4 POTENTIAL ENVIRONMENTAL EFFECTS/ IMPACTS AND MITIGATION MEASURES

4.1 Human Beings/Socio-Economic

4.1.1 Potential Effects/ Impacts

4.1.1.1 Predicted Impact of Operation

There are a limited number of residences that will be impacted negatively upon by the proposed Kilshane Cross Recycling Park. There are 15No. dwellings within a 1km radius of the proposed development. The majority of those residing within a one-kilometre radius of the subject site will not have their social or travel patterns disrupted and will encounter little or no change to their existing situation. The communities within Mulhuddart and Corduff to the west of the subject lands and Finglas to the south, are served by the social, employment, educational, and retail landuses contained within their respective areas, including those to be found in Blanchardstown and the Dublin City core. Likewise, though in a more limited manner, those residing in St. Margaret's to the east of the proposed site are served by a school, post office, church and shops within that hamlet.

The traffic movements generated by the business parks and industrial estates to the west of the N2 are not generally undertaken on that section of the national route between Kilshane Cross and the nearby M50 interchange. As such, the economic travel patterns in the vicinity of the proposed site are likely to remain unaffected.

The proposed site of the Recycling Park is not contained within or is not located adjacent to any area of high natural beauty, high quality landscape character, views or prospects, listed buildings, scenic routes, amenity use designated areas, proposed Natural Heritage Area, European sites, Special Areas of Conservation, or Special Protection Areas.

The proposed development will provide employment for at least 80 people directly over its lifespan. Further indirect employment will be created for service personnel.

The enterprise will provide for the recycling of some 211,511 tonnes per annum of recyclable waste.

In the Fingal Development Plan 2005-2011, the proposed Recycling Park is located within Zoning Objective 'RU' relating to Rural and Agriculture. This zone seeks to preserve rural amenity by ensuring that new developments fit sensitively into the landscape and that natural features are protected. Public Service Utilities will be permitted in principle within this zone.

The "do nothing scenario" would be for the land to remain as agriculture land. The land is currently fallow and is not being utilised for agriculture

4.1.2 Mitigation Measures

- The day-to-day operation of the Recycling Park, including the workings associated with all machinery and visitors to the site, will be undertaken in compliance with all health and safety laws and regulations. Galvanised steel palisade security fencing, to the height of 2.4m will be placed along the full non-public road boundaries of the site. The barrier will have warning signs placed along it at intervals acceptable to the EPA and Fingal County Council. Each facility in the Recycling Park will also be surrounded with its own security fencing.

- Along the public road frontage (N2) on the site there will be a 2.4m high galvanised steel railing entrance gate and fencing. The existing embankment will be retained along the N2 and it will be topped with 1.4m high post and wire security fencing. The embankment will be landscaped on the inside with indigenous species. Another 3-4m high embankment will be constructed in the southeast corner of the site adjacent to the existing residences. The embankment will also be landscaped with indigenous species. The embankment will further mitigate any impacts on the residences.

- There will only be one vehicular/pedestrian entrance to the subject lands, which shall be properly and secured against unauthorised access and trespass.

- All machinery, which will be secured for those non-working periods, will be located within buildings to be erected a considerable distance from the public and out of sight to passers-by.

- The limited number of dwellings in the general area of the site and the fact that the N2 is not a walking route will undoubtedly reduce opportunistic trespass.

4.2 Flora & Fauna

The proposed site for the Recycling Park is currently unmanaged and comprises of one large field with 3No. hedgerows along the southeastern, the southern and the western boundaries. A small stream also bounds the site to the west.

4.2.1 Potential Effects/ Impacts

4.2.1.1 Designated Areas of Nature Conservation

There are no designated areas in the direct vicinity of the proposed site. There are, however, 2No. sites within 5km of the site:

- Santry Demesne
- Royal Canal

Neither of these sites will be impacted either directly or indirectly by the proposed development.

4.2.1.2 Habitats on the Proposed Site

The principal habitat occurring on the site is Dry Meadows and Grassy Verges (GS2). This habitat type is considered to be of moderate local ecological value. The majority of this habitat will be removed as part of the proposed development, resulting in a moderate permanent impact on local ecology.

Several hedgerows occur along the boundaries of the proposed site. These are considered to be of moderate to high local ecological value. The hedgerow along the southeastern boundary of the site will be removed, thereby resulting in direct habitat loss and loss of connectivity, and giving rise to a small negative impact on local ecology. The western and southern hedgerows will be retained and will not be impacted upon by the proposed development.

The proposed development has the potential to adversely affect the adjacent watercourse through discharges to surface water and surface water runoff. As this stream drains into the River Ward, an important salmonid river, any negative impacts on this watercourse would be considered of high significance.

4.2.1.3 Impacts on Fauna

Fauna recorded on the proposed site are regarded as common and widespread. The proposed development will not have any significant impact on existing fauna.

All waste will be covered during transportation and handled indoors, and subsequently will not have the potential to attract either rodents or birds. An attenuation pond is proposed as part of the development. However, this pond will be small in size and will not act as an attractant to birds.

4.2.2 Mitigation Measures

Hedgerows will be retained where possible. The following measures are recommended to reduce the impact of hedgerow removal:

- Clearing of hedgerows will be undertaken outside of the bird nesting period from March 1st to August 31st.
- Hedgerows and associated habitats to be retained will be adequately fenced to protect their root structure.
- The trees and hedgerows planted, before, during and after the proposed developments life span, will consist of species representative of those in the surrounding environs.

It is recommended that lands (Area 3.7ha) directly to the north of the proposed site under the ownership of Fingal County Council be suitably fenced and appropriately managed as a semi-improved grassland, in order to replace loss of this habitat type caused by the proposed development. Two principle management regimes are recommended in order to promote species diversity and prevent scrub colonisation:

- Mowing: Maintain as a high sward with mowing once annually in late summer following flowering of plants. The ideal period would be between the end of August and October in order to protect breeding birds nesting in the high sward. Cuttings will be removed from the habitat in order to reduce fertility, thereby encouraging grassland diversity.

- Grazing: The area should be grazed extensively. Crofts and Jefferson (1999) describe stocking levels in *The Lowland Grassland Management Handbook*[6] for semi-improved

[6] A. Crofts and R.G. Jefferson (Eds.). 1999. *The Lowland Grassland Management Handbook*. English Nature/The Wildlife Trusts. 2nd Edition.

pastures. Table 5.7 from their book in included in Appendix 4 and is given as a guide for stocking levels.

The stream on site will not be affected and all water generated on site is to be treated as described in Section 4.4. Strict controls will be implemented to avoid pollution or sedimentation of the stream during the construction phase.

4.3 Geology

4.3.1 Potential Impacts

The proposed development will involve the removal of subsoils at the site to facilitate construction and to create level platforms for construction. This is a direct permanent impact but is not considered to be a significant negative impact.

The operation will have no potential impacts on the soil and geology aspect of the environment. The development will result in a permanent covering of part of the site with roadways, paths and other impervious surfaces. Land to the north of the site boundary will remain as agricultural land. All surface water drainage will be diverted off-site to services.

4.3.2 Mitigation Measures

The removal of subsoil is an inevitable consequence of implementing the proposed development and no mitigation measures could be proposed.

Any material removed off site will be done so in accordance with the Waste Management Act and Regulations. Topsoil and other soils that can be used for amenity purposes will be stockpiled on the site for use in the final landscaping of the development.

All vehicles will either be serviced and fuelled offsite or in appropriate designated areas onsite with appropriate measures such as spill kits etc. available.

There is no requirement for monitoring of the soils post construction.

4.4 Water

4.4.1 Potential Effects/ Impacts

Increased Run-Off and Reduced Recharge

If the proposed development is implemented, it is estimated that runoff would be generated from c.70% of the site that will be covered with impermeable surfaces. A drainage system will be installed to accommodate this runoff, which is described in Section 3.2.13. The generation of additional runoff is a direct, long-term effect but is not considered to be a significant negative impact.

If the proposed development is implemented, there would be reduced recharge to the ground in the area of the impermeable surfaces. However, this reduction of potential recharge to underlying groundwater resources is not considered to be a significant negative impact given the location of this area within a wider rural setting where most rainfall will percolate to the underlying watertable, and because the area of the subject site is extremely small when compared with the catchment of the River Ward as a whole.

Surface Water Protection

As part of the water management system, it is proposed to discharge treated water runoff to St. Margaret's Stream. This could have a potential negative impact on the water quality in the stream. However, the correct design and use of attenuation ponds, petrol interceptors and grit traps will prevent the occurrence of surface water contamination.

Groundwater Resource Protection

The proposed development would have a potential to cause groundwater contamination from leakages from the wastewater collection and disposal systems and from vehicular fuel spillages and leakages on roads and car parking areas. However, correct design and maintenance of wastewater and surface water runoff collection and disposal systems would prevent the occurrence of contamination leakage.

Furthermore, the subject site is underlain by bedrock that is considered to have poor potential for groundwater resources, and there are no private groundwater abstractions between the subject site and the St. Margaret's Stream, which is considered to be the discharge zone for groundwater moving beneath the site.

4.4.2 Mitigation Measures

Increased Runoff and Reduced Recharge

Increase in runoff is an inevitable consequence of the proposed development. This additional runoff will be accommodated within a proposed drainage system that will discharge to St Margaret's Stream.

The reduction of recharge to underlying groundwater resources is insignificant in the context of the overall catchment area, and is an inevitable consequence of the proposed development. No reasonable measures could be implemented to mitigate the reduction.

Surface Water Protection

Surface water and runoff will be diverted through a drainage system to an attenuation pond on site where settlement will occur before discharge to St. Margaret's Stream. Runoff will also be diverted through grit traps and petrol interceptors prior to discharge. A discharge licence will be required for this activity and the runoff will meet the quality standards defined in the licence. A sampling point will be provided to sample the runoff leaving the site. Surface water samples will be taken at regular intervals to determine if the development is adversely impacting the surface water environment in St. Margaret's Stream. The frequency of sampling will be agreed with the planning authority.

The proposed drainage system, described in Section 3.2.13, will ensure that the release of particulate matter (mainly grit and dust) to St. Margaret's Stream will be minimal and consequently there will be no significant adverse impact on the surface water quality.

All site works during the construction phase will be conducted in an environmentally responsible manner so as to minimise any adverse impacts on the water environment that may occur as a result of works associated with the construction phase. Any water ingress that may be encountered during the construction phase will be intercepted by a french drain and diverted to drainage. During the construction phase all water to be discharged off-site will be undergo treatment prior to discharge to ensure that it does not adversely impact on the surface water environment.

During the operation phase all personnel will adhere to procedures outlined in on-site good practice and management system. This will reduce the effect of uncontrolled release of contaminants entering surface waters, e.g. bunded fuel stores and sludge handling protocols. The surface water drainage system will have measures to reduce the peak flows potentially entering St. Margaret's stream and control contaminants release, e.g. from spilled sludge or oils, probably in the form of a retention basin and oil interceptors.

Groundwater Resource Protection

The correct design and maintenance of wastewater collection and disposal systems and petrol interceptors in car parking areas will be used to prevent groundwater contamination. The proposed foul drainage system is described in more detail in Section 3.2.12.

The treated liquor production will be licensed for discharge to the sewerage system with appropriate on-site and off-site (at Ringsend WWTW) treatment to ensure no water quality effects occur. A licence will be enforced for the discharge to the sewerage system to ensure the initial on-site treatment produces an effluent acceptable for the main system to cope with. This is the main mitigation measure for the operational phase.

Construction Phase

All site works will be conducted in an environmentally responsible manner so as to minimise any adverse impacts on the soils and water that may occur as a result of works associated with the construction phase.

Any water ingress that may be encountered during the construction phase will be intercepted by a French drain and diverted to drainage.

Storage of Raw Materials

With regard to on-site storage facilities and activities, any raw materials, fuels and chemicals, will be stored within structurally sound warehousing units and/or bunded areas if appropriate. On-site transfer areas will have adequate protective measures to guard against potential accidental spills or leakages. All equipment and machinery will have regular checking for leakages and quality of performance.

Water Supply

Water supply for the proposed development will be sourced from the public main supply located along the road to the northeast of the subject site. The connection will be at the site entrance and will be subject to prior approval from Fingal County Council Drainage Division.

4.5 Climate

4.5.1 Potential Effects/ Impacts

The proposed development will not impact of the regional climate.

4.5.2 Mitigation Measures

As there is no impact envisaged no mitigation measures are necessary.

4.6 Air

4.6.1 Potential Effects/ Impacts

4.6.1.1 Dust

The main potential impact from dust at the proposed facility will be from the outdoor C&D Waste Recovery Facility (C&DWRF). The closest receptors are the residences adjacent to the eastern boundary of the site, along the existing N2; approximately 220m to the southeast. The prevailing wind direction in the vicinity of the site is from the southwest (Refer to Section 2.5.2.3), which means that the C&DWRF is effectively upwind from the residences and the potential for dust impact to these residences is negligible. The nearest properties downwind to the C&DWRF are approximately 300m to the northeast. Potential for dust impact from the facility will be reduced by the elevated section of the new N2 motorway, which is located between the houses and the site of the C&DWRF.

It is considered that the rest of the facility operations will not be a source of significant dust. While handling of residual waste in the Waste Transfer Facility (WTF) has the potential for dust generation, all waste transfer activities will take place inside the WTF building, thus reducing the potential for the off-site deposition of dust. The facility roads will be paved and regularly swept, which will minimise the potential for dust generation.

In the Biological Waste Treatment Facility (BTF) and the Sludge Hub Centre (SHC) buildings there will be no open storage of waste or compost. All tipping and mechanical pre-treatment of waste will be carried out on designated tipping areas within the enclosed building under a slight negative pressure, so any dust generated will be contained within the building. The fresh biowaste will be largely wet in nature; not giving rise to dust emissions when treated. The dry solids content of the compost will be kept below 65-70% by process control measures, since higher dry solids contents may give rise to excess dust formation. Compost transport will take place in covered trucks only.

4.6.1.2 Odour

As part of the air quality impact assessment of the proposed Kilshane Cross Recycling Park, Odour Monitoring Ireland performed a desktop odour impact assessment utilising dispersion modelling software ISC ST3. Like the majority of industries, the operation of the proposed Kilshane Cross Recycling Park is faced with the issue of preventing odours causing impact to the public at large.

As the proposed Kilshane Cross Recycling Park is a Design/Build/Operate (DBO) project, quantifying odour emissions from the site is difficult. Therefore, utilising expected proposed design and library odour emission data, dispersion-modelling techniques were used to establish maximum allowable odour emission rates from the proposed site in order to limit any odour impact on the surround population.

The BTF will consist of two technology options, to include either indoor composting or anaerobic digestion. Both scenarios will have significantly different odour emissions. No odours are expected from the C&DRF processing facility.

Two odour emission scenarios were developed to take account of the proposed design with odour abatement. These odour emission rates and specified source characteristics were input into ISC ST3 in order to determine any significant odour impacts.

These scenarios include:

Scenario 1: Biological composting system incorporating indoor composting, and operation of a Waste Transfer Station and Sludge Hub Centre. Three sub scenarios were run for this proposed operation to take account of the varying design odour emission rates from the biofiltration system treating the odours from the biological waste treatment composting facility.

Scenario 2: Biological treatment system incorporating indoor Anaerobic Digestion technology, a gas utilisation plant, a biofilter treating the odours from the preparation hall, and operation of a Waste Transfer Station and Sludge Hub Centre. Three sub scenarios were run for this proposed operation to take account of the varying design odour emission rates from the biofiltration system treating the odours from the biological waste treatment preparation hall.

What is an Odour Unit?

The odour concentration of a gaseous sample of odourant is determined by presenting a panel of selected screened human panellists with a sample of odourous air and varying the concentration by diluting with odourless gas, in order to determine the dilution factor at the 50% detection threshold. The Z_{50} value (threshold concentration) is expressed in odour units (Ou_E m^{-3}).

SIMPLY, ONE ODOUR UNIT IS THE CONCENTRATION OF AN ODOURANT, WHICH INDUCES AN ODOUR SENSATION TO 50% OF A SCREEN PANEL

Although odour concentration is a dimensionless number, by analogy, it is expressed as a concentration in odour units per cubic metre (Ou_E m^{-3}), a term which simplifies the calculation of odour emission rate. The European odour unit is that amount of odourant(s) that, when evaporated into one cubic metre of neutral gas (nitrogen), at standard conditions elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one European Reference Odour Mass (EROM) evaporated in one cubic meter of neutral gas at standard conditions. One EROM is that mass of a substance (n-butanol) that will elicit the Z_{50} physiological response assessed by an odour panel in accordance with this standard. *n*-Butanol is one such reference standard and is equivalent to 123ug of n-butanol evaporated in one cubic meter of neutral gas at standard conditions (CEN, 2003).

Characterisation of odour.

The sense of smell plays an important role in human comfort. The sensation of smell is individual and unique to each human and varies with the physical condition of the person, the odour emission conditions and the individual's odourous education or memory. The smell reaction is the result of a stimulus created by the olfactory bulb located in the upper nasal passage. When the nasal passage comes in contact with the odourous molecules, signals are sent via the nerve fibres where the odour impressions are created and compared with stored memories referring to individual perceptions and social values. Since the smell is individual some people will be hypersensitive and some will be less sensitive (ansomia). Therefore, the sense of smell is the most useful detection technique available as it specialises in synthesising complex gas mixtures rather than analysing the chemical compound (Sheridan, 2000).

Odour Qualities

An odour sensation consists of a number of inter-linked factors. These include:

- Odour threshold/concentration;
- Odour intensity;
- Hedonic tone;
- Quality/Characteristics; and
- Component characteristics.

The odour threshold concentration dictates the concentration of the odour in Ou_E m^{-3}. The odour intensity dictates the strength of the odour. The Hedonic quality allows for the determination of pleasantness/unpleasantness. Odour quality/characteristics allow for the comparison of the odour to a known smell (i.e. turnip, like dead fish, flowers). Individual chemical component identity determines the individual chemical components that constitute the odour (i.e. ammonia, hydrogen sulphide, methyl mercaptan, carbon disulphide, etc.). Once odour qualities are determined, the overall odour impact can be assessed. This odour impact assessment can then be used to determine if an odour minimisation strategy is to be implemented and if so, which technology.

Perception of Emitted Odours

Complaints are the primary indicators that odours are a problem in the vicinity of any facility. Perceptions of odours vary from person to person, with several conditions governing a person's perception of odour:

- **Control:** A person is better able to cope with an odour if they feel it can be controlled.
- **Understanding:** A person can better tolerate an odour impact if they understand its source.
- **Context:** A person reacts to the context of an odour as they do to the odour itself.
- **Exposure:** When a person is constantly exposed to an odour they may lose their ability to detect that odour. For example, a plant operator who works in the facility may grow immune to the odour.

From these criteria, we can predict that odour complaints are more likely to occur when:

- A new facility locates in areas where people are unfamiliar with facilities;
- When a new process establishes within the facility; or
- When an urban population encroaches on an existing facility.

The ability to characterise odours being emitted from the facility will help to develop a better understanding of the impact of the odour on the surrounding vicinity. It will also help to implement and develop better techniques to minimise/abate odours using existing technologies and engineering design.

Characteristics of Odours

Odours from composting, anaerobic digestion, waste transfer stations and sludge drying hubs arise mainly from the following sources:

- The uncontrolled anaerobic biodegradation of proteins and carbohydrates to produce unstable intermediates in the waste inlet stream;
- Directly from the accepted organic materials and bad handling/management practices;
- Odour release from the pressure release manifolds on the Anaerobic Digestion vessels;
- Odour release from the gas compression engine/flare due to intermittent start/stop operation. By incorporating a slam shut valve or equivalent will prevent/reduce such occurrence;
- Positive wind pressure on buildings, open doors and temperature increases will increase positive

pressure within the Waste Transfer and Biological Treatment Facility and cause the fugitive release of odour from the facility. By incorporating efficient air extraction system providing negative ventilation and treatment of extracted air within a biofilter will reduce/eliminate odour impact.

Odours are generated by a number of different components, the most significant being the sulphur containing compounds (thiols, mercaptans, hydrogen sulphide), volatile fatty acids (butyric acid, valeric acid), amines (methylamine, Dimethylamine), phenols (4-methylphenol), etc. (Dawson et al. 1997). Most of these compounds have very low odour threshold concentrations as illustrated in Table 4.6.1. Different concentrations and mixtures of these compounds can intensify or reduce odour threshold concentration, determined as synergism and antagonism respectively.

Table 4.6.1 Odour Detection Thresholds of Composting Odour Precursors

Chemical component	Threshold Concentration (mg m^{-3})
Ammonia	0.03-37.8
Methylamine	0.0012-6.1
Trimethylamine	0.00026-2.1
Hydrogen Sulphide	0.002-0.02
Methyl mercaptan	0.0000003-0.038
Ethyl mercaptan	0.000043-0.00033
Butyric acid	0.0004-42
Valeric acid	0.0008-0.12

O'Neill & Phillips et al. (1992)

Odourous Compound Formation at the Proposed Kilshane Cross Recycling Park

<u>Biological Treatment Facility-Scenario1 Composting</u>

The rate of release of odourous compounds into the atmosphere at composting operations is influenced by:

1. Long residence time of accepted input product in containers and on-site;
2. Temperature of accepted raw materials (increased temperature causes increased anaerobic conditions and volatilisation of odourous compounds);
3. The concentration of odourous compounds in the solid phase exposed to air and exposed surface area;
4. Processes that generate turbulence like mixing and screening processes;
5. Excess moisture;
6. Incorrect Carbon: Nitrogen ratio;
7. Maintenance of oxygen rich conditions within the composting operations;

8. Tipping, screening and shredding of raw materials;
9. Non-homogenous aeration and mixing;
10. Inappropriate storage of finished material;
11. This is a non-exhaustive list.

Raw materials for composting can be odourous due to the development of anaerobic zones within the input material. When this raw material is disturbed through tipping, mixing and shredding/mixing operations, pockets of odourous air are released. Inappropriate storage of raw material such as in wet environments can lead to the rapid development of anaerobic material resulting in odourous release. It is important that basic odour management plans are implemented for site operation to prevent such situations from occurring (i.e. get raw material into the process as soon as possible, maintain raw material under enclosed dry area; avoid acceptance of severely septic raw material). These scenarios should be covered within the acceptance procedure documentation developed for the site.

