


AIR QUALITY ASSESSMENT
The Royal Mint, Llantrisant

Prepared for:
The Royal Mint

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Contents

EXECUTIVE SUMMARY

Sol Environment Ltd has been commissioned by The Royal Mint to undertake an assessment of the local air quality impacts arising from the existing emission sources at their facility in Llantrisant, South Wales.

Detailed dispersion modelling of existing emission sources has been undertaken to determine the impact of the facility at nearby sensitive human and ecological receptors.

The maximum impact of pollutant emissions from the site is considered insignificant on the basis of the Environment Agency/ Natural Resources Wales assessment criteria and professional judgement.

The impact of emissions from the proposed development on local habitat sites was also assessed and found to be negligible compared with existing background conditions and relevant critical levels and loads.

Based on the above information, it is considered that current operations at the Site are not adversely impacting on local air quality.

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1. INTRODUCTION

Sol Environment Ltd has been commissioned by The Royal Mint to undertake an assessment of the local air quality impacts arising from the existing emission sources at their facility at Llantrisant, South Wales.

The facility is located in a semi-rural area. To the north of the Site is agricultural land with outlying residential properties and farms. The Llantrisant Business Park lies immediately to the east, south and west and The Royal Glamorgan Hospital is approximately 450 m south-southwest.

The primary emissions sources at the site are those associated with coin production, primarily annealing furnaces and metal plating gas scrubbers. The pollutants for which there are authorised emissions points are as follows:

- Oxides of nitrogen (NOx as NO_2)
- hydrogen chloride;
- hydrochloric acid;
- ammonia; and
- trace metals (cadmium, thallium, arsenic, antimony, chromium, cobalt, copper, lead, manganese, nickel, tin, vanadium and zinc)

This report presents the findings of a dispersion modelling assessment to determine the impact of the installation on air quality at sensitive human and habitat receptors in the surrounding area. The emissions parameters used in the assessment are based on recent monitoring carried out at the facility.

A glossary of common air quality terminology is provided in **Appendix A**.

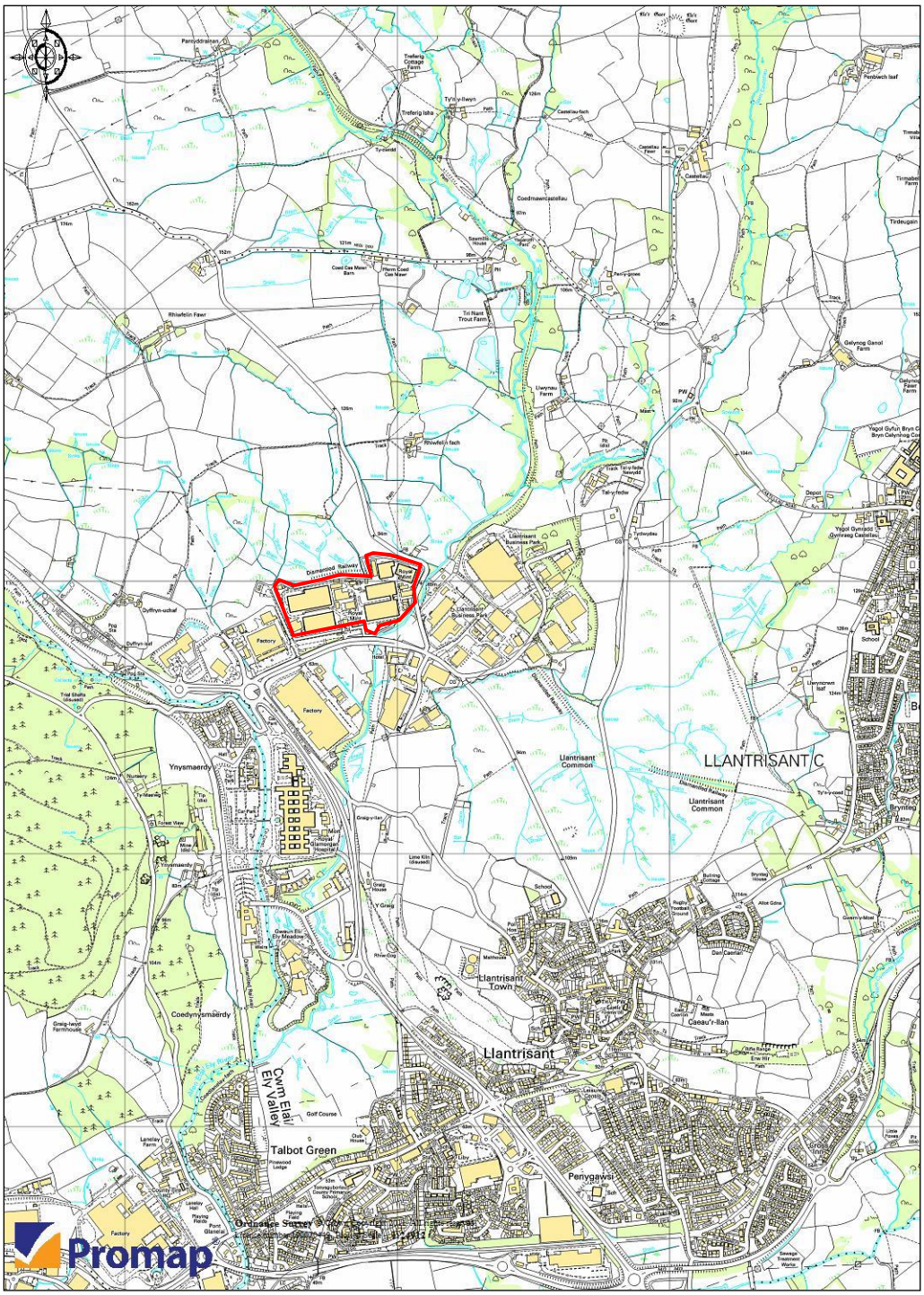

Figure 1: Site Location Plan

2. LEGISLATION AND POLICY

2.1 The European Directive on Ambient Air and Cleaner Air for Europe

European Directive 2008/50/EC of the European Parliament and of the Council of 21st May 2008, sets legally-binding Europe-wide limit values for the protection of public health and sensitive habitats. The Directive streamlines the European Union's air quality legislation by replacing four of the five existing Air Quality Directives within a single, integrated instrument.

The pollutants included are sulphur dioxide (SO_2), nitrogen dioxide (NO_2), particulate matter of less than 10 micrometres (μm) in aerodynamic diameter (PM_{10}), particulate matter of less than 2.5 μm in aerodynamic diameter lead ($PM_{2.5}$), lead (Pb), carbon monoxide (CO), benzene (C_6H_6), ozone (O_3), polycyclic aromatic hydrocarbons (PAHs), cadmium (Cd), arsenic (As), nickel (Ni) and mercury (Hg).

2.2 Air Quality Strategy for England, Scotland, Wales and Northern Ireland

The Government's policy on air quality within the UK is set out in the Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland (AQS) published in July 2007[1], pursuant to the requirements of Part IV of the Environment Act 1995. The AQS sets out a framework for reducing hazards to health from air pollution and ensuring that international commitments are met in the UK. The AQS is designed to be an evolving process that is monitored and regularly reviewed.

The AQS sets standards and objectives for ten main air pollutants to protect health, vegetation and ecosystems. These are benzene (C6H6), 1,3-butadiene (C4H6), carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), particulate matter (PM_{10}, $PM_{2.5}$), sulphur dioxide (SO_2), ozone (O_3) and polycyclic aromatic hydrocarbons (PAHs).

The air quality standards are long-term benchmarks for ambient pollutant concentrations which represent negligible or zero risk to health, based on medical and scientific evidence reviewed by the Expert Panel on Air Quality Standards (EPAQS) and the World Health Organisation (WHO). These are general concentration limits, above which sensitive members of the public (e.g. children, the elderly and the unwell) might experience adverse health effects.

The air quality objectives are medium-term policy based targets set by the Government which take into account economic efficiency, practicability, technical feasibility and timescale. Some objectives are equal to the EPAQS recommended standards or WHO guideline limits, whereas others involve a margin of tolerance, i.e. a limited number of permitted exceedences of the standard over a given period.

1 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland – July 2007

For some pollutants there is both a long-term (annual mean) standard and a short-term standard. In the case of nitrogen dioxide (NO_2), the short-term standard is for a 1-hour averaging period, whereas for fine particulates (PM_{10}) it is for a 24-hour averaging period. These periods reflect the varying impacts on health of differing exposures to pollutants (e.g. temporary exposure on the pavement adjacent to a busy road, compared with the exposure of residential properties adjacent to a road).

2.3 Air Quality Standards Regulations

The Air Quality Standards Regulations 2010 have adopted into UK law the limit values required by EU Directive 2008/50/EC and came into force on the 10th June 2010. These regulations prescribe the 'relevant period' (referred to in Part I2V of the Environment Act 1995) that local authorities must consider in their review of the future quality of air within their area. The regulations also set out the air quality objectives to be achieved by the end of the 'relevant period'..

