Appendix 9.1

Air Quality Assessment Levels

Appendix 9.1: Air Quality Assessment Levels

Table 9.1: Air Quality Strategy Objective Levels and Environmental Assessment Levels

Pollutant	Averaging Period	AQO / EAL ($\mu g/m^3$)	Comments
Nitrogen Dioxide (NO_2)	Annual	40	UK AQO and EU Limit Value
	1-Hour	200	UK AQO and EU Limit Value, not to be exceeded more than 18 times per annum, equivalent to the 99.8th percentile of 1-hour means
Sulphur Dioxide (SO_2)	24-Hour	125	UK AQO and EU Limit Value, not to be exceeded more than 3 times per annum, equivalent to the 99.2nd percentile of 24-hour means
	1-Hour	350	UK AQO and EU Limit Value, not to be exceeded more than 24 times per annum, equivalent to the 99.7th percentile of 1-hour means
	15-minute	266	UK AQO, not to be exceeded more than 35 times per annum, equivalent to the 99.9th percentile of 15-minute means
Carbon Monoxide (CO)	8-hour	10,000	UK AQO and EU Limit Value
	1-hour	30,000	EAL
Particulate Matter (PM_{10})	Annual	40	UK AQO and EU Limit Value
	24-hour	50	UK AQO and EU Limit Value, not to be exceeded more than 35 times per annum, equivalent to the 90.4th percentile of 24-hour means
Particulate Matter ($PM_{2.5}$)	Annual	25 (a)	EU Limit Value
Benzene (C_6H_6)	Annual	5	AQO and EU Limit Value
	24-hour	30	EAL

Pollutant	Averaging Period	AQO / EAL (μg/m^3)	Comments
Hydrogen Chloride (HCl)	1-hour	750	EAL
Hydrogen Fluoride (HF)	Monthly	16	EAL
	1-hour	160	EAL
Antimony (Sb)	Annual	5	EAL
	1-hour	150	EAL
Arsenic (As)	Annual	0.006	EU Target Value and EAL
Cadmium (Cd)	Annual	0.005	EU Target Value
Chromium III and Compounds (CrIII)	Annual	5	EAL
	1-hour	150	EAL
Chromium VI (CrVI)	Annual	0.00025	EAL
Cobalt (Co)	Annual	1	EAL
	1-hour	30	EAL
Copper (Cu)	Annual	10	EAL
	1-hour	200	EAL
Manganese (Mn)	Annual	0.15	EAL
	1-hour	1500	EAL
Lead (Pb)	Annual	0.25	UK AQO
Mercury (Hg)	Annual	0.25	EAL
	1-hour	7.5	EAL
Nickel	Annual	0.02	EU Target Level
Thallium (Tl)	Annual	1	EAL
	1-hour	30	EAL
Vanadium (V)	Annual	5	EAL
	24-hour	1	EAL
Polycyclic Aromatic Hydrocarbons (PAH) as Benzo [a] Pyrene (B[a]P)	Annual	0.001	EU Target Level
	Annual	0.00025	EAL
Polychlorinated Biphenyls (PCBs)	Annual	0.2	EAL
	1-hour	6	EAL
Ammonia (NH_3)	Annual	180	EAL
	1-hour	2500	EAL

Appendix 9.2

Dust and Particulate Emission Management Plan

Dust and Particulate Emission Management Plan

Biomass UK No.2 Ltd

Renewable Energy Generation Facility

Woodham Road

Barry

CF63 4JE

Environmental Permit Reference: EPR/AB3790ZB

Contents

Version	Date	Reviewed by	Change
1	October 2017	Steve Butler	Original
2	March 2018	Steve Butler	Updated to Correct Waste Code

1. Introduction

The purpose of this Dust and Particulate Emission Management Plan D&PEMP is to show that any potential dust produced by the proposed renewable energy generation facility at Woodham Road, Barry will be managed effectively and with no impact to the neighbouring environment. The site is located at Woodham Road, Barry, CF63 4JE.

The site is not located within an Air Quality Management Area, though is within close vicinity of sensitive resisdential dust receptors.

This D&PEMP should be read in conjunction with the suite of Environmental Management documents and associated operational control documents for the Site. This document provides guidance and information on the additional procedures for the control of other amenity issues, routine monitoring requirements and record management.

Biomass UK No.2 Ltd.'s ('BUK2') management team is committed to manage pollution risk from the permitted activities and will ensure that the facility is operated in full compliance with the conditions stipulated within the Environmental Permit.

This commitment includes making all necessary plant and infrastructure investments required to meet the environmental permit conditions, protect the environment and human health. The proposed design for the Barry development is largely driven by this desire and need to limit potential adverse effects of operations.

This D&PEMP has been written as a separate component of the Environmental Management System, so that it can be reviewed at least annually as a matter of routine and at additional times to reflect proactive improvements in management techniques. In addition, it will be reviewed following any incidents or issues identified on site.

All staff will be trained within the D&PEMP and a copy of the plan will be accessible to all staff at any time.

It should be noted that the site has limited potential to cause offsite dust emissions and impacts under normal operating conditions, due to the low dust generation of site activities and the control measures outlined within this document.

Potential emissions from the facility would only arise from the following sources as a result of abnormal events or emergency activities:

- Unloading, movement and transfer of shredded wood material;
- Storage of shredded wood in fuel storage building;
- Emissions from the combustor flue; and
- Collection and transport offsite of ash material.

The main areas of dust control for this site relate to:

- The Fuel Storage Building;
- External Ash Silos; and
- Plant within the Main Process Building.

The primary control measure on site is the unloading, storage and processing of all wood internally within the Fuel Storage Building which incorporates an air extraction and filtration system. Other dust control measures and a visual monitoring regime are detailed within this document.

A summary of the key control measures on site are as follows:

- Stringent Pre-acceptance and Acceptance Procedures to minimise the presence of high dust content (fines) fuel feedstock materials onsite;
- The reception and storage of all shredded wood feedstocks internally within a sealed enclosed Fuel Storage Building;
- Fast roller shutter doors fitted to the Fuel Storage building;
- The use of an extraction and filtration system within the Fuel Storage Building to prevent emissions;
- Washing of wheels on site for any vehicles which may require it;
- All relevant plant / equipment is fitted with dust abatement technology;
- The boiler system is run under negative pressure;
- Use of sealed silos for ash collection, storage and transfer;
- Continual visual monitoring during plant operation and daily visual inspection during site walkover procedures; and
- General site maintenance and good housekeeping measures.

Site personnel will be trained to be vigilant for dust levels on site and its potential migration and will be instructed to report any such potential or actual emissions immediately to Site Management.

1.1 Sensitive Receptors

The nearest sensitive receptors that have been identified around the site are detailed in the Table 1 overleaf and illustrated in the Figure 1.1.

The distances between the permitted site and the receptors, have been estimated using online maps of the area.

It is generally understood that the greater the distance from the site the less potential impacts of the emissions, due to ‘drop out’ and deposits.

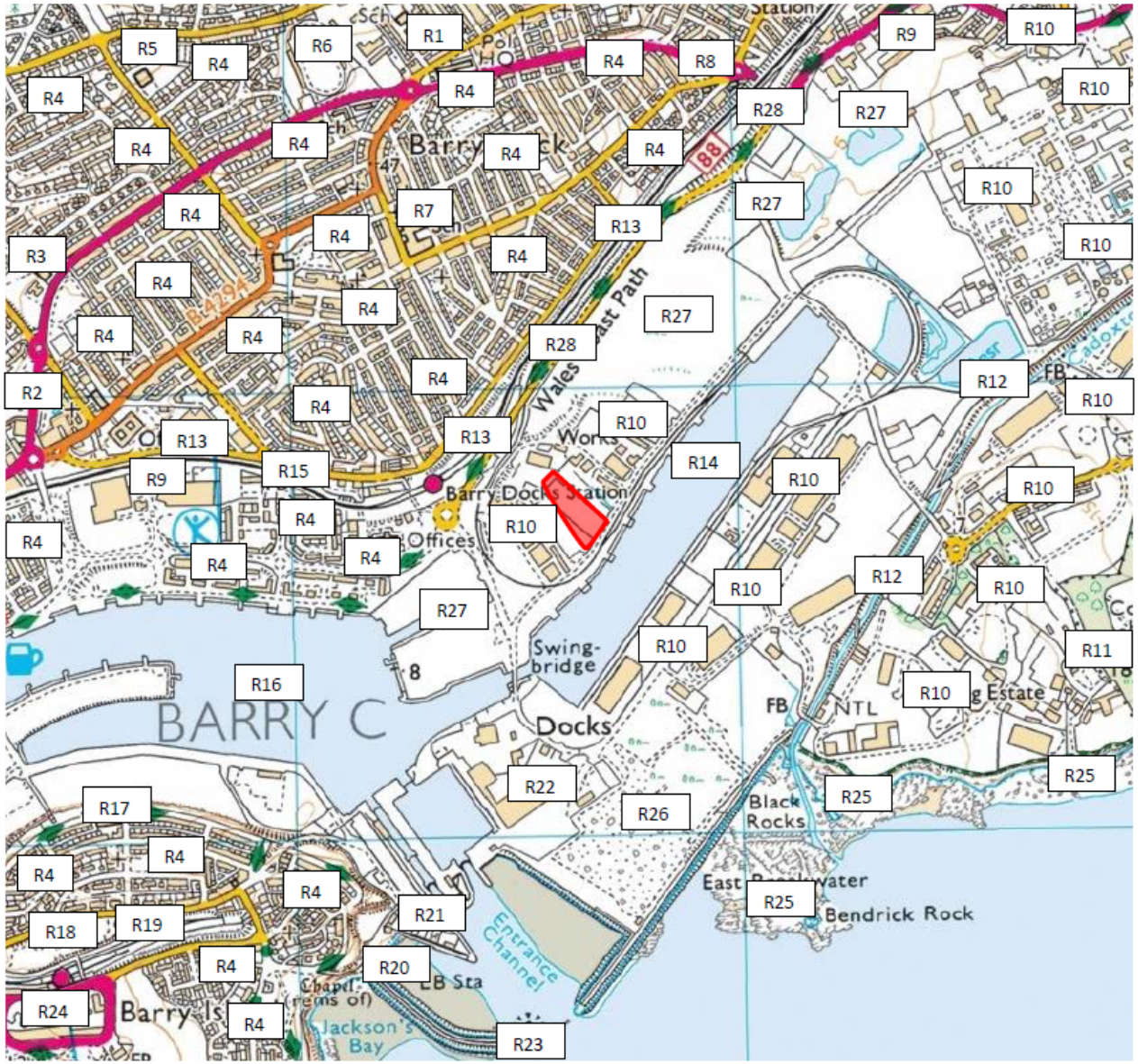
However, the operator also recognises that local ambient weather conditions and surrounding buildings can have an impact on the pathway, by causing eddy-current effects on the prevailing wind.

The site lies in a predominantly industrial setting. The closest residential development to the site is located on Dock View Road, 370 m north of the site.

In the vicinity of the permitted site, potential emission sources comprise other industrial / commercial operations which have associated areas of unpaved/unsurfaced land.

These sources have the potential to emit dust and will contribute to the ambient dust environment.

Table 1: Receptor Sensitivity				
Receptor No.	Receptor Name	Direction and Approximate Distance from Site	Sensitivity	Risk / Likelihood of Impact
R1	Jenner Park Primary School	1 km north	High Sensitivity	Low
R2	Memo Arts Centre / Theatre	1.1 km west	Medium Sensitivity	Low
R3	Gladstone Primary School	1.1 km northwest	High Sensitivity	Low
R4	Residential Receptors	250 m north, 450 m west, 880 m southwest	High Sensitivity	Medium/ Low
R5	St Helens R.C Junior School	1.2 km northwest	High Sensitivity	Low
R6	Barry Town United FC	1 km north	Medium Sensitivity	Low
R7	Holton Primary School	600 m north	High Sensitivity	Medium / Low
R8	Barry Mosque	980 m northeast	Medium Sensitivity	Low
R9	Retail Units	1 km northeast	Low Sensitivity	Low
R10	Industrial Units	Adjacent east and west, 250 m south	Low Sensitivity	Low
R11	HMS Cumbria	1.1 km southeast	Low Sensitivity	Low
R12	Cadoxton River	600 m southeast	Medium Sensitivity	Low
R13	Railway Line	150 m north	Low Sensitivity	Low
R14	Entrance Channel	780 m southwest	Low Sensitivity	Low
R15	Waterfront Medical Centre (GP)	850 m west	High Sensitivity	Medium / Low
R16	Barry Dock	50 m south	Low Sensitivity	Low
R17	Barry Island Primary School	1 km southwest	High Sensitivity	Medium / Low
R18	Maslin Park	1.2 km southwest	Medium Sensitivity	Low
R19	Barry Island Train Station	1.3 km southwest	Low Sensitivity	Low
R20	Barry Yacht Club	920 m southwest	Medium Sensitivity	Low
R21	Barry Dock Lifeboat Station	890 m southwest	Low Sensitivity	Low
R22	Associated British Ports Barry	475 m south	Low Sensitivity	Low
R23	Barry Docks Light house	1 km south	Low Sensitivity	Low
R24	Barry Island Pleasure Park	1.4 km southwest	Medium Sensitivity	Low
R25	SSSI (Hayes Point to Bendrick Rock)	700 m south	High Sensitivity	Medium / Low
R26	Solar PV Farm	430 m south	Medium Sensitivity	Low
R27	Unoccupied Land	200 m northeast	Low Sensitivity	Low
R28	A4055 Road	980 m north	Low Sensitivity	Low



Receptor No.	Receptor Name
R1	Jenner Park Primary School
R2	Memo Arts Centre / Theatre
R3	Gladstone Primary School
R4	Residential Receptors
R5	St Helens R.C Junior School
R6	Barry Town United FC
R7	Holton Primary School
R8	Barry Mosque
R9	Retail Units
R10	Industrial Units
R11	HMS Cumbria
R12	Cadoxton River
R13	Railway line
R14	Entrance Channel
R15	Waterfront Medical Centre (GP)
R16	Barry Dock
R17	Barry Island Primary School
R18	Maslin Park
R19	Barry Island Train Station
R20	Barry Yacht Club
R21	Barry Dock lifeboat station
R22	Associated British Ports Barry
R23	Barry Docks lighthouse
R24	Barry Island Pleasure Park
R25	SSSI (Hayes point to Bendrick Rock)
R26	Solar PV Farm
R27	Unoccupied Land
R28	A4055 Road

Figure 1.1: Closest Sensitive Properties

1.2 Weather Conditions

The prevailing wind conditions at the site are predominantly from the west. The site location, on the coast in South Wales, is also considered to be in an area with high precipitation.

Wind direction will determine the distribution of dust if emitted from the plume. As such, the exhaust flue is located in the south west of the site, furthest from the sites eastern boundary. Daily checks of the weather conditions will be undertaken as will visual monitoring of the plume as part of the daily site walkover. Continuous monitoring for dust emissions will also be undertaken during plant operation as part of the CEMS (Continuous Emissions Monitroing System), on the exhaust flue.

The internal nature of the unloading and storage of the shredded wood means that the weather conditions have no impact on this aspect of the sites operations.

2 Operations at Barry Renewable Energy Generation Facility

2.1 Waste Wood Deliveries and Processing

The transport of waste wood into the facility and deposit of materials during delivery has the potential to result in dust emissions in some cases such as;

- the direct escape of material from vehicles;
- the process of unloading vehicles;
- deposits on roads via the wheels when the vehicle leaves the site;
- processing of material (screening and sampling); and
- transferral of material from storage bays to fuel transfer system via mechanical loading shovels.

All of these sources are prevented and minimised at site through the following measures;

- Prior to wood fuel receipt, inspections are completed by the management team to ensure the quality of wood is acceptable in accordance with site waste pre-acceptance procedures. No inherently dusty or fines materials will be accepted at the site.
- All wood fuel delivered to site via road will be in covered walking floor transporters, which are sealed to prevent any material escape and mechanically deposit the material at slow speed and at low tipping height, reducing potential for dust release and migration;
- Every load received onsite is subject to inspection by trained operations staff. Loads will be rejected in the event of the material being particularly dusty.
- The process of unloading and subsequent transfer takes place internally within the Fuel Storage Building;
- Electrical '*Fast Action'* Roller Doors are used for entrance / egress from the Fuel Storage Building;
- Air from within the Fuel Storage Building is extracted via a filtration system in the push floor area which removes dust from the fuel storage building and abated prior to release to atmosphere;
- The fuel storage building is equipped with a push floor which uses a conveyor system to transport waste wood to the gasifier, this minimises double handling and tipping (and hence minimises dust creation) through shovel loaders;
- Prior to leaving the Fuel Storage Building, vehicle wheels will be checked for dust and washed if required;
- None of the materials processed at site will be deposited on site roads or tracked over by vehicles; and
- All roads are constructed of sealed concrete hardstanding, which avoids dust generated from un-paved surfaces during dry weather.

As part of the pre-acceptance / acceptance procedures, no potential dry/fines containing loads will be accepted on site. All wastes accepted on site are subject to stringent waste acceptance criteria in accordance with the site environmental management plan and associated procedures:

- BUK-E01 Pre-acceptance Procedure;
- BUK-E02 Waste Acceptance Procedure; and
- BUK-E03 Waste Rejection Procedure.

All fuel feedstocks will be accepted on site in accordance with the procedures outlined above. If any waste is inspected and found to contain fines, powders or excessively dusty materials above the contracted acceptance specification, then the load will be immediately rejected off site in accordance with site procedures.

Incoming loads are reported to the site manager and respective staff by the weighbridge personnel upon arrival and will be directed to the Fuel Storage Building via the designated access route and electrically operated roller shutter doors. A check will be made that the waste load has be Pre-accepted in accordance with procedure BUK-E01 and the load is inspected for any non-conforming materials.

Details including the following are recorded for each load:

- Date and time of delivery
- Details and description of the vehicle delivering the waste, drivers name and vehicle operator; and
- Description of the waste including type and quantity.

Please refer to Table 2.1 which identifies all fuel grade materials accepted at the site.

Table 2.1: Typical Waste Types brought to Barry Renewable Energy Generation Facility

Table 2.1 Typical waste types				
European Waste Code (EWC)	Product Description	Tonnes/year	Destination within Facility	Process
19 12 07	'Fuel Grade' Mixed Waste Wood	86,400	Waste Wood will be stored within the Fuel Storage Building prior to use as a fuel for the gasification process.	Combustion

2.2 Overview of Gasification Process and Dust Controls

The site layout includes the following key areas:

Table 2.2: Overview of Proces and Dust controls			
Area	**Purpose**	**Potential for dust releases?**	**Control Measure**
Fuel Storage Building:	For the delivery and reception of mixed waste wood feedstocks including an enclosed transfer system;	YES	• Enclosed Building • Covered Delivery • Extraction Systems • Wheelwash
Waste Processing:	For the screening and sampling of the fuel feedstocks before being delivered to the gasification unit;	YES	• Internal Process • Building Extraction and Abatement • Covered Enclosed Conveyors
Fluidised Bed Gasification System:	Comprising a gasification line for the thermal conversion and combustion of syngas from the fuel feedstocks;	YES	• Fully enclosed ash handling process
Steam Turbine Generator:	Comprising a steam turbine and generator for the conversion of steam into electricity within a steam turbine; and	NO	Fully enclosed process
Gas Cleaning and Pollution Abatement Plant:	Consisting of selective non-catalytic reduction (SNCR) and selective catalytic reduction (SCR) for the reduction of Nitrogen Oxides (NOx), sorbent injection for acid gas neutralisation and activated carbon powder injection for absorption and removal of heavy metals, dioxins, VOC and other harmful substances.	YES	• Sealed reagent hoppers • Baghouse filtration • Sealed ash silos

In addition, ancillary infrastructure also includes two externally located ash silos, air cooled codensers / cooling plant and a 44m high exhaust stack.

Please refer to the site layout below which identifies the key areas mentioned above.


Fuel Storage Building
Feedstock Reception Area
Gasifier
Main Process Building
Flue Gas Treatment and Exhaust
Combustor Flue (A1)
Ash Silos
Air Blast Cooler
Generator and Fuel Tank
Substation and Transformer Compound
Welfare and Turbine Building
Weighbridge
Steam Turbine
Air Cooled Condenser
Fire Water Tank and Pumphouse
01
02
03
04
05
06
07
08
09
10
11
WOODHAM ROAD
DAVID DAVIES ROAD
SITE PLAN

The main gasification activity has the potential to produce dust in the form of ash as part of the combustion process. The ash is formed in the following locations:

- Boiler;
- Multicyclone;
- Economiser; and
- Air pollution devices.

Ash Handling and Disposal
A mechanical ash system is provided for continuous collection and transport from each discharge point of the process to a multi-day storage tank. A rapid unloading and conditioning system is included to empty the ash storage tank into sealed articulated vehicles for removal from site.

All ash handling processes are fully contained and have limited potential for dust release.

Ash Pick-up and Conveyance (to Storage)
The Installation has two ash systems.