Biological Treatment Facility-Scenario 2 Anaerobic Digestion

The rate of release of odourous compounds into the atmosphere at Anaerobic Digestion operations is influenced by:

1. Long residence time of accepted input product in containers and on-site;
2. Temperature of accepted raw materials (increased temperature causes increased anaerobic conditions and volatilisation of odourous compounds);
3. The concentration of odourous compounds in the solid phase exposed to air and exposed surface area;
4. Processes that generate turbulence like mixing and screening processes;
5. Positive sour gas release from the pressure release manifolds;
6. Gas leakage due to start/stop operation of gas compression engines and flare.

Waste Transfer Station

Odours from WTS operations may arise due to:

1. Waste tipping;
2. Waste movement through front-end loader operation. Sealed refuse sacks are broken easily and emit odourous compounds and trapped gases;
3. Waste movement through use of grab; the waste is removed and tipped into the trailer using a grab. This movement allows for the stripping and volatilisation of odourous compounds from the waste matrix. Waste refuse sacks are squeezed and odourous gases are released;
4. Waste storage within the building has the potential to contaminate any air in contact with the

waste. Also anaerobic conditions proliferate and the waste "cooks";

5. Other minor sources include waste trucks, waste storage trucks, grease traps, oil separator and exposed manholes around the yard. Generally, these sources are insignificant to overall emissions but localised complaints may be received from local walkers especially if a grease trap does not operate properly and are not cleaned regularly;
6. All dirty surfaces especially in warmer summer months radiate odour;
7. Dust deposits within the building radiate odour and increase background odours within the building;
8. This list is non-exhaustive.

Sludge Hub Centre

Odours from Sludge Hub Centre operations may arise due to:

1. Delivery of sludge to site in skips may lead to the fugitive emissions of odours during emptying,
2. Pumping of sludge from tankers can release odours from the storage tank and pressure release manifold on tanker. Negative ventilation will be provided on the sludge storage tank and all odourous air treated in and Odour Control Unit (OCU),
3. Depending on the drying technology, incomplete combustion of odours within the combustion chamber of the sludge drying plant can be emitted untreated,
4. Cyclic loading on the OCU may allow for the release of odours from the sludge drying OCU. This will be considered during the design of the OCU,
5. Leaks around fans can lead to the emissions of odours from the sludge drying equipment.
6. Particulate removal from the odour stream is essential for efficient operation of the sludge drying OCU,
7. Open sludge storage areas may cause odours. All sludge storage will be enclosed.
8. This list is non-exhaustive.

Dispersion Modelling

Atmospheric Dispersion Modelling of Odours

Any material discharged into the atmosphere is carried along by the wind and diluted by wind turbulence, which is always present in the atmosphere. This process has the effect of producing a plume of air that is roughly cone shaped with the apex towards the source and can be mathematically described by the Gaussian equation. Atmospheric dispersion modelling has been applied to the assessment and control of odours for many years, originally using Gaussian form ISCST 3 and more recently utilising advanced boundary-layer physics models such as ADMS and AERMOD (Keddie et al. 1992). Once the odour emission rate from the source is known, ($Ou_E\ s^{-1}$), the impact on the vicinity can be estimated. These models can effectively be used in three different ways: firstly, to assess the dispersion of odours and to correlate with complaints; secondly, in a "reverse" mode, to estimate the maximum odour emissions which can be permitted from a site in order to prevent odour complaints occurring; and thirdly, to determine which process is contributing greatest to the odour impact and estimate the amount of required abatement to reduce this impact within acceptable levels (McIntyre et al. 2000). In this latter mode, models have been employed for imposing emission limits on industrial processes, odour control systems and intensive agricultural processes (Sheridan et al., 2002).

Industrial Source Complex 3 (ISC3).

The model used is BREEZE Industrial Source Complex (ISC ST Ver. 4.011). This model is recommended in Environmental Protection Agency (EPA) guideline on Air Quality Modelling for applications to refinery-like sources and other industrial sources. It is a straight-line trajectory, Gaussian-based model. It was also recently recommended (*Complex 1 section*) by the Irish EPA to model the potential odour impact from intensive agriculture, mushroom composting and tannery facilities (EPA, 2001). It is used with meteorological input data from the nearest representative source. The most important parameters needed in the meteorological data are wind speed, wind direction, ceiling heights, cloud cover, and Pasquill-Gifford stability class for each hour. ISC ST 3 (Ver. 4.011) is run with a sequence of hourly meteorological conditions to predict concentrations at receptors for averaging times of one hour up to a year. It is necessary to use many years of hourly data to develop a better understanding of the statistics of calculated short-term hourly peaks or of longer time averages.

Establishment of Odour Impact Criterion for the Proposed Kilshane Cross Recycling Park

Odours from the recycling operations arise from the identified processes described earlier. Some of the compounds emitted are characterised by their high odour intensity. A sample of a report carried out in the Netherlands ranking 20 generic and 20 environmental odours according to the like or dislike by a group of people professionally involved in odour management is illustrated in Table 4.6.2 (EPA, 2001).

Table 4.6.2 Ranking of Environmental Odours According to Like and Dislike (i.e. Odour Character)

Environmental Odours	Mean Ranking
Intensive agricultural farm	12.8 (Limit value 6.0 $Ou_E\ m^{-3}$)
Waste water treatment plant	12.9 (Limit value 3.5 $Ou_E\ m^{-3}$)
Green fraction composting	14.0 (Limit value 3.0 $Ou_E\ m^{-3}$)
Landfill	14.10 (Limit value 3.18 $Ou_E\ m^{-3}$)

As can be observed, intensive agricultural farm odours and WWTP odours are similar in their dislike ability, and therefore it is rational to suggest that a similar odour impact criterion may be based on these facts. Green waste composting and landfill odour are similar in their dislike ability and considered more dislikeable than Intensive agriculture or wastewater treatment. Since composting and anaerobic digestion are considered options it is prudent to establish a strict odour impact criterion.

Odour Annoyance Criteria.

Commonly used odour annoyance criteria in Ireland, UK and Netherlands are illustrated in Table 4.6.3. In Ireland, in order to prevent complaints, odour concentrations should be below 3.0 $Ou_E\ m^{-3}$ (for 98th percentile) for new composting and landfill facilities and below 6.0 $Ou_E\ m^{-3}$ (for 98th percentile) for existing pig production facilities.

Table 4.6.3 Odour Annoyance Criteria for Dispersion Modelling

Concentration Limit $Ou_E\ m^{-3}$	Percentile value %	Application
Dutch (MPTER and Complex 1 Model)		
≤3.5	98	Waste water treatment plants existing site, rural area or industrial estate.
≤3.0	98	Compost facility existing site
English (ADMS model)		
≤5	98	Wastewater treatment plants Greenfield site.
Ireland (ISC ST Complex 1 section)		
≤3.0	98	Target limit for new pig production facility/Limit value for tanning and mushroom compost industry
≤6.0	98	Limit value for existing pig production facility
England (Complex 1 model)		
>3.18	98	Acceptable guideline for elimination of significant odour impact in vicinity of landfill

(McIntyre et al. 2000; EPA, (2001); Longhurst et al. 1998)

It is accepted that an odour threshold concentration of 1 $Ou_E\ m^{-3}$ is the level at which an odour is detectable by 50% of screened panellists. According to research on wastewater treatment plants, the odour recognition threshold is approximately 3-5 times this concentration and is liable to cause offence (3-5 $Ou_E\ m^{-3}$). Sheridan (2004) has suggested that a WWTP odour becomes perceptible (i.e. recognisable) approximately 2 to 3 times its detection threshold. An odour impact criterion of 5 $Ou_E\ m^{-3}$ is implemented in England for wastewater treatment plants (Newbiggin-by-the-Sea, Northumberland, 1993 Planning Board) and is accepted in planning applications for these facilities to limit odour impact (McIntyre et al., 2000).

During a considered planning application for Bogborough Landfill, Bedfordshire, significant research was performed by Silsoe Odour research facility and concluded that an odour impact criterion of 3.0 $Ou_E\ m^{-3}$ at the 98th percentile was consider applicable for the assessment of odour nuisance form the landfill. In Ireland, a considered odour impact criterion of 3.0 $Ou_E\ m^{-3}$ at the 98th percentile is currently used for the assessment of odour impact from tanning facilities, landfill facilities, WWTP's, pig production units, and composting facilities (EPA 2002).

As the cumulative odour generated within the Kilshane Cross Recycling Park are from a range of industries, it is prudent to use an odour impact criterion of 1.50 $Ou_E\ m^{-3}$ at the 98th percentile in a worst-case year. It is important to emphasise that all odour generated on site will be treated in Odour

Control Units (OCU) and therefore the residual odour being emitted will be less offensive than untreated odours. Based on this fact, a two stage conservative approach is accounted within the dispersion modelling estimated, thereby providing confidence in the assessment criterion to demonstrate no odour impact in the vicinity of the proposed site.

Considered Odour Scrubbing Systems

The following technologies may be considered as best available techniques for odour abatement within the proposed Kilshane Cross Recycling Park:

- Biofiltration system for the treatment of odours from the proposed composting system;
- Biofiltration system for the treatment of odours from the proposed preparation hall of the Anaerobic digestion plant,
- Flare and/or gas utilisation engine for the treatment of anaerobic digestion gas,
- Annular bed filtration system for the treatment of odours from the proposed Waste Transfer Station,
- Two stage chemical scrubbing, thermal oxidation or other odour removal systems that will achieve required boundary odour levels will be considered for odour scrubbing for the Sludge Hub Centre.

All the above odour abatement system have been shown to obtain >90% efficiency if proper engineering design parameters and operational parameters are implemented. The exhaust of any odour abatement systems will be located higher than the surrounding buildings in order to enhance dispersion and reduce building wake effects. Engineering and operational design are outside the scope of this document. Minimum volumetric airflow rate from the various processes are discussed later in the document. The engineering and operational design will be clarified during detailed design.

Precise Odour Abatement Strategies

In a covered storage tank, ventilation is required only to contain and collect odours and should be kept to a minimum by maintaining a slight negative pressure. Ventilation rates in this case are typically one air change per hour of the volume of the empty tank, and will be no less than the maximum filling rate. If the tank is normally operated full, the ventilation rate could be reduced to four air-changes per hour for the air space, or the maximum filling rate. Odour abatement equipment tends to work more efficiently at lower flow-rates. If any process air is added to the tank then this will be accounted for in the ventilation rate calculations. All negative air should be evenly removed across the surface of the tanks to prevent any zones of positive air pressure within the tank.

When an odour abatement system is provided, the outlet stack will be sited away from the boundary and any potential complainants, and at an elevated height in order to reduce building wake effects and increase dispersion. The exit velocity of the outlet of the odour abatement system will be optimised to increase dispersion effects.

Odour Modelling of proposed Kilshane Cross Recycling Park

Odour Emission Points

The location of possible odour emission points in relation to the existing residential dwellings is shown in Figure 4.6.1.

Odour Emission Rate Calculation

The measurement of the strength of a sample of odourous air is only part of the problem of quantifying odour. Just as pollution from a stack is best quantified by a mass emission rate, the rate of production of an odour is best quantified by the odour emission rate. For a chimney or ventilation stack, this is equal to the odour threshold concentration (Ou_E m^{-3}) of the discharge air multiplied by its flow-rate (m^3 s^{-1}). It is equal to the volume of air contaminated every second to the threshold odour limit (Ou_E s^{-1}). The odour emission rate can be used in conjunction with dispersion modelling in order to estimate the approximate radius of impact or complaint (Hobson et al, 1995).

All odour sources are stack sources with an efflux velocity of at least 15 m s^{-1}

Meteorological Data

Three years worth of hourly sequential meteorology data was used for the operation of ISC ST 3. This allowed for the determination of the worst-case meteorological year for the determination of overall odour impact from the proposed Kilshane Cross Recycling Park design on the surrounding population.

Terrain Data

Upon examination of the terrain it was noted that the topography (in terms of residents) around the proposed site is relatively flat. All significant deviations in terrain are examined in modelling computations through terrain incorporation using AerMap software. All building wake effects are accounted for in the modelling scenarios (i.e. building effects on point sources) as this can have a significant effect on the odour plume dispersion at short distances.

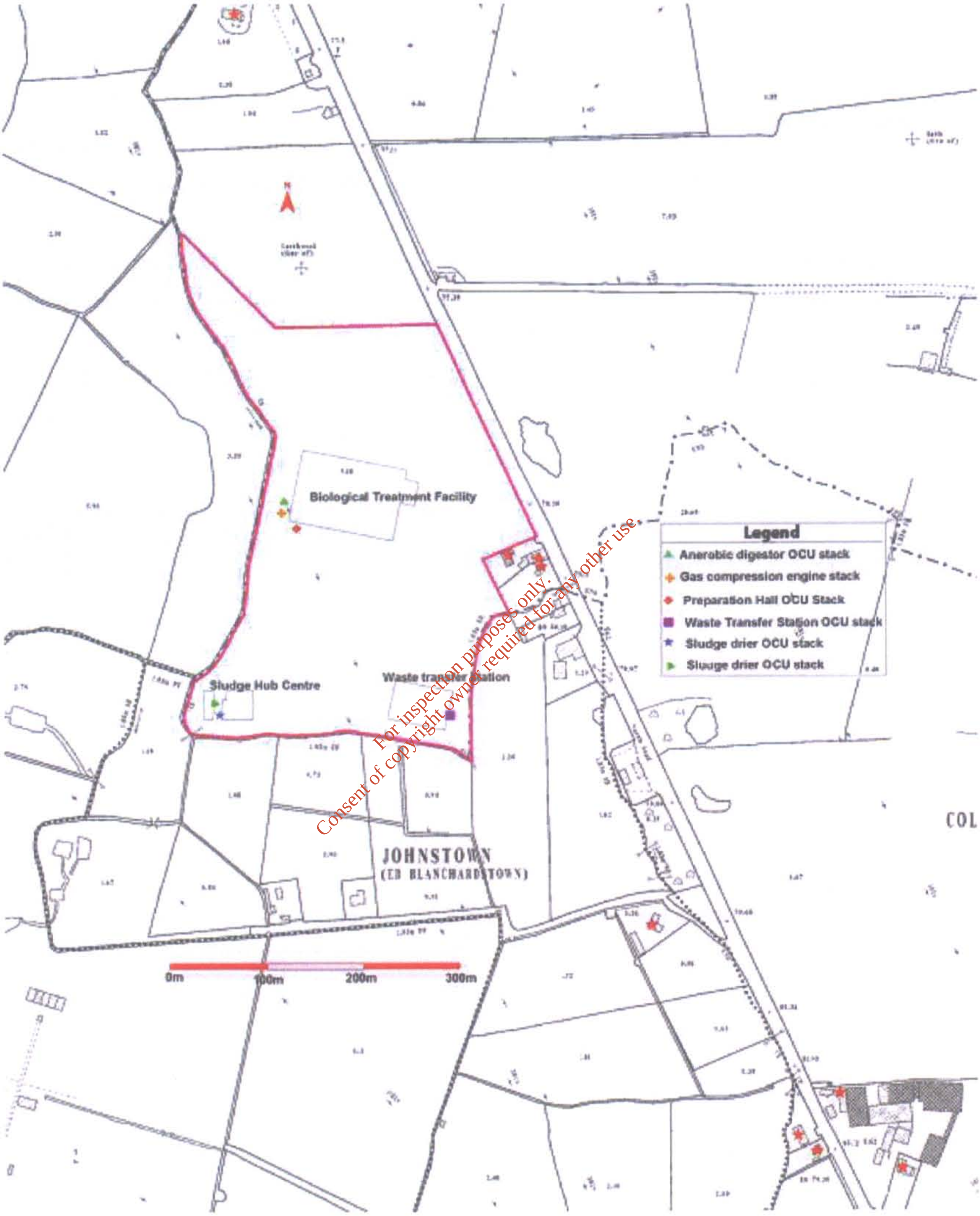

Figure 4.6.1 Schematic diagram of proposed Kilshane Cross Recycling Centre, with possible odour emission points, site boundary (▬) and resident in the vicinity of the site (★).

Results of Odour Modelling

Odour Emission Data

Two data sets for odour emission rates were calculated to determine the potential odour impact of the proposed Kilshane Cross Recycling Park operation and design. These scenarios included:

1. Predicted overall odour emission rate from proposed Kilshane Cross Recycling Park design utilising Composting Biological treatment, Waste Transfer Station, and Sludge Hub Centre (Scenario 1) (see Table 4.6.4).
2. Predicted overall odour emission rate from proposed Kilshane Cross Recycling Park design utilising Anaerobic Digestion Biological Treatment Facility, Waste Transfer Station, and Sludge Hub Centre (Scenario 2) (see Table 4.6.5).

A worst-case odour-modelling scenario was chosen to estimate worst-case odour impact from the proposed Kilshane Cross Recycling Park.

Odour Emission Rates from Individual Processes During Operation

Tables 4.6.4 and 4.6.5 illustrate the specific odour emission rates used to determine an overall odour emission rate from the proposed operations for Scenario 1 and 2. Each odour source emission factor is presented as an emission rate ($Ou_E\ s^{-1}$) including source characteristics. Each odour source descriptor and offensiveness level based on previous experience is also presented.

Since the most hedonically offensive odours within the proposed Kilshane Cross Recycling Park are abated (Composting/Anaerobic Digestion, Waste Transfer Station, Sludge Hub), no significant odour impact will be perceived by the residual odours emitted. These residual odours are significantly less offensive and more dilutable (i.e. in terms of odour intensity) that the inlet process odours.

Table 4.6.4 Predicted Overall Odour Emission Rate from Proposed Design Incorporating Odour Abatement (Scenario 1)

Source identity	Stack height (m)	Efflux velocity ($m\ s^{-1}$)	Volumetric airflow rate ($m^3\ s^{-1}$)	Odour threshold concentration ($Ou_E\ m^{-3}$)[5]	Odour emission rate ($Ou_E\ s^{-1}$)[5]	Expected odour offensiveness level[3, 4]
Composting operations-Biological treatment facility[1]	15	15	40.10	1000	40,100	3.0 to 6.0 $Ou_E\ m^{-3}$
Waste Transfer Station	15	16.3	32.80	300	9840	6.0 to 8.0 $Ou_E\ m^{-3}$
Sludge drier stack[2]	25	15	5.93	851	5045	1.50 $Ou_E\ m^{-3}$
Sludge drier OCU[2]	15	15	2.94	680	2000	1.50 $Ou_E\ m^{-3}$
Total			-	-	**56,985**	

Note: [1] denotes that a maximum allowable limit is used to model the odour emission rate from the biofilter. This odour emission rate is based on the expected volumetric flow rate ($m^3\ s^{-1}$) multiplied by an established maximum odour concentration from the biofilter ($Ou_E\ m^{-3}$). This prevents any errors due to estimation of odour emission rate from the composting operations. It is assumed that all odourous air generated from the composting operations is passed through the proposed biofiltration system. The volumetric airflow rate is based on a minimum of 3 AC/H in order to maintain negative ventilation within the overall composting building. A strategy of recirculation of air within processes should be performed to reduce any positive pressures within the building (i.e. aeration air for in vessel composting system should come from second stage composting hall). The air exchange rate within various processes within the composting building will change and depend on design volume.

[2] denotes odour emission rate supplied by Entec Ltd, UK based on experience on similar Sludge Drying Hubs;

[3] denotes in-house odour intensity and hedonic tone evaluation of odours performed in Ireland and USA. This is a worst-case scenario.

[4] denotes it is important that the odour abatement system changes the odour character of the influent flow (i.e. from rotten eggs/rotten vegetables to musty clean odour.) This can be assessed in accordance with VDI Hedonic assessment document, VDI Guidelines 3882 Part II-assessment of hedonic tone of odours

[5] denotes maximum allowable odour threshold concentration and maximum allowable odour emission rate allowable from the odour control units.

Table 4.6.5 Predicted Overall Odour Emission Rate from Proposed Design Incorporating Odour Abatement (Scenario 2)

Source identity	Stack height (m)	Efflux velocity ($m\ s^{-1}$)	Volumetric airflow rate ($m^3\ s^{-1}$)	Odour threshold concentration ($Ou_E\ m^{-3}$)[5]	Odour emission rate ($Ou_E\ s^{-1}$)[5]	Expected odour offensiveness level[3, 4]
Anaerobic Digestor-Biological treatment facility preparation hall[1]	15	15	9.80	1000	9800	3.0 to 6.0 $Ou_E\ m^{-3}$
Anaerobic digestor OCU for pressure release manifolds and overflow chamber	15	15	0.26	21369	5556	1.50 $Ou_E\ m^{-3}$
Gas compression engine	10	15	1.0	2880	2880	1.50 $Ou_E\ m^{-3}$
Waste Transfer Station	15	16.3	32.80	300	9840	6.0 to 8.0 $Ou_E\ m^{-3}$
Sludge drier stack[2]	25	15	5.93	851	5045	1.50 $Ou_E\ m^{-3}$
Sludge drier OCU	15	15	2.94	680	2000	1.50 $Ou_E\ m^{-3}$
Total			-	-	**35,121**	

Note: [1] denotes that a maximum allowable limit is used to model the odour emission rate from the biofilter. This odour emission rate is based on the expected volumetric flow rate ($m^3\ s^{-1}$) multiplied by an established maximum odour concentration from the biofilter ($Ou_E\ m^{-3}$). This prevents any errors due to estimation of odour emission rate from the composting operations. It is assumed that all odourous air generated from the preparation hall is passed through the proposed biofiltration system. The volumetric airflow rate is based on a minimum of 3 AC/H in order to maintain negative ventilation within the overall composting building. A strategy of recirculation of air within processes should be performed to reduce any positive pressures within the building (i.e. aeration air for in vessel composting system should come from second stage composting hall). The air exchange rate within various processes within the composting building will change and depend on design volume.

[2] denotes odour emission rate supplied by Entec Ltd, UK based on experience on similar Sludge Drying Hubs;

[3] denotes in-house odour intensity and hedonic tone evaluation of odours performed in Ireland and USA. This is a worst-case scenario

[4] denotes it is important that the odour abatement system changes the odour character of the influent flow (i.e. from rotten eggs/rotten vegetables to musty clean odour.) This can be assessed in accordance with VDI Hedonic assessment document, VDI Guidelines 3882 Part II-assessment of hedonic tone of odours.

[5] denotes maximum allowable odour threshold concentration and maximum allowable odour emission rate allowable from the odour control units.

