INDAVER
■ IRELAND

Administration,
Waste Management Licensing,
Environmental Protection Agency,
PO Box 3000,
Johnstown Castle Estate,
Co. Wexford.

06/05/02

W.L. Application Ref:167-1

Re: Notice in accordance with Article 14(2)(b)(ii) of the Waste Management (Licensing) Regulations

Dear Sir / Madam,

Further to the above notice dated 8th April 2002, please find attached the following information as requested under **Article 12** of the Waste Management (Licensing) Regulations

- An original copy of the amended Article 9 notification plus five copies.

As a result of the inclusion of additional activities to this application, the following documents have been updated accordingly and are attached.

- An original plus five copies of Table B.6 of the license application form
- An original plus five copies of Attachment A1.1 of the licence application
- An original plus five copies of Attachment B6.1 of the licence application
- An original and 5 copies of the Waste License Application- Non Technical Summary
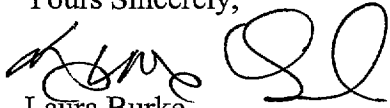
Additionally, following a request by the Agency under **Article 13** of the Waste Management (Licensing) Regulations, please find the following documents attached.

- An original plus fifteen copies of the revised E.I.S. –Air Quality chapter.
- An original plus fifteen copies of the revised Air Dispersion Model report.

Finally, Indaver Ireland have completed a three month PM_{10} baseline study at the proposed site. An original plus fifteen copies of the corresponding report are also attached.

INDAVER ■IRELAND

I trust that the above is to your satisfaction, however should you require any additional information please do not hesitate to contact me.

Yours Sincerely,

Laura Burke
Projects Manager
Indaver Ireland

NON-TECHNICAL SUMMARY

1.   INTRODUCTION

Indaver Ireland is submitting this application for a Waste Licence for a proposed waste management facility at Carranstown, Co. Meath. The application is being made to the Environmental Protection Agency (EPA) under the Waste (Licensing) Regulations 1997 as amended.

The principal class of activity at the facility is listed under the **Third Schedule** of the Waste Management Act, 1996, namely:

8.   Incineration on land or at sea.

The following other activities will take place at the facility:

Third Schedule

7.   *Phyisco-chemical treatment not referred to elsewhere in this Schedule (including evaporation, drying and calcination) which results in final compounds or mixtures which are disposed of by means of any activity referred to in paragraphs 1. to 10 of this schedule (including evaporation, drying and calcination)*

12.   *Repackaging prior to submission to any activity referred to in a preceding paragraph of this Schedule.*

13.   *Storage prior to submission to any activity referred to in a preceding paragraph of this schedule, other than temporary storage, pending collection, on the premises where the waste concerned is produced.*

Fourth Schedule

2.   *Recycling or reclamation of organic substances which are not used as solvents.*

3.   *Recycling or reclamation of metals and metal compounds.*

4.   *Recycling or reclamation of other inorganic materials.*

6.   *Recovery of components used for pollution abatement.*

9.   *Use of any waste principally as a fuel or other means to generate energy*

13.   *Storage of waste intended for submission to any activity referred to in a preceding paragraph of this schedule, other than temporary storage, pending collection, on the premises where such waste is produced.*

Indaver has received a notification from Meath County Council in July 2001 of a decision to grant planning permission for this proposed waste management facility. This is currently subject to an appeal with an Bord Pleanala.

Indaver intend to apply their experience of waste management to construct a waste management facility consisting of the following elements:

- A community recycling park serving the local community with an estimated throughput of 2,000 tonnes per annum

- A materials recycling facility for non hazardous waste with an anticipated throughput of 20,000 tonnes per annum

- A waste to energy plant for non hazardous waste with a nominal capacity of 150,000 tonnes per annum

Indaver Ireland aims to reduce any potential emissions and environmental impacts by incorporating Best Available Technologies and Techniques. Indeed, Indaver NV has extensive experience of operating incineration plants which not only comply with the new EU Regulations, but operates to levels well below the regulatory limits. For example, two dioxin removal steps will be installed in the waste to energy plant to ensure that dioxin emissions are well below the new EU limit of 0.1 ng/m^3.

1.1   SITE LOCATION

The proposed development will be located on a c.25 acre green-field site in the Carranstown, County Meath (see Figure 1.1 overleaf). A comprehensive site selection exercise was carried out. The Carranstown site was chosen due to its central location with respect to waste production, proximity to existing industrial activity, access to electricity export facilities and major access routes.

1.2   COMPANY PROFILE

Indaver is a company that specialises in Waste Management. Indaver recycle and treat both domestic and industrial waste and provide advice on how to prevent waste as an integral part of our service. 'Sustainable Waste Management' is Indaver's philosophy that demonstrates their commitment to establishing long-term relationships with customers and the community.

Indaver employs more than 800 people and handled over 800,000 tonnes of waste in year 2000. Of this, approximately 400,000 tonnes was recycled, approximately 350,000 tonnes went for waste to energy and approximately 50,000 tonnes went for treatment or disposal.

Since its establishment, Indaver has given a high priority to environmental management, quality and safety. Indaver has over 100 licences for the treatment of a broad range of waste materials. Complying with the most stringent standards all installations have been designed to minimise the residue burden on the environment.

Indaver is involved in a comprehensive range of waste management activities at their various plants in Flanders. A selection of such activities are as follows (see also Figure 1.2):

- Sorting and purification of packaging waste
- Sorting of paper and cardboard for recycling
- Solvent recycling
- Recovery of wood waste

- Glass recycling

- Physio-chemical treatment of liquid waste
- Treatment of chlorinated waste
- Sludge treatment

- Composting
- Sorting and recovery of tyres
- Ash treatment

- Landfill
- Hazardous waste incineration
- Non hazardous waste incineration

Indaver Ireland is a wholly owned subsidiary of Indaver NV, and is registered as a branch of Indaver NV at the Companies Registration Office in Dublin Castle. Indaver owns a 60% share of MinChem Environmental Services Limited, an Irish hazardous waste management company with offices in Dun Laoghaire, Dublin Port and Cork. MinChem has been operating in Ireland since 1977 and currently employ 35 people.
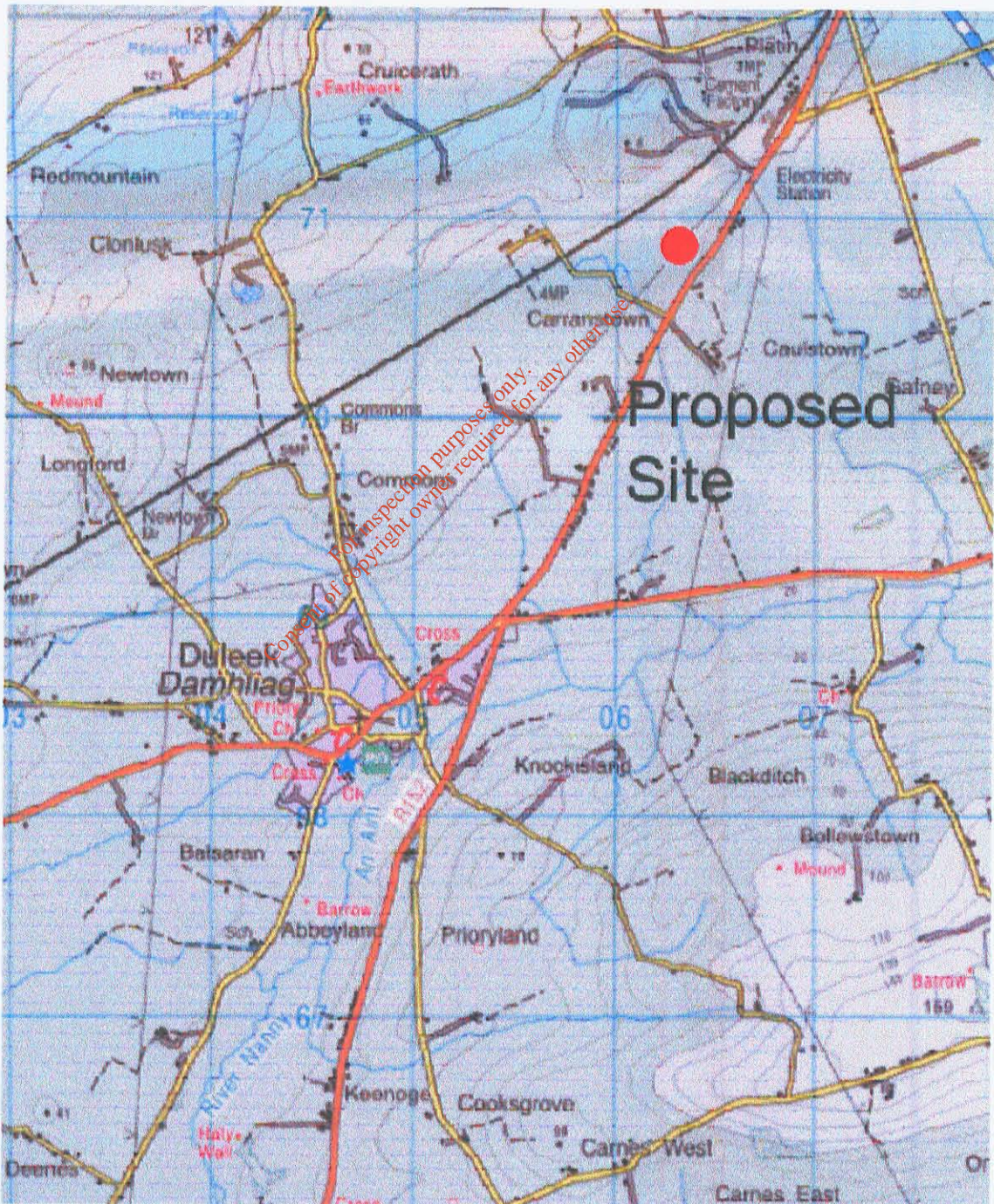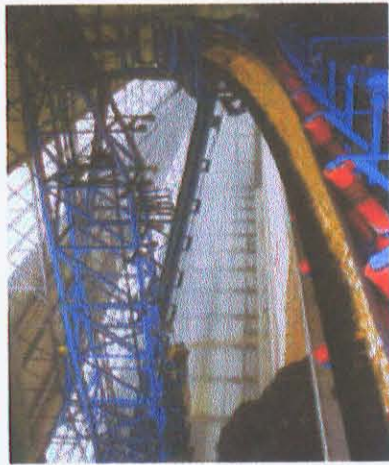

Figure 1.1   Site Location Map

Solvent Recovery

Glass Recovery

Paper Recovery

Incineration

Composting

Fluorescent Tube Treatment

Figure 1.2   Some of Indaver's Activities

2.   PLANT DESIGN

The waste management facility will consist of three separate areas, which are addressed in the following sections.

2.1   COMMUNITY RECYCLING PARK

The community recycling park will be located inside the entrance to the facility and will be open to the public six days a week. The park will allow members of the public to deposit items of waste for recycling into specially designed containers. The facility will accept recyclable waste such as:

- Cardboard
- Newspaper
- Aluminium drink cans
- Glass and wood
- Waste oils and batteries
- Textiles and footwear

Through comparison with similar facilities, it is estimated that the park will accept approximately 2,000 tonnes per annum. The community recycling park will be manned during opening hours to monitor deliveries of waste and ensure that inappropriate waste, such as kitchen waste, will not be accepted. The area will be kept clean and odour free through good housekeeping practices, such as regular washing and sweeping of the area, provision of hand washing facilities for members of the public and monitoring of waste deliveries. There will be no raw or ancillary material requirements at the park and there will be no requirement for fixed items of plant in the park, however mobile shredding units (for garden waste) and a forklift may be required from time to time.

There will be no emissions arising from the waste recovery activities at the park and therefore there will be no monitoring or sample points located in this area. All surface water runoff will pass through a petrol interceptor before entering the underground water storage tank.

All materials collected will be transported for further recycling to appropriately licensed facilities. Materials such as plastic and cardboard may be compacted and baled in the materials recycling facility located on site prior to being shipped for further recycling. All recovered materials leaving the recycling park will be enclosed in containers or will be covered. This requirement will prevent littering as a result of transport. It is anticipated that residual waste arising from the park will be minimal due to assistance provided by Indaver Ireland staff.

Environmental literature will be available to members of the public from the recycling park staff. The literature will provide details to members of the public on issues relating to Composting and Household Waste Management.

2.2   MATERIALS RECYCLING FACILITY

The materials recycling facility will provide for deliveries of approximately 20,000 tonnes of unsorted dry recyclable commercial and industrial waste per annum. All waste delivery trucks will be weighed and recorded upon arrival at the facility. Each load arriving at the facility will be required to have a waste certificate, which will detail the name of the carrier/collector of waste and vehicle registration, a description of the waste, the quantity of waste collected and the name of the person inspecting the delivery.

Dry recyclable waste will be accepted into the recycling hall, where it will be stored prior to processing. The waste recycling area will be maintained under negative air pressure to prevent potential odours being released from the hall. Air drawn from outside through the main doors of the building will be used as part of the primary air source in the furnace of the waste to energy plant.

The typical composition of recyclable waste is as follows:

- Paper
- Cardboard
- Plastics
- Wood
- Metals

The dry recyclable waste will be discharged from the trucks in the recycling hall and large items, such as bulky pieces of wood or metal, will be removed and put directly into containers, which will be sent to licensed recycling facilities off-site.

The remaining waste will then be lifted onto conveyors and passed through a large rotating screen to remove small particles, which will be disposed of in the waste to energy plant. Paper, plastic and cardboard will be manually removed by sorters who will be located within a picking station. The manually removed items will be dropped through chutes within the picking station and will be collected in bunkers located at ground level. These materials will then be either put in containers or baled, and sent onwards for recycling.

Metals will then be removed from the waste stream. These metals will then be placed directly into containers or may be baled and sent for recycling. The remaining, residual fraction of the stream will be sent to the incinerator for disposal. The total residual waste will represent approximately 20% of the input.

Items of plant such as front loaders and forklifts will be diesel-powered while all other material handling equipment will be electrically powered. The material recycling facility will require no raw materials or preparations, however there will be a requirement for rolls of baling wire which will be used to hold compacted bales of material in shape during transport.

The plant will be designed to sort 20,000 tonnes of waste per annum. This plant will operate between 8am to 6.30pm Monday to Friday and from 8am to 2pm on Saturdays, however additional working hours may be required depending on incoming

waste volumes. The sorting plant will be operated by up to 16 personnel consisting of 13 sorters, a foreman, a forklift driver and a front loader truck driver.

There will be no solid, liquid or gaseous emissions arising from this activity. The only potential emission that may be considered is that of noise, however owing to the fact that all items of plant will be located within a building, the impact arising from this will be negligible. Indaver Ireland will carry out noise monitoring at agreed intervals and locations around the site boundary.

As with the community recycling park, all materials leaving this process will be either within enclosed containers or will have to be covered to prevent the risk of litter during transport off site.

2.3   WASTE TO ENERGY PLANT

The waste to energy plant is based on conventional grate incineration technology, with modern flue gas treatment techniques employed. The plant will accept 150,000 tonnes of non-hazardous waste per annum and heat produced as a result of the incineration process will be used to generate approximately 14 mega watts (MW) of electricity, of which approximately 11 MW will be exported to the ESB distribution network, which is enough to power approximately 16,000 homes. The principle unit processes in the plant are described below.

2.3.1   Reception

All waste delivery trucks will be weighed and recorded upon arrival at the facility. Each load arriving at the facility will be required to have a waste certificate, which will detail the name of the carrier/collector of waste and vehicle registration, a description of the waste, the quantity of waste collected and the name of the person inspecting the delivery. Trucks will then drive into the enclosed waste reception hall where the waste will be tipped into the waste bunker. This area will be enclosed and maintained under negative pressure (air will be drawn into the building through the entrance doors and used as combustion air in the furnace) and as a result there will be no odours or littering outside this area.

The waste reception hall will be supervised to ensure that the waste arriving at the facility is in accordance with Indaver's waste acceptance procedures. The reception hall will contain a waste inspection area in which visual checks can be carried out on selected deliveries. In the event of material arriving at the facility that is not suitable for the process, this waste will be held in a waste quarantine area while transport off site is arranged. Any large or bulky items will be mechanically shredded prior to entering the bunker.

The waste materials will enter the storage bunker via one of five discharge chutes. The capacity of the bunker will be sufficient to allow waste deliveries to continue during periods of maintenance shutdown and during long weekends, etc.

The waste in the bunker will be mixed before it enters the furnace. The operation of mixing and loading will be carried out by a plant operator located in the control room directly above the bunker. The plant operator will use a semi-automatically controlled grab crane.

The only potential for unexpected emissions in the bunker would be due to a fire in the waste. In practice, the grab operator would remove this burning waste and place it into the furnace hopper where it will then enter the furnace. In the event of the fire becoming larger the operator would direct either one of two water cannons at the source. These cannons will have a flow rate of 300 cubic metres per hour which would be sufficient to extinguish a fire. In the event of large quantities of water being used, the bunker would contain this water prior to it being transported off-site for treatment at an appropriately licensed facility.

2.3.2   Combustion

The waste will be automatically lifted into the furnace feed hopper by the bunker's grab crane mechanism. The hopper will transfer the waste into the furnace using a ram system.

The furnace will be a "Grate" type and will continually move the waste from the entrance side to the ash discharge side. Gas-fired burners will be located within the furnace and will be used in start up situations. The burners will also provide auxiliary firing during normal operation to ensure the required temperature of 850 °C is maintained.

The waste will stay in the furnace for approximately one hour, which will ensure that the waste is completely burned. Air will be supplied to the furnace to assist burning, in addition parameters such as temperature and oxygen levels will be measured continuously in the furnace.

Small particles of waste or "siftings" that fall through the grate will be collected in a hopper, cooled using primary air for the furnace and returned by means of a conveyor system to the bunker. This will amount to approximately 1% of the input volume.

The residual ash that will represent approximately 20% of the total weight input is the solid by-product of the incineration stage. This ash will be quenched in a water bath upon leaving the furnace, where metals will be removed and sent off-site for recycling. The ash will be stored in an ash bunker prior to transport off site. This material may be used as a raw material in the construction industry, however if such an outlet is not established it will be disposed of to a non-hazardous landfill.

The waste to energy plant will have two furnace lines, which will allow one line to be shut down for maintenance without effecting the entire process.

2.3.3   Energy Recovery

The hot combustion gases leaving the furnace will enter a boiler to recover the heat generated by burning the waste, where the boiler water will be converted into superheated steam. The gas temperature at the inlet to the boiler is required, under the EU Directive on Incineration of Waste (2000/76/EC), to be a minimum of 850 °C with a residence time of at least two seconds.

The superheated steam will leave the boiler at a pressure of 40 bar, a temperature of 400 °C and will be expanded through a electricity generating turbine which will supply an output of approximately 14 MW. The steam exiting the turbine will pass through an air-cooled condenser where the remaining heat will be removed. The condensed

boiler water will then pass through a re-heating economiser before re-entering the boiler.

This closed loop process reduces the requirement for large volumes of boiler make-up water and instead, smaller volumes of boiler blowdown will be regularly removed to prevent the build up of salts in the system, this boiler blowdown will be diverted to the evaporating spray tower for recycling. All water entering the boiler water system will be of a high purity, which will be achieved using a de-ionised system or a combined de-ionised/reverse osmosis system. In addition, chemicals will be added to the water to inhibit corrosion of the pipework.

NO_x will be removed in the first pass of the boiler by the injection of ammonia or urea. These chemicals will react with nitrogen oxides to produce nitrogen and water. As a result the plant is expected to operate below the EU limit of 200 mg/m^3.

The only emission from the boiler will be boiler ash, which will represent approximately 1-2% or 1,500 to 3,000 tonnes per annum of the input weight. Depending on analysis of this ash, this material will go to either a hazardous or non-hazardous landfill. However, from Indaver's experience of operating a similar facility, it is expected that this ash will be classified as non-hazardous.

The waste to energy plant will have two boilers, which will allow the plant to shut down one line for maintenance without effecting the entire process.

2.3.4   Flue Gas Cleaning

The flue gases leaving the boiler will enter a five stage cleaning process involving cooling, dioxin and heavy metal removal, dust removal, acid gas removal and a final stage of dioxin and heavy metal removal. The final stage of flue gas cleaning will ensure that all emissions are well below the new EU limit values (EU Directive on Incineration of Waste (2000/76/EC)).

The plant will be equipped with a continuous dioxin sampler to provide records of any dioxin emissions from the plant.

Gas Cooling

The combustion gases leaving the boiler at a temperature of approximately 230°C will pass into an evaporating spray tower where they will be cooled to approximately 170°C. Cooling will be provided by spraying the liquid effluent from other process operations into an evaporating tower as the gases pass through, and therefore the tower will serve as both a gas cooling stage as well a recycling stage for the plant's effluent.