- The first system handles the ash from the boiler, multiclone and the economiser; and
- The second system will remove and store the ash from the air pollution control devices.

The boiler / multiclone / economiser system starts from the discharge flange of a manual isolation valve and powered seal valve on each ash collection hopper.

Ash from the boiler hopper seal valves discharge to a water cooled mechanical conveyor transporting the high temperature ash to downstream collection conveyors.

A series of mechanical collection conveyors pick up ash from the multiclone and economiser hoppers and transports it to the boiler / multiclone / economiser lift elevator for discharge into the ash silo for storage.

As this is a water cooled conveyor, the ash is transported in wet form, which significantly reduces the potential for dust generation.

The air pollution control ash system is a mechanical system that includes the required components to collect and transport ash from each ash hopper on the pollution control system to a second ash storage tank dedicated to store ash from these components. This generally consists of a bag house filter as part of the flue gas cleaning process.

Ash Storage and Conditioning System
The storage tank for the boiler / multiclone / economiser system provides approximately 212m^3 of storage.

The storage tank for the air pollution control equipment provides approximately 141m^3 of storage. Each tank is equipped with a fabric filter bin vent that filters the air of particulate prior to venting to atmosphere. The

storage system is complete with supports, fluidising nozzles to enhance mass flow and an isolation slide gate valve in the lower cone section. The discharge is elevated to facilitate unloading into sealed trucks.

An ash wetting system is included to condition the fly ash and suppress fugitive dust during the normal unloading operation from the storage bin.

A pneumatic knife gate and rotary feeder seals the ash tank and discharges ash into the conditioning mixer. The conditioning mixer is equipped with an automated water spray system that wets the ash during the mixing process to reduce fugitive emissions during discharge into truck containers.

A Continual Flue Gas Monitoring System is fitted to the exhaust stack to monitor all dust and gas emissions.

Visual monitoring of the site will be undertaken daily as part of the site walkover, and will include dust sources in the Fuel Storage Building, exhaust stack and ash storage silos.

All site infrastructure, including dust abatement systems will be inspected at least daily and records kept as part of the site routine maintenance inspection programme/procedures.

Site roadways will also be inspected during the daily site walkover and if required a road sweeper will be employed.

For worker, site safety and dust minimisation issues, vehicle speeds will also be limited to 5 mph at all times.

In the event that dust emissions are observed or reported to be leaving the site (i.e. causing nuisance to the sites neighbours), the operation causing the emission will be ceased immediately. This ceasing of operations on site will ensure that the site does not continue to create a nuisance to any nearby receptors.

Please refer to Table 2.2 which identifies the wastes removed from site.

Table 2.2: Typical Destination for Residual Wastes

Table 2.1 Typical Destination for Recovered and Residual Materials: Export from Port Clarence Biomass Processing Plant			
European Waste Code (EWC)	Product Description	Average yearly tonnage	Material End Use
10 01 15	Bottom Ash	3,944	Aggregate
19 01 05*	Fly Ash (Air Pollution Control (APC) Residues)	2,072	Reclaimed and reused offsite
20 03 01	Oversized Particles	88	Reclaimed and reused offsite
02 01 10	Metals	88	Reclaimed and reused offsite
10 01 15	Used Bed Material	400	Aggregate

3 Dust and Particulate (PM_{10}) Management

3.1 Responsibility for Implementation of the D&PEMP

The Site Manager is responsible for the D&PEMP and making sure that the site is compliant at all times.

The technically competent site management team will provide formal training to ensure all site staff are aware of the D&PEMP. Each staff member will receive refresher training on the D&PEMP annually.

The D&PEMP is 'live' and will be reviewed at least annually and after any environmental incidents, significant change to the site activities, or at the request of Natural Resources Wales (NRW).

3.2 Sources and Control of Fugitive Dust / Particulate Emissions

Diffuse emissions from the renewable energy generation facility may arise from abnormal operations regarding the wood storage and processing area, exhaust stack and ash storage and transportation as detailed below:

- *Vehicles entering and/or leaving the site with mud and debris on wheels, and tracking dust on to or off the site.*
  Wood is unloaded within the enclosed Fuel Storage Building which prevents fugitive emissions to atmosphere during unloading. Prior to leaving the site, vehicle wheels are checked for dust and washed if required.

  The site is hard paved only which is a recognised method of reducing dust on site from vehicle movements.

  A site speed limit of 5 mph will be enforced via signage and site staff and management.

- *Wood dust when unloading waste wood from vehicles*
  All vehicles delivering wood to site will be covered walking floor transporters. These vehicles push the material at low level and at low speed into the storage areas. There will be no 'high level' tipping. The dust generated by this process is minimal.

  In addition, wood is unloaded within the enclosed Fuel Storage Building with an active air extraction and filtration system which negates fugitive emissions to atmosphere during unloading.

- *Vehicles and plant moving around the site generating dust*
  Please see above comments regarding emissions from vehicles entering and leaving site.

  A site speed limit of 5 mph will be enforced via signage and site staff and management.

  Mechanical loading shovels are used within the Fuel Storage Building for the transfer of wood fuel from storage piles to the push floor feed system. Prior to movement to another area of site, the

wheels of the vehicles are checked and cleaned prior to leaving the building. Due to the design of the push floor, there is no need to 'lift and tip' the wood fuels and thus dust generation will be naturally minimised.

Site roadways will be assessed as part of the daily site walkover and a road sweeper employed from an external contractor should the need arise.

- *Processing waste wood - screening*
  The processing of the wood feedstock comprises screening and is undertaken within a sealed system. This consists of a conveyor system equipped with a ferrous and non-ferrous metal separator to remove any metals contained within the feedstock materials. Metals will be separated using an overband magnet and segregated into a dedicated container.

  Downstream of the metal separator, the wood chips will travel over a police screen. Oversize feedstock parts will be too large to fall through the screen and will be collected in a separate container. Smaller feedstock parts will be dropped onto a chain conveyor, which will transport the waste wood towards the gasifier metering bins and onwards into the gasifier.

  An air extraction system is in place within the Fuel Storage Building. Air is extracted via the push floor area and the system is fitted with filtration to prevent dust emissions.

- *Waste storage in stockpile*
  Dust will not tend to be generated by the stockpile due to the very low content of fines. In addition, all storage of shredded wood is undertaken within the enclosed Fuel Storage Building with an active extraction and filtration system.

- *Particulate emissions from the exhaust stack*
  A flue gas treatment system is employed to remove particulates from the stack prior to emission to atmosphere. Particulate in the gas stream is captured in a pulse-jet baghouse system. The air passes through the filter media, depositing dust on the outside of the bag. The cleaned air passes inside the bag to the clean air chamber at the top of the unit.

  Treated filter ash is retained within the filter unit and is collected directly in a bagging unit located underneath the filter.

  The stack is also fitted with a continuous monitoring system which logs the particulate emission and is fitted with an alarm should abnormal operating conditions arise.

  Visual monitoring of the plume is undertaken daily as part of the site walkover.

- *Bottom Ash Handling and Disposal*
  Bottom ash generated by the combustion process is continually collected from the boiler/economiser/ multicyclone via a series of mechanical conveyors and transported to the

dedicated ash silo for storage. Ash from the boiler is transported in wet form due to the water cooling which acts as effective dust suppression. In addition, the entire system is sealed.

- *APC Residue Handling and Disposal*
  The flue gas cleaning system removed fly ash and absorbents from the flue gas as it passes through the baghouse filter leaving them behind as APC ash. This is recovered from the bottom of the filter and transported via a series of mechanical conveyors to the dedicated ash silo for storage. This entire system is sealed.

- *Ash Storage and Loading*
  Both ash silos are sealed and located externally. They are fitted with fabric filter bin vents to filter the air of particulate prior to venting to atmosphere.

  Both ash types are transported offsite via covered truck containers for offsite recycling. The discharge point on both silos is elevated to facilitate loading of the trucks.

  An ash wetting system involving a conditioning mixer and automated water spray system is incorporated into the silos to reduce fugitive emissions during ash discharge.

- *Particulate emissions from the exhaust of vehicles/ machinery on site.*

  This will not be an issue with regard to off-site emissions. All equipment used on site will be incorporate the latest low emission types of engine ensuring lowest possible levels of particulate arising from this source. The machinery used on site will be subject to a regular preventative inspection and maintenance programme to maintain fuel efficient operations and avoid interruption to processing.

The dust sources on site, pathways, receptors and measures proposed to interrupt those pathways are summarised in Table 3.2.

Table 3.1: Control of Dust / Particulates (PM_{10})

Abatement Measure	Description / Effect	Overall Consideration and implementation
Preventative Measures		**Low Cost Options**
Speed Limit	Vehicle speeds will be limited to 5 mph on site which is a recognised method of controlling dust.	• Fully Implemented
Type of Vehicle and Minimising Drop Heights of Waste	All vehicles delivering wood to site will be covered walking floor transporters. These vehicles push the material at low level and at low speed into the processing area. There will be no 'high level' tipping. An enclosed feed transfer system in the form of a hydraulic push floor screens and transports feedstock from the storage area to the gasifier. This is a system of conveyors with no significant drop heights.	• Fully Implemented
Type of Material Stored on Site	All incoming materials are free from fines and dusts as far as possible and purchased in accordance with a strict specification. There are no fines being generated at site.	• Fully Implemented
Inspection	All plant will be regularly maintained, inspected and kept clean to avoid a build-up of material, which may lead to spillage and emissions.	• Fully Implemented
Visual monitoring	Daily site checks in the form of a walkover will include monitoring for dust around the site, roadways and the plume, taking note of the weather conditions.	• Fully implemented
Road Surfaces	All haul roads are constructed of concrete, there will be no unsurfaced roadways, resulting in dust being minimal. This also makes the roads easy to clean. Roads and surfaces are inspected daily and road sweeping may be undertaken by hire in contractors if required.	• Fully Implemented
Preventative Measures		**Medium Cost Options**
Wetting of bottom ash during transport	Bottom ash from the boiler is collected via a mechanical system and water cooled during transport which provides a form of dust suppression.	• Fully implemented
Sealed coveyor systems	Both the feedstock transfer conveyors and the ash collection system conveyors are located internally and additionally sealed systems to prevent loss of material during transport around the site.	• Fully implemented
Filter bin vents	Both ash silos are fitted with fabric filter ben vents to remove particulates prior to venting to atmosphere.	• Fully implemented

Preventative Measures		High Cost Options
Dedicated enclosed building for storage and processing of waste wood	The reception, processing and transfer of waste wood takes place within a fully enclosed Fuel Storage Building. Access to this building is via electronically operated fast roller shutter doors. The building includes an air extraction system with included filtration to prevent escape of fugitive emissions from the building.	• Fully Implemented – Dedicated Fuel Storage Building has been incorporated onsite.
Flue Gas Treatment System	The removal of particulates from the flue gas prior to emission to atmosphere via a bag house filter system. Removal of the APC ash is undertaken by a mechanical ash conveyor system and transported to the sealed ash silos for disposal. A Continuous Emission Monitoring System (CEMS) is fitted to the flue to monitor emissions of dust and gases to atmosphere.	• Fully implemented
Ash conditioning	Both the ash silos (one for bottom ash and the other for APC) are fitted with ash conditioning mixers which wets the ash prior to discharge to covered trucks for removal offsite, thereby minimizing potential for dust release offsite.	• Fully implemented
Remedial Measures		**Low Cost Options**
Wheel Washing	• All vehicles will be inspected prior to leaving the site. Should dust / mud / debris be present, vehicle wheels will be washed before the vehicle leaves site, thereby reducing the risk of dust being tracked offsite.	• Fully implemented
Remedial Measures		**Medium Cost Options**
N/A		
Remedial Measures		**High Cost Options**
N/A		

Table 3.2: Source – Pathway – Receptor Routes

Source/Activity on Site	Pathway	Receptor	Type of Impact	Measures to break Source-Receptor Pathway can be interrupted
Mud/Dust from vehicles entering and leaving site	Tracking mud on wheels of vehicles	Residential Properties / Roads	Visual Soiling Resuspension as PM_{10}	• The carriage of mud from the site onto the public highway is unlikely to occur due to the material types handled and concrete hard-paving proposed for the entire site. • Vehicles wheels are inspected prior to leaving the site and washed if necessary. • All vehicles passing through the weighbridge will be stopped and inspected. Any debris or other fugitive material to be removed from the wheels. • Should it become apparent that debris from site is being deposited on the public highway, sweeping of the haul roads and other relevant areas of the site will be organised immediately to prevent further mud emissions to the public highway. • Site surfaces will be inspected daily by site staff. • The trigger for any repairs will be where any areas become damaged or worn to the extent which require diversion by site traffic. Any repairs will be undertaken by suitable contractors.
Dust generated when Unloading	Atmospheric Dispersion (Inhalation and Deposition)	Residential, School, Commercial and Industrial Premises (Humans and Property)	Respiratory irritation, surface soiling and nuisance	• All unloading activities are undertaken within the fully enclosed Fuel Storage Building, with electrically controlled roller shutter doors and an active air extraction and filtration system. • Material will be delivered in walking floor trailers offering full enclosure until delivery, minimising loss of material on surrounding road network prior to entering or upon exiting site. • Any spillages of material will be internal and cleared by the loading shovel or manually by site operatives.
Dust generated during Vehicle Movements on Site	Atmospheric Dispersion (Inhalation and Deposition)	Residential, School, Commercial and Industrial Premises (Humans and Property)	Respiratory irritation, surface soiling and nuisance	• Entire site hard paved as above. • Site speed limit of 5mph enforced via signage and site management. • Vehicle movements are minimised on site via the usual operational need for efficiency and reduction of fuel use.
Dust generated during processing	Atmospheric Dispersion	Residential, School, Commercial and Industrial	Respiratory irritation, surface soiling and nuisance	• There is no pre-processing carred out on site.

of wood feedstocks	(Inhalation and Deposition)	Premises (Humans and Property)		
Dust generated from stockpile	Atmospheric Dispersion (Inhalation and Deposition)	Residential, School, Commercial and Industrial Premises (Humans and Property)	Respiratory irritation, surface soiling and nuisance	• All storage of waste takes place within the fully enclosed Fuel Storage Building, with electrically controlled roller shutter doors and an active air extraction and filtration system. • In addition, dust will not tend to be generated by the stockpile or its forming, due to the material size and low content of fines.
Particulate from the exhaust stack	Atmospheric Dispersion (Inhalation and Deposition)	Residential, School, Commercial and Industrial Premises (Humans and Property)	Respiratory irritation, surface soiling and nuisance	• A flue gas treatment system removes particulates from the stack prior to emission to atmosphere via a pulse-jet baghouse system. • The stack is fitted with a continuous emissions monitoring system which logs the particulate emission and is fitted with an alarm should abnormal operating conditions arise. • Visual monitoring of the plume is undertaken daily as part of the site walkover.
Bottom ash generated during combustion	Atmospheric Dispersion (Inhalation and Deposition)	Residential, School, Commercial and Industrial Premises (Humans and Property)	Respiratory irritation, surface soiling and nuisance	• Bottom ash is continually collected from the boiler/economiser/ multiclone via a series of mechanical conveyors and transported to the dedicated ash silo for storage. • The boiler system is operated at negative pressure thereby diminishing fugitive emissions. • Ash from the boiler is transported in wet form due to the water cooling which acts as effective dust suppression. • In addition, the entire mechanical ash transport system and storage silo is sealed. • The storage silo is fitted with a fabric filter bin vent to prevent emissions to atmosphere during venting.
APC residue generated during flue gas cleaning	Atmospheric Dispersion (Inhalation and Deposition)	Residential, School, Commercial and Industrial Premises (Humans and Property)	Respiratory irritation, surface soiling and nuisance	• The flue gas cleaning system removes fly ash and absorbents from the flue gas as it passes through the baghouse filter leaving them behind as APC ash. This is recovered from the bottom of the filter and transported via a series of mechanical conveyors to the dedicated ash silo for storage. • This entire system is enclosed, preventing any fugitive emissions during transportation. • The storage silo is sealed and fitted with a fabric filter bin vent to prevent emissions to atmosphere during venting.

Dust generated during collection of ash for offsite recycling	Atmospheric Dispersion (Inhalation and Deposition)	Residential, School, Commercial and Industrial Premises (Humans and Property)	Respiratory irritation, surface soiling and nuisance	• Ash is collected from the silos for transportation offsite via sealed articulated vehicles. • The discharge points on each silo are elevated to facilitate discharge into truck containers. • Prior to discharge the ash is conditioned via an ash wetting system to suppress fugitive dust during normal unloading operation from the storage silo. • The ash collection process shall be overseen by a trained and competent site operative.
Particulate from exhausts of equipment and vehicles on site	Atmospheric Dispersion (Inhalation and Deposition)	Residential, School, Commercial and Industrial Premises (Humans and Property)	Respiratory irritation, surface soiling and nuisance	• All equipment on site will incorporate the latest low emission types of engine. • All machinery will be subject to a routine inspection and preventative maintenance programme to ensure smooth efficient running and avoid unnecessary emissions.
Litter	Atmospheric Dispersion (Deposition)	Residential Properties, Local School and Industrial Premises	Visual Soiling Resuspension as PM10	• The primary control measure proposed for litter is picking. This will be undertaken when required as identified by the daily site walkover inspections.

3.3 Dust Monitoring

Monitoring of dust will be undertaken at the site consisting of regular visual inspections of the site operations.

3.3.1 Visual Monitoring

Visual monitoring will be carried out as part of the daily site checks, with results recorded on Daily Site Checklist BUK-E08. Any incidents of dust appearing to leave the site boundary will be recorded and immediately reported to Site Management.

The recorded checks will take place once per day, however site staff will be monitoring dust throughout the day. Any dust emissions with the potential to migrate from site will be reported to site management immediately.

The visual monitoring will be undertaken all around the site perimeter, with particular focus on the areas downwind of any area which had been viewed as a potential source of off-site dust emissions. (The precise location of the downwind monitoring points would move dependent on wind direction, hence it is not possible to mark these monitoring points on a site plan). Results will be recorded on the Daily Site Checklist.

All plant and equipment will be subject to daily inspections and usual checks to ensure that all dust controls are effective.

Site staff will be able to judge whether there is a risk of dust migrating from site and report it accordingly to Site Management. Site staff will be trained by the Site Manager in undertaking their responsibilities for dust monitoring. All records for training will be held on site. The relevant procedures in which staff will be trained are:

BUK-E06 *Environmental Records*

BUK-E07 *Environmental Management and Monitoring*

BUK-E08 *Infrastructure Management and Monitoring*

Site staff will also be trained in recording observations on the Daily Site Checklist and any remedial actions undertaken will also be recorded in the site diary. Refresher training on these and any other relevant procedure will be undertaken on at least an annual basis.

3.3.2 Trigger for Enacting Control Measures

The trigger for enacting further control measures will be observations by site staff of dust emissions with the potential to migrate beyond the site boundary. This in turn will depend upon the volume of dust present, the location of the dust on site and current weather conditions.

In any event, site staff will alert site management to areas where dust is being released on site, so that these can be monitored for dust migration and need for control.

A brief visual check (<1 minute) at each location will be carried out to determine dust levels. This combined with the visual checks throughout the day by operations personnel will efficiently identify any dust emissions from site. The site will be manned at all times during processing and deliveries. Any obvious signs of dust will be reported to the site management immediately.

If there is a potential for dust beyond the site boundary, the relevant activity will be ceased immediately to allow investigation by Site Management and appropriate dust control measures to be implemented.

4 PM_{10} Monitoring

The plant will have continuous emissions monitors (CEMS) located on the exhaust flues of the gasification plant. These will monitor stack emissions and provide data reporting and will include continuous monitoring for particulates.

The continuous monitoring equipment will operate on a 24-hour basis and will include the facility for on-line monitoring of the gas concentrations and provide for any out-of-tolerance indications to be monitored by remote staff.

All CEMS equipment and associated platforms and sampling ports installed on site will meet the requirements of the NRW Technical Guidance Note M2. All CEMS equipment shall be MCERTS approved.

Procedures will be created for monitoring undertaken at the site. These procedures will conform to M1 and M2 guidance and those required by the operator monitoring and assessment scheme and are incorporated into the sites EMS system.

The CEMS will be used such that:

- The values of the 96% confidence intervals of a single measured result at the daily ELV shall not exceed the following percentages:
  - Carbon Monoxide – 10%
  - Sulphur Dioxide – 20%
  - Oxides of Nitrogen (NO and NO_2) – 20%
  - Particulate Matter – 30%
  - Total Organic Carbon – 30%
  - Hydrogen Chloride – 40%
- Valid half-hourly average values or 10-minute averages shall be determined within the effective operating time from the measured values;
- Where is it necessary to calibrate or maintain the monitor resulting in data not being available for a complete half hour period, the half-hourly average or 10-minute average shall in any case be considered valid if measurements are available for a minimum of 20 minutes or 7 minutes during the half-hour or 10-minute period respectively;
- Daily average values shall be determined as the average of all valid half-hourly average or 10-minute average values within a calendar day; and
- No more than ten daily average values per year shall be determined not to be valid.