Results of Odour Dispersion Modelling for the Proposed Operation and Design

ISC ST3 was used to determine the overall odour impact of the proposed Kilshane Cross Recycling Park operation to be located in Kilshane Cross, Co. Dublin as set out in odour annoyance criteria Tables 4.6.4 and 4.6.5. The output data was analysed to calculate:

- Predicted odour emission contribution of overall Kilshane Cross Recycling Park operation with abatement (Scenario 1) (Table 4.6.4), to odour plume dispersal at the 98th percentile for an odour concentration of 1.20 $Ou_E\ m^{-3}$ (see Figure 4.6.2).
- Predicted odour emission contribution of overall Kilshane Cross Recycling Park operation with abatement (Scenario 2) (Table 4.6.5), to odour plume dispersal at the 98th percentile for an odour concentration of 1.50 $Ou_E\ m^{-3}$ (see Figure 4.6.3).
- Predicted odour emission contribution of individual processes for Scenario 1 within the Kilshane Cross Recycling Park (see Figure 4.6.4).
- Predicted odour emission contribution of individual processes for Scenario 2 within the Kilshane Cross Recycling Park (see Figure 4.6.5).

These computations give the odour concentration at each 50-meter X Y Cartesian grid receptor location that is predicted to be exceeded for 2% (175 hours) of the year.

This will allow for the predictive analysis of any potential impact on the neighbouring sensitive locations while the Kilshane Cross Recycling Park is in operation. It will also allow the operators of the Kilshane Cross Recycling Park to assess the effectiveness of their considered odour abatement/minimisation strategies. The intensity of the odour from the two or more sources of the Kilshane Cross Recycling Park operation will depend on the strength of the initial odour threshold concentration from the sources and the distance downwind at which the prediction and/or measurement is being made. Where the odour emission plumes from a number of sources combine downwind, then the predicted odour concentrations may be significantly higher than that resulting from an individual emission source.

It is important to note that various odour sources have different odour characters/qualities. This is important when assessing those odour sources to minimise and/or abate. Although an odour source may have a high odour emission rate, the corresponding odour intensity (strength) may be low and therefore it is easily diluted. Those sources that express the same odour character as an odour impact should be investigated first for abatement/minimisation before other sources are examined, as these sources are the driving force behind the character of the perceived odour.

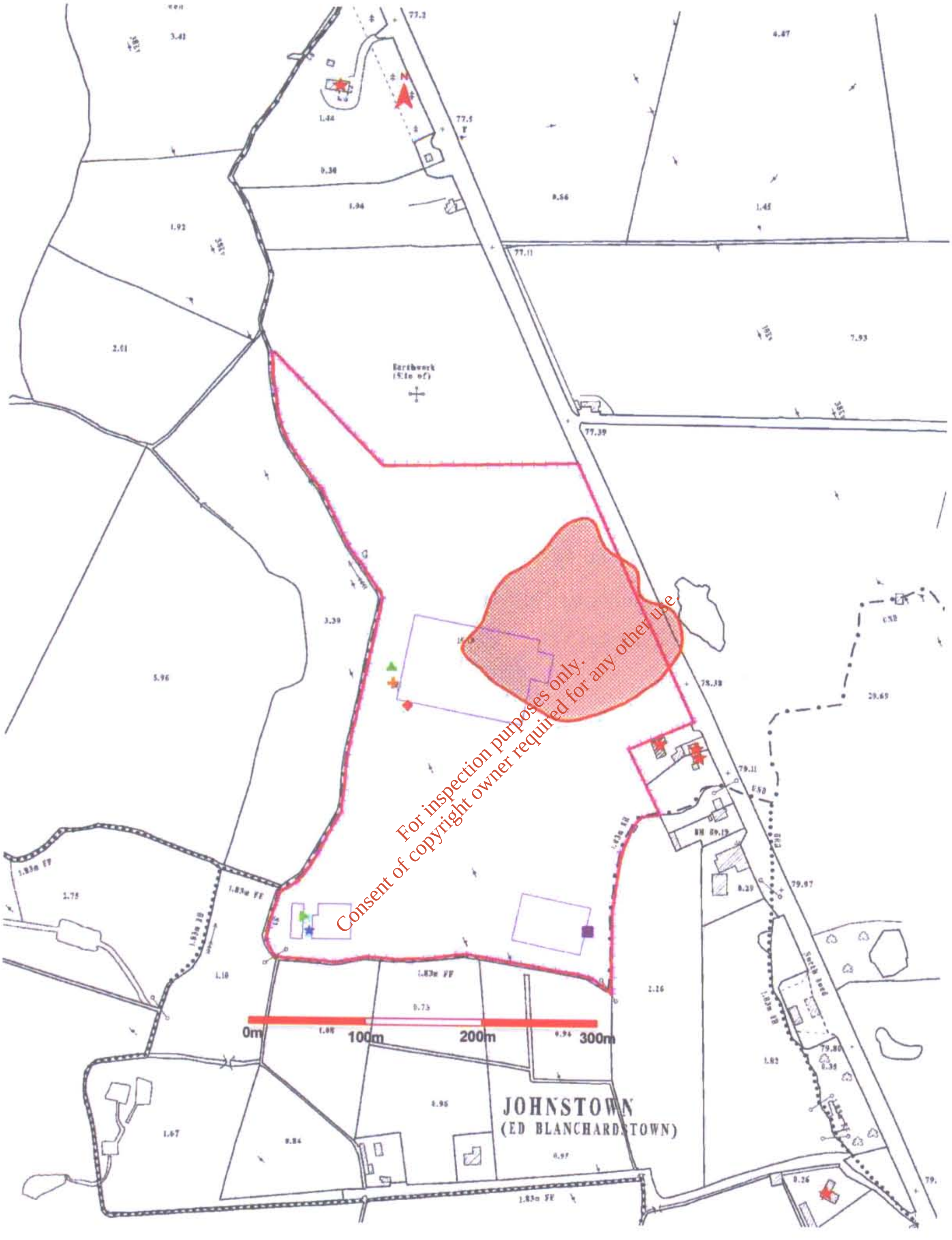

Figure 4.6.2 **Predicted Odour Emission Contribution of Proposed Operation with the Implementation of Odour Abatement to Odour Plume Dispersal for Scenario 1 at the 98th percentile for odour concentrations ≤ 1.20 Ou_E m^{-3} (▬)**

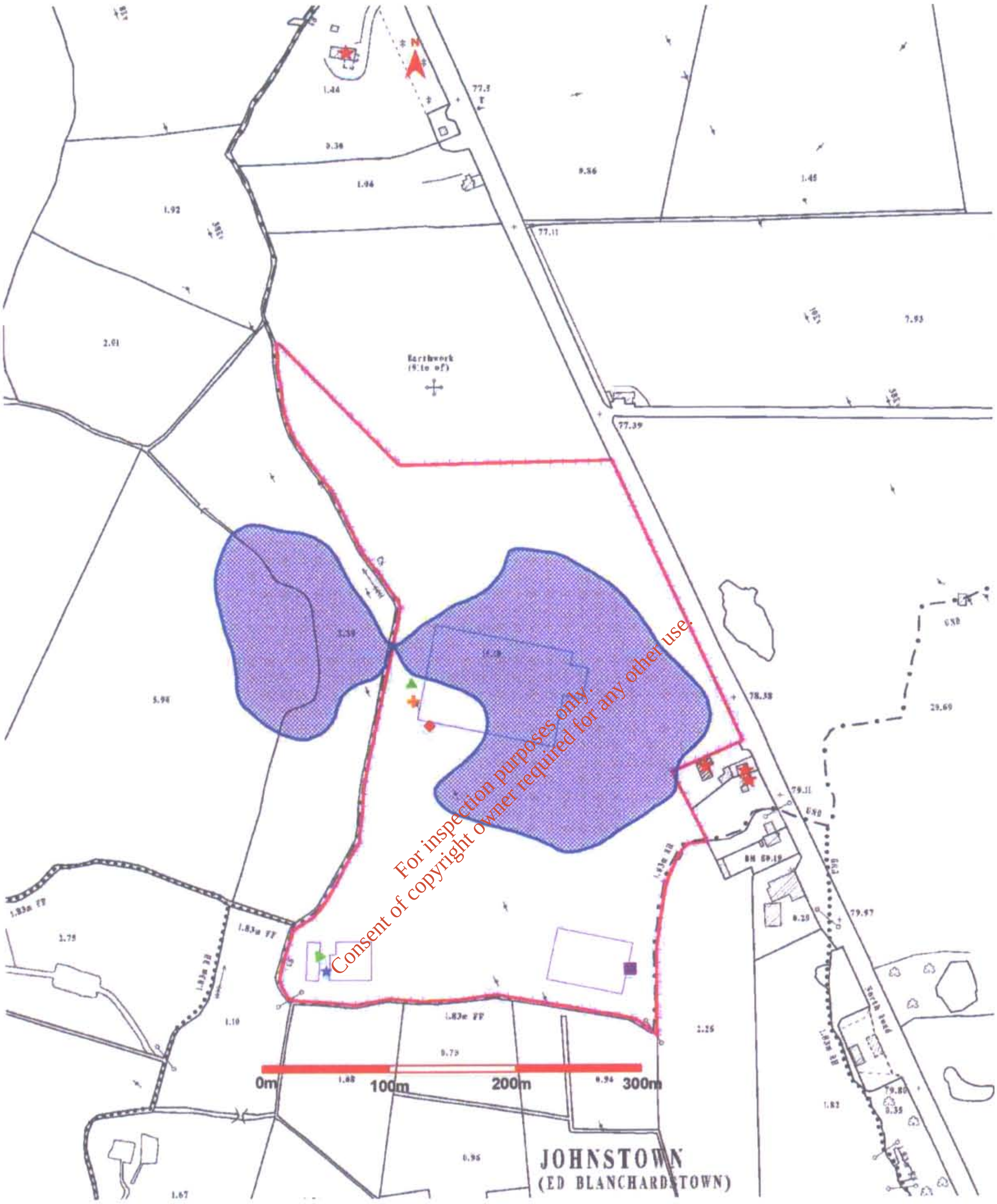

Figure 4.6.3 Predicted Odour Emission Contribution of Proposed Operations with the Implementation of Odour Abatement to Odour Plume Dispersal for Scenario 2 at the 98th percentile for odour concentrations ≤ 1.50 Ou_E m^{-3} (——)

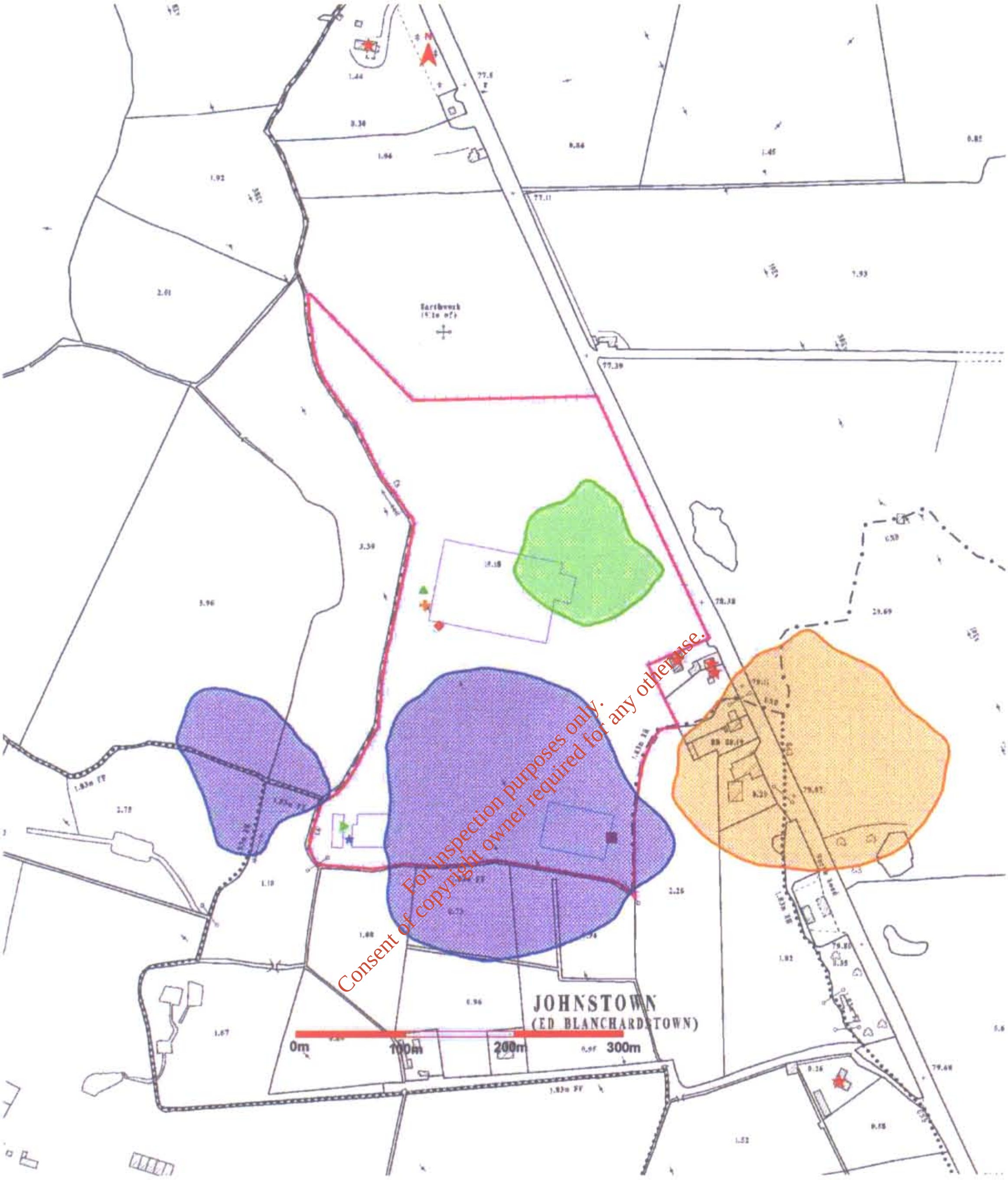

Figure 4.6.4 Comparison Between Predicted Odour Emission Contribution of Individual Processes: Biological Treatment Facility (——) (1.20 $Ou_E\ m^{-3}$), Waste Transfer Station (——) (0.5 $Ou_E\ m^{-3}$), and Sludge Hub Centre (——) (0.30 $Ou_E\ m^{-3}$) to Odour Plume Dispersal for Scenario 1 at the 98th Percentile

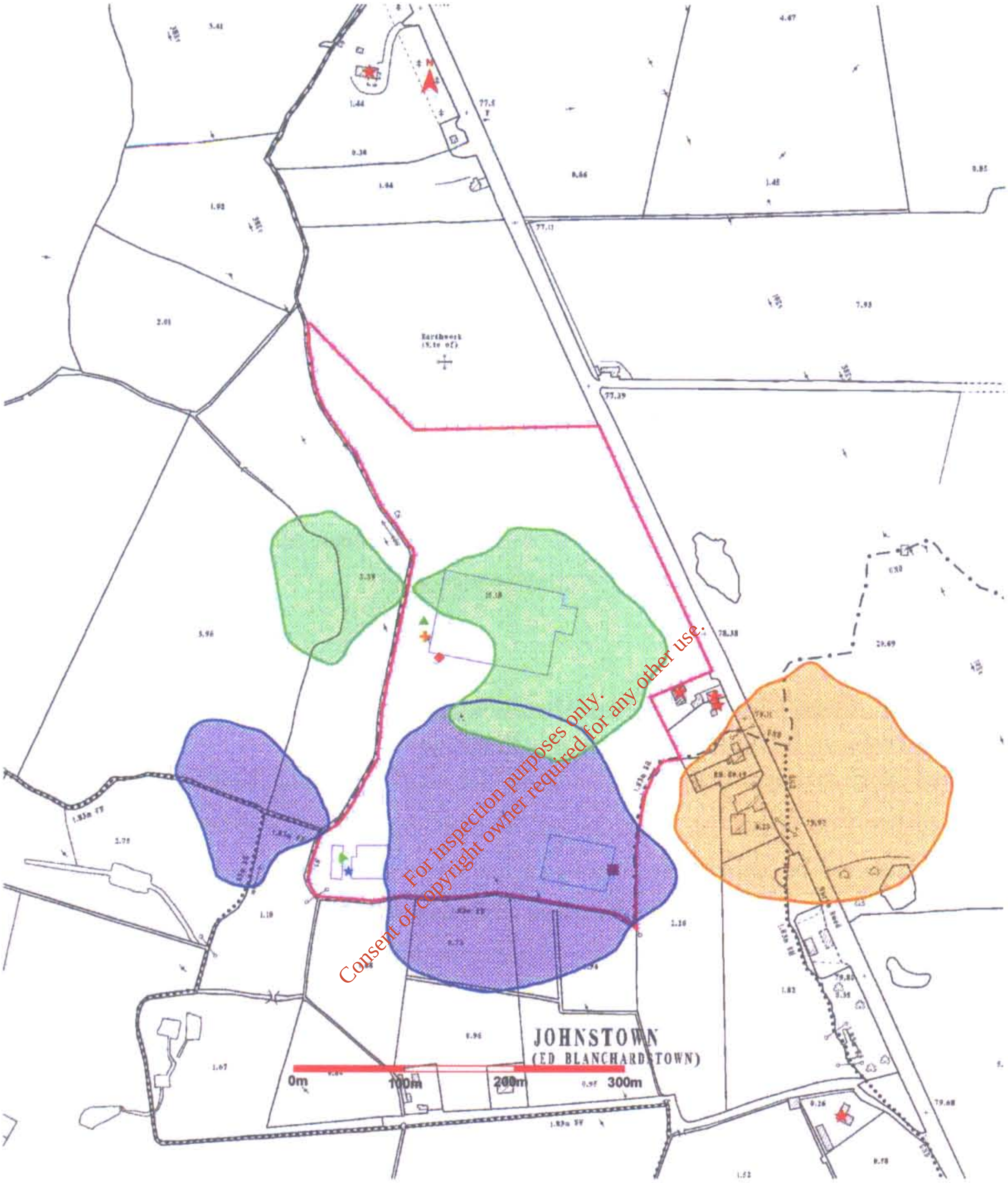

Figure 4.6.5 Comparison Between Predicted Odour Emission Contribution of Individual Processes: Biological Treatment Facility (——) (1.50 Ou_E m^{-3}), Waste Transfer Station (——) (0.50 Ou_E m^{-3}), and Sludge Hub Centre (——) (0.30 Ou_E m^{-3}) to Odour Plume Dispersal for Scenario 1 at the 98th Percentile

Discussion of Results

Odour Plume Dispersal for Proposed Operations with the Incorporation of Considered Abatement Protocols for Scenario 1-Composting.

The plotted odour concentrations of ≤ 1.20 Ou_E m^{-3} for the 98th percentile for the proposed Kilshane Cross Recycling Park operations, incorporating composting, with abatement is illustrated in Figure 4.6.2. As can be observed, it is predicted that odour plume spread is radial with a diameter of 110 metres. In accordance with odour annoyance criterion in Table 4.6.3, and in keeping with current recommended odour annoyance criterion in this country, no odour complaints will be experienced by residences in the vicinity of the facility operations assuming cumulative impacts from all processes. The maximum perceived odour concentration of 0.98 Ou_E m^{-3} at the 98th percentile at residences is below the detectable odour threshold concentration. The maximum perceived ground level odour concentration of 1.62 Ou_E m^{-3} is within the facility boundary.

Odour Plume Dispersal for Proposed Operations with the Incorporation of Considered Abatement Protocols for Scenario 2-Anaerobic Digestion

The plotted odour concentrations of ≤ 1.50 Ou_E m^{-3} for the 98th percentile for the proposed Kilshane Cross Recycling Park operations, incorporating anaerobic digestion, with abatement is illustrated in Figure 4.6.3. As can be observed, it is predicted that odour plume spread is oval with a maximum spread of 320 metres. In accordance with odour annoyance criterion in Table 4.6.3, and in keeping with current recommended odour annoyance criterion in this country, no odour complaints will be experienced by residences in the vicinity of the facility operations assuming cumulative impacts from all processes. The maximum perceived odour concentration of 1.48 Ou_E m^{-3} at the 98th percentile at residences is below the established odour impact criterion. The maximum perceived ground level odour concentration of 3.1 Ou_E m^{-3} is within the facility boundary.

Individual Odour Impacts Associated with Processes to be Operated within the Proposed Kilshane Cross Recycling Park

Figures 4.6.4 and 4.6.5 illustrate the individual impacts of processes to be operated within the Kilshane Cross Recycling Park. The individual processes can be graded in term of maximum odour plume spread and maximum ground level concentration. The maximum ground level impact odour concentration for the 98th percentile for individual odour sources within the facility boundary can be graded as follows for Scenario 1 and 2, respectively:

- Biological Treatment Facility-Anaerobic Digestion-3.0 Ou_E m^{-3}
- Biological Treatment Facility-Composting operations-1.50 Ou_E m^{-3}

- Waste Transfer Station-0.78 $Ou_E\ m^{-3}$
- Sludge Hub Center-0.64 $Ou_E\ m^{-3}$

By increasing stack height on the gas compression engine by 5 metres, the ground level concentration associated with the anaerobic digestion facility can be reduced by 33%.

Interim Conclusions

A worst-case odour emission scenario was modelled using the atmospheric dispersion model ISC ST 3 with 3 years worth of hourly sequential meteorology data representative of the study area. A worst-case meteorological year and worst-case odour emission data was used to predict any potential odour impact in the vicinity of the proposed Kilshane Cross Recycling Park. Odour impact potential was discussed for the proposed operation of the Kilshane Cross Recycling Park with the implementation of considered abatement protocols. It was concluded that:

- During operation of the Kilshane Cross Recycling Park with considered abatement protocols implemented, no odour impact will be registered by residents living in the vicinity of the facility.
- Following investigation of individual odour impacts from the individual processes to be operated within the Kilshane Cross Recycling Park, it was concluded that:
    - Biological Treatment Facility-Anaerobic Digestion contributed a maximum of 3.0 $Ou_E\ m^{-3}$ at the 98th percentile within the facility boundary,
    - Biological Treatment Facility-Composting contributed a maximum of 1.50 $Ou_E\ m^{-3}$ at the 98th percentile within the facility boundary,
    - Waste Transfer Station contributed a maximum of 0.78 $Ou_E\ m^{-3}$ at the 98th percentile within the facility boundary,
    - Sludge Hub Centre contributed a maximum of 0.64 $Ou_E\ m^{-3}$ at the 98th percentile within the facility boundary,
- By increasing stack height on the gas compression engine by 5 metres, the ground level concentration associated with the anaerobic digestion facility can be reduced by 33%.
- The proposed Kilshane Cross Recycling Park operation will not exceed the odour emission rate of 56,985 $Ou_E\ s^{-1}$ assuming identical source characteristics and no fugitive emissions from ground level sources.