The tower will require approximately 5m^3 of water per hour. The required temperature of the flue gases will be achieved by controlling the rate of water to the tower. A small amount of solid residue will be deposited at the base of the tower due to evaporation. This residue will be removed and combined with the flue gas cleaning residues removed from the baghouse filter.

As with the furnace and boiler, the facility will operate two evaporating spray towers to avoid disruption to the process during times of maintenance.

Dioxin & Heavy Metal Removal

Activated carbon/lime mixture will be injected into the cooled flue gases exiting the spray tower. The activated carbon/lime mixture will be injected at a rate of 15kg/hr for each line when the plant is operating at a nominal capacity of 150,000 tonnes /annum. The activated carbon/lime mixture will adsorb heavy metals, organics and dioxins. The activated carbon/lime mixture will become entrained in the flue gases and will be removed along with other particulates in the baghouse filter.

Dust Removal

The baghouse filter will consist of 1,000 individual fabric filters, which will allow the flue gas to pass through while solid particulates will be captured on the filter sleeves. The removal of the solid cake from the sleeves will be undertaken at regular intervals using compressed air, and the cake now termed "flue gas cleaning residues" will be conveyed to a storage silo. The flue gas cleaning residues will amount to between 2-3% or 3,500 to 5,000 tonnes /annum of the input weight.

The plant will operate two baghouse filters, to avoid disruption to the process during times of maintenance.

Gases generated from both furnace lines will be combined after the baghouse filtration stage.

Acid Gas Removal

The combined flue gases will now enter a wet scrubbing system to remove any hydrochloric acid (HCl), hydrofluoric acid (HF), sulphur dioxide (SO_2) and heavy metals in the gas stream. The acid gas removal system will use lime/limestone as the reagent. Either reagent will be equally effective and the decision to use either one will be made on the basis of potential suppliers. It is anticipated that approximately 1,600 tonnes/annum of limestone or approximately 900 tonnes/annum of lime will be required for this process. The lime/limestone will be mixed with water in a blending tank to form a solution prior to entering the scrubbers. There are two options for this treatment stage and both options are described below.

Option 1

The flue gases will pass through two wet scrubbers. The gases will enter the first scrubber from the bottom and pass up through the tower against the falling reagent liquid. This scrubber will remove hydrochloric and hydrofluoric acids (HCl and HF). A controlled amount of reagent will be regularly removed from the circulating stream, which will pass through a neutralisation tank and will then be recycled in the evaporating spray tower. Lime/limestone will be used as the neutralisation solution in this scrubber.

In the second scrubber, lime/limestone will react with SO_2 to produce gypsum. A proportion of the circulating liquid from the second scrubber will be regularly removed and will pass through a vacuum belt filter to remove the gypsum. Approximately 1,000 tonnes/annum of gypsum will be produced from this treatment stage.

An alternative within this option would be to use water only in the first scrubbing tower. This would not effect the removal efficiency for HCl, HF and heavy metals. The balance of lime/limestone would, however, be required in the neutralisation tank.

Option 2

The second option for this treatment step would involve removing the first scrubbing tower and instead adding the lime/limestone solution into the evaporating spray tower.

The second scrubber would operate as per Option 1.

Tail End Cleaning

An Induced Draught (ID) fan will draw the combustion gases through the flue gas cleaning plant and maintain the plant in underpressure. This will ensure that no combustion gases escape from the process without going through the flue gas cleaning plant.

The tail end flue gas treatment will involve either (a) a second activated carbon/lime mixture injection with a baghouse filtration unit or (b) a fixed bed of lignite cokes known as a carbon bed.

In the case of (a) above, the principle will be the same as that mentioned above. In the case of (b) the flue gases will be forced through the bed of cokes, where the cokes will absorb trace dioxins, heavy metals and acid gases. Approximately once a week a small fixed amount of cokes will be extracted from the bottom of the filter. During commissioning of the plant, a rate of removal of the cokes will be established in order to ensure optimum performance of the bed. All removed cokes will be disposed of in the incineration process.

In the case of the carbon bed, the ID fan will be located between the wet scrubbers and the tail end flue gas cleaning system, as the carbon bed operates more effectively in overpressure. In the case of the baghouse filter, the fan will be located downstream of the tail end flue gas cleaning system as the baghouse filter operates more effectively in underpressure.

The use of wet scrubbers in the plant will both cool the flue gases and saturate them with water, which would result in a visible plume at the discharge of the stack. In order to reduce this plume the gases will be reheated from about 60 °C to 100 °C via a heat exchanger.

A tabulated summary of the expected stack emission concentrations from the waste to energy plant are included overleaf, along with a comparison to the appropriate EU limits.

Table 2.1 Comparison of Anticipated Stack Emissions versus EU Limits

Emission	Typical Emission Concentration (mg/Nm³)	EU Emission Concentration Limits (mg/Nm³)*
NO_x (as NO_2)	150	200
SO_2	20	50
Dust	1	10
CO	20	100
TOC	1	10
HCl	1	10
HF	1	1
PCDD / PCDF (ng/m³)	0.01	0.1
Cd & Tl	0.025	0.05
Hg	0.025	0.05
Sum of 9 Heavy Metals: Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V	0.25	0.5

* These emission concentration limits are those specified in the EU Directive on Waste Incineration (2000/76/EC).

2.3.5 Operation

The waste to energy plant will generally operate twenty-four hours a day, seven days a week for approximately 7,500 hours per year. The plant when operating will generally run at full output, which results in optimum efficiency. However, for approximately 2 weeks each year, a single line will be shut down for maintenance while the other line remains operational.

2.4 RAW MATERIALS

The raw materials to be used in the waste to energy plant are ammonia solution (25%) or urea, activated carbon/lime mixture, lime or limestone, lignite cokes, cement or iron silicate, sodium hydroxide (caustic), hydrochloric acid, trisodium phosphate and marketed boiler water treatment chemicals.

2.5 FUEL SUPPLY/ELECTRICITY GENERATION

Waste that is not suitable for re-use or recycling will be incinerated in the proposed plant, with the objective being to recover as much of the energy content of the waste as possible, in line with EU policy. The proposed development contains energy recovery in the form of electricity production through use of a steam turbine, which is standard for waste incineration in Europe and is considered BAT (best available

techniques[1]). The electricity production from the waste to energy plant is expected to be approximately 14 MW, approximately 11 MW of which will be exported to the ESB distribution network. Efficient use of energy at the waste management facility will be a priority and will be a key objective of the Environmental Management Programme for the site.

The plant will use small quantities of natural gas for start up and potentially for auxiliary firing. However, the demand will not be large and gas can be supplied from the nearby natural gas supply.

There will be a gas-fired back-up electricity generator on site, which will only be used in the unlikely circumstance of both the plant not producing electricity and no power supply being available from the ESB distribution network.

3. PREDICTED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

It is Indaver Ireland's policy to avoid any release, disposal or emission that might harm the environment, and to minimise impacts including atmospheric emissions, discharges to water, solid waste and local noise nuisance. Compliance with national and European regulations will be achieved as a minimum expectation. Mitigation measures will be implemented in accordance with Best Available Techniques (BAT). The plant will be operated in accordance with the principles of an accredited Environmental Management System, e.g. EN ISO 14001 or EMAS.

3.1 AIR

The proposed waste to energy plant will have one main emission point through which the combustion gases will be discharged via a 40m stack after cleaning. The discharge, mainly carbon dioxide (CO_2) and water vapour, will potentially also contain a number of substances, the emissions of which are regulated by EU and Irish legislation, and for which ambient air quality standards are specified.

The proposed plant will achieve limits for air emissions well within strict EU legislative requirements by implementing various abatement technologies including ammonia/urea and activated carbon/lime mixture injection, wet scrubbers and filters.

A single stage of dioxin removal is sufficient to meet the new EU limit of 0.1 TEQ ng/m^3. This is usually achieved by activated carbon/lime mixture injection, which adsorbs dioxins, hydrocarbons and heavy metals. However, the proposed plant will be also equipped with an additional dioxin removal process, which acts to reduce emissions even further. As a result, it has been estimated that, for an individual living at the point where dioxin concentrations are predicted to be highest from the waste to energy plant, the person's inhaled intake of dioxins would be equivalent to drinking less than an additional half glass of milk per month, assuming a glass volume of 300ml[2].

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[1] As defined in the EC Directive 96/61/EC concerning integrated pollution prevention and control.

[2] It has been assumed that the individual referred to above would be located at this point of highest dioxin concentration 24 hours per day, 365 days per year.

The Irish and US EPA approved Industrial Source Complex (ISC 3) computer model was used to carry out dispersion modelling to assess the potential impact of the emissions from the stack to atmosphere. The results of the modelling showed that the predicted ground level concentrations were significantly below the most stringent Air Quality Standards and therefore the impact of these emissions on the surrounding environment will be insignificant.

There will also be minor atmospheric emissions from the back-up gas-fired generator on site. This generator will never be in continuous operation as it will only be used when electricity supply is unavailable both from the ESB distribution network and from the plant. The back-up generator will also be in operation for a period of half an hour once per month for testing purposes.

The activated carbon/lime mixture silo located externally will be fitted with high quality dust filters which will effectively eliminate any dust emissions. The silos for the purposes of storage of flue gas cleaning residues and boiler ash will be located within the waste to energy plant and will also be fitted with high quality dust filters. Within enclosed areas, bottom ash will be discharged into trucks that will be covered to prevent windblown ash emissions.

Continuous monitoring of oxides of nitrogen (NO_x), sulphur dioxide (SO_2), particulates (dust), hydrocarbons (expressed as Total Organic Carbon (TOC)), carbon monoxide (CO) and hydrogen chloride (HCl) in the flue gases from the stack will be carried out. PCDDs and PCDF's (dioxins and furans) will be continuously sampled and analysed at least twenty times per year. Heavy metal and HF monitoring and analysis will be carried out four times in the first year and twice per annum thereafter.

3.2   CLIMATE

3.2.1   Acidification

The generation of sulphur dioxide (SO_2)and nitrogen oxides (NO_X), which are acid gases, can give rise to acidification and resultant environmental degradation. The power generation sector is the single largest contributor to emissions of SO_2 and is a significant contributor to total NO_X emissions. The problem of acidification and degradation of ecosystems arising from these emissions have long been recognised.

The proposed plant will produce SO_2 and NO_x emissions. However, it will produce less NO_x and SO_2 per unit electricity that is currently produced, on average, by power stations in Ireland (based on figures contained in ESB's Environmental Report, 1997)and will be below current EU limits.

3.2.2   Global Warming

There is a consensus in the scientific community that there is a real and existing problem arising from emissions of carbon dioxide (CO_2) and other greenhouse gases which give rise to global warming. When waste is disposed of to landfill, large quantities of methane are produced, which is an extremely potent greenhouse gas (15 times more powerful than CO_2). By treating the waste in a waste to energy plant, inert ash is produced, avoiding the formation of large quantities of methane. There will be

an overall net reduction in greenhouse gases arising from this facility as compared to landfilling the same amount of waste material.

3.3 WATER

3.3.1 Surface Water

All surface water run-off, such as rainwater, from hard-surfaced areas and building roofs on the site will drain via petrol interceptors into a 1500 m^3 storage tank located underground beneath the main building complex. This water will be used to supplement process water requirements. During flood conditions only (1 in 20 year storm), the capacity of the tank may be exceeded and it may be necessary to discharge to the wet drain currently to the west of the site, which is in turn drains to the River Nanny. Therefore, the existing surface water flow regime will not be significantly altered by the proposed development.

All chemicals or other potentially polluting substances used during the operation of the facility will be stored within bunded areas and will also be handled in a manner to eliminate the risk of any spillages contaminating surface water (or groundwater).

Petrol interceptors will be installed on surface water drains draining hard-surfaced areas (car-parking and marshalling areas) to contain any leakages of petrol/oil from vehicles on site.

3.3.2 Trade Effluent

There will be no trade effluent generated on site.

3.3.3 Groundwater

A domestic effluent treatment system will be used to treat all the domestic effluent from the facility to a very high standard before discharging it to a percolation area. The quality of the water discharged will be well within set limits before entering the percolation area.

Groundwater will be regularly monitored during operation of the plant to ensure that there is no adverse impact on groundwater quality.

3.4 NOISE

During operation of the facility, there will be a number of external noise sources at the plant such as the stack, air-cooled condenser, turbine cooler and noise emitted through louvres from buildings. A noise modelling analysis was carried out based on the anticipated noise emissions from the main noise sources on the site. The anticipated noise emissions are based on a survey of noise sources carried out at a similar plant in Belgium. The predicted noise levels at the nearest sensitive receptors are significantly below the Environmental Protection Agency recommended limit of 45 dBA and therefore the impact from noise generated at the facility on the surrounding area is not considered significant. A noise monitoring programme will be put in place to confirm compliance with the limits.

3.5   TRAFFIC

A detailed assessment of the potential impacts of the traffic due to the proposed development up to 2020 was carried out as part of the environmental impact assessment. The increase in the predicted two-way peak hour traffic volumes due to the proposed development will be no more than 7.1% on any of the roads in the vicinity of the development. The level of service within which these roads operate, will not be affected. The increase in predicted annual average daily traffic flows on the road network will be no more than 4.3%. Therefore it is predicted that the road network will not be adversely affected by the proposed development.

The facility will be provided with a high quality entrance including deceleration lane and right-hand turning lane. A traffic management plan will be implemented to ensure that impacts during construction will be minimal.

3.6   LANDSCAPE & VISUAL IMPACTS

The proposed site is contained within a predominantly agricultural landscape, and is designated as an area of visual quality VQ 11 – Rural and Agricultural, as defined in the Meath County Draft Development Plan, 2000, which can effectively absorb development. The landscape within which the proposed site is located is not significant or valued in a regional or national context. The Boyne valley is not in the same landscape envelope as the proposed development site.

However, the site can be viewed from other vulnerable landscape areas with a low visual absorption capacity such as Bellewstown Ridge (V16 of the 1994 Development Plan and the Draft Development Plan). Given the industrial character of the area, and the distance to these elevated views, it is considered that the impact of the proposed development will not be significant.

During construction, there will be minor and temporary impacts due to constructional works, moving and storage of machinery, etc. This intrusion will be short term and will be typical of any construction site.

The waste to energy plant will be the largest structure on the site (30m tall and a 40m stack) and will be located at the lower, rear section of the site, reducing its apparent scale when seen from the surrounding area. The exhaust gases will be heated to approximately 100 °C to reduce the formation of a visible plume at the stack discharge.

Landscaping measures such as berms and planting of native species of trees and shrubs (50,000 saplings) will minimise the impact of the facility, and should render the facility unobtrusive to passing traffic after the planting has matured (see overleaf for Figures 3.1 to 3.3).

Figure 3.1 Photomontage from R152, immediately south of the proposed entrance

Figure 3.2 Photomontage from R152, north of development

Figure 3.3 Photomontage from the R152 near Duleek

3.7   FLORA AND FAUNA

A baseline study carried out at the site found that flora and fauna present are represented by a few common species which are typical of the agricultural habitat. No rare, threatened or legally protected plant species or fauna of ecological significance were observed within the site. No part of the site or its immediate surroundings is covered by a scientific or conservation designation or proposed designation as recognised by Dúchas, the Heritage Service.

During construction, only on-site flora and fauna contained therein will be disturbed. The removal of this arable habitat during construction is not predicted to have significant ecological impacts. Mitigation measures will be taken to prevent any further damage to hedgerows and to protect the watercourses in adjacent fields.

Emissions from the facility are not predicted to have any significant negative impact on flora and fauna in the surrounding areas. The development will not therefore have any significant ecological impacts.

3.8   CULTURAL HERITAGE

In an archaeological survey of the site, it was established that the site is located in a region of historical importance, however no known archaeological monuments are recorded on the proposed site in the County Meath Sites & Monuments Record or elsewhere. No archaeological remains or artefacts were identified during the field walk, nor was there any evidence of archaeological remains in the trial pits dug on site as part of the soils survey.

It is therefore proposed that all topsoil stripping and groundworks be monitored by an archaeologist licensed under the terms of the National Monuments Act 1930, as amended. Any archaeological discoveries will be immediately reported to the Keeper of Irish Antiquities, National Museum of Ireland, and to Dúchas, The Heritage Service.

3.9   HUMAN ENVIRONMENT

The site is located in the townsland of Carranstown approximately 3 km north-east of Duleek village. The land use in the area is predominantly agricultural with the exception of the Platin cement factory and its associated quarry located to the north-east of the proposed development site. A commercial freight railway line, used to transport freight for Tara Mines and Platin Cement, runs within 50-100 metres of the northern boundary of the site. The area does not have any specific land zoning in either the existing (1994) or proposed Meath County Development Plan and is considered rural and agricultural. The development plans allow for industrial development in unzoned areas. One of the development objectives in the Development Plan for rural areas is to 'ensure that commercial and industrial proposals for rural areas are sustainable'.

The construction and operational phases of the development will result in the change of use of some land (ca. 25 acres) that was previously used for agricultural purposes.

The facility will employ a permanent staff of approximately 50 people and will therefore have a positive impact on employment in the area. Goods and services required during the operation of the plant will be sourced locally where possible which will have a further positive impact on the local economy and employment in the area. The provision of the community recycling park will add to the amenity of the area.

The proposed plant will be designed in accordance with BAT and will be operated in an environmentally sound manner. All discharges from the plant will comply with the relevant regulatory limits designed for the protection of human health and the environment. Therefore, the operation of the development will not have any adverse impact on human health.

4.   WASTE MANAGEMENT

While the type and quantity of ash produced from any solid waste incineration process is dependent on the nature of the waste feed, experience has shown that with a typical mix of industrial, commercial and municipal waste, approximately 250 kg of solid waste residue is produced per tonne of waste or 10% by volume. There will be four solid waste residues collected from the proposed waste to energy plant which will be collected from separate parts of the process:

- Bottom ash – collected from the grate of the furnace. Bottom ash will account for the majority of the solid residues produced by the plant (30,000 tonnes/annum or 20% of waste input by weight).

- Boiler ash – collected from the boiler. About 1-2% (by weight) of the waste input (1,500 to 3,000 tonnes) of boiler ash will be produced per annum.

- Flue gas cleaning residues – About 4,000 tonnes of flue gas cleaning residues will be collected from the flue gas cleaning plant each year.

- Gypsum – About 1,000 tonnes per annum of gypsum will be recovered from the flue gas cleaning plant per annum.

A large proportion of the bottom ash is suitable for use as construction material and if an outlet can be found in Ireland it will be used for this purpose. Otherwise it will be disposed of to non-hazardous landfill.

The boiler ash will also be solidified, either on or off site, and disposed of to a hazardous or non-hazardous landfill, depending on analysis.

The flue gas cleaning residues will contain a high percentage of soluble salts as well as some heavy metals and will therefore be classified as hazardous waste. It will be solidified, either on or off site, and will be disposed of to a hazardous waste landfill in accordance with regulatory requirements. If no hazardous waste landfills exist in Ireland, the solidification and/or disposal may take place either in Ireland or abroad.

The gypsum can be used in the construction industry, if a market exists, and is otherwise suitable for disposal to non hazardous landfill.

5. CONTINGENCY PLANNING

5.1 INCIDENT AND EMERGENCY MANAGEMENT

Management of environmental risk is a continuous process. An Environmental Management System (EMS), based on an accredited standard e.g. EN ISO 14001 or EMAS, will be implemented at the facility to continuously monitor and improve the environmental performance of the plant. A quality management system and a safety management system based on the ISO 9002 and OSHAS 18001 standards respectively will also be developed and implemented at the site. Indaver Ireland will regularly identify the hazards and assess, and hence prevent, the risks associated with site activities. The results of the identification and assessment process will be used to develop the necessary measures to prevent unauthorised or unexpected emissions as well as emergency response procedures to limit the potential outcome of such emissions.

A site emergency response plan will be prepared prior to start-up which will set out the response measures to be taken by Indaver personnel and the facilities available for use in the event of an emergency. These measures will be designed to ensure maximum protection for the site employees, site visitors and people in other premises near to the site, to minimise any impacts on the environment, to limit plant damage and to minimise the impact on site operations.

5.2 CESSATION OF ACTIVITY

The plant has a projected life span of a minimum of 20 years, however this can be extended with maintenance/replacement of items of equipment. Should circumstances arise whereby it becomes necessary to abandon the site, then Indaver Ireland will ensure that the site and buildings are left in a secure manner and that all equipment, chemicals and wastes are removed off site to avoid any pollution risk and return the site of operation to a satisfactory state.