5 Actions when alarm is triggered

Should any activities be seen to be generating dust which, combined with weather conditions, could result in its migration off site, the operation shall be ceased until adequate measures are in place to prevent further dust emissions. The Site Manager has the ability to cease operations at any time in order to achieve this control.

Control measures used on site and this D&PEMP will be reviewed at least annually by Biomass UK No 2 Ltd Management, or after any incident of dust migration off site. NRW will be notified of any changes to site arrangements or permit documentation.

The visual monitoring regime will identify any dust emissions. Should any visible dust emissions be seen emanating from the site, or in the event of a substantiated dust complaint, the site will immediately investigate the source and initiate remedial action.

Any operations on site which are observed to have the potential for dust migration beyond the site boundary will be ceased until adequate control measures are in place (i.e., to prevent migration beyond the boundary).

6 Reporting and Complaints Response

Any instance of visible dust emissions or occurrence of any external complaint will be actioned immediately and responded to within 2 working days.

In the event that any ongoing significant off-site dust problem is identified which the site cannot control by other means, the operations will be reduced or ceased until such a time as other control or mitigation measures can be put in place; or the circumstances have changed to reduce impact as identified in this plan.

In addition to the above, all incidents, accidents and complaints will be recorded and all relevant site managers and where necessary NRW will be informed.

6.1 Engagement with the Community

Neighbours will be advised of the most effective method of communicating with the site and site contact details will be presented on the site notice board.

Biomass UK No. 2 Ltd will engage proactively with neighbours and complaints will be responded to effectively and dealt with as a matter of priority. Biomass UK No. 2 Ltd will contact all immediate adjacent neighbours prior to commencement of the operation.

6.2 Reporting of complaints

Compliments, complaints or environmental incidents received at the site will be processed using the relevant complaints form and procedures.

6.3 Management Responsibilities

The site manager will be responsible for delivery of the actions and controls included within this Plan.

Emission complaints will be taken seriously and regarded as providing a useful insight into public perception and concerns. They will be used to inform the annual review of the Management System to aid the development of site controls. All complaints will be investigated immediately and action taken swiftly following the assessment.

Clear feedback will be given to the informant via the nominated single point of contact. All staff will be fully trained in the feedback process and how to handle complaints to ensure swift and appropriate action is taken.

6.4 Summary

The control measures presented in this Dust Management Plan reduce the potential for emissions from the Barry site to a point where there is very low risk of nuisance or exposure of the local receptors.

This document is 'live' and will be reviewed at least annually and also after any environmental incidents or at the request of Natural Resources Wales (NRW).

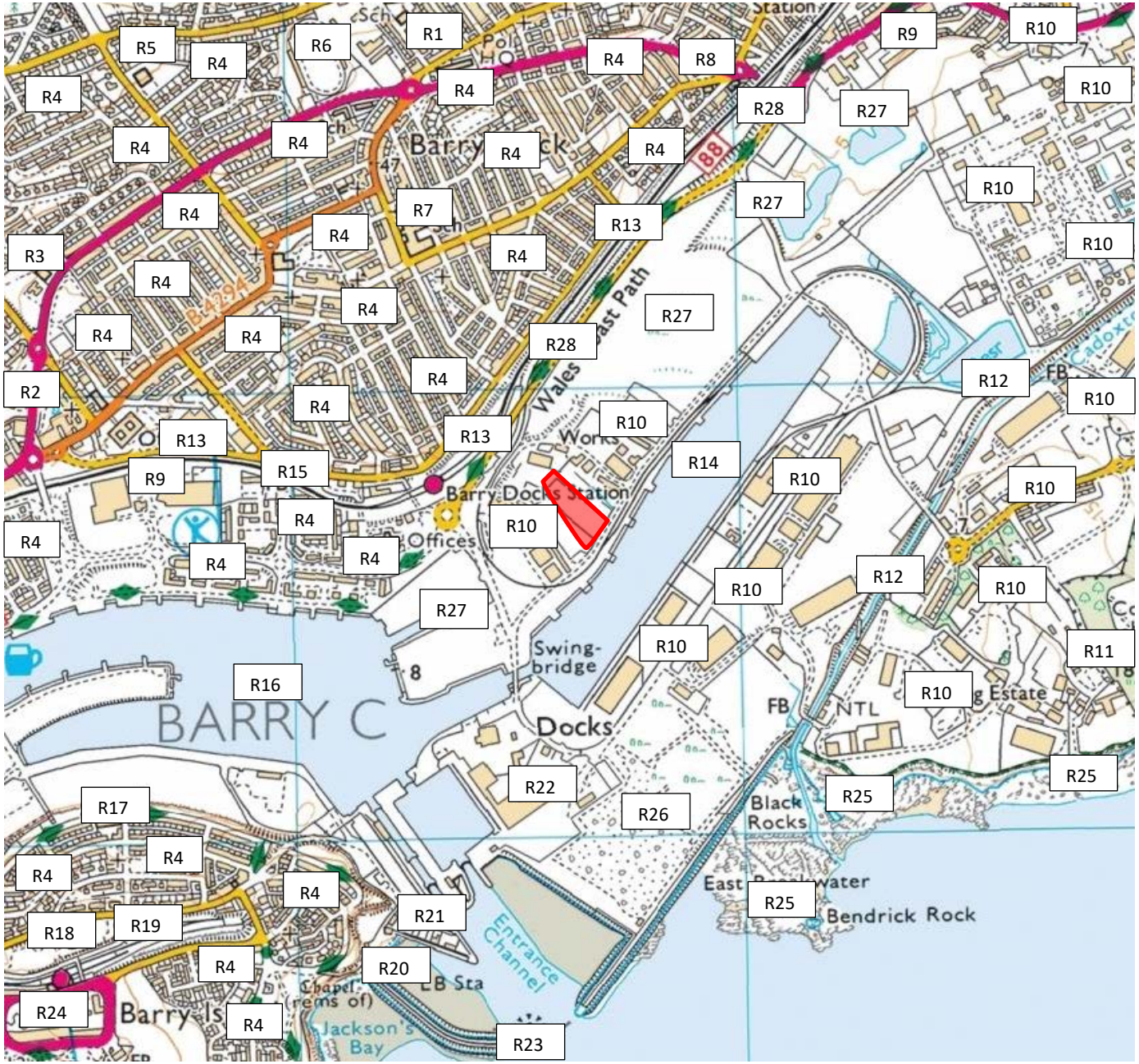
Appendix A Site Plans

1. Do not scale off this drawing
2. All dimensions to be confirmed on site
3. This drawing is copyright of Sol Environment Ltd
4. This drawing is to be read in conjunction with relevant consultant drawings and specifications

Rev:	Date:	Desc:
0	OCT 16	Original

Client:	BIOMASS UK NO.2 LTD	**Job No:**	SOL1605BUK201	**Drawing No:**	BUK201
Project:	BARRY ENERGY RECOVERY FACILITY	**Date:**	OCT 16	**Revision:**	0
Drawing Title:	SITE LOCATION	**Drawn By:**	STEVE BUTLER	**Scale:**	NTS

Sol Environment Ltd
2nd Floor,
10 The Lees, Malvern,
Worcestershire WR14 3HT
t: +44(0)1684 572727
e: enquiries@sol-environment.co.uk
www.sol-environment.co.uk



Receptor No.	Receptor Name
R1	Jenner Park Primary School
R2	Memo Arts Centre / Theatre
R3	Gladstone Primary School
R4	Residential Receptors
R5	St Helens R.C Junior School
R6	Barry Town United FC
R7	Holton Primary School
R8	Barry Mosque
R9	Retail Units
R10	Industrial Units
R11	HMS Cumbria
R12	Cadoxton River
R13	Railway line
R14	Entrance Channel
R15	Waterfront Medical Centre (GP)
R16	Barry Dock
R17	Barry Island Primary School
R18	Maslin Park
R19	Barry Island Train Station
R20	Barry Yacht Club
R21	Barry Dock lifeboat station
R22	Associated British Ports Barry
R23	Barry Docks lighthouse
R24	Barry Island Pleasure Park
R25	SSSI (Hayes point to Bendrick Rock)
R26	Solar PV Farm
R27	Unoccupied Land
R28	A4055 Road

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4. This drawing is to be read in conjunction with relevant consultant drawings and specifications

Rev:	Date:	Desc:
0	OCT 17	Original

Client:	BIOMASS UK NO.2 LTD	Job No:	SOL1605BUK201	Drawing No:	BUK205
Project:	BARRY ENERGY RECOVERY FACILITY	Date:	OCT 17	Revision:	0
Drawing Title:	SENSITIVE RECEPTOR PLAN	Drawn By:	SOPHIE PERRIN	Scale:	NTS

Sol Environment Ltd
2nd Floor,
10 The Lees, Malvern,
Worcestershire WR14 3HT
t: +44(0)1684 572727
e: enquiries@sol-environment.co.uk
www.sol-environment.co.uk

Appendix B Dust Complaint Form

Customer Details	
Customer Name	
Address	
Postcode	
Customer Contact Details	
Tel	
Email	
Date	
Complaint Reference Number	
Complaint Details	
Investigation Details	
Investigation carried out by	
Position	
Date and time of investigation	
Weather conditions	
Wind direction and speed	
Investigation Findings	
Feedback given to NRW and / or LA	
Date feedback given	
Review and Improve	
Improvements needed to prevent reoccurrence	
Proposed date for completion of improvement works	
Actual date of completion	
If different, reason for delay	
Does the dust management plan need updating	
Date of D&PEMP update	
Closure	
Site Manager review date	
Site manager signature	

Appendix 9.3

Emission Parameters

Appendix 9.3: Emission Parameters

Table 9.3.1: Emission Parameters (Normal Operations)

Parameter	Main Stack	
Stack Height (m)	43.19	
Stack Diameter (m)	1.6	
Temperature of release (K)	419	
Actual Flow Rate (Am^3/s)	35.7	
Emission velocity at stack exit (m/s)	17.8	
Normalised Flow Rate (Nm^3/s)	21.6	
Emission Concentration (mg/Nm^3) (b)	**Long Term**	**Short Term**
Dust	10	30
TOC	10	20
HCl	10	60
HF	1	4
SO_2	50	200
NO_x	200	400
CO	50	100
Group I (Cd, Tl)	0.05	
Group II (Hg)	0.05	
Group II (Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V)	0.5	
Dioxins and Furans	1.0×10^{-7}	
PAHs (as BaP) (c)	0.0001	
PCB	0.005	
NH_3	20	
Emission Rate (g/s)	**Long Term**	**Short Term**
Dust	0.22	0.65
TOC	0.22	0.43
HCl	0.22	1.29
HF	0.02	0.09
SO_2	1.08	4.31
NO_x	4.31	8.63
CO	1.08	2.16
Group I (Cd, Tl)	0.0011	
Group II (Hg)	0.0011	

Parameter	Main Stack
Group III (Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V)	0.0108
Dioxins and Furans	2.2×10^{-9}
PAHs (as BaP)	2.2×10^{-6}
PCBs	0.0001
NH_3	0.43

(a) Actual Flow Rate at 419K, 10.1% O2, 101.3kPa, 15% H2O
(b) Reference conditions: 273K, 11% O2, 101.3kPa, dry gas
(c) Obtained from review of Figure 8.122 BaP emissions from Other Non Hazardous Waste Plants

Table 9.3.2: Emission Parameters (Failure of Activated Carbon)

Parameter	Main Stack	
Emission Concentration (mg/Nm^3)	**Long Term**	**Short Term**
Group I (Cd, Tl)	0.03	
Group II (Hg)	0.03	
Group II (Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V)	5	
Dioxins and Furans	1.0×10^{-7}	
PCB	3.0×10^{-11}	
Emission Rate (g/s)		
Group I (Cd, Tl)	0.00065	
Group II (Hg)	0.00065	
Group III (Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V)	0.11	
Dioxins and Furans	6.5×10^{-9}	
PCBs	6.5×10^{-11}	

Table 9.3.3: Emission Parameters (Failure of Bag Filter)

Parameter	Main Stack
Emission Concentration (mg/Nm^3)	
Dust	150
Emission Rate (g/s)	
Dust	3.2

Appendix 9.4

Comparison of Results using Alternative Model

Appendix 9.4: Comparison of Results using Alternative Model

A summary of the maximum PC's at a sensitive receptor from both models are presented in Table 9.4.1 below along with the significance for each pollutant determined from both sets of modelling.

Table 9.4.1: Comparison of Modelled Results

Pollutant	Averaging Period	AERMOD Results			ADMS Results		
		PC	PC (as % AQAL)	Significance	PC	PC (as % AQAL)	Significance
NO_2	Annual Mean	1.6	3.9	Negligible	1.6	4.0	Negligible
	Hourly Mean	10.3	5.1	Negligible	16.2	8.1	Negligible
CO	8 Hour Mean	6.8	0.068	Negligible	10.1	0.10	Negligible
	Hourly Mean	8.0	0.027	Negligible	13.2	0.04	Negligible
SO_2	24 Hour Mean	2.6	2.1	Negligible	3.1	2.5	Negligible
	Hourly Mean	14.6	4.2	Negligible	22.3	6.4	Negligible
	15 Minute Mean	20.0	7.5	Negligible	25.1	9.5	Negligible
PM_{10}	Annual Mean	0.11	0.28	Negligible	0.12	0.29	Negligible
	24 Hour Mean	0.29	0.58	Negligible	0.34	0.7	Negligible
$PM_{2.5}$	Annual Mean	0.11	0.44	Negligible	0.12	0.5	Negligible
TOC	Annual Mean	0.11	2.2	Negligible	0.12	2.3	Negligible
	Hourly Mean	1.6	0.21	Negligible	2.6	1.3	Negligible
HCl	Hourly Mean	4.8	0.64	Negligible	7.8	1.0	Negligible
HF	Hourly Mean	0.32	0.2	Negligible	0.52	0.3	Negligible
Dioxins	Annual Mean	1.1	4.5[(b)]	Negligible	1.2	4.0	Negligible
PAH	Annual Mean	0.11	11.1	Negligible	0.12	11.6	Negligible
PCB	Annual Mean	0.056	0.028	Negligible	0.058	0.03	Negligible
NH_3	Hourly Mean	0.40	0.0066	Negligible	0.66	0.01	Negligible

(a) Presented as fg/m^3
(b) As % of UK background concentration
(c) Presented as ng/m^3

As illustrated in Table 9.4.1 above, the maximum concentration predicted at a sensitive human receptor for each of the pollutants is very similar using either model. Further analysis of the results, indicated that for the long term (annual mean) predicted concentrations the results predicted by AERMOD 7 model are generally marginally higher than the concentrations predicted by the alternative model ADMS 5.2. For short term predicted concentrations the results predicted by AERMOD 7 are generally marginally lower than the concentrations predicted by the alternative model ADMS 5.2.

The results of the modelling of trace metals within the stack emissions also show the same similarity between the two models. The key metal of concern was determined to be Cr VI in the assessment above. The results of the additional Cr VI assessment using the result from both models are provided in Table 9.4.2 below.

Table 9.4.2: Comparison of Modelled Results for Cr VI Assessment (ng/m^3)

Pollutant	Averaging Period	AERMOD Results			ADMS Results		
		PC	PC (as % AQAL)	Significance	PC	PC (as % AQAL)	Significance
Cr VI	Annual Mean	0.014	0.72	Negligible	0.0015	0.74	Negligible

For all of the pollutants and scenarios modelled, the significance of the impact is not changed by using a different model. Therefore, it is concluded that the choice of model does not have a significant impact on the predicted results or the conclusions drawn from the modelling.

Appendix 9.5

Comparison of Results using Coastal Effects Module

Appendix 9.5: Comparison of Results using Coastal Effects Module

A summary of the maximum annual mean and hourly mean NO_2 PC's at each of the human sensitive receptor from both the model runs to determine the effect of the coastline are presented in Tables 9.5.1 and 9.5.2 below along with the significance determined from each set of modelling.

Table 9.5.1: Predicted Annual Mean NO_2 Concentrations ($\mu g/m^3$)

Receptor	With Coastal Effects			Without Coastal Effects		
	PC	PC (as % AQAL)	Significance	PC	PC (as % AQAL)	Significance
Vistamar House	0.63	1.6	Negligible	0.63	1.6	Negligible
Docks Office	0.37	0.9	Negligible	0.42	1.1	Negligible
Phillipa Freeth Court	0.40	1.0	Negligible	0.44	1.1	Negligible
Barry Dock Station	0.28	0.7	Negligible	0.38	1.0	Negligible
54 Dock View Road	0.29	0.7	Negligible	0.37	0.9	Negligible
89 Dock View Road	0.34	0.8	Negligible	0.37	0.9	Negligible
131 Dock View Road	0.24	0.6	Negligible	0.25	0.6	Negligible
Wimbourne Buildings	1.42	3.6	Negligible	1.42	3.6	Negligible
FoBendrick Road	1.01	2.5	Negligible	1.01	2.5	Negligible
Public Recycling Facility	0.53	1.3	Negligible	0.53	1.3	Negligible
Atlantic Crescent	0.52	1.3	Negligible	0.52	1.3	Negligible
Port Office	0.15	0.4	Negligible	0.15	0.4	Negligible
Queens Way	0.42	1.1	Negligible	0.42	1.1	Negligible
Dyfrig Street	0.43	1.1	Negligible	0.44	1.1	Negligible

Table 9.5.2: Predicted Hourly Mean NO_2 Concentrations (as 99.8th percentile) ($\mu g/m^3$)

Receptor	With Coastal Effects			Without Coastal Effects		
	PC	PC (as % AQAL)	Significance	PC	PC (as % AQAL)	Significance
Vistamar House	12.4	6.2	Negligible	12.0	6.0	Negligible
Docks Office	12.6	6.3	Negligible	13.5	6.7	Negligible
Phillipa Freeth Court	12.1	6.1	Negligible	11.5	5.7	Negligible
Barry Dock Station	13.4	6.7	Negligible	15.2	7.6	Negligible
54 Dock View Road	12.5	6.3	Negligible	14.2	7.1	Negligible

Receptor	With Coastal Effects			Without Coastal Effects		
	PC	PC (as % AQAL)	Significance	PC	PC (as % AQAL)	Significance
89 Dock View Road	12.0	6.0	Negligible	11.3	5.6	Negligible
131 Dock View Road	9.1	4.6	Negligible	7.8	3.9	Negligible
Wimbourne Buildings	10.6	5.3	Negligible	10.6	5.3	Negligible
FoBendrick Road	7.2	3.6	Negligible	7.2	3.6	Negligible
Public Recycling Facility	6.6	3.3	Negligible	6.6	3.3	Negligible
Atlantic Crescent	11.6	5.8	Negligible	11.6	5.8	Negligible
Port Office	9.8	4.9	Negligible	9.8	4.9	Negligible
Queens Way	10.5	5.3	Negligible	10.5	5.3	Negligible
Dyfrig Street	6.5	3.2	Negligible	6.5	3.2	Negligible

As illustrated in Table 9.5.1 and 9.5.2, the difference between the PC's for both annual mean and hourly mean NO_2 concentrations with and without considering the effects of the coastline are minimal and both sets of results indicate there will be negligible impacts on each receptor.

Furthermore, the annual mean results show that for all receptors the effect of the coastline will be to reduce the likely concentrations experienced at the sensitive receptors. The hourly mean results show a similar pattern with the exception of three receptors which show a slight increase. For all receptors the results are lower than the results presented in the main results section which take into account the effects of buildings and terrain.

It is considered that the presence of the coastline has a negligible impact on the pollutant concentrations likely to be experienced at the sensitive receptors.

Appendix 9.6

Environmental Assessment Levels for the Protection of Vegetation and Ecosystems

Appendix 9.6: 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 are summarised in Table 9.6.1.

Table 9.6.1: Critical Levels for the Protection of Vegetation and Ecosystems

Pollutant	PC	PC (as % AQAL)
Oxides of Nitrogen (NOx)	Annual Mean	30
	Daily Mean	75
Sulphur Dioxide (SO2)	Annual Mean	10 (sensitive habitats with lichen and bryophytes)
		20 (all other habitats)
Hydrogen Fluoride (HF)	Weekly Mean	0.5
	Daily Mean	5
Ammonia (NH3)	Annual Mean	1 (sensitive habitats with lichen and bryophytes)
		3 (all other habitats)

Background NO_x, SO_2 and NH_3 concentrations for the identified habitat sites have been obtained from Air Pollution Information System (APIS) and are summarised in Table 9.5.2. In the absence of site specific data, the rural background HF concentration of 0.5 µg/m^3 is assumed to provide a reasonable estimate of the background concentration at the designated sites.

