more than 18 times per year	31/12/2005
	40 µg/m^3	-	Annual mean	31/12/2005
		200 µg/m^3	1 hr mean; not to be exceeded more than 18 times per year	01/01/2010
	-	40 µg/m^3	Annual mean	01/01/2010
Particulate Matter (PM_{10})	50 µg/m^3	-	24 hr mean not to be exceeded more than 35 times per year	31/12/2004
	40 µg/m^3	-	Annual mean	31/12/2004
	-	50 µg/m^3	24 hr mean not to be exceeded more than 35 times per year	01/01/2005
	-	40 µg/m^3	Annual mean	01/01/2005
Sulphur Dioxide	266 µg/m^3	-	15 minute mean	31/12/2005
	350 µg/m^3	-	1 hr mean; not to be exceeded more than 24 times a year	31/12/2004
	125 µg/m^3	-	24 hr mean; not to be exceeded more than 3 times a year	31/12/2004
	-	350 µg/m^3	1 hr mean; not to be exceeded more than 24 times a year	01/01/2005
	-	125 µg/m^3	24 hr mean; not to be exceeded more than 3 times a year	01/01/2005

2.4.3 Most of the AQS objectives have been set to protect human health. However, national objectives for nitrogen oxides (NOx) and sulphur dioxide (SO_2) have also been specified for the protection of vegetation and ecosystems. Whilst these AQS objectives have not been included in the Air Quality Regulations, the objectives are numerically equivalent to mandatory EU limit values which are included in the Air Quality Limit Values Regulations. The objectives/limit values apply to locations more than 20 km from towns with more than 250,000 inhabitants, or more than 5 km from other built-up areas, industrial installations or motorways. As monitoring sites are required to be representative of an area of 1000km^2, the limits do not have a statutory basis in micro-scale environments such as those close to a road. However, the Statutory Nature Conservation Agencies' (in Wales, Countryside Council for Wales) policy is to apply the limit values, on a precautionary basis, as a benchmark in internationally designated conservation sites and Sites of Special Scientific Interest

(SSSI). Table 2-3 provides details of the objectives/limit values for the protection of vegetation and ecosystems relevant to this assessment.

Table 2-3 Air quality objectives and EU limit values for the protection of vegetation and ecosystems relevant to the assessment of the Barry Gasification Facility

Pollutant	AQS Objective	EU Limit Value	Measured as	To be Achieved by
Nitrogen Oxides	30 µg/m^3	-	Annual mean	31/12/2000
	-	30 µg/m^3	Annual mean	19/07/2001
Sulphur Dioxide	20 µg/m^3	-	Annual mean	31/12/2000
	20 µg/m^3	-	Winter average	31/12/2000
	-	20 µg/m^3	Annual mean	19/07/2001
	-	20 µg/m^3	Winter average	19/07/2001

2.4.4 There are no UK legislated standards or objectives for nitrogen deposition and, therefore, the potential impacts of the Gasification Facility must be assessed against empirical critical loads for nitrogen set by the UNECE in 2003. The relevant critical loads shown in Table 2-4 were obtained from the Air Pollution Information System (APIS).

Table 2-4 Critical loads for nitrogen associated with sensitive ecosystems and resources within the study area

Ecosystem type found within study area	Name of site featuring ecosystem	Critical load kg N ha^{-1} year^{-1}
Shingle rocks and cliffs	Barry Island, Hays Point to Bendrick Rock	10-15

2.4.5 The design and operation of the Facility shall be governed by the Waste Incineration Directive (WID)[4]. The WID includes Emission Limit Values (ELVs) for a range of pollutants emitted during the waste incineration process. The assessment criteria are the same as those set out in the UK AQS where available. However, there are a number of pollutants which are not covered in the AQS but which require stringent emission standards. Table 2-5 shows the relevant non-AQS pollutants covered in WID and the corresponding health criteria from the Workplace Exposure Levels (WELs).

[4] European Council Directive (2000/76/EC) on the incineration of waste.

Table 2-5 Workplace Exposure Levels (WELs) for pollutants not covered by the National Air Quality Strategy.

Pollutant	Annual Mean (ug/m3)	1 hour Maximum (ug/m3)
HCL	20	800
HF	-	250
Cadmium	0.005	1.5
Thallium	1	30
Mercury	0.25	7.5
Antimony	5	150
Arsenic	0.006	15
Chromium	0.1	3
Cobalt	0.2	6
Copper	2	60
Manganese	1 (24 hour max)	1500
Nickel	0.02	30
Vanadium	5	1 (24 hour max)
Dioxins and Furans	None	None

2.5 Background Levels

2.5.1 Under the requirements of LAQM, Vale of Glamorgan Council have carried out air quality monitoring and reported on conditions in accordance with the timetable set out in the Environment Act 1995. To date, the council have not declared any Air Quality Management Areas (AQMAs) within 10km of the site. Table 2-6 shows nitrogen dioxide concentrations from diffusion tubes located in Barry. It should be noted that measured conditions are below the objectives set out in the AQS.

Table 2-6 Barry NO_2 diffusion tube data (bias adjusted)

Location	Easting	Northing	Type	Distance from site (m)	Annual Mean (ug/m^3)		
					2004	2005	2006
Gladstone Road	311797	168503	Roadside	1604	28	29	30
St Teilo Avenue	311464	168852	Background	2085	14	14	13
Gwenog Court	310475	168457	Background	2624	14	14	14
Port Road	310813	169691	Roadside	3146	21	21	23

2.5.2 With respect to NO_2 there are no suitable monitoring locations, either continuous or passive, which provide a suitable background concentration at the proposed site. Therefore, to estimate background concentrations of NO_2, the National Air Quality Information Archive (NAQIA) 1km mapped data for 2004 have been taken and projected forward to future years (Table 2-7). Background concentrations have also been obtained for NOx, PM_{10} and CO.

Table 2-7 NAQIA Background Concentrations

Year	NOx (ug/m^3)	NO_2 (ug/m^3)	PM_{10} (ug/m^3)	CO (ug/m^3)	Benzene (ug/m^3)	1,3 Butadiene (ug/m^3)
2004	19.4	16.1	16.5	0.125	0.107	0.045
2007	17.3	15.1	15.8	0.097	0.094	0.035
2010	15.4	12.1	15.3	0.085	0.089	0.030

2.5.3 SO_2 background concentrations have been obtained from the nearest AURN site at Cardiff Centre and are given in Table 2-8.

Table 2-8 Background concentrations of SO_2 for 2007 obtained from the AURN

Location	Easting	Northing	Distance from site (m)	Annual mean (µg/m^3)
Cardiff Centre	318415	176503	10883	2.79

2.5.4 The background concentrations for metals assessed in this study have been taken as the 2007 annual average over the UK monitoring network (16 sites). Table 2-9 shows these concentrations.

Table 2-9 Background metal concentrations

Pollutant	2007 (ng/m3)
Arsenic	0.925958
Cadmium	0.396484
Chromium	4.872334
Copper	17.50639
Manganese	8.094257
Nickel	3.782168
Vanadium	2.251424
Mercury	0.435187

2.5.5 Background nitrogen deposition was derived from data provided by the Air Pollution Information System (APIS). The data represent the average total deposition within a 5km square and include an area averaged contribution from roads. Deposition close to roads will be higher than this average, whereas at distances more than 200m from major roads, the deposition rate may be lower.

2.5.6 The APIS data were extracted from the region 313000,167000 to 318000,172000 as the average of 2003 to 2005, assumed to be representative of conditions in the year 2004. Following the advice in DMRB, the deposition was reduced by 2% (straight line reduction) per year for extrapolation to 2007.

2.5.7 The background deposition rate was calculated following the methodology set out in DMRB. Table 2-10 shows the background deposition rate used in the assessment for the sensitive ecosystems.

Table 2-10 Background nitrogen deposition (kg N/ha/yr) used in the assessment of impacts.

Year	Sensitive Ecosystem	5km average Nitrogen Deposition (from APIS)
2004	Barry Island and Bendrick Rock	12.9
2007	Barry Island and Bendrick Rock	12.1

2.5.8 Following the guidance in IPPC H1 and LAQM TG(03), the background concentration used in assessing short term effects is assumed to be twice the annual mean concentration.