B6.1   TYPE OF ACTIVITY

1.   PRINCIPAL ACTIVITY

The principal class of activity under the Third Schedule of the Waste Management Act, 1996, will be as follows:

8.   *Incineration on land or at sea*

The proposed waste to energy plant to be located at the site will be based on conventional grate incineration technology. This technology is proven and reliable and has been widely used in many countries worldwide. In summary, the incineration process will involve non-hazardous municipal and industrial solid waste material firstly being tipped into a bunker prior to being fed into the furnace. In the furnace the waste will be incinerated, producing heat, ash and combustion gases. The flue gases will then be cooled, filtered, passed through scrubbers and reheated prior to discharge via the stack. The waste liquids produced by the scrubbers will be used in the cooling process and a solid waste produced, rather than an aqueous liquid, thereby eliminating any process effluent from the facility. The heat produced by the combustion of the waste will be used to generate steam, which will be used to drive a steam turbine and electrical generator. The plant will produce approximately 14MW of electricity, approximately 11MW of which will be exported to the ESB distribution network, which is equivalent to supplying electricity to approximately 16,000 homes.

2.   OTHER RELEVANT ACTIVITIES

The following other activities will take place at the site under the Third Schedule of the Waste Management Act, 1996:

7.   *Phyisco-chemical treatment not referred to elsewhere in this Schedule (including evaporation, drying and calcination) which results in final compounds or mixtures which are disposed of by means of any activity referred to in paragraphs 1. to 10. of this Schedule (including evaporation, drying and calcination).*

Boiler ash produced at the waste to energy plant may require solidification prior to disposal to landfill. Also, flue gas cleaning residues produced will require solification prior to landfill. If a soldification plant is installed at the facility the above activity will occur.

12.   *Repackaging prior to submission to any activity referred to in a preceding paragraph of this Schedule.*

This activity will occur on site if, for example, hazardous items such as cylinders or small quantities of laboratory materials are deposited at the community recycling park by mistake and it is necessary to repackage the material prior to sending it off site for disposal.

*13.   Storage prior to submission to any activity referred to in a preceding paragraph
        of this Schedule, other than temporary storage, pending collection, on the
        premises where the waste concerned is produced.*

This actvity will take place at the site if, for example, non-recyclable material is
deposited at the community recycling park by mistake and it is necessary to send the
material off site for disposal. Materials, such as concrete blocks, may also be
delivered as part of a load to the materials recycling facility that are not suitable for
recycling or incineration and must be sent off site for disposal. All of the ashes and
gypsum will be temporarily stored on site prior to off-site disposal. If a market exists
for recycling of gypsum or bottom ash, these activities will be covered under activities
6 and 13 of the fourth schedule, as discussed below.

The other activities that will take place at the site under the Fourth Schedule of the
Waste Management Act, 1996, are as follows:

*2.   Recycling or reclamation of organic substances which are not used as solvents
        (including composting and other biological transformation processes).*

In the materials recycling facility, paper, cardboard, wood and plastics will be
separated, baled where applicable and transported to appropriate licensed facilities for
recycling.

3.   Recycling or reclamation of metals and metal compounds.

The sorting process in the materials recycling facility will also involve the separation
of metals. The metals will then be baled or put directly into containers and sent to
appropriately licensed faciltities for recycling. Metals will also be recovered from the
bottom ash in the waste to energy plant and sent off site for recycling.

4.   Recycling or reclamation of other inorganic materials.

Glass may be separated in the materials recycling facility and transported to
appropriate licensed facilities for recycling.

6.   Recovery of components used for pollution abatement.

Gypsum will be recovered from the wet flue gas cleaning system within the waste to
energy plant. It can be used in the construction industry, and the gypsum recovery
facility will be designed to comply with the standards required if a market exists,
depending on the sulphur content of the waste.

9.   Use of any waste principally as a fuel or other means to generate energy.

Hot gases released during the incineration of the waste will pass through a boiler to
produce super-heated steam. This steam will then be passed through an electricity
generating turbine that will generate approximately 14MW of electricity, of which
approximatley 11 MW will be exported to the National Grid.

13.   *Storage of waste intended for submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where such waste is produced.*

The segregated waste streams at the materials recycling facility and the different waste streams collected at the community recycling park will be stored on site prior to transport off-site for recycling by a permitted waste contractor. Waste may be stored in the bunker in the waste to energy plant for a period of 3 to 4 days prior to incineration. The bottom ash that will be produced in the furnace of the waste to energy plant is suitable for use in road construction and may be recycled if a market exists. If this material is suitable for recycling it will be temporarily stored on site prior to removal off site.

B.5 Type of Activity

Specify the relevant activities in the Third Schedule or Fourth Schedule to the Waste Management Act 1996 as amended by S.I. No. 166 of 1998, to which the application relates (check the relevant box(es) and mark the principal activity with a 'P'). **Attachment B.6** should identify the principle activity and include a description of each of the other activities specified. **There can only be one principal activity.**

The relevant boxes that apply to the waste management facility are ticked in the table below. The reasons for applicability are described in Attachment B6.1.

TABLE B.6 THIRD AND FOURTH SCHEDULES OF THE WASTE MANAGEMENT ACT 1996

Waste Management Act, 1996			
THIRD SCHEDULE Waste Disposal Activities		**FOURTH SCHEDULE** Waste Recovery Activities	
1. Deposit on, in or under land (including landfill).		1. Solvent reclamation or regeneration.	
2. Land treatment, including biodegradation of liquid or sludge discards in soils.		2. Recycling or reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes).	✓
3. Deep injection of the soil, including injection of pumpable discards into wells, salt domes or naturally occurring repositories.		3. Recycling or reclamation of metals and metal compounds.	✓
4. Surface impoundment, including placement of liquid or sludge discards into pits, ponds or lagoons.		4. Recycling or reclamation of other inorganic materials.	✓
5. Specially engineered landfill, including placement into lined discrete cells which are capped and isolated from one another and the environment.		5. Regeneration of acids or bases.	
6. Biological treatment not referred to elsewhere in this Schedule which results in final compounds or mixtures which are disposed of by means of any activity referred to in paragraphs 1. To 10. of this Schedule.		6. Recovery of components used for pollution abatement.	✓
7. Physico-chemical treatment not referred to elsewhere in this Schedule (including evaporation, drying and calcination) which results in final compounds or mixtures which are disposed of by means of any activity referred to in paragraphs 1. to 10. of this Schedule (including evaporation, drying and calcination).	✓	7. Recovery of components from catalysts.	
8. Incineration on land or at sea.	P	8. Oil re-refining or other re-uses of oil.	
9. Permanent storage, including emplacement of containers in a mine.		9. Use of any waste principally as a fuel or other means to generate energy.	✓
10. Release of waste into a water body (including a seabed insertion).		10. The treatment of any waste on land with a consequential benefit for an agricultural activity or ecological system.	
11. Blending or mixture prior to submission to any activity referred to in a preceding paragraph of this Schedule.		11. Use of waste obtained from any activity referred to in a preceding paragraph of this Schedule.	
12. Repackaging prior to submission to any activity referred to in a preceding paragraph of this Schedule.	✓	12. Exchange of waste for submission to any activity referred to in a preceding paragraph of this Schedule.	
13. Storage prior to submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where the waste concerned is produced.	✓	13. Storage of waste intended for submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where such waste is produced.	✓

B.6 Fees

State each class of activity for which a fee is being submitted as per Part I of the Third Schedule of the Waste Management (Licensing) Regulations, S.I. No. 133 of 1997 as amended by S.I. No. 166 of 1998.

Fee (in £)	Waste Activity
£5,000	Recovery of Waste
£10,000	Disposal of Waste (>100 kilo tonnes/yr)

A total fee of £15,000 applies to the waste management facility.

B.7 Quantity and Nature of Wastes

Provide the annual amount of waste accepted/to be accepted at the site. Additional information including the amounts of waste recovered and/or disposed of per annum since 1988 should be included in **Attachment B.8.** The tonnage per annum should be given of that expected for the life of the licence, with at least the next five years tonnages provided.

TABLE B.8.1 ANNUAL QUANTITIES AND NATURE OF WASTES

This table has been expanded and included in Attachment B8.1.

Year	Non-hazardous waste (tonnes per annum)	Hazardous waste (tonnes per annum)	Total annual quantity of waste (tonnes per annum)

1   Air Quality Study

Executive Summary

Air dispersion modelling was carried out using the United States Environmental Protection Agency's (USEPA) regulatory model ISCST3. The aim of the study was to assess the impact of typical emissions and at the emission limits outlined in Council Directive 2000/76/EC, in the ambient environment. The study demonstrates that all substances which will be emitted from Indaver Ireland will be at levels that are well below even the most stringent ambient air quality standards and guidelines. The dispersion model study consisted of the following components:

- Review of design emission levels and other relevant information needed for the modelling study;
- Identification of the significant substances which are released from the site;
- Review of background ambient air quality in the vicinity of the plant;
- Air dispersion modelling of significant substance concentrations released from the site;
- Deposition modelling of dioxin and heavy metals released from the site;
- Identification of predicted ground level concentrations of released substances beyond the site boundary and at sensitive receptors in the immediate environment;
- A full cumulative assessment of significant releases from the site taking into account the releases from all other significant industry in the area based on the USEPA's Prevention of Significant Deterioration (PSD) approach;
- Evaluation of the significance of these predicted concentrations, including consideration of whether these ground level concentrations are likely to exceed the most stringent ambient air quality standards and guidelines.

Modelling and a subsequent impact assessment was undertaken for the following substances released from the site:

- Nitrogen dioxide (NO_2)
- Sulphur Dioxide (SO_2)
- Total Dust (as PM_{10})
- Gaseous and vaporous organic substances expressed as total organic carbon (TOC)
- Hydrogen Chloride (HCl)
- Hydrogen Fluoride (HF)
- PCDD/PCDFs (Dioxins)
- Mercury (Hg)
- Cadmium (Cd) and Thallium (Tl)
- Sum of Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni) and Vanadium (V).

Assessment Approach

Emissions from the site have been assessed under firstly typical operations and secondly under maximum operating conditions. Maximum operations are based on those outlined in EU Directive 2000/76/EC. Predicted ambient air concentrations have also been identified at the most sensitive residential receptors and in Carranstown and the surrounding geographical area as far away as Duleek, Drogheda and Newgrange.

Modelling Under Typical & Maximum Operations

In order to assess the possible impact from Indaver Ireland under typical and maximum operations, a conservative approach was adopted, that is designed to over-predict ground level concentrations. This cautious approach will ensure that an over-estimation of impacts will occur and that the resultant emission standards adopted are protective of ambient air quality. The approach incorporated several conservative assumptions regarding operation conditions at Indaver Ireland. This approach incorporated the following features:

- For the maximum operating scenario, it has been assumed that the emission point is continuously operating at its maximum operating volume flow. This will over-estimate the actual mass emissions from the site.

- For both scenarios, it has been assumed that the emission point is operating for 24-hrs/day over the course of the full year.

- Typical emissions are the expected annual average expected emissions from the plant when operating at 100% of its design capacity.

- Worst-case meteorological conditions have been used in all assessments. The worst-case year leads to annual average concentrations which are 30% higher than the five-year average. The year of meteorological data for the years between 1993 and 1997 that gave rise to the highest predicted ground level concentrations of nitrogen dioxide has been reported in this study (Year 1994).

- A comparison with more advanced modelling formulations (AERMOD and AERMOD-PRIME) has indicated that the current model (ISCST3) is conservative and particularly so for long-term averaging periods.

As a result of these conservative assumptions, there will be an over-estimation of the emissions from the site and the impact of Indaver Ireland in the surrounding environment.

Modelled Locations

In relation to the spatial assessment of emissions from the site, modelling has been carried out to cover locations at the boundary of the site and beyond, regardless of whether any sensitive receptors are located in the area. Ambient air quality legislation designed to protect human health is generally based on assessing ambient air quality at locations where the exposure of the population is significant relevant to the averaging time of the pollutant. However, in the current assessment, ambient legislation has been applied to all locations regardless of whether any sensitive receptors (such as residential locations) are present for significant periods of time. Thus, again, this represents a worst-case approach, an examination of the corresponding concentrations at the nearest sensitive receptors relative to the actual quoted maximum concentration indicates that these receptors generally experience ambient concentrations significantly lower than that reported for the maximum value.

Baseline Air Quality Review

An extensive baseline survey was carried out in the region of the site between June and October 2000 (see Section 4 – Air Quality of the main body of the EIS). The survey focussed on the significant pollutants likely to be emitted from the source and which have been regulated in Council Directive 2000/76/EC.

NO_2 concentrations measured over the monitoring period were significantly less than the EU limit value. Smoke concentrations measured over the period averaged 4 $\mu g/m^3$, which is significantly lower than the PM_{10} annual limit value of 40 $\mu g/m^3$. Similarly, levels of SO_2, HF and HCl were all significantly below the respective limit values.

Background levels of PCDD/PCDFs cannot be compared to ambient air quality concentration or deposition standards. However, levels of dioxins and furans can be compared to existing levels measured sporadically in Ireland and continuously in the UK as part of the TOMPS network. Existing levels in Carranstown are typical of the range of values encountered in rural locations in the UK and Continental Europe and significantly lower than urban locations in the UK and Europe.

Average concentrations of cobalt, cadmium, nickel, chromium, copper, mercury, lead, vanadium, antimony, and thallium measured were significantly below their respective annual limit values. Arsenic was below the detection limit for each of the four weeks in the monitoring period. However, the monitoring methodology's detection limits could not achieve the stringent limits of the proposed ambient standard for As. However, no significant local sources of this compound could be identified and thus, it may be expected that background levels of this compound is likely to be minor.

Study Conclusions

The main study conclusions are presented below for each substance in turn:

NO_2

NO_2 modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards for nitrogen dioxide under both typical and maximum operation of the site. Thus, no adverse environmental impact is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient NO_2 concentrations (including background concentrations) which are 43% of the maximum ambient 1-hour limit value (measured as a 99.8th%ile) at the worst-case boundary receptor.

SO_2 & PM_{10}

Modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards for sulphur dioxide and PM_{10} under both typical and maximum operation of the site. Thus, no adverse environmental impact is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient concentrations (including background concentrations) ranging from 17% - 51% of the respective limit values at the worst-case receptors.

TOC, HCl & HF

Modelling results indicate that the ambient ground level concentrations are below the relevant air quality guidelines for TOC and HCl under both typical and maximum operation of the site. Thus, no adverse environmental impact is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient concentrations (including background concentrations) for HCl and TOC of only 7% and 11% respectively of the maximum ambient 1-hour limit value (measured as a 98th%ile).

HF modelling results indicate that emissions at maximum operations equate to ambient HF concentrations (including background concentrations) which are 23% of the maximum ambient 1-hour limit value (measured as a 98th%ile) and 19% of the annual limit value.

PCDD / PCDFs

Currently, no internationally recognised ambient air quality concentration or deposition standards exist for PCDD/PCDFs. Both the USEPA and WHO recommended approach to assessing the risk to human health from PCDD/PCDFs entails a detailed risk assessment analysis involving the determination of the impact of PCDD/PCDFs in terms of the TDI (Tolerable Daily Intake) approach. The WHO currently proposes a maximum TDI of between 1-4 pgTEQ/kg of body weight per day.

Background levels of PCDD/PCDFs occur everywhere and existing levels in the surrounding area have been extensively monitored as part of this study. Modelling results indicate that the existing levels are significantly lower than urban areas and typical of rural areas in the UK and Continental Europe. The contribution from the site in this context is minor, with levels under maximum operation remaining significantly below levels which would be expected in urban areas at the worst-case boundary receptor to the south of the site. Levels at the nearest residential receptor will be minor, with the annual contribution from Indaver Ireland accounting for less than 10% of the existing background concentration under maximum operating conditions.

Hg

Hg modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards under both typical and maximum operation of the site. Thus, no adverse environmental impact is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient mercury concentrations (excluding background concentrations) which are only 2% of the annual average limit value at the worst-case receptor.

Cd and Tl

Modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standards for cadmium under expected maximum levels (based on data from a similar site in Belgium) from the site. Emissions at expected maximum levels equate to ambient Cd concentrations (excluding background concentrations) which are 24% of the suggested annual limit value close to the site boundary. In addition, levels from Indaver Ireland are below the respective PSD increment (less than 25% of the ambient limit value).

Sum of Sb, Pb, Cr, Co, Cu, Mn and V

Modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards for manganese and antimony (the metals with the most stringent limit values) under both typical and maximum emissions from the site. Thus, no adverse environmental impact is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient Mn concentrations (excluding background concentrations) which are only 23% of the annual limit value at the worst-case boundary receptor whilst emissions at maximum operations equate to ambient Sb concentrations (excluding background concentrations) which are only 16% of the maximum 1-hour limit value at the worst-case boundary receptor.

As

Modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standards for arsenic under expected maximum levels (based on data from a similar site in Belgium) from the site. Thus, no adverse environmental impact is envisaged to occur under these conditions at or beyond the site boundary. Emissions at expected maximum levels equate to ambient As concentrations (excluding background concentrations) which are 20% of the suggested annual EU limit value at the site boundary. Background concentrations of As were monitored over a one-month period. However, the monitoring methodology's detection limits could not achieve the stringent limits of the proposed ambient standard for As. However, no significant local sources of this compound could be identified in a detailed cumulative assessment of nearby sources. Thus, it may be expected that background levels of this compound are likely to be minor.

Ni

Modelling results indicate that the ambient ground level concentrations (excluding background concentrations) will be below the relevant air quality standards for nickel at the expected maximum levels from the site. Emissions at these levels (based on data from a similar site in Belgium) equate to ambient Ni concentrations (excluding background concentrations) which are 8% of the suggested annual EU limit value at the site boundary. In addition, levels from Indaver Ireland are below the respective PSD increment (less than 25% of the ambient limit value).

Summary

Modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards or guidelines for all compounds under both typical and maximum operations of the site. The modelling results indicate that this maximum occurs at or near the site's northern boundary. Maximum operations are based on the emission concentrations outlined in EU Directive 2000/76/EC.

An appropriate stack height has been determined based on ensuring that ambient air quality standards will not be approached even under worst-case operating scenarios. The stack height determined by air dispersion modelling which will lead to adequate dispersion was 40 metres.

Concentrations fall off rapidly away from this maximum and the short-term limit values at the nearest residential receptor will be less than 30% of the worst-case concentration. The annual average concentration has an even more dramatic decrease in maximum concentration away from the site with concentrations from emissions at Indaver Ireland accounting for less than 6% of the limit value (not including background concentrations) at worst case sensitive receptors near the site. Thus, the results indicate that the impact from Indaver Ireland is minor and limited to the immediate environs of the site.

In the surrounding main population centres, Duleek and Drogheda, levels are significantly lower than background sources with the concentrations from emissions at Indaver Ireland accounting for less than 1% of the annual limit values for all pollutants.

1.1 Introduction

Indaver Ireland commissioned an extensive and detailed examination of air emissions from the proposed waste management facility in Carranstown, Co. Meath. As described in detail elsewhere, the waste management facility will be based on conventional grate incineration technology. The waste is tipped into a bunker prior to being fed into the furnace. In the furnace the waste is incinerated, producing heat, ash and combustion gases.

The combustion of waste produces a number of emissions, the discharges of which is regulated by the EU Directive on Waste Incineration (2000/76/EC). The emissions to atmosphere which have been regulated are:

- Nitrogen Dioxide (NO_2)
- Sulphur Dioxide (SO_2)
- Total Dust
- Carbon Monoxide (CO)
- Total Organic Carbon (TOC)
- Hydrogen Fluoride (HF) and Hydrogen Chloride (HCl)
- Dioxins/Furans (PCDD/PCDFs)
- Cadmium (Cd) & Thallium (Tl)
- Mercury (Hg)
- and the sum of Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Maganese (Mn), Nickel (Ni) and Vanadium (V).

This scope of the study consists of the following components:

- Review of both maximum and typical emission levels and other relevant information needed for the modelling study;
- Identification of the significant substances which are released from the site;
- Review of background ambient air quality in the vicinity of the plant;
- Air dispersion modelling of significant substances concentrations released from the site;
- Air dispersion and deposition modelling of dioxin and heavy metals released from the site;
- Identification of predicted ground level concentrations of released substances at the site boundary and at sensitive receptors in the immediate environment;
- A full cumulative assessment of significant releases from the site taking into account the releases from all other significant industry in the area based on the Prevention of Significant Deterioration (PSD) approach.
- Evaluation of the significance of these predicted concentrations, including consideration of whether these ground level concentrations are likely to exceed the most stringent ambient air quality standards and guidelines.