Table 9.6.2: Annual Mean Background NO_x, SO_2 and NH_3 Concentrations (µg/m^3)

Pollutant	NO_x	SO_2	NH_3
Cadoxton River SINC	13.55	1.73	1.17
Cadoxton Wetland SINC	19.20	1.73	1.17
Cadoxton Ponds Wildlife Reserve	19.20	1.73	1.17

Pollutant	NO_x	SO_2	NH_3
Fields at Merthyr Dyfan SINC	13.02	1.73	1.17
Gladstone Road Pond SINC	14.63	1.73	1.17
Nells Point East SINC	16.79	1.73	1.17
Friars Point SINC	10.93	1.73	1.17
North of North Road SINC	19.20	1.73	1.17
Hayes Lane Ancient Woodland	13.55	1.73	1.17
Severn Estuary SPA & Ramsar Site (Sully Island)	9.15	1.15	0.86
Severn Estuary SPA & Ramsar Site (Penarth Coast)	7.72	1.01	0.86
Severn Estuary SPA & Ramsar Site (Flat Holm)	7.09	0.81	1.54
Severn Estuary SAC	8.98	0.91	1.46

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 APIS and are summarised in Table 9.5.3 for the identified habitat sites.

Table 9.6.3: Critical Loads (Eutrophication) and Background Nutrient Nitrogen Deposition

Pollutant	Critical Load (kgN/ha/yr)	Background N Deposition Rate (kgN/ha/yr)
Cadoxton River SINC	15 to 30	11.62
Cadoxton Wetland SINC	15 to 30	11.62
Cadoxton Ponds Wildlife Reserve	15 to 30	11.62
Fields at Merthyr Dyfan SINC	20 to 30	11.62
Gladstone Road Pond SINC	15 to 30	11.62
Nells Point East SINC	20 to 30	11.62
Friars Point SINC	20 to 30	11.62
North of North Road SINC	15 to 30	11.62

Pollutant	Critical Load (kgN/ha/yr)	Background N Deposition Rate (kgN/ha/yr)
Hayes Lane Ancient Woodland	10 to 20	19.46
Severn Estuary SPA & Ramsar Site (Sully Island)	20 to 30	9.8
Severn Estuary SPA & Ramsar Site (Penarth Coast)	20 to 30	9.8
Severn Estuary SPA & Ramsar Site (Flat Holm)	20 to 30	0
Severn Estuary SAC	20 to 30	10.1

The background nutrient nitrogen deposition rates are within the critical loads at the majority of the identified habitat sites.

For acidic deposition, the critical load of a habitat site is largely determined by the underlying geology and soils. The critical load of acidification is defined by a critical load function (CLF), which describes the relationship between the relative contributions of sulphur (S) and nitrogen (N) to the total acidification.

The critical load function is defined by the following parameters:

- CLmaxS, the maximum critical load of acidity for S, assuming there is no N deposition;
- CLminN, is the critical load of acidity due to nitrogen removal processes in the soil only (i.e. independent of deposition); and
- CLmaxN, is the maximum critical load of acidity for N, assuming there is no S deposition.

Where available from APIS, the critical loads for acidification for the identified habitat sites are presented in Table 9.6.4. For comparison with the critical load function (CLF), the HCl acidification rate is combined with the S acidification rate.

Table 9.6.4: Critical Loads (Acidification) and Background Nitrogen and Sulphur Acidification Rates

Pollutant	Critical Load (kgN/ha/yr)			Background Acidification (kgN/ha/yr)	
	Max S	Min N	Max N	N	S
Cadoxton River SINC	Not sensitive to acidity			0.83	0.18
Cadoxton Wetland SINC	Not sensitive to acidity			0.83	0.18
Cadoxton Ponds Wildlife Reserve	Not sensitive to acidity			0.83	0.18
Fields at Merthyr Dyfan SINC	4	1.071	5.071	0.83	0.18
Gladstone Road Pond SINC	Not sensitive to acidity			0.83	0.18

Pollutant	Critical Load (kgN/ha/yr)			Background Acidification (kgN/ha/yr)	
	Max S	Min N	Max N	N	S
Nells Point East SINC	0	0	0	0.83	0.18
Friars Point SINC	4	0.856	4.856	0.83	0.18
North of North Road SINC	Not sensitive to acidity			0.83	0.18
Hayes Lane Ancient Woodland	2.775	0.357	3.132	1.39	0.22
Severn Estuary SPA & Ramsar Site (Sully Island)	4.1	0.2	4.3	0.7	0.2
Severn Estuary SPA & Ramsar Site (Penarth Coast)	No critical loads			0.7	0.2
Severn Estuary SPA & Ramsar Site (Flat Holm)	No critical loads			0	0.1
Severn Estuary SAC	Not sensitive to acidity			0.7	0.1

Appendix 9.7

Committed / Proposed Development Results

Appendix 9.7: Committed / Proposed Development Results

Table 9.7.1: Predicted annual and hourly mean NO_2 Concentrations ($\mu g/m^3$)

Receptor			Annual Mean			Hourly Mean		
		Grid Reference	PC	PC as % Standard	PEC	PC	PC as % Standard	PEC
R32	Land at Barry Waterfront	311123.7, 167330.7	0.21	0.5	13.6	4.3	2.2	31.1
R33	East Quay, Barry Waterfront	312475.5, 167479.6	0.16	0.4	13.6	14.9	7.5	41.7
R34	East Quay, Barry Waterfront	312540.5, 167542.4	0.02	0.0	13.4	20.4	10.2	47.2
R35	East Quay, Barry Waterfront	312295.3, 167443.9	0.87	2.2	14.3	11.9	5.9	38.7
R36	East Quay, Barry Waterfront	312412.5, 167468.7	0.46	1.1	13.9	13.4	6.7	40.2
R37	East Quay, Barry Waterfront	312397, 167635.9	0.25	0.6	13.6	13.5	6.8	40.3
R38	Winmill Park, Hayes Road	313761.3, 167991.6	0.44	1.1	13.8	5.3	2.7	32.1
R39	Spider Camp, Hayes Lane	313636, 167500.7	0.80	2.0	14.2	6.7	3.3	33.5
R40	Former LME UK Ltd Site, Sully	314244.6, 168443.7	0.19	0.5	13.6	3.5	1.7	30.3
R41	Land to the South of Cog Road, Sully	315871.3, 168631.1	0.08	0.2	13.5	2.0	1.0	28.8

R42	Land at Hayes Wood, Sully	313691.6, 167695.7	0.68	1.7	14.1	6.2	3.1	33.0
R43	Land at Hayes Road, Barry	313597.2, 167666.9	0.79	2.0	14.2	6.9	3.4	33.7
R44	Land at Subway Road, Barry	312144.6, 167672.2	0.59	1.5	14.0	11.3	5.7	38.1
R45	Sea View Labour Club, Dock View Road, Barry	312457.3, 168050.5	0.35	0.9	13.8	11.2	5.6	38.0
R46	The Windsor, 177-170 Holton Road, Barry	312169.8, 168205.5	0.29	0.7	13.7	8.3	4.2	35.1
R47	Castle Hotel, 44 Jewel St, Barry	312486.7, 168203.4	0.31	0.8	13.7	10.5	5.2	37.3
R48	Land at Upper Cosmeston Farm, Penarth	317932.6, 169037.6	0.04	0.1	13.4	1.4	0.7	28.2
R49	Land West of Swanbridge Road, Sully	315952.9, 168313.3	0.09	0.2	13.5	2.1	1.1	28.9
R50	Land to the South and West of the Goodsheds, Barry	311121.2, 167596	0.18	0.4	13.6	4.4	2.2	31.2
R51	Former Railway Sidings, Ffordd y Mileniwm, Barry	312876.2, 168434.9	0.25	0.6	13.7	7.8	3.9	34.6
R52	Land at Model Farm, Port Road, Rhoose	308672.4, 167179.5	0.05	0.1	13.4	1.8	0.9	28.6
R53	Leckwith Quay, Leckwith Road, Leckwith	316045.9, 174849.7	0.01	0.0	13.4	0.9	0.4	27.7
	Standard		40μg/m^3			200		
	Baseline		13.4μg/m^3			26.8μg/m^3		

Table 9.7.2: Predicted annual and 24 hour mean PM_{10} Concentrations ($\mu g/m^3$)

Receptor			Annual Mean			24-Hour Mean		
		Grid Reference	PC	PC as % Standard	PEC	PC	PC as % Standard	PEC
R32	Land at Barry Waterfront	311123.7, 167330.7	0.02	0.04	12.42	0.06	0.12	12.46
R33	East Quay, Barry Waterfront	312475.5, 167479.6	0.01	0.03	12.41	0.04	0.07	12.44
R34	East Quay, Barry Waterfront	312540.5, 167542.4	0.00	0.00	12.40	0.00	0.01	12.40
R35	East Quay, Barry Waterfront	312295.3, 167443.9	0.06	0.16	12.46	0.26	0.52	12.66
R36	East Quay, Barry Waterfront	312412.5, 167468.7	0.03	0.08	12.43	0.11	0.22	12.51
R37	East Quay, Barry Waterfront	312397, 167635.9	0.02	0.04	12.42	0.06	0.12	12.46
R38	Winmill Park, Hayes Road	313761.3, 167991.6	0.03	0.08	12.43	0.09	0.17	12.49
R39	Spider Camp, Hayes Lane	313636, 167500.7	0.06	0.14	12.46	0.13	0.26	12.53
R40	Former LME UK Ltd Site, Sully	314244.6, 168443.7	0.01	0.03	12.41	0.04	0.08	12.44
R41	Land to the South of Cog Road, Sully	315871.3, 168631.1	0.01	0.01	12.41	0.02	0.03	12.42
R42	Land at Hayes Wood, Sully	313691.6, 167695.7	0.05	0.12	12.45	0.12	0.24	12.52

R43	Land at Hayes Road, Barry	313597.2, 167666.9	0.06	0.14	12.46	0.14	0.28	12.54
R44	Land at Subway Road, Barry	312144.6, 167672.2	0.04	0.11	12.44	0.14	0.29	12.54
R45	Sea View Labour Club, Dock View Road, Barry	312457.3, 168050.5	0.03	0.06	12.43	0.08	0.15	12.48
R46	The Windsor, 177-170 Holton Road, Barry	312169.8, 168205.5	0.02	0.05	12.42	0.07	0.13	12.47
R47	Castle Hotel, 44 Jewel St, Barry	312486.7, 168203.4	0.02	0.06	12.42	0.06	0.13	12.46
R48	Land at Upper Cosmeston Farm, Penarth	317932.6, 169037.6	0.00	0.01	12.40	0.01	0.02	12.41
R49	Land West of Swanbridge Road, Sully	315952.9, 168313.3	0.01	0.02	12.41	0.02	0.04	12.42
R50	Land to the South and West of the Goodsheds, Barry	311121.2, 167596	0.01	0.03	12.41	0.05	0.10	12.45
R51	Former Railway Sidings, Ffordd y Mileniwm, Barry	312876.2, 168434.9	0.02	0.04	12.42	0.06	0.11	12.46
R52	Land at Model Farm, Port Road, Rhoose	308672.4, 167179.5	0.00	0.01	12.40	0.01	0.03	12.41
R53	Leckwith Quay, Leckwith Road, Leckwith	316045.9, 174849.7	0.00	0.00	12.40	0.00	0.01	12.40
	Standard		40µg/m^3			50		
	Baseline		12.4µg/m^3			12.4µg/m^3		

Table 9.7.3: Predicted annual mean $PM_{2.5}$ Concentrations ($\mu g/m^3$)

Receptor			Annual Mean		
		Grid Reference	PC	PC as % Standard	PEC
R32	Land at Barry Waterfront	311123.7, 167330.7	0.02	0.06	8.12
R33	East Quay, Barry Waterfront	312475.5, 167479.6	0.01	0.04	8.11
R34	East Quay, Barry Waterfront	312540.5, 167542.4	0.00	0.00	8.10
R35	East Quay, Barry Waterfront	312295.3, 167443.9	0.06	0.25	8.16
R36	East Quay, Barry Waterfront	312412.5, 167468.7	0.03	0.13	8.13
R37	East Quay, Barry Waterfront	312397, 167635.9	0.02	0.07	8.12
R38	Winmill Park, Hayes Road	313761.3, 167991.6	0.03	0.13	8.13
R39	Spider Camp, Hayes Lane	313636, 167500.7	0.06	0.23	8.16
R40	Former LME UK Ltd Site, Sully	314244.6, 168443.7	0.01	0.06	8.11
R41	Land to the South of Cog Road, Sully	315871.3, 168631.1	0.01	0.02	8.11
R42	Land at Hayes Wood, Sully	313691.6, 167695.7	0.05	0.19	8.15
R43	Land at Hayes Road, Barry	313597.2, 167666.9	0.06	0.23	8.16
R44	Land at Subway Road, Barry	312144.6, 167672.2	0.04	0.17	8.14
R45	Sea View Labour Club, Dock View Road, Barry	312457.3, 168050.5	0.03	0.10	8.13
R46	The Windsor, 177-170 Holton Road, Barry	312169.8, 168205.5	0.02	0.08	8.12
R47	Castle Hotel, 44 Jewel St, Barry	312486.7, 168203.4	0.02	0.09	8.12
R48	Land at Upper Cosmeston Farm, Penarth	317932.6, 169037.6	0.00	0.01	8.10
R49	Land West of Swanbridge Road, Sully	315952.9, 168313.3	0.01	0.03	8.11
R50	Land to the South and West of the Goodsheds, Barry	311121.2, 167596	0.01	0.05	8.11
R51	Former Railway Sidings, Ffordd y Mileniwm, Barry	312876.2, 168434.9	0.02	0.07	8.12

R52	Land at Model Farm, Port Road, Rhoose	308672.4, 167179.5	0.00	0.01	8.10
R53	Leckwith Quay, Leckwith Road, Leckwith	316045.9, 174849.7	0.00	0.00	8.10
	Standard		25µg/m^3		
	Baseline		8.1µg/m^3		

Table 9.7.4: Predicted 8 hour mean and 1 hour mean CO Concentrations (µg/m^3)

Receptor			8 Hour Mean			1-Hour Mean		
		Grid Reference	PC	PC as % Standard	PEC	PC	PC as % Standard	PEC
R32	Land at Barry Waterfront	311123.7, 167330.7	2.3	0.02	211.3	3.4	0.01	212.4
R33	East Quay, Barry Waterfront	312475.5, 167479.6	2.7	0.03	211.7	6.5	0.02	215.5
R34	East Quay, Barry Waterfront	312540.5, 167542.4	0.6	0.01	209.6	3.1	0.01	212.1
R35	East Quay, Barry Waterfront	312295.3, 167443.9	6.9	0.07	215.9	7.9	0.03	216.9
R36	East Quay, Barry Waterfront	312412.5, 167468.7	6.1	0.06	215.1	7.3	0.02	216.3
R37	East Quay, Barry Waterfront	312397, 167635.9	3.3	0.03	212.3	6.8	0.02	215.8
R38	Winmill Park, Hayes Road	313761.3, 167991.6	2.9	0.03	211.9	4.0	0.01	213.0
R39	Spider Camp, Hayes Lane	313636, 167500.7	3.7	0.04	212.7	4.6	0.02	213.6
R40	Former LME UK Ltd Site, Sully	314244.6, 168443.7	1.9	0.02	210.9	2.9	0.01	211.9
R41	Land to the South of Cog Road, Sully	315871.3, 168631.1	0.9	0.01	209.9	1.7	0.01	210.7
R42	Land at Hayes Wood, Sully	313691.6, 167695.7	3.5	0.04	212.5	4.5	0.01	213.5

R43	Land at Hayes Road, Barry	313597.2, 167666.9	3.8	0.04	212.8	4.8	0.02	213.8
R44	Land at Subway Road, Barry	312144.6, 167672.2	6.6	0.07	215.6	7.6	0.03	216.6
R45	Sea View Labour Club, Dock View Road, Barry	312457.3, 168050.5	6.0	0.06	215.0	7.9	0.03	216.9
R46	The Windsor, 177-170 Holton Road, Barry	312169.8, 168205.5	3.7	0.04	212.7	6.0	0.02	215.0
R47	Castle Hotel, 44 Jewel St, Barry	312486.7, 168203.4	5.1	0.05	214.1	7.0	0.02	216.0
R48	Land at Upper Cosmeston Farm, Penarth	317932.6, 169037.6	0.4	0.00	209.4	1.3	0.00	210.3
R49	Land West of Swanbridge Road, Sully	315952.9, 168313.3	0.8	0.01	209.8	1.7	0.01	210.7
R50	Land to the South and West of the Goodsheds, Barry	311121.2, 167596	2.7	0.03	211.7	3.5	0.01	212.5
R51	Former Railway Sidings, Ffordd y Mileniwm, Barry	312876.2, 168434.9	4.2	0.04	213.2	5.4	0.02	214.4
R52	Land at Model Farm, Port Road, Rhoose	308672.4, 167179.5	0.8	0.01	209.8	2.6	0.01	211.6
R53	Leckwith Quay, Leckwith Road, Leckwith	316045.9, 174849.7	0.3	0.00	209.3	1.0	0.00	210.0
	Standard		10000µg/m^3			30000µg/m^3		
	Baseline		209µg/m^3			209µg/m^3		

Table 9.7.5: Predicted 24 hour mean, 1 hour mean and 15 min mean SO_2 Concentrations ($\mu g/m^3$)

Receptor			24 Hour Mean			1-Hour Mean			15-Min Mean		
		Grid Reference	PC	PC as % Standard	PEC	PC	PC as % Standard	PEC	PC	PC as % Standard	PEC
R32	Land at Barry Waterfront	311123.7, 167330.7	0.6	0.5	8.4	5.7	1.6	13.5	8.6	3.2	16.4
R33	East Quay, Barry Waterfront	312475.5, 167479.6	0.9	0.7	8.7	6.0	1.7	13.8	11.0	4.1	18.8
R34	East Quay, Barry Waterfront	312540.5, 167542.4	0.1	0.1	7.9	1.8	0.5	9.6	4.9	1.9	12.7
R35	East Quay, Barry Waterfront	312295.3, 167443.9	2.6	2.1	10.4	14.7	4.2	22.5	20.0	7.5	27.8
R36	East Quay, Barry Waterfront	312412.5, 167468.7	2.0	1.6	9.8	12.9	3.7	20.7	18.0	6.8	25.8
R37	East Quay, Barry Waterfront	312397, 167635.9	0.7	0.6	8.5	8.6	2.4	16.4	13.7	5.1	21.5
R38	Winmill Park, Hayes Road	313761.3, 167991.6	0.8	0.7	8.6	7.2	2.1	15.0	10.3	3.9	18.1
R39	Spider Camp, Hayes Lane	313636, 167500.7	1.2	0.9	9.0	8.7	2.5	16.5	12.2	4.6	20.0
R40	Former LME UK Ltd Site, Sully	314244.6, 168443.7	0.4	0.4	8.2	4.8	1.4	12.6	7.1	2.7	14.9
R41	Land to the South of Cog Road, Sully	315871.3, 168631.1	0.2	0.1	8.0	2.7	0.8	10.5	4.1	1.5	11.9
R42	Land at Hayes Wood, Sully	313691.6, 167695.7	1.1	0.9	8.9	8.4	2.4	16.2	11.6	4.3	19.4

R43	Land at Hayes Road, Barry	313597.2, 167666.9	1.3	1.0	9.1	9.1	2.6	16.9	12.6	4.7	20.4
R44	Land at Subway Road, Barry	312144.6, 167672.2	2.2	1.8	10.0	13.5	3.9	21.3	19.0	7.1	26.8
R45	Sea View Labour Club, Dock View Road, Barry	312457.3, 168050.5	1.1	0.9	8.9	12.7	3.6	20.5	19.3	7.3	27.1
R46	The Windsor, 177-170 Holton Road, Barry	312169.8, 168205.5	0.8	0.7	8.6	10.5	3.0	18.3	15.3	5.7	23.1
R47	Castle Hotel, 44 Jewel St, Barry	312486.7, 168203.4	1.4	1.1	9.2	12.5	3.6	20.3	18.1	6.8	25.9
R48	Land at Upper Cosmeston Farm, Penarth	317932.6, 169037.6	0.1	0.1	7.9	1.9	0.5	9.7	2.9	1.1	10.7
R49	Land West of Swanbridge Road, Sully	315952.9, 168313.3	0.2	0.2	8.0	2.7	0.8	10.5	4.2	1.6	12.0
R50	Land to the South and West of the Goodsheds, Barry	311121.2, 167596	0.7	0.5	8.5	6.0	1.7	13.8	8.6	3.2	16.4
R51	Former Railway Sidings, Ffordd y Mileniwm, Barry	312876.2, 168434.9	0.9	0.7	8.7	9.7	2.8	17.5	13.9	5.2	21.7
R52	Land at Model Farm, Port Road, Rhoose	308672.4, 167179.5	0.2	0.1	8.0	2.4	0.7	10.2	3.8	1.4	11.6
R53	Leckwith Quay, Leckwith Road, Leckwith	316045.9, 174849.7	0.1	0.0	7.9	0.9	0.3	8.7	2.1	0.8	9.9
	Standard		125µg/m^3			350µg/m^3			266µg/m^3		
	Baseline		7.8µg/m^3			7.8µg/m^3			7.8µg/m^3		