Ozone is not included in the Regulations as, due to its trans-boundary nature, mitigation measures must be implemented at a national level rather than at a local authority level.

The EALs, air quality standards and objectives for the pollutants considered in the assessment are presented in **Appendix B.**

2.4 Local Air Quality Management (LAQM)

Part IV of the Environment Act 1995 also requires local authorities to periodically review and assess the quality of air within their administrative area. The Reviews have to consider the present and future air quality and whether any air quality objectives prescribed in Regulations are being achieved or are likely to be achieved in the future.

Where any of the prescribed air quality objectives are not likely to be achieved the authority concerned must designate that part an Air Quality Management Area (AQMA).

For each AQMA, the local authority has a duty to draw up an Air Quality Action Plan (AQAP) setting out the measures the authority intends to introduce to deliver improvements in local air quality in pursuit of the air quality objectives. Local authorities are not statutorily obliged to meet the objectives, but they must show that they are working towards them.

The Department of Environment, Food and Rural Affairs (DEFRA) has published technical guidance for use by local authorities in their Review and Assessment work[2]. This guidance, referred to in this chapter as LAQM.TG(09), has been used where appropriate in the assessment.

2 Department for Environment, Food and Rural Affairs (DEFRA), (2009): Part IV The Environment Act 1995 Local Air Quality Management Review and

2.5 Rhondda-Cynon-Taff County Borough Council Review and Assessment of Air Quality

Rhondda-Cynon-Taff County Borough Council (RCTCBC) carries out frequent review and assessments of air quality within the area and produce Updating and Screening Assessments and Progress Reports in accordance with the requirements of Defra. The most recent LAQM report is the 2013 Progress Report[3], which also includes a detailed assessment for nitrogen dioxide.

On average, the county enjoys relatively good air quality, with background pollutant concentrations in rural areas well within the air quality standards. However, in a number of urban areas there are measured exceedences of the annual mean air quality objective for NO_2 due to road traffic congestion, which are accentuated by topographical and urban features (e.g. street canyons) which impede dispersion.

To date, the council have declared thirteen AQMAs for NO_2. The facility is not within a designated AQMA. The nearest AQMA is around 3km east of the site and encompasses a section of the A473 from Llantwit Fardre to Tonteg. At this distance it is considered unlikely to be adversely impacted by NO_2 emissions from the Site.

assessment Technical Guidance LAQM.TG(09).
3 Rhondda Cynon Taf County Borough Council Progress Report and Detailed Assessment for Nitrogen Dioxide, August 2013.

3. METHODOLOGY

3.1 Scope of the Assessment

The scope of the assessment has been determined in the following way:

- review of air quality data for the area surrounding the site, including data from the DEFRA Air Quality Information Resource (UK-AIR);
- desk study to confirm the location of nearby areas that may be sensitive to changes in local air quality; and
- review and modelling of emissions data which has been used as an input to the Breeze AERMOD dispersion modelling assessment.

Predicted ground level concentrations are compared with relevant air quality standards for the protection of health and critical levels/ loads for the protection of sensitive ecosystems and vegetation.

3.2 Dispersion Model Parameters

3.2.1 Introduction

The predicted impact of the proposed installation on local air quality has been undertaken using the Breeze AERMOD 7 dispersion model (version 12060).

The emission points that have been included in the assessment are presented in Table 1.

Table 1: Emission Points		
ID	Receptor	Authorised Pollutants
A1	Zinc Plating Acid Gas Scrubber	HCl, H_2SO_4, NOx
A2	Zinc Plating Acid Gas Scrubber	HCl, H_2SO_4, NOx
A8	Copper Plating Scrubber	HCl, H_2SO_4, NOx
A9	Nickel Plating Plant 2	HCl, H_2SO_4, NOx
A10	Nickel Plating Plant 2 - Acid Gas Scrubber	HCl, H_2SO_4, NOx
A15	Nickel Plating - Armour 1	HCl, H_2SO_4, NOx, Metals
A16	Nickel Plating - Armour 2	HCl, H2SO4, NOx, Metals
A17	SAFED Annealing Oven Furnace Stack 1	NH_3, NOx
A18	SAFED Annealing Oven Furnace Stack 2	NH_3, NOx
A19	SAFED Annealing Oven Furnace Stack 3	NH_3, NOx
A21	SAFED 6 Annealing Ovens	NH_3, NOx
A22	SECO Warwick Furnace	H_2SO_4,NH3,NOx
A23	Wellman 3	NH_3, NOx
A24	Wellman 2	NH_3, NOx
A25	Rogers Annealing Oven	NH_3, NOx
A30	Trial Plating Line 1	HCl, H_2SO_4, NOx
A31	Trial Plating Line 2	HCl, H_2SO_4 NOx

For the purposes of the modelling assessment all units are assumed to be operating at full load, continually throughout the year.

Recent stack monitoring has been undertaken for emission points A2, A9, A10, A16, A22, A23, A25, A 30 and A31. Due to an accessibility issue monitoring of emissions from the SAFED units was not undertaken, therefore emissions from these stacks are assumed to be the same as those measured for the Rogers Annealing Oven (A25). Similarly, the A24 (Wellman) emissions are assumed to be representative of A23, and the A2 (zinc plating acid gas scrubber) emissions representative of A1 and A8.

A summary of the input parameters used in the assessment are identified in **Appendix C**.

3.2.2 Meteorological Data

Dispersion modelling has been undertaken using five years (2005-2011) of hourly sequential meteorological data in order to take account of inter-annual variability and reduce the effect of any atypical conditions. Data from a meteorological station at Rhoose - Cardiff Airport (approximately 18 km south of the Site) has been used for the assessment, which is the most representative data currently available for the area.

Windroses for each year of meteorological data are presented in **Appendix D.**

3.2.3 Building Downwash / Entrainment

The presence of buildings close to emission sources can significantly affect the dispersion of pollutants by leading to a phenomenon called downwash. This occurs when a building distorts the wind flow, creating zones of increased turbulence. Increased turbulence causes the plume to come to ground earlier than otherwise would be the case and result in higher ground level concentrations closer to the stack.

Downwash effects are only significant where building heights are greater than 30 to 40% of the emission release height. The downwash structures also need to be sufficiently close for their influence to be significant.

All potential downwash structures have been included in the model.

3.2.4 Nitric Oxide to NO_2 Conversion

Oxides of nitrogen (NO_x) emitted to atmosphere as a result of combustion will consist largely of nitric oxide (NO), a relatively innocuous substance. Once released into the atmosphere, NO is oxidised to NO_2. The proportion of NO converted to NO_2 depends on a number of factors including wind speed, distance from the source, solar irradiation and the availability of oxidants, such as ozone (O_3).

A conversion ratio of 70% NOx:NO_2 has been assumed for comparison of predicted concentrations with the long-term objectives for NO_2. A conversion ratio of 35% has been utilised for the assessment of short-term impacts, as recommended by Environment Agency guidance[4].

3.3 Significance Criteria

The Environment Agency has developed criteria for assessing the significance of an impact compared with relevant air quality standards and background air quality[5]. A process contribution (PC) is considered significant if:

- The long-term PC > 1% of the long-term air quality standard
- The short-term PC > 10% of the short-term air quality standard

At 1% of the long-term air quality standard, the impact of a development is unlikely to be significant compared with background air quality. Both the short-and long term criteria are also designed to ensure that there is a substantial safety margin to protect public health and the environment.

4 Environment Agency AQMAU, Conversion Rates for NOx and NO_2
5 Environment Agency Horizontal Guidance Note H1, Annex (f) Air emissions, Version 2.2, December 2011.

If the screening criteria are not met, the process contribution should be considered in combination with relevant ambient background pollutant concentrations. The air quality standards are likely to be met if:

- The long-term PC + background concentration < 70% of the air quality standard
- The short-term PC < 20% (air quality standard – short-term background concentration), where the short-term background concentration is assumed to be twice the long-term background concentration

3.4 Sensitive Receptors

Specific receptors have been identified where people are likely to be regularly exposed for prolonged periods of time (e.g. residential areas). The location of the discrete sensitive receptors is presented in Table 2 and Figure 2.