1.2 Study Methodology

1.2.1 Introduction

The air dispersion modelling input data consists of detailed information on the physical environment (including building dimensions and terrain features), design details from all emission points on-site and a full year of worst-case meteorological data. Using this input data, the model predicts ambient ground level concentrations beyond the site boundary for each hour of the modelled meteorological year. The model post-processes the data to identify the location and

maximum of the worst-case ground level concentration in the applicable format for comparison with the relevant limit values. This worst-case concentration is then added to the existing background concentration to give the worst-case predicted ambient concentration. The worst-case ambient concentration is then compared with the relevant ambient air quality standard to assess the significance of the releases from the site.

Throughout this study a worst-case approach was taken. This will most likely lead to an over-estimation of the levels that will arise in practice. The worst-case assumptions are outlined below:

- Emissions from all emission points in the cumulative assessment were assumed to be operating at their maximum emission level, 24 hours/day over the course of a full year.

- All emission points were assumed to be operating at their maximum volume flow, 24 hours/day over the course of a full year.

- Maximum predicted ambient concentrations were reported in this study even though, in most case, no residential receptors were near the location of this maximum.

- Worst-case background concentrations were used to assess the baseline levels of substances released from the site

- Worst-case meteorological conditions have been used in all assessments. The worst-case year leads to annual concentrations, which are 30% higher than the five-year average.

- A comparison with more advanced modelling formulations (AERMOD and AERMOD-PRIME) has indicated that the current model (ISCST3) is conservative and particularly so for long-term averaging periods.

1.2.2 Meteorological Considerations

Meteorological data is an important input into the air dispersion model. The local airflow pattern will be greatly influenced by the geographical location. Important features will be the location of hills and valleys or land-water-air interfaces and whether the site is located in simple or complex terrain.

The selection of the appropriate meteorological data has followed the guidance issued by the USEPA[1]. A primary requirement is that the data used should have a data capture of greater than 90% for all parameters. Two meteorological stations were identified near the site – Casement Aerodrome and Dublin Airport. Data collection of greater than 90% for all parameters is required for air dispersion model. Both Casement Aerodrome and Dublin Airport fulfil this requirement.

The additional requirements of the selection process depend on the representativeness of the data. The representativeness can be defined as "the extent to which a set of measurements taken in a space-time domain reflects the actual conditions in the same or different space-time domain taken on a scale appropriate for a specific application"[2]. The meteorological data should be representative of conditions affecting the transport and dispersion of pollutants in the area of interest as determined by the location of the sources and receptors being modelled.

The representativeness of the data is dependent on[1]:

1) the proximity of the meteorological monitoring site to the area under consideration

2) the complexity of the terrain

3) the exposure of the meteorological monitoring site (surface characteristics around the meteorological site should be similar to the surface characteristics within the modelling domain)

4) the period of time during which data is collected

In the region of the site, Dublin Airport is the nearest suitable meteorological station to the site and thus the weather pattern experienced would be expected to be similar to the current site. On account of the modest terrain features to the north of the site, some channelling of wind may be expected to occur along the direction of the Boyne Valley. However, this would not be expected to be significant at stack height due to the modest nature of this terrain feature.

The windrose from Dublin Airport for the years 1993-97 is shown in Figure 1.1. The windrose indicates the prevailing wind speed and direction over the five-year period. The prevailing wind direction is generally from the W-SW direction. In the worst-case year of 1994, wind speeds were generally moderately strong, averaging around 5-6 m/s.

1.2.3 Modelling Methodology

Emissions from the Indaver Ireland site have been modelled using the ISCST3 dispersion model which has been developed by the U.S. Environmental Protection Agency (USEPA)[3]. The model is a steady-state Gaussian plume model used to assess pollutant concentrations associated with industrial sources. The model has been designated the regulatory model by the USEPA for modelling emissions from industrial sources in both flat and rolling terrain[1]. An overview of the model is outlined in Appendix 1.1.

As part of an on-going program to improve the theoretical basis and accuracy of air dispersion models, the USEPA has recently reassessed the regulatory status of ISCST3. At the recently convened 7th Conference on Air Dispersion Modelling (2000)[4], a new modelling formulation was suggested as a replacement for ISCST3 – AERMOD. This model has more advanced algorithms and gives better agreement with monitoring data in extensive validation studies[5-6]. Although AERMOD is a new generation model, the building downwash algorithm is similar to ISCST3. In recognition of this shortcoming, the USEPA are currently reviewing the possibility of incorporating a more advanced building downwash algorithm (PRIME Module) into the AERMOD modelling platform[7-9]. Thus, the current status of this model is still under review and it has not been granted regulatory approval at the current time.

In order to ensure that the current assessment is protective of air quality into the future and does not under-estimate air concentrations in the current application, a comparison of emissions from Indaver Ireland has been made with AERMOD and AERMOD-PRIME (Appendix 1.1). Results have indicated that the current model (ISCST3) is conservative and particularly so for short-term averaging periods. Thus, modelling results reported here should be viewed as upper limits.

1.2.4   Assessment Methodology

Council Directive 2000/76/EC

The assessment methodology used in the current study was developed following the recommendations outlined in the recently enacted Council Directive 2000/76/EC on the Incineration of Waste.

The Directive has outlined air emission limit values, which are to be complied with as set out in Table 1.1. The Directive has also outlined stringent operating conditions in order to ensure sufficient combustion of waste thus ensuring that dioxin formation is minimised. Specifically, the combustion gases must be maintained at a temperature of 850°C for at least two seconds under normal operating conditions for non-hazardous waste whilst for hazardous waste containing more than 1% halogenated organic substances, the temperature should be raised to 1100°C for at least two seconds. These measures will ensure that dioxins, PCBs and PAHs are minimised through complete combustion of waste.

Specific emission measurement requirements have been outlined in the directive for each pollutant:

1)   continuous measurements of the following substances; NO_x, CO, total dust, TOC, HCl, and SO_2.
2)   bi-annual measurements of heavy metals, dioxins and furans.

Indaver Ireland are committed, as a minimum, to meeting all the requirements of Council Directive 2000/76/EC. Indeed, due to the advanced post-combustion flue gas cleaning technology employed, expected average emission values will be significantly lower than these values. The maximum and typical emission concentrations and mass emission rates have been detailed in Table 1.2.

Very low levels of dioxin will be emitted under typical operating conditions from the incineration process. Typical emissions will be well below the stringent limit value set out in Council Directive 2000/76/EC. This rigorous limit value will be achieved through a targeted removal system over several stages of the flue gas cleaning system. Prior to abatement, the formation of dioxins will be minimised by the maintenance of high combustion temperatures (over 850°C at all times) for a period of two seconds followed by rapid cooling of gases from 400°C to 200°C which is the critical temperature range for dioxins formation in combustion systems. Post-combustion, dioxins will be removed via a two-stage removal process. The first stage involves the injection of activated carbon into the combustion gas duct, directly after the evaporator coolers. The large surface area of the activated carbon helps to adsorb dioxins, furans, hydrocarbons and heavy metals. In the second stage, the exhaust gas from the wet scrubbers undergoes a final gas-cleaning step in an activated wet lignite coke bed or by the injection of activated carbon and by removal in the baghouse filter. The combined efficiency of these filters will ensure that emission concentrations will be less than the EU Council Directive 2000/76/EC. In order to confirm this efficiency target, a continuous dioxin sampler will be employed to determine average fortnightly concentrations, thus allowing an accurate comparison with the emission limit values.

USEPA Guidelines On Air Quality Models

In the absence of detailed guidance, the selection of appropriate modelling methodology has followed the guidance from the USEPA which has issued detailed and comprehensive guidance on the selection and use of air quality models[1,3,10-11].

Based on guidance from the USEPA, the most appropriate regulatory model for the current application is the ISCST3 model (Version 3.4). The model is applicable in both flat and rolling terrain, urban or rural locations and for all averaging periods[1,3].

ISCST3 uses two algorithms to treat terrain based on the relative height variation between the source's stacks and surrounding terrain. In simple terrain, which is defined in ISCST3 as terrain below stack height, the ISCST3 simple terrain algorithm is used to model concentrations. In complex terrain, which is defined as when the plume centreline height is below the terrain height for that modelled hour, the COMPLEX1 complex terrain screening algorithm is used to model concentrations. In areas of intermediate terrain, which occur with terrain that exceeds the height of the release but is below the plume centreline height, concentrations from both the simple terrain algorithm and the complex terrain algorithm are obtained and the higher of the two concentrations is used for that hour and that source. For deposition calculations, the intermediate terrain analysis is first applied to the concentrations at a given receptor, and the algorithm (simple or complex) that gives the highest concentration at that receptor is used to calculate the deposition value.

The selection of urban/rural classification is based on the land use procedure of Auer[12] as recommended by the USEPA[1]. If 50% of the land use within a 3km circumference of the source is classified as high density residential, medium to heavy industry or commercial, urban dispersion coefficients should be used; otherwise rural dispersion coefficients should be use. An examination of the land-use type around the site indicated that rural dispersion coefficients were appropriate.

The USEPA has outlined guidance in order to establish the operating conditions that causes the maximum ground level concentration. The guidance indicates that a range of operating conditions should be assessed in the initial screening analysis. Table 1.3 outlines the recommended range of operating conditions to be assessed and which was adopted in the current assessment.

Cumulative Assessment

As the region around Carranstown is partly industrialised and thus has several other potentially significant sources of pollutants, a detailed cumulative assessment has been carried out using the methodology outlined by the USEPA. Table 1.4 outlines the recommended range of operating conditions to be assessed in the cumulative assessment.

The impact of nearby sources should be examined where interactions between the plume of the point source under consideration and those of nearby sources can occur. These include:

1) the area of maximum impact of the point source,
2) the area of maximum impact of nearby sources,
3) the area where all sources combine to cause maximum impact[1].

Background concentrations for the area, based on natural, minor and distant major sources need also to be taken into account in the modelling procedure. A major baseline monitoring program (see Section 4 - Air Quality of the main body of the EIS) was undertaken over several months which, in conjunction with other available baseline data, was used to determine conservative background concentrations in the region (see Table 1.6).

The methodology adopted in the cumulative assessment was based on the USEPA recommended Prevention of Significant Deterioration (PSD) Increment approach[13]. The PSD increment is the maximum increase in concentration that is allowed to occur above a baseline concentration for each pollutant. However, no exceedence of the ambient air quality limit values (or NAAQS in the USA) is allowed even if not all of the PSD increment is consumed.

The PSD has three classifications of land use as outlined below:

Class I Areas: Class I areas include national parks, national wilderness areas and other areas of special national or regional value.

Class II Areas: Attainment areas that are neither industrialised nor meet the specific requirements for classification as Class I areas.

Class III Areas: Industrialised attainment areas.

The current location would be considered a Class II area and thus the PSD applicable to Class II areas has been applied in the current case. Due to the variations in pollutant averaging times and standards between the USA and the EU, only relative PSD Increments can be derived. The relative PSD Increment, as a percentage of the respective NAAQS, is shown in Table 1.4 with the corresponding concentration as it would be applied to the EU ambient air quality standards. In the current context, the PSD increment has been applied only to zones were significant overlap occurs between plumes from each of the sources.

In the context of the cumulative assessment, all significant sources should be taken into account. The USEPA has defined "significance" in the current context as an impact leading to a $1\mu g/m^3$ annual increase in the annual average concentration of the applicable criteria pollutant (PM_{10}, NO_2, and SO_2)[13]. However, no significant ambient impact levels have been established for non-criteria pollutants (defined as all pollutants except PM_{10}, NO_2, SO_2, CO and lead). The USEPA does not require a full cumulative assessment for a particular pollutant when emissions of that pollutant from a proposed source would not increase ambient levels by more than the significant ambient impact level (annual average of $1\mu g/m^3$). An assessment of releases from Indaver Ireland has indicated that releases of CO, PM_{10} and TOC are not significant and thus no cumulative assessment has been carried out for these substances (see Table A1.6 in Appendix 1.3).

The project impact area for the cumulative assessment is the geographical area for which the required air quality analysis for PSD increments are carried out. The USEPA has defined the "impact area" as a circular area with a radius extending from the source to the most distant point where dispersion modelling predicts a significant ambient impact will occur irrespective of pockets of insignificant impact occurring within it. Within this impact area, all nearby sources should be modelled, where "nearby" is defined as any point source expected to cause a significant concentration gradient in the vicinity of the proposed new source.

In order to determine compliance, the predicted ground level concentration (based on the full impact analysis and existing air quality data) at each model receptor is compared to the applicable ambient air quality limit value or PSD increment. If the predicted pollutant concentration increase over the baseline concentration is below the applicable increment, and the predicted total ground level concentrations are below the ambient air quality standards, then the applicant has successfully demonstrated compliance.

When an air quality standard or PSD increment is predicted to be exceeded at one or more receptor in the impact area, it should be determined whether the net emissions increase from the proposed source will result in a significant ambient impact at the point of each violation, and at the

time the violation is predicted to occur. The source will not be considered to cause or contribute to the violation if its own impact is not significant at any violating receptor at the time of each violation[13].

Table 1.1   Council Directive 2000/76/EC, Annex V Air Emission Limit Values

Daily Average Values	Concentration	
Total Dust	10 mg/m^3	
Gaseous & vaporous organic substances expressed as total organic carbon (TOC)	10 mg/m^3	
Hydrogen Chloride (HCl)	10 mg/m^3	
Hydrogen Fluoride (HF)	1 mg/m^3	
Sulphur Dioxide (SO$_2$)	50 mg/m^3	
Nitrogen Oxides (as NO$_2$)[1]	200 mg/m^3	
Half-hourly Average Values	**Concentration**	
	(100%)	**(97%)**
Total Dust[2]	30 mg/m^3	10 mg/m^3
Gaseous & vaporous organic substances expressed as total organic carbon (TOC)	20 mg/m^3	10 mg/m^3
Hydrogen Chloride (HCl)	60 mg/m^3	10 mg/m^3
Hydrogen Fluoride (HF)	4 mg/m^3	2 mg/m^3
Sulphur Dioxide (SO$_2$)	200 mg/m^3	50 mg/m^3
Nitrogen Oxides (as NO$_2$)	400 mg/m$^{3[1]}$	200 mg/m^3
Average Value Over 30 mins to 8 Hours	**Concentration[3]**	
Cadmium and its compounds, expressed as Cd	Total 0.05 mg/m^3	
Thallium and its compounds, expressed as Tl		
Mercury and its compounds, expressed as Hg	0.05 mg/m^3	
Antimony and its compounds, expressed as Sb		
Arsenic and its compounds, expressed as As		
Lead and its compounds, expressed as Pb		
Chromium and its compounds, expressed as Cr		
Cobalt and its compounds, expressed as Co	Total 0.5 mg/m^3	
Copper and its compounds, expressed as Cu		
Manganese and its compounds, expressed as Mn		
Nickel and its compounds, expressed as Ni		
Vanadium and its compounds, expressed as V		
Average Values Over 6 – 8 Hours	**Concentration**	
Dioxins and furans	0.1 ng/m^3	
Average Value	**Concentration[4]**	
	Daily Average Value	**30 Min Average Value**
Carbon Monoxide	50 mg/m^3	100 mg/m^3

(1)   Until 1/1/2007 the emission limit value for NO$_x$ does not apply to plants only incinerating hazardous waste

(2)   Total dust emission may not exceed 150 mg/m^3 as a half-hourly average under any circumstances

(3)   These values cover also the gaseous and vapour forms of the relevant heavy metals as well as their compounds

(4)   Exemptions may be authorised for incineration plants using fluidised bed technology, provided that emission limit values do not exceed 100 mg/m^3 as an hourly average value.

Table 1.2   Air Emission Values From Indaver Ireland, Carranstown, Co. Meath

Daily Average Values	EU Maximum Emission Concentration	Maximum Operating Values Emission Rate (g/s)	Typical Emission Concentration	Expected Operating Values Emission Rate (g/s)
Total Dust	10 mg/m^3	0.419	1 mg/m^3	0.035
Gaseous & vaporous organic substances expressed as total organic carbon (TOC)	10 mg/m^3	0.419	1 mg/m^3	0.035
Hydrogen Chloride (HCl)	10 mg/m^3	0.419	1 mg/m^3	0.035
Hydrogen Fluoride (HF)	1 mg/m^3	0.042	1 mg/m^3	0.035
Sulphur Dioxide (SO$_2$)	50 mg/m^3	2.10	20 mg/m^3	0.7
Nitrogen Oxides (as NO$_2$)	200 mg/m^3	8.39	150 mg/m^3	5.25
Hourly Average Value	**Emission Concentration**	**Emission Rate (g/s)**	**Emission Concentration**	**Emission Rate (g/s)**
Cadmium and its compounds, expressed as Cd	Total 0.05 mg/m^3	0.0021	Total 0.025 mg/m^3	0.000875
Thallium and its compounds, expressed as Tl				
Mercury and its compounds, expressed as Hg	0.05 mg/m^3	0.0021	0.025 mg/m^3	0.000875
Antimony and its compounds, expressed as Sb				
Arsenic and its compounds, expressed as As				
Lead and its compounds, expressed as Pb				
Chromium and its compounds, expressed as Cr				
Cobalt and its compounds, expressed as Co	Total 0.5 mg/m^3	0.021	Total 0.25 mg/m^3	0.00875
Copper and its compounds, expressed as Cu				
Manganese and its compounds, expressed as Mn				
Nickel and its compounds, expressed as Ni				
Vanadium and its compounds, expressed as V				
Average Values Over 6 – 8 Hours	**Emission Concentration**	**Emission Rate (g/s)**	**Emission Concentration**	**Emission Rate (g/s)**
Dioxins and furans	0.1 ng/m^3	4.19 x 10^{-9}	0.01 ng/m^3	3.5 x 10^{-10}
Average Value	**Emission Concentration**	**Emission Rate (g/s)**	**Emission Concentration**	**Emission Rate (g/s)**
Carbon Monoxide	100 mg/m^3	4.2	20 mg/m^3	0.7

Tonnes per annum can be calculated based on operating conditions of 24 hours per day at design volume flow for 7500 hours/annum.

Table 1.3   Model Input Data For Point Sources For PSD Compliance[1]

Average Time	Emission Limit (mg/m³)	X Operating Level (mg/hr)	X Operating Factor (hr/year)
Proposed Major New Source			
Annual	Maximum allowable emission limit	Design capacity	Continuous operation
Short term (≤ 24 hrs)	Maximum allowable emission limit	Design capacity	Continuous operation
Nearby Major Source			
Annual	Maximum allowable emission limit	Design capacity	Actual Operating Factor averaged over 2 years
Short term (≤ 24 hrs)	Maximum allowable emission limit	Design capacity	Continuous operation

Table 1.4   PSD Increments Relative To NAAQS (US) and As Applied To EU Directives

Pollutant	Averaging Period	Class II PSD Increment µg/m³	% of NAAQS (& % of EU Directives)	PSD Increment as applied to EU Standards (µg/m³) / Averaging Periods
PM_{10}	Annual	34	25%	Annual - 10 / 24-Hour – 12.5
SO_2	24-Hour	182	25%	24-Hour – 31.3 / 1-Hour – 87.5
NO_2	Annual	50	25%	Annual - 10 / 1-Hour - 50

1.3 Modelling Results

1.3.1 Introduction

Emissions from the Indaver Ireland site has been modelled using the ISCST3 dispersion model which is the USEPA's regulatory model used to assess pollutant concentrations associated with industrial sources[1]. Emissions have been assessed, firstly under typical operating conditions and secondly under the maximum emissions limits of the EU Directive 2000/76/EC.

1.3.2 Process Emissions

Indaver Ireland has one main process emission point (stack). The operating details of this major emission point has been taken from information supplied by Indaver Ireland and are outlined in Table 1.5. Full details of emission concentrations and mass emissions are given in Appendix 1.4.

Table 1.5   Process Emission Design Details

Stack Reference	Stack Height (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temp (K)	Volume Flow (Nm^3/hr)	Exit Velocity (m/sec actual)
Stack	40	2.0	3.14	373	126000 – Typical 150980 – Maximum	17.2 20.5

Emissions from the site have been assessed using the approach recommended by the USEPA[1]. The approach involved identifying the operating conditions which will give rise to the maximum ground level concentrations. Maximum operating conditions will be 1.2 times typical operating conditions. Both these above conditions, in addition to 50% loading were modelled, in order to confirm that the worst-case operating conditions were being modelled.

The ISCST3 model was run using a unitised emission rate of 1 g/s. The unitised concentration and deposition output has then been adjusted for each substance based on the specific emission rate of each.