Table 9.7.6: Predicted annual and 24 hour mean C_6H_6 Concentrations ($\mu g/m^3$)

Receptor			Annual Mean			24-Hour Mean		
		Grid Reference	PC	PC as % Standard	PEC	PC	PC as % Standard	PEC
R32	Land at Barry Waterfront	311123.7, 167330.7	0.02	0.3	0.22	0.17	0.6	0.57
R33	East Quay, Barry Waterfront	312475.5, 167479.6	0.01	0.2	0.21	0.19	0.6	0.59
R34	East Quay, Barry Waterfront	312540.5, 167542.4	0.00	0.0	0.20	0.03	0.1	0.43
R35	East Quay, Barry Waterfront	312295.3, 167443.9	0.06	1.2	0.26	0.61	2.0	1.01
R36	East Quay, Barry Waterfront	312412.5, 167468.7	0.03	0.7	0.23	0.51	1.7	0.91
R37	East Quay, Barry Waterfront	312397, 167635.9	0.02	0.4	0.22	0.28	0.9	0.68
R38	Winmill Park, Hayes Road	313761.3, 167991.6	0.03	0.6	0.23	0.19	0.6	0.59
R39	Spider Camp, Hayes Lane	313636, 167500.7	0.06	1.1	0.26	0.27	0.9	0.67
R40	Former LME UK Ltd Site, Sully	314244.6, 168443.7	0.01	0.3	0.21	0.12	0.4	0.52
R41	Land to the South of Cog Road, Sully	315871.3, 168631.1	0.01	0.1	0.21	0.04	0.1	0.44
R42	Land at Hayes Wood, Sully	313691.6, 167695.7	0.05	1.0	0.25	0.25	0.8	0.65

R43	Land at Hayes Road, Barry	313597.2, 167666.9	0.06	1.1	0.26	0.29	1.0	0.69
R44	Land at Subway Road, Barry	312144.6, 167672.2	0.04	0.8	0.24	0.50	1.7	0.90
R45	Sea View Labour Club, Dock View Road, Barry	312457.3, 168050.5	0.03	0.5	0.23	0.30	1.0	0.70
R46	The Windsor, 177-170 Holton Road, Barry	312169.8, 168205.5	0.02	0.4	0.22	0.29	1.0	0.69
R47	Castle Hotel, 44 Jewel St, Barry	312486.7, 168203.4	0.02	0.4	0.22	0.31	1.0	0.71
R48	Land at Upper Cosmeston Farm, Penarth	317932.6, 169037.6	0.00	0.1	0.20	0.02	0.1	0.42
R49	Land West of Swanbridge Road, Sully	315952.9, 168313.3	0.01	0.1	0.21	0.06	0.2	0.46
R50	Land to the South and West of the Goodsheds, Barry	311121.2, 167596	0.01	0.3	0.21	0.18	0.6	0.58
R51	Former Railway Sidings, Ffordd y Mileniwm, Barry	312876.2, 168434.9	0.02	0.4	0.22	0.24	0.8	0.64
R52	Land at Model Farm, Port Road, Rhoose	308672.4, 167179.5	0.00	0.1	0.20	0.05	0.2	0.45
R53	Leckwith Quay, Leckwith Road, Leckwith	316045.9, 174849.7	0.00	0.0	0.20	0.02	0.1	0.42
	Standard		$5\mu g/m^3$			30		
	Baseline		$0.2\mu g/m^3$			$0.4\mu g/m^3$		

Table 9.7.7: Predicted 1-hour mean HCl Concentrations (µg/m^3)

Receptor			1-Hour Mean		
		Grid Reference	PC	PC as % Standard	PEC
R32	Land at Barry Waterfront	311123.7, 167330.7	2.04	0.3	2.52
R33	East Quay, Barry Waterfront	312475.5, 167479.6	3.89	0.5	4.37
R34	East Quay, Barry Waterfront	312540.5, 167542.4	1.83	0.2	2.31
R35	East Quay, Barry Waterfront	312295.3, 167443.9	4.75	0.6	5.23
R36	East Quay, Barry Waterfront	312412.5, 167468.7	4.40	0.6	4.88
R37	East Quay, Barry Waterfront	312397, 167635.9	4.08	0.5	4.56
R38	Winmill Park, Hayes Road	313761.3, 167991.6	2.42	0.3	2.90
R39	Spider Camp, Hayes Lane	313636, 167500.7	2.77	0.4	3.25
R40	Former LME UK Ltd Site, Sully	314244.6, 168443.7	1.72	0.2	2.20
R41	Land to the South of Cog Road, Sully	315871.3, 168631.1	1.03	0.1	1.51
R42	Land at Hayes Wood, Sully	313691.6, 167695.7	2.68	0.4	3.16
R43	Land at Hayes Road, Barry	313597.2, 167666.9	2.87	0.4	3.35
R44	Land at Subway Road, Barry	312144.6, 167672.2	4.54	0.6	5.02
R45	Sea View Labour Club, Dock View Road, Barry	312457.3, 168050.5	4.72	0.6	5.20
R46	The Windsor, 177-170 Holton Road, Barry	312169.8, 168205.5	3.60	0.5	4.08
R47	Castle Hotel, 44 Jewel St, Barry	312486.7, 168203.4	4.21	0.6	4.69
R48	Land at Upper Cosmeston Farm, Penarth	317932.6, 169037.6	0.78	0.1	1.26
R49	Land West of Swanbridge Road, Sully	315952.9, 168313.3	1.04	0.1	1.52
R50	Land to the South and West of the Goodsheds, Barry	311121.2, 167596	2.09	0.3	2.57
R51	Former Railway Sidings, Ffordd y Mileniwm, Barry	312876.2, 168434.9	3.23	0.4	3.71

R52	Land at Model Farm, Port Road, Rhoose	308672.4, 167179.5	1.58	0.2	2.06
R53	Leckwith Quay, Leckwith Road, Leckwith	316045.9, 174849.7	0.59	0.1	1.07
	Standard		$750\mu g/m^3$		
	Baseline		$0.24\mu g/m^3$		

Table 9.7.8: Predicted monthly and 1 hour mean HF Concentrations (µg/m^3)

Receptor			Monthly Mean			1-Hour Mean		
		Grid Reference	PC	PC as % Standard	PEC	PC	PC as % Standard	PEC
R32	Land at Barry Waterfront	311123.7, 167330.7	0.004	0.02	1.02	0.14	0.1	1.14
R33	East Quay, Barry Waterfront	312475.5, 167479.6	0.003	0.02	1.02	0.26	0.2	1.26
R34	East Quay, Barry Waterfront	312540.5, 167542.4	0.000	0.00	1.00	0.12	0.1	1.12
R35	East Quay, Barry Waterfront	312295.3, 167443.9	0.015	0.09	1.09	0.32	0.2	1.32
R36	East Quay, Barry Waterfront	312412.5, 167468.7	0.008	0.05	1.05	0.29	0.2	1.29
R37	East Quay, Barry Waterfront	312397, 167635.9	0.004	0.03	1.03	0.27	0.2	1.27
R38	Winmill Park, Hayes Road	313761.3, 167991.6	0.005	0.03	1.03	0.16	0.1	1.16
R39	Spider Camp, Hayes Lane	313636, 167500.7	0.010	0.06	1.06	0.19	0.1	1.19
R40	Former LME UK Ltd Site, Sully	314244.6, 168443.7	0.003	0.02	1.02	0.11	0.1	1.11
R41	Land to the South of Cog Road, Sully	315871.3, 168631.1	0.001	0.01	1.01	0.07	0.0	1.07
R42	Land at Hayes Wood, Sully	313691.6, 167695.7	0.009	0.06	1.06	0.18	0.1	1.18

R43	Land at Hayes Road, Barry	313597.2, 167666.9	0.010	0.06	1.06	0.19	0.1	1.19
R44	Land at Subway Road, Barry	312144.6, 167672.2	0.011	0.07	1.07	0.30	0.2	1.30
R45	Sea View Labour Club, Dock View Road, Barry	312457.3, 168050.5	0.006	0.04	1.04	0.31	0.2	1.31
R46	The Windsor, 177-170 Holton Road, Barry	312169.8, 168205.5	0.004	0.03	1.03	0.24	0.2	1.24
R47	Castle Hotel, 44 Jewel St, Barry	312486.7, 168203.4	0.007	0.04	1.04	0.28	0.2	1.28
R48	Land at Upper Cosmeston Farm, Penarth	317932.6, 169037.6	0.001	0.00	1.00	0.05	0.0	1.05
R49	Land West of Swanbridge Road, Sully	315952.9, 168313.3	0.001	0.01	1.01	0.07	0.0	1.07
R50	Land to the South and West of the Goodsheds, Barry	311121.2, 167596	0.003	0.02	1.02	0.14	0.1	1.14
R51	Former Railway Sidings, Ffordd y Mileniwm, Barry	312876.2, 168434.9	0.006	0.04	1.04	0.22	0.1	1.22
R52	Land at Model Farm, Port Road, Rhoose	308672.4, 167179.5	0.001	0.01	1.01	0.11	0.1	1.11
R53	Leckwith Quay, Leckwith Road, Leckwith	316045.9, 174849.7	0.000	0.00	1.00	0.04	0.0	1.04
	Standard		16µg/m^3			160µg/m^3		
	Baseline		1.0µg/m^3			1.0µg/m^3		

Table 9.7.9: Predicted annual mean Dioxin and Furan Concentrations (fg/m^3)

Receptor			Annual Mean	
		Grid Reference	PC	PC as % Existing Background
R32	Land at Barry Waterfront	311123.7, 167330.7	0.15	1.6
R33	East Quay, Barry Waterfront	312475.5, 167479.6	0.11	1.2
R34	East Quay, Barry Waterfront	312540.5, 167542.4	0.01	0.1
R35	East Quay, Barry Waterfront	312295.3, 167443.9	0.62	6.5
R36	East Quay, Barry Waterfront	312412.5, 167468.7	0.33	3.4
R37	East Quay, Barry Waterfront	312397, 167635.9	0.18	1.8
R38	Winmill Park, Hayes Road	313761.3, 167991.6	0.31	3.3
R39	Spider Camp, Hayes Lane	313636, 167500.7	0.57	5.9
R40	Former LME UK Ltd Site, Sully	314244.6, 168443.7	0.14	1.4
R41	Land to the South of Cog Road, Sully	315871.3, 168631.1	0.06	0.6
R42	Land at Hayes Wood, Sully	313691.6, 167695.7	0.48	5.0
R43	Land at Hayes Road, Barry	313597.2, 167666.9	0.56	5.9
R44	Land at Subway Road, Barry	312144.6, 167672.2	0.42	4.4
R45	Sea View Labour Club, Dock View Road, Barry	312457.3, 168050.5	0.25	2.6
R46	The Windsor, 177-170 Holton Road, Barry	312169.8, 168205.5	0.21	2.1
R47	Castle Hotel, 44 Jewel St, Barry	312486.7, 168203.4	0.22	2.3
R48	Land at Upper Cosmeston Farm, Penarth	317932.6, 169037.6	0.03	0.3
R49	Land West of Swanbridge Road, Sully	315952.9, 168313.3	0.07	0.7
R50	Land to the South and West of the Goodsheds, Barry	311121.2, 167596	0.13	1.3
R51	Former Railway Sidings, Ffordd y Mileniwm, Barry	312876.2, 168434.9	0.18	1.9

R52	Land at Model Farm, Port Road, Rhoose	308672.4, 167179.5	0.03	0.4
R53	Leckwith Quay, Leckwith Road, Leckwith	316045.9, 174849.7	0.01	0.1
	Baseline		9.6fg/m^3	

Table 9.7.10: Predicted annual mean B[a]P Concentrations (ng/m^3)

Receptor			Monthly Mean		
		Grid Reference	PC	PC as % Standard	PEC
R32	Land at Barry Waterfront	311123.7, 167330.7	0.0001	0.06	0.2601
R33	East Quay, Barry Waterfront	312475.5, 167479.6	0.0001	0.04	0.2601
R34	East Quay, Barry Waterfront	312540.5, 167542.4	0.0000	0.00	0.2600
R35	East Quay, Barry Waterfront	312295.3, 167443.9	0.0006	0.23	0.2606
R36	East Quay, Barry Waterfront	312412.5, 167468.7	0.0003	0.12	0.2603
R37	East Quay, Barry Waterfront	312397, 167635.9	0.0002	0.07	0.2602
R38	Winmill Park, Hayes Road	313761.3, 167991.6	0.0003	0.12	0.2603
R39	Spider Camp, Hayes Lane	313636, 167500.7	0.0005	0.21	0.2605
R40	Former LME UK Ltd Site, Sully	314244.6, 168443.7	0.0001	0.05	0.2601
R41	Land to the South of Cog Road, Sully	315871.3, 168631.1	0.0001	0.02	0.2601
R42	Land at Hayes Wood, Sully	313691.6, 167695.7	0.0004	0.18	0.2604
R43	Land at Hayes Road, Barry	313597.2, 167666.9	0.0005	0.21	0.2605
R44	Land at Subway Road, Barry	312144.6, 167672.2	0.0004	0.16	0.2604
R45	Sea View Labour Club, Dock View Road, Barry	312457.3, 168050.5	0.0002	0.09	0.2602
R46	The Windsor, 177-170 Holton Road, Barry	312169.8, 168205.5	0.0002	0.08	0.2602
R47	Castle Hotel, 44 Jewel St, Barry	312486.7, 168203.4	0.0002	0.08	0.2602
R48	Land at Upper Cosmeston Farm, Penarth	317932.6, 169037.6	0.0000	0.01	0.2600
R49	Land West of Swanbridge Road, Sully	315952.9, 168313.3	0.0001	0.02	0.2601
R50	Land to the South and West of the Goodsheds, Barry	311121.2, 167596	0.0001	0.05	0.2601
R51	Former Railway Sidings, Ffordd y Mileniwm, Barry	312876.2, 168434.9	0.0002	0.07	0.2602

R52	Land at Model Farm, Port Road, Rhoose	308672.4, 167179.5	0.0000	0.01	0.2600
R53	Leckwith Quay, Leckwith Road, Leckwith	316045.9, 174849.7	0.0000	0.00	0.2600
	Standard		$0.25 ng/m^3$		
	Baseline		$0.26 ng/m^3$		

Table 9.7.11: Predicted annual and 1 hour mean PCBs Concentrations (ng/m^3)

Receptor			Annual Mean			1-Hour Mean		
		Grid Reference	PC	PC as % Standard	PEC	PC	PC as % Standard	PEC
R32	Land at Barry Waterfront	311123.7, 167330.7	0.007	0.003	0.103	0.2	0.003	0.35
R33	East Quay, Barry Waterfront	312475.5, 167479.6	0.005	0.003	0.101	0.3	0.005	0.49
R34	East Quay, Barry Waterfront	312540.5, 167542.4	0.001	0.000	0.097	0.1	0.002	0.33
R35	East Quay, Barry Waterfront	312295.3, 167443.9	0.029	0.014	0.125	0.4	0.006	0.56
R36	East Quay, Barry Waterfront	312412.5, 167468.7	0.015	0.008	0.111	0.3	0.006	0.53
R37	East Quay, Barry Waterfront	312397, 167635.9	0.008	0.004	0.104	0.3	0.005	0.51
R38	Winmill Park, Hayes Road	313761.3, 167991.6	0.015	0.007	0.111	0.2	0.003	0.38
R39	Spider Camp, Hayes Lane	313636, 167500.7	0.026	0.013	0.122	0.2	0.004	0.41
R40	Former LME UK Ltd Site, Sully	314244.6, 168443.7	0.006	0.003	0.102	0.1	0.002	0.32
R41	Land to the South of Cog Road, Sully	315871.3, 168631.1	0.003	0.001	0.099	0.1	0.001	0.27

R42	Land at Hayes Wood, Sully	313691.6, 167695.7	0.022	0.011	0.118	0.2	0.003	0.40
R43	Land at Hayes Road, Barry	313597.2, 167666.9	0.026	0.013	0.122	0.2	0.004	0.41
R44	Land at Subway Road, Barry	312144.6, 167672.2	0.020	0.010	0.116	0.4	0.006	0.54
R45	Sea View Labour Club, Dock View Road, Barry	312457.3, 168050.5	0.012	0.006	0.108	0.4	0.006	0.56
R46	The Windsor, 177-170 Holton Road, Barry	312169.8, 168205.5	0.010	0.005	0.106	0.3	0.005	0.47
R47	Castle Hotel, 44 Jewel St, Barry	312486.7, 168203.4	0.010	0.005	0.106	0.3	0.005	0.52
R48	Land at Upper Cosmeston Farm, Penarth	317932.6, 169037.6	0.001	0.001	0.097	0.1	0.001	0.25
R49	Land West of Swanbridge Road, Sully	315952.9, 168313.3	0.003	0.002	0.099	0.1	0.001	0.27
R50	Land to the South and West of the Goodsheds, Barry	311121.2, 167596	0.006	0.003	0.102	0.2	0.003	0.35
R51	Former Railway Sidings, Ffordd y Mileniwm, Barry	312876.2, 168434.9	0.008	0.004	0.104	0.2	0.004	0.44
R52	Land at Model Farm, Port Road, Rhoose	308672.4, 167179.5	0.002	0.001	0.098	0.1	0.002	0.31
R53	Leckwith Quay, Leckwith Road, Leckwith	316045.9, 174849.7	0.000	0.000	0.096	0.0	0.001	0.24
	Standard		200ng/m^3			6000ng/m^3		
	Baseline		0.096ng/m^3			0.192ng/m^3		

Table 9.7.12: Predicted annual and 1 hour mean NH_3 Concentrations ($\mu g/m^3$)

Receptor			Annual Mean			1-Hour Mean		
		Grid Reference	PC	PC as % Standard	PEC	PC	PC as % Standard	PEC
R32	Land at Barry Waterfront	311123.7, 167330.7	0.03	0.02	2.55	0.68	0.03	5.72
R33	East Quay, Barry Waterfront	312475.5, 167479.6	0.02	0.01	2.54	1.30	0.05	6.34
R34	East Quay, Barry Waterfront	312540.5, 167542.4	0.00	0.00	2.52	0.61	0.02	5.65
R35	East Quay, Barry Waterfront	312295.3, 167443.9	0.12	0.07	2.64	1.58	0.06	6.62
R36	East Quay, Barry Waterfront	312412.5, 167468.7	0.07	0.04	2.59	1.47	0.06	6.51
R37	East Quay, Barry Waterfront	312397, 167635.9	0.04	0.02	2.56	1.36	0.05	6.40
R38	Winmill Park, Hayes Road	313761.3, 167991.6	0.06	0.03	2.58	0.81	0.03	5.85
R39	Spider Camp, Hayes Lane	313636, 167500.7	0.11	0.06	2.63	0.92	0.04	5.96
R40	Former LME UK Ltd Site, Sully	314244.6, 168443.7	0.03	0.02	2.55	0.57	0.02	5.61
R41	Land to the South of Cog Road, Sully	315871.3, 168631.1	0.01	0.01	2.53	0.34	0.01	5.38
R42	Land at Hayes Wood, Sully	313691.6, 167695.7	0.10	0.05	2.62	0.89	0.04	5.93

R43	Land at Hayes Road, Barry	313597.2, 167666.9	0.11	0.06	2.63	0.96	0.04	6.00
R44	Land at Subway Road, Barry	312144.6, 167672.2	0.08	0.05	2.60	1.51	0.06	6.55
R45	Sea View Labour Club, Dock View Road, Barry	312457.3, 168050.5	0.05	0.03	2.57	1.57	0.06	6.61
R46	The Windsor, 177-170 Holton Road, Barry	312169.8, 168205.5	0.04	0.02	2.56	1.20	0.05	6.24
R47	Castle Hotel, 44 Jewel St, Barry	312486.7, 168203.4	0.04	0.02	2.56	1.40	0.06	6.44
R48	Land at Upper Cosmeston Farm, Penarth	317932.6, 169037.6	0.01	0.00	2.53	0.26	0.01	5.30
R49	Land West of Swanbridge Road, Sully	315952.9, 168313.3	0.01	0.01	2.53	0.35	0.01	5.39
R50	Land to the South and West of the Goodsheds, Barry	311121.2, 167596	0.03	0.01	2.55	0.70	0.03	5.74
R51	Former Railway Sidings, Ffordd y Mileniwm, Barry	312876.2, 168434.9	0.04	0.02	2.56	1.08	0.04	6.12
R52	Land at Model Farm, Port Road, Rhoose	308672.4, 167179.5	0.01	0.00	2.53	0.53	0.02	5.57
R53	Leckwith Quay, Leckwith Road, Leckwith	316045.9, 174849.7	0.00	0.00	2.52	0.20	0.01	5.24
	Standard		180µg/m^3			2500µg/m^3		
	Baseline		2.52µg/m^3			5.04µg/m^3		

