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Baile Átha Cliath

Dublin Waste to Energy Project
Baseline Monitoring

Volume 2
Technical Appendices

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Dublin Waste to Energy

Baseline Environmental Study

Site Investigation & Topographical Surveys

PREAMBLE

This baseline report is for information purposes only and was prepared solely based on site surveys, measurements, investigations and other data collected over the period of the survey. The data supplied are warranted to be accurate for the dates and locations shown in the report. The report does not purport to interpolate between recorded data or to be necessarily representative of environmental conditions in locations or circumstances different to those encountered on the recorded dates and locations. Any opinions stated in the reports are not warranted.

Recipients of this document must conduct their own investigations, appraisals and due diligence procedures to satisfy themselves as to the soil, water, air or other environmental conditions required for the safe and timely completion of this project.

Approved

15.7.05

Volume 2 - Technical Appendices

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Appendix A

Terrestrial Ecology

DUBLIN WASTE TO ENERGY PROJECT:

BASELINE ECOLOGICAL MONITORING FLORA AND FAUNA

FINAL REPORT

Prepared for

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CONSULTING ENGINEERS.

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1.0 INTRODUCTION

The site for the proposed waste to energy plant is on the southern side of Pigeon House Road and immediately west of the new sewage treatment works. To the west of the site there is a further industrial complex and an electricity station. Recently cleared ground lies to the south. The Irishtown Nature Park is located to the east-southeast of the site.

All of this area of Dublin Port is reclaimed land and much of it was used as a municipal landfill in the past. The reclaimed land of the former landfill is a rich hunting ground for casual and alien plant species and in the Flora of County Dublin, published by the Dublin Naturalists' Field Club, it is noted that some 200 different kinds of plants were recorded during field surveys (see Doogue et al. 1999).

The present study provides a baseline assessment of the flora and fauna species within the around the site for the waste to energy plant. While important areas of conservation value exist in the immediate vicinity, these are estuarine and/or ornithological in character and are described and evaluated elsewhere.

2.0 SURVEY METHODS

Two visits were made to the site during 2003 – one in late-May and one in mid-August. These were timed so as to provide the maximum amount of information on plants and breeding birds. A visit in winter is not considered necessary as the character of the site would not support any wintering bird species of conservation importance.

The survey methodology consisted of systematically walking the site area and recording habitats, plant species and vegetation types present. Habitat classification is according to the system recommended by The Heritage Council (Fossitt 2000). Notes were made on bird species present within and around the site. For mammals, the main emphasis was on search for signs of activity or dwellings. During the survey, particular attention was given to the possible presence of habitats and/or species which are legally protected under Irish or European legislation (especially the Flora Protection Order 1999; Wildlife Act 1976; Wildlife Amendment Act 2000; EU Habitats Directive; EU Birds Directive). A cursory examination was made of Irishtown Nature Park.

The standard literature was checked for references to the site and locality. The main source of information for the area is the Flora of County Dublin. A 1998 report on Irishtown Nature Park and Sandymount Strand by J. O'Neill was also consulted.

3.0 BASELINE ENVIRONMENT

3.1 Habitats, vegetation and flora within site

The site (i.e. the rectangular area that is fenced) comprises two principal habitats: buildings and artificial surfaces (BL3) and recolonising bare ground (ED3). In addition, there is a small patch of amenity grassland (GA2) at the entrance to the Hibernian Mollasses complex. Habitat codes are from Fossitt (2000). The habitats are described below with reference to the accompanying map (Fig. 1). Both English and scientific names are given for plant species following Scannell and Synnott (1987).

Buildings and artificial surfaces (code BL3)

The majority of the site is classified as built ground. Included is the Hammond Lane industrial complex and the Hibernian Mollasses complex. The survey was concentrated in the southern part of the site where some plants would be expected on the open tarmacadam surfaces. Much of this area, which is a former car-park, still has a smooth surface though some breaks and cracks are appearing which provide a niche for plant species (see Plate 1). The southernmost strip, approximately 15 m in width, comprises a rough gravel surface and here plants have been able to colonise, with greatest growth alongside the fence line (see Plate 2). These are typical ruderal species (i.e. weed-like) and include the following:

Groundsel *Senecio vulgaris*
Colt's-foot *Tussilago farfara*
Yarrow *Achillea m illefolium*
Robin-run-the-hedge *Galium aparine*
Scentless mayweed *Tripleurospermum inodorum*
Nettles *Urtica dioica*
Red clover T*rifolium repens*
Wild teasel *Dipsacus fullonum*
Fennel *Foeniculum vulgare*
Butterfly-bush *Buddleja davidii*
Common mallow *Malva sylvestris*
Red Valerian *Centranthus ruber*

Some gorse *Ulex europaeus* and sycamore *Acer pseudoplatanus* (some in excess of 5 m high) is established along the fenceline, along with brambles *Rubus fruticosus* and wild rose (*Rosa* spp.).

Recolonising bare ground (ED3)

A small, mostly enclosed area of unmanaged ground occurs in the mid eastern sector of the site. This is well vegetated with a range of ruderal species, including some common grasses. This habitat is more extensive and better developed in the areas which surround the site and a full species list is given in the description for those areas.

Amenity grassland (improved) (GA2)

A small patch of amenity grassland occurs at the entrance to the Hibernian Mollasses complex. This is a typical mown sward of grasses such as rye grass *Lolium perenne* and meadow grasses *Poa spp*., along with such species as creeping buttercup *Ranunculus repens*, speedwell *Veronica serpyllifolia*, and narrow-leaved plantain *Plantago lanceolata.*

3.2 Habitats, vegetation and flora around site

Recolonising bare ground (ED3) is the principal habitat which surrounds the site to the north, east and south. Some bare ground and spoil heaps (ED2) also occurs to the south to of the site. The Shellybanks Road skirts the western boundary of the site and associated with this is a line of planted sycamore trees (WL2) and a strip of shrubbery (WS3).

Recolonising bare ground (ED3)

This habitat occurs between the northern boundary of the site and the Pigeon House Road (strip of c.20 m in width) (see Plate 3), between the eastern boundary of the site and the adjacent sewage treatment works (strip of c.5 m in width), and to the south of the site (area up to 30 m in width). It also occurs scattered along the Shellybanks Road. A wide range of ruderal species occur, with rank grasses well-established in some parts.

Wild teasel *Dipsacus fullonum*
Butterfly-bush *Buddleja davidii*
Colt's-foot *Tussilago farfara*
Fennel *Foeniculum vulgare*
Bastard cabbage *Rapistrum rugosum*
Mugwort *Artemsia vulgaris*
Japanese knotweed *Fallopia japonica*
Thistles *Cirsium* spp.
Groundsel *Senecio vulgaris*
Scentless mayweed *Tripleurospermum inodorum*
Common mallow *Malva sylvestris*
Red dead-nettle *Lamium purpureum*
Purple toadflax *Linaria purpurea*
Yarrow *Achillea millefolium*
Nettles *Urtica dioica*
Red clover *Trifolium repens*
Meadow vetchling *Lathyrus pratensis*
Common vetch *Vicia cracca*
Black medick *Medicago lupulina*
Robin-run-the-hedge *Galium aparine*
Dove's-foot cranesbill *Geranium molle*
Dock *Rumex obtusifolius,*
Spear-leaved Orache *Atriplex prostrata*
Cock's-foot *Dactylis glomerata*
Scutch *Elymus repens*
Yorkshire fog *Holcus lanatus*
Common bent *Agrostis stolonifera*

In areas which have not been recently disturbed, brambles and young sycamore are becoming established.

Ornamental / non-native shrub WS3

A line of shrubbery has been planted along the western side of the Shellybanks Road (see Plate 4). This is dense and predominantly of Escallonia (*Escallonia* spp.), with brambles and such species as butterfly bush. Some trees also occur, with cypress (*Cypressus* spp.), white poplar (*Populus alba*) and sycamore.

Treeline WL2

A line of approximately 26 sycamore trees has been planted along the eastern side of the Shellybanks Road (see Plate 4). These are in the region of 7-8 m in height.

3.3 Fauna

Mammals, amphibians and reptiles

Brown rat (*Rattus norvegicus*) was the only mammal species recorded within the site. House mouse would also be expected, and perhaps the ubiquitous pygmy shrew (*Sorex minutus*). The low number of species reflects the low diversity of habitats present.

Signs of fox (*Vulpes vulpes*) were found near the boundary fence of the Irishtown Nature Park and this species probably has a permanent presence in the port area. Long-tailed field mouse (*Apodemus sylvaticus*) may also occur, and possibly rabbits (*Oryctolagus cuniculus*).

The habitats on site or in the immediate vicinity are not suitable for the common frog (*Rana temporaria*) or the common lizard (*Lacerta vivepara*).