4.6.1.3 Bioaerosols

Since composting is one of the considered technologies for the treatment of organic waste at the proposed Kilshane Cross Recycling Park development, a Bioaerosol impact assessment was performed in order to take account of any potential Bioaerosol emissions from the proposed biofiltration system to be used to treat odour emissions from the biological treatment facility. The biological treatment facility will be maintained under negative ventilation and all exhaust air will pass through a biofiltration system. Bioaerosol emission rates were calculated from library based Bioaerosol concentration levels from other biofilters treating composting air streams. The biofiltration system surface area (m^2) and superficial gas velocity ($m\ min^{-1}$) were taken account of during the calculations, in order to ensure similar biofiltration operation as library based systems. Dispersion modelling using ISC ST3 was used to assess downwind maximum 1-hour impact concentrations. A worst-case meteorological year and worst-case Bioaerosol emission dataset was used to predict any potential Bioaerosol impacts in the vicinity of the proposed biological treatment facility.

Bioaerosol Dispersion Modelling

In essence, dispersion modelling involves the use of a computer model to calculate downwind concentrations of the emission from a study site. The dispersion model incorporates the emission source characteristics, topography of the study area, long-term meteorological data from a representative station and source emissions rate. The specific impact concentration and frequency of impact can be determined in order to assess the risks associated with a particular operation or group of operations.

The dispersion model used in this study is ISC ST3 and Screen 3. ISCST3 is recommended in the EPA guideline on air quality modelling for applications to refinery-like sources and other industrial sources. It is a straight-line trajectory, Gaussian-based model. The EPA also recently recommended it (*Complex 1 section*) to model the potential odour impact from intensive agriculture, mushroom composting and tannery facilities (EPA, 2001). It is used with meteorological input data from the nearest representative source. The most important parameters needed in the meteorological data are wind speed, wind direction, ceiling heights, cloud cover, and Pasquill-Gifford stability class for each hour. ISC ST 3 is run with a sequence of hourly meteorological conditions to predict concentrations at receptors for averaging times of one hour up to a year. It is necessary to use many years of hourly data to develop a better understanding of the statistics of calculated short-term hourly peaks or of longer time averages. The computations used in this modelling assessment of proposed Kilshane Cross Biological Treatment facility give the Bioaerosol concentration at each 50-meter x y Cartesian grid receptor location.

Bioaerosol Impact Criterion

Suggested Occupational Exposure Limits (OEL), Threshold Limit Values (TLV), Residential Limit Values (RLV) and a recommended WHO guideline value for Bioaerosol exposure is presented in Table 4.6.6. Ranges of exposure concentrations range from 1000 to 5000 CFU m^{-3} for Total Bacteria and from 500 to 10^7 CFU m^{-3} for Total Fungi concentration. In order to assuming worst case scenario, values of 1000, 1000 and 500 CFU m^{-3} for Total Fungi, Mesophilic Bacteria and Aspergillus *fumigatus* will be used as upper threshold levels within the dispersion model to assess Bioaerosol impact area. The distance downwind to achieve background levels of Aspergillus *fumigatus* and Total Mesophilic Bacteria from the two main Bioaerosol sources within the facility will also be assessed. A 1-hour maximum concentration calculation will be used to generate the output plots for presentation as contours. These contours can then be observed visually to assess the Bioaerosol impact on the surrounding area. This can then be compared to the proposed Bioaerosol exposure levels. The Bioaerosol impact can also be assessed for factors such as changing facility operation and facility design.

Proposed Occupational Exposure Levels for Bioaerosols

Table 4.6.6 illustrates proposed OEL, TLV and RLV for Bioaerosols encountered in different environments. Independently of these reference values, in an assessment of indoor exposure, the general assumption will be that in certain circumstances the microbial pathogen may be a cause of health problems, even at concentrations below the reference limit.

OEL for airborne substances are set at a level at which, based on current scientific knowledge, there is no indication of risk to the health of workers who breathe it in day after day. At present, there are no international OEL for airborne microorganisms or their associated toxins.

Thorne et al., 2000, stated that in order to produce reliable exposure data rigorous exposure chamber design, aerosol generation systems, exposure quantification and experimental protocols must be utilized. Inhalation models serve as important adjuncts to epidemiology studies. Fung et al., 2003 reported health effects caused by fungal Bioaerosol exposure include allergy, infection, irritation, and toxicity. While the first three categories have well-established mechanisms, there is a lack of dose-response data, and a highly variable degree of individual susceptibility.

It can be concluded that workers at composting facilities are potentially exposed to considerably higher concentrations of bacteria, including Gram-negative bacteria, actinomycetes, fungi and their associated toxins than are likely to be present in background air away from Bioaerosol sources, and there is a lack of reported health related effects among compost workers in literature. Since they are exposed to higher concentrations on a continuous basis, the effects of bioaerosols on health are not clearly understood. The precise risk of bioaerosols is impossible to quantify due to this lack of defined dose-response relationships. (Wheeler et al., 2001)

Table 4.6.6 Proposed Occupational Exposure Levels (OEL's), Threshold Limit Values (TLV's) and Residential Limit Values (RLV's)

Suggested Value	Total Bacteria (CFU m^{-3})	Gram negative bacteria (CFU m^{-3})	Fungi (CFU m^{-3})	Total micro organisms (CFU m^{-3})	Reference
Residential dwelling (RLV)	$5 X 10^3$		$5 X 10^3$		
Industrial setting contaminated by dust (OEL) For respirable fraction the limit proposed should be twice as low.	Total Mesophilic bacteria $100 X 10^3$	$20 X 10^3$	$50 X 10^3$		Gorny and Dutkiewicz (2002)
Suggested OELS in Scandinavia		1,000	10^5		Rylander et al 1994
OEL		$2 x 10^4$		$1 x 10^4$	Makros 1992
OEL					Dutkiewitz & Jablonski1989
Suggested OEL (biotechnology)		300			Palchak 1990
WHO Guideline			500		McNeel et al., 1999
Suggested OEL in Scandinavia	10^4	Toxic pneumonitis 10^5 Respiratory inflam. 10^2 10^3	Toxic pneumonitis 10^7 Respiratory inflam. 10^5		Rylander 1994 Lavoie and Guertin (2001)
Suggested OEL 8 hr average	5-10,000	1,000			Sigsgaard 1990
Health based OEL*		$2 x10^4$	$5 x 10^4$	$1 x 10^5$	Dutkiewitz 1997
Threshold values	1,000	1,000			Rylander et al 1980, 1983
Threshold values		1,000	5,000	5,000-10,000	Peterson & Vikstrom1984
Threshold values		1,000			Lacey et al 1992
Recommended maximum for residences, schools and offices	<4500			<500 in winter <2500 in summer	Finnish Ministry of Social Affaires and Health 1997
Provisional Dutch guideline for indoor air in the work environment	10,000				Dutch Occupational Health Association NWA 1989.
Number of spores necessary for development of acute symptoms				10^8	Miller 1992
Health based - number which can cause sensitisation				$> 10^8$	Malmberg 1991
Increased risk of EAA and ODTS				10^6	Lacey et al 1990
Proposed risk assessment concentrations UK EA (2002)	1000 Mesophillic bacteria		500 total fungi	1000	Wheeler (2002)

* Health based OEL refers to when continuous exposure to micro organisms concentrations above 10^5 CFU m^{-3} occurs, work-related respiratory disorders in workers are very common.

Dispersion Modelling Characteristics

Table 4.6.7 illustrates the dispersion modelling characteristics used to build ISC ST3 dispersion model for this study.

Table 4.6.7 Dispersion Model Characteristics

Parameter	Description
Source characteristics	Outlet of biofiltration system through a stack with an efflux velocity of 15 m s^{-1}. The media bed will be mainly composed of softwood wood chip.
Meteorological data	3 years of meteorological data from Dublin Airport was used to assess the long-term dispersion estimates from the site. This allowed for the analysis of a worst-case meteorological year for estimation of Bioaerosol impact area.
Topography	Topography for the site was obtained from an on-site topographical survey.
Bioaerosol emission rate	Worst-case library based Bioaerosol emission rate in CFU s^{-1} were used to estimate impact area for the different operations.

Meteorological Data

Three years worth of hourly sequential meteorology data was used for the operation of ISC ST 3. This allowed for the determination of the worst-case meteorological year for the determination of overall Bioaerosol impact from the current operations and proposed new facility design.

Terrain Data.

Upon examination of terrain it was noted that the topography around the current site is simple. All significant deviations in terrain are examined in modelling computations through terrain incorporation using AerMap software. All building wake effects are accounted for in the modelling scenarios (i.e. building effects on biofilter source from proposed enclosed operations) as this can have a significant effect on the bioaerosol plume dispersion at short distances.

Bioaerosol Emission Rate Calculation

Bioaerosol emission rate (CFU s^{-1}) was calculated from library based individual Bioaerosol emission concentrations (CFU m^{-3}) multiplied by volumetric airflow rate (m^3 s^{-1}). The resulting Bioaerosol emission rates (CFU s^{-1}) were inputted in the dispersion model with source characteristics in order to predict downwind Bioaerosol concentrations.

Results and Assumptions

The Bioaerosol dispersion modelling uses the following assumptions:

- The Bioaerosol is treated as an ideal gas and therefore no removal due to deposition (wet or dry) is accounted for in modelling scenarios,
- Bioaerosols are known to clump and fall close to the emission point due to deposition. No clumping is accounted for in the dispersion modelling assessment,
- A worst-case meteorological year is used,
- A worst-case maximum 1-hour concentration value is assessed.
- Worst case published Bioaerosol emission rates are used for the development of the data set.

Bioaerosol Modelling Scenarios and Emission Rates for ISC ST 3 Dispersion Model

Table 4.6.8 illustrates the predicted average worst-case Bioaerosol emission rate from the proposed Kilshane Cross Biological Treatment Facility for different Bioaerosol classes. Three scenarios are presented and these include:

1. Predicted worst-case library Aspergillus *fumigatus* impact from operations carried out at Kilshane Cross Recycling Park (*Scenario 1*).
2. Predicted worst-case library Mesophilic Bacteria impact from operations carried out at Kilshane Cross Recycling Park (*Scenario 2*).
3. Predicted worst-case library Total Fungi impact from operations carried out at Kilshane Cross Recycling Park (*Scenario 3*).

The Bioaerosol emissions rates used are assumed to be worst-case based on library data.

Table 4.6.8 Bioaerosol Emission Rates from Proposed Operation and Frequency of Emission Rate

Emission type	Emission concentration (CFU m^{-3})[1]	Volumetric air flow rate (m^3 s^{-1})	Bioaerosol emission rate (CFU s^{-1})
Aspergillus fumigatus	1200	40.1	48,120
Mesophillic bacteria	5000	40.1	200500
Total fungi	10,000	40.1	401000

Notes: [1] denotes the library based emission concentration obtained from:

- Sanchez, MA., Steinford, E., (2003). Environ. Sci. Tech. 37, 4299-4303.
- Ottengraf, S. P. P., Konings, J., H. G. (1991). Bioprocess Eng, 7 (1-2), 89 to 96.
- Martens, W., Martinec, M., Zapirain, R., Stark, M., Hartung, E., Palmgre, U., (2001). Int, J. Hyg. Environ. Health, 203. 335 to 345.

Predicted Bioaerosol Impact from Proposed Operations at the Kilshane Cross Recycling Park.

Figure 4.6.6 to 4.6.8 presents the predicted Bioaerosol concentration in the vicinity of the proposed Kilshane Cross Recycling Park. For the examination of proposed operations, it is assumed that all ventilation air is passed through a biofiltration system. Three different Bioaerosol entities are examined including Aspergillus *fumigatus*, Mesophilic Bacteria, and Total Fungi.

The graphical contour represents the impact area for each of the activities carried out within the proposed site. The contour concentrations are assessed on maximum boundary level concentration. These are compared to the lowest reported OEL/TLV value for Total Fungi and Total Bacterial Bioaerosols (see Table 4.6.6). This value corresponds to 500 CFU m^{-3} for Total Fungi and 1000 CFU m^{-3} for Total Bacteria. Aspergillus *fumigatus* was also assessed using the WHO assessment level of 500 CFU m^{-3} for Total Fungi. A worst-case meteorological year (i.e. the meteorological year that provided worst case Bioaerosol impact) was selected to estimate worst-case impact area. All scenarios were examined using a worst-case meteorological year (Dublin Airport data), as sufficient site-specific meteorological data is not available.

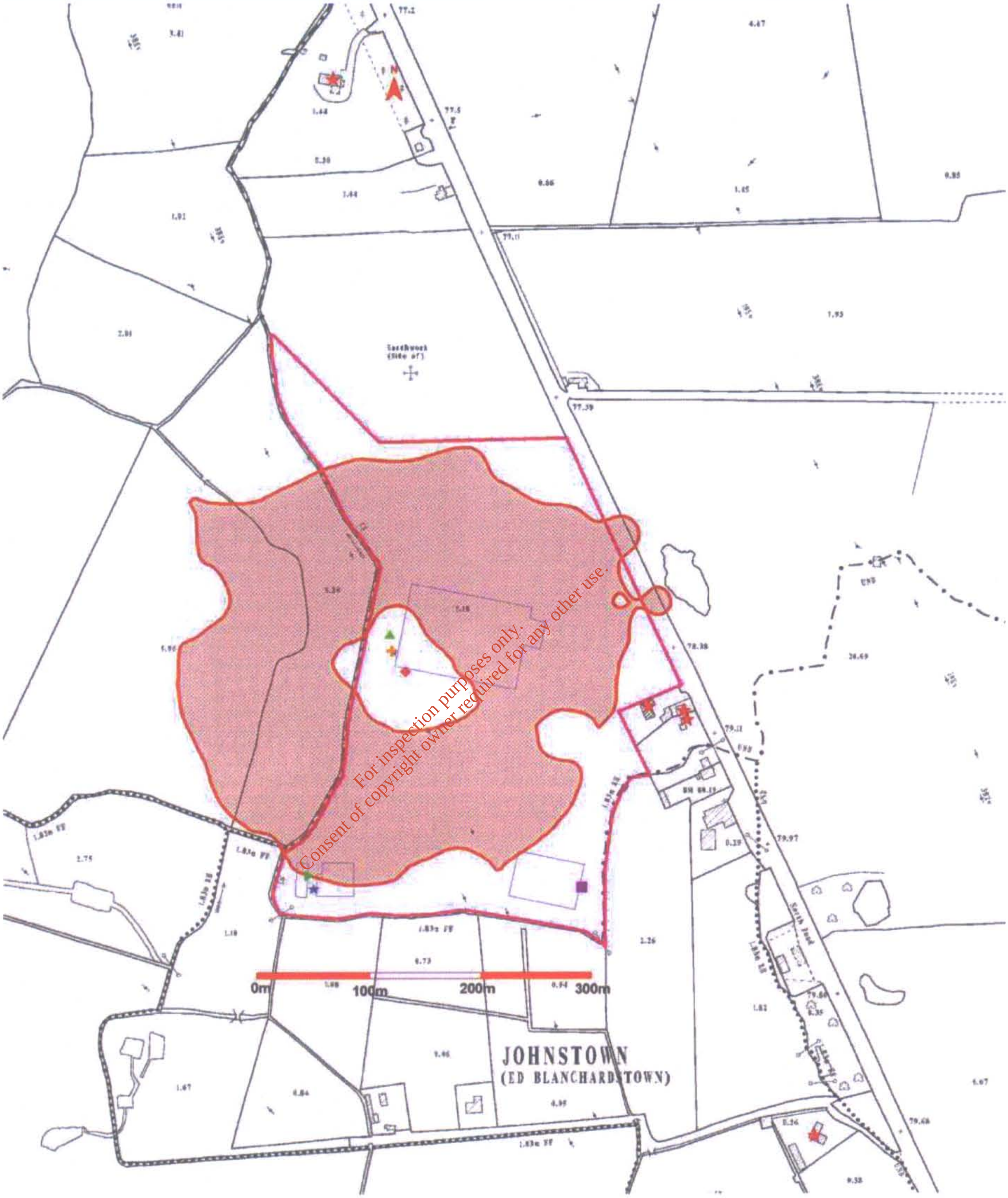

Figure 4.6.6 **Predicted Aspergillus *fumigatus* contribution from proposed Kilshane Cross Recycling Park Composting system to bioaerosol impact area at the 1-hour worst-case scenario for a total Aspergillus *fumigatus* concentration of less than 4.20 CFU m^{-3} (——)**

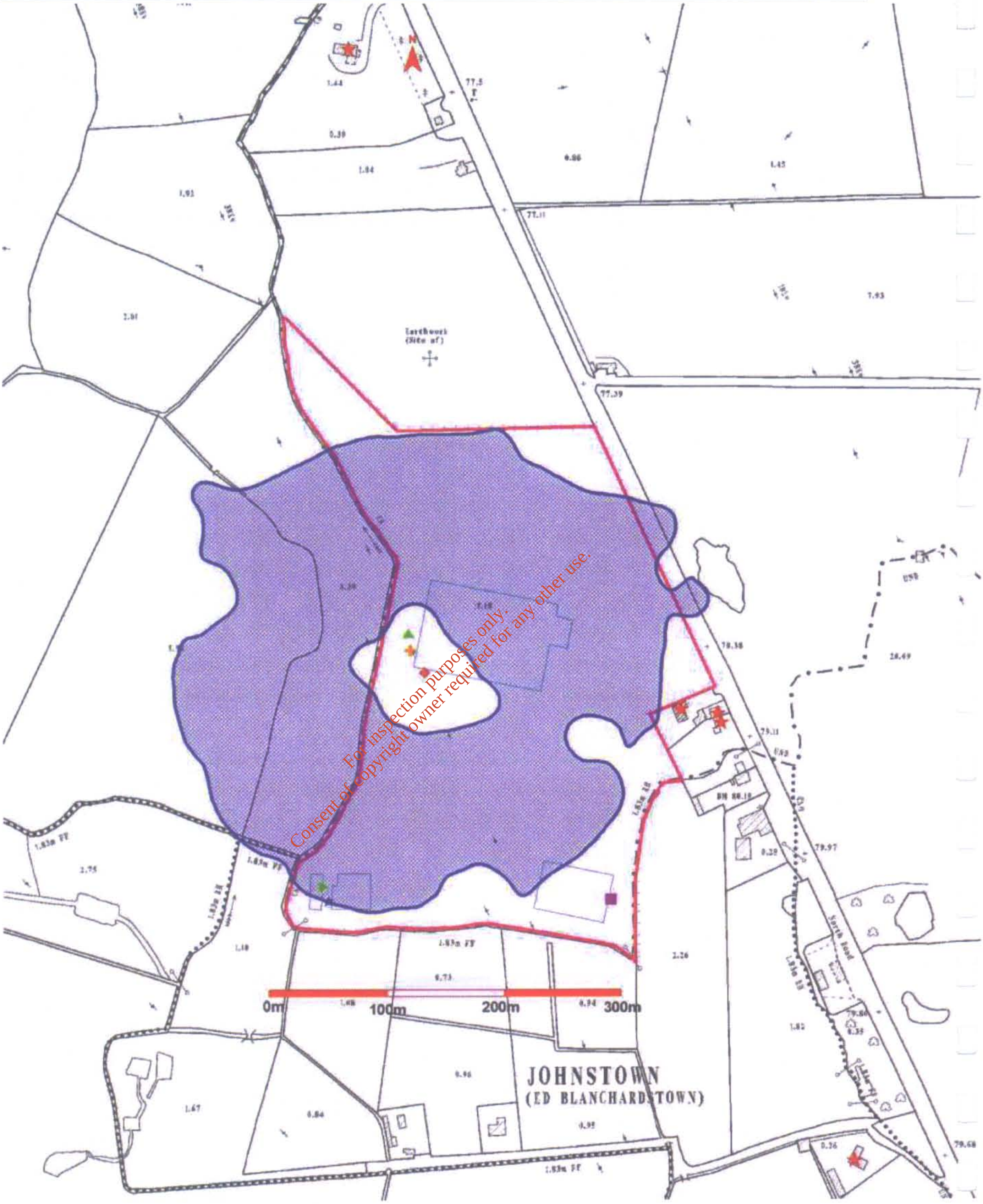

Figure 4.6.7 **Predicted Total Mesophilic Bacteria contribution from proposed Kilshane Cross Recycling Park Composting system to Bioaerosol impact area at the 1-hour worst-case scenario for a total Mesophilic bacteria concentration of less than 17 CFU m^{-3} (——)**

Figure 4.6.8 **Predicted Total Fungi contribution from proposed Kilshane Cross Recycling Park Composting system to Bioaerosol impact area at the 1-hour worst-case scenario for a Total Fungi concentration of less than 34 CFU m^{-3} (——)**

Compost Facility Set Back Distances

Table 4.6.9 illustrates various setback distances formulated through regulatory guidance and through downwind measurement of bioaerosols from various composting sites. Although not reported, facility size and operation can have a significant effect on the measured downwind Bioaerosol concentration. As all composting activities to be carried out at the proposed Kilshane Cross Recycling Park will be indoors and all air is to be extracted to a biofiltration system, it is therefore anticipated that a smaller distance can be applied to attain ambient background levels. Technically, and in accordance with the UK Environment Agency, Bioaerosol risk assessment is not required unless the facility is within 250 metres of resident locations. This proposed facility is not within 250 metres so this study would not have been required. The EPA has adapted such methodologies also in recent times. This adoption is based on the fact that no impact/reduced impact has been reported in literature at these distances and the risk associated with any health effects are greatly reduced at such distances.