1.3.3 Background Concentrations

The ambient concentrations detailed in the following sections include both the emissions from the site and the ambient background concentration for that substance. Background concentrations have been derived from a worst-case analysis of the cumulative sources in the region in the absence of the development. Firstly, a detailed baseline air quality assessment (see Section 4 – Air Quality of the main body of the EIS) was carried out to assess background levels of those pollutants, which are likely to be significant releases from the site. Secondly, modelling of traffic emissions (see Appendix 1.4) was carried out both with and without the scheme to assess the impact of traffic emissions in the region. Thirdly, a detailed cumulative assessment of all significant releases from nearby sites was carried out based on an analysis of their IPC Licences (see Appendix 1.3). Appropriate background values have been outlined in Table 1.6. In arriving at the combined annual background concentration, cognisance has been taken of the accuracy of the approach and the degree of double counting inherent in the assessment. In relation to NO$_2$, the baseline monitoring program will have taken into account both the existing traffic levels and existing industrial sources. However, some increases in traffic levels will occur due to the development which has been incorporated into the final combined background levels. Again, in recognition of the various inaccuracies in this approach, the values have been rounded accordingly. A similar approach has been adopted for the other pollutants. In relation to the

baseline heavy metals and dioxins, a range of concentrations has been given in recognition of the influence that non-detects have on the reported values.

In order to obtain the predicted environmental concentration (PEC), background data was added to the process emissions. In relation to the annual averages, the ambient background concentration was added directly to the process concentration. However, in relation to the short-term peak concentrations, concentrations due to emissions from elevated sources cannot be combined in the same way. Guidance from the UK DETR[14] advises that an estimate of the maximum combined pollutant concentration can be obtained by adding the maximum short-term concentration due to emissions from the source to twice the annual mean background concentration.

Table 1.6   Estimated annual background concentrations In Carranstown Region (μg/m^3).

	NO$_2$	SO$_2$	PM$_{10}$	CO	TOC	HCl	HF	Dioxins[1]	Cd[1]	Hg[1]	Sb[1]	As[1]	Mn[3]	Ni[1]
Baseline Monitoring Program[1]	8	3	4	-	-	0.01	0.005	0.046 pg/m^3 0.028 pg/m^3	< 0.023 < 0.012	< 0.005 < 0.0025	0.012 < 0.0003	< 0.02 < 0.01	0.012	0.006 0.005
Traffic Impact Assessment	1	-	2	200	8	-	-	-	-	-	-	-	-	-
Cumulative Assessment	1	1	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]
Annual Background Concentration	10	4	20[4]	200	100	0.01	0.005	0.046pg/m^3 0.028 pg/m^3	0.023 0.012	0.005 0.0025	0.012 0.0003	0.02 0.01	0.012	0.006 0.005

(1)   Baseline results for dioxins and metals given as firstly (i) Non-detects = limit of detection, (ii) Non-detects = 50% of limit of detection.

(2)   No cumulative assessment carried out as emissions from the site are less than significance criteria (defined as greater than 2% of ambient limit value)

(3)   No baseline measurements carried out for Manganese.

(4)   Conservative estimate based on typical rural background values and the existing industrial sources of PM$_{10}$ in the region.

1.4   Nitrogen Dioxide Emissions and Results

1.4.1   Source Information

Source information including emission release heights, volume flows, locations and stack diameters has been summarised in Appendix 1.5.

1.4.2   Modelling of Nitrogen Dioxide

Nitrogen oxides (NO_X), containing both nitrogen oxide (NO) and nitrogen dioxide (NO_2) are emitted from the combustion process on-site, although it is the latter which is considered the more harmful to human health. These combustion processes lead to emissions which are mainly in the form of nitrogen oxide (NO) (typically 95%) with small amounts of the more harmful nitrogen dioxide.

NO_2 has been modelled following the approach outlined by the USEPA[1] for assessing the impact of NO_X from point sources. The approach involves assessing the air quality impact through a three tiered screening technique. The initial analysis, termed the Tier 1 approach, assumes a worst-case scenario that there is total conversion of NO_X to NO_2. The guidance indicates that if this worst-case assumption leads to an exceedance of the appropriate limit value, the user should proceed to the next Tier, as in the current case.

Tier 2 is appropriate for estimating the annual average NO_2 concentration. The Tier 2 approach indicates that the annual average concentration should either be derived from an empirically derived NO_2/NO_X ratio or alternatively to use the default value of 0.75. This default value has been used in the current assessment.

In order to determine the maximum one-hour value, the Tier 3 approach is recommended by the USEPA. The Tier 3 approach involves the application of a detailed screening method on a case-by-case basis. The suggested methodologies include the ozone-limiting method or a site-specific NO_2/NO_X ratio. In the current assessment, no site-specific ratio has been developed because the monitoring data obtained by Indaver Ireland measured much lower concentrations than that predicted to occur very occasionally during operations at the boundary of the site. However, empirical evidence suggests that a conservative estimate of this ratio would be 0.30 (see Appendix 1.2). Thus, a ratio of 0.30 for NO_2/NO_X has been used in the current assessment for the 99.8[th]%ile of one-hour maximum concentrations.

Ambient Ground Level Concentrations (GLCs) of Nitrogen Dioxide have been predicted for the following scenarios in Table 1.7.

Table 1.7   Emission Scenario for Nitrogen Dioxide

Pollutant	Scenario	Concentration	Emission Rate (g/s)
NO_2	Max	200 mg/m^3	8.39
	Typical	150 mg/m^3	5.25
	50% of Maximum	200 mg/m^3	4.19

1.4.3 Comparison with Standards and Guidelines

The relevant air quality standards for Nitrogen Dioxide has been detailed in Table 1.8. In this report the ambient air concentrations have been referenced to Council Directive 1999/30/EC, which will shortly come into force. The directive also details margins of tolerance, which are trigger levels for certain types of action in the period leading to the attainment date. The margin of tolerance is 50% for both the hourly and annual limit value for NO_2. The margin of tolerance will start to reduce from 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0% by the attainment date of 2010. However, reflecting a worst-case approach, results have been compared with the applicable limit value which will be enforceable in 2010.

Table 1.8   EU Ambient Air Standards - Council Directive 1999/30/EC

Pollutant	Regulation	Limit Type	Margin of Tolerance	Value
Nitrogen Dioxide	1999/30/EC	Hourly limit for protection of human health - not to be exceeded more than 18 times/year	50% until 2001 reducing linearly to 0% by 2010	200 $\mu g/m^3$ NO_2
		Annual limit for protection of human health	50% until 2001 reducing linearly to 0% by 2010	40 $\mu g/m^3$ NO_2
		Annual limit for protection of vegetation	None	30 $\mu g/m^3$ $NO + NO_2$

1.4.4 Modelling Results

Modelling was carried out for the three scenarios described in Section 1.4.2. Table 1.9 details the predicted Tier 2 (applied to the annual average) & Tier 3 (applied to the maximum one-hour) NO_2 GLC for each scenario at the worst-case boundary locations whereas Table 1.10 details the spatial variation in nitrogen dioxide concentrations at specific locations in the surrounding region.

Table 1.9   Dispersion Model Results – Nitrogen Dioxide

Pollutant / Scenario	Annual Mean Background ($\mu g/m^3$)[1]	Averaging Period	Process Contribution ($\mu g/m^3$)	Predicted Emission Concentration ($\mu g/Nm^3$)	Standard[2] ($\mu g/Nm^3$)	Indaver emissions as a % of ambient limit value
NO_2 / Maximum	10	Annual Mean[3]	8	18	40	20%
		99.8th%ile of 1-hr means[4]	65	85	200	33%
NO_2 / Typical	10	Annual Mean[3]	5.8	15.8	40	15%
		99.8th%ile of 1-hr means[4]	46	66	200	23%
NO_2 / 50% of maximum	10	Annual Mean[3]	7	17	40	18%
		99.8th%ile of 1-hr means[4]	52	72	200	26%

(1)   Includes contribution from traffic and background sources (based on results from continuous monitor and diffusion tubes) and incorporating the cumulative assessment results.

(2)   Directive 1999/30/EC

(3)   Conversion factor following guidance from USEPA (Tier 2 analysis, annual average) based on the default ratio of 0.75 (worst-case).

(4)   Conversion factor, following guidance from USEPA (Tier 3 analysis), based on empirically derived site-specific maximum 1-hour value for NO_2 / NO_X of 0.30

Table 1.10   Dispersion Model Results – Nitrogen Dioxide Maximum Operation, Specific Receptors

Pollutant / Location	Annual Mean Background ($\mu g/m^3$)[1]	Averaging Period	Process Contribution ($\mu g/m^3$)	Predicted Emission Concentration ($\mu g/Nm^3$)	Standard[2] ($\mu g/Nm^3$)	Indaver emissions as a % of ambient limit value
NO_2 Typical / Worst-case Residential Receptor	10	Annual Mean[3]	2.3	12.3	40	6%
		99.8[th]%ile of 1-hr means[4]	31	51	200	15%
NO_2 Typical / Donore School	10	Annual Mean[3]	0.64	10.6	40	2%
		99.8[th]%ile of 1-hr means[4]	13	33	200	7%
NO_2 Typical / Duleek	10	Annual Mean[3]	0.09	10.1	40	0.2%
		99.8[th]%ile of 1-hr means[4]	2.8	23	200	1%
NO_2 Typical / Drogheda	10	Annual Mean[3]	0.19	10.2	40	0.5%
		99.8[th]%ile of 1-hr means[4]	2.2	22	200	1%
NO_2 Typical / Newgrange Cemetery	10	Annual Mean[3]	0.09	10.1	40	0.2%
		99.8[th]%ile of 1-hr means[4]	2.2	22	200	1%

(1) Includes contribution from traffic and background sources (based on results from continuous monitor and diffusion tubes) and incorporating the cumulative assessment results.

(2) Directive 1999/30/EC

(3) Conversion factor following guidance from USEPA (Tier 2 analysis, annual average) based on site-specific ratio of 0.75 (worst-case).

(4) Conversion factor, following guidance from USEPA (Tier 3 analysis), based on empirically derived site-specific maximum 1-hour value for NO_2 / NO_x of 0.30

1.4.5 Concentration Contours

The geographical variation in NO_2 ground level concentrations beyond the site boundary are illustrated as concentration contours in Figures 1.2 to 1.3. The figures have been expressed as a percentage of the appropriate ambient air quality standard or guideline. The contents of each figure are described below.

Figure 1.2   Maximum Operations: <u>Predicted Tier 3 NO_2 99.8th Percentile Concentration</u>

Figure 1.3   Maximum Operations: <u>Predicted Tier 2 NO_2 Annual Average Concentration</u>

1.4.6 Result Findings

In relation to the maximum one-hour limit value, NO_2 Tier 3 modelling results indicate that the ambient ground level concentrations are below these ambient standards under both typical and maximum operation of the site. Thus, no adverse environmental impact is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient NO_2 concentrations (including background concentrations) which are 43% of the maximum ambient 1-hour limit value (measured as a 99.8th%ile) at the worst-case receptor (near the northern site-boundary). Annual averages (including background concentrations) are also significantly below the limit value accounting for 45% of the annual limit value at the worst-case receptor.

The modelling results indicate that the maximum 1-hour and annual average concentrations occur at or near the site's north and east boundary. Concentrations fall off rapidly away from this maximum and for the maximum 1-hour concentration (as a 99.8th%ile) will be only 15% of the limit value (not including background concentrations) at the nearest sensitive receptor to the site (see Table 1.10). The annual average concentration decreases in maximum concentration away from the site with concentrations from emissions at Indaver Ireland accounting for only 6% of the limit value (not including background concentrations) at worst case sensitive receptors near the site. Thus, the results indicate that the impact from Indaver Ireland is minor and limited to the immediate environs of the site.

In the surrounding main population centres, Drogheda and Duleek, levels are significantly lower than background sources with the concentrations from emissions at Indaver Ireland accounting for less than 1% of the annual limit value.

1.5 Sulphur Dioxide and Total Dust (as PM_{10}) Emissions and Results

1.5.1 Source Information

Source information including emission release heights, volume flows, locations and stack diameters has been summarised in Appendix 1.5.

Ambient Ground Level Concentrations (GLC's) of Sulphur Dioxide (SO_2) and Total Dust (as PM_{10}) have been predicted for the following scenarios in Table 1.11.

Table 1.11   Emission Scenario for Sulphur Dioxide and Total Dust

Pollutant	Scenario	Concentration	Emission Rate (g/s)
SO$_2$	Max	50 mg/m^3	2.1
	Typical	20 mg/m^3	0.70
	50% of maximum	50 mg/m^3	1.0
Total Dust	Max	10 mg/m^3	0.42
	Typical	1 mg/m^3	0.04
	50% of maximum	10 mg/m^3	0.21

1.5.2   Comparison with Standards And Guidelines

The relevant air quality standards for Sulphur Dioxide and PM$_{10}$ have been detailed in Table 1.12.   In this report the ambient air concentrations for SO$_2$ and PM$_{10}$ have been referenced to Council Directive 1999/30/EC, which will come into force shortly.   The margin of tolerance is 43% for the hourly limit value for SO$_2$ and 50% for the 24-hr limit value for PM$_{10}$.   However, reflecting a worst-case approach, results have been compared with the applicable limit value which will be enforceable in 2005.

Table 1.12   EU Ambient Air Standard - Council Directive 1999/30/EC

Pollutant	Regulation	Limit Type	Margin of Tolerance	Value
Sulphur Dioxide	1999/30/EC	Hourly limit for protection of human health - not to be exceeded more than 24 times/year	43% until 2001 reducing linearly until 0% by 2005	350 µg/m^3
		Daily limit for protection of human health - not to be exceeded more than 3 times/year	None	125 µg/m^3
		Annual & Winter limit for the protection of ecosystems	None	20 µg/m^3
Particulate Matter Stage 1	1999/30/EC	24-hour limit for protection of human health - not to be exceeded more than 35 times/year	50% until 2001 reducing linearly to 0% by 2005	50 µg/m^3
		Annual limit for protection of human health	20% until 2001 reducing linearly to 0% by 2005	40 µg/m^3
Particulate Matter Stage 2[1]	1999/30/EC	24-hour limit for protection of human health - not to be exceeded more than 7 times/year	To be derived from data and to be equivalent to Stage 1 limit value	50 µg/m^3
		Annual limit for protection of human health	50% until 2005 reducing linearly to 0% by 2010	20 µg/m^3

(1)   Indicative limit values to be reviewed in the light of further information on health and environmental effects, technical feasibility and experience in the application of Stage 1 limit values in the Member States

1.5.3 Modelling Results

Modelling was carried out for the three scenarios described in Section 1.5.1.

Tables 1.13 – 1.14 details the predicted SO_2 and PM_{10} GLC for each scenario.

Table 1.13   Dispersion Model Results – Sulphur Dioxide

Pollutant / Scenario	Background ($\mu g/m^3$)	Averaging Period	Process Contribution ($\mu g/m^3$)	Predicted Emission Concentration ($\mu g/Nm^3$)	Standard[1] ($\mu g/Nm^3$)
SO_2 / Maximum	4	99.7th%ile of 1-hr means	52	60	350
		99.2th%ile of 24-hr means	20	24	125
SO_2 / Typical	4	99.7th%ile of 1-hr means	20	28	350
		99.2th%ile of 24-hr means	7	11	125
SO_2 / 50% of maximum	4	99.7th%ile of 1-hr means	42	50	350
		99.2th%ile of 24-hr means	15	19	125

(1)   Directive 1999/30/EC

Table 1.14   Dispersion Model Results – Total Dust (referenced to PM_{10})

Pollutant / Scenario	Annual Mean Background ($\mu g/m^3$)	Averaging Period	Process Contribution ($\mu g/m^3$)	Predicted Emission Concentration ($\mu g/Nm^3$)	Standard[1] ($\mu g/Nm^3$)
PM_{10} / Maximum	20	90.5th%ile of 24-hr means	1.9	21.9	50
		Annual mean	0.51	20.5	40
PM_{10} / Typical	20	90.5th%ile of 24-hr means	0.18	20.2	50
		Annual mean	0.05	20.1	40
PM_{10} / 50% of maximum	20	90.5th%ile of 24-hr means	1.38	21.4	50
		Annual mean	0.45	20.5	40

(1)   Directive 1999/30/EC

1.5.4 Concentration Contours

The geographical variation in SO_2 and PM_{10} ground level concentrations beyond the site boundary are illustrated as concentration contours in Figures 1.4 to 1.7. The figures have been expressed as a percentage of the appropriate ambient air quality standard or guideline. The contents of each figure are described below.

Figure 1.4   Maximum Operations: Predicted SO_2 99.7th Percentile of Hourly Concentrations

Figure 1.5   Maximum Operations: Predicted SO_2 99.2th Percentile of 24-Hourly Concentrations

Figure 1.6   Maximum Operations: Predicted PM_{10} 90.5th Percentile of 24-Hourly Concentrations

Figure 1.7   Maximum Operations: Predicted PM_{10} Annual Concentrations

1.5.5 Result Findings

SO_2

SO_2 modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards for sulphur dioxide under both typical and maximum operation of the site. Thus, no adverse environmental impact is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient SO_2 concentrations (including background concentrations) which are 17% of the maximum ambient 1-hour limit value (measured as a 99.7th %ile) and 19% of the maximum ambient 24-hour limit value (measured as a 99.2th %ile) at the worst-case boundary receptor.

PM_{10}

PM_{10} modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards for PM_{10} under both typical and maximum operation of the site. Thus, no adverse environmental impact is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient PM_{10} concentrations (including background concentrations) which are 44% of the maximum ambient 24-hour limit value (measured as a 90.5th %ile) and 51% of the annual average limit value at the worst-case boundary receptor.

1.6 Total Organic Carbon (TOC), Hydrogen Chloride and Hydrogen Fluoride Emissions and Results

1.6.1 Source Information

Source information including emission release heights, volume flows, locations and stack diameters has been summarised in Appendix 1.5.

Ambient Ground Level Concentrations (GLC's) of Total Organic Carbon (TOC), Hydrogen Chloride (HCl) and Hydrogen Fluoride (HF) have been predicted for the following scenarios in Table 1.15.

Table 1.15   Emission Scenario for TOC, HCl and HF

Pollutant	Scenario	Concentration	Emission Rate (g/s)
TOC	Max	10 mg/m^3	0.42
	Typical	1 mg/m^3	0.035
	50% of maximum	10 mg/m^3	0.21
HCl	Max	10 mg/m^3	0.42
	Typical	1 mg/m^3	0.035
	50% of maximum	10 mg/m^3	0.21
HF	Max	1 mg/m^3	0.042
	Typical	1 mg/m^3	0.035
	50% of maximum	1 mg/m^3	0.021

1.6.2   Comparison With Standards And Guidelines

TA Luft standards have been proposed for TOC, HCl and HF. The TA-Luft standard is based on a 30-minute averaging period. As the meteorological data used in the modelling is collated on an averaging period of one hour, the dispersion model can only predict concentrations for averaging periods of one hour or above. Predicted hourly-average concentrations have subsequently been compared against the standard. Typically the peak 30-minute average will be 10 to 20% higher than the corresponding 1-hour period average.

Table 1.16   Air Standards for TOC, HCl and HF

Pollutant	Regulation	Limit Type	Class	Value
TOC	TA Luft	Hourly limit for protection of human health – expressed as a 98th%ile	Class III	1000 μg/m^3
			Class II	200 μg/m^3
			Class I	50 μg/m^3
HCl	TA Luft	Hourly limit for protection of human health – expressed as a 98th%ile	100 μg/m^3	
HF	TA Luft	Hourly limit for protection of human health – expressed as a 98th%ile	3 μg/m^3	
HF	WHO	Gaseous fluoride (as HF) as an annual average.	0.3 μg/m^3	
HF	Dutch	Mean fluoride (as HF) concentration during the growing season (April to September)	0.4 μg/m^3	
HF	Dutch	Ambient gaseous fluoride (as HF) as a 24-hour average concentration.	2.8 μg/m^3	

1.6.3   Modelling Results

Modelling was carried out for the three scenarios described in Section 1.6.1 for each pollutant.

Tables 1.17 – 1.19 details the predicted TOC, HCl and HF GLC for each scenario.