Birds

Few bird species occur within the site owing to the low diversity of habitats present. Only two species, wren (*Troglodytes troglodytes)* and dunnock (*Prunella modularis*), were considered to nest within the site, and these were confined to the strip of vegetation along the southern and south-west boundary fence-lines. Starlings (*Sturnus vulgaris*) and pied wagtail (*Motacilla alba*) were noted in the vicinity of the buildings on site and could breed in suitable holes or gaps within the buildings.

A small number of other species were recorded in the shrubbery along the Shellybanks Road, with robin (*Erithacus rubecula*), blackbird (*Turdus merula*), great tit (*Parus major*), blue tit (*Parus caerulea*) and chaffinch (*Fringilla coelebs*) all nesting. A single reed bunting (*Emberiza schoeniclus*) was recorded in August in the rough vegetation to the south of the site and could nest locally. At least one pair of skylarks was present in the recently cleared ground south of the site (see Plate 6). Other birds which nest in the general vicinity include woodpigeon (*Columba palumbus*), jackdaws (*Corvus monedula*), hooded crow (*Corvus corone cornix*) and magpie (*Pica pica*).

A flock of c.30 linnets (*Carduelis cannabina*) was present on the rough ground to the south of the south in August, along with a small number of goldfinches (*Carduelis carduelis*).

Recently planted grassland within the adjacent sewage works and also to the south of it may support brent geese (*Branta bernicla horta*) during winter. Gulls, mostly black-headed (*Larus ridibundus*), are common in the vicinity of the sewage works during winter.

3.4 Irishtown Nature Park

Irishtown Nature Park is located to the east-southeast of the site. The Park was designed as an ecological park with a focus on habitat creation and nature conservation. Native trees, shrubs and wildflowers and grasses were planted. The park is now a well-used amenity area.

A detailed survey of the flora of the park was undertaken by Conservation Volunteers Ireland in 1997/98 on behalf of Dublin Corporation Parks Department. Monthly visits were made between August 1997 and July 1998. Species lists were compiled and a comparison made with the list of wildflowers originally planted by Dublin Corporation.

The park now comprises a mix of young trees and shrubs and open areas of grassland (see Plates 5 & 6). It appears that the area of grassland is gradually being diminished as the trees and shrubbery become more established.

Tree species include birch (*Betula pubescens*), alder (*Alnus glutinosa*), willow (*Salix* spp.) and oak (*Quercus* spp.). The 1997 survey found that some of the original wild flowers were still present, such as bird's-foot trefoil (*Lotus corniculatus*), yellow rattle (*Rhianthus minor*), oxeye daisy (*Leucanthemun vulgare*) and yarrow (*Achilla millefolium*). The flora also included a range of additional species, many of which are typical ruderal plants that occur elsewhere on the Poolbeg peninsula – these include teasal (*Dipascus fullonum*), oxford ragwort (*Senecio squalidus*), spiny restharrow (*Ononis spinosa*), mugwort (*Artemisa vulgaris*), red valerian (*Centrathus ruber*), common soapwort (*Saponaria officinalis*), butterfly-bush (*Buddleja davidii)* and fennel (*Foeniculum vulgare).*

3.5 Assessment of scientific importance of survey area

The site for the waste to energy plant represents ground that has been entirely modified by man and is mostly being used for industrial purposes. All habitats present within and immediately around the site are classified in the broad categories of built land and disturbed ground – such habitats are not of conservation value. There are no flora or fauna species of significant conservation value in this area. However, the area around the site does support a wide range of plant species, many alien in origin, including such localised plants as bastard cabbage (*Rapistrum rugosum*) and wild teasel (*Dipsacus fullonum*).

The presence of skylarks on waste ground to the south of the south is of some note as skylark is listed as a species of moderate conservation concern owing to a moderate decline in the breeding population in Ireland in the last 25 years (Newton et al. 1999). The known presence in winter of brent geese on the grasslands associated with the sewage treatment works is of note as these are part of the Dublin Bay internationally important population. The Irishtown Nature Park, to the south-east of the site, while not of significant conservation importance does have local ecological interest and is an important amenity site.

4.0 REFERENCES

Fossitt, J.A. (2000) *A Guide to Habitats in Ireland.* The Heritage Council, Kilkenny.

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Plate 1. The southern part of the site is a former car-park. Some cracks are appearing in the tarmacadam surface which provide a niche for plants. View is looking northwards.

Plate 2. The southernmost part of the site comprises a strip of rough gravel surface and here plants have been able to colonise, with greatest growth alongside the fence line. Plants are typical ruderal species, and include butterfly bush and wild teasel.

Plate 3. The habitat recolonising bare ground surrounds much of the site. Photograph shows the strip between the northern boundary of the site and the Pigeon House Road. This is well vegetated with a range of ruderal species.

Plate 4. A line of shrubbery has been planted along the western side of the Shellybanks Road, while a line of sycamore trees occur on the eastern side. View is looking northwards.

Plate 5. Young trees and shrubbery are well established in Irishtown Nature Park. View is looking north-eastwards towards the South Wall.

Plate 6. Areas of open grassland, comprised of both native and naturalised species, occur in parts of Irishtown Nature Park.

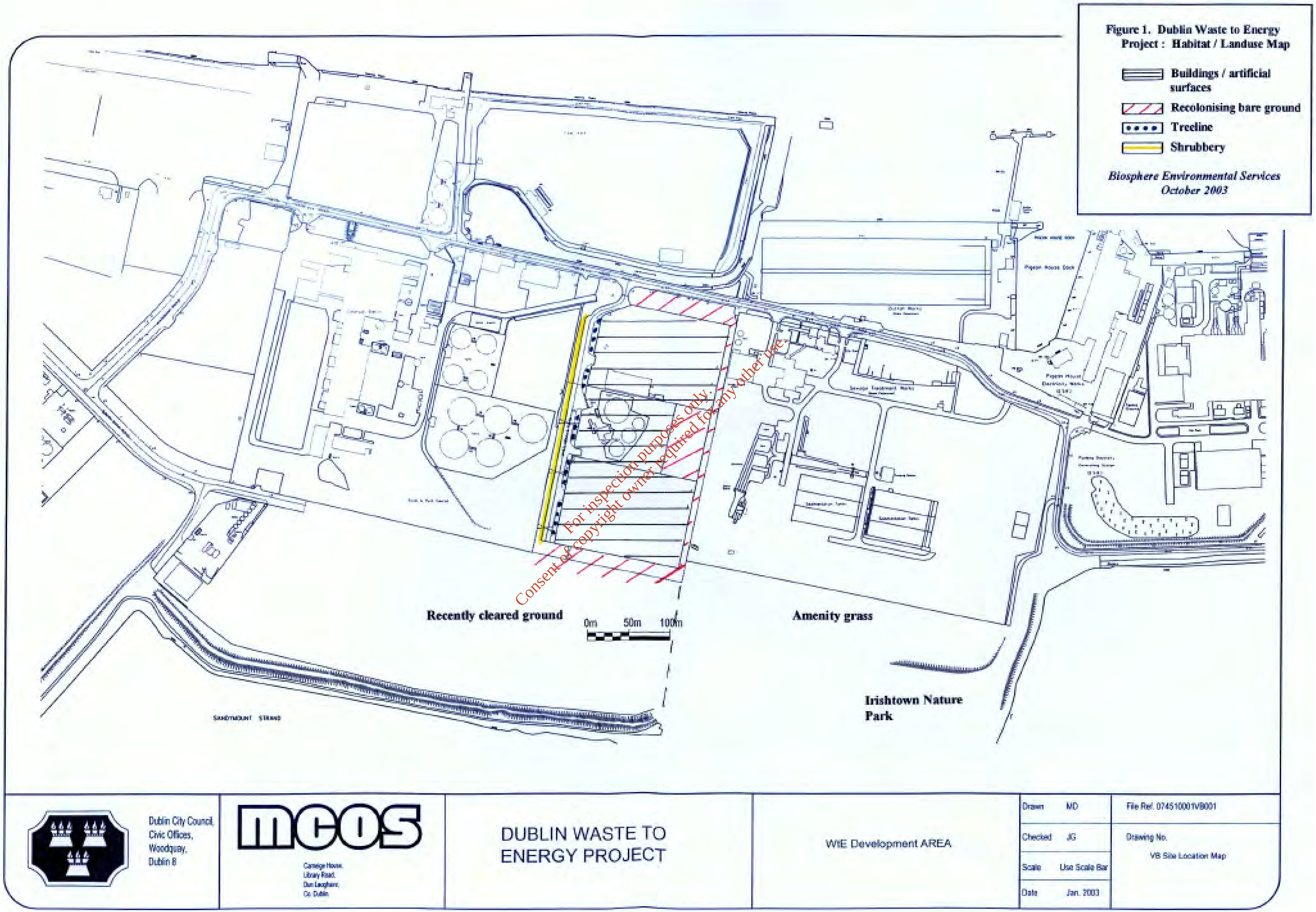
Figure 1. Dublin Waste to Energy Project : Habitat / Landuse Map
Buildings / artificial surfaces
Recolonising bare ground
Treeline
Shrubbery
Biosphere Environmental Services
October 2003
Recently cleared ground
0m
50m
100m
Amenity grass
Irishtown Nature Park
SANDYMOUNT STRAND
Dublin City Council, Civic Offices, Woodquay, Dublin 8
mcos
Carnegie House, Library Road, Dun Laoghaire, Co. Dublin
DUBLIN WASTE TO ENERGY PROJECT
WtE Development AREA
Drawn MD
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Date Jan. 2003
File Ref. 074510001VB001
Drawing No.
VB Site Location Map

Plate 1. The southern part of the site is a former car-park. Some cracks are appearing in the tarmacadam surface which provide a niche for plants. View is looking northwards.