Table 4.6.9 Reported Setback Distances Required to Achieve Sufficient Dilution of Bioaerosols to Ambient Background

Facility	Parameter	Distance (metres)	Comments	Reference
Green waste composting	Aspergillus fumigatus	152 - 502	-	McNeel et al., 1999
Biosolids		149 - 806	-	
Waste Sorting Open Windrow	Bacteria and Aspergillus fumigatus	At 200 concentrations are significantly reduced	At 200 concentrations are significantly reduced	Reinthaler et al., 1998/1999
General Recommendation	Aspergillus fumigatus	61- 152	-	Millner et al., 1995
Oregon Department of Environmental Quality 2001 (Tetratach 2001)	Aspergillus fumigatus	1: 76-304 2: at 182 no effect on public health	-	Prasad et al., 2003
Herhof System	Endotoxin	150	-	Danneberg et al., 1997
	Total microbial concentrations	No increase > 500	-	
Sewage Sludge- enclosed system.	Aspergillus fumigatus	610 upwind 304-2614	-	California Integrated Waste Management Board, (Ault et al., 1993)
Green waste composting	Aspergillus fumigatus	452	-	McNeel et al., 1999
Green waste composting	Aspergillus fumigatus	152	-	
Green waste composting	Aspergillus fumigatus	541	When downwind - A.*f* at 1775 ft was up to 4 times higher than reference (p<0.05)	
Green waste composting	Total culturable fungi	290		
Green waste composting	Aspergillus fumigatus	503	modelled at 500 m (1650 ft), measured at 150 m	
Household	Aspergillus fumigatus	101	-	
Biosolids composting	Aspergillus fumigatus	396	-	
Biosolids composting	Aspergillus fumigatus	175	575 ft = site boundary	
Biosolids composting	Aspergillus fumigatus	150	-	
Biosolids composting	Aspergillus fumigatus	>250	-	
Biosolids composting	Aspergillus fumigatus	500	From air dispersion model	
Biosolids composting	Aspergillus fumigatus	805	-	
Composting facilities	Aspergillus *fumigatus*	200	Set back distance proposed for bioaerosols to reach background levels	Gilbert et al., 2002
UK Environment Agency	Bioaerosols	250 for risk assessment (if any resident within 250 metres then risk assessment needs to be performed)	Set-back distance required for operation of composting facility	Swan et al., 2003
CRE Irish composting association	Bioaerosols	200	Set-back distance proposed through intense literature review performed on available research data	Prasad et al., 2003
Draft Irish EPA Guideline	Bioaerosols	250	Draft guideline distance proposed by Irish EPA	EPA 2004

As can be observed setback distances range from 61 to 805 metres. Recent research in the UK and significant reviews of literature suggest a set back distance of 250 metres is sufficient to reduce risk to acceptable levels. The risk associated with Kilshane Cross Recycling Park composting facility is further reduced as the facility will be operated as a fully enclosed indoor facility and all air will be passed through a biofiltration system. Many of the facilities reported in literature are outdoor facilities.

Discussion of Results

<u>ISC ST3 Worst-Case Dispersion Modelling</u>

Figures 4.6.6 to 4.6.8 illustrates the Bioaerosol impact area (as contours in graphical form) for Aspergillus *fumigatus*, Mesophilic Bacteria and Total Fungi. The boundary of the facility was set as the limit extent of impact area. As can be observed, the maximum predicted 1-hour concentration of bioaerosols for the three classes at the resident locations is:

- CFU m^{-3} for Aspergillus *fumigatus* (see Figure 4.6.6)
- 17 CFU m^{-3} for Mesophilic Bacteria (see Figure 4.6.7).
- 34 CFU m^{-3} for Total Fungi (see Figure 4.6.8) for a worst-case library based Bioaerosol emission rate.

The maximum predicted Bioaerosol concentration at ground level is:

- 9 CFU m^{-3} for Aspergillus *fumigatus* for a 1-hour maximum concentration level,
- 38 CFU m^{-3} for Mesophilic Bacteria for a 1-hour maximum concentration level,
- 70 CFU m^{-3} for Total Fungi for a 1-hour maximum concentration level,

These maximum impact concentration levels are near background levels and from 29 to 119 times lower than the proposed Bioaerosol impact criterions in Table 4.6.6.

4.6.1.4 Ambient Air Quality

This section of the report presents the results of an ambient air quality assessment utilising atmospheric dispersion modelling software due to operation of the processes within the proposed Kilshane Cross Recycling Park as outlined in Table 4.6.10. The operation of such processes will lead to emissions of air pollutants and by using atmospheric dispersion modelling, the potential impact of these pollutants are assessed and compared to relevant ambient air quality objectives and limits. Background air quality data was obtained form on-site assessment and review of the available baseline air quality data generated by the Irish EPA. The main compounds assessed include oxides of Nitrogen (NO_X), Carbon Monoxide (CO), Sulphur Dioxide (SO_2), Total Organic Carbon (TOC), particulates (PM), Hydrogen Fluoride, Hydrogen Chloride and Formaldehyde.

Table 4.6.10 Outlined Processes Contributing to Ground Level Concentrations of Air Quality Pollutants

Scenario 1		
Process	**Anticipated pollutants**	**Notes**
Biological treatment facility-Composting biofilter stack	Odours and bioaerosols	See Sections 4.6.1.2 and 4.6.1.3 for odours and bioaerosols
Waste transfer station-Carbon filtration stack	Odours	See Section 4.6.1.2
Sludge drier stack	Odours, NO_X, SO_2, CO, Total Organic Carbon, Hydrogen fluoride and chloride,	See Section 4.6.1.2 for odours
Sludge drier odour control unit	Odours	See Section 4.6.1.2 for odours
Scenario 2		
Process	**Anticipated pollutants**	**Notes**
Biological treatment facility-Preparation hall biofilter stack	Odours	See Sections 4.6.1.2 for odours
Biological treatment facility-Off gas odour control stack	Odours	See Sections 4.6.1.2 for odours
Biological treatment facility-Gas compression engine/flare[1]	NO_X, SO_2, CO, Total Organic Carbon, Hydrogen fluoride and chloride,	-
Waste transfer station-Carbon filtration stack	Odours	See Section 4.6.1.2
Sludge drier stack	Odours, NO_X, SO_2, CO, Total Organic Carbon, Hydrogen fluoride and chloride,	See Section 4.6.12 for odours
Sludge drier odour control unit	Odours	See Section 4.6.1.2 for odours

Notes: [1] denotes as gas compression engine emission limit values are larger than the emission limit values for the flare, a worst case scenario was assessed by using the emission limit values for the gas compression engine. The ground level impact associated with the flare will always be less than the gas compression engine. It is assumed that based on 45,000 tonnes per year capacity, a 0.8 MW gas compression engine will be required to burn the off gas from the Anaerobic digesters. This will be confirmed during detailed and selection process. .

Various modelling scenarios were performed to allow for comparison with relevant air quality criteria. These included 1 hour mean, 8-hour mean, 24-hour mean, Annual mean and maximum number of exceedences expressed as percentiles. It was assumed for the basis of modelling that the proposed processes will operate 24 hour/day and 7 days per week. It was assumed that the Sludge Drier will use natural gas to operate while the gas compression engine will use biogas to operate.

Objectives of Study

The main objectives of the air quality impact assessment is to provide quantitative assessment of the likely and potential impacts associated with the proposed operation of the Kilshane Cross Recycling Park site in relation to the estimated/EPA Emission Limit Values from the processes outlined in Table 4.6.10. The methodology adapted involved a number of distinct steps: these included:

- Identification of substances, which may be present in the emission from the proposed operation of the processes;
- Estimation of emission rates for such air components;
- Prediction of Ground Level Concentrations (GLC) of components dispersed from the process stacks;
- Comparison between dispersed GLC + background concentrations and relevant air quality objectives and limits for these air pollutants.

The approach adopted in this assessment is considered a worst-case investigation in respect of emissions to the atmosphere from the facility. These predictions are therefore most likely to over estimate the GLC that may actually occur for each modelled scenario. These assumptions are summarised and include:

- Emissions to the atmosphere from the proposed operation of the processes were assumed to occur simultaneously and continuously 24 hours per day, 365 days per year;
- All emissions were assumed to occur at maximum potential emission concentration and mass emission rates,
- Maximum GLC + background concentrations were compared with relevant air quality objects and limits;
- Worst-case available meteorological input data was assumed in the study;

Atmospheric Dispersion Modelling of Air Quality: Dispersion Model Selection

The model chosen in this study was ISC ST3. This model is recommended and promulgated in EPA guideline on air quality modelling for applications to refinery-like sources and other industrial sources. It is a straight-line trajectory, Gaussian-based model. It was also recently recommended (*Complex 1 section*) by the EPA to model the potential odour impact from intensive agriculture, mushroom composting and tannery facilities (EPA, 2001). The most important parameters needed in the meteorological data are wind speed, wind direction, ceiling heights, cloud cover, and Pasquill-Gifford stability class for each hour. ISC ST 3 is run with a sequence of hourly meteorological conditions to predict concentrations at receptors for averaging times of one hour up to a year. It is necessary to use many years of hourly data to develop a better understanding of the statistics of calculated short-term hourly peaks or of longer time averages.

Air Quality Impact Assessment Criteria

The predicted air quality impact from the proposed operation of the Kilshane Cross Recycling Park is compared to relevant air quality objectives and limits. Air quality standards and guidelines referenced in this report include:

- SI 271 of 2002 Air Quality legislation;
- EU limit values laid out in the EU Daughter directives on Air Quality 99/30/EC;
- TA Luft Technical instructions on Air Quality Control for TOC in ambient air;
- Danish Industrial Air pollution control guidelines;
- The Netherlands Emissions Regulation Office; and
- World Health Organisation Air Quality Guidelines for Europe.

Air quality is judged relative to the relevant Air Quality Standards, which are concentrations of pollutants in the atmosphere, which achieve a certain standard of environmental quality. Air quality Standards are formulated on the basis of an assessment of the effects of the pollutant on public health and ecosystems.

In general terms, air quality standards have been framed in two categories, limit values and guideline values. Limit values are concentrations that cannot be exceeded and are based on WHO guidelines for the protection of human health. Guideline values have been established for long-term precautionary measures for the protection of human health and the environment. European legislation has also considered standards for the protection of vegetation and ecosystems.

Where ambient air quality criteria do not exist as in the case for some of the substances of interest; it is usual to use 1/100th of the Occupational Exposure Limit (OEL) for an eight-hour reference period to compare with the annual average predictions. The one-hour predictions are generally compared with a standard derived from 1/40th of the Short Term Exposure Limit (STEL). OEL are published by the Occupational Safety and Heath Authority (i.e. EH 40). The relevant air quality standards are presented in Tables 4.6.11 and 4.6.12.

Table 4.6.11 EU and Irish Limit Values Laid Out in the EU Daughter Directive on Air Quality 99/30/EC[1] and SI271 of 2002

Pollutant	Objective				To be achieved by[4]
	Concentration[2]	Maximum No. Of exceedences allowed[3]	Exceedence expressed as percentile[3]	Measured as	
Nitrogen dioxide and oxides of nitrogen	200 µg m^{-3} NO_2 40 µg m^{-3} NO_2 30 µg m^{-3} NO_2	18 times in a year -- --	99.79th percentile -- --	1 hour mean Annual mean Annual mean	1 Jan 2010 1 Jan 2010 19 Jul 2001[5]
Particulates (PM_{10})	50 µg m^{-3} 20 µg m^{-3}	7 times in a year --	98.08th percentile --	24 hour mean Annual mean	1 Jan 2010[6] 1 Jan 2010[6]
Carbon monoxide (CO)	10 mg m^{-3}	None	100th percentile	Running 8 hour mean	31st Dec 2003
Sulphur dioxide (SO_2)	350 µg m^{-3} 125 µg m^{-3} 20 µg m^{-3}	24 times in a year 3 times in a year --	99.73th percentile 99.18th percentile --	1 hour mean 24 hour mean Annual mean and winter mean (1st Oct to 31st March	1st Jan 2005 1st Jan 2005 19th Jul 2001[5]

Notes: [1] denotes Directive 99/30/EC: Council Directive 1999/30/EC of 22nd April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen and particulate matter in ambient air;

[2] denotes conversions of ppb and ppm to µg m^{-3} and mg m^{-3} at 293.15 Kelvin and 101.3 KPa;

[3] denotes Number of exceedences are quoted in the directive, exceedences or percentiles are used in AMDS;

[4] A margin of tolerance is accepted while limit value is phased in; this will reduce progressively every year;

[5] denotes limit value for the protection of vegetation/ecosystem;

[6] denotes Stage 2 values to be achieved by EU following the implementation of Stage 1.

Table 4.6.12 Irish EPA Limit Values Laid Out in Ireland for other Possible Pollutants

Parameter	Air quality Standard	Averaging period	Limit Value/Guideline (µg m^{-3})	
HCL	TA Luft[1]	98th percentile of 1 hour	100	
	Fractional Exposure[2]	Annual 1 hour average	700 350	
	Danish C Value[3]	99 percentile of 1 hour	50	
HF	TA Luft[1]	98th percentile of 1 hour	3.0	
	WHO[4]	Annual average	0.3	
	Dutch[5]	Mean concentration April to September	0.4	
	Dutch	24 hour average	2.8	
Total Organic Carbon (TOC)[6]	TA Luft	98th percentile of 1 hour	Class I	50
			Class II	200
			Class III	1000
Formaldehyde	Fractional Exposure	1 hour average Annual	62.50 25	

Notes: [1] denotes TA Luft German Technical Instructions on Air Quality Control

[2] denotes Where an air quality standard does not exist, it is appropriate to use either 1/100th of the 8 hour Reference Occupational Exposure Level or 1/40thth of the Short Term Exposure Limit.

[3] denotes the Danish Industrial Air Pollution Control Guidelines specify a C value which is the value which must not be exceeded when expressed as the 99th percentile of 1 hour average values.

[4] World Health Organisation Air Quality Guidelines for Europe, 2000.

[5] denotes the Netherlands Emission Regulation Office.

[6] denotes that in addition to the above individual limits, the sum of the concentrations of Class I, II and III shall not exceed the Class III limits, (EPA, 2002). The TA Luft system classifies organic substances in accordance with their environmental significances, the more significant compounds (Class I), are assigned lower air quality standards. There is no specific air quality standard for TOC so the predictions may be compared with the individual Class I and Class II standards.

Materials and Methods

The location of possible air emission points in relation to the existing residential dwellings is shown in Figure 4.6.9.

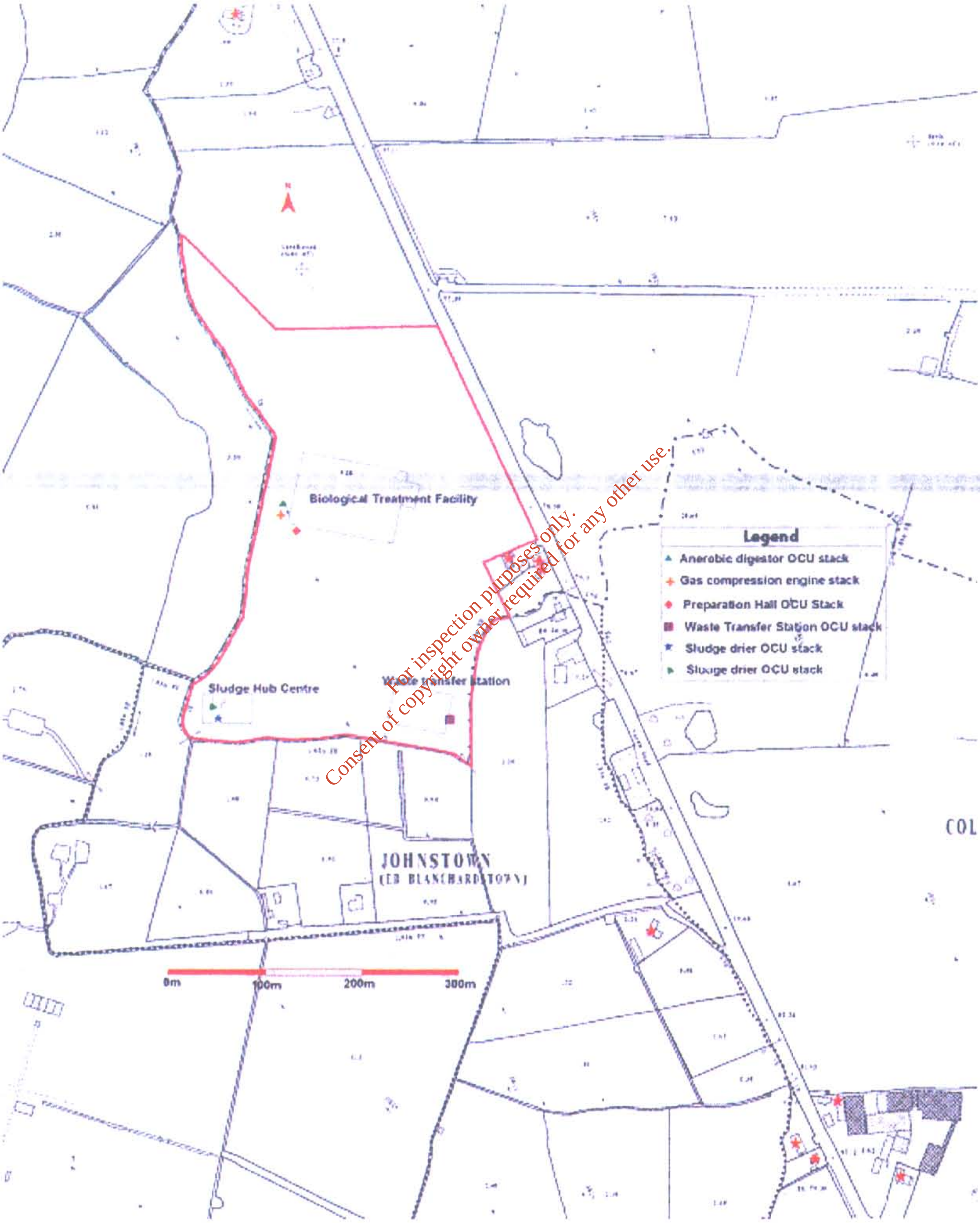

Figure 4.6.9 Schematic diagram of proposed Kilshane Cross Recycling Centre, with possible air emission points, site boundary (▬) and resident in the vicinity of the site (★)

Meteorological Data

Three years of hourly sequential meteorological data was chosen for the modelling exercise (i.e. Dublin 2001 to 2003 inclusive). The nest nearest meteorological station is located in Casement Aerodrome, approximately 20 Km away. Casement suffers heavily from a biased southwesterly wind field. A schematic windrose and tabular cumulative wind speed and direction are presented in Figure 4.6.10 and Table 4.6.13.

Terrain Data

Following a topographical survey, it was concluded that there is no significant deviation in terrain. Terrain is defined by the base elevation of the source, the height of the stack and the height of the final plume rise. The definitions are as follows:

- Simple terrain: when terrain elevations are below the stack height level;
- Intermediate: When terrain elevations are between the stack height and the final plume rise;
- Complex: when terrain elevations are the height of the final plume rise.

The terrain deviation across the entire site is 3.25 metres. All resident locations are similar in terrain height as the existing site. All stack heights are greater than 10 metres so the topographical features can be considered as simple and therefore terrain will not have any significant impact on predicted ground level concentrations. All resident locations are represented as flagpole receptors at a height of 1.8 metres with the dispersion model.

Building effects

Building wake effects are accounted for in the modelling scenarios (i.e. Biological Treatment Facility and Sludge Hub Centre on Odour Control Units) as this can have a significant effect on the compound plume dispersion at short distances and can significantly increase GLC's in close proximity in the vicinity of the facility. The Biological treatment facility building and Waste Transfer station building were represented as 15 metre structures within the dispersion modelling assessment. The sludge hub centre buildings were represented as 18 metre buildings.

Emission Rate Calculation and Normalisation

The contaminant concentration from a stack is best quantified by a mass emission rate. For a chimney or ventilation stack, this is equal to the compound concentration (g m^{-3}) of the discharge air multiplied by its flow-rate (m^3 s^{-1}). It is equal to the volume of air contaminated every second to the concentration limit (g s^{-1}). The mass emission rate (g s^{-1}) is used in conjunction with dispersion modelling in order to estimate the approximate radius of impact. All data used in the dispersion modelling exercise was obtained from library and emission limit values established by the Environmental Protection Agency for such processes. Table 4.6.14 illustrates the emission limit values (ELV) established by regulatory bodies for the processes to be operated within the Kilshane Cross Recycling Park. Table 4.6.15 illustrates the actual emission values used to calculate mass emission rates from the individual processes within the Kilshane Cross Recycling Park.

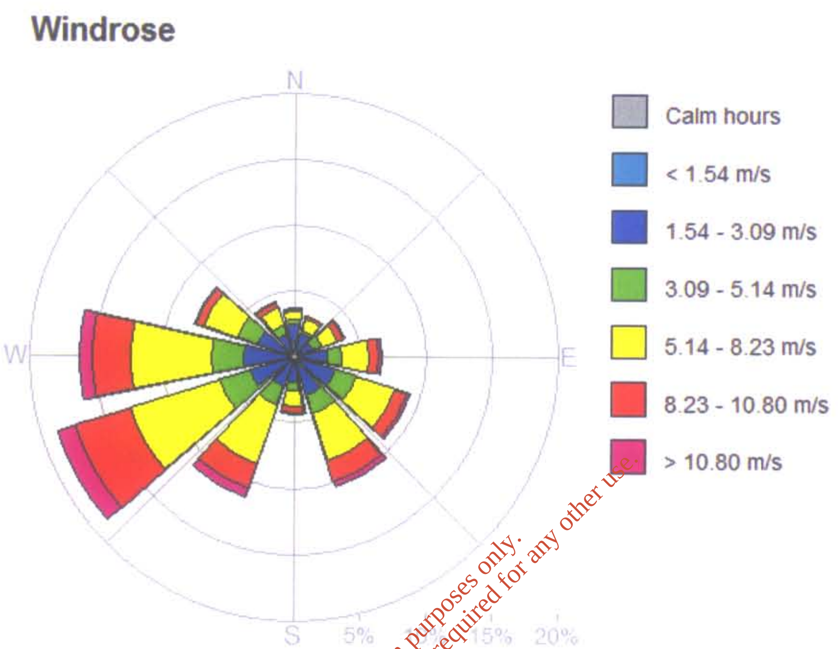

Figure 4.6.10 Schematic Diagram Illustrating the Windrose for Meteorological Data Used for the Atmospheric Dispersion Modelling

Table 4.6.13 Cumulative Wind Speed and Direction for Meteorological Data Used for the Atmospheric Dispersion Modelling

	Cumulative Wind Speed Categories						
Relative Direction	**> 1.54**	**>3.09**	**>5.14**	**>8.23**	**> 10.80**	**< 10.80**	**Total**
0.0	216	353	94	188	33	20	**904**
30.0	57	364	80	206	57	5	**769**
60.0	33	303	196	306	138	21	**997**
90.0	54	520	297	546	183	83	**1683**
120.0	75	710	425	809	258	61	**2338**
150.0	91	630	394	989	435	107	**2646**
180.0	83	348	150	318	143	40	**1082**
210.0	63	511	370	1241	528	184	**2897**
240.0	75	778	644	1844	1143	368	**4852**
270.0	74	870	643	1586	753	284	**4210**
300.0	97	626	410	697	167	34	**2031**
330.0	96	324	179	357	118	14	**1088**
Total	**1014**	**6337**	**3882**	**9087**	**3956**	**1221**	**25497**
Calms	-	-	-	-	-	-	**783**
Missing	-	-	-	-	-	-	**0**

Table 4.6.14 Emission Limit Values (ELV) Established by Regulatory Bodies for the Individual Applicable Processes Within the Proposed Site

Parameter	Flare ELV ($mg\ m^{-3}$)[1,4]	Gas Compression Engine ELV ($mg\ m^{-3}$)[1,4]	Sludge Drier Plant ELV ($mg\ m^{-3}$)[2,4]
CO	100	650	100
NO_X (NO_2 and NO)	200	500	200
SO_2	-	-	350
TOC	10	20	20
HF	5 (at mass flows > 0.05 kg/hr)	5 (at mass flows > 0.05 kg/hr)	5 (at mass flows > 0.05 kg/hr)
HCL	30 (at mass flows >0.30 kg/hr)	30 (at mass flows >0.30 kg/hr)	30 (at mass flows >0.30 kg/hr)
Formaldehyde	60	60	-
Total Particulates (PM_{10})[3]	-	80	20

Notes: [1] denotes BAT guidance for the waste sector: Waste treatment activities, Draft, Nov 2003. EPA, Johnston Castle, Wexford, Co. Wexford.