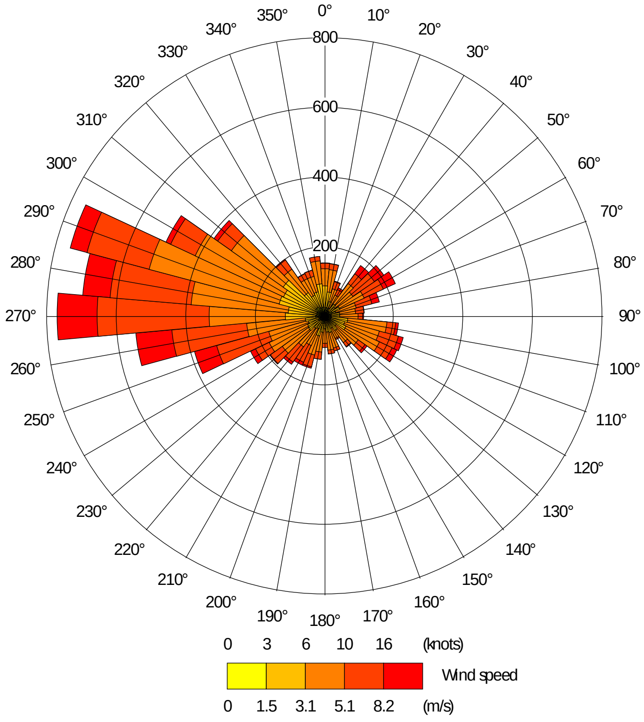
2.5.9 Background pollutant concentrations are not available for some of the pollutants assessed in this study. However, since the available background concentrations are well below the objectives and there are no other significant sources of pollution close by, it is assumed that background concentrations for all other pollutants are also well below the relevant objectives and EALs.

2.6 Meteorology/surface characteristics

2.6.1 Meteorological data were taken from the station at Cardiff Airport (Rhoose), approximately 12.5 km to the west of the site (Diagram 1). This is considered to be the most appropriate station to represent meteorological conditions at the proposed site. The base case for the modelling used hourly sequential data from 2004, with the inter-annual variability assessed by undertaking sensitivity tests using similar data for 2003 to 2007. 2004 was used as the base case since it represented the worst of the 5 available meteorological years in terms of dispersion of air pollutants. This ensures a conservative assessment. Inter-annual variability is discussed further in Section 3.1.

2.6.2 The roughness length was set to 0.75m for the model runs to represent the open industrial area of the site. The surface albedo and Priestly-Taylor parameter were unchanged from the model defaults, 0.23 and 1 respectively.

Diagram 1 Cardiff Airport wind rose for 2004.



2.7 Stack parameters

2.7.1 The stack parameters shown in Table 2-11 have been calculated from information provided by BioGen and ENERGOS (the Gasification Facility manufacturers). Table 2-12 shows emission rates which have been derived from WID limits under normal operating conditions. By using the WID limits for plant emissions, the process contribution to pollutant concentrations from a fully WID compliant facility will be overestimated. This is a measure which ensures a conservative assessment.

Table 2-11 Model input parameters

	Location		Stack Height (m)	Internal Diameter (m)	Exit Temperature(^{o}C)	Efflux Velocity (m/s)
	X	Y				
Stack	312775	167195	45	1.04	130	13.03

Table 2-12 Emissions from the proposed plant, derived from WID limits

Pollutant	WID Daily Emissions Limit Value ($\mu g/m^3$)	Emission Rate (g/s) at WID Limit Value
Dust (assumed to be PM_{10})	10	0.1845
Total Organic Carbon	10	0.1845
Hydrogen Chloride	10	0.1845
Hydrogen Fluoride	1	0.01845
Sulphur Dioxide	50	0.9225
NOx as NO_2	200	3.69
CO	50	0.9225
Group 1 Metals (total of)	0.5	0.001025
Mercury (Group 2 Metals)	0.05	0.0009225
Cadmium & Thallium (Group 3)	0.05	0.00046125
Dioxins and Furans	0.00000001	1.845×10^{-8}

2.8 Assessment of significance

2.8.1 There are no universally accepted criteria for assessing the significance of air quality impacts. In general, a comparison is simply made between the predicted concentration and the relevant Air Quality Objective or EU Limit Value. In this assessment it is considered appropriate to specify significance criteria.

2.8.2 Environmental Protection UK (formerly the National Society for Clean Air, NSCA) has proposed the significance criteria given in Table 2-13. The impacts of the facility have been assessed against these where appropriate.

Table 2-13 NSCA Significance Criteria

Change / Concentration	<1%	1-5%	5-10%	10-15%	15-25%	>25%
Above objective without scheme	Minor adverse	Minor adverse	Substantial adverse	Substantial adverse	Very substantial adverse	Very substantial adverse
Below objective without scheme, above with scheme	Minor adverse	Moderate adverse	Substantial adverse	Substantial adverse	Very substantial adverse	Very substantial adverse
Below objective with scheme	Negligible	Minor adverse	Minor adverse	Moderate adverse	Moderate adverse	Substantial adverse
Well below objective with scheme	Negligible	Negligible	Minor adverse	Minor adverse	Minor adverse	Moderate adverse

2.9 Terrain

2.9.1 Topographical features can have a significant effect on the dispersion of pollutants. A gradient that exceeds 1:10 would need to be allowed for in the model. However, due to the relatively flat terrain of the proposed site, topographic effects were not included.

2.10 Buildings

2.10.1 The proposed gasification plant will be located within a building approximately 79m by 53m, and 20m at the apex of the roof. Turbulent wakes can form in the lee of buildings, and recirculation zones can form on the sides and roofs. These flow features can result in the trapping, and rapid mixing of pollutants down to ground level from initially elevated plumes. For stacks taller than 2.5 times the building height, downwash effects are not significant. For lower stacks, located close to the building, there is an increasing likelihood that plume material will be caught within the recirculation zones.

2.10.2 ADMS includes a buildings module for modelling downwash effects. The proposed incinerator stack is less than 2.5 times the building height and, therefore, the building has been included in the modelling. Table 2-14 shows the building parameters of the plant. There are no other significant buildings on site.

Table 2-14 Building parameters

X	Y	Height (m)	Length (m)	Width(m)	Angle the building length makes with north (°)
312800	167230	20	79	53	38

2.11 NOx to NO_2 chemistry

2.11.1 The majority of NO_x emissions from combustion sources occur as NO; generally less than 10% are direct NO_2. The NO is oxidised in air to form NO_2. Following EA guidance[5], the short term concentration of NO_2 has been based on 50% conversion from NO_x, including the original 10% direct NO_2. The long term concentration of NO_2 has been taken from 100% conversion of NO_x. These are conservative assumptions.

[5] http://www.environment-agency.gov.uk/commondata/acrobat/noxno2conv2005_1233043.pdf

SECTION 3

RESULTS

3 RESULTS

3.1 Determination of the worst case meteorological year

3.1.1 The worst case meteorological year was determined from the maximum long and short term nitrogen dioxide concentrations from the Barry Plant. The available years of meteorological data for Cardiff Airport were 2003 to 2007. Table 3-1 shows the inter-annual variability.

Table 3-1 Determination of the worst case meteorological year

Year	Maximum annual mean NO_2 (µg/m^3)	Maximum 99.79th percentile of 1 hour mean NO_2 (µg/m^3)
2003	4.1	19
2004	5.1	19.2
2005	4.5	17.8
2006	4.8	19.5
2007	4.5	18.9

3.1.2 The predicted ground level concentrations show that for annual mean NO_2, the 2004 meteorological data results in the highest concentration. The 2005 data results in the highest short term NO_2 concentration with 2004 producing the second highest concentration. The 2004 meteorological data has therefore been used to predict the impacts of the proposed facility.

3.2 Pollutant concentrations

3.2.1 The process contribution (PC) to ground level concentrations at the specific receptors are presented in Table 3-2 to Table 3-11. Figures 3-1 to 3-7 show the predicted ground level concentrations for the AQS pollutants over various averaging periods.