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Plate 6. Areas of open grassland, compromised of both native and naturalised species, occur in parts of Irishtown Nature Park.

IRISHTOWN NATURE PARK:

HABITAT AND FLORA STUDY

FINAL REPORT

Prepared for

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August 2004

1.0 GENERAL DESCRIPTION

The Irishtown Nature Park, which has been developed on the site of the former Ringsend Dump, physically consists of an elevated central plateau of land which slopes down to the sea on its southern side and is bounded on its northern edge by amenity grassland adjacent to the sewage works (used as a feeding site by Brent Geese). Its eastern boundary contains a small area of sand dune in front of the main road whilst its western edge culminates in a path linking the Park with the road at Sandymount. A number of paths and tracks traverse the Park, the main one being that which occurs along its southern perimeter and which follows the sea.

The vegetation and plant species complement reflect the past use of the site together with its current management as a park and as an amenity area. The mixture of species has originated from the planting of ornamental shrubs and small trees, from the invasion of native species over the years, from the original, ruderal plants which once occupied the dump and from the invasion of several, very weedy exotic species.

The plant habitats and communities also reflect the past and present use and management of the site as well as the coastal location of the Park. Most of the southern side is under the influence of the sea and especially salt spray and this has allowed coastal vegetation to develop in places. Finally, a small section is directly influenced by the movement of sand transported by the sea, and this has allowed a small beach to develop (at eastern edge).

2.0 MAIN HABITATS FOUND WITHIN THE PARK

As might be expected from the past use of the area and from the planting that has been carried out, there is little in the way of natural or semi-natural habitats to be found within the Park. The only piece, which has not been directly influenced in its development by humans, lies on the eastern side in the corner between the Park proper and the main road. Here a small area of sand dune occurs.

The various habitats can be described using the system given within Fossitt (2000) and they are as follows:-

Sand dunes:

Three sand dune habitats are present at the eastern entrance of the Park. The very early stages in dune development are found at High Water Mark and here a number of annual plants, characteristic of this zone are found. These are 2 species of Orache, *Atriplex prostrata, A. laciniata,* sea rocket *Cakile maritime* and prickly saltwort *Salsola kali*. These represent the early stages of the habitat ***Embryonic dunes CD1*** and are properly called **Annual vegetation of drift lines**.

In the zone landward of this, two species of grass, responsible for initiating the building of sand dunes are found. These are Lyme grass *Leymus arenarius* and sea couch *Elymus farctus*. These are the main species of **Embryonic dunes CD1**. Behind this zone stands of marram grass *Ammophila arenaria* occur and a small area of the habitat **Marram dunes CD2** has developed. The final sand dune habitat found here (in small amount) is that of **Fixed Dunes CD3** which is the stable phase found in most sand dunes.

Other habitats:

Over most of the Park a habitat of coarse grassland is found which mostly corresponds to the category **Amenity Grassland GA2**. The main species are perennial rye grass *Lolium perenne*, false oat grass *Arrhenatherum elatius*, red fescue *Festuca rubra*, creeping bent *Agrostis stolonifera* and creeping thistle *Cirsium arvense*. Blackberry *Rubus fruticosus* is invading this in parts. The mown portions on the eastern side of the Park, adjacent to the sewerage facility and which is used by Brent Geese in the winter, is also part of this habitat.

Also invading this grassland are stretches of scrub consisting mostly of native species such as blackthorn *Prunus spinosa*, elder *Sambucus nigra* and ash *Fraxinus excelsior*. However, two exotic species, sycamore *Acer pseudoplatanus* and Japanese knotweed *Reynoutria japonica,* are acting invasively here. This habitat can be broadly accommodated within the category of **Scrub WS1**.

Non-native, planted shrubs have formed a scrub of sorts, the main species being as follows: Escallonia *Escallonia macrantha,* karo *Pittosporum crassifolium*, butterfly bush *Buddleja davidii*, field maple *Acer campestre* and 2 species of Cotoneaster. Trees are present in the form of evergreen oak *Quercus ilex,* sessile oak *Quercus petraea* and Italian alder *Alnus cordata*. This habitat is that of **Ornamental, non-native shrubs WS3**.

The stony, rock and boulder-dominated areas adjacent to the sea, reflect the infilled nature of the area and the species cover is sparse and very scattered. Some clay fractions are found throughout which allows some diversity to occur chiefly, weedy species such as teasel, *Dipsacus fullonum,* mugwort *Artemisia vulgaris*, red valerian *Centranthus ruber* and common mallow *Malva sylvestris*. This habitat can be included within **Buildings and artificial surfaces BL3** and nearer the sea, the influence of salt spray has allowed the growth of a number of coastal species notably sea beet *Beta maritima* and sea mayweed *Matricaria maritima*. Sections adjacent to the path have reflexed salt-marsh grass *Puccinellia distans* and lesser sea-spurrey *Spergularia marina*.

The habitat **Re-colonizing bare ground ED3** is common throughout and the principal species here is coltsfoot *Tussilago farfara* and hoary mustard *Hirschfeldia incana*.

In summary, the Park, whilst not of significant conservation importance, is rich in plant species as they have come from a number of sources. However, the issue of invasive species should be addressed, especially Japanese knotweed and hedge bindweed *Calystegia sepium,* as the dominance of these will lower the diversity of plant species in the Park. Also, the issue of allowing native scrub of elder, blackthorn and hawthorn to spread into the grassland areas should be addressed.

A full species list of vascular plants is given in **Table 1**. This list was compiled on 3rd August 2004 and many of the spring and early-summer species would not be in evidence at this time. Consequently, the list is not fully comprehensive.

3.0 REFERENCES

Fossitt, J.A. (2000) *A Guide to Habitats in Ireland.* The Heritage Council, Kilkenny.

Doogue, D., Nash, D., Parnell, J., Reynolds, J. & Wyse Jackson, P. (1998) *Flora of County Dublin*. The Dublin Naturalists' Field Club, Dublin.

O'Neill, J. (1998) A Study of Irishtown Nature Park and Sandymount Strand. Unpublished report.