Table 1.17   Dispersion Model Results – TOC

Pollutant / Scenario	Annual Mean Background ($\mu g/m^3$)	Averaging Period	Process Contribution ($\mu g/m^3$)	Predicted Emission Concentration ($\mu g/Nm^3$)	Standard[1] ($\mu g/Nm^3$)
TOC / Maximum	100	98th%ile of 1-hr means	6.7	107	1000
TOC / Typical	100	98th%ile of 1-hr means	0.65	101	1000
TOC / 50% of maximum	100	98th%ile of 1-hr means	5.6	106	1000

(1)   TA Luft Immission Standard

Table 1.18   Dispersion Model Results – HCl

Pollutant / Scenario	Annual Mean Background ($\mu g/m^3$)	Averaging Period	Process Contribution ($\mu g/m^3$)	Predicted Emission Concentration ($\mu g/Nm^3$)	Standard[1] ($\mu g/Nm^3$)
HCl / Maximum	0.01	98th%ile of 1-hr means	6.7	6.7	100
HCl / Typical	0.01	98th%ile of 1-hr means	0.65	0.66	100
HCl / 50% of maximum	0.01	98th%ile of 1-hr means	5.6	5.6	100

(1)   TA Luft Immission Standard

Table 1.19   Dispersion Model Results – HF

Pollutant / Scenario	Annual Mean Background ($\mu g/m^3$)	Averaging Period	Process Contribution ($\mu g/m^3$)	Predicted Emission Concentration ($\mu g/Nm^3$)	Standard ($\mu g/Nm^3$)
HF / Maximum	0.005	98th%ile of 1-hr means	0.68	0.69	3.0[1]
		Maximum 24-hr	0.59	0.60	2.8[2]
		Annual Average	0.051	0.056	0.3[3]
HF / Typical	0.005	98th%ile of 1-hr means	0.65	0.66	3.0[1]
		Maximum 24-hr	0.59	0.60	2.8[2]
		Annual Average	0.052	0.057	0.3[3]
HF / 50% of maximum	0.005	98th%ile of 1-hr means	0.56	0.57	3.0[1]
		Maximum 24-hr	0.46	0.47	2.8[2]
		Annual Average	0.045	0.050	0.3[3]

(1)   TA Luft Immission Standard
(2)   Netherlands Emission Regulations Staff Office
(3)   World Health Organisation

1.6.4 Concentration Contours

The geographical variation in TOC, HCl and HF ground level concentrations beyond the site boundary is illustrated as concentration contours in Figures 1.8 – 1.11. The figures have been expressed as a percentage of the appropriate ambient air quality guideline. The content of the figures is described below.

Figure 1.8   Maximum Operations: <u>Predicted TOC Maximum 1-Hour Concentration (as a 98th%ile)</u>

Figure 1.9   Maximum Operations: <u>Predicted HCl Maximum 1-Hour Concentration (as a 98th%ile)</u>

Figure 1.10   Maximum Operations: <u>Predicted HF 98th Percentile Of Hourly Concentrations</u>

Figure 1.11   Maximum Operations: <u>Predicted HF Annual Average Concentration</u>

1.6.5 Result Findings

TOC

TOC modelling results indicate that the ambient ground level concentrations are below the relevant air quality guidelines for TOC under both typical and maximum operation of the site. Thus, no adverse environmental impact is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient TOC concentrations (including background concentrations) which are 11% of the maximum ambient 1-hour limit value (measured as a 98th%ile).

HCl

HCl modelling results indicate that the ambient ground level concentrations are below the relevant air quality guideline for HCl under both typical and maximum operation of the site. Thus, no adverse environmental impact is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient HCl concentrations (including background concentrations) which are 7% of the maximum ambient 1-hour limit value (measured as a 98th%ile).

HF

HF modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards and guidelines for HF under both typical and maximum operation of the site. Thus, no adverse environmental impact is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient HF concentrations (including background concentrations) which are 23% of the maximum ambient 1-hour limit value (measured as a 98th%ile) and 19% of the annual limit value.

1.7   Dioxin-Like Compounds

1.7.1   Description of Dioxin-Like Compounds

The term "Dioxin-like Compounds" generally refers to three classes of compounds; polychlorinated dibenzo-p-dioxins (PCDDs or CDDs), polychlorinated dibenzofurans (PCDFs or CDFs), and polychlorinated biphenyls (PCBs). PCDDs include 75 individual compounds, or congeners, PCDFs include 135 congeners and PCBs include 209 congeners (see Table X.20). Both PCDDs and PCDFs are usually formed as unintentional by-products through a variety of chemical reactions and combustion processes. These compounds are lipophilic that bind to sediment and organic matter in the environment and tend to be absorbed in animal and human fatty tissue. They are also generally extremely resistant towards chemical and biological degradation processes, and, consequently, persist in the environment and accumulate in the food chain[15].

The toxic effects of dioxins are initiated at the cellular level, by the binding of the dioxin to a specific protein in the cytoplasm of the body cells, the aryl hydrocarbon receptor (AhR). The binding of TCDD to the Ah receptor constitutes a first and necessary step to initiate the toxic and biochemical effects of this compound. Dioxins effects in humans include increased prevalence of diabetes, immunotoxic effects and effects on neurodevelopment and neurobehaviour in children. Studies have shown TCDD to be carcinogenic but a lack of direct DNA-damaging effects indicates that TCDD is not an initiator but a promoter of carcinogenesis[16].

130 of the 209 PCB congeners have historically been manufactured for a variety of uses including dielectric fluids in transformers and capacitors and as lubricants and adhesives. However, the marketing, use and disposal of PCBs has been severely restricted in the EU through Directives 85/467/EC and 96/59/EC[15].

The toxicity of dioxins varies widely with 2,3,7,8-TCDD being the most potent dioxin congener and with only particular configurations of these compounds thought to have dioxin-like toxicity (See Table X.20). For PCDDs, only 7 of the 75 congeners have dioxin-like toxicity; these are the ones with chlorine substitutions in, at least, the 2,3,7 and 8 positions. For PCDFs, only 10 of the 135 congeners have dioxin-like toxicity; these are again the ones with chlorine substitutions in, at least, the 2,3,7 and 8 positions. In relation to PCBs, only 13 of the 209 congeners are likely to have dioxin-like toxicity; these are the PCBs with four or more chlorines with just one or no substitutions in the ortho position (coplanar)[15,17].

As dioxin-like compounds have varying degrees of toxicity, a toxicity equivalency procedure has been developed to describe the cumulative toxicity of these mixtures. The procedure involved assigning individual Toxicity Equivalency Factors (TEFs) to the 2,3,7,8- substituted PCDD and PCDF congeners and to selected coplanar and mono-ortho PCBs. The TEFs are referenced to 2,3,7,8-TCDD, which is assigned a TEF of 1.0. Calculation of the toxic equivalency (TEQ) of a mixture involves multiplying the concentration of individual congeners by their respective TEF. The sum of the TEQ concentrations for the individual congeners is the TEQ concentration for the mixture.

Since 1989, three different TEF schemes have been developed[17]:

I-TEQ$_{DF}$ – Developed by NATO/CCMS in 1988, the I-TEQ$_{DF}$ (DF = dioxin, furan, I = International) procedure assigns TEFs only for the 7 dioxins (PCDDs) and 10 furans (PCDFs). This scheme does not include dioxin-like PCBs. This scheme has been adopted in Council Directive 2000/76/EC and has been applied in the current assessment.

TEQ$_{DFP}$-WHO$_{94}$ – In 1994, the WHO added 13-dioxin-like PCBs to the TEF scheme for dioxins and furans. However, no changes were made to the TEFs for dioxins and furans I-TEQ$_{DF}$ (DFP = dioxin, furan, PCBs).

TEQ$_{DFP}$-WHO$_{98}$ – In 1998, the WHO re-evaluated the TEF scheme for dioxins, furans and dioxin-like PCBs. Changes were made to the TEFs for dioxins, furans and dioxin-like PCBs. Table X.21 outlines the TEF for the most recent scheme for comparison with the scheme recommended in Council Directive 200/76/EC (I-TEQ$_{DF}$).

1.7.2 Modelling Strategy

The emissions of dioxin-like compounds from the waste-to-energy plant have been evaluated in this chapter. Firstly, the stack emissions have been characterised in terms of mass of each PCDD/PCDF congener released, and the partitioning of these releases into a vapour and particle phase. Thereafter, air dispersion modelling has been used to translate these releases to ambient air vapour and particle phase concentrations, and wet vapour and wet and dry particulate deposition fluxes, in the vicinity of the release.

As recommended by the USEPA, individual dioxin congeners have been modelled from source to receptor. Only at the interface to human exposure, e.g., ingestion, inhalation, dermal absorption, etc., are the individual congeners recombined and converted into the toxic equivalence of 2,3,7,8-TCDD to be factored into a quantitative risk assessment.

Emission Rate

The dioxin emission factor is defined as the total mass (in vapour and particulate form) of dioxin-like compound emitted per mass of feed material combusted. For the current proposal, a test burn is not possible as the waste-to-energy plant has not been commissioned yet. However, Indaver Ireland has several flue gas cleaning systems similar to that proposed in the current scheme, in operation in Belgium. An analysis of these flue gas cleaning systems has suggested that the likely emission rate will out perform the most stringent limit value set by the EU in the recent Council Directive on Incineration (2000/76/EC).

Congener-specific emission data are needed for the analyses of the ambient air impacts and deposition flux of dioxin-like compounds using air dispersion and deposition models. As each specific congener has different physico-chemical properties, the proportion of each congener will affect the final result. Thus, the congener profile expected from the current facility must be derived. The congener profile will be dependent on various factors including the type of waste being burnt, the temperature of combustion, the type of combustion chamber being operated and the air pollution control devices (APCDs) installed. In the present case, no site-specific stack testing for specific congeners is possible as the facility is not yet built. Shown in Table 1.22 are typical relative PCDD/PCDF congener emission factors for a municipal waste incinerator similar to that proposed in the current scheme, a mass burn refractometry system with wet scrubbing (MB-REF WS) taken from the Database of Sources of Environmental Releases of Dioxin-Like Compounds in the United States (USEPA, 1998 (CD-ROM))[18]. It would be expected that the relative congener profiles for this type of waste-to-energy plant would be somewhat similar to the current case. Figures 1.12 – 1.13 show the ratio of congeners and the TEQ equivalent releases from this type of facility corrected to the maximum emission limit outlined in Council Directive 2000/76/EC.

Vapour / Particulate Partitioning

In order to accurately model emissions of PCDD/PCDFs and mercury, the partitioning of stack emissions into the vapour and particle (V/P) state is required.

In relation to PCDD/PCDFs, V/P partitioning based on stack tests data is highly uncertain[10]. Research has indicated that higher temperatures favour the vaporous states for the lower chlorinated congeners and the particulate state for the higher chlorinated congeners[10]. However, measured data has indicated significant variability in the V/P partitioning. For these reasons, the USEPA has indicated that V/P distributions obtained from stack sampling should not be used.

Data can also be obtained from ambient air sampling using a glass fibre particulate filter and polyurethane foam (PUF) absorbent trap. As the sampler is not subjected to artificial heating or cooling, the method can be used to imply the vapour phase and particle bound partitioning of PCDD/Fs in ambient air. However, the results will be only approximate as mass transfer between the particulate matter on the filter and the vapour trap cannot be ruled out[10].

The recommended USEPA approach to obtaining the vapour/particulate partitioning at the current time is theoretical and based on the Junge-Pankow model for estimating the particle/gas distribution of PCDD/PCDFs[10]. This model is the one most commonly used for estimating the adsorption of semi-volatile compounds to aerosols:

$$\Phi = c\Theta / (\rho^o{}_L + c\Theta)$$

where:
Φ = fraction of compound adsorbed to aerosol particles
c = constant (assumed 17.2 Pa-cm)
Θ = particle surface area per unit volume of air, cm^2 aerosol/cm^3 air
$\rho^o{}_L$ = saturation liquid phase vapour pressure, Pa

The particulate fraction can also be expressed by:

$$\Phi = C_p(TSP) / (C_g + C_p(TSP))$$

where:
Φ = fraction of compound adsorbed to aerosol particles
C_p = concentration of semivolatile compounds associated with aerosols, ng/μg particles
C_g = gas-phase concentration, ng/m^3
TSP = total suspended particle concentration, μg/m^3

In the above calculations, it is assumed that all compounds emitted from the combustion sources are freely exchangeable between vapour and particle fractions. This may be a simplification as some of the particulate fraction may be trapped and be unavailable for exchange.

As the $\rho^o{}_L$ is referenced to 25°C and an ambient temperature of 10°C has been assumed which is appropriate for average annual temperatures in Ireland, the $\rho^o{}_L$ has been converted to the ambient temperature as indicated in Table 1.23. Other relevant data used in the calculations and the derived particle fraction at 10°C is also shown in Table 1.23.

The advantages of the theoretical approach is that it is based on current adsorption theory, considers the molecular weight and degree of halogenation of the congeners and uses the availability of surface area for adsorption of atmospheric particles corresponding to specific airsheds (background plus local sources used in the current case).

1.7.3 Modelling of Vapours and Particles Concentrations

PCDD/PCDFs have a range of vapour pressures and thus exist in both vapour and particle-bound states to various degrees. In order to adequately model dispersion and deposition of PCDD/PCDFs, modelling of both vapour and particle-bound states is thus necessary. For the vapour phase modelling, no dry deposition was assumed, as recommended by the USEPA[10,11]. Using the congener profile from Table 1.22 and the vapour – particle partitioning from Table 1.23, the vapour concentrations of the respective dioxin congeners was determined as outlined in Tables 1.25 for a default MWI (MS-Ref WS) profile and diagrammatically in Figure 1.14. Results are shown under maximum operating conditions. The impact of wet deposition on the modelled vapour concentration has also been reported in Table 1.25 and diagrammatically in Figure 1.15.

When modelling semi-volatile organics (such as PCDD/PCDFs) and mercury (Hg) the surface area weighting rather than mass weighting is used for deposition. The surface weighting reflects the mode of formation where volatiles condense on the surface of particulates in the post-combustion chamber (see Column 6 of Table 1.24). Thus, the apportionment of emissions by particle size becomes a function of the surface area of the particle which is available for chemical adsorption.

For the particle-phase concentration, the congener profile from Table 1.22 and the vapour – particle partitioning from Table 1.23 were used to give the particulate concentrations of the respective dioxin congeners as determined in Table 1.26 and diagrammatically in Figure 1.14. Results are shown under maximum operating conditions.

1.7.4 Deposition Modelling of Particulates

Deposition refers to a range of mechanisms which can remove emissions from the atmosphere. These include Brownian motion of aerosol particles and scavenging of particles and vapours by precipitation.

Dry Deposition

Dry deposition of particles refers to the transfer of airborne particles to the surface by means of the forces of gravity and turbulent diffusion followed by diffusion through the laminar sub-layer (thickness of 10^{-1} to 10^{-2} cm) to the surface (collectively know as the deposition flux)[10]. The meteorological factors which most influence deposition include the friction velocity and aerodynamic surface roughness. The ISCST3 model uses an algorithm which relates the deposition flux to functions of particle size, density, surface roughness and friction velocity.

In order to model dry deposition using ISCST3, the particle-size distribution from the stack must be derived. In the absence of a site-specific particle-size distribution, a generalised distribution recommended by the USEPA has been outlined in Table 1.24. This distribution is suitable as a default for some combustion facilities equipped with either electrostatic precipitators (ESPs) or fabric filters (such as the current case), because the distribution is relatively typical of particle size arrays that have been measured at the outlet to advanced equipment designs[11]. As described above, the particles are apportioned based on the fraction of available surface area (see Column 6 of Table 1.24).

Dry gaseous deposition, although considered in the ISCST3 model, has not been calibrated for the estimation of the deposition flux of dioxin-like compounds into vegetation and thus the USEPA has recommended that this algorithm should not be used for site-specific applications[10,11].

Wet Deposition

Wet deposition physically washes out the chemically contaminated particulate and vapours from the atmosphere. Vapour scavenging is not yet well understood and is not integrated fully into the ISCST3 model. However, for informational purposes, the impact of vapour scavenging on both vapour concentration and total deposition has been reported.

Wet deposition flux depends on the fraction of the time precipitation occurs and the fraction of material removed by precipitation per unit of time by particle size. The ISCST3 model uses a scavenging ratio approach which is the product of the scavenging coefficient and precipitation rate. The scavenging coefficient depends on the size distribution for particles and the nature or form of the precipitation, i.e., liquid or frozen[10,11].

Modelling Approach

For the deposition modelling of PCDD/PCDFs, both wet and dry particulate deposition were calculated. The modelling also incorporated wet and dry depletion into the calculations to ensure that the conservation of mass was maintained, as recommended by the USEPA.

For the particle-phase deposition, the congener profile from Table 1.22 and the vapour – particle partitioning from Table 1.23 were used to give the particulate emission rate of the respective dioxin congeners as determined in Table 1.27. The deposition flux for each congener was calculated by multiplying the emission rate of each congener by the unitised deposition flux as shown in Table 1.27 and diagrammatically in Figure 1.15. Results are shown under maximum operating conditions.

1.7.5 Comparison with Standards And Guidelines

Currently, no internationally recognised ambient air quality concentration or deposition standards exist for PCDD/PCDFs. Both the USEPA and WHO recommended approach to assessing the risk to human health from PCDD/PCDFs entails a detailed risk assessment analysis involving the determination of the impact of PCDD/PCDFs in terms of the TDI (Tolerable Daily Intake) approach[19,20]. A TDI has been defined by the WHO as "an estimate of the intake of a substance over a lifetime that is considered to be without appreciable health risk"[20]. Occasional short term excursions above the TDI would have no health consequences provided the long-term average is not exceeded. The WHO currently proposes a maximum TDI of between 1-4 pgTEQ/kg of body weight per day. A TDI of 4 pgTEQ/kg of body weight per day should be considered a maximal tolerable intake on a provisional basis and that the ultimate goal is to reduce human intake levels of below 1 pgTEQ/kg of body weight per day. This reflects the concept that guidance values for the protection of human health should consider total exposure to the substance including air, water, soil, food and other media sources.

Table 1.20 The number of dioxin-like and total congeners within dioxin, furan, and coplanar PCB Homologue groups[1].

Homologue Group	n: Number of Dioxin-Like Congeners	N: Number of Congeners	1/N
I. Dioxins			
Tetra-CDD	1	22	0.022
Penta-CDD	1	14	0.071
Hexa-CDD	3	10	0.100
Hepta-CDD	1	2	0.500
Octa-CDD	1	1	1.000
II. Furans			
Tetra-CDF	1	38	0.026
Penta-CDF	2	28	0.036
Hexa-CDF	4	16	0.063
Hepta-CDF	2	4	0.250
Octa-CDF	1	1	1.000
III. Mono-ortho coplanar PCBs			
Tetrachloro-PCBs	1	42	0.024
Pentachloro-PCBs	5	46	0.022
Hexachloro-PCBs	4	42	0.024
Heptachloro-PCBs	3	24	0.042

(1)   USEPA (2000) Estimating Exposure to Dioxin-Like Compounds Volume II, Chapter 3

Table 1.21 The TEF scheme for $TEQ_{DFP}\text{-}WHO_{98}$ and $I\text{-}TEQ_{DF}$[1].

Dioxin Congeners	TEF	Furan Congeners	TEF
2,3,7,8-TCDD	1.0	2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDD	1.0 (0.5)[2]	1,2,3,7,8-PeCDF	0.05
1,2,3,4,7,8-HxCDD	0.1	2,3,4,7,8-PeCDF	0.5
1,2,3,6,7,8-HxCDD	0.1	1,2,3,4,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDD	0.1	1,2,3,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDD	0.01	1,2,3,7,8,9-HxCDF	0.1
OCDD	0.0001 (0.001)[2]	2,3,4,6,7,8-HxCDF	0.1
PCB Chemical Structure	**TEF**	1,2,3,4,6,7,8-HpCDF	0.01
3,3',4,4'-TeCB	0.0001	1,2,3,4,7,8,9-HpCDF	0.01
3,4,4',5-TCB	0.0001	OCDF	0.0001 (0.001)[2]
2,3,3',4,4'-PeCB	0.0001		
2,3,4,4',5-PeCB	0.0005		
2,3',4,4',5-PeCB	0.0001		
2',3,4,4',5-PeCB	0.0001		
3,3',4,4',5-PeCB	0.1		
2,3,3',4,4',5-HxCB	0.0005		
2,3,3',4,4',5'-HxCB	0.0005		
2,3',4,4',5,5'-HxCB	0.00001		
3,3',4,4',5,5'-HxCB	0.01		
2,3,3',4,4',5,5'-HpCB	0.0001		

(1)   USEPA (2000) Estimating Exposure to Dioxin-Like Compounds Volume II, Chapter 1
(2)   Values in parentheses are those given in Annex 1, Council Directive 2000/76/EC and equate to $I\text{-}TEQ_{DF}$.