Table 3-2 Modelled Process Contribution (PC) to annual mean and 1 Hour mean nitrogen dioxide concentrations at the specific receptors

Receptor	Annual mean NO_2 (µg/m^3)	% of AQS objective (40µg/m^3)	99.79th percentile of 1 hour mean NO_2 (µg/m^3)	% of AQS objective (200µg/m^3)
Hayes Lane	1.21	3.02	5.39	2.69
Hayes Hospital	0.76	1.90	4.06	2.03
Bendrick Road	1.19	2.96	7.55	3.77
Hayes Road	0.61	1.53	5.19	2.60

Southleigh home	0.19	0.48	2.02	1.01
Dock View Rd	0.27	0.67	5.88	2.94
Dyfrig Street	0.48	1.20	7.22	3.61
Childrens hospice	0.40	0.99	2.88	1.44

3.2.2 The maximum annual mean nitrogen dioxide concentration over all of the specific receptors is approximately 3% of the objective. For short term nitrogen dioxide concentrations, the process contribution to concentrations at the receptors is less than 3.8% of the objective. Since background concentrations are well below the objectives, these are considered to be negligible impacts.

Table 3-3 Modelled Process Contribution (PC) to annual mean and 24 hour mean Particulate Matter (PM_{10}) concentrations at the specific receptors

Receptor	Annual mean PM_{10} (µg/m^3)	% of AQS objective (40µg/m^3)	90.41st percentile of 24 hour mean PM_{10} (µg/m^3)	% of AQS objective (50µg/m^3)
Hayes Lane	0.06	0.15	0.16	0.32
Hayes Hospital	0.04	0.09	0.10	0.20
Bendrick Road	0.06	0.15	0.17	0.35
Hayes Road	0.03	0.08	0.09	0.17
Southleigh home	0.01	0.02	0.03	0.06
Dock View Rd	0.01	0.03	0.05	0.09
Dyfrig Street	0.02	0.06	0.08	0.15
Childrens hospice	0.02	0.05	0.06	0.11

3.2.3 PM_{10} concentrations, over all averaging periods are well below 1% of the relevant objectives at all of the specific receptors. Since background particulate concentrations are well below the objectives, this is considered to be a negligible impact.

Table 3-4 Modelled Process Contribution (PC) to short term Sulphur Dioxide (SO_2) concentrations at the specified receptors

Receptor	99.9th percentile of 15 minute mean SO_2 (µg/m^3)	% of AQS objective (266µg/m^3)	99.73rd percentile of 1 hour mean SO_2 (µg/m^3)	% of AQS objective (350µg/m^3)	99.2nd percentile of 24 hour mean SO_2 (µg/m^3)	% of AQS objective (125µg/m^3)
Hayes Lane	3.61	1.36	2.65	0.76	1.29	1.03
Hayes Hospital	2.72	1.02	1.94	0.55	0.88	0.70
Bendrick Road	5.06	1.90	3.64	1.04	1.48	1.18
Hayes Road	3.48	1.31	2.60	0.74	0.87	0.70
Southleigh home	1.35	0.51	0.90	0.26	0.26	0.21
Dock View Rd	3.94	1.48	2.79	0.80	0.81	0.65
Dyfrig Street	4.84	1.82	3.55	1.01	1.47	1.17
Childrens hospice	1.93	0.73	1.33	0.38	0.48	0.38

3.2.4 For all short term averaging periods, concentrations of SO_2 at the specific receptors are well below the AQS objective. Daily average concentrations are less than 1.2% of the objective, hourly averaged concentrations are up to 1% and 15 minute averaged concentrations are below 2% of the objective. Since background concentrations are well below the relevant objectives, these are deemed to be negligible impacts.

Table 3-5 Modelled Process Contribution (PC) to long term (annual) averaged Sulphur Dioxide (SO_2) concentrations at the specified receptors

Receptor	Annual mean SO_2 (µg/m^3)	% of AQS objective (20µg/m^3)
Hayes Lane	0.30	1.51
Hayes Hospital	0.19	0.95
Bendrick Road	0.30	1.48
Hayes Road	0.15	0.76
Southleigh home	0.05	0.24
Dock View Rd	0.07	0.33
Dyfrig Street	0.12	0.60
Childrens hospice	0.10	0.50

3.2.5 The maximum annual averaged SO_2 concentration, across all specific receptors, is 1.5% of the objective. Given the low background concentrations, this impact is considered negligible.

Table 3-6 Modelled Process Contribution (PC) to Carbon Monoxide (CO) concentrations at the specific receptors

Receptor	8 hour running mean CO (µg/m^3)	% of AQS objective (10mg/m^3)
Hayes Lane	0.30	0.0030
Hayes Hospital	0.19	0.0019
Bendrick Road	0.30	0.0030
Hayes Road	0.15	0.0015
Southleigh home	0.05	0.0005
Dock View Rd	0.07	0.0007
Dyfrig Street	0.12	0.0012
Childrens hospice	0.10	0.0010

3.2.6 The process contribution to carbon monoxide concentrations at the specific receptors is well below 1% of the objective and can be considered a negligible impact, based on the low background concentrations.

Table 3-7 Modelled Process Contribution (PC) to Hydrogen Chloride (HCL) concentrations at the specific receptors

Receptor	Annual mean HCL (µg/m^3)	% of Long Term EAL (20µg/m^3)	100th percentile of 1 hour mean HCL (µg/m^3)	% of hourly EAL (800µg/m^3)
Hayes Lane	3.4E-04	0.0017	0.62	0.08
Hayes Hospital	2.1E-04	0.0011	0.49	0.06
Bendrick Road	3.3E-04	0.0016	0.85	0.11
Hayes Road	1.7E-04	0.0008	0.63	0.08
Southleigh home	5.4E-05	0.0003	0.28	0.03
Dock View Rd	7.4E-05	0.0004	0.67	0.08
Dyfrig Street	1.3E-04	0.0007	0.84	0.11
Childrens hospice	1.1E-04	0.0006	0.37	0.05

3.2.7 The process contribution to hydrogen chloride concentrations is below 0.01% of the EAL at all specified receptors over all averaging periods. This is considered to be a negligible impact.

Table 3-8 Modelled Process Contribution (PC) to Hydrogen Fluoride (HF) concentrations at the specific receptors

Receptor	Annual mean HF ($\mu g/m^3$)	100^{th} percentile of 1 hour mean HF ($\mu g/m^3$)	% of hourly EAL ($250\mu g/m^3$)
Hayes Lane	3.4E-04	0.06	0.02
Hayes Hospital	2.1E-04	0.05	0.02
Bendrick Road	3.3E-04	0.08	0.03
Hayes Road	1.7E-04	0.06	0.03
Southleigh home	5.4E-05	0.03	0.01
Dock View Rd	7.4E-05	0.07	0.03
Dyfrig Street	1.3E-04	0.08	0.03
Childrens hospice	1.1E-04	0.04	0.01

3.2.8 There is no EAL for annual mean HF concentrations against which the impacts of the facility can be assessed. The process contribution to concentrations of HF at the specific receptors over a 1 hour averaging period is deemed to be negligible since the maximum is less than 0.1% of the relevant EAL. It is therefore assumed that since the short term mean is well below the EAL, the annual mean will also be negligible.

Table 3-9 Modelled Process Contribution (PC) to annual mean concentrations of non-AQS metals at the specified receptors

Receptor	Cadmium (µg/m^3)	Thallium (µg/m^3)	Mercury (µg/m^3)	Antimony (µg/m^3)	Arsenic (µg/m^3)	Chromium (µg/m^3)	Cobalt (µg/m^3)	Copper (µg/m^3)	Nickel (µg/m^3)	Vanadium (µg/m^3)
Hayes Lane	1.5E-04	1.5E-04	3.0E-04	3.4E-04	3.4E-04	3.4E-04	3.4E-04	3.4E-04	3.4E-04	3.4E-04
Hayes Hospital	9.5E-05	9.5E-05	1.9E-04	2.1E-04	2.1E-04	2.1E-04	2.1E-04	2.1E-04	2.1E-04	2.1E-04
Bendrick Road	1.5E-04	1.5E-04	3.0E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04	3.3E-04
Hayes Road	7.6E-05	7.6E-05	1.5E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04	1.7E-04
Southleigh home	2.4E-05	2.4E-05	4.8E-05	5.4E-05	5.4E-05	5.4E-05	5.4E-05	5.4E-05	5.4E-05	5.4E-05
Dock View Rd	3.3E-05	3.3E-05	6.7E-05	7.4E-05	7.4E-05	7.4E-05	7.4E-05	7.4E-05	7.4E-05	7.4E-05
Dyfrig Street	6.0E-05	6.0E-05	1.2E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04
Childrens hospice	5.0E-05	5.0E-05	9.9E-05	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04

3.2.9 The maximum process contribution to annual mean concentrations of non-AQS metals at the specific receptors is 3% of the relevant EAL. Since background concentrations are well below the EALs, this is considered to be a negligible impact.