Table 1:List of plants growing in Irishtown Nature Park

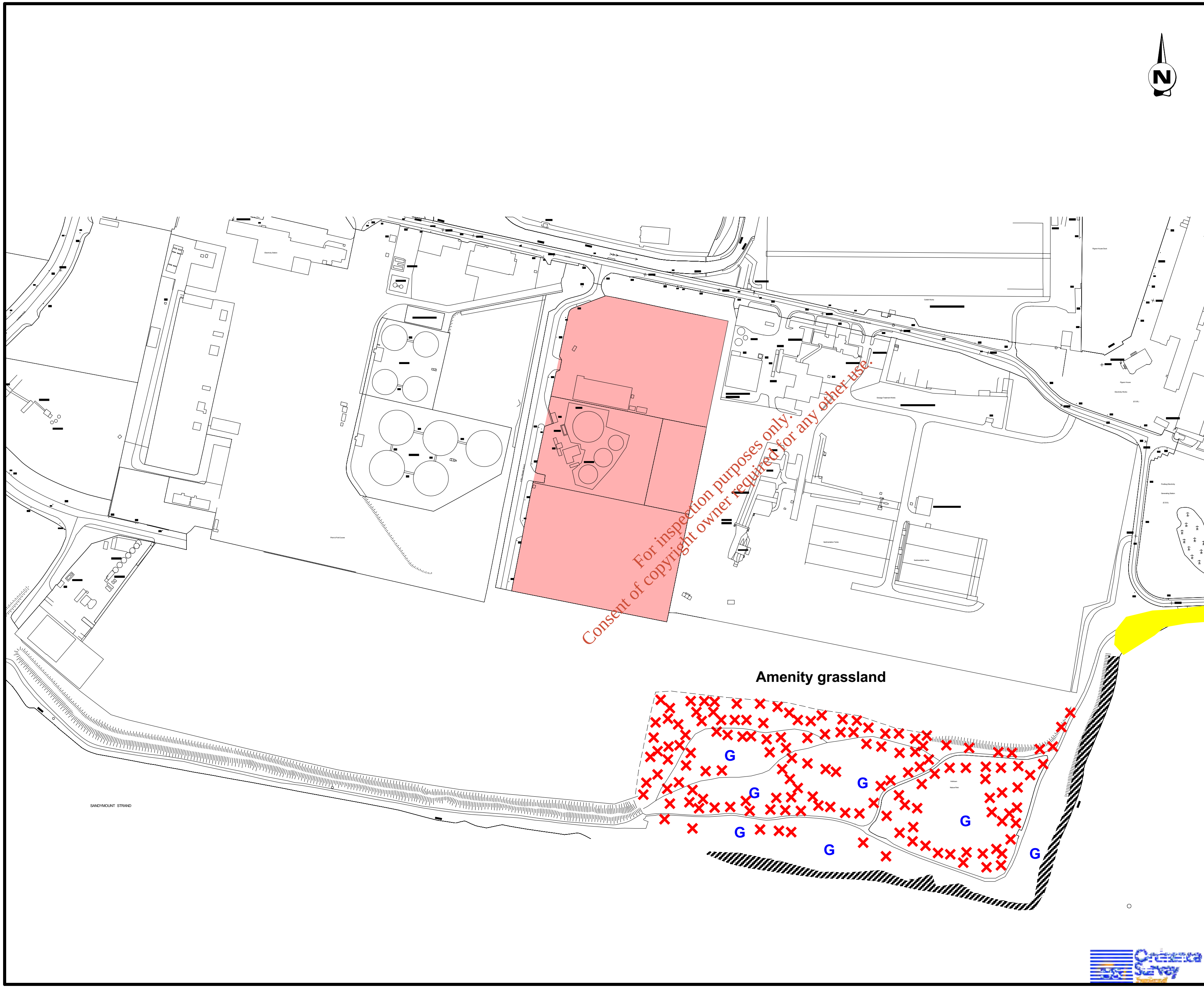
Scientific Name	Common Name
Acer campestre	Field maple
Acer pseudoplatanus	Sycamore
Achillea millefolium	Yarrow
Aesculus hippocastanum	Horse chestnut
Agrostis capillaris	Common bent
Agrostis stolonifera	Creeping bent
Allium vineale	Crow garlic
Alnus cordata	Italian alder
Alnus glutinosa	Alder
Ammophila arenaria	Marram grass
Anthriscus sylvestris	Cow parsley
Anthyllis vulneraria	Ladies fingers
Arctium lapa	Burdock
Arrhenatherum elatius	False oat grass
Artemisia vulgaris	Mugwort
Atriplex laciniata	Frosted orache
Atriplex prostrata	Spear-leaved orache
Beta vulgaris	Sea beet
Betula pendula	Silver birch
Blackstonia perfoliata	Yellow-wort
Bromus hordeaceus	Soft brome
Bromus sterilis	Barren brome
Buddleja davidii	Butterfly bush
Cakile maritima	Sea rocket
Calystegia sepium	Hedge bindweed
Carex pendula	Pendulous sedge
Carex remota	Remote sedge
Centaurea nigra	Knapweed

Centranthus ruber	Red valerian
Cerastium semidecandrum	Little mouse ear
Chenopodium album	Fat hen
Cirsium arvense	Creeping thistle
Clematis vitalba	Traveller's joy
Convolvulus arvensis	Field convolvulus
Cordyline australis	Cordyline
Cornus sanguinea	Dogwood
Corylus avellana	Hazel
Cotoneaster lacteus	Late cotoneaster
Cotoneaster simonsii	Himalayan cotoneaster
Crataegus monogyna	Hawthorn
Crepis capillaris	Smooth hawk's beard
Crepis vesicaria	Beaked hawk's beard
Cynosurus cristatus	Crested dog's tail
Dactylis glomerata	Cocksfoot
Daucus carota	Wild carrot
Desmazeria marinum	Sea fern grass
Dipsacus fullonum	Teasel
Elymus farctus	Sea couch
Elymus repens	Scutch grass
Epilobium angustifolium	Rosebay willowherb
Epilobium ciliatum	American willowherb
Epilobium hirsutum	Hairy willowherb
Equisetum arvense	Field horsetail
Equisetum palustre	Marsh horsetial
Escallonia macrantha	Escallonia
Festuca rubra	Red fescue
Foeniculum vulgare	Fennel
Fraxinus excelsior	Ash
Galium verum	Ladie's bedstraw

Heracleum sphondylium	Hogweed
Hippophae rhamnoides	Sea buckthorn
Hirschfeldia incana	Hoary mustard
Holcus lanatus	Yorkshire fog
Honkenya peploides	Sea sandwort
Hordeum murinum	Wall barley
Hypericum maculatum	Imperforate St John's Wort
Hypochoeris radicata	Cats ear
Iris pseudacorus	Yellow flag
Knautia arvensis	Field scabious
Laburnum anagyroides	Yellow laburnum
Larix decidua	European larch
Lathyrus latifolius	Everlasting pea
Lathyrus pratensis	Meadow vetchling
Leontodon autumnalis	Autumn hawkbit
Leucanthemum vulgare	Ox eye daisy
Leymus arenarius	Lyme grass
Linaria purpurea	Purple toadflax
Lolium perenne	Perennial rye grass
Lotus corniculatus	Bird's foot trefoil
Malus domestica	Apple
Malva moschata	Musk mallow
Malva sylvestris	Common mallow
Matricaria maritima	Sea mayweed
Matricaria perforata	Scentless mayweed
Medicago lupulina	Black medick
Odontites verna	Red bartsia
Onobrychis viciifolia	Sainfoin
Ononis spinosa	Spiny rest harrow
Pastinaca sativa	Wild parsnip

Petasites fragrans	Winter heliotrope
Phleum pratense	Timothy
Pinus contorta	Beach pine
Pittosporum crassifolium	Karo
Plantago cornopus	Buckshorn plantain
Plantago lanceolata	Ribwort plantain
Plantago major	Greater plantain
Poa annua	Annual meadow grass
Poa pratensis	Smooth meadow grass
Poa trivialis	Rough meadow grass
Polygonum aviculare	Knotgrass
Potentilla anserina	Silverweed
Potentilla reptans	Creeping cinquefoil
Prunus spinosa	Blackthorn
Puccinellia distans	Reflexed saltmarsh grass
Quercus ilex	Evergreen oak
Quercus petraea	Sessile oak
Quercus robur	Pedunculate oak
Ranunculus acris	Meadow buttercup
Ranunculus repens	Creeping buttercup
Reynoutria japonica	Japanese knotweed
Ribes uva-crispa	Gooseberry
Rosa canina	Dog rose
Rosa rugosa	Japanese rose
Rubus fruticosus	Blackberry
Rumex crispus	Curled dock
Salix atrocinerea	Grey willow
Salix fragilis	Crack willow
Salix x sepulcralis	Weeping willow
Salsola kali	Prickly saltwort
Sambucus nigra	Elder

Sanguisorba minor	Salad burnet
Saponaria officinalis	Soapwort
Senecio jacobea	Ragwort
Senecio squalidus	Oxford ragwort
Smyrnium olusatrum	Alexanders
Sonchus oleraceus	Smooth sow thistle
Spergularia marina	Lesser sea spurrey
Taraxacum officinale	Dandelion
Tortula ruraliformis	a dune moss
Trifolium repens	White clover
Tussilago farfara	Coltsfoot
Ulex europaeus	Gorse
Urtica dioica	Stinging nettle
Veronica officinalis	Heath speedwell
Viburnum lantana	Wayfaring tree



Legend

× × ×	Main Areas of Scrub
G G	Main Areas of open grassland
(yellow)	Sand dunes
(hatched)	Boulders/rocky vegetation

Note:
Distribution of scrub is very approximate

Source:
Biosphere Environmental Services
Agust 2004

Dublin City
Baile Átha Cliath

Project: *Dublin Waste to Energy Project - Baseline Monitoring*

Title

Irishtown Nature Park Habitat Map

Figure 1

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Notes

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Plate 1. A coarse grassland is the main habitat in the Park but this is being encroached by scrub. View is of one of the few remaining 'open' areas of grass.

Plate 2. The scrub is dense in places and compromises a mix of native and non-native species.

Appendix B

Estuarine Ecology – Literature Review

Introduction

In order to assess the potential impact of any development on an area it is first necessary to be familiar with the ecology of that area, the impacts of similar developments on other areas be these impacts short or long-term in nature due to the physical construction of the development, or, as a result of substances released to the environment once construction has finished.

A literature review is in progress in relation to the development of a thermal waste treatment plant to be developed at Ringsend on the Poolbeg Peninsula in Dublin Bay.

This review has a number of objectives:

1. To identify literature from published and unpublished sources relating to Dublin Bay, particularly with reference to those areas within the Bay of known ecological importance i.e. North Bull Island, Booterstown Marsh, areas of importance to fisheries. Previous Environmental Impact Surveys relating to the Dublin Bay area fall within this category.
2. To identify literature from published documents relating to the ecological impacts of similar developments internationally Dublin Bay

Dublin Bay

Dublin Bay is open and broad at its mouth with generally shallow water depths of less than 10m (ERU, 1991a). As it is sheltered from the prevailing south-westerly winds, tidal currents assume the dominant influence over mixing processes in the bay (Marine Institute, 1999).