[2] denotes personal communication EPA, 2005.

[3] denote that assumed Total particulates are PM_{10} to allow comparison with SI 271 of 2002. This will facilitate the assessment of a worst-case scenario.

[4] denotes emission limit values are expressed at standard conditions of 273 Kelvin and 101.3 kPa. Oxygen reference for flare is 3%, for gas compression engine is 5%, for sludge drier is 11%.

Table 4.6.15 Emission Limit Values (ELV) Used in the Modelling for the Proposed Site

Parameter	Flare ELV (mg m^{-3})[1, 4,5]	Gas Compression Engine ELV (mg m^{-3})[1,4]	Sludge Drier Plant ELV (mg m^{-3})[2,4]
CO	100	650	100
NO_X (NO_2 and NO)	100	100	129
SO_2	-	15	85
TOC	10	20	20
HF	5	5	2.42
HCL	30	30	4.85
Formaldehyde	-	60	-
Total Particulates (PM_{10})[3]	-	80	3.39

Notes: [1] denotes BAT guidance for the waste sector: Waste treatment activities, Draft, Nov 2003. EPA, Johnston Castle, Wexford, Co. Wexford.

[2] denotes personal communication EPA, 2005.

[3] denote that assumed Total particulates are PM_{10} to allow comparison with SI 271 of 2002. This will facilitate the assessment of a worst-case scenario.

[4] denotes emission limit values are expressed at standard conditions of 273 Kelvin and 101.3 kPa. Oxygen reference for flare is 3%, for gas compression engine is 5%, for sludge drier is 11%.

[5] denotes that either the flare or gas compression engine will run separately and not at identical times. The flare is a means of duty standby for the gas engine. Since the gas compression engine emission limit values are greater than the flare and stack height is similar, the GLC associated with the gas compression engine will be greater and therefore this is worst-case scenario.

Table 4.6.16 EPA Checklist for Air Dispersion Modelling

Item	Yes/No	Reason for omission
Location map	Drawing No. 1234/01/400	-
Site plan	Drawing No. 1234/01/403	-
List of pollutants modelled and relevant air quality guidelines	Yes	-
Details of modelled scenarios	Yes	-
Details of relevant ambient concentrations used	Section 2.6.2.2	-
Model description and justification	Yes	-
Special model treatments used	Yes	-
Table of emission parameters used	Yes	-
Details of modelled domain and receptors	Yes	-
Details of meteorological data used (including origin) and justification	Yes	-
Details of terrain treatment	Yes	-
Details of building treatment	Yes	-
Details of modelled wet/dry deposition	No	No mass fraction data, particle densities and no particle distribution data for specific operation. The modelling scenario is considered worst-case scenario.
Sensitivity analysis	No	All other meteorological stations not considered valid due to water bodies/distance. Terrain effects are accounted for in the modelling assessment.
Assessment of impacts	Yes	-
Model input files	No	E-mailed upon request

Results

Projected Emissions from the Proposed Kilshane Cross Recycling Park Operations

The predicted emissions to atmosphere from the Kilshane Cross Recycling Park operation are set out in Table 4.6.15. These emission rates (g s^{-1}) and stack characteristics were used as input data to ISC ST 3 to assess maximum ground level concentration values for comparison with the statutory instruments and relevant air quality impact criteria.

Pollutant Mass Emission Rates

Table 4.6.17 and 4.6.18 illustrate the mass emission rates used in the dispersion modelling study to assess the ground level impacts associated with the proposed development.

Table 4.6.17 Estimated Emissions from Gas Compression Engine Operation

Parameter	Gas conc. (mg m^{-3})	Expected volumetric flow rate ($m^3 s^{-1}$)	Mass emission rate (g s^{-1})	Mass emission rate (kg h^{-1})
Carbon Monoxide (CO)	650	1	0.65	2.34
Nitrogen Oxides(as NO_2)	100	1	0.1	0.36
Sulphur Dioxide	15	1	0.015	0.054
Organic Compounds (TOC)	20	1	0.02	0.072
Hydrogen fluoride (HF)	3	1	0.003	0.0108
Hydrogen chloride (HCL)	30	1	0.030	0.108
Formaldehyde	30	1	0.030	0.108
Total Particulates (as PM_{10})	80	1	0.080	0.288
Oxygen reference	5%	-	-	-
Emission Temperature (K)	723 K	-	-	-
Stack height (m)	10	-	-	-
Efflux velocity	15 m s^{-1}	-	-	-

Table 4.6.18 Estimated Emissions from Sludge Drying Operation

Parameter	Gas concentration (mg m^{-3})	Expected volumetric flow rate (m^3 s^{-1})[1]	Mass emission rate (g s^{-1})	Mass emission rate (kg h^{-1})
Carbon Monoxide (CO)	100	5.9	0.59	2.12
Nitrogen Oxides(as NO_2)	129[1]	5.9	0.76	2.74
Sulphur Dioxide	85[1]	5.9	0.50	1.81
Organic Compounds (TOC)	20	5.9	0.12	0.42
Hydrogen fluoride (HF)	0.50	5.9	0.003	0.0108
Hydrogen chloride (HCL)	4.85	5.9	0.03	0.10
Formaldehyde	-	5.9	-	-
Total Particulates (as PM_{10})	3.39[1]	5.9	0.02	0.07
Oxygen reference	11%	-	-	-
Emission Temperature (K)	453 K[1]	-	-	-
Stack height (m)	25[1]	-	-	-
Efflux velocity[1]	15 m s^{-1}	-	-	-

Notes: [1] denotes emission limit values and volumetric airflow rate provided by Entec Ltd.

Results of Air Quality Dispersion Modelling for the Proposed Kilshane Cross Recycling Park

ISC ST 3 was used to determine the overall air quality impact of the proposed Kilshane Cross Recycling Park operation to be located in Kilshane Cross, Co. Dublin as set out in air quality assessment criteria in Tables 4.6.11 and 4.6.12.

These computations give the relevant GLC's at each 50-meter x y Cartesian grid receptor location that is predicted to be exceeded for the specific air quality impact criteria. The Cartesian grid encompasses the facility location on all boundaries by a minimum of 700 metres. This 50-metre spaced Cartesian grid consisted of 2116 receptors. As part of the assessment, an additional 38 flagpole receptors were included in the modelling scenarios and maximum predicted concentrations within the modelled grid are reported for the relevant modelling scenario.

The modelling scenario was based on the following assumptions:

- All process operated simultaneously 24/7 365 days of the year,
- That emission limit values are established from regulatory agency guidance,
- A worst case meteorological year was used in the dispersion estimates,

As can be observed in Table 4.6.17 and 4.6.18 the mass emission rates chosen are at or within those limits established by the Environmental Protection Agency. This would represent highest emission event and therefore represent maximum predicted air quality impact based on these facts. Therefore, this will allow for the predictive analysis of maximum potential impact on the neighbouring sensitive locations while the facility is in operation.

Various averaging intervals were chosen to allow direct comparison of predicted GLC's with the relevant air quality assessment criteria as outline in Tables 4.6.11 and 4.6.12. In particular, 1 hour, 8 hour, 24 hour, and annual average GLC's of the various pollutants were calculated at various distances from the site. Relevant percentiles of these GLC's were also computed for comparison with the relevant Air Quality Standards presented in Tables 4.6.11 and 4.6.12.

The results are presented as follows:

- Predicted maximum air quality impact in the vicinity of Kilshane Cross Recycling Park during operation of Biological treatment facility-Anaerobic Digestion, Sludge Drying Hub and Waste transfer Station (see Table 4.6.19); This scenario was chosen as it represents worst case air pollutant mass emission conditions.

Table 4.6.19 Predicted Maximum Air Quality Impact in the Vicinity of the Proposed Kilshane Cross Recycling Park during operation of Biological Treatment Facility-Anaerobic Digestion, Sludge Drying Hub and Waste Transfer Station

Identity	Compound	Maximum predicted conc. value ($\mu g\ m^{-3}$)	Percentile value (%)
Maximum 8 hour concentration	CO	493	100th
Maximum 1 hour concentration	NO_2 as NO_X	124	99.79th
Annual average concentration	NO_2 as NO_X	4.85	--
Maximum 98th percentile of 1 hour averages	TOC	10.55	98th
Maximum 99th percentile of 1 hour averages	TOC	15.38	99th
Maximum 100th percentile of 1 hour averages	TOC	67.31	100th
Maximum 24 hour concentration	PM	16.60	98.08th
Annual average concentration	PM	3.0	--
Maximum 1 hour concentration	SO_2	25.50	99.73th
Maximum 24 hour concentration	SO_2	17.81	99.18th
Annual average concentration	SO_2	1.53	--
Maximum 1 hour average	HCL	60.5	-
Maximum 98th percentile of 1 hour averages	HCL	15.8	98th
Maximum 99th percentile of 1 hour averages	HCL	23.10	99th
Annual average concentration	HCL	1.15	-
Maximum 98th percentile value of 1 hour averages	HF	1.58	98th
Annual average concentration	HF	0.12	-
Maximum 24 hour average concentration	HF	1.10	-
Maximum of 1 hour average concentration	Formaldehyde	54	-
Annual average concentration	Formaldehyde	1.17	-

Discussion of Results

The dispersion model predictions of the worst case scenario are presented in Tables 4.6.19. The results are presented in a manner to allow for comparison between potential impacts for the proposed facility and relevant air quality guidelines and limits presented in Table 4.6.20.

Assessment of Air Quality Impacts

Table 4.6.20 presents the comparison between model predictions for air quality impacts, baseline air quality concentrations for the compounds and the percentage impact of the air quality criterion. As can be observed, there are no exceedences on air quality impacts for the modelled parameters.

Table 4.6.20 Comparison Between Predicted Air Quality Impacts and Assessment Criterion for the Modelled Parameters

Identity	Compound	Maximum predicted conc. Value ($\mu g\ m^{-3}$)	Baseline concentration value ($\mu g\ m^{-3}$)[1]	Total predicted impact conc. (Baseline + Predicted contribution) ($\mu g\ m^{-3}$)	Impact criterion ($\mu g\ m^{-3}$)	% of Criterion
Maximum 8 hour concentration	CO	493	600	1093.00	10,000	10.93
Maximum 1 hour concentration at 99.79th percentile	NO_2 as NO_X	124	30.80	154.80	200	77.40
Annual average concentration	NO_2 as NO_X	4.85	22	26.85	40	67.13
Maximum 98th percentile of 1 hour averages	TOC	10.55	146	156.55	1000	15.66
Maximum 99th percentile of 1 hour averages	TOC	15.38	146	161.38	1000	16.14
Maximum 100th percentile of 1 hour averages	TOC	67.31	146	213.31	1000	21.33
Maximum 24 hour concentration	PM	16.60	28	44.60	50	89.20
Annual average concentration	PM	3.0	15	18.00	20	90.00
Maximum 1 hour concentration	SO_2	25.50	47	72.50	350	20.71
Maximum 24 hour concentration	SO_2	7.81	0.65	8.46	125	6.77
Annual average concentration	SO_2	1.53	0.65	2.18	20	10.90
Maximum 1 hour average	HCL	60.5	0.0002[3]	60.50	350	17.29
Maximum 98th percentile of 1 hour averages	HCL	15.8	0.0002[3]	15.80	100	15.80
Maximum 99th percentile of 1 hour averages	HCL	23.1	0.0002[3]	23.10	700	3.30
Annual average concentration	HCL	1.15	0.0002[3]	1.15	50	2.30
Maximum 98th percentile value of 1 hour averages	HF	1.58	0.0001[3]	1.58	3.0	52.67
Annual average concentration	HF	0.12	0.0001[3]	0.12	0.3	40.04
Maximum 24 hour average concentration	HF	1.10	0.0001[3]	1.10	2.8	39.29
Maximum of 1 hour average concentration	Formaldehyde	54	4.84	58.84	62.50	94.14
Annual average concentration	Formaldehyde	1.17	4.84	6.01	25	24.04

Notes: See Overleaf

Notes: [1] denotes for baseline data see Section 2.6.2.2;

[2] denotes for impact criterion see Tables 4.6.11 and 4.6.12;

[3] denotes data taken from Indaver Ireland EIS-Carranstown Waste Management Facility.

[4] denotes 3 to 45 ppb is found in the atmosphere of major cities. A value of 0.05 to 4 ppb has been recorded for monitoring stations in Mace Head, Galway and Weybourne, UK. A value of 4 ppb was used for this study to represent this suburban environment, Hak, C. (2005). Inter comparison of four different in-situ techniques for ambient measurements in urban air. Atmos. Chem. Phys. Discuss., 5, 2897-2945.

Oxides of Nitrogen (NO_2) Air Quality Impact

The results for the potential air quality impact for dispersion modelling of NO_2 based on the emission rates in Tables 4.6.17 and 4.6.18 are presented in Table 4.6.20. Results are presented for the identified maximum emission regime. As can be observed, the maximum Ground Level Concentration (GLC) for NO_2 from the operation of the Recycling Park is 124 $\mu g\ m^{-3}$ for the 99.79[th] percentile for a 1-hour mean concentration. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 99/30/EC, this is 22.6% lower than the set target limits. An annual average was also generated to allow comparison. When compared the annual average NO_2 air quality impact is 67.13% less than the target limit. This maximum annual concentration is also 13.16% less than the strict ground level concentration for the protection of vegetation and ecosystems.

As the Recycling Park was assumed to be operating 24 hours per day and 365 days per year, and a worst case available meteorological data set was used, it is predicted that the operation of the Recycling Park will have no detrimental contributory air quality impacts.

Carbon Monoxide (CO) Air Quality Impact

The results for the potential air quality impact for dispersion modelling of CO based on the emission rates in Tables 4.6.17 and 4.6.18 are presented in Table 4.6.20. Results are presented for the maximum emission regime. As can be observed, the maximum GLC for CO from the operation of the Recycling Park is 493 $\mu g\ m^{-3}$ for the maximum 8-hour mean concentration. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 99/30/EC, this is 89.10% lower than the set target limits.

Sulphur dioxide (SO_2) Air Quality Impact

The results for the potential air quality impact for dispersion modelling of SO_2 based on the emission rates in Tables 4.6.17 and 4.6.18 are presented in Table 4.6.20. Results are presented for the identified maximum emission regime. As can be observed, the maximum GLC for SO_2 from the operation of the Recycling Park is 7.81 $\mu g\ m^{-3}$ for the 99.18[th] percentile for a 24-hour mean concentration. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 99/30/EC, this is 93.30% lower than the set target limits. A 1 hour maximum GLC for the 99.73th percentile was generated to allow comparison with the assessment criteria. This predicted value including baseline is 79% lower than the assessment criterion. An annual average was also generated to allow comparison. When compared the annual average SO_2 air quality impact is 89.10% less than the target limit.

As the Recycling Park was assumed to be operating 24 hours per day and 365 days per year, and a worst-case available meteorological data set was used, it is predicted that the operation of the Recycling Park will have no detrimental contributory air quality impacts.

Particulates (PM) as PM_{10}

The results for the potential air quality impact for dispersion modelling of PM_{10} based on the emission rates in Tables 4.6.17 and 4.6.18 are presented in Table 4.6.20. Results are presented for the identified maximum emission regime. As there was a lack of data on air stream particulate composition, mass fractions and particle densities, it was assumed that the particle air stream was similar to a gaseous air stream. Wet and/or dry deposition and scavenging were not accounted for in the modelling scenarios. The results are discussed in relation to the air quality guidelines for PM_{10}.

As can be observed in Table 4.6.20, the maximum GLC for PM_{10} from the operation of the Recycling Park is 16.60 μg m^{-3} for the 99.08th percentile for a 24-hour mean concentration. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 99/30/EC, this is 10.80% lower than the set target limits. An annual average was also generated to allow comparison. When compared the annual average PM_{10} air quality impact is 10% less than the target limit.

As the Recycling Park was assumed to be operating 24 hours per day and 365 days per year, and a worst-case available meteorological data set was used, it is predicted that the operation of the Recycling Park will have no detrimental contributory air quality impacts.

Total Organic Carbon (TOC)

The results for the potential air quality impact for dispersion modelling of TOC based on the emission rates in Tables 4.6.17 and 4.6.18 are presented in Table 4.6.20. Results are presented for the identified maximum emission regime. As can be observed, the maximum GLC for TOC from the operation of the Recycling Park is 10.55, 15.38, and 67.31 μg m^{-3}, respectively for the 98th, 99th, and 100th percentile for a 1-hour mean concentration. When combined predicted and baseline conditions are compared to the adapted TA Luft guidelines, this is 78.7% lower than the set target limits of 1000 μg m^{-3} for Class III compounds. It is therefore predicted that the operation of the Recycling Park for any of the modelled scenarios will have no significant contributory air quality impacts.

Hydrogen Fluoride (HF), Hydrogen Chloride (HCL) and Formaldehyde (CH_2O)

The results for the potential air quality impact for dispersion modelling of HF, HCL and CH_2O based on the emission rates in Tables 4.6.17 and 4.6.18 are presented in Table 4.6.20. Results are presented for the identified maximum emission regime. As can be observed, the maximum GLC for HF from the operation of the Recycling Park is 1.58 $\mu g\ m^{-3}$ for the 98^{th} percentile for a 1-hour mean concentration and 1.10 $\mu g\ m^{-3}$ for a 24-hour mean concentration. When combined predicted and baseline conditions are compared to the TA Luft, Dutch and WHO guideline values, this is 47.4 to 60.8% lower than the set target limits. An annual average was also generated to allow comparison. When compared, the annual average HF air quality impact is 59.96% less than the target fractional limit.

Predicted GLC of HCL are negligible when compared to the TA Luft, Danish C and fractional exposure limit values. Predicted GLC impacts are from 82 to 97% lower than the limit values.

Predicted GLC of Formaldehyde are between 4.9 to 73% lower than the fractional and annual exposure limit values established. It is therefore concluded that GLC of formaldehyde will not contribute significant impact to the surrounding environment.

Interim Conclusions

The following interim conclusions were drawn from the dispersion modelling assessment:

- A worst-case assessment was analysed to estimate the worst case air quality impact in the vicinity of the proposed Kilshane Cross Recycling Park;
- The maximum GLC for NO_2 from the operation of the Recycling Park is 124 $\mu g\ m^{-3}$ for the 99.79^{th} percentile for a 1-hour mean concentration. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 99/30/EC, this is 22.6% lower than the set target limits. An annual average was also generated to allow comparison. When compared the annual average NO_2 air quality impact is 13.16% less than the target limit.
- The maximum GLC for CO from the operation of the Recycling Park is 493 $\mu g\ m^{-3}$ for the maximum 8-hour mean concentration. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 99/30/EC, this is 89.10 % lower than the set target limits.
- The maximum GLC for SO_2 from the operation of the Recycling Park is 7.81 $\mu g\ m^{-3}$ for the 99.18^{th} percentile for a 24-hour mean concentration. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the

EU Daughter directive on Air Quality 99/30/EC, this is 93.30% lower than the set target limits. A 1 hour maximum GLC for the 99.73th percentile was generated to allow comparison with the assessment criteria. This predicted value including baseline is 79% lower than the assessment criterion. An annual average was also generated to allow comparison. When compared the annual average SO_2 air quality impact is 89.10% less than the target limit.

- The maximum GLC for PM_{10} from the operation of the Recycling Park is 16.60 μg m^{-3} for the 99.08th percentile for a 24-hour mean concentration. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 99/30/EC, this is 10.80 % lower than the set target limits. An annual average was also generated to allow comparison. When compared the annual average PM_{10} air quality impact is 10% less than the target limit.
- The maximum GLC for TOC from the operation of the Recycling Park is 10.55, 15.38, and 67.31 μg m^{-3}, respectively for the 98th, 99th, and 100th percentile for a 1-hour mean concentration. When combined predicted and baseline conditions are compared to the adapted TA Luft guidelines, this is 78.7% lower than the set target limits of 1000 μg m^{-3} for Class III compounds. It is therefore predicted that the operation of the Recycling Park for any of the modelled scenarios will have no significant contributory air quality impacts.
- The maximum GLC for HF from the operation of the Recycling Park is 1.58 μg m^{-3} for the 98th percentile for a 1-hour mean concentration and 1.10 μg m^{-3} for a 24-hour mean concentration. When combined predicted and baseline conditions are compared to the TA Luft, Dutch and WHO guideline values, this is 47.4 to 60.8 % lower than the set target limits. An annual average was also generated to allow comparison. When compared, the annual average HF air quality impact is 59.96 % less than the target fractional limit. Predicted GLC of HCL are negligible when compared to the TA Luft, Danish C and fractional exposure limit values. Predicted GLC impacts are from 82 to 97% lower than the limit values. Predicted GLC of Formaldehyde are between 5 to 75% lower than the fractional and annual exposure limit values established. It is therefore concluded that GLC of formaldehyde will not contribute significant impact to the surrounding environment.