Table 3-10 Modelled Process Contribution (PC) to 100th percentile of 1 hour mean concentrations of non-AQS metals at the specified receptors

Receptor	Cadmium (µg/m^3)	Thallium (µg/m^3)	Mercury (µg/m^3)	Antimony (µg/m^3)	Arsenic (µg/m^3)	Chromium (µg/m^3)	Cobalt (µg/m^3)	Copper (µg/m^3)	Manganese (µg/m^3)	Nickel (µg/m^3)
Hayes Lane	1.6E-03	1.6E-03	3.1E-03	3.4E-03	3.4E-03	3.4E-03	3.4E-03	3.4E-03	3.4E-03	3.4E-03
Hayes Hospital	1.2E-03	1.2E-03	2.4E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03	2.7E-03
Bendrick Road	2.1E-03	2.1E-03	4.2E-03	4.7E-03	4.7E-03	4.7E-03	4.7E-03	4.7E-03	4.7E-03	4.7E-03
Hayes Road	1.6E-03	1.6E-03	3.2E-03	3.5E-03	3.5E-03	3.5E-03	3.5E-03	3.5E-03	3.5E-03	3.5E-03
Southleigh home	6.9E-04	6.9E-04	1.4E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03
Dock View Rd	1.7E-03	1.7E-03	3.3E-03	3.7E-03	3.7E-03	3.7E-03	3.7E-03	3.7E-03	3.7E-03	3.7E-03
Dyfrig Street	2.1E-03	2.1E-03	4.2E-03	4.7E-03	4.7E-03	4.7E-03	4.7E-03	4.7E-03	4.7E-03	4.7E-03
Childrens hospice	9.3E-04	9.3E-04	1.9E-03	2.1E-03	2.1E-03	2.1E-03	2.1E-03	2.1E-03	2.1E-03	2.1E-03

3.2.10 The process contribution to hourly mean concentrations of the non-AQS metals at the specific receptors is less than 0.2% of the relevant EAL for all pollutants. Since background concentrations are well below the EALs, this is considered to be a negligible impact.

Table 3-11 Modelled Process Contribution (PC) to 100th percentile of 24 hour mean concentrations of non-AQS metals at the specified receptors

Receptor	Manganese (µg/m^3)	Vanadium (µg/m^3)
Hayes Lane	1.6E-03	1.6E-03
Hayes Hospital	1.1E-03	1.1E-03
Bendrick Road	2.6E-03	2.6E-03
Hayes Road	1.4E-03	1.4E-03
Southleigh home	4.8E-04	4.8E-04
Dock View Rd	1.3E-03	1.3E-03
Dyfrig Street	2.3E-03	2.3E-03
Childrens hospice	7.1E-04	7.1E-04

3.2.11 The process contribution to daily mean concentrations of the non-AQS metals at the specific receptors is less than 0.3% of the relevant EAL for both pollutants. Since background concentrations are well below the EALs, this is considered to be a negligible impact.

3.3 Health Risk Assessment

3.3.1 The EU Waste Incineration Directive (WID) requires new incinerators to meet certain standards for emissions to air. These limits are primarily set for the protection of human health. This assessment has used the WID Emissions Limit Values (ELVs) for dioxin emissions from the proposed facility and dispersion modelling to derive a concentration of dioxins in air. This represents a worst case scenario, where the emissions from the incinerator are set to the ELV. In reality, the incinerator will fully comply with the ELVs and so emissions would be no greater than this and the true concentrations could be smaller. Concentrations were calculated on a regular grid as well as at specific receptors given in Table 2-1.

3.3.2 The methodology outlined in the HMIP (Her Majesty's Inspectorate of Pollution) commissioned document on health risk from dioxins[6] has been used to calculate a total daily intake of dioxins for a range of human receptors; adult residents, child residents, infants, subsistence farmers and children of subsistence farmers via numerous pathways.

3.3.3 Dioxins accumulate in fatty foods due to their lipophilic properties and therefore over 90% of human background exposure to dioxins is estimated to come from the diet with animal products being the dominant source[7]. Direct inhalation and ingestion of soil, water and plants provide a relatively smaller contribution to total intake of dioxins. Although there are no drinking water supplies nearby and no subsistence fishermen

[6] ERM, 1996, Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes, HMIP/CPR2/41/1/181.
[7] World Health Organization, 1998, Assessment of the health risk of dioxins: re-evaluation of the Tolerable Daily Intake (TDI), WHO Consultation, May 25-29, Geneva, Switzerland, http://www.who.int/ipcs/publications/en/exe-sum-final.pdf.

living in the area, the fish and drinking water pathways were still included in the assessment to provide a worst case scenario.

3.3.4 The results at the specific receptors (Table 3-12) show that for the worst case exposure scenario of a subsistence farmer and child of subsistence farmer, the total intake of dioxins does not exceed the World Health Organization (WHO) recommended Tolerable Daily Intake (TDI) of 1-4 pg/kg-bw/day. The total daily intake for an infant is expected to be 1-2 orders of magnitude greater than that of an adult[6], based on a 'per kilogramme' amount. This is, however, only sustained for a very short period of the individuals' life.

Table 3-12 Modelled concentrations and resulting total daily intake of dioxins (Process Contribution) for receptors close to the proposed facility

Receptor	Concentration (μg/m^3)	Total Daily Intake (pg/kg-bw/day)				
		Adult	Child	Infant	Subsistence farmer	Child of subsistence farmer
Hayes Lane	6.0E-09	1.1E-01	2.2E-01	7.8E+00	7.9E-01	1.5E+00
Hayes hospital	3.8E-09	7.1E-02	1.4E-01	4.9E+00	5.0E-01	9.5E-01
Bendrick Road	5.9E-09	1.1E-01	2.2E-01	7.6E+00	7.8E-01	1.5E+00
Hayes Road	3.1E-09	5.7E-02	1.1E-01	3.9E+00	4.0E-01	7.7E-01
Southleigh	9.7E-10	1.8E-02	3.5E-02	1.2E+00	1.3E-01	2.4E-01
Dock View	1.3E-09	2.51E-02	4.86E-02	1.72E+00	1.76E-01	3.37E-01
Dyfrig	2.4E-09	4.5E-02	8.7E-02	3.1E+00	3.1E-01	6.0E-01
Hospice	2.0E-09	3.7E-02	7.2E-02	2.5E+00	2.6E-01	5.0E-01

3.3.5 The maximum on site total intake for the gridded receptors was found to be above the WHO recommended TDI. However, this intake is based on the maximum concentration close to the incinerator where no human receptors would be living or farming the land. It is therefore not a realistic result for human exposure.

3.4 Nitrogen deposition and NOx concentrations

3.4.1 A prediction of nitrogen deposition on sensitive ecosystems has been carried out using relevant HA draft guidance (Table 3-13). Barry Island and Hayes Point to Bendrick Rock are nearby sites designated for their ecological importance.