Residual currents are northerly in direction with water entering the bay from the south and exiting at Howth. (Fig. 1). As offshore ebb tides run southerly, a clockwise rotation is generated (MI, 1999). There are a number of ridges of hard sand in the vicinity of the bay mouth. The bay has extensive intertidal areas including broad strands and sandflats. There are also some areas of saltmarsh.

North Bull Island includes sand dunes, saltmarsh and mudflats of international importance for wintering waterfowl. It is classified as an Area of Scientific Interest, a National Nature Reserve RAMSAR site (Wetland of International Importance) and a Special Area of Conservation.

Rockabill Island is classified as a Refuge for Fauna.

Borrer's saltmarsh grass, *Puccinellia fasciculata* a nationally rare plant is found in Booterstown Marsh and Baldoyle Estuary.

The bedrock in Dublin Bay is the same granite as in the Dublin area generally. Carboniferous limestone occurs at depth under the port area. The bedrock of the bay, and the rest of the Dublin area, is covered by sediments of glacial origin. The sediments at the surface in the bay are predominantly sands, with some silt and mud accumulations between the sandbanks.

The building of the North Bull Wall resulted in the development, during the last century , of the North Bull Island. The island, along with its associated intertidal zone is an internationally important wildlife habitat.

The three principle rivers discharging to Dublin Bay are the Liffey, the Tolka and the Dodder. There are also several streams and the Grand and Royal Canals discharge into the Liffey estuary.

Waste Loads

Continuous discharges to Dublin Bay include effluent from the Ringsend Sewage Treatment Plant (RSTP), which serves about 70% of the population of Dublin, and from smaller outfalls, as well as contaminants carried down in the rivers and streams. These are the major sources of pollution in the bay. Other sources of pollution are dredge spoil disposal, litter, chronic spillages of small amounts of oil, ores and other toxic substances and diffuse sources. The principle diffuse contaminants entering the bay and its surroundings directly are from groundwater and atmospheric deposition (Environmental Research Unit, 1991a). Since 1999 there has been no dumping of sewage sludge at sea because that produced at RSTP is sold as fertiliser to tillage farmers (Dublin Bay Project, 2002). Dumping of sewage sludge at sea constituted a significant waste input to the bay prior to 1990, when the dumpsite was re-located to an offshore location (MI, 1999).

The largest input to the bay by far is that at Ring send, comprising preliminary and primary- treated sewage effluent mixed with cooling water from the Poolbeg Electricity Generating Station which is discharged from a common outfall. The daily mean sewage effluent flow is $3.33m^3/s$.

Other outfalls discharging to Dublin Bay

1. The existing sewer network in the North Dublin/South Fingal area serves 310,000 people and discharges untreated sewage off the Nose of Howth, just north of the bay, at a rate of $78,000m^3/day$.

2. There is a small outfall (serving an estimated population of 280) discharging to Doldrum Bay, Howth.

The smaller streams in general show, on occasion, much greater levels of organic pollution than the three inflowing rivers (ERU, 1991 b). However, eutrophication is the main effect in evidence above the tidal limits in these rivers and they probably contribute to the eutrophic state of the estuary and bay. Wastewater from RSTP is not particularly high in nitrates and freshwater influences dominate oxidised nitrogen inputs to the bay (MI, 1999).

Total phosphorus and molybdate reactive phosphate (MRP) levels are low along the section of the Royal Canal from Mullingar to Dublin and the Grand Canal from Lowtown to Dublin also shows good water quality with MRP levels well below $0.02mg\ 1^{-1}$ at all times (Environmental Protection Agency (EP A), 2002a).

Dublin Bay Project

This is a major current initiative, which is approaching its conclusion, undertaken to improve water quality in Dublin Bay. The scheme is designed for 1.7 million population equivalent and has three main elements: Upgrading RSTP to meet EU and Dublin Bay Water Quality Standards by providing secondary and tertiary sewage treatment, building a new pumping station at Sutton and laying a submarine pipeline under Dublin Bay from the Sutton pumping station to RSTP. The sewerage network for North Dublin/South Fingal will be connected to RSTP via this pumping station and pipeline, and therefore disposal of raw sewage off the Nose of Howth will stop. The water quality at Dollymount and Seapoint beaches is expected to improve (Dublin Bay Project, 2002). Also expected is an 85% net reduction in the municipal BOD load to the bay with parallel decreases in nutrient inputs (MI, 1999).

General water quality of the Bay area.

Biochemical oxygen demand (BOD) concentrations in the Liffey estuary, Dublin Bay and adjacent coastal waters are generally low. Oxygen saturation levels are generally within the range of normal saturation (80-120%) and levels in the waters adjacent to the RSTP outfall are indistinguishable from the remainder of the outer Liffey estuary .Water quality of the bay is considered high in terms of nutrient and chlorophyll levels. In the outer Liffey estuary nutrient levels are significantly higher than in the upper estuary and the bay. Bacterial contamination in the bay is low (EPA, 2002a). However, Merrion and Sandymount Strands do not comply with Guide or Mandatory or National Limit Value (NLV) levels of water quality parameters, and Dollymount Strand with Guide or NLV levels. Seapoint beach, adjacent to the DL sites, does not comply with Mandatory levels (EPA, 2002b). Ships sail up Dublin Harbour via a central dredged channel and in doing so cause the release of hydrogen sulphide from the sediments; such sediments are anoxic and toxic which may result in the complete extinction of benthic flora and fauna.

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Effluent Dispersion

The pattern of movement of effluent released from RSTP depends on both the tidal level on its release and the stage of the tidal cycle (ERU, 1991d).

On neap tides, effluent discharged on the late ebb tide moves towards the mouth of the estuary but generally does not enter the bay. It reverses in direction on the subsequent flood tide, moving back into the Liffey and Tolka estuaries. Effluent discharged at low water or on the flood tide tends to move northwards well into the Tolka estuary or else westward up the Liffey on the flood tide. Very little effluent leaves the bay during the first cycle after its release on neap tides.

On spring tides, effluent released around high water tends to move further out into the bay on the ebb tide than on neaps, so that on the subsequent flood tide a substantial amount may have exited the bay. Effluent released at mid-ebb does has not moved as far east by low water and tends to move northwards towards Sutton on the flood tide. Effluent released at low water or on the flood tide moves either to the northwest, into the Tolka estuary , or west, into the Liffey estuary .In contrast to the situation on neaps, a substantial amount of effluent may leave the bay on the first tidal cycle after its release on spring tides (ERU, 1991 d).

Howth is vulnerable to exposure to the dispersing effluent if it is released at mid-ebb of a spring tide, as it moves out into the bay but is then pushed north towards Sutton by the subsequent incoming tide.

This pattern of effluent dispersion caused by the currents and tidal movement in the harbour and bay mean that the North Bull Wall area and the inner great southern wall suffer most exposure to the effluent on both neap and spring tides.

Most effluent exits the estuary through the southern side of the harbour mouth, while a small amount drifts more slowly towards the mouth close to the Great Southern Wall (ERU, 1991c).

The rates of exchange of water between the Liffey estuary and Dublin Bay and between Dublin Bay and the open sea are very good, due mainly to the asymmetry of currents. This ensures that when effluent leaves the estuary very little is returned on the subsequent tide (ERU, 1991a).

River inflow and meteorological influences, such as wind speed and direction, have little influence on the movement of the water mass. The effluent dispersal pattern which the water movements cause means that the Liffey and Tolka estuaries are the parts of the bay which suffer the most exposure to the released effluent most of the time.

The overall pattern of currents and dispersion is effective in reducing the impact of the discharge on the shoreline waters of the north bay area, however the effluent has a more adverse impact in times of neaps than springs (ERU, 1991d, Fig. 1).The estuarine section is characterised by a steady fall in salinity throughout its length with a long-term mean tidal range of 2.57m (Marine Institute, 1999). Hydrographical and physiochemical studies of the estuary by Crisp (1976), Jones and Jordan (1979), and Wilson et al (1986) show it to be a "classic" salt wedge estuary. The dredged channel downstream of the Matt Talbot Bridge has shown to trap sediment and organic matter and that anoxic condition prevail, although the oxygen levels in the water column are sufficient enough to allow the passage of migratory fish. (Britton, 2001, EIS Poolbeg Power Station, 1997)

Previous Surveys on the Area

Studies by Crisp (1976) (Figs. 1-3), Jones and Jordan (1979) and Wilson et al (1986) on the Liffey estuary concluded that the Camac was a major source of pollutants with high levels of organics, humic acid and heavy metals reported at its confluence. It was believed that this pollution originated from the trade waste of a paper, pulp or saw mill and made the sediments anoxic and foul smelling. A consequent study was done by Brennan (1988), following the closure of the paper mill, the upgrading of the main drainage scheme and the development of a new treatment works providing primary treatment at Pigeon House. The results show that although the Camac was still a major source of pollution, its impact was deteriorating.