Table 2: Human Health Receptors

ID	Receptor	Type	Easting	Northing
1	Rhiwfelin Fawr	Residential	303163	185915
2	Rhiwfelin Nursing Home	Nursing Home	303276	186124
3	Rhiwfelin Fach	Residential	304036	185512
4	Glanmychydd-Fach	Residential	304071	185111
5	Llantrisant Dialysis Centre	Medical Facility	304500	185110
6	Tal-y-fedw	Residential	304693	185336
7	Tyclwydau	Residential	304847	184161
8	Llwyncrwn Isaf	Residential	305459	184617
9	Ty'n-y-coed	Residential	305649	184240
10	Coed-yr-Escob Primary School	School	304482	183941
11	Graig-y-llan	Residential	303946	184107
12	Royal Glamorgan Hospital	Hospital	303610	184366
13	Glan-yr-ely	Residential	303378	184553
14	Signalmans Cottage	Residential	303047	184627
15	Dyffryn-isaf	Residential	303012	184754
16	Dyffryn-uchaf	Residential	303063	184907
17	Bedw	Residential	302567	185478

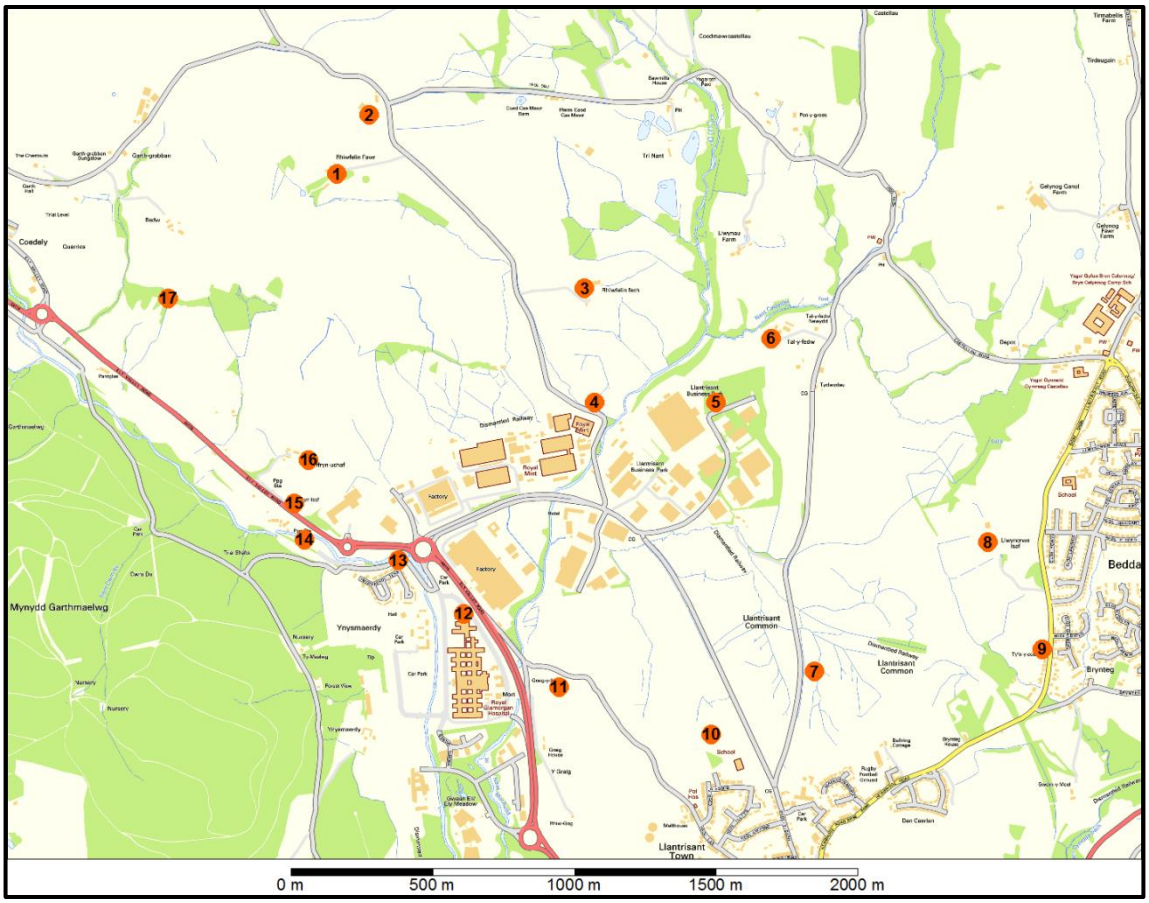

Figure 2: Sensitive Human health Receptor Locations (Contains OS data © Crown Copyright 2014)

Pollutant concentrations have been predicted at both discrete receptor locations and over a 4 km by 3 km Cartesian grid of 50m resolution.

3.5 Habitat Assessment

The Environment Agency's H1 guidance states that the impact of emissions to air on vegetation and ecosystems should be assessed for the following habitat sites within 10 km of the source:

- Special Areas of Conservation (SACs) and candidate SACs (cSACs) designated under the EC Habitats Directive[6];
- Special Protection Areas (SPAs) and potential SPAs designated under the EC Birds Directive[7]; and
- Ramsar Sites designated under the Convention on Wetlands of International Importance[8].

Within 2km of the source:

- Sites of Special Scientific Interest (SSSI) established by the 1981 Wildlife and Countryside Act;
- National Nature Reserves (NNR);
- Local Nature Reserves (LNR);
- local wildlife sites (Sites of Interest for Nature Conservation, SINC and Sites of Local Interest for Nature Conservation, SLINC); and
- ancient woodland.

Habitat receptor designations and locations relevant to the assessment are presented in Table 3.

Table 3: Sensitive Habitat Receptors

Receptor	Primary Habitat	Approx. Location (Relative to Site)
Llantrisant Common and Pastures SSSI	Lowland marshy grassland	300 m south and southwest
Rhos Tonyrefail SSSI	Acidic grassland and fen	100 m northwest
Cardiff Beech Woods SAC	Beech Woodland	7.5 km east-southeast

6 Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora.
7 Council Directive 79/409/EEC on the conservation of wild birds
8 Ramsar (1971), The Convention of Wetlands of International Importance especially as Waterfowl Habitat.

Due to the close proximity of the SSSIs to the Site, the designated areas have been modelled using a Cartesian grid of 50m resolution to enable the maximum impact to be determined. Cardiff Beech Woods SAC, which is 7.5 km from the facility, has been represented in the model by a discrete receptor at the nearest boundary of the designated area.

The modelled ground level pollutant concentrations are used to predict deposition rates, using typical deposition velocities. A summary of typical NO_2, and NH_3 dry deposition velocities is presented in Table 4.

Table 4: Dry Deposition Velocities (m/s)

Pollutant	Grassland	Woodland
Nitrogen Dioxide (NO_2)	0.0015	0.0030
Ammonia (NH_3)	0.02	0.030

The predicted nitrogen deposition rates assume a 100% NOx: NO_2 conversion. This represents a worst-case for the assessment since nitric oxide (NO) has a lower deposition velocity than NO_2 and consequently results in lower deposition rates.

Predicted ground level concentrations and nutrient nitrogen deposition rates are compared with relevant air quality standards, critical levels and critical loads for the protection of sensitive ecosystems and vegetation (see **Appendix E**).

4. BASELINE CONDITIONS

4.1 Nitrogen Dioxide

RCTCBC undertake automatic monitoring of NOx at four locations. Unfortunately, the nearest monitoring station is at a roadside location, approximately 6 km northeast of the facility. However, RCTCBC operate an extensive network of 66 passive diffusion tubes. Until 2005, there was a RCTCBC diffusion tube around 370 m southwest of the Site at the Royal Glamorgan Hospital. Concentrations measured at this location were well within the air quality objective of 40 µg/m^3. Until recently, rural background concentrations of NO_2 were measured at Llwynmilwas Farm, around 3.8 km southwest of the facility. Annual mean concentrations measured at this location between 2009 and 2011 ranged from 14.9 to 18.2 µg/m^3.

For comparison, annual mean NO_2 background concentrations for 2014 have been obtained from the DEFRA UK Background Air Pollution Maps[9]. The latest NO_2 background maps were issued in August 2012 and are based on 2010 monitoring data.

The 2014 mapped annual mean NO_2 background concentration for the facility and the surrounding area is 23.0 µg/m^3, 58% of the air quality objective. The mapped concentration is somewhat higher than the measured concentrations at Llwynmilwas Farm and has been utilised in the assessment as a worst-case.

4.2 Hydrogen Chloride

Ambient monitoring of Hydrogen Chloride is carried out as part of the DEFRA Nitric Acid Network at a number of locations around the UK. The closest monitoring sites are at Narbeth in Pembrokeshire and Rosemaund in Herefordshire, which are around 95 km northwest and 80 km northeast of Llantrisant respectively. Over the period 2010 to 2012, the average annual mean HCl concentration at these sites was the same as the UK average at 0.24 µg/m^3.

This concentration is assumed to provide a reasonable estimate of the background concentration of HCl at the Site.

9 http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html

4.3 Sulphuric Acid

Monitoring of airborne sulphuric acid concentrations is not currently carried out in the UK, therefore the assessment will focus on the process contribution only in comparison with the EAL.

4.4 Ammonia

Ambient monitoring of ammonia (NH_3) concentrations is carried out as part of the National Ammonia Monitoring Network (NAMN) at 95 locations around the UK. The majority of the sites in Scotland are at rural background locations. The Air Pollution Information Service, APIS10 uses the measured concentration to calibrate the FRAME dispersion model, which estimates concentrations at a 5 km grid resolution. The three year average (2009 – 2011) NH_3 concentration for the grid square containing the facility is 1.5 µg/m^3.