Table 3-13 Concentrations of nitrogen oxides (NOx) and nitrogen deposition for nearby sensitive ecosystems

Receptor	NOx concentration (μg/m^3)	% of AQS objective (30μg/m^3)	Nitrogen deposition (kg N /ha /yr)	% of critical load

Bendrick Rock	3.99	13.3	0.2	1.3-2.0
Barry Island	0.36	1.2	0.04	0.3-0.4

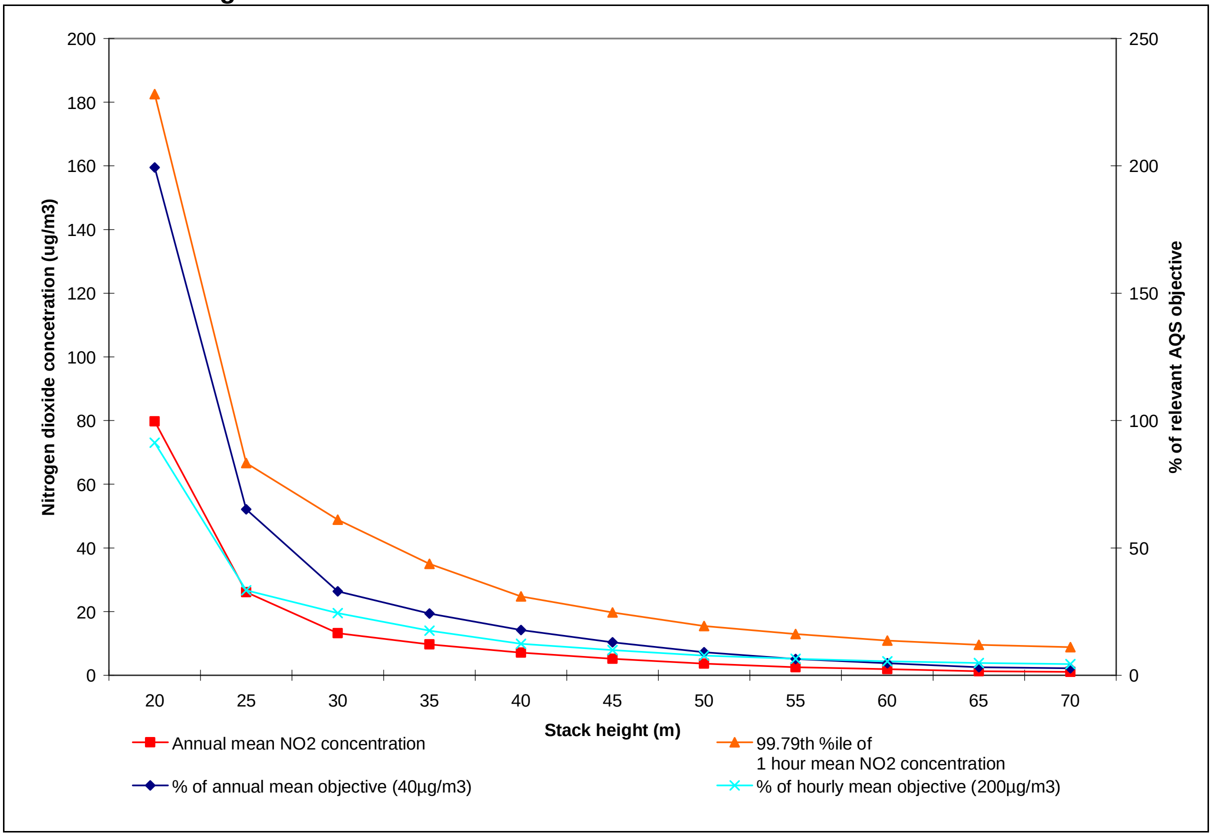
3.4.2 The process contribution to NOx concentrations and nitrogen deposition levels over the sensitive ecosystems are less than the AQS objective and critical load respectively. Since background concentrations of NOx are well below the objective, the process contribution is considered negligible at Barry Island and Minor Adverse at Bendrick Rock. The PC to nitrogen deposition is less than 2% of the critical load, this is deemed minor adverse for both sensitive sites.

3.5 Stack Height Determination

3.5.1 The determination of a recommended stack height was carried out by modelling nitrogen dioxide concentrations over a regular grid for stack heights ranging from 20m to 70m. The maximum concentrations were taken from the gridded receptors and it should therefore be noted that these concentrations do not necessarily occur at locations where sensitive receptors are present.

3.5.2 It can be seen that ground level concentrations are inversely related to stack height (see Chart 1). There is an initial rapid decrease in concentrations when increasing the stack height from 20m to 25m but as stack height increases further, there is a reduction in the rate at which concentrations decrease. Overall it is recommended that the stack height should be at least 45m.

Chart 1 Stack height determination



SECTION 4

CONCLUSIONS

4 CONCLUSION

4.1 Summary

4.1.1 It has been shown that process contributions to pollutant concentrations, at all specified receptors, are less than 5% of the relevant objective and since background concentrations are low, this is considered to be a Negligible impact.

4.1.2 The health risk assessment of dioxins showed that for a subsistence farmer and child, the daily intake of dioxins is below the WHO recommended Tolerable Daily Intake (TDI). The daily intake for an infant is expected to be significantly higher than that of an adult. The total daily intake for an infant is expected to be 1-2 orders of magnitude greater than that of an adult, based on a 'per kilogramme' amount. This is, however, only sustained for a very short period of the individuals' life.

4.1.3 Nitrogen deposition on the nearest sensitive ecosystems is considered to be Minor Adverse. NOx concentrations at Bendrick Rock are approximately 13% of the objective which is deemed to be a minor adverse impact. At Barry Island, the process contribution to NOx concentrations has been determined to be a Negligible impact.

4.1.4 In determining the stack height for the plant, it is recommended that the stack be at least 45m above ground level.