The sediments of the Liffey have elevated metal levels, Jones and Jordan(1979), Wilson et al (1986) and Brennan (1988)(Table 1). Toxic metals such as copper, nickel, zinc, cadmium, lead and iron were all present in high concentrations. The metal levels exceeded the baseline (unpolluted) and threshold levels (damaged) levels as recommended in the pollution load index (PLI) by Jeffrey and Wilson (1985), and continue to remain so, Britton (2001) (Table 2.)

Present Sources of Pollution

Organic pollution in the water column in the River Liffey estuary is monitored on a regular basis by Dublin Corporation and the EPA. Every three years the water quality of the River Liffey is evaluated until the Lucan Bridge by the EPA under the Biological Survey of River Quality (1998). They concluded that through their system of biological assessment and biotic indices that the Liffey is described as a Class C River i.e. it is moderately polluted. They also evaluated the tributaries of the Liffey including the Camac, which is classed as seriously polluted (Class D), the Dodder that is moderately polluted (Class C) and the Tolka, which is moderately polluted (Class C). These statistics do illustrate in some ways the various pollution sources to the estuary of the Liffey, but the parameters on which they are based do not incorporate metal contamination. Hence they can only serve as a guide to show the relative inputs of organic pollution to the estuary (Biological Survey of River Quality, 1998)

Many of the metal pollutants affecting the estuary come from the headwaters of the Liffey, such as the natural minerals released from the weathering of the rocks, leaching of soils and vegetation and from discharge from the sewage treatment works at Leixlip and Oberstown. Although no published data exists on the concentration of metals from these sources they are thought not to be too serious.

Activities like the burning of fossil fuels release metals such as cadmium, zinc, lead and copper into the atmosphere. These metals are washed down in rainwater and accumulate in grit on the roads, and after rainfall the resulting urban run-off enters the river directly from the storm drains. This has been shown to be a major source of heavy metal pollution of sediments in several studies on urban estuaries e.g:-Thames estuary (Atrill and Thomes, 1995), Pymmes Brook (Faulkner et al,1992)

A number of industries also discharge effluent into the estuary although these companies all have licenses under the Water Pollution Act, 1977 and 1990, with strict controls on their effluent. Guinness at Victoria Quay, Conservation Engineering at 'North Wall Quay, Hammond Lane Metal Company at Pigeon House Road as well as the ESB at North Wall and Poolbeg all possess licences to discharge to the Liffey estuary. These licences allow a suspended solid load of a maximum of 25 mg/l as well as other restrictions on individual metal concentrations, BOD levels, temperature levels and other organic contaminants.

Further pollution comes from the major sewage treatment plant at Ringsend, which discharges effluent at the head of the estuary. Tides influence the dispersion of these wastewaters and it was noticed in the study by the Marine Institute (1999) that much of the effluent leaving the confines of the harbour wall under neap tide conditions is returned to the estuary on the following tides (Fig. 1). These pollutants are often deposited in the estuary, especially in the non-dredged area around Butt Bridge.

Britton (2001) concluded that the level of contaminants especially the heavy metals copper, lead and zinc found throughout the Liffey estuary were at very elevated levels (Fig. 4, Table 2.). A peak concentration of pollutants was found in the middle estuary from where the levels dropped off upstream and downstream. Britton's results are comparable to those of Brennan (1988), and a change on the results of Wilson et al, 1986 and Crisp (1976) when the river Camac was the source of most pollution.

The concentrations of cadmium, chromium, and nickel were not studied by Brennan, however, the sites studied by Britton (2001) and Brennan (1988) are comparable (Britton 2001). The results of Britton (2001) can be compared to the studies of Wilson *et al*, (1986) and Jones and Jordan (1979) and the concentrations appear to have dropped off by 2001. (Table 2.) However, the levels of Cu, Pb, and Zn were so high at some sites they breached the Dutch regulations for contaminated lands (Cairney and Hobson, 1998). These are a set of target and intervention values for soils (mg/kg dry weight) as set out in Dutch law, that are used to classify the contamination of soils. The intervention values were exceeded, thereby classing this region as contaminated land according to Dutch guidelines.

A significant input of heavy metals to the river Liffey still exists particularly in the middle reaches of the Liffey sediments from Ushers Quay to Aston Quay. (Britton, 2001; Brennan, 1988). Brennan (1988 claimed this was primarily due to urban run-off.)

Numerous studies on heavy metal pollution in urban receiving waters have found that metal transport by surface run-off is closely correlated to the partitioning of metal forms to particulate phases (Yuan et al, 2001). In a study by Sutherland and Tolosa (2000) it was found that road deposited sediment (RDS) and its associated contaminant load play a critical role in degrading receiving water bodies. Inputs intrinsic to RDS include road surface wear, vehicle wear (tyres, body, and brake linings), vehicle fluid, particulate emissions and road paint degradation.
That study on an urban drainage basin concluded that Cu, Pb and Zn were the major polluting elements found in the RDS and in the sediment of the receiving water (Sutherland and Tolosa 2000).

Since the urban run-off flows directly from the roads adjacent to the river Liffey into the estuary via the storm drains, it can be concluded the elevated metal levels are as a result of road run-off. Also due to the hydrographic conditions of the estuary this area is the region of little mixing (Jones and Jordan, 1979), maximum turbidity and high deposition.

Fauna

In the Liffey, de-oxygenation of the deeper water exerts an additional stress so that although some macro-organisms can live on the quay walls all the way up the estuary, the bed is virtually devoid of life from Kingsbridge down to about 1.5 km below Butt Bridge (Fig. 2). In the port reach of the estuary (Fig. 3) there is a classical series of the bottom communities to be expected in areas accumulating excessive amounts of organic detritus. Out-side the lifeless zone the first worms to be found are species well known for their ability to withstand low oxygen levels and their ability to capitalise on the lack of competition for the enhanced food resources. Progressively the fauna becomes more normal towards Poolbeg, though in the vicinity of the South Wall outfalls the communities show polluted characteristics. The fauna of the flats on the north shore appears almost normal. There are some signs of enrichment that become more noticeable further towards the shoreline and the River Tolka. There is also sufficient organic detritus in the north shore sediments for deoxygenated conditions to come close to the surface in hot weather and for mortalities to occur in the cockle population. Sediments close to the opening of the Tolka consist of soft mud, which, like areas of deposition in other urban estuaries, show in places some evidence of contamination by oily substances and at times of animal mortality.

Although eels can be found in the upper reaches of the Liffey, the deoxygenated conditions in the port reach probably at times restrict the passage of the more demanding migratory fish. (Crisp 1976 – sampling stations Figs. 2 & 3)

Britton (2001) made similar observations.

Surveys were carried out by the Hydraulic Research Station (HRS), Wallingford, U.K. to determine the effects of power station cooling water discharges on the receiving waters of Dublin Harbour, based on a installation of 1000Mwe of conventional steam/condensing power station capacity on the Poolbeg site. The study concluded that outside the immediate area of the outfall itself, temperature increases above ambient would be very small and that the temperature rises would not be detrimental to marine life or to the passage of salmonid fish to and from the fresh waters of the liffey. A further study was carried out during 1991 on temperature profiles and water quality in the estuary in the vicinity of the Poolbeg outfall. (Table 3).

The measured percentage saturation of oxygen in the surface waters at Poolbeg was invariably greater than 75%. Only a minority of the measurements showed saturations of less than 7.5mg/l.

The Poolbeg Power Station Extension EIS General Summary, 1991, concluded :
"The salmon population in the River Liffey has increased considerably in the recent past due to reduced pollution loads entering the river and considerable restocking efforts. ESB has been involved in these latter efforts. The River Liffey is not a designated salmonid river under the European Directive 78/659/EEC regarding the quality of fresh waters to support fish life. Nonetheless, it is the aim of the Eastern Regional Fisheries Board that salmon stocks be maintained in the river. To that end, it is desirable that the temperature limit of 21.5° C, outside a mixing zone, set down in the Directive for the freshwater reaches should not be exceeded where possible. The increased thermal discharge associated with the proposed combined cycle station will not increase the temperature of the estuary to this level outside the mixing zone, and will not, therefore, affect the migration of salmonid fish." (Hildebrand measured water temperatures at distance from the outfall Table 4)

The water quality in the estuary is of significance to salmonid fish during the migration of salmon smolt from the freshwater reaches to the sea and during the upstream migration of the adult salmon to the freshwater reaches. (The estuary also forms a zone of passage for other migratory fish such as sea-trout and eels).
The downstream migration of the salmon smolt usually occurs during March/April. From contact with the Eastern Regional Fisheries Board, it appears that the discharge from the existing station at Poolbeg is not interrupting this downstream movement at present. The temperature increases anticipated at this time of the year arising from the increased thermal discharge will not raise the temperature of the estuary to levels which are harmful to salmon smolt.

ii) Upstream Migration
To date, interruption of the upstream migration patterns of adult salmon has not been a problem in the estuary .This indicates that the adult fish avoid the thermal discharge by moving outside and below the region of excess temperature.