4.5 Trace Metals

DEFRA has undertaken monitoring of trace elements at a number of locations in the UK since 1976 as part of the UK Urban and Rural Heavy Metals Monitoring Networks.

To provide an indication of the range of trace metal concentrations that occur in the UK the average concentrations measured at rural and urban sites between 2008 and 2011 are summarised in Table 5. With the exception of Cr(VI), all the measured concentrations are well below their respective EAL's.

For the purposes of the assessment, the UK average rural concentrations are assumed to be reasonably representative of the baseline trace metal concentrations at the Site.

10 www.apis.ac.uk

Table 5: Annual Mean Trace Metal Concentrations (ng/m^3)			
Metal	**Rural**	**Urban**	**EAL**
Antimony (Sb)	Not measured	Not measured	5,000
Arsenic (As)	0.47	0.68	3
Cadmium (Cd)	0.10	0.30	5
Chromium (Cr)	0.76	4.2	5,000 (a) 0.2 (b)
Cobalt (Co)	0.047	0.21	1,000
Copper (Cu)	2.8	16.8	10,000
Lead (Pb)	4.4	13.9	250 – 500
Manganese (Mn)	2.2	13.2	150
Mercury (Hg) (c)	1.2	2.0	250
Nickel (Ni)	0.83	3.8	20
Thallium (Tl)	Not measured	Not measured	1,000
Tin (Sn)	Not measured	Not measured	n/a
Vanadium (V)	1.1	1.7	5,000
Zinc (Zn)	Not measured	Not measured	50 (d)
(a)Trivalent Chromium, Cr(III) (b)Hexavalent Chromium, Cr(VI) (c)Total particulate and vapour (d) As zinc oxide			

4.6 Summary of Background Concentrations

A summary of the annual mean and short-term background concentrations assumed for the assessment is presented in Table 6. The concentrations are assumed to be representative of future year concentrations. Since pollutant concentrations are expected to decline in the future, this methodology ensures that the worst-case impacts are determined (i.e. future impacts combined with existing air quality).

Table 6: Summary of Background Concentrations

Pollutant	Annual Mean	Short-Term
Nitrogen Dioxide (NO_2)	23.0 µg/m^3	46.0 µg/m^3 (a)
Hydrogen Chloride (HCl)	0.24 µg/m^3	0.48 µg/m^3 (a)
Sulphuric Acid (H_2SO_4)	n/a	n/a
Ammonia (NH_3)	1.5 µg/m^3	3.0 µg/m^3
Antimony (Sb)	n/a	n/a
Arsenic (As)	0.47 ng/m^3	n/a
Cadmium (Cd)	0.10 ng/m^3	n/a
Trivalent Chromium, Cr(III)	0.76 ng/m^3	1.5 ng/m^3 (a)
Hexavalent Chromium, Cr(VI)	0.76 ng/m^3	1.5ng/m^3 (a)
Cobalt (Co)	0.047 ng/m^3	0.094 ng/m^3 (a)
Copper (Cu)	2.8 ng/m^3	5.6 ng/m^3
Lead (Pb)	4.4 ng/m^3	n/a
Manganese (Mn)	2.2 ng/m^3	4.4 ng/m^3 (a)
Nickel (Ni)	0.83 ng/m^3	n/a
Thallium (Tl)	n/a	n/a
Tin (Sn)	n/a	n/a
Vanadium (V)	1.1 ng/m^3	1.3 ng/m^3 (a)(b)
Zinc (Zn)	n/a	n/a

(a) 1-hour mean background concentration estimated by multiplying the annual mean by a factor of 2 in accordance with the H1 Guidance.

(b) 24-hour mean background concentration estimated by multiplying the 1-hour mean by a factor of 0.59 in accordance with the H1 Guidance.

5. ASSESSMENT OF IMPACT, MITIGATION & RESIDUAL EFFECTS

5.1 Human Health Impact

5.1.1 Introduction

Predicted pollutant concentrations (PC) for the five years of meteorological data are presented as the maximum concentration for each of the discrete receptors identified in Section 3.4.

The maximum PC is added to the estimated background concentration for the area (see Table 6) to give the total predicted environmental concentration (PEC) for comparison with the relevant air quality objectives.

The significance of the impacts has been assessed in accordance with the Environment Agency's H1 Guidance.

5.1.2 Nitrogen Dioxide (NO_2)

The maximum predicted annual mean and 99.8th percentile of 1-hour mean ground level NO_2 concentrations are presented as a percentage of the relevant AQOs in Table 7.

Table 7: Predicted NO_2 Impacts

Receptor	Annual Mean		99.8th Percentile of 1-Hour Means	
	PC	PEC	PC	PEC
Rhiwfelin Fawr	0.0088%	57.5%	0.048%	23.0%
Rhiwfelin Nursing Home	0.0087%	57.5%	0.049%	23.0%
Rhiwfelin Fach	0.088%	57.6%	0.42%	23.4%
Glanmychydd-Fach	1.6%	59.1%	2.9%	25.9%
Llantrisant Dialysis Centre	0.29%	57.8%	0.86%	23.9%
Tal-y-fedw	0.062%	57.6%	0.30%	23.3%
Tyclwydau	0.093%	57.6%	0.49%	23.5%
Llwyncrwn Isaf	0.066%	57.6%	0.18%	23.2%
Ty'n-y-coed	0.072%	57.6%	0.33%	23.3%
Coed-yr-Escob Primary School	0.033%	57.5%	0.14%	23.1%
Graig-y-llan	0.11%	57.6%	0.72%	23.7%
Royal Glamorgan Hospital	0.11%	57.6%	0.64%	23.6%
Glan-yr-ely	0.17%	57.7%	0.77%	23.8%
Signalmans Cottage	0.11%	57.6%	0.50%	23.5%
Dyffryn-isaf	0.084%	57.6%	0.44%	23.4%
Dyffryn-uchaf	0.046%	57.5%	0.33%	23.3%
Bedw	0.010%	57.5%	0.069%	23.1%
AQO (µg/m³)	40		200	
Background (µg/m³)	23.0		46.0	

Maximum predicted annual mean NO_2 impacts are insignificant (<1% of the AQO) at all of the identified receptors except Glanmychydd-Fach, which is close to the north-eastern site boundary. However, the total predicted concentration at this location is less than 70% of the AQO therefore the impact is considered negligible.

The hourly-mean predictions are less than 10% of the AQO at all locations and therefore the short-term impacts are insignificant according to the EA screening criteria.

Maximum predicted annual and 99.8th percentile of hourly mean NO_2 concentrations are presented as contour plots in Figures 3 and 4 respectively.

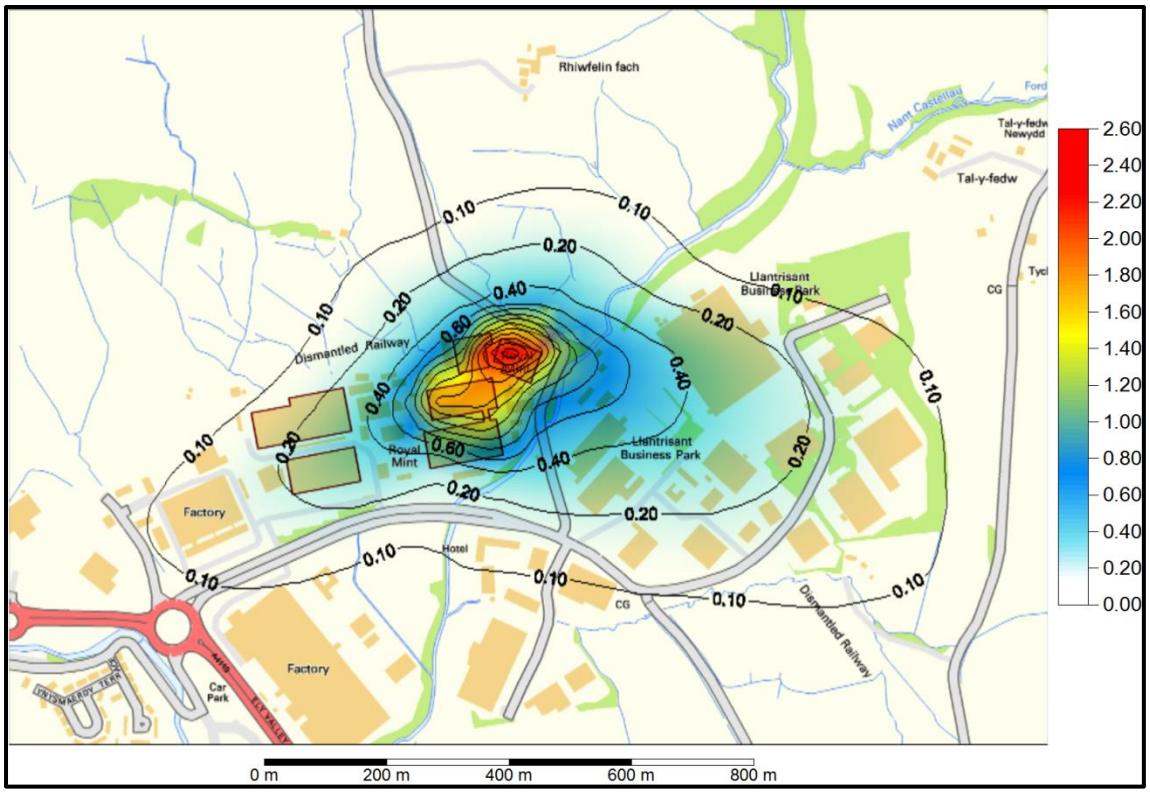

Figure 3: Predicted Annual Mean NO_2 Concentrations (µg/m^3, Contains OS data © Crown Copyright 2014)