Figure 1-1 Barry site location

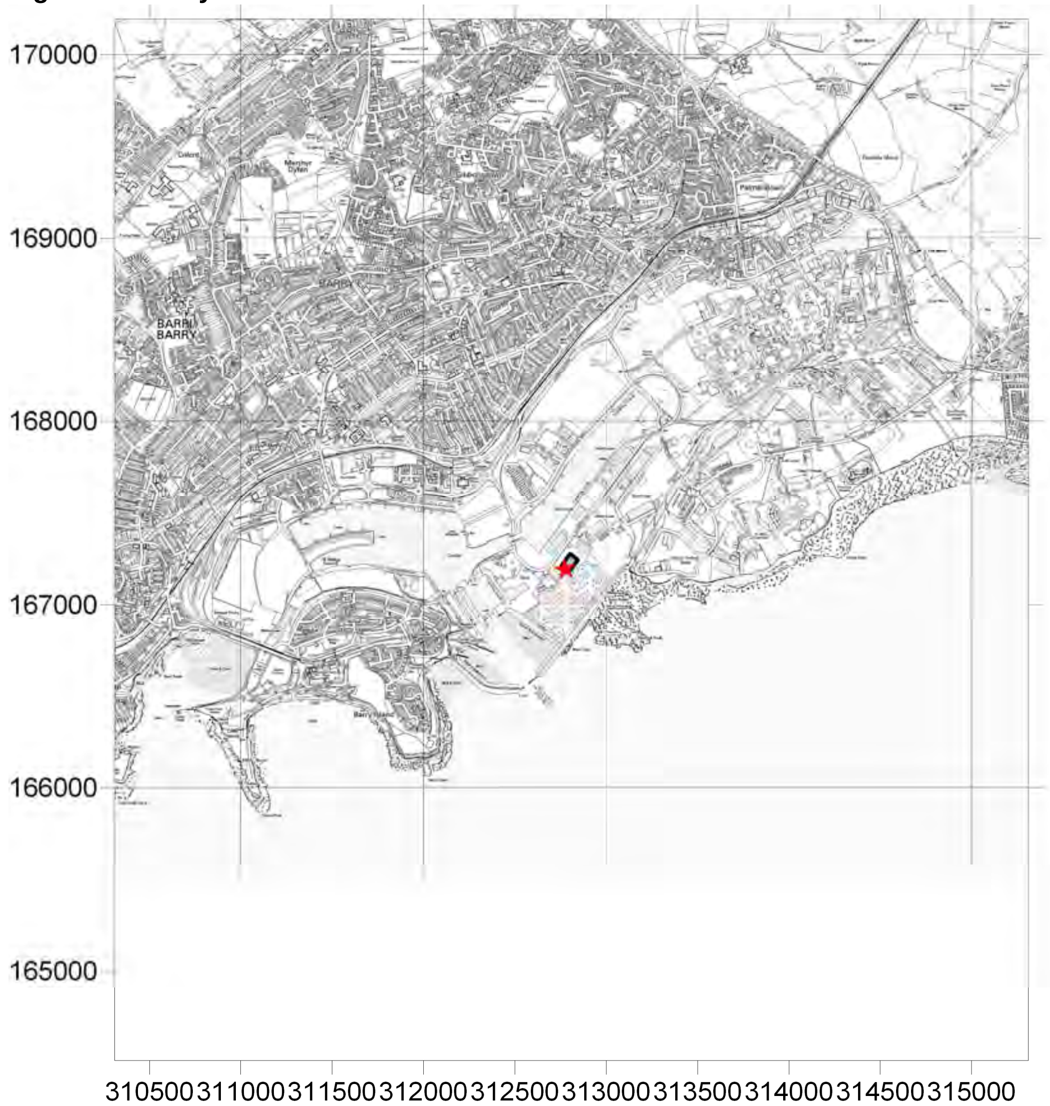


Figure 3-1: Process Contribution (PC) to annual mean NO_2 concentrations

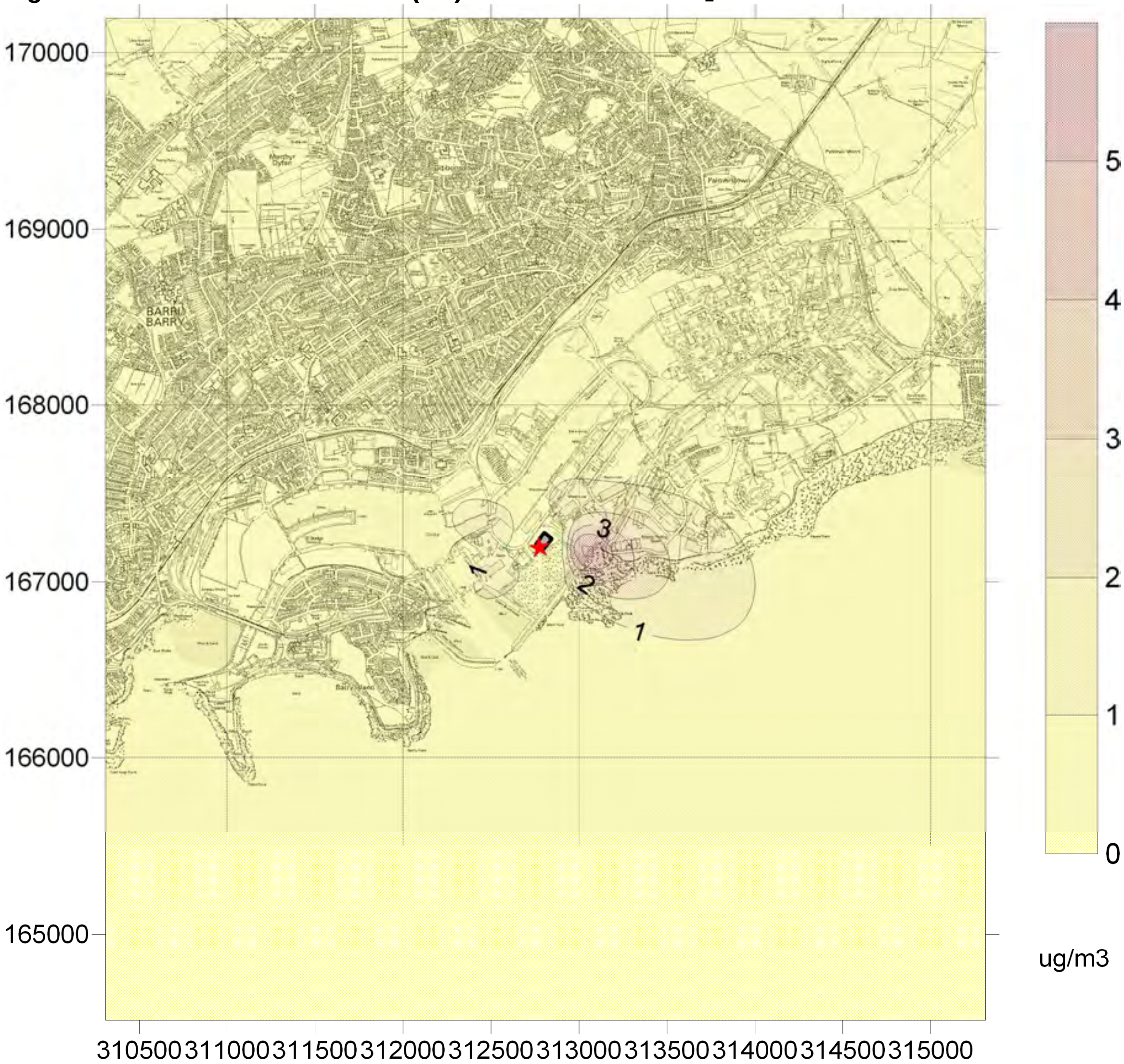


Figure 3-2: Process Contribution (PC) to annual mean SO_2 concentrations