Table 1.22 PCDD/PCDF Relative Emission Factors for Municipal Waste Incinerator (MB-Ref WS)[1]

Congener Group	Emission Factor (relative to sum of toxic congeners) Nondetects set to zero	Emission Concentration (ng/m³ from stack) Nondetects set to zero	Emission Factor (ng/sec from stack) Nondetects set to zero
2,3,7,8-TCDD	0.0009	0.00231	0.09663
1,2,3,7,8-PeCDD	0.0068	0.00896	0.37559
1,2,3,4,7,8-HxCDD	0.0117	0.00307	0.12880
1,2,3,6,7,8-HxCDD	0.0235	0.00620	0.25975
1,2,3,7,8,9-HxCDD	0.0284	0.00747	0.31281
1,2,3,4,6,7,8-HpCDD	0.2063	0.00543	0.22757
OCDD	0.3152	0.00083	0:03477
2,3,7,8-TCDF	0.0310	0.00817	0.34222
1,2,3,7,8-PeCDF	0.0062	0.00082	0.03438
2,3,4,7,8-PeCDF	0.0163	0.02150	0.90081
1,2,3,4,7,8-HxCDF	0.0484	0.01275	0.53433
1,2,3,6,7,8-HxCDF	0.0161	0.00423	0.17705
1,2,3,7,8,9-HxCDF	0.0032	0.00085	0.03553
2,3,4,6,7,8-HxCDF	0.0535	0.01409	0.59045
1,2,3,4,6,7,8-HpCDF	0.0878	0.00231	0.09680
1,2,3,4,7,8,9-HpCDF	0.0267	0.00070	0.02950
OCDF	0.1178	0.00031	0.01300
Total PCDD/PCDF	**1.0**	**0.1 ng/m³**	**4.19 ng/sec**

(1)   Database of Sources of Environmental Releases of Dioxin-Like Compounds in the United States (1998, USEPA (CD-ROM)).

Table 1.23 PCDD/PCDF Particle Fraction, Φ, at 10°C In Airshed (Background plus Local Sources)[1]

Congener Group	$E-H\rho^o{}_L$ (25°C)	$E-H\rho^o{}_L$ (10°C)[2]	Particle Fraction
2,3,7,8-TCDD	1.14×10^{-4}	1.87×10^{-5}	0.763
1,2,3,7,8-PeCDD	1.74×10^{-5}	2.47×10^{-6}	0.961
1,2,3,4,7,8-HxCDD	3.96×10^{-6}	4.98×10^{-7}	0.992
1,2,3,6,7,8-HxCDD	3.96×10^{-6}	4.98×10^{-7}	0.992
1,2,3,7,8,9-HxCDD	3.96×10^{-6}	4.98×10^{-7}	0.992
1,2,3,4,6,7,8-HpCDD	1.02×10^{-6}	1.18×10^{-7}	0.998
OCDD	2.77×10^{-7}	2.91×10^{-8}	0.9995
2,3,7,8-TCDF	1.23×10^{-4}	2.01×10^{-5}	0.75
1,2,3,7,8-PeCDF	3.64×10^{-5}	5.46×10^{-6}	0.917
2,3,4,7,8-PeCDF	2.17×10^{-5}	3.11×10^{-6}	0.951
1,2,3,4,7,8-HxCDF	8.09×10^{-6}	1.09×10^{-6}	0.982
1,2,3,6,7,8-HxCDF	8.09×10^{-6}	1.09×10^{-6}	0.982
1,2,3,7,8,9-HxCDF	4.99×10^{-6}	6.49×10^{-7}	0.989
2,3,4,6,7,8-HxCDF	4.99×10^{-6}	6.49×10^{-7}	0.989
1,2,3,4,6,7,8-HpCDF	2.24×10^{-6}	2.77×10^{-7}	0.995
1,2,3,4,7,8,9-HpCDF	1.31×10^{-6}	1.56×10^{-7}	0.9974
OCDF	2.60×10^{-7}	2.71×10^{-8}	0.9995

(1)   USEPA (2000) Estimating Exposure to Dioxin-Like Compounds Volume II, Chapter 3
(2)   Background plus local sources default values: $\Theta = 3.5 \times 10^{-8}$ cm² aerosol/cm³ air, TSP =42 $\mu g/m^3$.

Table 1.24   Generalized Particle Size Distribution & Proportion of Available Surface Area[1]

Mean Particle Diameter (μm)	Particle Radius (μm)	Surface Area/Volume (μm⁻¹)	Fraction of Total Mass[2]	Proportion Available Surface Area	Fraction of Total Surface Area[3]
>15.0	7.50	0.400	0.128	0.0512	0.0149
12.5	6.25	0.480	0.105	0.0504	0.0146
8.1	4.05	0.741	0.104	0.0771	0.0224
5.5	2.75	1.091	0.073	0.0796	0.0231
3.6	1.80	1.667	0.103	0.1717	0.0499
2.0	1.00	3.000	0.105	0.3150	0.0915
1.1	0.55	5.455	0.082	0.4473	0.1290
0.7	0.40	7.500	0.076	0.5700	0.1656
>0.7	0.40	7.500	0.224	1.6800	0.4880

(1)   USEPA (1998) Chapter 3: Air Dispersion and Deposition Modelling, Human Health Risk Assessment Protocol, Region 6
Centre for Combustion Science and Engineering
(2)   Used in the deposition modelling of metals (except Hg)
(3)   Used in the deposition modelling of PCDD/PCDFs and Hg

1.7.6 Modelling Results

Tables 1.25 – 1.29 details the predicted PCCD/PCDFs GLC and deposition flux for the maximum scenario.

Table 1.25 PCDD/PCDF Annual Vapour Concentrations & Wet Vapour Deposition (Based on a Default MWI Profile (MB-Ref WS)) Under Maximum Operating Conditions

Congener Group	Vapour Fraction	Vapour Emission Rate (ng/sec)	Annual Vapour Concentration (fg/m^3)	Annual Wet Vapour Deposition (ng/m^2)
2,3,7,8-TCDD	0.237	0.02290	0.02769	0.00653
1,2,3,7,8-PeCDD	0.039	0.01465	0.01771	0.00417
1,2,3,4,7,8-HxCDD	0.008	0.00103	0.00125	0.00029
1,2,3,6,7,8-HxCDD	0.008	0.00208	0.00251	0.00059
1,2,3,7,8,9-HxCDD	0.008	0.00250	0.00303	0.00071
1,2,3,4,6,7,8-HpCDD	0.002	0.00046	0.00055	0.00013
OCDD	0.0005	0.00002	0.00002	0.000005
2,3,7,8-TCDF	0.25	0.08556	0.10344	0.02438
1,2,3,7,8-PeCDF	0.083	0.00285	0.00345	0.00081
2,3,4,7,8-PeCDF	0.049	0.04414	0.05337	0.01258
1,2,3,4,7,8-HxCDF	0.018	0.00962	0.01163	0.00274
1,2,3,6,7,8-HxCDF	0.018	0.00319	0.00385	0.00091
1,2,3,7,8,9-HxCDF	0.011	0.00039	0.00047	0.00011
2,3,4,6,7,8-HxCDF	0.011	0.00649	0.00785	0.00185
1,2,3,4,6,7,8-HpCDF	0.005	0.00048	0.00059	0.00014
1,2,3,4,7,8,9-HpCDF	0.0026	0.00008	0.00009	0.00002
OCDF	0.0005	0.00001	0.00001	0.000002
Sum			0.24 fg/m^3	0.056 ng/m^2

Table 1.26   PCDD/PCDF Annual Particulate Concentrations (Based on a Default MWI Profile (MB-Ref WS)) Under Maximum Operating Conditions

Congener Group	Particulate Fraction	Particulate Emission Rate (ng/sec)	Annual Particulate Concentration (fg/m^3)
2,3,7,8-TCDD	0.763	0.07373	0.08737
1,2,3,7,8-PeCDD	0.961	0.36094	0.42772
1,2,3,4,7,8-HxCDD	0.992	0.12777	0.15141
1,2,3,6,7,8-HxCDD	0.992	0.25767	0.30534
1,2,3,7,8,9-HxCDD	0.992	0.31030	0.36771
1,2,3,4,6,7,8-HpCDD	0.998	0.22712	0.26914
OCDD	0.9995	0.03475	0.04118
2,3,7,8-TCDF	0.75	0.25667	0.30415
1,2,3,7,8-PeCDF	0.917	0.03153	0.03736
2,3,4,7,8-PeCDF	0.951	0.85667	1.01516
1,2,3,4,7,8-HxCDF	0.982	0.52472	0.62179
1,2,3,6,7,8-HxCDF	0.982	0.17387	0.20603
1,2,3,7,8,9-HxCDF	0.989	0.03514	0.04164
2,3,4,6,7,8-HxCDF	0.989	0.58395	0.69199
1,2,3,4,6,7,8-HpCDF	0.995	0.09632	0.11414
1,2,3,4,7,8,9-HpCDF	0.9974	0.02943	0.03487
OCDF	0.9995	0.01299	0.01539
Sum			4.73 fg/m^3

Table 1.27 PCDD/PCDF Annual Particulate Deposition Fluxes (Based on a Default MWI Profile (MB-Ref WS)) Under Maximum Operating Conditions

Congener Group	Particulate Emission Rate (ng/sec)	Dry Particulate Deposition Flux (ng/m^2)	Wet Particulate Deposition Flux (ng/m^2)	Combined Particulate Deposition Flux (ng/m^2)
2,3,7,8-TCDD	0.07373	0.01710	0.01423	0.02064
1,2,3,7,8-PeCDD	0.36094	0.08374	0.06966	0.10106
1,2,3,4,7,8-HxCDD	0.12777	0.02964	0.02466	0.03578
1,2,3,6,7,8-HxCDD	0.25767	0.05978	0.04973	0.07215
1,2,3,7,8,9-HxCDD	0.31030	0.07199	0.05989	0.08688
1,2,3,4,6,7,8-HpCDD	0.22712	0.05269	0.04383	0.06359
OCDD	0.03475	0.00806	0.00671	0.00973
2,3,7,8-TCDF	0.25667	0.05955	0.04954	0.07187
1,2,3,7,8-PeCDF	0.03153	0.00731	0.00608	0.00883
2,3,4,7,8-PeCDF	0.85667	0.19875	0.16534	0.23987
1,2,3,4,7,8-HxCDF	0.52472	0.12173	0.10127	0.14692
1,2,3,6,7,8-HxCDF	0.17387	0.04034	0.03356	0.04868
1,2,3,7,8,9-HxCDF	0.03514	0.00815	0.00678	0.00984
2,3,4,6,7,8-HxCDF	0.58395	0.13548	0.11270	0.16351
1,2,3,4,6,7,8-HpCDF	0.09632	0.02235	0.01859	0.02697
1,2,3,4,7,8,9-HpCDF	0.02943	0.00683	0.00568	0.00824
OCDF	0.01299	0.00301	0.00251	0.00364
Sum		0.93 ng/m^2	0.77 ng/m^2	1.12 ng/m^2
Equivalent Daily Deposition Flux		2.55 pg/m^2/day	2.11 pg/m^2/day	3.07 pg/m^2/day

Table 1.28   Dispersion Model Summary of Combined Vapour and Particulate Concentrations – PCCD/PCDFs.

Pollutant / Scenario	Annual Mean Background[1] (pg/m^3)	Averaging Period	Process Contribution (pg/m^3)	Predicted Emission Concentration (pg/Nm^3)
PCCD/PCDFs / Maximum	0.028 0.046	Annual Average	0.005	0.033 0.051
PCCD/PCDFs / Typical	0.028 0.046	Annual Average	0.0004	0.0284 0.0464

[1]   Baseline results for dioxins given as sum of cumulative impacts (in the absence of Indaver Ireland) and baseline monitoring data firstly as (i) Non-detects = zero, (ii) Non-detects = limit of detection.

Table 1.29   Deposition Model Summary of Combined Particulate Deposition Flux – PCCD/PCDFs.

Pollutant / Scenario	Averaging Period	Process Contribution (pg/m^2/day)	Predicted Total Particulate Deposition Flux (pg/m^2/day)
PCCD/PCDFs / Maximum	Annual Average	3.07	3.07

Table 1.30   I-TEQ values derived from measurements of airborne dioxins in various locations.

Location	Site Type	I-TEQ[1] (fg/m^3)
Kilcock , Co. Meath (1998)[2]	Rural	Range 2.8 – 7
Ireland[2]	Baseline	Mean – 26
	Potential Impact Areas	Mean – 49
Ringaskiddy (2001)[3]	Rural	Range 4 – 16
Germany (1992)[4]	Rural	< 70
	Urban	71 – 350
	Close to Major Source	351 – 1600
UK[5]	London (1993)	Mean – 50
	Manchester (1993)	Mean – 100
	Cardiff (1993)	Mean – 100
	Stevenage (1993)	Mean – 70
Sweden[5]	Urban/Suburban	13 – 24
	Remote/Coastal	3 – 4
Manchester (1999)[6]	Urban	Lower Limit – 16[7]
Middlesbrough (1999)[6]	Urban	Lower Limit – 7.9[7]
Hazelrigg (1999)[6]	Semi-rural	Lower Limit – 2.8[7]
Stoke Ferry (1999)[6]	Rural	Lower Limit – 1.9[7]
High Muffles (1999)[6]	Rural	Lower Limit – 0.26[7]
Ringaskiddy (2001)	Industrial	Lower Limit – 4.0[7] Upper Limit – 16.4[8]

(1)   I-TEQ$_{DF}$ values based on NATO/CCMS (1988) and as used in Annex 1, Council Directive 2000/76/EC.
(2)   Taken from Chapter 8 of Thermal Waste Treatment Plant, Kilcock EIS, Air Environment (1998)
(3)   Taken from Chapter 9 of Waste Management Facility, Indaver Ireland Ringaskiddy EIS, Baseline Dioxin Survey (2001)
(4)   Raffe, C (1996) Sources and environmental concentrations of dioxins and related compounds, *Pure & Appl. Chem* **Vol. 68**, No. 9, pp 1781-1789
(5)   Duarte-Davidson et al (1994) Polychlorinated Dibenzo-*p*-Dioxins (PCDDs) and Furans (PCDFs) in Urban Air and Deposition, *Environ. Sci. & Pollut. Res.*, 1 **(4)**, 262-270
(6)   Taken from TOMPS Network website, WWW.aeat.co.uk/netcen/airqual.
(7)   Lower Limit TEQ calculated assuming non-detects are equal to zero.
(8)   Upper limit assuming non-detects are equal to limit of detection.

Table 1.31   Mean I-TEQ Deposition Fluxes Of Dioxins In Various Locations

Location	Site Type	Mean I-TEQ[1] (pg/m^2/ day)
Germany (1992)[2]	Rural	5 -22
	Urban	10 – 100
	Close to Major Source	123 - 1293
UK[3]	Stevenage	3.2
	London	5.3
	Cardiff	12
	Manchester	28

(1)   I-TEQ$_{DF}$ values based on NATO/CCMS (1988) and as used in Annex 1, Council Directive 2000/76/EC.
(2)   Raffe, C (1996) Sources and environmental concentrations of dioxins and related compounds, *Pure & Appl. Chem* Vol. 68, No. 9, pp 1781-1789
(3)   Duarte-Davidson et al (1994) Polychlorinated Dibenzo-*p*-Dioxins (PCDDs) and Furans (PCDFs) in Urban Air and Deposition, *Environ. Sci. & Pollut. Res.*, 1 (4), 262-270

1.7.7 Concentration Contours

The geographical variation in PCCD/PCDFs ground level concentrations and deposition fluxes beyond the site boundary are illustrated as concentration contours in Figures 1.16-1.19. The content of the figure is described below.

Figure 1.16 Maximum Operations: <u>Predicted PCCD/PCDFs Annual Average Vapour Concentration</u>

Figure 1.17 Maximum Operations: <u>Predicted PCCD/PCDFs Annual Average Particulate Concentration</u>

Figure 1.18 Maximum Operations: <u>Predicted PCCD/PCDFs Annual Average Wet Gas Deposition</u>

Figure 1.19 Maximum Operations: <u>Predicted PCCD/PCDFs Annual Average Total Particulate Deposition</u>

1.7.8 Result Findings

Background levels of PCDD/PCDFs occur everywhere and existing levels in the surrounding area have been extensively monitored as part of this study. Modelling results indicate that the existing levels are significantly lower than urban areas and typical of rural areas in the UK and Continental Europe. The contribution from the site in this context is minor with levels under maximum operation remaining significantly below levels which would be expected in urban areas even at the worst-case boundary receptor to the south of the site (see Table 1.30). Levels at the nearest residential receptor will be minor, with the annual contribution from Indaver Ireland accounting for less than 10% of the existing background concentration under maximum operating conditions.

Shown in Table 1.29 is the maximum dioxin deposition rate. Modelled total dioxin particulate deposition flux indicate that deposition levels would be expected to be significantly less than that experienced in urban locations and similar to rural locations (< 5 pg/m^2/day) (see Table 1.31).

1.8 Mercury

1.8.1 Mercury's Environmental Transport & Fate

Mercury exists in three oxidation states; metallic or elemental (Hg^0); mercurous (Hg$_2^{2+}$); and mercuric (Hg^{2+}). Elemental Hg is a liquid at room temperature with low volatility. Other forms of mercury are solids with low vapour pressures. It is naturally occurring and cycles between the atmosphere, land and water through a series of complex transformations. Elemental mercury is the most common form of mercury found in the atmosphere whereas in all other environmental media, mercury is found in the form of inorganic mercuric salts and organo-mercury compounds[21].

USEPA methodology relating to waste waste-to-energy plants assumes that stack emissions containing mercury include both vapour and particle-bound phases. Additionally, the USEPA assumes that mercury exits the stack in only the elemental and divalent species. Of the total mercury in the stack, 80% is estimated to be in the vapour phase and 20% is particle-bound. In addition, the USEPA assumes that speciation of the total mercury is 80% divalent (20% in the

particle-bound and 60% in the vapour phase) and 20% elemental (all 20% in the vapour phase)[21]. Although the USEPA allows a loss to the global cycle for each form of mercury (99% of the elemental vapour form, 32% of the divalent vapour form, and 64% of the particle-bound form are assumed lost to the global cycle and do not deposit within the localized study area), this has not been incorporated into the current assessment in keeping with the worst-case approached adopted in this assessment.

1.8.2 Modelling Strategy

The emissions of mercury from the waste-to-energy plant have been evaluated in terms of mass of release into both vapour and particle-bound phases. Thereafter, air dispersion and deposition modelling has been employed to translate these releases to ambient air vapour and particle phase concentrations, and wet vapour & wet and dry particulate deposition amounts, in the vicinity of the release. Both typical and maximum scenarios have been modelled as outlined in Table 1.32

Vapour / Particulate Partitioning

In order to adequately model dispersion and deposition of mercury, modelling of both vapour and particle-bound states is thus necessary. For the vapour phase modelling, no dry deposition was assumed, as recommended by the USEPA[11,21]. Using the vapour – particle partitioning described in Section 1.8.2, the vapour concentrations of mercury was determined as outlined in Table 1.33. Results are shown under maximum operating conditions.

When modelling mercury (Hg) the surface area weighting rather than mass weighting is used for deposition. The surface weighting reflects the mode of formation where volatiles condense on the surface of particulates in the flue gas cleaning system (see Column 6 of Table 1.24). Thus, the apportionment of emissions by particle size becomes a function of the surface area of the particle which is available for chemical adsorption.

For the particle-phase concentration, the vapour – particle partitioning described in Section 1.8.2 was used to give the particulate concentrations of mercury as determined in Table 1.34. Results are shown under both maximum and typical operating conditions.

1.8.3 Deposition Modelling of Particulates

In order to model dry deposition, using ISCST3, the generalised particle-size distribution recommended by the USEPA has been used as outlined in Table 1.24[11]. This distribution is suitable as a default for some combustion facilities equipped with either ESPs or fabric filters (such as the current case), because the distribution is relatively typical of particle size arrays that have been measured at the outlet to advanced equipment designs. As described above, the particles are apportioned based on the fraction of available surface area (see Column 6 of Table 1.24).

Dry gaseous deposition, although considered in the ISCST3 model, has not been adequately calibrated for the estimation of the deposition flux into vegetation and thus the USEPA has recommended that this algorithm should not be used for site-specific applications[10].

Wet Deposition

Wet deposition physically washes out the chemically contaminated particulate and vapours from the atmosphere. The impact of vapour scavenging on both vapour concentration and deposition has been reported.

Wet deposition flux depends on the fraction of the time precipitation occurs and the fraction of material removed by precipitation per unit of time by particle size. The ISCST3 model uses a scavenging ratio approach which is the product of the scavenging coefficient and precipitation rate. The scavenging coefficient depends on the size distribution for particles and the nature or form of the precipitation, i.e., liquid or frozen.

Modelling Approach

For the deposition modelling of mercury both wet and dry particulate deposition were calculated in addition to wet vapour deposition. The modelling also incorporated wet and dry depletion into the calculations to ensure that the conservation of mass was maintained, as recommended by the USEPA[11]. Results are shown in Tables 1.34 and 1.35 for both maximum and typical operating conditions.