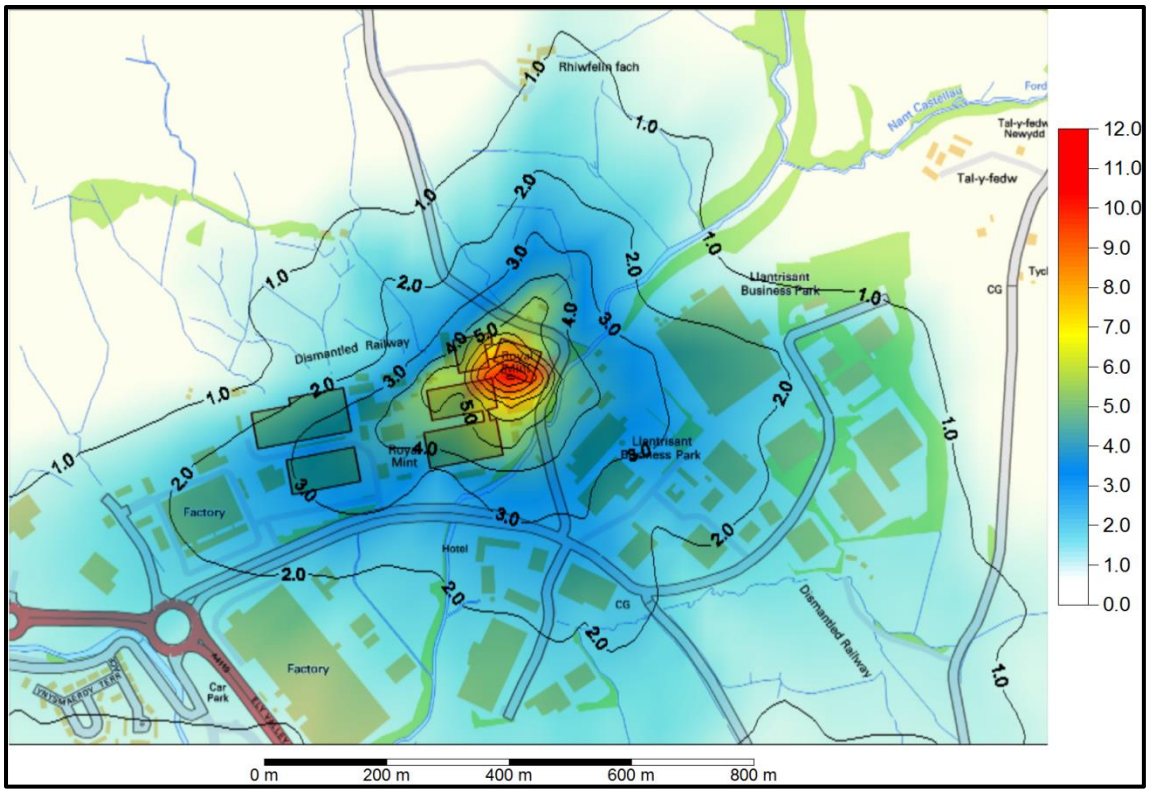

Figure 4: Predicted 99.8th Percentile of 1-Hour Mean NO_2 Concentrations (µg/m³, Contains OS data © Crown Copyright 2014)

5.1.3 Hydrogen Chloride (HCl)

The predicted maximum 1-hour mean ground-level hydrogen chloride concentrations at identified sensitive receptor locations are presented as a percentage of the EPAQS Guideline Value in Table 8.

Table 8: Predicted HCl Impact		
Receptor	Maximum 1-Hour Mean	
	PC	PEC
Rhiwfelin Fawr	0.013%	0.045%
Rhiwfelin Nursing Home	0.017%	0.037%
Rhiwfelin Fach	0.13%	0.15%
Glanmychydd-Fach	0.28%	0.30%
Llantrisant Dialysis Centre	0.31%	0.33%
Tal-y-fedw	0.16%	0.18%
Tyclwydau	0.21%	0.23%
Llwyncrwn Isaf	0.075%	0.095%
Ty'n-y-coed	0.099%	0.12%
Coed-yr-Escob Primary School	0.083%	0.10%
Graig-y-llan	0.23%	0.25%
Royal Glamorgan Hospital	0.16%	0.18%
Glan-yr-ely	0.19%	0.21%
Signalmans Cottage	0.24%	0.26%
Dyffryn-isaf	0.24%	0.26%
Dyffryn-uchaf	0.26%	0.28%
Bedw	0.028%	0.048%
EPAQS Guideline Value (µg/m^3)	750	
Background (µg/m^3)	0.23	

The maximum predicted hourly mean receptor concentrations are less than 10% of the EPAQS Guideline Value, therefore HCl emissions from the facility are considered insignificant.

5.1.4 Ammonia (NH_3)

The maximum predicted annual and 1-hour mean ground level NH_3 concentrations are presented as a percentage of the relevant EALs in Table 9.

Table 9: Predicted NH_3 Impacts

Receptor	Annual Mean		Maximum 1-Hour Mean	
	PC	PEC	PC	PEC
Rhiwfelin Fawr	0.00021%	0.83%	0.0016%	0.12%
Rhiwfelin Nursing Home	0.00020%	0.83%	0.0017%	0.12%
Rhiwfelin Fach	0.0020%	0.84%	0.017%	0.14%
Glanmychydd-Fach	0.030%	0.86%	0.082%	0.20%
Llantrisant Dialysis Centre	0.0054%	0.84%	0.022%	0.14%
Tal-y-fedw	0.0013%	0.83%	0.017%	0.14%
Tyclwydau	0.0023%	0.84%	0.018%	0.14%
Llwyncrwn Isaf	0.0015%	0.83%	0.0043%	0.12%
Ty'n-y-coed	0.0016%	0.83%	0.010%	0.13%
Coed-yr-Escob Primary School	0.00086%	0.83%	0.0082%	0.13%
Graig-y-llan	0.0028%	0.84%	0.021%	0.14%
Royal Glamorgan Hospital	0.0028%	0.84%	0.019%	0.14%
Glan-yr-ely	0.0046%	0.84%	0.021%	0.14%
Signalmans Cottage	0.0028%	0.84%	0.013%	0.13%
Dyffryn-isaf	0.0019%	0.84%	0.012%	0.13%
Dyffryn-uchaf	0.0010%	0.83%	0.013%	0.13%
Bedw	0.00024%	0.83%	0.0026%	0.12%
EAL ($\mu g/m^3$)	180		2500	
Background ($\mu g/m^3$)	1.5		3.0	

Maximum predicted long and short-term NH_3 impacts are insignificant, compared with the EALs at all of the identified receptors.

5.1.5 Sulphuric Acid (H_2SO_4)

The maximum predicted annual and 1-hour mean ground level H_2SO_4 concentrations are presented as a percentage of the relevant EALs in Table 10.

Table 10: Predicted H_2SO_4 Impacts

Receptor	Annual Mean PC	Maximum 1-Hour Mean PC
Rhiwfelin Fawr	0.016%	0.050%
Rhiwfelin Nursing Home	0.016%	0.051%
Rhiwfelin Fach	0.151%	0.49%
Glanmychydd-Fach	1.7%	1.2%
Llantrisant Dialysis Centre	0.44%	0.94%
Tal-y-fedw	0.11%	0.56%
Tyclwydau	0.17%	0.70%
Llwyncrwn Isaf	0.12%	0.25%
Ty'n-y-coed	0.13%	0.35%
Coed-yr-Escob Primary School	0.058%	0.32%
Graig-y-llan	0.19%	0.75%
Royal Glamorgan Hospital	0.19%	0.54%
Glan-yr-ely	0.30%	0.64%
Signalmans Cottage	0.20%	0.67%
Dyffryn-isaf	0.15%	0.66%
Dyffryn-uchaf	0.081%	0.67%
Bedw	0.019%	0.089%
EAL (µg/m³)	**10**	**300**
Background (µg/m³)	**n/a**	**n/a**

Maximum predicted annual mean H_2SO_4 impacts are insignificant (<1% of the EAL) at all of the identified receptors except Glanmychydd-Fach, which is close to the north-eastern site boundary. However, there are no other significant sources of H_2SO_4 in the area and there it is considered very unlikely that an exceedence of the EAL would occur at this location.