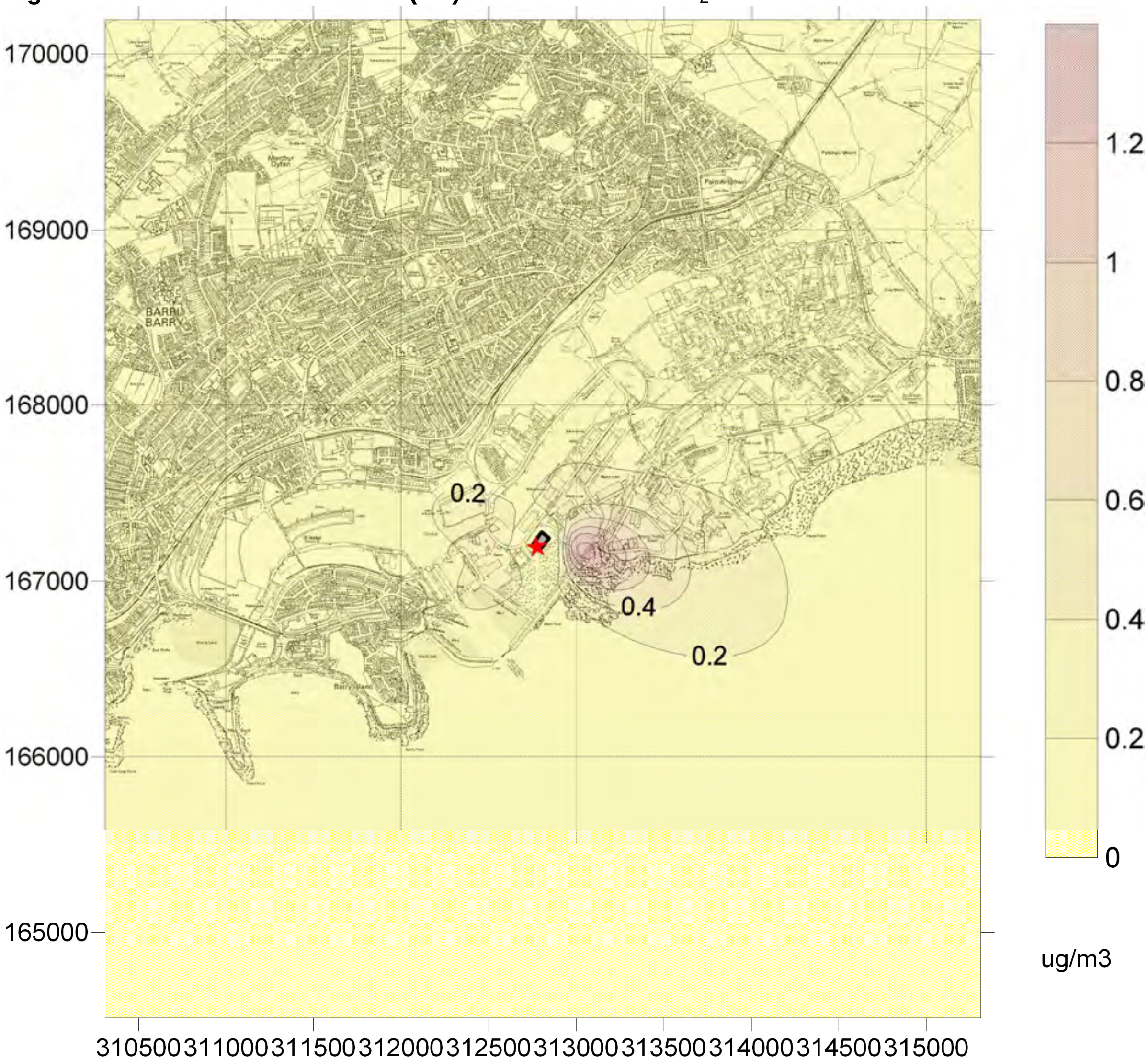


Figure 3-3: Process Contribution (PC) to annual mean PM_{10} concentrations

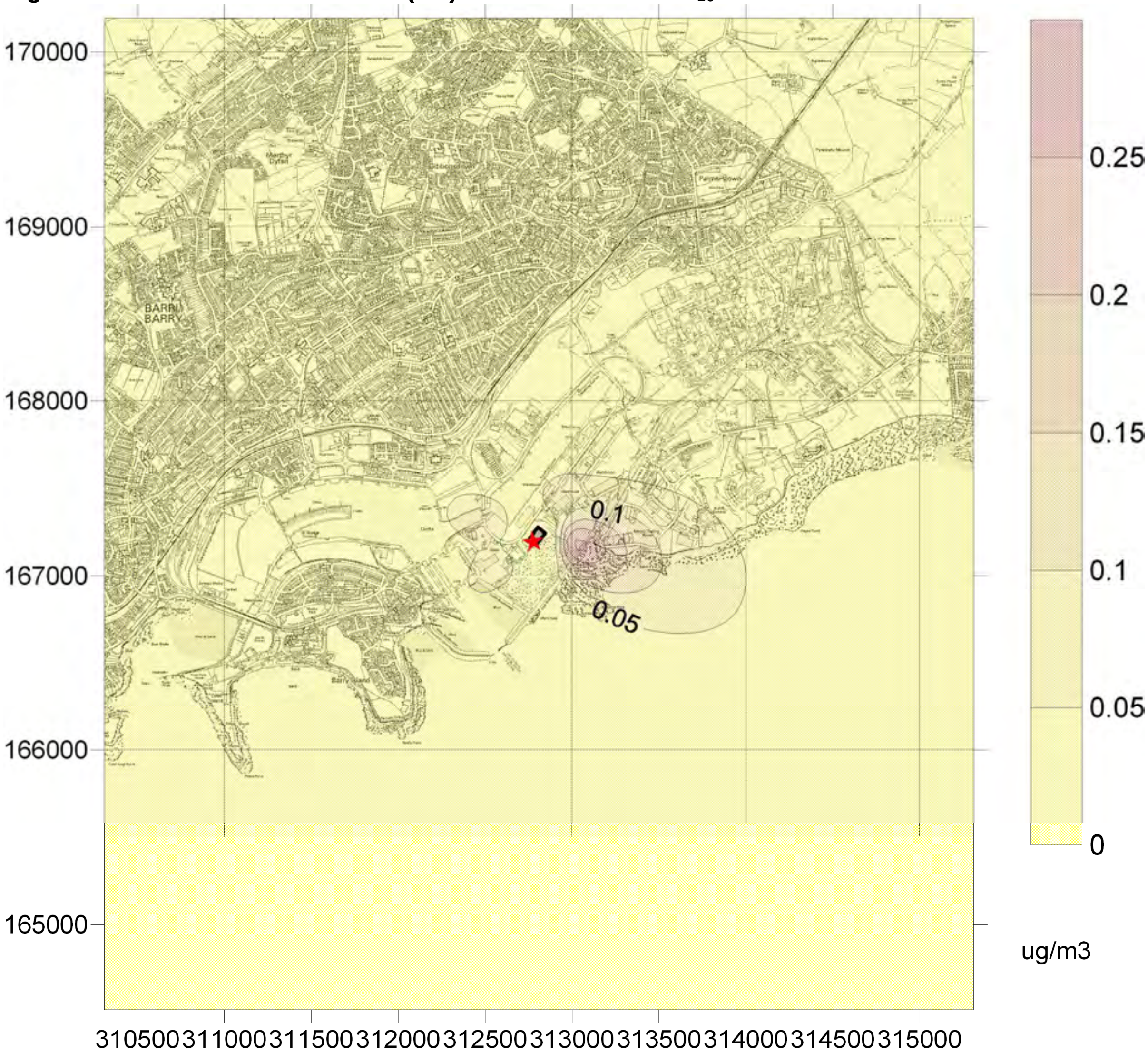


Figure 3-4: Process Contribution (PC) to annual mean CO concentrations

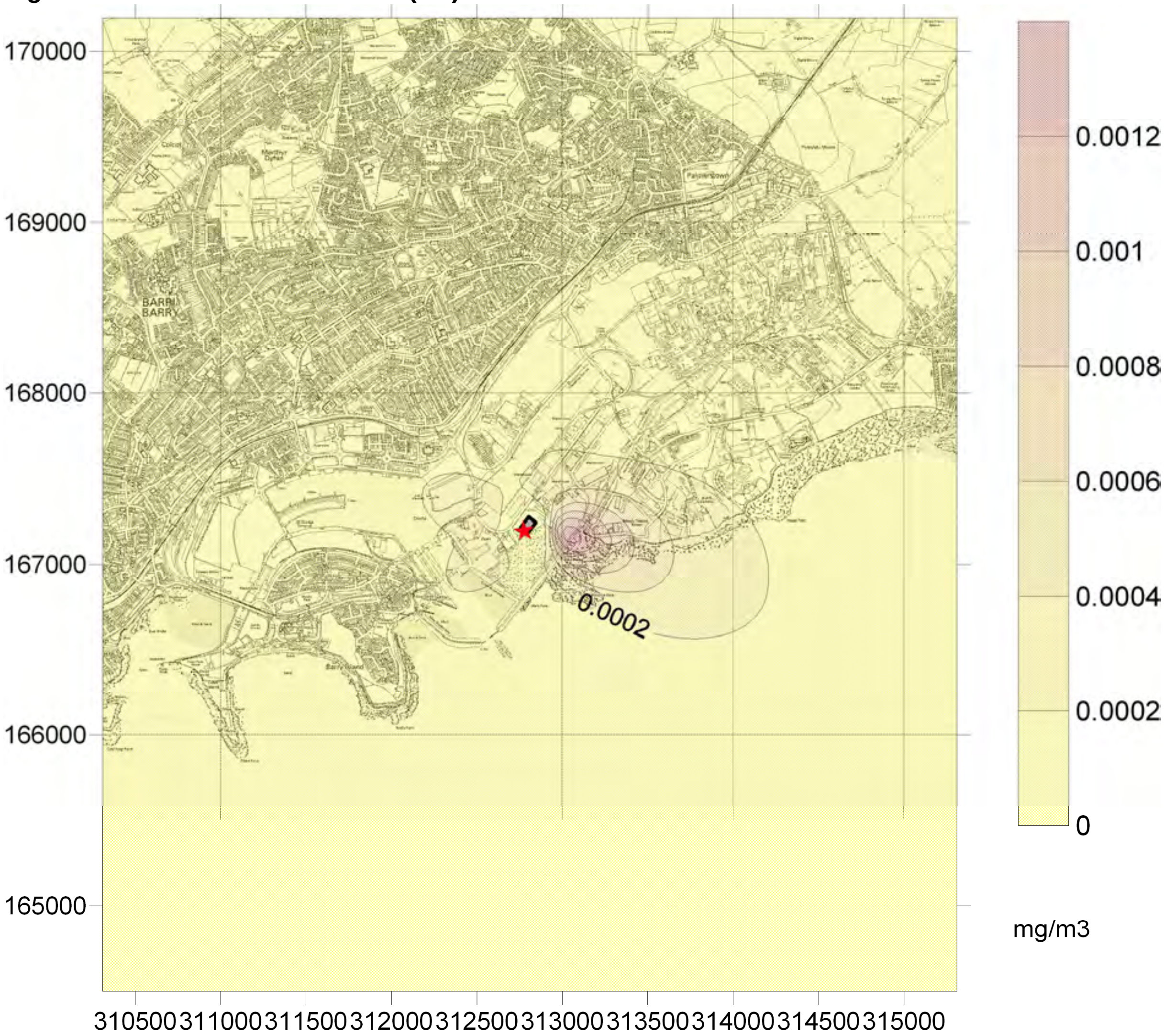