Appendix 9.8

Human Health Risk Assessment (July, 2022)

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environmental & transportation

Wood Gasification Facility
Woodham Road, Barry

Human Health Risk Assessment

Wood Gasification Facility
Woodham Road, Barry

Human Health Risk Assessment

Revision	Date	Notes	Author	Checked	Approved
1	13/05/2022	E3199	AG	AB	Dr N Davey
1.1	14/07/2022	E3199	AG	AB	Dr N Davey

Entran Limited
2nd & 3rd Floors
Northgate House
Upper Borough Walls
Bath
BA1 1RG

T: 0117 937 4077
www.entranltd.co.uk

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1 INTRODUCTION

Background

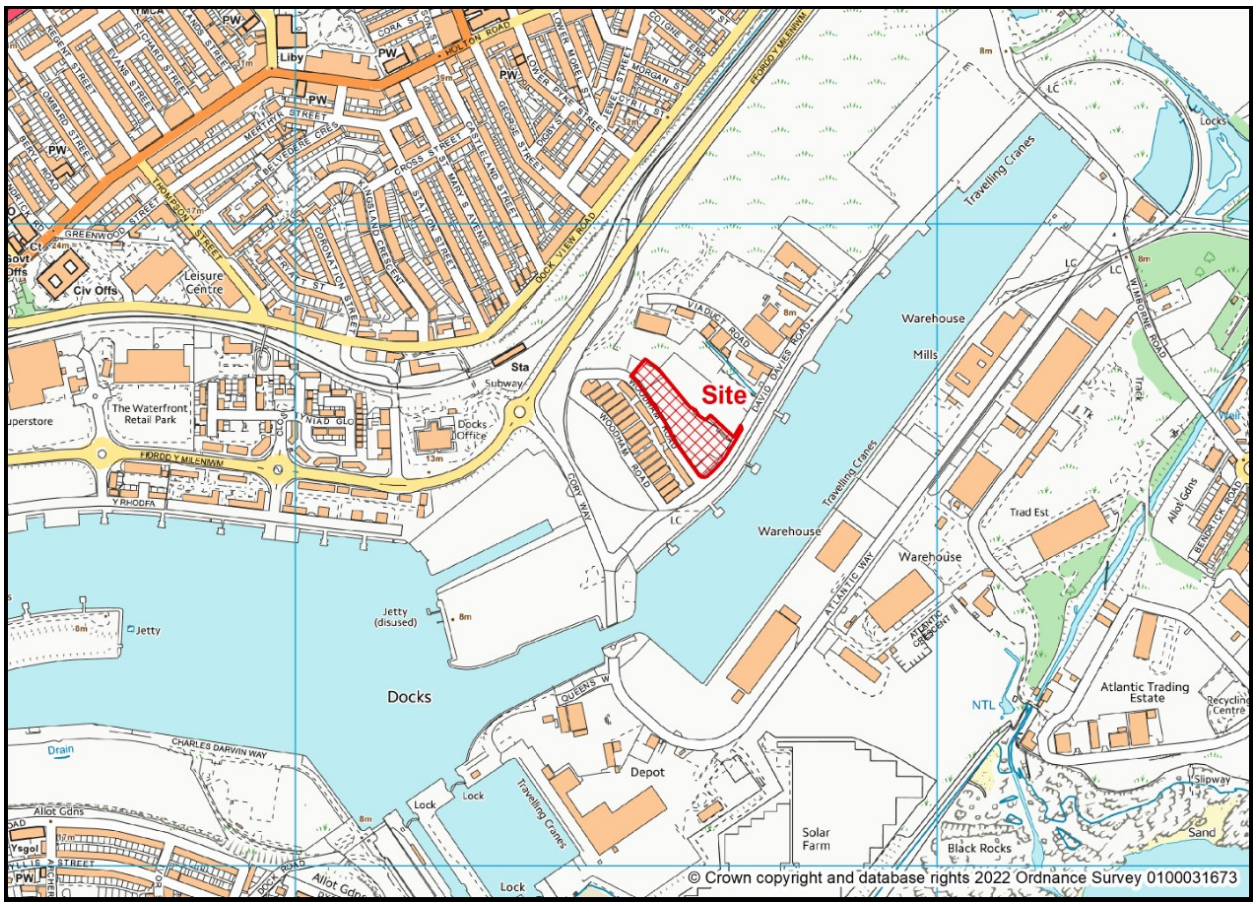
1.1 Entran Ltd has been commissioned to undertake an assessment to consider the effects on human exposure from emissions to air from a wood gasification facility located adjacent to No 2 Dock, in the Port of Barry, Vale of Glamorgan, South Wales. The assessment supplements the air quality assessment provided for the Development. The assessment only considers emissions to air as human exposure to any harmful pollutants discharged directly to the aquatic environment and from solid waste disposal is considered to be negligible.

1.2 The Site is located to the west and north of No 2 Dock and is located within an industrial setting. The nearest existing residential receptors are located along Dock View Road approximately 250 m to the northwest of the site boundary. The populated area of Barry is located to the northwest, north and northeast of the Site. Therefore, the immediate surroundings are characterised by commercial/industrial with residential beyond. However, there are proposals to redevelop land approximately 120m to the southwest of the site (Barry Waterfront Development) and the impact on this Development has been assessed. Rural areas where farming activities would be carried out are limited, the nearest area being around 2 km to the east. The location of the Facility is presented in Figure 1.1.

1.3 The Facility consists of a gas boiler utilising synthetic gas (Syngas) generated from the gasification of waste wood. The high-pressure steam generated by the boiler would be directed to a steam turbine and used to generate electricity for supply to the National Grid. The Facility is designed to operate 24 hours a day, 365 days per year. Emissions to air would be via a single 43 m stack and will be governed by the Industrial Emissions Directive [1] (IED).

1.4 The air quality assessment for the Facility[2] provides a comparison of predicted concentrations for pollutant emissions at off-site locations with background air quality and air quality standards and guidelines for the protection of human health. The air quality assessment assumes the theoretical position that the maximum permissible emission limit values (ELVs) stipulated for compliant thermal treatment of waste plants are emitted during all times of operation. This position is considered unlikely to be a realistic operating scenario.

Figure 1.1: Location of the Facility



1.5 Given the above operating scenario, the emissions from the gas boiler associated with the Facility would contain a number of substances that cannot be evaluated in terms of their effects on human health simply by reference to ambient air quality standards. Health effects could occur through exposure routes other than purely inhalation. As such, an assessment needs to be made of the overall human *exposure* to the substances by the local population and then the *risk* that this exposure causes.

Purpose of the Assessment

1.6 This assessment has been undertaken principally to support the Planning Application for the Development and has been prepared in accordance with our understanding of the requirements of the Environment Agency and NRW for these types of development. This is a human health risk assessment of dioxin/furan emissions from the Facility based on the US EPA HHRAP methodology. Human exposure to dioxins and furans has been compared against the Committee of Toxicity (COT)

1 The Industrial Emissions Directive (2010/75/EU)

2 ES Air Quality Chapter (2022)

Tolerable Daily Intake (TDI) of 2 pg/kg per day. An assessment of exposure to dioxin-like PCBs has also been included.

1.7 It should be noted that the former HMIP method does not have the capability to consider dioxin-like PCBs and the US EPA HHRAP method is limited in this respect. The HHRAP method does not contain physical properties or exposure parameters for individual dioxin-like PCBs but does provide information for two dioxin-like PCB mixtures (Aroclor 1016 and Aroclor 1254). Therefore, for these two substances typical emissions for dioxin-like PCBs have been included in the IRAP model and these have been assumed to comprise entirely of Aroclor 1016 or Aroclor 1254 depending on which substance gives rise to the highest exposure.

Scope of the Assessment

1.8 The emissions from the Facility during the modelled operational scenario would contain a number of substances that cannot be evaluated in terms of their effects on human health simply by reference to ambient air quality standards. Health effects could occur through exposure routes other than purely inhalation. As such, an assessment needs to be made of the overall human *exposure* to the substances by the local population and then the *risk* that this exposure causes.

1.9 The assessment presented here considers the potential impact of substances released by the Facility on the health of the local population at the point of maximum exposure. These substances are those that are 'persistent' in the environment and have several pathways from the point of release to the human receptor. Essentially, they can be described as dioxins/furans and dioxin-like polychlorinated biphenyls (PCBs) and are present in extremely small quantities and are typically measured in mass units of nanograms (ng = 10^{-9} g), picograms (pg = 10^{-12} g) and femtograms (fg = 10^{-15} g).

1.10 Unlike substances such as nitrogen dioxide, which have short term, acute effects on the respiratory system, dioxins/furans and dioxin-like PCBs have the potential to cause effects through long term, cumulative exposure. A lifetime is the conventional period over which such effects are evaluated. A lifetime is taken to be 70 years.

1.11 The exposure scenarios used here represent highly unrealistic situations in which all exposure assumptions are chosen to represent a worst case and should be treated as an extreme view of the risks to health. While individual high-end exposure estimates may represent actual exposure possibilities (albeit at very low frequency), the possibility of all high-end exposure assumptions accumulating in one individual is, for practical purposes, never realised. Therefore,

intakes presented here should be regarded as an extreme upper estimate of the actual exposure that would be experienced by the real population in the locality.

Approach to the Assessment

1.12 The risk assessment process is based on the application of the US EPA Human Health Risk Assessment Protocol (HHRAP)[3]. This protocol has been assembled into a commercially available model, Industrial Risk Assessment Program (IRAP, Version 5.1.0) and marketed by Lakes Environmental of Ontario.

1.13 The approach seeks to quantify the *hazard* faced by the receptor, the *exposure* of the receptor to the substances identified as being a potential hazard and then to assess the *risk* of the exposure, as follows:

1.14 *Quantification of the exposure*: an exposure evaluation determines the dose and intake of key indicator chemicals for an exposed person. The dose is defined as the amount of a substance contacting body boundaries (in the case of inhalation, the lungs) and intake is the amount of the substance absorbed into the body. The evaluation is based upon worst-case, conservative scenarios, with respect to the following:

- location of the exposed individual and duration of exposure;
- exposure rate;
- emission rate from the source.

1.15 *Risk characterisation*: following the above steps, the risk is characterised by examining the toxicity of the chemicals to which the individual has been exposed, and evaluating the significance of the calculated dose in the context of probabilistic risk. The risk is further characterised by a comparison of intakes with the tolerable daily intake (TDI) for dioxins/furans and dioxin-like PCBs.

3 US EPA Office of Solid Waste (September 2005) Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities

2 METHODOLOGY FOR ESTIMATING EXPOSURE TO EMISSIONS

Introduction

2.1 An exposure assessment for the purposes of characterising the health impact of the Facility emissions requires the following steps:

(1) Measurement or estimation of emissions from the source.

(2) Modelling the fate and transport of the emitted substances through the atmosphere and through soil, water and biota following deposition onto land. Concentrations of the emitted chemicals in the environmental media are estimated at the point of exposure, which may be through inhalation or ingestion.

(3) Calculation of the uptake of the emitted chemicals into humans coming into contact with the affected media and the subsequent distribution in the body.

2.2 With regard to Step (3), the exposure assessment considers the uptake of polychlorinated dibenzo-para-dioxins and polychlorinated dibenzofurans (PCDD/Fs, often abbreviated to 'dioxins/furans') and dioxin-like PCBs by various categories of human receptors.

Potential Exposure Pathways

2.3 There are two primary exposure 'routes' where humans may come into contact with chemicals that may be of concern:

- direct, via inhalation; or
- indirect, via ingestion of water, soil, vegetation and animals and animal products that become contaminated through the food chain.

2.4 There are four other potential exposure pathways of concern following the introduction of substances into the atmosphere:

- ingestion of drinking water;
- dermal (skin) contact with soil;
- incidental ingestion of soil; and
- dermal (skin) contact with water.

Exposure Pathways Considered in the Assessment

2.5 The possible exposure pathways included in the IRAP model are shown in Figure 2.1. Dermal contact with soil is an insignificant exposure pathway on the basis of the infrequent and sporadic nature of the events and the very low dermal absorption factors for this exposure route, coupled with the low plausible total dose that may be experienced (when considered over the lifetime of an individual). Health risk assessments of similar emissions (Pasternach (1989) The Risk Assessment of Environmental and Human Health Hazards, John Wiley, New York) have concluded that dermal absorption of soil is at least one order of magnitude less efficient than lung absorption.

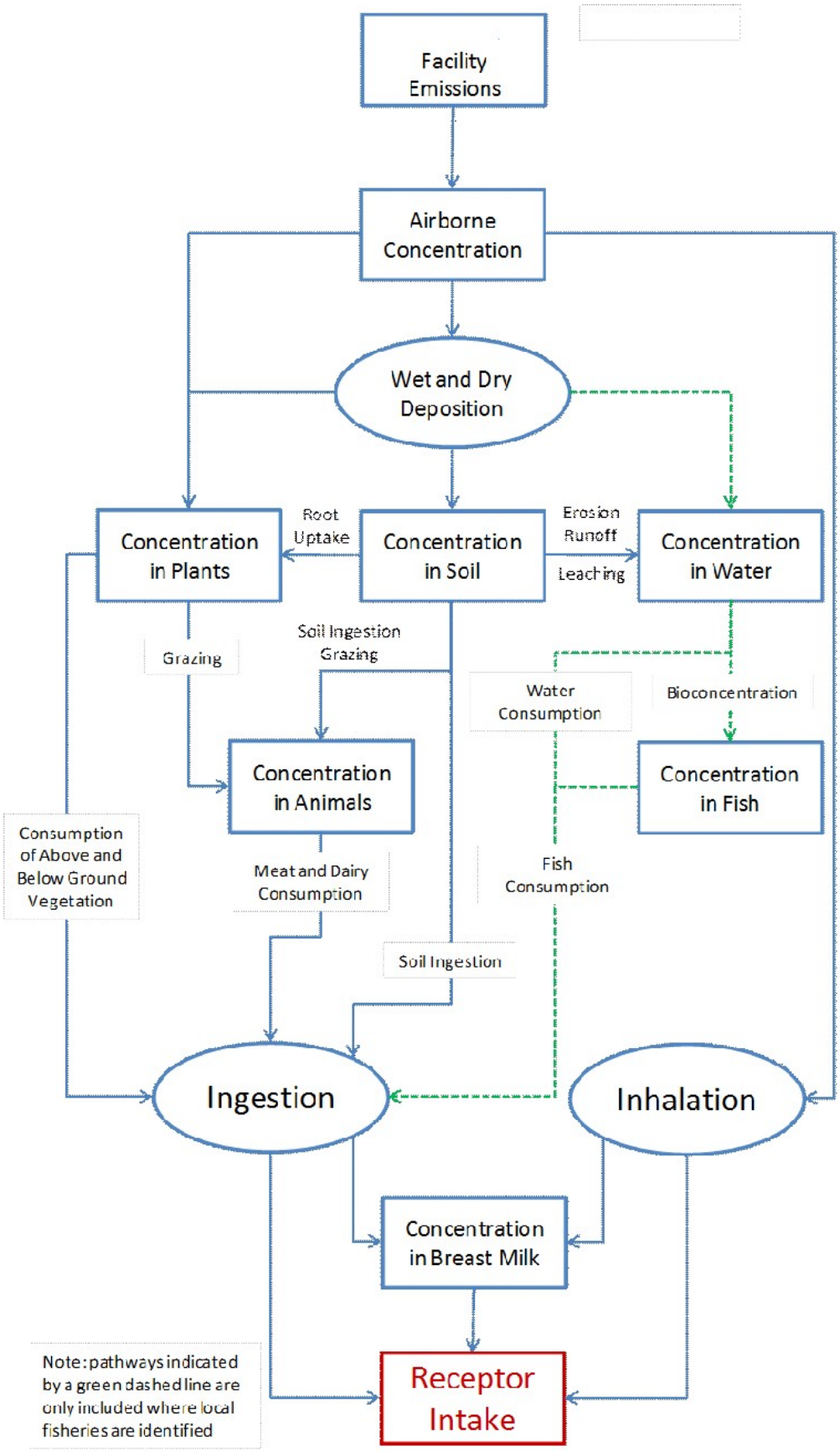
2.6 Similar arguments are relevant with respect to the elimination of aquatic pathways from consideration; swimming, fishing and other recreational activities are also sporadic and unlikely to lead to significant exposures or uptake of any contamination into the human body via dermal contact with water.

2.7 Exposure via drinking water requires contamination of surface drinking water sources local to the point of consumption. The likelihood of contamination reaching a level of concern in the local water sources and ground water supplies is extremely low, particularly where there is no large-scale storage (e.g. reservoirs) or catchment areas for local water supplies. However, the US EPA's HHRAP does include the ingestion of drinking water from surface water sources as a potential exposure pathway where water bodies and water sheds have been defined within the exposure scenario. The ingestion of groundwater as a source of local drinking water is not considered by the HHRAP as it is considered to be an insignificant exposure pathway for combustion emissions.

2.8 On the basis of the assessment of the potential significance of the exposure pathways the key exposure pathways which are relevant to the assessment and, hence, subject to examination in detail are as follows:

- inhalation;
- ingestion of food; and
- ingestion of soil.

Figure 2.1: Exposure Pathways for Receptors



2.9 Therefore, the exposures arising from ingestion are assessed with reference to the following:

- milk from home-reared cows;
- eggs from home-reared chickens;
- home-reared beef;
- home-reared pork;
- home-reared chicken;
- home-grown vegetable and fruit produce;
- breastmilk; and
- soil (incidental).

2.10 The inclusion of all food groups in the assessment conservatively assumes that both arable and pasture land are present in the vicinity of the predicted maximum annual average ground level concentration within farmland areas. This is, in reality, an unlikely scenario, but it has been included as a means of building a high degree of conservatism into the assessment and, hence, reducing the risk of exposures being underestimated. However, it should be noted that not all exposure scenarios will result in the ingestion of home-reared meat and animal products and these food products are only considered by the HHRAP for farmers and the families of farmers. Similarly, the ingestion of fish is only considered where there is a local closed water body that is used for fishing and where the diet of the fisher (and family) may be regularly supplemented by fish caught from these local water sources. A review of local fisheries indicates that there are no fisheries within 3 km where edible fish (e.g. trout or salmon) may be taken. Therefore, the ingestion of locally caught fish has not been considered, as consumption rates are likely to be very small.

Emissions and Dispersion Modelling Input Data

Compounds of Potential Concern (COPCs)

2.11 The substances which have been considered in the assessment are referred to as the Compounds of Potential Concern (COPCs) and include the seventeen PCDD/F congeners that are known to be toxic. In addition, the IRAP model includes two dioxin-like PCBs (Aroclor 1016 and Aroclor 1254). These comprise a mixture of congeners with one to four chlorine atoms for Aroclor 1016 with a chlorine content of 41% by mass (average of three chlorine atoms). Similarly, Aroclor 1254 has between four and seven chlorine atoms and a chlorine content of 54% by mass (average of five chlorine atoms).

Emission Parameters

2.12 Emissions from the Facility will be via a single 43 m high stack. Emission parameters assumed for the assessment are consistent with those used for the air quality assessment as follows:

- stack diameter of 1.6 m;
- emission velocity of 17.8 m/s;
- actual flow rate of 35.7 Am^3/s;
- normalised flow rate of 21.6 Nm^3/s; and
- emission temperature of 146 ºC.

Emission Concentrations for the COPCs

2.13 The general term dioxins denotes a family of compounds, with each compound composed of two benzene rings interconnected with two oxygen atoms. There are 75 individual dioxins, with each distinguished by the position of chlorine or other halogen atoms positioned on the benzene rings. Furans are similar in structure to dioxins, but have a carbon bond instead of one of the two oxygen atoms connecting the two benzene rings. There are 135 individual furan compounds. Each individual furan or dioxin compound is referred to as a congener and each has a different toxicity and physical properties with regard to its atmospheric behaviour. It is important, therefore, that the exposure methodology determines the fate and transport of PCDD/Fs on a congener specific basis. It does this by accounting for the varying volatility of the congeners and their different toxicities. Consequently, information regarding the PCDD/F annual mean ground level concentrations on a congener specific basis is required. For the purposes of the exposure assessment, the congener profile for the Facility is presented in Table 2.1, which is a standard profile for municipal waste incinerators derived by Her Majesty's Inspectorate of Pollution (HMIP), one of the predecessors of the Environment Agency. The international toxic equivalency factors are given and used to derive the toxic equivalent emission (I-TEQ).

2.14 It is assumed that PCDD/F emissions are at the IED emission limit (0.1 ng I-TEQ/Nm^3). However, it is likely that the plant would emit at a lower level.