The hourly-mean predictions are less than 10% of the AQO at all locations and therefore the short-term impacts are insignificant according to the EA screening criteria.

5.1.6 Trace Metals

The predicted maximum long and short-term trace metal impacts are presented in Tables 11 and 12 respectively. The proportion of the total chromium emission from the Site that is trivalent or hexavalent is

unknown therefore the predicted total chromium concentration is compared with the EALs for Cr(III) and Cr(VI), as a worst-case.

There are no relevant EALs for tin (Sn), which is generally considered to be of low toxicity with respect to human health. The maximum predicted concentration occurs at Glanmychydd-Fach, at just 9.0×10^{-5} µg/m^3.

Table 11: Maximum Long-Term Trace Metal Concentrations

Pollutant	EAL (µg/m^3)	PC (% of EAL)	PEC (% of EAL)	Significance
Cd	0.005	1.2%	3.2%	Insignificant
Tl	1	0.018%	n/a	Insignificant
As	0.003	3.8%	19.4%	Insignificant
Sb	5	0.0079%	n/a	Insignificant
Cr (III)	5	0.070%	0.085%	Insignificant
Cr (VI)	0.0002	1748%	2128%	Potentially significant
Co	1	0.0031%	0.0078%	Insignificant
Cu	10	0.054%	0.082%	Insignificant
Pb	0.25	0.81%	2.6%	Insignificant
Mn	0.15	0.32%	1.8%	Insignificant
Ni	0.02	17.9%	22.0%	Insignificant
V	5	0.0026%	0.025%	Insignificant
Zn	50 (a)	0.019%	0.019%	Insignificant

(a) As zinc oxide

Table 12: Maximum Short-Term Trace Metal Concentrations

Pollutant	EAL (µg/m^3)	PC (% of EAL)	PEC (% of EAL)	Significance
Tl	30	0.024%	n/a	Insignificant
Sb	150	0.011%	n/a	Insignificant
Cr (III) (a)	150	0.093%	0.094%	Insignificant
Cr (VI) (a)	3	4.7%	4.7%	Insignificant
Co	30	0.042%	0.045%	Insignificant
Cu	200	0.11%	0.11%	Insignificant
Mn	150	0.013%	0.016%	Insignificant
V	1	0.090%	0.038%	Insignificant
Zn	1000 (a)	0.038%	n/a	Insignificant

(a) As zinc oxide

The maximum predicted annual mean concentrations at the identified receptors are insignificant for all trace metals except Cr(VI). For this pollutant the maximum process contribution is significantly in excess of the EAL, however information is not available regarding the proportion of the total chromium emission that is in the hexavalent form. For all trace metals the maximum predicted concentrations occur at

Glanmychydd-Fach. On this basis the indicated modelled hexavalent chromium emissions are considered unrepresentative of the overall site impacts.

The short-term impacts are insignificant (<10% of the EALs) for all trace metals.

5.2 Habitat Impact

5.2.1 Airborne Concentrations of NOx and NH_3

Predicted maximum ground level concentrations of NOx and NH_3 at the identified habitat sites are compared with the relevant critical levels in Tables 13 and 14.

Table 13: Predicted Maximum NOx Concentrations as a Percentage of the Critical Levels

Habitat Site	Annual Mean		24-Hour Mean	
	PC	PEC	PC	PEC
Llantrisant Common and Pastures SSSI	0.70%	58.7%	3.8%	31.2%
Rhos Tonyrefail SSSI	0.20%	40.3%	1.1%	20.0%
Cardiff Beech Woods SAC	0.012%	63.0%	0.047%	29.8%
Critical Level	*30*		*75*	

Table 14: Predicted Maximum NH_3 Concentrations as a Percentage of the Critical Level

Habitat Site	Annual Mean	
	PC	PEC
Llantrisant Common and Pastures SSSI	0.57%	50.6%
Rhos Tonyrefail SSSI	0.16%	49.5%
Cardiff Beech Woods SAC	0.0088%	50.7%
Critical Level	*3*	

The maximum predicted NOx and NH_3 concentrations at the identified habitat sites are less than 1% and 10% of the relevant long and short-term critical levels respectively; therefore the impact of the facility is insignificant.

5.2.2 Eutrophication

Predicted maximum nutrient nitrogen deposition rates are compared with the critical loads (CL) for eutrophication in Table 15.

Table 15: Predicted Eutrophication Rates

Habitat Site	Critical Load (kg N/ha/yr)	PC (% of CL)	PEC (% CL)
Llantrisant Common and Pastures SSSI	10	0.58%	196%
Rhos Tonyrefail SSSI	5	0.33%	432%
Cardiff Beech Woods SAC	10	0.015%	307%

Due to the high background nitrogen deposition rates, the critical load is exceeded at all of the habitat sites, however the predicted contributions from the facility are less than 1% of the critical load and therefore considered insignificant.

6. CONCLUSIONS

Detailed air quality modelling using the AERMOD 7 dispersion model has been carried out to determine the local air quality impacts associated with existing emissions from the Royal Mint works at LLantrisant, South Wales.

The stack emissions used in the assessment have been determined from recent sampling at the facility. Predicted pollutant concentrations at sensitive receptor locations are insignificant compared with the air quality standards and objectives set for the protection of human health.

At the identified habitat sites, the predicted process contributions are insignificant compared with the relevant critical levels and critical loads for nutrient nitrogen deposition.

Based on the above information, it is considered that current operations at the Site are not adversely impacting on local air quality.

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Appendix A – Air Quality Terminology

Term	Definition
Accuracy	A measure of how well a set of data fits the true value.
Air quality objective	Policy target generally expressed as a maximum ambient concentration to be achieved, either without exception or with a permitted number of exceedences within a specific timescale (see also air quality standard).
Air quality standard	The concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on the assessment of the effects of each pollutant on human health including the effects on sensitive sub groups (see also air quality objective).
Ambient air	Outdoor air in the troposphere, excluding workplace air.
Annual mean	The average (mean) of the concentrations measured for each pollutant for one year. Usually this is for a calendar year, but some species are reported for the period April to March, known as a pollution year. This period avoids splitting winter season between 2 years, which is useful for pollutants that have higher concentrations during the winter months.
AQMA	Air Quality Management Area.
DEFRA	Department for Environment, Food and Rural Affairs.
Exceedence	A period of time where the concentrations of a pollutant is greater than, or equal to, the appropriate air quality standard.
Fugitive emissions	Emissions arising from the passage of vehicles that do not arise from the exhaust system.
LAQM	Local Air Quality Management.
NO	Nitrogen monoxide, a.k.a. nitric oxide.
NO_2	Nitrogen dioxide.
NO_x	Nitrogen oxides.
O_3	Ozone.
Percentile	The percentage of results below a given value.
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10 micrometres.
ppb parts per billion	The concentration of a pollutant in the air in terms of volume ratio. A concentration of 1 ppb means that for every billion (10^9) units of air, there is one unit of pollutant present.
ppm parts per million	The concentration of a pollutant in the air in terms of volume ratio. A concentration of 1 ppm means that for every billion (10^6) units of air, there is one unit of pollutant present.
Ratification (Monitoring)	Involves a critical review of all information relating to a data set, in order to amend or reject the data. When the data have been ratified they represent the final data to be used (see also validation).
µg/m³ micrograms per cubic metre	A measure of concentration in terms of mass per unit volume. A concentration of 1ug/m3 means that one cubic metre of air contains one microgram (millionth of a gram) of pollutant.
UKAS	United Kingdom Accreditation Service.
Uncertainty	A measure, associated with the result of a measurement, which characterizes the range of values within which the true value is expected to lie. Uncertainty is usually expressed as the range within which the true value is expected to lie with a 95% probability, where standard statistical and other procedures have been used to evaluate this figure. Uncertainty is more clearly defined than the closely related parameter 'accuracy', and has replaced it on recent European legislation.
USA	Updating and Screening Assessment.
Validation (modelling)	Refers to the general comparison of modelled results against monitoring data carried out by model developers.
Validation (monitoring)	Screening monitoring data by visual examination to check for spurious and unusual measurements (see also ratification).
Verification (modelling)	Comparison of modelled results versus any local monitoring data at relevant locations.