4.6.2 Mitigation Measures

4.6.2.1 Dust

In order to mitigate dust emissions on-site, most areas of the site that traffic will be on will be paved. Hardstand and paved areas will be sprayed with water when necessary, to avoid dust generation. A 3.5m high soil berm will be constructed around the material processing and stockpiling area of the C&DWRF, in order to mitigate the potential impact of dust generation at the facility. The hardcore areas and the stockpiles in the outdoor C&D waste recovery area will be sprayed, if there is excessive dust generation during dry periods. All other waste activities will take place indoors. Visual inspections will be carried out at each facility on a daily basis, and all hardstand areas, roads and building floors will be cleaned when required. In addition dust monitoring will be carried out annually at the locations shown in Figure No.3.4.1 and as outlined in Section 2.6.1.

4.6.2.2 Odour

The following mitigation measures are recommended to reduce the impact of odours:

1. All odour abatement and minimisation procedures stated in Sections 4.6.1.9 and 4.6.1.10 of this report will be implemented throughout the proposed Kilshane Cross Recycling Park in order to prevent any odour nuisance in the surrounding area.
2. During DBO procurement, odour emission limit values as discussed in Tables 4.6.4 and 4.6.5 will be used for specification. Any reduction in stack height can only be allowed if odour emission rates for the particular process are reduced. Verification of no odour impact will be confirmed using dispersion modelling techniques operated in accordance wit the Irish and UK EPA.
3. Maintain good housekeeping practices, closed-door management strategy (i.e. to eliminate puff odour emissions from composting and waste transfer building) and implement an odour management plan for the operators of the Kilshane Cross Recycling Park (i.e. for preventative maintenance of odour abatement systems, etc.).
4. Ensure exhaust chimney height and efflux velocity of abatement systems are situated away from buildings and have an efflux of no less than 15 m s^{-1}.
5. Enclose and seal all significant odourous processes to eliminate the contamination of large building volumes. If this is not possible use dividing wall to contain significant odourous processes. By adapting flexible extraction systems, air changes per hour can be adapted for the particular process during the particular worst-case odour emission time period.

4.6.2.3 Bioaerosols

The following are the main conclusions of the Bioaerosol desktop study for the proposed Recycling Park:

1. All air produced by the proposed composting facility will be treated using a biofiltration system
2. The maximum predicted 1 hour concentration of bioaerosols for the three classes at the boundary is:
   - CFU m^{-3} for Aspergillus *fumigatus* (see Figure 4.6.6)
   - 17 CFU m^{-3} for Mesophilic Bacteria (see Figure 4.6.7)

- 34 CFU m^{-3} for Total Fungi (see Figure 4.6.8) for a worst-case library based Bioaerosol emission rate.

3. The maximum predicted Bioaerosol concentration at ground level is:
   - 9 CFU m^{-3} for Aspergillus *fumigatus* for a 1-hour maximum concentration level,
   - 38 CFU m^{-3} for Mesophilic Bacteria for a 1-hour maximum concentration level,
   - 70 CFU m^{-3} for Total fungi for a 1-hour maximum concentration level,
4. These maximum impact concentration levels are near background levels and from 29 to 119 times lower than the proposed Bioaerosol impact criterions in Table X.
5. The proposed composting facility is outside the recommended setback distance proposed by the Irish EPA, CRE (Irish composting Council) and the UK Environment Agency. This setback distance is to provide safety for residential locations in the vicinity of the composting facility. All composting processes will be carried out indoors and all air passed through a biofiltration system, which will even further reduce any risks associated with the facility.

It is recommended that:

Good housekeeping techniques:

- Keeping the dry material damp with a clean water source;
- Keeping hard surfaces and roads damp and cleaning them regularly to prevent any dust emissions;
- Eliminate unessential mixing and turning within the composting building,
- Ensure all offloading is performed indoors and away from external doors. Where space is a problem, the installation of air curtains will help maintain a physical barrier to the release of bioaerosols;
- Enclose tipping area within tipping bay

Extraction system and filtration:

- A suitable extraction system incorporating essential hood extraction to reduce and Bioaerosol emission will be installed in the Biological Treatment Facility.
- The building will be maintained under negative ventilation and all air will be extracted through the biofiltration system.
- Door areas will be kept to a minimum in order to reduce air exchange rate and building fabric will be maintained in good condition to prevent any fugitive emissions.
- Air curtains can be used as physical barriers between the atmosphere and indoor environment to prevent fugitive emissions from the open doors area.

Preventive maintenance:

- Ensure that all air extraction equipment (fans and ductwork, etc.) have indicator instrumentation (i.e. pressure sensors, etc) and are visually checked weekly to maintain maintenance log records for predictive maintenance schedules.

- Ductwork will require access ports in order to allow investigation of any dust build-up.
- All ductwork will be operated in the 15 m s^{-1} air velocity range to reduce dust deposition within the ductwork.

4.7 Noise & Vibration

4.7.1 Characteristic of Proposal

The proposed Recycling Park will consist of a construction and demolition waste recovery facility, a biological waste treatment facility treating segregated domestic and commercial organic waste, a waste transfer facility processing municipal waste and a sludge hub centre treating de-watered sludge cake from wastewater treatment facilities.

4.7.2 Potential Effects/ Impacts

The proposed development consists of:

- The construction of the all the facilities
- The operation of the completed facilities
- The subsequent road traffic flow associated with operation of the completed facilities

4.7.2.1 Noise Criterion

For outdoor noise at residential properties the basic criterion for industrial activity at night-time is normally less than 45 dB(A), while the day-time criterion is normally less than 55 dB(A). Local Authorities throughout Ireland and the EPA through their Integrated Pollution Licensing apply the aforementioned limits with the additional specification that there should be no clearly audible tonal components at any sensitive residence at night time. For this development, a night time (22.00 to 08.00 hrs) limit of 40 dB(A) will apply at all residences with a day time (08.00 to 22.00 hrs) limit of 55 dB(A).

For construction there are no Irish guidelines for noise, however it is normal to use the methodology and information outlined in *BS 5228: Noise and Vibration Control on Construction and Open sites, 1997.* This standard does not give limits but outlines methods of control.

4.7.2.2 *Construction Noise*

Typical Construction Noise Sources and Measurements

Construction activities on a large site have the potential to generate considerable levels of noise. Noise emissions are associated both with the movement of construction traffic to and from the site, and the operation of equipment on the site e.g. excavators, lifting equipment, dumping trucks ready-mix trucks etc.

The construction programme has been established in preliminary form only, however it is possible to calculate the magnitude of noise emissions based on typical construction activity. It is also worth noting that with construction activity on a large site, doubling the activity onsite (which will result in a shorter duration) may not mean a resultant doubling of the noise emission by 3 dB(A). This is due to the fact that in theory (and in prediction models) when noise sources are added, an assumption is made that the noise sources are together. In practice only a limited number of pieces of equipment can be operating close to each other which means a doubling of activity may increase the noise emission on the boundary of the site by no more than 1 dB(A). A list of the noisier pieces of construction plant that could be operating on the construction site is shown in Table 4.7.1. Activities such as steel erection, installation of mechanical plant etc. is not considered as a noisy activity.

The construction predictions are based on all four facilities, which forms the Recycling Park being constructed simultaneously.

Leq measurements were taken of construction noise sources at other sites within the country at 20m from the geometric centre of activity when the equipment was in continuous operating mode. Noise levels of the noise sources are given in Table 4.7.1 and were as follows:

Table 4.7.1 Noise Levels from Construction Activity

Noise Source	Noise Level – Leq 1hr
Readymix truck	70 dB(A)
Large Excavator	73 dB(A)
Vibratory Roller	68 dB(A)
Dump truck	71 dB(A)
Caterpillar D8	76 dB(A)
Water Pump	73 dB(A)
40 tonne Crane	69 dB(A)
Poker Vibrators	68 dB(A)

4.7.2.3 Calculation and Prediction of Construction Noise

Methodology

The predicted noise levels generated by construction activity at a particular location can be calculated according to the following formula:

Lp2 = Lp1 + ΔLψ - ΣΔL where,

Lp2 = Sound Pressure level in decibels at Residence.

Lp1 = Sound pressure level in decibels at 20 metres.

ΔLψ = correction for direction effects in a horizontal plane,

ΣΔL = ΔLd + ΔLa + ΔLr + ΔLs + ΔLv + ΔLg +ΔLw, and where,

ΔLd = geometric spreading (spherical radiation) and is calculated according to:

ΔLd = 20 $\log_{10}$ (d1/d2), where, d1 is the residence distance in metres, while d2 is 20 metres.

ΔLa = air absorption

ΔLr = reflection and diffraction

ΔLs = screening

ΔLv = vegetation

ΔLg = ground absorption

ΔLw = wind gradients

The attenuation effects due to air absorption, reflection, refraction and vegetation is small within distances of 100m and in the predictive calculations the attenuation from these factors is assumed to be zero within 100m. The other attenuating factors have been taken accounted of in the proposed development. The predicted levels (in one-hour Leq values) are given in Table 4.7.2. Locations of the receiver positions are shown in Figure No. 4.7.1.

The maximum noise levels predicted assume that activity is at a location closest to the receiver position. Civil works including the removal of topsoil will give rise to the maximum noise levels at nearest residences, however this type of essential activity will be of short duration and will be for no more than 2 weeks equivalent at any residence.

Table 4.7.2 Predicted Noise Levels at Key Locations from Construction Activity

Receiver Position	Predicted Maximum Levels L_{AeqT} - 1 hour dB(A)	Predicted Typical Levels L_{AeqT} - 1 hour dB(A)
R1 (residence)	63.5	<53.5
R2 (residence)	63.4	<53.4
R3 (residence)	57.5	<50
R4 (residence)	53.7	<45
R5 (Veridian Plant)	57.5	<50
R6 (unused structure alongside N2)	68.0	<50

Note: Location R1 assumes a 3.5m high barrier (between noise source and receiver). The maximum Leq noise levels will pertain for short periods (less than 2-week equivalent at any location for entire project), while typical noise levels are for a period in excess of 50% of the total construction period.

All construction will be carried out in accordance with BS 5228: Part 1: 1997[1] Accordingly, all construction traffic to be used on site will have effective well-maintained silencers. Operators of all mobile equipment will be instructed to avoid unnecessary revving of machinery and limiting the hours of site activities that are likely to give high noise level emissions. Where possible the contractor will be instructed to use the least noisy equipment. With efficient use of well maintained mobile equipment considerably lower noise levels (3-6 dB(A)) than those predicted can be attained. The Project Engineer will closely supervise all construction activity. Construction activity due to its nature is a temporary activity and thus any impacts will be short term. All construction works will be carried out during daytime periods.

suffix	revisions	date	inl

Fingal County Council
Comhairle Contae Fhine Gall

Project
KILSHANE CROSS RECYCLING PARK

Drawing Title
LOCATION OF POTENTIAL NOISE RECEIVERS

Scale 1/4000 (A3)

Drawn by	Checked by	Date
Colin Peacock	DB	September 2005

ENGINEER IN CHARGE: Sean Finlay

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Drawing No.
FIGURE 4.7.1

Rev.

Construction Road Traffic

Material deliveries and work force movements will be via the existing road network directly on to the N2 (See Traffic Section Assessment). All construction traffic will be controlled to enter and leave the development area through the main entrance on to the National Primary Route (N2). The construction road traffic is predicted to generate a maximum of 40 trips per day (20 HCV and 20 light vehicles). The predicted construction traffic represents an increase on the present daily flow of less than 0.5% (assumes that the proposed new motorway will not be opened). There is a logarithmic relationship between noise levels and traffic volume and the higher the existing traffic volume the greater is the traffic increase required to produce a perceptible noise change. Typically, doubling the traffic flow produces a 3 dB(A) change in noise level. The increase in noise levels resulting from construction road traffic will be insignificant (at less than 0.2 dB(A)) and there will be no night-time traffic noise.

4.7.2.4 Potential Effects/ Impacts from Completed Development

The main noise sources will be those associated with:

- Sludge Hub Centre treating 26,511 tonnes per annum of dewatered sludge cake
- Waste Transfer Facility processing 65,000 tonnes per annum of residual waste
- Biological Waste Treatment Facility, composting or aerobic digestion treating 45,000 tonnes of segregated domestic and commercial waste
- C & D Waste Recycling Facility processing 75,000 tonnes per annum

It has not been decided whether composting or aerobic digestion will be used in the biological waste treatment facility, however, for the purpose of predicting the cumulative impacts of the completed development the option that would be most likely to have the highest noise emission output was considered.

The main mobile and fixed plant noise sources (typical) to be used in the completed operational recycling facility are detailed in Table 4.7.3. The noise level data was taken from existing databases and from Bies and Hansen, Engineering Noise Control. Other noise sources such as conveyors, small air compressors are not considered, as these are insignificant when compared to the major sources.

Table 4.7.3 Main Mobile & Fixed Plant Noise Levels & Sources to be Used in the Operational Recycling Park

Noise Source	Noise Level dB(A) @ 10m	Duration of Activity
Sludge Hub Centre Treating 26,511 tonnes/annum*		
Wall mounted extraction fan	66	24hr/day
Oil burner	68	24hr/day
Drier – Cylindrical chamber	58	24hr/day
Waste Transfer Facility Processing 65,000 tonnes/annum*		
Front End Loaders x 2	80	8hrs/day
Crane/Grab x 2	78	8hrs/day
Trommel Screen	82	8hrs/day
Shredder	85[1]	8hrs/day
Biological Waste Treatment Facility, Composting 45,000 tonnes/annum*		
Front End Loaders x 2	80	8hrs/day
Crane/Grab	78	8hrs/day
Shredder	85	8hrs/day
Sieving	52	8hrs/day
Roll/off truck	77	8hrs/day
Air Blowers(Ventilation)	<47	24hrs/day
CHP - Unit	<45	24hrs/day
Gas Flare	54.5	24hrs/day
C & D Waste Recycling Facility processing 75,000 tonnes/annum		
Crane/Grab x 2	78	8hrs/day
Front End Loaders x 2	80	8hrs/day
Mobile Crusher	85	4hrs/day
Trommel Screen	82	8hrs/day
Roll on/off trucks	77	4hrs/day

* Noise sources / activity will be enclosed in housing envelopes

The projected noise levels from on-site operations of the completed recycling works are given in Table 4.7.4. The predicted levels assume that all mobile and fixed plant is operational together and that all these main noise sources are housed inside a building structure / envelope giving an overall sound transmission loss of 15 dB(A).

Table 4.7.4 Predicted Noise Levels from Operation of Completed Recycling Park

Receiver Position	Predicted Maximum Levels L_{AeqT} - 1 hour dB(A)
R1 (residence)	46.2
R2 (residence)	46.5
R3 (residence)	42.0
R4 (residence)	39..5
R5 (Veridian Plant)	42.1
R6 (unused structure alongside N2)	50.7

4.7.2.5 Potential Road Traffic Effects/ Impacts from Operation of Completed Development

Following construction and with the development completed, the principal road traffic noise will be that associated with delivery of materials to and from the recycling facility, staff movements, and visitors. The total flow as predicted in the traffic section assessment is 450 movements (310 HCV's + 140 light vehicles). This projected flow represents less than 2% of the existing flow projected for the N2 in 2004. This increase in noise levels resulting from the completed development will be insignificant at less than 0.3 dB(A)) along the N2.

It is however predicted that when the recycling facility is completed, the traffic flow on the N2 will be substantially reduced by the opening of the new N2 motorway. The traffic flow increase on the existing N2 in year 2006 (with new N2 motorway open) is predicted at less than 10% of the projected 2004 N2 flow. This increase in noise levels will be insignificant at less than 0.8 dB(A)) along the N2.

4.7.2.6 Ground Vibration

Ground vibration can be generated from construction traffic, light vehicles on the roadway and by construction activity.

Standards Criteria and Guidelines

Peak particle velocity (PPV) is well established as being the best single descriptor to use when assessing vibration damage to structures. Research in structural dynamics has also shown that structures respond differently when exited by vibrations, equal in all respects, but differing in principal or resonant frequency (Dowding 1996). The recognition of the importance of frequency has led to the necessity of adopting a vibration monitoring approach that includes frequency.

The USBM/OSMRE analysis is one of the most widely used and some of our European Partners have adopted variations of this standard. The German Standard, DIN 4150 is also widely used, however it has been difficult to obtain the data upon which this standard was derived (New). In 1993 British Standards Institute adopted BS 7385 Part 2: 1993, a standard which is based predominately on a literature review of other standards and guidelines and which is also widely used. The Swiss Standard: 'Vibration Effects on Construction' 1992[7] is particularly relevant as it relates directly to construction type activity and takes into consideration the class of frequency, number of occurrences and the sensitivity of the structure being impacted upon.

The determining factor used to assess the harmful effects of ground vibrations is the maximum vector - particle velocity (mm/sec), taking into account the frequency of the transmitted wave and the number of occurrences. The velocity versus frequency plots are internationally known recommendations/standards for damage control assessment and are for measurements taken with respect to dwellings. Structures are more susceptible to damage when subjected to frequencies below 20 Hz. This is due to the fact that concrete walls and floors of homes/structures have their own fundamental or natural frequencies below 20 Hz (below 15 Hz for two storey houses). Dowding 1996 (Construction Vibrations) demonstrates the relationship between the many different types of vibration sources and how the generated vibration waves are assessed for damage using particle velocity and frequency.

Humans are much more sensitive to vibration than building structures. The human threshold for vibration is 0.2mm/sec peak particle velocity.

The ground vibration generated by construction traffic will be less than the level of perception, at less than 0.2 mm/sec, at all residences. Construction activity vibration (vibratory roller) will be controlled by adhering to the Swiss Standard:

"Vibration Effects on Construction 1992. (limit of 6 mm/sec peak particle velocity for frequent vibration at normal sensitive structures at frequencies below 30 Hz and 12 mm/sec for frequencies above 60 Hz)."

4.7.3 *Mitigation Measures*

- A 3.5m topsoil berm will be constructed along the southeast boundary of the site in line with house locations R1, R2 and R3, and to the around the processing and stockpiling areas of the C&DWRF.

- Operators of all mobile equipment will be instructed to avoid unnecessary revving of machinery, turn off equipment / plant when not in use and limit the hours of site activities that are likely to give high noise level emissions.

- The structure that will house all the main noise sources will be designed to give an overall sound transmission loss of 15 dB(A)

The maximum noise levels predicted will occur during the construction phase of the development and will pertain for short periods only. Construction by nature is a temporary activity. The noise level predictions from the increase in road traffic flow attributable to construction will be negligible along the N2 at less than 0.2 dB(A).

There will be no perceptible increase in road traffic generated ground vibration. Using best practice the level of ground vibration generated from construction activities will be kept well below the guidelines in all of the recognised standards and guidelines.

The noise level predicted from the operation of the completed recycling facility are well below the limits as set by the EPA Licensing and well below the existing baseline noise levels.

The noise level predictions from the increase in road traffic flow attributable to completed development will be negligible along the N2 at less than 0.8 dB(A).

There will be no perceptible increase in road traffic generated ground vibration from the completed development.

4.8 Landscape

4.8.1 Introduction

Landscape and visual impacts can arise from the development in a number of ways, in particular:

- Removal of landscape features (temporary or permanent)
- Construction impacts (short term)
- Operational impacts, including lighting (medium or long term)

Removal of landscape features

Nearly all development projects require an element of site clearance prior to or during construction. It is anticipated that it will be necessary to remove a section of the earth embankment alongside the N2, to make an entrance into the site. Existing boundary hedgerows will not be removed, and the stream on the western boundary will be left unculverted. Existing grassland within the site will be removed

Construction impacts (Short Term)

Construction impacts may potentially arise from the short term presence of contractor's compounds, construction activities and the working areas. Features are likely to include plant activity, including mobile cranes, parking of contractors vehicles, storage of materials and fuel, movement of excavated materials, delivery of materials and plant and incomplete structures.

Operational Impacts (Long Term)

Operational impacts will arise from the presence of new structures in the landscape. These elements will comprise the Waste Transfer Facility, Sludge Drying Facility, Biological Facility and C&D Waste Facility. The Biological Facility is the most significant of these and, given the height and location of some of the structures and associated emission stacks (up to 20 metres high), there is the potential impact for these to be dominant features of the local landscape. There is also the potential for lighting of the Recycling Plant to feature in the nocturnal landscape. However this would be in the context of the existing power plant, which is already lit at night.

4.8.2 Potential Effects/ Impacts

At this stage, we have considered the scope of the proposed development, the relevant planning context and landscape policies for the area, the potential landscape and visual impacts that might arise from the proposed development and the range of mitigation measures that are likely to be employed in implementing this project. This section of the landscape and visual impact assessment will describe in detail the anticipated likely impacts upon the landscape and visual amenity of the area arising from the proposed development.

4.8.2.1 Likely Effects/ Impacts During Construction

Construction impacts are likely to have significant impacts, but by their nature will be short-lived. Perimeter vegetation will be retained wherever possible. The working area will be kept away from the site of the archaeological earthwork.

Construction activities will be largely screened from the south and southwest of the site by the temporary quarry workings and presence of intervening vegetation. Views from the north and northwest will be partially screened by the construction of the new N2 road and intervening vegetation.

The construction of Recycling Park will be phased according to the type of individual facility proposed.

4.8.2.2 Likely Effects/ Impacts on the Landscape

The effect of the proposals would be to increase the footprint area and size of industrial type facilities within the Kilshane area. This would serve to increase the dominance of industrial scale buildings within the landscape. The effects would be localised between the Kilshane Cross Bridge, Johnstown, Huntstown, Newtown and Coldwinters. The nature of the development is consistent with other nearby land uses, as the presence of the quarry, power plant and associated structures; power lines and pylons already heavily influence and degrade the landscape character of the area immediately adjacent to the proposed development (refer to Photograph 8). The ongoing construction of the new N2 road is further degrading the existing landscape character. From the south, southwest and west, the proposed development will be screened by the existing quarry buildings and temporary embankments and existing hedgerows (refer to Photographs 3 and 4). However the tallest elements of the structures would be visible.