The study of Hildebrand (2002) concluded that the biochemical oxygen demand concentrations in the Liffey estuary, Dublin Bay and adjacent waters were generally low, and that the oxygen saturation levels were generally within the range of normal saturation (18-120%) with levels in the waters adjacent to the Ringsend Sewage Treatment Plant outfall being indistinguishable from the remainder of the outer Liffey. Temperature varied with distance from the outfall, but remained below 21.5 ^{o}C at all sampling sites with the exception of 1 (Grid ref. O214337) (Table 4.)

Tolka river
The fauna of the estuarine section of the river Tolka has been sampled by Wilson *et al*, 1982 (Table 5 & 7, Fig. 5) and Nairn (1995). Sites in the area of the Bull wall are also considered here. No real comparisons can be made between these two surveys.

Heavy metal concentrations in the sediments of the Tolka were measured by Nairn and the results with compared with those of other surveys (Table 6)

Nairn, 1995 concluded that the heavy metal levels in the sediment had declined significantly between 1989 and 1995. The area upstream of the Eastpoint causeway was used by relatively small numbers of estuarine birds in winter and is not used as a significant feeding area for populations of waders and wildfowl which overwinter in Dublin as a whole. The area downstream of the Eastpoint causeway was of major significance as a low tide feeding area for waders and wildfowl and formed a continuum with the intertidal area of the lower Tolka estuary and the rest of North Dublin Bay which is of international importance for birds..

Bull Island Lagoons

The fauna of the mud flats and salt marshes of Bull island were surveyed by Goodwillie *et al*, 1971 ; Healy, 1975 and Wilson, *et al* 1982 (Tables 11 & 12). No maps were given in the Goodwillie *et al*, 1971 report.

More recently some stations have been surveyed at the edge of the northern lagoon as part of the environmental impact surveys for the proposed submarine pipeline in Dublin Bay, 1997 and an extension to Sutton Dinghy Club, 1999. Table 8 lists the species of the Bull Island lagoons as recorded by Goodwillie *et al*,(1971) Wilson, (1982) and the submarine pipeline (1997). Whilst the conclusion is reached that there has been little change in the fauna composition of Dublin Bay in the intervening years, on the basis of statistical analysis, comparison of sampling stations from the same area in the Bull Lagoon shows a difference in species composition. (Figures 6 , 7 ; Tables 9 and 10).

Wilson, 2001, states that the densities of *Macoma balthica* have varied between "around 40-200 individuals per m^2 at both Sandymount and Bull Island over the last 12 years" with more pronounced variations at Bull Island. Similar peaks and declines have occurred in other bivalve species such as *Cerastoderma edule*, which was lacking in the Bull Island sample of 1993. Wilson (1993), suggested that the increasing coverage by macroalgal mats was inhibiting juvenile recruitment into the sediments, however, temperature is also believed to play a part – directly or indirectly (Wilson, 2001).

Seasonal changes in population structures do occur amongst invertebrates and true comparisons can only be made between surveys carried out at the same time of the year.

The fact that the genus or authority is not listed in the Taxa list of the pipeline study creates difficulties with any comparisons. Species names can and do change, the species list for the pipeline study, has been identified based on the fact that it is known to occur in the locality and that there are not two different genera with a species of the same name – for example *M. palmata* could be *Melinna palmata* or it could be *Melita palmata*.

The fauna of salt marshes differs from that of the general intertidal area, being composed of aquatic, semi-aquatic and terrestrial species. The only published report on the fauna of the Bull Island salt marshes is that of Healy 1972 (Fig. 8, Table 13). Zonation on salt marshes is determined by the flora present as it is on any other intertidal shoreline, and this is determined by tolerance to submergence. Zonation of the flora in 1972 was recorded as being as described by O'Reilly and Pantin, 1952. (Fig. 9)

Bull Island Flora

Bull Island Salt marsh was surveyed by O'Reilly and Pantin, 1957.

The marsh at that time was divided into three main vegetative zones:
Zone 1 – uppermost on the marsh: composed of the following plant species:
Juncus maritimus
Juncus gerardi
Glaux maritima
Cochlearia maritima
Armeria maritime
Triglochin maritima
Plantago maritima
Aster tripolium
Puccinellia maritima
Festuca rubra
Salicornia ramosissima

Zone II – gradual change to this zone from Zone I. Composed of:
Armeria maritima
Triglochin maritima
Olantago maritima
Aster tripolium
Limnoium humile
Salicornia ramosissima
Cochlearia officinalis
Glaux maritima
Suaeda maritima
Puccinellia maritima
Halimione portulacoides
Spartina townsendii
Fucus sp and *Pelvetia* sp

Zone III – a narrow zone, 3-5 yards wide, at the front of the marsh. Composed of:
Puccinellia maritima
Suaeda maritima
Salicornia ramosissima
Spergularia marginata
Triglochin maritima
Limonium humile

During 1971, Goodwillie *et al,* listed the following as occurring on the Bull Island Mudflats:

Salicornia
Ulva lactuca
Enteromorpha sp.
Spartina townsendii
Zostera angustifolia
Ruppia maritima

Rhizoclonia sp.
Ceramium sp.
Fucus sp

A survey of Zostera distribution was carried out in Dublin Bay by Madden et al, 1990. (Fig. 10)

Zostera noltii
Stands occur at Sutton Creek. In Sutton Creek (0255390) *Z. noltii* has a sparse distribution within an area of fucoid and green algae. In 1990 the densest part of the bed covered an area of about 40m^2.

Zostera angustifolia
The only site for *Z. angustifolia* in the bay is in a channel, which traverses the *Salicornia* flat within the north lagoon of the North Bull Island (0230380). It is a dense stand of 100% coverage, but extends for only 100m by 2-3m wide.

Other records of *Zostera* from Dublin Bay: A 1964 (Trinity college, herbarium) specimen from 'sandy mudflats, North Bull', and a 1973 specimen from 'sandy mudflats at the Howth end of the Bull Island'. There are two references to *Z. angustifolia* growing in north Dublin Bay. Colgan (1904) reports a 1902 record from 'below Raheny' and there is a 1973 herbarium specimen (TCD) from the Sutton Creek area.

It appears that *Spartina* competes with *Zostera* for space and also modifies the physical structure of the sediments. Goodwillie et al, 1972 comented: "The effect of *Spartina* on silting is substantial, in fact some of the highest rates of accretion in the British isles have been recorded for this species (*Salicornia* comes second) Ranwell, (1964). It has the additional effect of discouraging wading birds, either because it utilises available organic matter quickly to the detriment of the invertebrate population of detritus feeders or because it forms tall cover from which birds keep away"

While Madden et al, (1992) stated that the scarcity of *Zostera* in northern Dublin Bay may be due to the thick green algal mats, mainly *Enteromorpha* sp., which have increased considerably.

Ranwell, D.S. 1964. Spartina salt marshes in S. England. II Rate and seasonal pattern of sediment accretion. J. Ecol. Vol. 52, No. 79.

Sutton Creek
Three published surveys have taken Sutton Creek into consideration, Wilson, et al, 1982 ; Dublin Bay Submarine Pipeline EIS, 1997 and the Sutton Dinghy Club extension EIS, 1999. (Table 14, Figs. 11 & 12)

Wilson stations:
1, 2, 4, 5, 7, 8, 9, 10, 11, 15 (Table 14, Fig. 6)

Submarine pipeline stations: 21, 22, 23, 27 (Table 14, Fig. 13)

Dublin Bay

Three surveys take the greater Dublin Bay area into consideration – those of Walker & Rees, 1980 (based on the research carried out during the 1970's in relation to the Power Plant Extension), Wilson *et al*, 1982, and the submarine pipeline EIS, 1997.

The Walker and Rees survey was subtidal (Table 15) as was the submarine pipeline survey (Table 14) that of Wilson *et al*, 1982 was intertidal (to low tide mark) (Fig. 6, Table 16) No true comparisons can be made between any of these surveys. The fauna of the transects (sampling grids) closest to Bull island of the Walker & Rees are listed in Table 15.

South Bull

Very few surveys have been published relating to the South Bull. That of Wilson *et al* 1982, remains the most detailed. Some stations in this area were sampled for the environmental impact statement for the pipeline, but these cannot be compared to Wilson's 1982 results as the fauna was impoverished and typical of a recovering fauna.

The distribution of *Zostera* beds in this area have been studied, Madden et al, 1992 (Fig. 14). No surveys on seagrasses have been done in this area since that time.

The Environmental Impacts surveys carried out for development in the Dun Laoghaire area did not take invertebrate fauna into consideration, and neither did the survey for the upgrading of the Ringsend Treatment plant. Considering the fact that no rare or protected species had been found in earlier studies, it was stated that upgrading the sewage treatment plant with the resulting cleaner effluent would have no deletrious long term effect on the fauna.