Appendix B – Air Quality Standards and Objectives

Pollutant	Averaging Period	EAL / AQS (μg/m³)	Comments
Nitrogen dioxide (NO_2)	annual	40	UK AQO
	1-hour	200	UK AQO, not to be exceeded more than 18 times per annum, equivalent to the 99.8th percentile of 1-hour means
Hydrogen Chloride (HCl)	1-hour	750	EPAQS Guideline Value
Sulphuric Acid (H_2SO_4)	Annual	10	EAL derived from long-term occupational exposure limits
	1-hour	300	EAL derived from long-term occupational exposure limits as no short-term limit exists
Ammonia (NH_3)	Annual	180	EAL derived from long-term occupational exposure limits
	1-hour	2,500	EAL derived from long-term occupational exposure limits as no short-term limit exists
Antimony (Sb)	annual	5	EAL derived from long-term occupational exposure limits
	1-hour	150	EAL derived from long-term occupational exposure limits as no short-term limit exists
Arsenic (As)	annual	0.003	EPAQS Guideline Value
Cadmium (Cd)	annual	0.005	WHO Guideline Value
Chromium III (CrIII)	annual	5	EAL derived from long-term occupational exposure limits
	1-hour	150	EAL derived from long-term occupational exposure limits as no short-term limit exists
Chromium VI (CrVI)	annual	0.0002	EPAQS Guideline Value
Cobolt (Co)	annual	1	EAL derived from long-term occupational exposure limits
	1-hour	30	EAL derived from long-term occupational exposure limits as no short-term limit exists
Copper (Cu)	Annual	10	Copper as dusts and mists. EAL derived from long-term occupational exposure limits
	1-hour	200	EAL derived from short-term occupational exposure limits
Manganese (Mn)	Annual	0.15	WHO Guideline Value
	1-hour	150	EAL derived from long-term occupational exposure limits as no short-term limit exists

Lead (Pb)	1-hour	0.25	UK AQO
Mercury (Hg)	annual	0.25	EAL derived from long-term occupational exposure limits
	1-hour	7.5	EAL derived from long-term occupational exposure limits as no short-term limit exists
Nickel (Ni)	annual	0.02	EPAQS Guideline Value
Thallium(Tl)	annual	1	EAL derived from long-term occupational exposure limits
	1-hour	30	EAL derived from long-term occupational exposure limits as no short-term limit exists
Vanadium (V)	annual	5	EAL derived from long-term occupational exposure limits
	24-hour	1	WHO Guideline Value
Zinc Oxide (ZnO)	annual	50	EAL derived from long-term occupational exposure limits
	1-hour	1,000	EAL derived from long-term occupational exposure limits as no short-term limit exists

Appendix C – Dispersion Model Input Parameters

Table C1: Emission Parameters

Parameter / Sources	A1, A2, A8	A9	A10	A15, A16	A17, A18, A19, A21, A25	A22	A23, A24	A30, A31
Stack height (m)								
Stack exit diameter (m)	0.75	0.55	0.45	0.90	0.25	0.30	0.30	0.20
Temperature of release (K)	286	293	295	293	335	311	352	294
Actual flow rate (Am3/s)	7.4	3.6	2.7	10.1	0.84	1.3	1.0	0.48
Normalised flow rate (Nm^3/s) (a)	7.0	3.4	2.5	9.3	0.68	1.1	0.80	0.44
Emission velocity at stack exit (m/s)	16.8	15.3	16.8	15.9	17.1	17.8	14.7	15.3
Emission Concentration (mg/Nm^3)								
HCl	0.53	0.30	0.030	0.17				0.066
H_2SO_4	0.48	0.43	0.25	0.36	0.50	0.33	0.65	0.459
NOx	0.51	0.20	0.0070	0.30	14.2	0.16	0.89	0.42
NH_3					0.77	0.91	0.86	
Cd				0.00078				
Tl				0.0023				
As				0.0014				
Sb				0.0050				
Cr				0.044				
Co				0.00039				
Cu				0.067				
Pb				0.025				
Mn				0.0060				
Ni				0.045				
Sn				0.0011				
V				0.0016				
Zn				0.12				
Emission Rate (g/s)								2.9×10^{-5}
HCl	0.0037	0.0010	7.4×10^{-5}	0.0016	3.4×10^{-4}	3.6×10^{-4}	5.2×10^{-4}	2.0×10^{-4}
H_2SO_4	0.0034	0.0015	0.00062	0.0033	0.0097	1.8×10^{-4}	7.2×10^{-4}	1.9×10^{-4}
NOx	0.0036	6.8×10^{-4}	1.7×10^{-5}	0.0028	5.2×10^{-4}	0.0010	6.9×10^{-4}	
NH_3								

Cd	7.2×10^{-6}	
Tl	2.1×10^{-5}	
As	1.3×10^{-5}	
Sb	4.6×10^{-5}	
Cr	4.0×10^{-4}	
Co	3.6×10^{-6}	
Cu	6.2×10^{-4}	
Pb	2.4×10^{-4}	
Mn	5.5×10^{-5}	
Ni	4.1×10^{-4}	
Sn	1.0×10^{-5}	
V	1.5×10^{-5}	
Zn	0.0011	