Figure 3-5: Process Contribution (PC) to 1 hour mean NO_2 concentrations

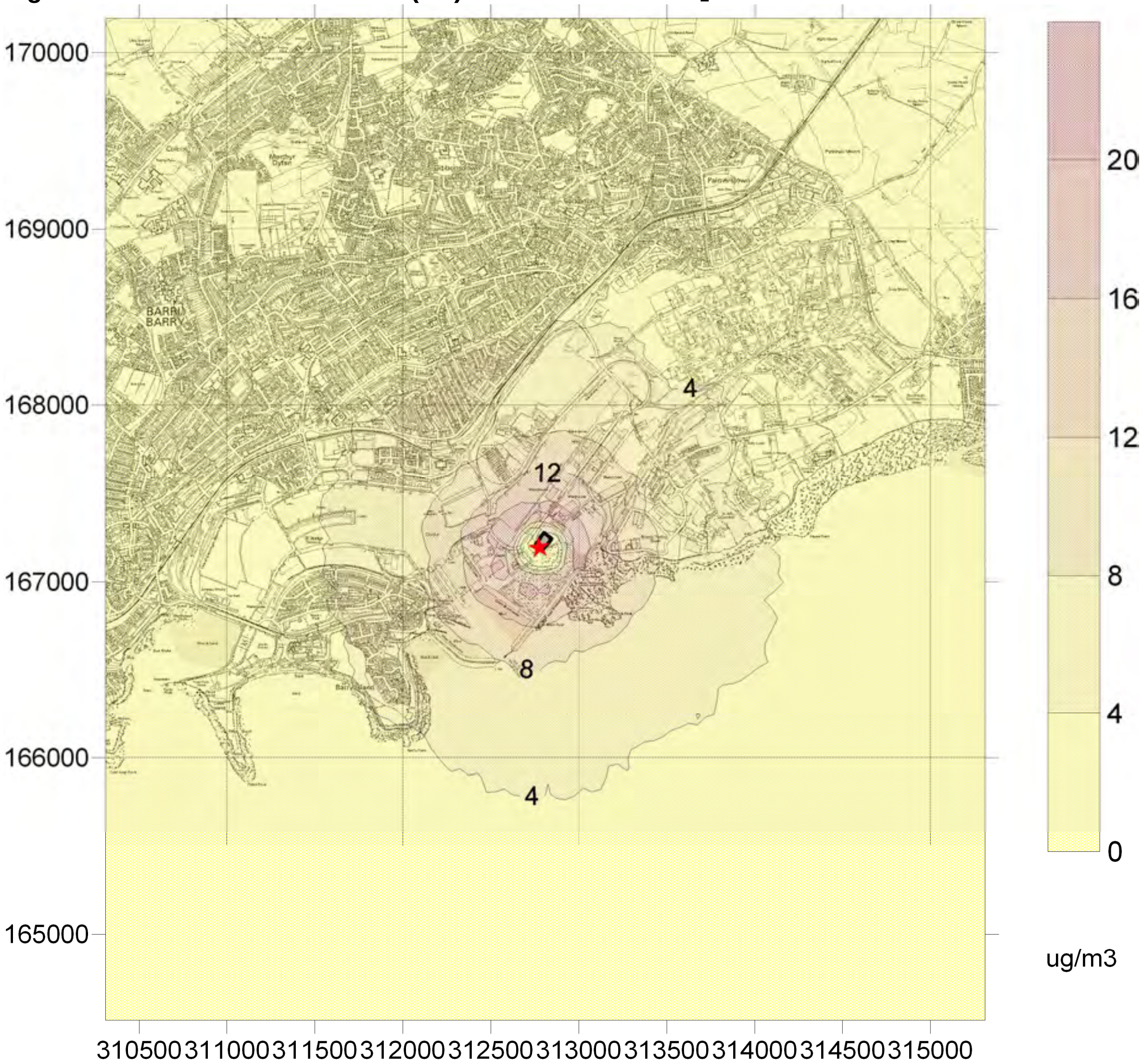


Figure 3-6: Process Contribution (PC) to 15 minute mean SO_2 concentrations

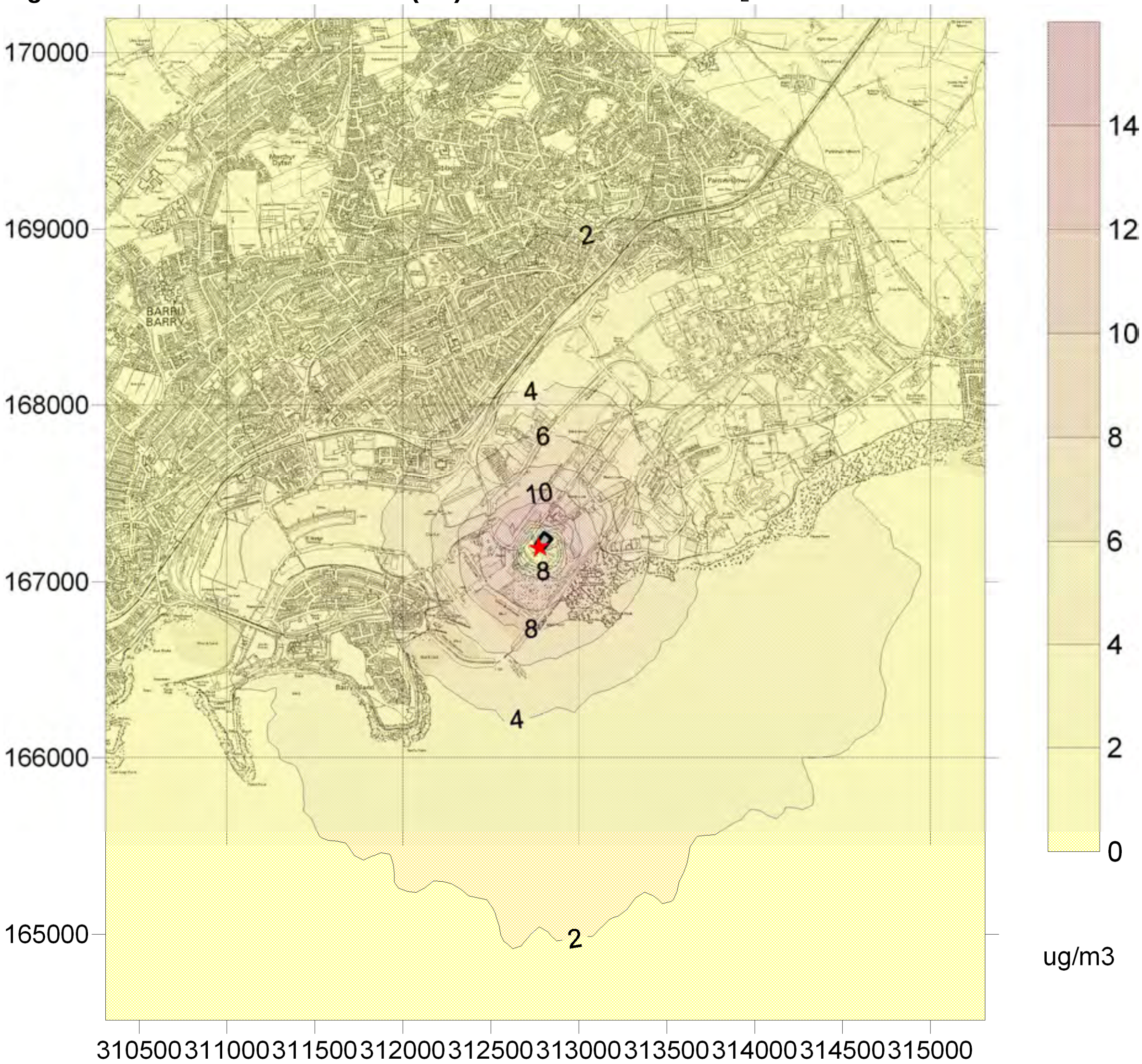


Figure 3-7: Process Contribution (PC) to annual mean nitrogen deposition