For the particle-phase deposition, the emission rate of particle bound mercury was multiplied by the unitised deposition flux as shown in Tables 1.36 and 1.37.

Table 1.32   Emission Scenario for Mercury

Pollutant	Scenario	Emission Concentration	Emission Rate (g/s)
Hg	Max	0.05 mg/m^3	0.002
	Typical	0.025 mg/m^3	0.00088

1.8.4   Comparison With Standards And Guidelines

Predicted GLCs have been compared with the applicable WHO ambient air quality guideline for mercury as set out in Table 1.33.

Table 1.33   Hg Ambient Air Quality Standards & Guidelines

Pollutant	Regulation	Limit Type	Value
Inorganic Mercury (as Hg)	WHO	Annual Average	1.0 μg/m^3

1.8.5   Modelling Results

Tables 1.34 – 1.38 details the predicted mercury GLC for each vapour and particulate concentration and deposition scenario.

Table 1.34   **Mercury Vapour Concentrations Under Both Maximum and Typical Operating Conditions**

Oxidation State	Vapour Fraction	Vapour Emission Rate (g/sec)	Vapour Concentration ($\mu g/m^3$)
Elemental Hg	0.20	Maximum - 0.00040	0.00048
Divalent Hg^{2+}	0.60	Maximum - 0.00120	0.00145
Sum			**0.0019 $\mu g/m^3$**
Elemental Hg	0.20	Typical - 0.00018	0.00025
Divalent Hg^{2+}	0.60	Typical - 0.00053	0.00076
Sum			**0.0010 $\mu g/m^3$**

Table 1.35   **Mercury Particulate Concentrations Under Both Maximum & Typical Operating Conditions**

Oxidation State	Particulate Fraction	Particulate Emission Rate (g/sec)	Particulate Concentration ($\mu g/m^3$)
Divalent Hg^{2+}	0.20	Maximum - 0.00040	0.00047
Divalent Hg^{2+}	0.20	Typical - 0.00018	0.00025

Table 1.36   **Mercury Deposition Fluxes – Maximum Operating Conditions**

Oxidation State	Fraction	Emission Rate (g/sec)	Annual Deposition Flux ($\mu g/m^2$)
Elemental Hg	Wet Vapour	0.00040	114
Divalent Hg^{2+}	Wet Vapour	0.00120	342
Divalent Hg^{2+}	Dry particulate	0.00040	93
	Wet particulate		77
	Total particulate		112
Sum of Total Particulate & Vapour Deposition[1]			**568 $\mu g/m^2$**

[1] Worst-case as maximum of total particulate deposition and wet vapour deposition are at different locations

Table 1.37   **Mercury Deposition Fluxes – Typical Operating Conditions**

Oxidation State	Fraction	Emission Rate (g/sec)	Annual Deposition Flux ($\mu g/m^2$)
Elemental Hg	Wet Vapour	0.00023	50
Divalent Hg^{2+}	Wet Vapour	0.00069	150
Divalent Hg^{2+}	Dry particulate	0.00023	45
	Wet particulate		34
	Total particulate		53
Sum of Total Particulate & Vapour Deposition[1]			**253 $\mu g/m^2$**

[1] Worst-case as maximum of total particulate deposition and wet vapour deposition are at different locations

Table 1.38 **Dispersion Model Summary Of Combined Vapour And Particulate Hg Concentrations Under Both Maximum And Typical Operating Conditions.**

Pollutant / Scenario	Annual Mean Background (μg/m^3)	Averaging Period	Process Contribution (μg/m^3)	Predicted Emission Concentration (μg/Nm^3)	Standard (μg/Nm^3)
Hg / Maximum	0.005	Annual mean	0.0024	0.0074	0.1
Hg / Typical	0.005	Annual mean	0.0013	0.0063	0.1

(1) Baseline results for mercury including cumulative impact given as firstly (i) Non-detects = zero, (ii) Non-detects = limit of detection.

1.8.6 Concentration Contours

The geographical variation in vapour mercury ground level concentrations beyond the site boundary is illustrated as concentration contours in Figure 1.20. The geographical variation in mercury total particle-bound deposition beyond the site boundary is illustrated as concentration contours in Figure 1.21.

Figure 1.20   Maximum Operations: Predicted Mercury Annual Average Vapour Concentration

Figure 1.21   Maximum Operations: Predicted Mercury Annual Average Total Particle-Bound Deposition

1.8.7 Result Findings

Hg modelling results indicate that the ambient ground level concentrations are significantly below the WHO guideline under both typical and maximum operation of the site. Thus, no adverse environmental impact is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient mercury combined concentration (both vapour and particle-bound) (excluding background concentrations) which are only 2% of the annual average limit value at the boundary of the site.

1.9 Heavy Metal Emissions and Results (excl. Mercury)

1.9.1 Modelling Approach

The emissions of heavy metals (except Hg) from the waste-to-energy plant have been evaluated in terms of mass of release into the particulate phase only as recommended by the USEPA[10,11]. Thereafter, air dispersion and deposition modelling has been employed to translate these releases to ambient particle phase concentrations, and wet and dry particulate deposition amounts, in the vicinity of the release.

When modelling heavy metals (except Hg) the mass weighting rather than surface weighting is used for deposition as it is assumed that the metals are all in the particulate state (see Column 4 of Table 1.24). Results are shown under both maximum and typical operating conditions.

Deposition Modelling of Particulates

For the deposition modelling of heavy metals (except Hg) both wet and dry particulate deposition were calculated. The modelling also incorporated wet and dry depletion into the calculations to ensure that the conservation of mass was maintained, as recommended by the USEPA[11].

Ambient ground level concentrations and deposition values (GLCs) of the Sum of antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni) and vanadium (V) have been investigated using the concentration limits outlined in Council Directive 2000/76/EC (see Table 1.39) and using expected typical concentrations from the site.

In relation to cadmium (Cd), nickel (Ni) and arsenic (As), modelling has been carried out at concentrations which would be considered upper levels based on an existing similar Waste Management Facility. Data is available from a similar Indaver site in Belgium (see Table 1.40) indicating low emission levels of these metals and thus the modelled emission scenarios would be considered conservative upper emission levels.

Table 1.39 Emission Scenario for Heavy Metals Taken From Council Directive 2000/76/EC

Pollutant	Scenario	Concentration	Emission Rate (g/s)
Sum of Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V	Max	0.5 mg/m^3	0.021
	Typical	0.25 mg/m^3	0.0088

Table 1.40 Actual Measured Emission Data From An Indaver Site In Belgium (mg/Nm^3)

BEVEREN	Monitoring Period 1	Monitoring Period 2	Monitoring Period 3	Monitoring Period 4	Monitoring Period 5
Arsenic	0.013	<0.0080	<0.0060	<0.020	<0.013
Cadmium	<0.00040	<0.0010	0.0005	<0.0011	<0.00080
Nickel	<0.0040	<0.0050	<0.0050	0.0009	<0.010
BEVEREN	Monitoring Period 6	Monitoring Period 7	Monitoring Period 8	Monitoring Period 9	Monitoring Period 10
Arsenic	<0.010	<0.017	<0.0050	<0.017	<0.016
Cadmium	<0.00080	<0.0010	<0.00050	<0.0012	<0.0010
Nickel	0.001	0.002	<0.0040	0.0005	0.0008

1.9.2 Comparison with Standards And Guidelines

Predicted GLCs have been compared with the applicable ambient air quality guidelines and standards as set out in Table 1.41 and 1.42.

In the absence of statutory standards, ambient air quality guidelines can also be derived from occupational exposure limits (OEL). The OEL for each compound (where available) divided by an appropriate safety factor may be used. This factor accounts for increased exposure time and susceptibility of the general population in comparison to on-site personnel. The OEL can be expressed on the basis of two averaging periods; an eight-hour average and a fifteen-minute average (the short term exposure limit or STEL). The OEL (8-hour reference) divided by a factor of 100 may be applied to generate an ambient air quality guideline or Environmental Assessment Level (EAL) for comparison with predicted annual averages and the STEL divided by 40 may be applied for comparison with the one-hour concentrations.

Table 1.41   Cd and Tl Ambient Air Quality Standards & Guidelines

Pollutant	Regulation	Limit Type	Value
Cd	TA Luft	Annual Average	0.04 $\mu g/m^3$
Cd	WHO	Annual Average	0.005 $\mu g/m^3$
Cd	EU	Annual Average	0.005 $\mu g/m^{3(1)}$
Tl	EAL	Annual Average	1.0 $\mu g/m^3$

(1)   Proposed standard recommended by majority of the EU working group for setting emission factors[22]

Table 1.42 **Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V Ambient Air Quality Standards & Guidelines**

Pollutant	Regulation	Limit Type	Value
Sb (organic compounds)	EAL	Maximum One-Hour	5 μg/m^3
Sb (organic compounds)	EAL	Annual Average	1.0 μg/m^3
As	WHO	Annual Average	0.005 μg/m^3
As	EU	Annual Average	0.004 μg/m$^{3(1)}$
Pb	EU	Annual Average	0.5 μg/m^3
Cr (except VI)	EAL	Annual Average	5.0 μg/m^3
Cr (VI)	EAL	Annual Average	0.5 μg/m^3
Co	EAL	Annual Average	1.0 μg/m^3
Cu (fumes)	EAL	Annual Average	2.0 μg/m^3
Cu (dust & mists)	EAL	Annual Average	10 μg/m^3
Mn	WHO	Annual Average	0.15 μg/m^3
Mn (fume)	EAL	Maximum One-Hour	75 μg/m^3
Ni	EU	Annual Average	0.01 μg/m$^{3(1)}$
V (fume & respirable dust)	EAL	Annual Average	0.4 μg/m^3
V	WHO	24-Hour Average	1.0 μg/m^3

(1) Proposed standard recommended by majority of the EU working group for setting emission factors[22]

1.9.3 Modelling Results

Air dispersion and deposition modelling was carried out for the three scenarios described in Section 1.9.1. Table 1.43 outlines the expected emission levels and Table 1.44 – 1.46 details the predicted Cd & Tl GLC and deposition value for each scenario and averaging period.

Table 1.43 **Expected Maximum Emission Levels for Cd & Tl**

Heavy Metal	Limit Type	Value
Cd & Tl	Expected Maximum Levels[1]	0.025 mg/m^3

(1)   Based conservatively on upper limit of measured emission data from a similar site (see Table 1.40)

Table 1.44   Cd & Tl Particulate Concentrations Under Expected Maximum Levels

Heavy Metal	Emission Rate (g/sec)	Concentration ($\mu g/m^3$)
Cd & Tl	Expected Maximum Levels - 0.001	0.0012

Table 1.45   Cadmium Deposition Fluxes – Expected Maximum Levels

Heavy Metal	Fraction	Emission Rate (g/sec)	Annual Deposition Flux (g/m^2)
Cd & Tl / Expected Maximum Levels	Dry particulate	0.001	0.0011
	Wet particulate		0.0005
Sum of Total Deposition			0.0012 g/m^2

Table 1.46   Cadmium & Thallium Particulate Concentration Summary

Heavy Metal	Annual Mean Background[1] (μg/m^3)	Averaging Period	Process Contribution (μg/m^3)	Applicable PSD Increment (μg/Nm^3)	Predicted Emission Concentration (μg/Nm^3)	Standard[3] (μg/Nm^3)
Cd & Tl / Expected Maximum Level	< 0.012 < 0.023	Annual mean	0.0012	0.00125[2]	< 0.013 < 0.024	0.005

(1)   Baseline results including cumulative impact given as firstly (i) Non-detects = 50% of limit of detection, (ii) Non-detects = limit of detection

(2)   PSD Increment for a Class II Area – 25% of the applicable limit value

(3)   Proposed standards recommended by majority of the EU working group for setting emission factors[22]

Tables 1.47 – 1.49 details the predicted GLC and deposition values for each scenario for the sum of Sb, Pb, Cr, Co, Cu, Mn and V.

Table 1.47   Sum of Sb, Pb, Cr, Co, Cu, Mn and V Particulate Concentrations Under Both Maximum & Typical Operating Conditions

Heavy Metal	Emission Rate (g/sec)	Maximum 1-hour Concentration ($\mu g/m^3$)	Maximum 24-hour Concentration ($\mu g/m^3$)	Annual Concentration ($\mu g/m^3$)
Sum of Sb, Pb, Cr, Co, Cu, Mn and V	Maximum - 0.021	0.77	0.27	0.023
Sum of Sb, Pb, Cr, Co, Cu, Mn and V	Typical - 0.0088	0.41	0.13	0.012

Table 1.48   Sum of Sb, Pb, Cr, Co, Cu, Mn and V Deposition Fluxes – Maximum and Typical Operating Conditions

Heavy Metal	Fraction	Emission Rate (g/sec)	Annual Deposition Flux (g/m^2)
Sum of Sb, Pb, Cr, Co, Cu, Mn and V / Maximum	Dry particulate	0.021	0.024
	Wet particulate		0.011
Sum of Total Deposition			**0.026 g/m^2**
Sum of Sb, Pb, Cr, Co, Cu, Mn and V / Typical	Dry particulate	0.0088	0.011
	Wet particulate		0.0044
Sum of Total Deposition			**0.012 g/m^2**

Table 1.49   Dispersion Model Results – Sum of Sb, Pb, Cr, Co, Cu, Mn and V

Heavy Metal / Scenario	Annual Mean Background ($\mu g/m^3$)[1]	Averaging Period	Process Contribution ($\mu g/m^3$)	Predicted Emission Concentration ($\mu g/Nm^3$)	Standard ($\mu g/Nm^3$)
Sum of metals / Maximum	0.012[2]	Annual mean	0.023	0.035	0.15[3]
Sum of metals / Maximum	0.024[4]	Maximum One-Hour	0.77	0.79	5.0[5]
Sum of metals / Typical	0.012[2]	Annual mean	0.012	0.024	0.15[3]
Sum of metals / Typical	0.024[4]	Maximum One-Hour	0.41	0.43	5.0[5]

(1)   Baseline results for metal including cumulative impact given as firstly (i) Non-detects = zero, (ii) Non-detects = limit of detection.
(2)   Background concentration for manganese including cumulative impact
(3)   Ambient standard for manganese which is the most stringent applicable limit value for this averaging period
(4)   Background concentration for antimony including cumulative impact
(5)   Ambient standard for antimony which is the most stringent applicable limit value for this averaging period.

In relation to nickel (Ni) and arsenic (As), modelling has been carried out at concentrations which would be considered upper levels based on data from an existing Waste Management Facility. Data is available from a similar Indaver site in Belgium (see Table 1.40) which indicates typically low levels of these metals and thus the modelled emission scenarios would be considered conservative upper emission levels. Table 1.50 outlines the expected emission levels and Table 1.51 – 1.53 outlines the corresponding ambient concentrations and deposition rates which will result from emissions at these levels.

Table 1.50   Expected Maximum Emission Levels for As and Ni

Heavy Metal	Limit Type	Value
Arsenic	Expected Maximum Emission Levels[1]	0.015 mg/m^3
Nickel	Expected Maximum Emission Levels [1]	0.015 mg/m^3

(1) Based conservatively on upper limit of measured emission data from a similar site (see Table 1.40)

Table 1.51   Particle-phase Concentrations Under Expected Maximum Emission Levels

Heavy Metal	Emission Rate (g/sec)	Concentration (μg/m^3)
As	0.00063	0.0008
Ni	0.00063	0.0008

Table 1.52   Deposition Fluxes – Expected Maximum Emission Levels

Heavy Metal	Fraction	Emission Rate (g/sec)	Annual Deposition Flux (g/m^2)
As	Dry particulate	0.00063	0.0007
	Wet particulate		0.0003
Sum of Total Deposition			**0.0008 g/m^2**
Ni	Dry particulate	0.00063	0.0007
	Wet particulate		0.0003
Sum of Total Deposition			**0.0008 g/m^2**

Table 1.53   Particle Phase Concentration Under Expected Maximum Emission Levels for Arsenic and Nickel

Heavy Metal	Annual Mean Background[1] (μg/m^3)	Averaging Period	Process Contribution (μg/m^3)	Applicable PSD Increment (μg/Nm^3)	Predicted Emission Concentration (μg/Nm^3)	Standard[3] (μg/Nm^3)
As / Expected Maximum Level	< 0.01 < 0.02	Annual mean	0.0008	0.0010[2]	< 0.0108 < 0.0208	0.004
Ni / Expected Maximum Level	0.006 0.005	Annual mean	0.0008	0.0025[2]	0.0068 0.0058	0.010

(1)   Baseline results including cumulative impact given as firstly (i) Non-detects = zero, (ii) Non-detects = limit of detection

(2)   PSD Increment for a Class II Area – 25% of the applicable limit value

(3)   Proposed standards recommended by majority of the EU working group for setting emission factors[22]

1.9.4 Concentration Contours

The geographical variations in heavy metal ground level concentrations and deposition flux beyond the site boundary are illustrated as a concentration and deposition contours in Figures 1.22 to 1.28. The figure has been expressed as a percentage of the appropriate ambient air quality guideline. The content of the figure is described below.

Figure 1.22   Expected Maximum Levels: <u>Predicted Cd Annual Average Concentration</u>

Figure 1.23   Expected Maximum Levels: <u>Predicted Cd Annual Deposition Flux</u>

Figure 1.24   Maximum Operations: <u>Predicted Sum of Sb, Pb, Cr, Co, Cu, Mn and V Annual Average Concentration</u>

Figure 1.25   Expected Maximum Levels: <u>Predicted As Annual Average Concentration</u>

Figure 1.26   Expected Maximum Levels: <u>Predicted As Annual Deposition Flux</u>

Figure 1.27   Expected Maximum Levels: <u>Predicted Ni Annual Average Concentration</u>

Figure 1.28   Expected Maximum Levels: <u>Predicted Ni Annual Deposition Flux</u>

1.9.5 Result Findings

Cd and Tl

Modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standards for cadmium under expected maximum levels (based on data from a similar site in Belgium) from the site. Emissions at expected maximum levels equate to ambient Cd concentrations (excluding background concentrations) which are 24% of the suggested annual limit value close to the site boundary. In addition, levels from Indaver Ireland are below the respective PSD increment (less than 25% of the ambient limit value).

Sum of Sb, Pb, Cr, Co, Cu, Mn and V

Modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards for manganese and antimony (the metals with the most stringent limit values) under both typical and maximum emissions from the site. Thus, no adverse environmental impact is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient Mn concentrations (excluding background concentrations) which are 23% of the annual limit value at the worst-case boundary receptor whilst emissions at maximum operations equate to ambient Sb concentrations (excluding background concentrations) which are only 16% of the maximum 1-hour limit value at the worst-case boundary receptor.

As

Modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standards for arsenic under expected maximum levels (based on data from a similar site in Belgium) from the site. Thus, no adverse environmental impact is envisaged to occur under these conditions at or beyond the site boundary. Emissions at expected maximum levels equate to ambient As concentrations (excluding background concentrations) which are 20% of the suggested annual EU limit value at the site boundary. Background concentrations of As were monitored over a one-month period. However, the monitoring methodology's detection limits could not achieve the stringent limits of the proposed ambient standard for As. However, no significant local sources of this compound could be identified in a detailed cumulative assessment of nearby sources. Thus, it may be expected that background levels of this compound are likely to be minor.

Ni

Modelling results indicate that the ambient ground level concentrations (excluding background concentrations) will be below the relevant air quality standards for nickel at the expected maximum levels from the site. Emissions at these levels (based on data from a similar site in Belgium) equate to ambient Ni concentrations (excluding background concentrations) which are 8% of the suggested annual EU limit value at the site boundary. In addition, levels from Indaver Ireland are below the respective PSD increment (less than 25% of the ambient limit value).

1.9.6   Summary Of Impacts

Based on the emission guidelines outlined in Council Directive 2000/76/EC an appropriate stack height has been determined through detailed air dispersion modelling to ensure that the most stringent ambient air quality standards are not exceeded. In respect of Cd, As and Ni, individual expected maximum levels have been derived (based on data from a similar site in Belgium) which would be considered conservative upper emission levels.

The modelling results indicate that the maximum ambient GLC occurs at or near the site's northern and eastern boundaries. Concentrations fall off rapidly away from this maximum and for the short-term limit values at the nearest residential receptors will be less than 30% of the worst-case concentration. The annual average concentration has an even more dramatic decrease in maximum concentration away from the site with concentrations from emissions at Indaver Ireland accounting for less than 6% of the limit value (not including background concentrations) at worst case sensitive receptors near the site. Thus, the results indicate that the impact from Indaver Ireland is minor and limited to the immediate environs of the site.

In the surrounding main population centres, Duleek and Drogheda, levels are significantly lower than background sources with the concentrations from emissions at Indaver Ireland accounting for less than 1% of the annual limit values for most pollutants.