Table 2.1: PCDD/F Congener Profile for the Facility

Congener	Annual Mean Emission Concentration (ng/Nm^3) (a)	I-TEF (toxic equivalent factors)	Annual Mean Emission Concentration (ng I-TEQ/Nm^3)
2,3,7,8 TCDD	0.0031	1.0	0.0031
1,2,3,7,8 PeCDD	0.025	0.5	0.012
1,2,3,4,7,8 HxCDD	0.029	0.1	0.0029
1,2,3,7,8,9 HxCDD	0.021	0.1	0.0021
1,2,3,6,7,8 HxCDD	0.026	0.1	0.0026
1,2,3,4,6,7,8 HpCDD	0.17	0.01	0.0017
OCDD	0.40	0.001	0.00040
2,3,7,8 TCDF	0.028	0.1	0.0028
2,3,4,7,8 PeCDF	0.054	0.5	0.027
1,2,3,7,8 PeCDF	0.028	0.05	0.0014
1,2,3,4,7,8 HxCDF	0.22	0.1	0.022
1,2,3,7,8,9 HxCDF	0.0040	0.1	0.00040
1,2,3,6,7,8 HxCDF	0.081	0.1	0.0081
2,3,4,6,7,8 HxCDF	0.087	0.1	0.0087
1,2,3,4,6,7,8 HpCDF	0.44	0.01	0.0044
1,2,3,4,7,8,9 HpCDF	0.040	0.01	0.00040
OCDF	0.40	0.001	0.00040
Total (ng I-TEQ/m^3)			**0.1**

(a) Congener profile from Table 7.2a DOE (1996) Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes Contract No. HMIP/CPR2/41/1/181

2.15 Given the limited availability of emissions data for energy from waste facilities burning Syngas, the total emission of dioxin-like PCBs from the Facility is assumed to be the same as for an Energy from Waste (EFW) plant and is considered to represent a worst case with respect to the facility emissions. Information on PCB emissions has been obtained from the Defra report WR 0608 **Error! Bookmark not defined.**. Based on the information provided, a maximum emission concentration of 3.6 x 10^{-9} mg/m^3 is assumed. It is not stated whether this is total PCBs or dioxin-like PCBs. Therefore, as a worst-case it is assumed to comprise entirely of dioxin-like PCBs. Furthermore, it is assumed that this is the total PCB emission and that these data are presented as the toxic equivalent concentration (i.e. 3.6 x 10^{-9} mg/m^3). For the dioxin-like PCBs, a toxic equivalent factor (TEF) of 0.1 has been used to provide an actual emission concentration

(i.e 3.6 x 10^{-8} mg/m^3). The same equivalence factor has been used to convert the total actual dose back to the total toxic equivalent dose.

2.16 The emission rates for each substance as input to the IRAP model are provided in Table 2.2.

Table 2.2: PCDD/F Emission Rates Used in the IRAP Model

Congener	Emission Concentration (mg/Nm^3)	Emission Rate (g/s)
2,3,7,8 TCDD	0.0031 x 10^{-6}	6.7 x 10^{-11}
1,2,3,7,8 PeCDD	0.025 x 10^{-6}	5.3 x 10^{-10}
1,2,3,4,7,8 HxCDD	0.029 x 10^{-6}	6.3 x 10^{-10}
1,2,3,7,8,9 HxCDD	0.021 x 10^{-6}	4.5 x 10^{-10}
1,2,3,6,7,8 HxCDD	0.026 x 10^{-6}	5.6 x 10^{-10}
1,2,3,4,6,7,8 HpCDD	0.17 x 10^{-6}	3.7 x 10^{-9}
OCDD	0.40 x 10^{-6}	8.6 x 10^{-9}
2,3,7,8 TCDF	0.028 x 10^{-6}	6.0 x 10^{-10}
2,3,4,7,8 PeCDF	0.054 x 10^{-6}	1.2 x 10^{-9}
1,2,3,7,8 PeCDF	0.028 x 10^{-6}	6.0 x 10^{-10}
1,2,3,4,7,8 HxCDF	0.22 x 10^{-6}	4.7 x 10^{-9}
1,2,3,7,8,9 HxCDF	0.0040 x 10^{-6}	8.6 x 10^{-11}
1,2,3,6,7,8 HxCDF	0.081 x 10^{-6}	1.7 x 10^{-9}
2,3,4,6,7,8 HxCDF	0.087 x 10^{-6}	1.9 x 10^{-9}
1,2,3,4,6,7,8 HpCDF	0.44 x 10^{-6}	9.5 x 10^{-9}
1,2,3,4,7,8,9 HpCDF	0.040 x 10^{-6}	8.6 x 10^{-10}
OCDF	0.40 x 10^{-6}	8.6 x 10^{-9}
Aroclor 1016/1254	0.036 x 10^{-6}	7.8 x 10^{-10}

Dispersion Modelling Assumptions

2.17 The air quality assessment has relied upon the use of AERMOD to estimate ground level concentrations of pollutants. The HHRA model has been designed to accept output files from the US EPA ISC or AERMOD dispersion models, reflecting its North American origins and its need to follow the US EPA risk assessment protocol. The use of AERMOD is consistent with the air quality assessment undertaken for the Facility and the emissions data and model set up are identical to that carried out for the air quality assessment [2].

2.18 For the modelling, all emission properties, building heights, and other relevant factors were retained from the air quality assessment provided for the Facility. As the health risk assessment requires information on the deposition of substances to surfaces as well as airborne concentrations of substances, the AERMOD dispersion model has also been used to predict the following:

- the airborne concentration of vapour, particle and particle bound substances emitted;
- the wet deposition rate of particle and particle bound substances; and
- the dry deposition rate of vapour, particle and particle bound substances.

2.19 For AERMOD, deposition velocities are determined from the assumed particle diameters and particle density of the emissions for three particle sizes based on information provided by the Minnesota Pollution Control Agency (MPCA)[4]. Details of particle sizes, density and assumed fractions are provided in Table 2.3.

Table 2.3: Particle Sizes, Particle Density and Particle Fractions Used in the IRAP Model

Particle Diameter	Particle Density (g/cm^3)	Mass Fraction (a)	Area Fraction (b)(c)
1 µm	1	0.25	0.625
2.5 µm	1	0.25	0.25
10 µm	1	0.5	0.125
(a) Fraction assumed for the particle phase (b) Fraction assumed for the particle bound phase (c) Calculated from the mass fraction utilising the method described in the US EPA HHRAP			

Dispersion Modelling Results

2.20 A summary of the key results from the AERMOD dispersion model is presented in Table 2.4. These have been predicted using the 2018 Rhoose (Cardiff International Airport) meteorological data set. This year was selected, as out of the five years considered, it was the year that provided highest predicted annual mean concentrations and deposition rates.

[4] Refined HHRAP-Based Analysis Form, AERA-26, Minnesota Pollution Control Agency (August 2011)

Table 2.4: Maximum Annual Average Particle Phase Concentrations and Particle Phase Deposition Rates Estimated by AERMOD for the Rhoose 2018 Meteorological Data

Pollutant	Max Annual Average Concentration (a)	Max Annual Average Deposition Rate (b)
PCDD/Fs	**(fg/m^3)**	**($ng/m^2/year$)**
2,3,7,8 TCDD	0.033	0.21
1,2,3,7,8 PeCDD	0.26	1.6
1,2,3,4,7,8 HxCDD	0.31	1.9
1,2,3,7,8,9 HxCDD	0.22	1.4
1,2,3,6,7,8 HxCDD	0.28	1.7
1,2,3,4,6,7,8 HpCDD	1.8	11.4
OCDD	4.3	26.8
2,3,7,8 TCDF	0.30	1.9
2,3,4,7,8 PeCDF	0.57	3.6
1,2,3,7,8 PeCDF	0.30	1.9
1,2,3,4,7,8 HxCDF	2.3	14.6
1,2,3,7,8,9 HxCDF	0.043	0.27
1,2,3,6,7,8 HxCDF	0.87	5.4
2,3,4,6,7,8 HxCDF	0.93	5.8
1,2,3,4,6,7,8 HpCDF	4.7	29.4
1,2,3,4,7,8,9 HpCDF	0.43	2.7
OCDF	4.3	26.8
Aroclor 1016/1254	0.39	2.4

(a) Where 1 fg/m^3 is equal to 1 x 10^{-15} g/m^3
(b) Where 1 $ng/m^2/year$ is equal to 1 x 10^{-9} $g/m^2/year$

3 INPUT PARAMETERS FOR THE IRAP MODEL

Introduction

3.1 Exposure of an individual to a chemical may occur either by inhalation or ingestion (including food, water and soil). Of interest is the total dose of the chemical received by the individual through the combination of possible routes, and the IRAP model has been developed to estimate the dose received by the human body, often referred to as the external dose.

3.2 Exposure to COPCs is a function of the estimated concentration of the substance in the environmental media with which individuals may come into contact (i.e. exposure point concentrations) and the duration of contact. The concentration at the point of contact is itself a function of the transfer through air, soil, water, plants and animals that form part of the overall pathway. Exposure equations have been developed which combine exposure factors (e.g. exposure duration, frequency and medium intake rate) and exposure point concentrations. The dose equations therefore facilitate estimation of the received dose and account for the properties of the route of exposure, i.e. ingestion and inhalation.

3.3 For those substances that bio-accumulate, i.e. become more concentrated higher up the food chain, especially in body fats, the exposure to meats and milk is of particular significance.

3.4 The IRAP model user has the Facility to adjust some of the key exposure factors. An example is the diet of the receptor and the proportion of which is local produce, which may be contaminated. Obviously, if a nearby resident eats no food grown locally, then that person's diet cannot be contaminated by the emissions from the source, in this case the Facility. It is conventional to investigate two types of receptor, a farmer and a resident. It is assumed that a farmer eats proportionately more locally grown food than a resident. Where the potential exists for the consumption of locally caught fish a fisher receptor may also be considered.

3.5 The receptor types can also be divided into adults and children. Children are important receptors because they tend to ingest soil and dusts directly and have lower body weights, so that the effect of the same dose is greater in the child than in the adult.

3.6 The IRAP model is designed to accept output files of airborne concentrations and deposition rates. From these, it proceeds to calculate the concentrations of the pollutants of concern in the environmental media, foodstuffs and the human receptor. The dose experienced by the human receptor can be compared to the tolerable daily intake (TDI) provided by the Committee on Toxicity for dioxins and dioxin like PCBs of 2 pg/kg/d.

3.7 The model requires a wide range of input parameters to be defined, these include:

- physical and chemical properties of the COPCs;
- site information, including site specific data; and
- receptor information – for each receptor type (e.g. adult or child, resident or farmer or fisher).

3.8 The HHRAP default values, which are incorporated into the IRAP model, have been used for the majority of these input values. These data are provided in the following sections.

Input Parameters for the COPCs

3.9 The IRAP model contains a database of physical and chemical parameters for each of 206 COPCs. This database is based on default values provided by the HHRAP and all default values have been used for this assessment.

3.10 These parameters are used to determine how each of the COPCs behaves in the environment and their presence and accumulation in various food products (meat, fish, animal products, vegetation, soil and water). For 2,3,7,8-TCDD (the most toxic of the PCDD/Fs), the default parameters are provided in Table 3.1.

Table 3.1: IRAP Input Parameters for 2,3,7,8-TCDD

Parameter Description	Symbol	Units	2,3,7,8-TCDD
Chemical abstract service number	CAS No.	-	1746-01-6
Molecular weight	MW	g/mole	322.0
Melting point of chemical	T_m	K	578.7
Vapour pressure	V_p	atm	1.97 x 10-12
Aqueous solubility	S	mg/l	1.93 x 10-5
Henry's Law constant	H	atm-m^3/mol	3.29 x 10-5
Diffusivity of COPC in air	D_a	cm^2/s	0.104
Diffusivity of COPC in water	Dw	cm^2/s	5.6 x 10-6
Octanol-water partition coefficient	K_ow	-	6,309,573
Organic carbon-water partition coefficient	K_oc	ml/g	3,890,451
Soil-water partition coefficient	Kd_s	ml/g	38,904
Suspended sediments/surface water partition coefficient	Kd_sw	l/kg	291,784
Bed sediment/sediment pore water partition coefficient	Kd_bs	ml/g	155,618

Parameter Description	Symbol	Units	2,3,7,8-TCDD
COPC loss constant due to biotic and abiotic degradation	K_sg	/a	0.03
Fraction of COPC air concentration in vapour phase	f_v		0.664
Root concentration factor	RCF	ml/g	39,999
Plant-soil bioconcentration factor for below ground produce	br_root_veg	-	1.03
Plant-soil bioconcentration factor for leafy vegetables	br_leafy_veg	-	0.00455
Plant-soil bioconcentration factor for forage	br_forage	-	0.00455
COPC air-to-plant biotransfer factor for leafy vegetables	bv_leafy_veg	-	65,500
COPC air-to-plant biotransfer factor for forage	bv_forage	-	65,500
COPC biotransfer factor for milk	ba_milk	day/kg	0.0055
COPC biotransfer factor for beef	ba_beef	day/kg	0.026
COPC biotransfer factor for pork	ba_pork	day/kg	0.032
Bioconcentration factor for COPC in eggs	Bcf_egg	-	0.060
Bioconcentration factor for COPC in chicken	Bcf_chicken	-	3.32
Fish bioconcentration factor	BCF_fish	l/kg	34,400
Fish bioaccumulation factor	BAF_fish	l/kg	0
Biota-sediment accumulation factor	BSAF_fish	-	0.09
Plant-soil bioconcentration factor for grain	br_grain	-	0.00455
Plant-soil bioconcentration factor for eggs	br_egg	-	0.011
COPC biotransfer factor for chicken	ba_chicken	day/kg	0.019

Site and Site Specific Parameters

3.11 The IRAP health risk assessment model requires information relating to the location and its surroundings. The parameters required include the following.

- The fraction of animal feed (grain, silage and forage) grown on contaminated soils and quantity of animal feed and soil consumed by the various animal species considered.
- The interception fraction for above ground vegetation, forage and silage and length of vegetation exposure to deposition. The yield/standing crop biomass is also required.

- Input data for assessing the risks associated with exposure to breast milk, including:
    - body weight of infant;
    - exposure duration;
    - proportion of ingested COPC stored in fat;
    - proportion of mother's weight that is fat;
    - fraction of fat in breast milk;
    - fraction of ingested contaminant that is absorbed; and
    - half-life of dioxins in adults and ingestion rate of breast milk.

- Other physical parameters (e.g. soil dry bulk density, density of air, soil mixing zone depth).

3.12 For all of these parameters the IRAP/EPA HHRAP default values have been used and these are presented in **Appendix A**. Other site specific parameters are also required which are not provided by the IRAP model. These parameters were specified for the Facility as follows:

- Annual average evapotranspiration rate of 79.8 cm/a (assumed to be 70% of total precipitation);
- Annual average precipitation of 114.0 cm/a (based on the average for the five year data set for 2017 to 2021 meteorological data);
- Annual average irrigation of 0 cm/a;
- Annual average runoff of 11.4 cm/a (assumed to be 10% of total precipitation);
- An annual average wind velocity of 4.9 m/s (average for the five years); and
- A time period over which deposition occurs of 30 years.

Receptor Information

3.13 Within the IRAP model there are three receptor types; Resident, Farmer and Fisher. Information relating to each receptor type (adult and/or child) is required by the model where these receptor types are used. The information required includes the following:

- Food (meat, dairy products, fish and vegetables), water and soil consumption rates for each receptor type. However, only Fishers are assumed to consume fish and only Farmers are assumed to consume locally reared animals and animal products.
- Fraction of contaminated food, water and soil which is consumed by each receptor type.

- Input data for the inhalation exposure including: inhalation exposure duration, inhalation exposure frequency, inhalation exposure time; and inhalation rate.
- Input data for the ingestion exposure including: exposure duration, exposure frequency, exposure time; and body weight of receptor.

3.14 For the purposes of this assessment the default IRAP/HHRAP parameters have mainly been used to define the characteristics of the receptors. The default input data for IRAP/HHRAP are presented in **Appendix B**. The only variation to this is the assumed body weight of a child receptor. The IRAP/HHRAP default value is 15 kg whereas in the UK a value of 20 kg is typically used. Therefore, a value of 20 kg has been used.

4 EXPOSURE ASSESSMENT

Selection of Receptors

4.1 In addition to defining specific locations for assessment, IRAP can be used to determine the location of maximum impact over an area based on the results of the dispersion model. For each defined land-use area, IRAP selects the locations which represent the maximum predicted concentrations or deposition rates for the area selected. The locations of these various maxima are often co-located resulting in the selection of one to nine receptor locations per defined area. This approach is adopted by IRAP since the maximum receptor impact may occur at any one of the maximum concentration or deposition locations identified.

4.2 Residential exposure within the immediate vicinity of the Facility is limited. The immediate locality is industrial and dominated by the docks to the east and southwest of the site. The nearest residential areas are to the north along Dock View Road and the extensive areas of Barry beyond to the north, northeast and northwest. However, the proposed Barry Waterfront Development lies close to the southwest boundary of the site. Therefore, eight areas where residential exposure may occur have been defined based on existing and proposed residential areas around the Facility. These are the nearest residential settlements.

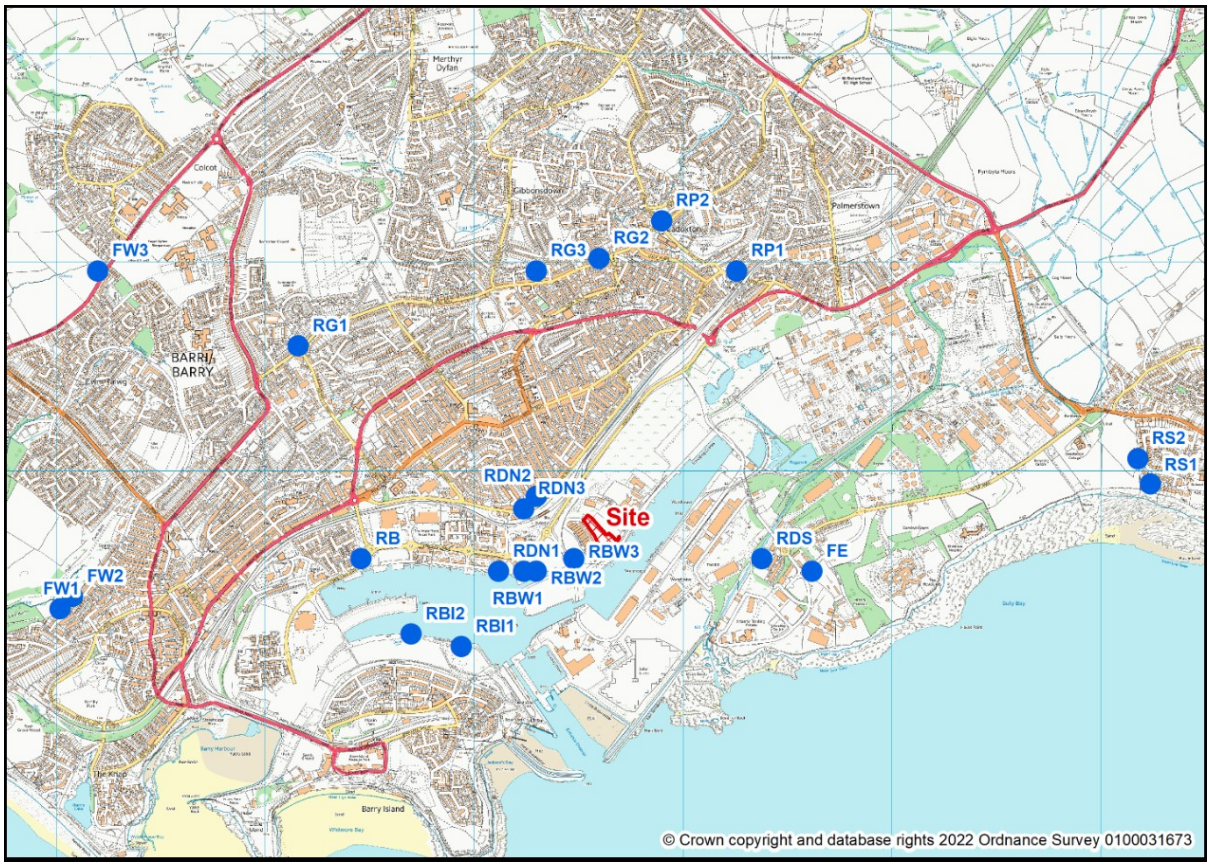
4.3 There are limited rural areas within the immediate vicinity of the Facility. The nearest extensive rural area where farming activities might be carried out lie approximately 2 km to the north and east of the site on the eastern boundary of Barry and 2.5 km to the north and west on the western boundary. There is also a small area 1.2 km to the east of the site above Sully Bay which has been used for growing crops. Therefore, two areas where the potential for farming exists have been defined with the area above Sully Bay included within the Farmer East area.

4.4 For each type of receptor up to nine locations are selected based on the maximum predicted airborne concentration, maximum predicted wet deposition rate and maximum dry deposition rate. However, often these maxima are co-located and, therefore, each receptor type will have between one and nine identified receptors per defined area. For the assessment, 17 Residential receptors and 4 Farmer receptors have been assessed. It is considered that the likelihood of locally caught fish being consumed is low and fisher receptors have not been included in the assessment. For all of the receptor types, adult and child receptors have been considered. The locations of the Resident and Farmer receptors are presented in Table 4.1 and Figure 4.1. At other locations not specifically considered in the assessment, the predicted hazards and risks will be lower than predicted for the discrete receptors considered.