From the north, northeast and east (refer to Photographs 6-8) the lower level elements of the proposals will be screened by the new N2 and associated planting, local topography and existing vegetation. The taller structures will be visible but would not significantly change views as tall existing industrial buildings to the southwest of the site are already prominent in theses views.

Appropriate finishes will lessen the impact of the larger buildings and structures within the landscape. The retention of existing vegetation and earth banks surrounding the site plus further woodland planting along the edges of the site will visually break up the scale of the development. The new planting would become an effective screen as it matures and will integrate the development into the surrounding mature field hedgerows. The proposed landscape bund in the south-east of the site, providing partial screening to the adjacent residential properties; this would be further enhanced by additional planting on the slopes facing the properties. The proposed earth bunding in the north of the site, will shelter the C&D Waste Facility; this would also be further enhanced by additional planting. The setting of the site of the ancient monument in the north of the site will benefit from screen planting to separate it from the C&D Waste facility.

Overall Effect: Moderately negative impact

4.8.2.3 Likely Effects/ Impacts on Public Open Space

Areas of public open space do not occur in the vicinity of the proposed development and therefore there will be no impacts.

4.8.2.4 Likely Effects/ Impacts on Roads

The users of the existing N2 road will receive a slightly negative impact from the development following mitigation. The retention of the existing earth embankment along the border of the site with the N2 road will provide some screening for road users (refer to Photograph 14). There would also be glimpsed views through gaps in the earth embankment. The impacts of the proposals could be mitigated by filling in some gaps in the earth embankment and by further screen planting to the eastern boundary of the development site.

The views from the new N2 will be greater than from the existing N2. This is because the new road will be elevated over the existing N2 in the northeast corner of the site (refer to Photograph 13). During the first year of the road opening, this will allow for views over the entire site. However as the tree and shrub planting on the embankments of the new N2 road matures, the views of the Recycling Park will be lessened. Further tree and shrub planting within the site especially between the archaeological feature and C&D waste facility will further mitigate undesirable views from the new N2 road. The visual impact is judged to be moderately negative.

The users of the minor road running through Kilshane, will experience a slightly negative visual impact. The existing dense hedgerows along the eastern boundary of this route, existing intermittent vegetation and the screening effect of the temporary quarry embankments will screen most of the development (refer to Photographs 4 and 5). The only section of the route than will experience a moderately negative visual impact is the very short section where the route will be elevated to cross the new N2 at the Kilshane overbridge (refer to Photograph 6).

Views from the minor road running between Kilshane Bridge and R122 road will have moderate change (refer to Photograph 7). Intervening screening elements; existing vegetation, topography and the new N2 road will provide some screening of the development. The taller buildings and structures will be visible. The visual impact is judged to be moderately negative.

Users of R122 road will experience slight changes to view from the construction and operation of the Recycling Park. The taller buildings and structures will be partially visible from the west. The visual impact is judged to be slightly negative.

The views from the minor road between N2 road and R122 road will experience a moderately negative impact. The taller buildings and structures will be partially visible from the west (refer to Photograph 8).

Views to the site from the access road to the quarry (refer to Photograph 3) will be partially screened by the existing quarry and industrial buildings. Views of the upper sections of structures and buildings will be available along sections of this route. The type of buildings and structures existing along this route are similar in type to those proposed in the development. The visual impact is judged to be slightly negative.

Along the access track to Johnstown (refer to Photographs 1 and 2), the dense trackside hedgerow and intermittent vegetation will screen the majority of the development except for some glimpses of upper parts of the structures. The visual impact is judged to be slightly negative.

4.8.2.5 Likely Effects/ Impacts on Residential Areas

The areas immediately surrounding the proposed development are not densely populated. Therefore providing limited scope for impact on residential amenity.

Properties located immediately by the southeastern end of the development and which line the existing

N2 road will experience the most significant effects of the development; due to their close proximity (refer to Photographs 9 and 15). The proposed landscape bunding and planting along the southeast boundary of the site will screen these properties from ground floor level in the opening year of the proposals. However the growth of shrub and tree material will also further lessen the visual impact over time but correspondingly will be a visual obstruction changing the nature and extent of views. The visual impact is judged to be significantly negative.

The property located on Johnstown lane to the south of the proposals is single story bungalow facing northeast. The existing vegetation will screen the development, however the upper parts of the tall buildings and structures will be visible. The visual impact is judged to be slightly negative.

Residential areas at Kilshane will be screened by existing vegetation, however the taller structures and buildings will be partially visible. The approach earthworks will screen one property to the north of the new Kilshane overbridge. Screening afforded by existing/ new vegetation, earthworks and the sensitive colour and finishes will all serve to further integrate the development into the landscape. The visual impact is judged to be slightly negative.

Properties at the southwest corner of Kilshane bridge, will be screened by the new vertical alignment of the new N2 where it crosses the existing N2, taller structures and buildings will be partially visible. However planting along the new N2 road and intermittent existing vegetation will mitigate the effects. The visual impact is judged to be slightly negative.

The residential property located along the access road from the R122 towards the former golf course; intervening existing vegetation, topography will screen the lower parts of the structures and buildings. Screening afforded by existing/ new vegetation, earthworks and the sensitive colour and finishes will all serve to further integrate the development into the landscape. The visual impact is judged to be moderately negative.

4.8.2.6 Likely Effects/ Impacts on Sites of Archaeological and/or Historical Importance

The Fingal Development Plan 2005 outlines the location and nature of such sites within the area. A protected archaeological site occurs to the immediate north of the development site (refer to Photograph 13). The landscape setting of these protected structures will be affected by the construction of the new N2 road to the north and the C&D Waste Facility to the south. The visual impact of the C&D Waste Facility will be mitigated if screen planting is positioned between it and the archaeological site, this would be in accordance with policy HP4. The visual effect after mitigation is judged to be moderately negative.

4.8.3 *The 'do nothing' scenario*

In the event that the proposed development does not proceed, the landscape will remain degraded and the development site will remain agricultural land. The dwellings located to the south-east of the site will not experience any further negative visual impacts. The landscape and visual impact of the proposals in the wider context is slight and would therefore experience no significant gain or detrimental effect from the proposals.

4.8.4 *Mitigation Measures*

The aims of the landscape mitigation recommendations are to:

a. Minimise the visual impact of the proposals on nearby properties and public areas and where possible improve on the existing situation

b. Generally enhance the landscape quality and amenity within the site and surrounding area.

This would be achieved by the following measures:

- Retention of existing hedgerows and trees surrounding the edges of the site for screening and provision of long-term management of theses features. This approach accords with Policies HP33, HP42, HP44 (refer to Planning Context section).

- Supplementary planting of local provenance plant material at the site's perimeter to reinforce the existing landscape structure and character and provide additional screening in the medium and long term. This approach accords with Policies HP42, HP45.

- Retention of earth embankment along the eastern boundary with the N2 road; any gaps in this boundary be in-filled. Further screening from the N2 road can be achieved by planting a belt of woodland on the land just inside of embankment. This would also act to further screen properties in the south-east of site. This approach accords with Policies HP33, HP42, HP45.

- The dwellings to the southeast of the site will be screened with landscape bunding to their north and west, and woodland planted on the slopes of these landscape bunds. This approach accords with Policies HP42, HP45.

- From the surrounding landscape the site is mostly seen against a backdrop of sky on account of the flat topography. The lower elements of the development will have the temporary quarry ridges as a background. For this reason finishes to the buildings and structures will use appropriate materials and colours so as to assimilate them into the surrounding landscape. Render finishes would be appropriate for some buildings; muted blue grey paint finishes to taller structures, and muted olive green and brown paint finishes to lower structures; perimeter fencing will also be finished with colours that recede into the background. This approach accords with Policy HP33.

- The aggregate screening machinery to be permanently used in C&D Waste Facility will also be painted in an appropriate colour so as to blend into the surrounding landscape. This approach accords with Policy HP33.

- Views to the aggregate stockpiles from the north of the site will be screened with the proposed soil bund and woodland planting to protect the setting of the listed monument. This approach accords with Policy HP4.

- The existing stream along the western boundary of the site will remain un-culverted. This approach accords with Policy HP48.

- Buildings and structures will be located back from the existing and upgraded N2 road.

4.8.4.1 Reinstatement Works

Finally, careful reinstatement of the landscape following construction works will be undertaken. This is likely to include removal of temporary construction areas and completion of the landscape scheme.

4.9 Cultural Assets & Heritage

Impact can be identified from detailed information about a project, the nature of the area affected and the range of archaeological resources potentially affected.

4.9.1 Potential Effects/ Impacts

The following are the potential impacts of the proposed development on the cultural assets and heritage:

- Archaeological deposits have been located in the area defined as a possible motte and bailey (site of) these consist of ditches, burnt area, gullies, possible pits and postholes.

- Archaeological deposits in the form of a spread of heat affected and shattered stone have been located in the area flagged as a geophysical anomaly.

- Archaeological deposits could potentially be located within the areas undisturbed by testing.

4.9.2 Mitigation Measures

The following mitigation measures are recommended:

- No development will proceed in the vicinity of the features associated with the possible motte site, prior to discussion with and directions of The Department of Environment, Heritage and Local Government.

- A buffer zone will be created around the possible motte and bailey site, which measures 10m to the south and east and 20m to the north and west.

- It is recommended that if the archaeological deposits identified as a spread of heat affected and shattered stone to the north west of the site and an area of burning cannot be avoided by the proposed development, then a full record of the site will be created through archaeological resolution under licence/ direction of The Department of Environment, Heritage and Local Government.

- It is recommended that full monitoring of any groundworks outside of the recommended buffer zone area be carried out by a suitably qualified archaeologist under licence/ direction of The Department of Environment, Heritage and Local Government.

4.10 Infrastructure & Transport

4.10.1 Potential Effects/ Impacts

4.10.1.1 Traffic Generated by the Proposed Facility

There will be a number of different facilities located at the proposed Kilshane Cross Recycling Park, each with its own individual traffic generating characteristics. These facilities include:

- **Sludge Hub Centre** (SHC) - treating 26,511 tonnes per annum (tpa) of dewatered sludge cake from waste treatment facilities in County Fingal with a projected staffing level of 6. It is expected that the SHC will generate some 28No. vehicle movements per day, comprising:
  - 6No. sludge in loaded (plus 6No. out empty) HCV movements;
  - 2No. dried sludge out HGV movements (plus 2No. empty in); and
  - 12 other vehicle movements.

- **Waste Transfer Facility** (WTF) - processing 65,000tpa of residual waste, with a projected staffing level of 5. It is expected that the WTF will generate some 102No. vehicle movements per day, comprising:
  - 33No. refuse collection vehicles in loaded (plus 33No. out empty) movements;
  - 13No. articulated HCV movements out (plus 13No. empty in); and
  - 10No. other vehicle movements

- **Biological Waste Treatment Facility**, composting or anaerobic digestion (BWTF)- treating 45,000tpa of segregated domestic and commercial organic waste with a projected staffing level of 12 (composting) or 10 (anaerobic digestion). This facility will be either a composting plant or an anaerobic digestion plant. It is expected that the BWTF composting will generate some 104No. vehicle movements per day, comprising:
  - 30No. organic waste and woodchip vehicles in loaded (plus 30No. out empty) movements;
  - 10No. compost HCV movements out (plus 10No. empty in); and
  - 24No. other movements.

  The anaerobic plant will generate 56No. vehicle movements per day, comprising:
  - 9No. organic waste trucks in loaded (plus 9No. out empty) movements:
  - 9No. digestate loaded out (plus 9No. in empty) movements; and
  - 20No. other movements.

The composting facility will generate more traffic. This represents the worst case scenario for traffic generation from the BWTF and is used in the analysis.

- **C&D Waste Recycling Facility** (CDRF)- processing 75,000tpa, with a staffing level of 6. It is expected that the CDRF will generate some 42No. vehicle movements per day, comprising:
  - 15No. vehicles in loaded (plus 15No. out loaded) movements (same vehicles can be used); and
  - 12No. other movements.

- **Facility Office Block-** with a staffing level of 5, generating some 10No. vehicle movements per day.

- It is expect that the facility would generate some 50No. other inward movements per week comprising visitors, maintenance staff, inspections etc. or 20No. movements per day.

The proposed facility forms some 8ha of a total existing site area of 16ha. Approximately 12ha of the total site is developable, with some 4ha excluded for new N2 Road Scheme and the preservation of an archaeological feature, both to the north. There are currently no proposals for the remainder of the site, but it is expected that it will be developed along similar lines. In this regard, it is proposed to make an allowance for the development of the additional area, on the same proportional basis as the other waste facilities.

Therefore, it is estimated that the total site, when fully developed, will generate some 450No. vehicle movements, comprising 310No. HCV movements and 140No. car and light goods movements during the normal working day.

During construction, it is estimated that the works will generate an average of 10No. HCV trips, with peaks of 20 HCV trips per day being generated during certain operations, such as the pouring of the concrete etc. It is estimated that the development will also generate approximately 20No. other car and light vehicle trips per day, this will include service vans, site visitors, journeys to work etc. The maximum estimated traffic generated by the development during the construction phase would be less than the predicted normal daily traffic.

4.10.1.2 Potential Effect/ Impact on Traffic on the N2 National Route

The traffic flow at the location of the proposed exit on the N2 is very high with a predicted AADT of over 30,000 in 2004 in the report prepared by Roughan & O'Donovan. Traffic statistics taken by the

NRA suggest that the current level of traffic at Kilshane is lower at under 20,000 (c. 66% of predicted levels). Observations on site, particularly during peak times, suggest that northbound traffic on the N2 is very often backed up past the entrance from the traffic signals at Kilshane Cross in the evening and southbound backed up from the M50 junction in the morning. At peak times, the level of service on this section of road would be E[7], even without the traffic lights in operation. The NRA data indicates that the peak hour (8am) flows on weekdays is just fewer than 1,600 vehicles (c. 2,250 based on the N2 EIS prediction).

As indicated in Section 2.10, there are proposals to provide a new motorway link between the M50 and the N2 north of Ashbourne. This road is at an advanced stage of construction and is expected to open in 2006. In this regard, the motorway will be in operation before the facility is commissioned. In the EIS for the N2, it was predicted that the flows on the old N2 would fall from 30,000 to 4,600 (c. 15.3% of existing) in the year 2004. At current levels this would equate to 3,100 or 3,300 (4,930 per N2 EIS) in the predicted opening year of the motorway of 2006. This would equate to a two-way peak hour flow of circa 340 (470 per N2 EIS) vehicles for an inter-town route in the opening year against current levels of 1,500 (2,250 per N2 EIS).

The level of service experienced on the section of the old N2 in the opening year of the motorway at the proposed site, including the proposed facility in full operation, will be at least B[7]. This would apply even if the predicted flow for the section of road for the year 2006 is in line with the N2 EIS and the traffic generated by the activities on the full site is in operation. The combination of the predicted flow on the old N2 in the year 2006 will be substantially less at 3,750 (5,380 per N2 EIS) vehicles per day than the flow in a do-nothing situation of 20,000 (30,000 per N2 EIS).

The N2 EIS states:

"By the design year traffic is predicted to have increased (on the old N2) to about half that of the existing flows on the existing N2. Therefore traffic conditions for those developments fronting onto the existing N2 and vehicles entering from side roads would be considerably improved. There would be the potential for the introduction of traffic calming measures to reduce vehicle speeds, discourage 'rat-running" and assist road safety throughout the length of the existing N2".

The proposed facility would fall into the category of "those fronting" in the above extract. In a situation where the motorway is operational and the Recycling Park is fully developed, traffic on the "old" N2 will be substantially less than the current level even in the design year of 2026 for the motorway. The

[7] National Roads Needs Study, National Roads Authority 1998. Level of service rating E refers to a single carriageway with an average speed of 72kph. Level of service rating B refers to a single carriageway with an average speed of 88kph.

recently published by the NRA document "Future Traffic Forecasts 2002-2040" indicates a growth of c.35% in traffic over the period 2006 to 2026. The traffic levels on the old N2 would be well below current levels even in 2026.

The construction phase of the waste facility project will, at worst, correspond with the final phase of the motorway construction. The overall increase in existing traffic in volumetric terms for the construction phase will be less than 0.5% of existing traffic level. The increased traffic will have no appreciable effects on the level of service experienced by road-users or the capacity of the road network in the area. This will only last until the proposed new motorway is operational.

The HCV traffic generated by the completed Recycling Park is expected to be in the region of 310 HCV trips per day. This HCV traffic will impact on the existing pavement. However, this will be more than offset by the reduction in traffic due to the opening of the new N2 Road Scheme, which will transfer some 2,500HCV trips per day in the opening year from the existing N2. A similar situation will prevail in respect of the light goods and car traffic. The net result is that the expected life of the existing pavement will be considerably longer than what would normally be expected in a do-nothing situation.

When the new N2 Road Scheme is in operation, the main impact on traffic on the existing N2 will be from traffic entering and leaving the facility. In order to minimise the impact of this traffic, the mitigation measures outlined in Section 4.10.2 are proposed. The prevailing practice in the country when an existing national route is replaced by a new section of motorway is that the old road is downgraded to regional status. It is expected that the practice will be the same in the case of the N2.

4.10.1.3 Potential Effect/ Impact on other Roads

There are numerous access points to the existing N2; the traffic generated by the facility will disperse between these various routes and particularly to the M50. The increase in volume on the various routes due to the facility will be minimal, particularly on the M50. Accordingly, the impact on all routes will be negligible.

4.10.2 Mitigation Measures

In the future situation where both the new N2 Road Scheme is in place and the Kilshane Cross Recycling Park is fully developed; the main impact of the proposal will be "local" to the traffic on the old N2 immediately outside of the entrance. Notwithstanding the possible downgrading of the old N2 to regional status, in order to minimise the impact of traffic from the proposed facility on the receiving traffic, the following measures are mitigation proposed:

- A single access point to the site is proposed; this main access will in the future also serve the section of land not included for development in this proposal. In this regard, individual accesses leading off the main access are proposed;

- The single access is located towards the centre of the total site in order to maximise the entrance sightlines in both directions;

- The fence line will be set back to facilitate the provision of sightlines at the entrance to comply with the requirements of NRA Design Manual for Roads and Bridges; the fence line can also be set back further to accommodate any future widening of the old N2, if required.

- It is proposed to incorporate into the design a right turning lane for traffic coming from the Kilshane Cross direction together with a left slip lane for traffic entering the site from the south (M50).

4.11 Interaction/ Inter-relationship of the Foregoing

4.11.1 Summary of Environmental Interactions/ Inter-relationships

These are summarised in Table 4.11.1 below. The interactions of environmental effects are detailed in Section 4.11.2. The table below highlights the causes of the environmental impacts and indicates where these impacts interact with other areas of the environment. The interactions/ inter-relationships are colour coded to highlight positive, neutral and negative interactions.

Table 4.11.1 Matrix of Interaction of Environmental Effects

CAUSE	EFFECT								
	Population	Economy	Ecology	Soil & Geology	Water Quality	Climate	Landscape	Roads	Cultural Herita[ge]
Physical Development	X	X	X	X	X	X	X	X	X
Population	--	X	--	--	--	--	--	--	--
Soil	--	--	--	--	--	--	--	--	X
Water Quality	X	--	X	--	--	--	--	--	--
Noise	X	--	X	--	--	--	--	--	--
Dust	X	--	X	--	X	X	--	X	--
Odour	X	--		--	--	--	--	--	--
Road Traffic	X	--	X	--	--	X	--	--	--

Legend

Colour	Interaction
X	Positive
X	Neutral
X	Negative

4.11.2 Interaction/ Inter-relationship of Environmental Effects

The significant impacts of the proposed Kilshane Cross Recycling Park and the measures proposed to mitigate these impacts have been outlined in this report. However, in any development with the potential for environmental impact, there is also the potential for interaction/ inter-relationships between impacts of the different environmental aspects.

The result may either exacerbate the magnitude of the impact or may in fact ameliorate it.

There is the potential for interaction/ inter-relationships between the impacts of the proposed development (shown graphically in Table 4.11.1) within and adjacent to the proposed development, as follows:

- Dust suppression and the use of a vehicle wheel wash at the C&D Waste Recycling Facility are proposed to mitigate the impact of wind blown dust around the site and to nearby dwellings. All waste handling and storage will take place within the confines each of the waste treatment buildings; therefore, there will be not external generation of dust. Road cleansing will be undertaken to minimise the impact on the road network. These measures will reduce the impact on human beings, ecology, water environment, climate and roads in the vicinity of the proposed development;
- Travel patterns will not be disrupted by the proposed facility. The new N2 Road Scheme will significantly reduce the vehicle numbers on the existing N2. The proposed facility will have negligible impact on the existing N2 once the new Road Scheme is opened, when compared with existing road usage levels. Mitigation measures to improve the entrance road and possible measures to repair any damage caused by the construction traffic to the local roads in the vicinity of the site will further reduce the impact of the facility. These measures will improve road safety for all road users in the Kilshane Cross area.
- The use of road-worthy and sealed containers, tankers and refuse collection vehicles for the transport of organic material and residual waste, both to and from the Sludge Hub Centre, the Biological Waste Treatment Facility and the Waste Transfer Facility, will mitigate against odour generation during transportation. This measure will reduce the impact on human beings and the local environment.
- Odours will be reduced by ensuring that there will be no external handling or treatment of waste. All waste treatment buildings will be constructed to the highest specifications to reduce the emissions and air abatement systems will be installed to treat air and exhaust gases. These measures will reduce impacts of odour on human beings.
- Professional vermin control experts will be employed, if deemed necessary, to ensure vermin activity is minimised. All waste operations will be carried out indoors, thus the proposed facility will not be an attractant to birds.
- Compliance monitoring will be undertaken, as per regulatory conditions and will be reported on, as part of the annual environmental report for whole facility. These reports will be made available to all interested parties, which will allay public concerns as to the operation of the site and will result in a positive interaction with respect to human beings.

- The facility will be operated to Best Available Techniques (BAT) as per EPA recommendations. All information will be available to interested parties; a complaints register will be maintained. The EPA will undertake regular environmental audits, which will demonstrate how the facility is performing. These measures will result in interaction in all environmental criteria.
- The baseline assessment for this project was completed prior to the design of the facility, which allowed major impacts to be avoided. Avoidance of impacts will be used during the design of the proposed facility. The impact and mitigation measures proposed are designed to further ameliorate the impact of the waste management facility on the wider environment.

While there is potential for the above impacts to interact/ inter-relate and result in a cumulative impact, it is unlikely that any of these cumulative impacts will result in significant environmental degradation.

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