(a) At 273.15K, and 101.3 mb

Appendix D – Windroses by year, Rhoose

Figure D1: 2005

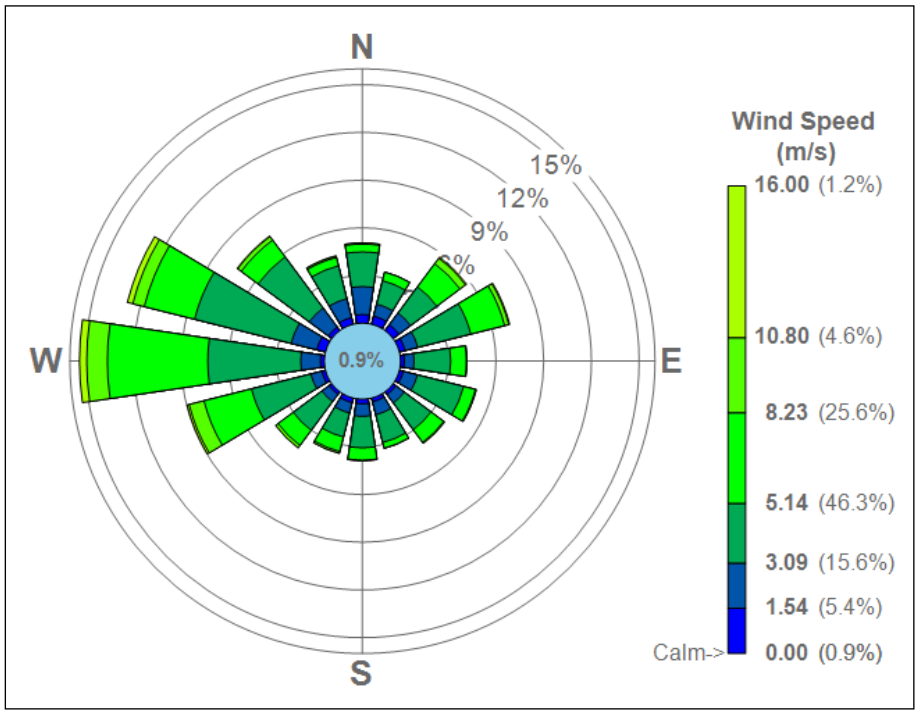


Figure D2: 2006

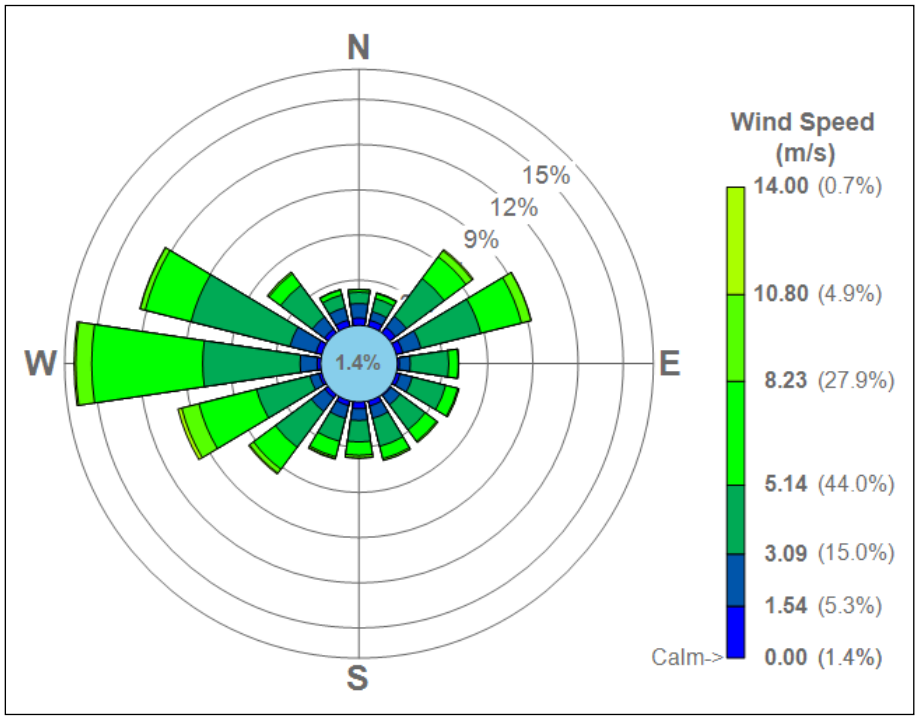


Figure D3: 2007

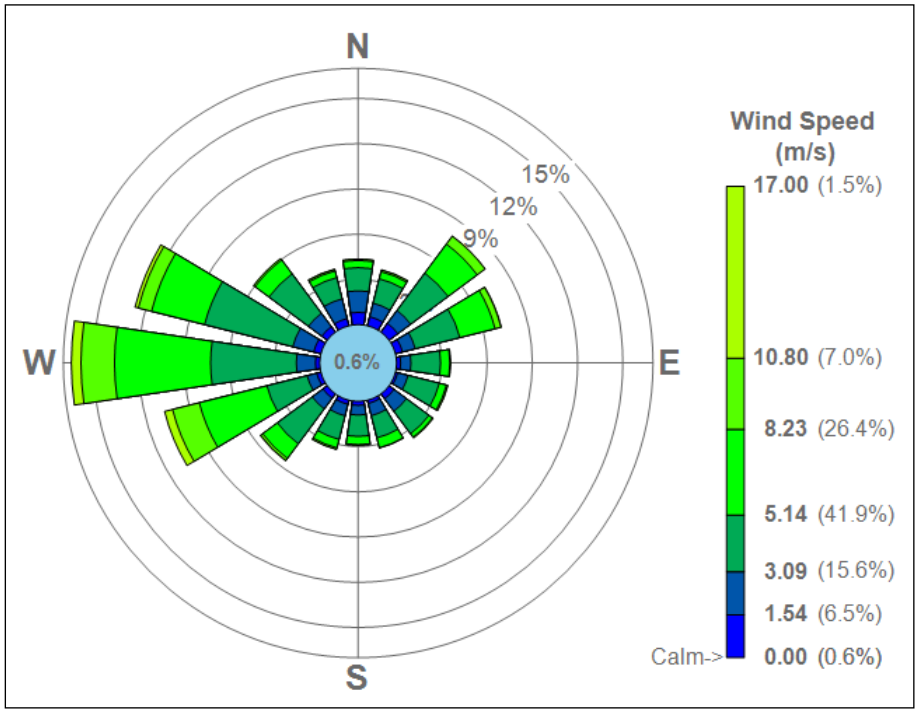


Figure D4: 2008

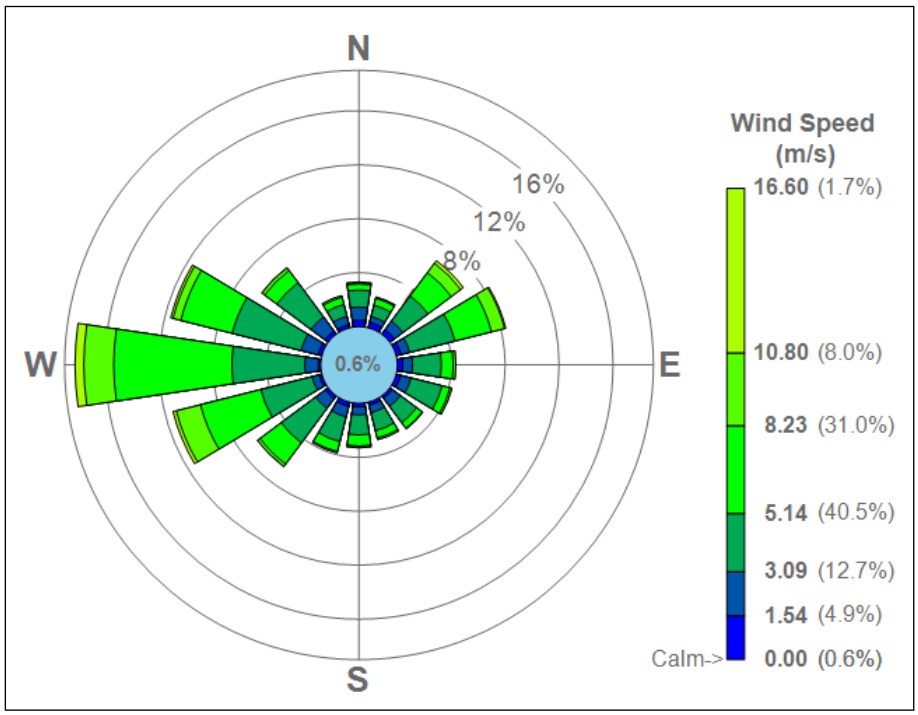
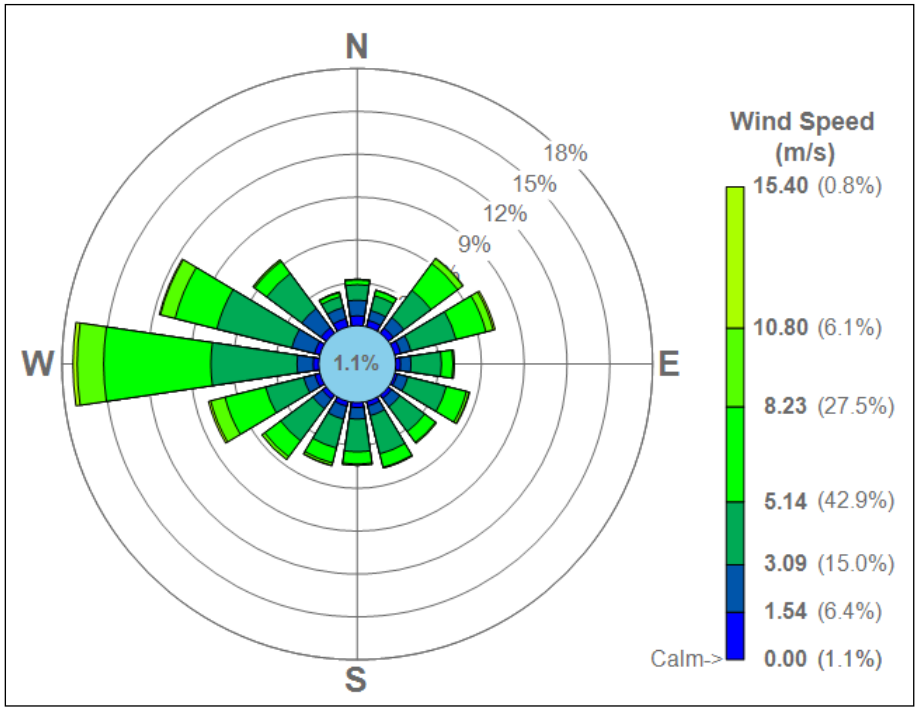


Figure D5: 2009



Appendix E – Environmental Assessment Levels for the Protection of Vegetation and Ecosystems

Critical Levels

Critical levels are thresholds of airborne pollutant concentrations above which damage may be sustained to sensitive plants and animals.

The critical levels for the protection of vegetation and ecosystems (as defined by the EU Directive 2008/50/EC and the 2010 UK Air Quality Standards Regulations) that are relevant to the assessment are summarised in Table E1.

Table E1: Critical Levels for the Protection of Vegetation and Ecosystems

Pollutant	Averaging Period	Concentration (µg/m^3)
Oxides of Nitrogen (NOx)	Annual Mean	30
	24-Hour Mean	75
Ammonia (NH_3)	Annual Mean	1 (ecosystems with lichen and bryophytes)
	Annual Mean	3 (all other ecosystems)

The critical levels are based on monitoring criteria and only apply in the following areas:

- more than 20 km from agglomerations; and
- more than 5 km away from other built up areas, industrial installations motorways and major roads with a traffic count of more than 50,000 vehicles per day.

Nationally, around 37% of designated sites currently do not fall within the above criteria and are therefore excluded from the objectives. None of the habitat sites within 10 km of the facility are sufficiently rural for the objectives to apply; however, the Environment Agency's H1 guidance states that:

"the critical levels should be applied at all locations as a matter of policy, as they represent a standard against which to judge ecological harm".

Critical Loads

Critical loads refer to the threshold beyond which deposition of pollutants to water or land results in measurable damage to vegetation and habitats. This takes the form of either gravitational settling of particulate matter (dry deposition) or wet deposition, where atmospheric pollutants dissolve in water vapour and then precipitate to the ground (e.g. as rain, snow, fog etc.).

Critical loads for eutrophication (nutrient nitrogen deposition) and background nutrient nitrogen deposition rates have been obtained from the Air Pollution Information System (APIS) and are summarised in Table E2 for the identified habitat sites.

Table E2: Critical Loads (Eutrophication) and Background Nutrient Nitrogen Deposition

Habitat Site	Primary Sensitive Habitat	Critical Load (kg N/ha/a)	Background N Deposition (kg N/ha/a)
Llantrisant Common and Pastures SSSI	Lowland Hay Meadow	10	19.5
Rhos Tonyrefail SSSI	Blanket Bog	5	21.6
Cardiff Beech Woods SAC	Woodland	10	30.7

The background nutrient nitrogen deposition rate exceeds the critical load at all of the identified habitat sites.