Table 4.1: Description of Resident and Farmer Receptors

Reference	Name	Type	Easting	Northing
FE	Farmer East	Farmer	313620	167520
FW1	Farmer West 1	Farmer	310020	167340
FW2	Farmer West 2	Farmer	310080	167400
FW3	Farmer West 3	Farmer	310200	168960
RB	Residential Barry	Residential	311460	167580
RBI1	Residential Barry Island 1	Residential	311940	167160
RBI2	Residential Barry Island 2	Residential	311700	167220
RBW1	Residential Barry Waterfront 1	Residential	312240	167520
RBW2	Residential Barry Waterfront 2	Residential	312300	167520
RBW3	Residential Barry Waterfront 3	Residential	312480	167580
RDN1	Residential Docks North 1	Residential	312120	167520
RDN2	Residential Docks North 2	Residential	312300	167880
RDN3	Residential Docks North 3	Residential	312240	167820
RDS	Residential Docks South	Residential	313380	167580
RG1	Residential Gibbonsdown 1	Residential	311160	168600
RG2	Residential Gibbonsdown 2	Residential	312600	169020
RG3	Residential Gibbonsdown 3	Residential	312300	168960
RP1	Residential Palmerstown 1	Residential	313260	168960
RP2	Residential Palmerstown 2	Residential	312900	169200
RS1	Residential Sully 1	Residential	315240	167940
RS2	Residential Sully 2	Residential	315180	168060

Figure 4.1: Location of the Resident and Farmer Receptors



Assessment of Intake

Ingestion Dose

4.5 The ingestion intake is calculated as the Average Daily Dose (ADD) from all ingestion exposure routes (e.g. soil, above ground vegetables, meat and dairy products) where for example:

$$ADD_{Ing,TCDD} = \frac{I_{Ing,TCDD} \bullet ED \bullet EF}{AT \bullet 365}$$

4.6 Where: $ADD_{Ing,TCDD}$ = total ingestion dose for TCDD; ED is the exposure duration (dependent on the receptor type); EF is the exposure frequency (350 days per year); and AT is the averaging time, and for determining the TDI, is assumed to be equal to the ED. The total dose is the sum of the dose for each of the individual congeners.

Inhalation Dose

4.7 For inhalation, the ADD from inhalation exposure is calculated as follows:

$$ADD_{Inh,\,TCDD} = \frac{C_a \bullet IR \bullet ED \bullet EF}{AT \bullet 365}$$

4.8 Where: ADD_{Inh}, TCDD is the total inhalation does for TCDD, C_a is the concentration of TCDD in air and IR is the daily inhalation rate. The total dose is the sum of the dose for each of the individual congeners.

Exposure to Dioxins and Furans

Comparison of Dioxin/Furan Exposure with WHO and UK COT Guidance

Facility Contribution to Intake

4.9 The World Health Organization (WHO) recommends a tolerable daily intake for dioxins/furans of 1 to 4 pg I-TEQ/kg-BW/d (picogrammes as the International Toxic Equivalent per kilogram bodyweight per day)[5]. The TDI represents the tolerable daily intake for lifetime exposure and short-term excursions above the TDI would have no consequence provided that the average intake over long periods is not exceeded. The average (lifetime) daily intake of dioxins/furans for the receptors considered is presented in Table 4.2. These are also compared to the Committee on Toxicity (COT) TDI for dioxins and dioxin-like PCBs of 2 pg I-TEQ/kg-BW/d.

[5] Assessment of the Health Risk of Dioxins: Re-evaluation of the Tolerable Daily Intake (TD), WHO Consultation, May 25-29 1998, Geneva, Switzerland

Table 4.2: Comparison of Average Daily Intakes with the UK COT and WHO's TDI for Dioxins/ Furans (pg I-TEQ/kg-BW/d)

Receptor Name	Adult	Child
Farmer East	0.11	0.16
Farmer West 1	0.0079	0.012
Farmer West 2	0.0080	0.012
Farmer West 3	0.0061	0.0088
Residential Barry	0.0015	0.0042
Residential Barry Island 1	0.0032	0.0092
Residential Barry Island 2	0.0027	0.0077
Residential Barry Waterfront 1	0.0085	0.024
Residential Barry Waterfront 2	0.0089	0.026
Residential Barry Waterfront 3	0.00056	0.0016
Residential Docks North 1	0.0065	0.019
Residential Docks North 2	0.0039	0.011
Residential Docks North 3	0.0039	0.011
Residential Docks South	0.0066	0.019
Residential Gibbonsdown 1	0.00051	0.0014
Residential Gibbonsdown 2	0.00054	0.0015
Residential Gibbonsdown 3	0.00049	0.0014
Residential Palmerstown 1	0.00048	0.0014
Residential Palmerstown 2	0.00042	0.0012
Residential Sully 1	0.00052	0.0015
Residential Sully 2	0.00052	0.0015
WHO TDI	*1 to 4 pg I-TEQ/kg-BW/d*	
Committee on Toxicity (COT) TDI	*2 pg I-TEQ/kg-BW/d*	

4.10 The maximum contribution of the Facility to the COT TDI is 7.8% for the Farmer East child receptor and 1.3% for the Resident Barry Waterfront 2 child receptor. However, this assumes as a worst-case that these receptors produce their own home reared and grown food at the location of maximum impact for the area and that emissions are at the IED ELV. Therefore, the predicted exposures are representative of an extreme worst-case.

Total Intake

4.11 The contribution of the Facility to total intake is provided as follows:

- predicted incremental intake due to emissions from the Facility;
- average daily background intake (i.e. that arising from other sources), referred to as the mean daily intake (MDI);
- the total intake (i.e. the sum of the predicted incremental intake and the MDI);
- a comparison of the total intake with the TDI for dioxin/furans.

4.12 For the key receptors (i.e. those which represent the predicted highest exposure for the receptor types considered) the results are presented in Table 4.3. Results are presented for both adult and child receptors.

4.13 The MDI is derived from data provided by the Environment Agency [6] and a value of 49 pg WHO-TEQ/d. The MDI for an adult receptor and child receptor is calculated as follows:

- for an adult receptor a MDI of 0.7 pg I-TEQ/kg/d [7] is derived by dividing the Environment Agency MDI by a bodyweight of 70 kg;
- for a child receptor a MDI of 1.8 pg I-TEQ/kg/d is derived by dividing the Environment Agency MDI by a bodyweight of 20 kg and applying an adult to child correction factor of 0.74.

4.14 A comparison of predicted intakes with the MDI and TDI is presented in Table 4.3. Results are presented for the Farmer East and Resident Barry Waterfront 2 receptors where highest farmer and resident exposures are predicted, respectively.

[6] Soil Guideline Values for dioxins, furans and dioxin-like PCBs in soil, Environment Agency, Science Report SC050021/Dioxins SGV, September 2009

[7] No correction is provided between the WHO-TEF and the I-TEF but a sensitivity analysis indicates that correcting between the two systems would have negligible impact on the results

Table 4.3: Comparison of Total Intake with the COT TDI

Receptor	Total Intake from the Facility (pg I-TEQ/kg/d)	Total Intake + MDI (pg I-TEQ/kg/d)	Facility as %age of TDI	Total Intake as %age of TDI
Farmer East Adult	0.11	0.81	5.4%	40.4%
Farmer East Child	0.16	1.96	7.8%	97.8%
Resident Barry Waterfront 2 Adult	0.0089	0.71	0.4%	35.4%
Resident Barry Waterfront 2 Child	0.026	1.83	1.3%	91.3%
COT TDI	*2*	*2*	-	-

4.15 For inhalation and oral intake of PCDD/Fs for adults, total intake is well below the TDI. Background exposure represents approximately 35% of total exposure. At worst, the Facility contributes 5.4% to the TDI for adults.

4.16 For inhalation and oral intake of PCDD/Fs for children, the background intake is relatively high at 90% of the TDI. At worst, the additional contribution from the Facility for a child is 0.16 pg I-TEQ/kg/d (7.8% of the COT TDI). Combined with the background exposure for a 20 kg child (1.8 pg I-TEQ/kg/d) the total intake would be below the TDI (97.8%). Furthermore, it should be noted that the TDI for PCCD/Fs is set for the purposes of assessing lifetime exposure and these elevated background exposures for children are therefore not representative of long-term exposure.

Infant Breast Milk Exposure to Dioxins and Furans

4.17 Another exposure pathway of interest is infant exposure to dioxins and furans via the ingestion of their mother's breast milk. This is because the potential for contamination of breast milk is particularly high for dioxin-like compounds such as these, as they are lipophilic (fat soluble) and hence likely to accumulate in breast milk. Further, the infant body weight is smaller and it could be argued that the effect is therefore proportionately greater than in an adult.

4.18 This exposure is measured by the Average Daily Dose (ADD) on the basis of an averaging time of 1 year. In the US, a threshold value of 50 pg/kg/d of 2,3,7,8-TCDD TEQ is cited as being potentially harmful. The IRAP model calculates the ADD that would result from an adult receptor breast feeding an infant. It should be noted that the ADD calculated by IRAP does not consider dioxin-like PCBs. A summary of the ADD for each of the infants of adult receptors considered for the assessment is presented in Table 4.4.

Table 4.4: Assessment of the Average Daily Dose for a Breast-fed Infant of an Adult Receptor

Receptor Name	Average Daily Dose from Breast Feeding (pg/kg/d of 2,3,7,8-TCDD)
Farmer East	1.2
Farmer West 1	0.090
Farmer West 2	0.091
Farmer West 3	0.070
Residential Barry	0.015
Residential Barry Island 1	0.032
Residential Barry Island 2	0.027
Residential Barry Waterfront 1	0.086
Residential Barry Waterfront 2	0.090
Residential Barry Waterfront 3	0.0057
Residential Docks North 1	0.066
Residential Docks North 2	0.040
Residential Docks North 3	0.040
Residential Docks South	0.067
Residential Gibbonsdown 1	0.0051
Residential Gibbonsdown 2	0.0054
Residential Gibbonsdown 3	0.0049
Residential Palmerstown 1	0.0048
Residential Palmerstown 2	0.0042
Residential Sully 1	0.0053
Residential Sully 2	0.0052
US EPA Criterion	*50*
WHO Criterion	*1 to 4*
UK Criterion (COT)	*2*

4.19 The highest ADDs are calculated for the infants of farmer receptors and represent at worst less than 2.4% of the US EPA criterion of 50 pg/kg/d of 2,3,7,8-TCDD. The calculated ADDs for residential receptors are lower compared to the farmer since the most significant exposure to dioxins/furans is via the food chain, particularly animals and animal products. The farmer receptors are assumed to consume contaminated meat and dairy products. However, residential receptors are only assumed to consume vegetable products which are less significant with regard to exposure to dioxins/furans.

4.20 As a worst case, the ADD for the highest exposure for the infants of farmers is 60% of the COT TDI. However, for these receptors it is assumed, as a worst-case, that all of their food produce is reared and grown locally at the location of maximum impact in their area. Furthermore, the duration of exposure is short and the average daily intake over the lifetime of the individual would be substantially less. For residential receptors, the maximum exposure via breast milk is 4.5% of the COT TDI.

4.21 The WHO recognises that breast-fed infants will be exposed to higher intakes for a short duration, but also that breast feeding itself provides associated benefits.

5 SUMMARY AND CONCLUSIONS

Summary

5.1 The possible impacts on human health arising from dioxins and furans (PCDD/F) and dioxin-like PCBs emitted from the Facility to the south of Barry, Vale of Glamorgan have been assessed under the very worst-case scenario, namely that of an individual exposed for a lifetime to the effects of the highest airborne concentrations and consuming mostly locally grown food. This equates to a hypothetical farmer consuming food grown on the farm, situated at the closest proximity to the Facility. Where there are no active farming areas in close proximity, a residential receptor is considered where it is assumed that the resident consumes locally grown vegetables.

5.2 The assessment has identified and considered the most plausible pathways of exposure for the individuals considered (farmer and resident). Deposition and subsequent uptake of the compounds of potential concern (COPCs) into the food chain is likely to be the more numerically significant pathway over direct inhalation.

5.3 The maximum contribution of the Facility to the COT TDI is 7.8% for the farmer receptors and 1.3% for the residential receptors. However, for the farmer this assumes as a worst-case that these receptors are located at the closest farming area to the Facility and all of their food is reared and grown at this location. Therefore, taking into account the worst-case assumptions adopted for the assessment, the impact of emissions on local sensitive receptors is considered to be not significant.

Conclusions

5.4 The risk assessment methodology used in this assessment has been structured so as to create worst case estimates of risk. A number of features in the methodology give rise to this degree of conservatism. It has been demonstrated that for the maximally exposed individual, exposure to dioxins, furans and dioxin-like PCBs is not significant.

APPENDIX A – SITE PARAMETERS

Table A1: Site Parameters Defined for the Health Risk Assessment

Parameter	Parameter Value	IRAP Symbol	Units
Soil dry bulk density	1.5	bd	g/cm^3
Forage fraction grown on contam. soil eaten by CATTLE	1.0	beef_fi_forage	-
Grain fraction grown on contam. soil eaten by CATTLE	1.0	beef_fi_grain	-
Silage fraction grown on contam. eaten by CATTLE	1.0	beef_fi_silage	-
Qty of forage eaten by CATTLE each day	8.8	beef_qp_forage	kg DW/d
Qty of grain eaten by CATTLE each day	0.47	beef_qp_grain	kg DW/d
Qty of silage eaten by CATTLE each day	2.5	beef_qp_silage	kg DW/d
Grain fraction grown on contam. soil eaten by CHICKEN	1.0	chick_fi_grain	-
Qty of grain eaten by CHICKEN each day	0.2	chick_qp_grain	kg DW/d
Fish lipid content	0.07	f_lipid	-
Fraction of CHICKEN's diet that is soil	0.1	fd_chicken	-
Universal gas constant	8.2×10^{-5}	gas_r	$atm\text{-}m^3/mol/K$
Plant surface loss coefficient	18	kp	/a
Fraction of mercury emissions NOT lost to the global cycle	0.48	merc_q_corr	-
Fraction of mercury speciated into methyl mercury in produce	0.22	mercmethyl_ag	-
Fraction of mercury speciated into methyl mercury in soil	0.02	mercmethyl_sc	-
Forage fraction grown contam. soil, eaten by MILK CATTLE	1.0	milk_fi_forage	-
Grain fraction grown contam. soil, eaten by MILK CATTLE	1.0	milk_fi_grain	-
Silage fraction grown contam. soil, eaten by MILK CATTLE	1.0	milk_fi_silage	-
Qty of forage eaten by MILK CATTLE each day	13.2	milk_qp_forage	kg DW/d

Parameter	Parameter Value	IRAP Symbol	Units
Qty of grain eaten by MILK CATTLE each day	3.0	milk_qp_grain	kg DW/d
Qty of silage eaten by MILK CATTLE each day	4.1	milk_qp_silage	kg DW/d
Averaging time	1	milkfat_at	a
Body weight of infant	9.4	milfat_bw_infant	kg
Exposure duration of infant to breast milk	1	milkfat_ed	a
Proportion of ingested dioxin that is stored in fat	0.9	milkfat_f1	-
Proportion of mothers weight that is fat	0.3	milkfat_f2	-
Fraction of fat in breast milk	0.04	milkfat_f3	-
Fraction of ingested contaminant that is absorbed	0.9	milkfat_f4	-
Half-life of dioxin in adults	2555	milkfat_h	d
Ingestion rate of breast milk	0.688	milkfat_ir_milk	kg/d
Viscosity of air corresponding to air temp.	1.81×10^{-4}	mu_a	g/cm/s
Fraction of grain grown on contam. soil eaten by PIGS	1.0	pork_fi_grain	-
Fraction of silage grown on contam. soil and eaten by PIGS	1.0	pork_fi_silage	-
Qty of grain eaten by PIGS each day	3.3	pork_qp_grain	kg DW/d
Qty of silage eaten by PIGS each day	1.4	pork_qp_silage	kg DW/d
Qty of soil eaten by CATTLE	0.5	qs_beef	kg/d
Qty of soil eaten by CHICKEN	0.022	qs_chick	kg/d
Qty of soil eaten by DAIRY CATTLE	0.4	qs_milk	kg/d
Qty of soil eaten by PIGS	0.37	qs_pork	kg/d
Density of air	1.2×10^{-3}	rho_a	g/cm^3
Solids particle density	2.7	rho_s	g/cm^3

Parameter	Parameter Value	IRAP Symbol	Units
Interception fraction - edible portion ABOVEGROUND	0.39	rp	-
Interception fraction - edible portion FORAGE	0.5	rp_forage	-
Interception fraction - edible portion SILAGE	0.46	rp_silage	-
Ambient air temperature	298	t	K
Temperature correction factor	1.026	theta	-
Soil volumetric water content	0.2	theta_s	ml/cm^3
Length of plant expos. to depos. - ABOVEGROUND	0.16	tp	a
Length of plant expos. to depos. - FORAGE	0.12	tp_forage	a
Length of plant expos. to depos. – SILAGE	0.16	tp_silage	a
Average annual wind speed	3.9	u	m/s
Dry deposition velocity	0.5	vdv	cm/s
Dry deposition velocity for mercury	2.9	vdv_hg	cm/s
Wind velocity	3.9	w	m/s
Yield/standing crop biomass - edible portion ABOVEGROUND	2.24	yp	kg DW/m^2
Yield/standing crop biomass - edible portion FORAGE	0.24	yp_forage	kg DW/m^2
Yield/standing crop biomass - edible portion SILAGE	0.8	yp_silage	kg DW/m^2
Soil mixing zone depth	2.0	z	cm

APPENDIX B – SCENARIO PARAMETERS

Table B1: Exposure Scenario Parameters

Parameter Description	Adult Resident	Child Resident	Adult Farmer	Child Farmer	Adult Fisher	Child Fisher	Units
Averaging time for carcinogens	70	70	70	70	70	70	a
Averaging time for noncarcinogens	30	6	40	6	30	6	a
Consumption rate of BEEF	0.0	0.0	0.00122	0.00075	0.0	0.0	kg/kg FW/d
Body weight	70	15	70	15	70	15	kg
Consumption rate of POULTRY	0.0	0.0	0.00066	0.00045	0.0	0.0	kg/kg FW/d
Consumption rate of ABOVEGROUND PRODUCE	0.00032	0.00077	0.00047	0.00113	0.00032	0.00077	kg/kg DW/d
Consumption rate of BELOWGROUND PRODUCE	0.00014	0.00023	0.00017	0.00028	0.00014	0.00023	kg/kg DW/d
Consumption rate of DRINKING WATER	1.4	0.67	1.4	0.67	1.4	0.67	l/d
Consumption rate of PROTECTED ABOVEGROUND PRODUCE	0.00061	0.0015	0.00064	0.00157	0.00061	0.0015	kg/kg DW/d
Consumption rate of SOIL	0.0001	0.0002	0.0001	0.0002	0.0001	0.0002	kg/d
Exposure duration	30	6	40	6	30	6	yr
Exposure frequency	350	350	350	350	350	350	d/a
Consumption rate of EGGS	0.0	0.0	0.00075	0.00054	0.0	0.0	kg/kg FW/d
Fraction of contaminated ABOVEGROUND PRODUCE	1.0	1.0	1.0	1.0	1.0	1.0	-
Fraction of contaminated DRINKING WATER	1.0	1.0	1.0	1.0	1.0	1.0	-
Fraction contaminated SOIL	1.0	1.0	1.0	1.0	1.0	1.0	-

Parameter Description	Adult Resident	Child Resident	Adult Farmer	Child Farmer	Adult Fisher	Child Fisher	Units
Consumption rate of FISH	0.0	0.0	0.0	0.0	0.0	0.0	kg/kg FW/d
Fraction of contaminated FISH	1.0	1.0	1.0	1.0	1.0	1.0	-
Inhalation exposure duration	30	6	40	6	30	6	a
Inhalation exposure frequency	350	350	350	350	350	350	d/a
Inhalation exposure time	24	24	24	24	24	24	h/d
Fraction of contaminated BEEF	1	1	1	1	1	1	-
Fraction of contaminated POULTRY	1	1	1	1	1	1	-
Fraction of contaminated EGGS	1	1	1	1	1	1	-
Fraction of contaminated MILK	1	1	1	1	1	1	-
Fraction of contaminated PORK	1	1	1	1	1	1	-
Inhalation rate	0.83	0.30	0.83	0.30	0.83	0.30	m^3/h
Consumption rate of MILK	0.0	0.0	0.01367	0.02268	0.0	0.0	kg/kg FW/d
Consumption rate of PORK	0.0	0.0	0.00055	0.00042	0.0	0.0	kg/kg FW/d
Time period at the beginning of combustion	0	0	0	0	0	0	a
Length of exposure duration	30	6	40	6	30	6	a