Booterstown Marsh

Booterstown Marsh (GR 2 200 306, Plate 1) is the only brackish water marsh in south county Dublin. Its status as a bird sanctuary and as one of the two most southerly Irish locations for the protected rare plant species *Puccinellia fasciculata* make it an important ecological site.

The marsh was formed in 1834 with the construction of the new Dublin to Kingstown railway lie. This cut across a shallow sandy bay between Blackrock and Merrion at which point two streams (Elm Park and Trimleston/St. Helen's) entered the sea. The steams were re-directed into a ditch along the railway line and then entered the sea through a flap valve built into a stone sluice at Williamstown. At high tide the sea entered through this flap. Land at either end of this marshland has been reclaimed since its construction. It is oblong in shape and about 4 hectares in area. The fauna and flora of the marsh have been surveyed in detail on a number of occasions on behalf of An Taisce, to ascertain it's biological status and/or design a management programme for it's conservation (Goodwillie *et al*, 1971; Goodwillie, R., 1986 ; McGibney, K., 1989 ; Reynolds, J.D. 1988, Reynolds, J. & Reynolds, S.C.P, 1990 ; O'Neill, M. 1996).

By 1995, the overall salinity within the marsh had decreased and *Scirpus maritimus* had spread throughout the marsh rendering it unacceptable to the avifauna that had used it for roosting and feeding. Recommendations were made to the Irish Wildlife Conservancy that the flap valve should be allowed remain open. Since that time, it would seem that the marsh has returned to a state similar to that of 1989 as regards vegetation and ground cover. No surveys have been carried out since the 1996 environmental audit by Mary O'Neill.

No survey took heavy metal contamination into account.

Fisheries

Fishing is important to the local economy of Howth with a fleet of 60 fishing boats. Annual tonnage has reached 12,000 tons compared to 6,848 for 1995.

The *Nephrops* fishery is one of the most important and this fishery is outside the inner Dublin Bay area. Plaice are a by catch of this fishery.

The *Buccinum* fishery (whelk) is also important to Howth, however the main beds stretch from the Kish bank and down the east coast.

Annual whelk landings (tonnes) from Howth:

1991	1992	1993	1994	1995	1996	1997	1998	1999
18	12	24	446	427	555	266	118	320

Fishing for Razor clam (*Ensis*) was important north of Dublin bay and the beds would seem to be fished out, there are however, *Ensis* beds in the area of Dublin bay close to the Ringsend power station. It is believed that these beds and the *Cerastoderma* beds on the south bull could become important with improvement in the water quality of the Bay.

The study by West *et al*, 1978, on the potential for a cockle fishery on the south bull, concluded that due to the low population density the catch per unit effort would probably be too small to be commercially viable. However studies of bivalve populations in Dublin Bay by Wilson (1997, 2001) based on surveys carried out since 1977, suggest that there is a seven year periodicity associated with the bivalve populations in Dublin Bay, with peaks around 1986, 1992/4 and 2000, and troughs in 1991 and 1997/98.

Annual catch (tonnes) landed at Howth

1993	1994	1995	2002
2,399	2,608	6,848	12,000

Seed Mussel beds are of major importance off the east coast, but those in the Dublin Bay area are not of commercial value. (Fig. 20.)

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Table 1. Comparison of metal levels in Liffey estuary to recommended baseline and threshold levels (Britton, 2001)

Metal conc. Mg/kg dry weight sediment	Cu	Pb	Zn	Fe	Ni	Cd	Source
Baseline	5	10	20	0.50%	5	0.5	Jeffrey & Wilson 1985
Threshold	50	100	100	2.00%	20	1.5	Jeffrey & Wilson 1985
Liffey	65-415	n/a	166-1280	1.5-13.2%	24-38	1.0-4.8	Jones & Jordan, 1979
Liffey	30-260	80-1480	180-780	1.2-2.5%	40-240	n/a	Wilson et al, 1986
Liffey	10.0-2529	57-1633	57-609	n/a	n/a	n/a	Brennan, 1988

Table 2. Average concentrations of heavy metals at sampling stations (Britton 2001)

Site No.	Chromium µg/g	Copper µg/g	Iron %	Lead µg/g	Nickel µg/g	Zinc µg/g	Cadmium µg/g
1	9.78204	22.6734	0.984456	65.341	16.5346	123.0569	0.503963
2	12.56962	24.64077	1.094461	103.5918	19.7631	165.7318	0.875614
3	17.77371	48.06335	1.627	103.4457	47.5425	253.4433	1.752154
4	14.70673	75.5356	1.539496	508.1609	30.03905	513.1634	1.251615
5	9.39379	48.973	0.9894	139.03	16.1573	181.613	0.563339
6	19.54673	970.9615	3.572015	680.6709	64.9401	6556.759	2.185703
7	28.03467	1170.216	7.891044	1518.144	62.57885	15800.65	3.504349
8	14.45979	55.71208	1.546131	121.0599	26.85382	400.6176	1.189347
9	21.93124	73.9174	2.055629	128.5903	32.4891	399.8982	1.624277
10	31.78817	77.09009	1.933491	160.0615	43.8036	466.1854	1.814748
11	23.48191	67.25635	1.929642	148.4941	27.22795	437.1092	1.373833
12	5.804799	6.679314	0.555606	19.73013	5.992162	81.20993	0.187363
13	22.21023	53.02408	2.31646	106.4533	27.17174	333.4185	1.269098
14	6.498051	8.872338	0.649805	29.49115	6.060682	99.97001	0.312406

Table 3. Water Quality results Poolbeg Power Station Extension ESBI 1991 survey

State of Tide	Depth (m)	Temp. rise above ambient °C	°C Rise not exceeded U/S (m)	°C Rise not exceeded D/S (m)	Comments
Spring	0.3	1	700m	To N. Bull lighthouse	Low water
Spring	0.3	2	640m	1750m	Low water
Spring	0.3	3	270m	682m	Low water
Spring	1.22	1	n/d	To N. Bull lighthouse	Low water
Spring	1.22	2	n/d	333m	Low water
Spring	1.22	3	n/d	190m	Low water
Spring	2.13	1	n/d	460m	only 2 instances measurable
Spring	2.13	2	n/d	254m	Low water
Spring	2.13	3	n/d	n/a	Low water
Neap	0.3	1	n/d	715m	Low water
Neap	0.3	2	n/d	460m	Low water
Neap	0.3	3	n/d	365m	Low water
Neap	1.22	1	n/d	575m	Low water
Neap	1.22	2	n/d	333m	Low water
Neap	1.22	3	n/d	238m	Low water
Neap	2.13	1	n/d	n/a	Low water
Neap	2.13	2	n/d	n/a	Low water
Neap	2.13	3	n/d	n/a	Low water

Table 3 notes: The power output range from Poolbeg during the survey ranged between 101MW and 266 MW.The temperature monitoring was carried out over the sampling period 28/3/1991 – 7/4/1991. U/S = Upstream D/S = Downstream

Table 4. Salinity and temperature results Hildebrand 2002.

Site Name	Grid Reference	Species No.	Salinity ppt	Temperature °C
Great South Wall 1	O220338	14	35.4	19.8
Great South Wall 2	O214337	1	28	22
Great South Wall 3	O232340	13	32.5	17.4
Great South Wall 4	O232339	15	35.2	16.1
Great South Wall 5	O222338	4	31.8	18.3
North Bull Wall 1	O224349	25	33.2	18.8
North Bull Wall 2	O217355	21	33.3	18.4
Dun Laoghaire 1	O233288	26	33.4	15.7
Dun Laoghaire 2	O234289	20	33.5	15.7
Howth 1	O272368	22	34.8	16.3
Howth 2	O275365	22	34.9	16.1
Dalkey Island 1	O279265	28	35	17
Dalkey Island 2	O279265	23	35	17.1

Table 5. Species recorded by Wilson, 1982 Tolka and Liffey estuarine area (Fig. 5)

118 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Spio filicornis* (Fabricius) *Tellina tenuis* (da Costa) *Tellina fabula* (Gmelin)	**123** *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Spio filicornis* (Fabricius) *Arenicola marina* (L.) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa)	**124** *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Spio filicornis* (Fabricius) *Tellina tenuis* (da Costa)
127 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Macoma balthica* (L.)	**128** *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Crangon crangon* (L.)	**129** *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Spio filicornis* (Fabricius) *Lanice conchilega* (Pallas)
130 *Nereis virens* (M. Sars) *Nereis diversicolor* (O.F. Muller) *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Spio filicornis* (Fabricius) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)	**133** *Tubifex costatus* (Claparede) *Scoloplos armiger* (O.F. Muller) *Nerine foliosa* (Audouin and Edwards)	**134** *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Macoma balthica* (L.) *Crangon crangon* (L.)
135 *Nereis virens* (M. Sars) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Macoma balthica* (L.) *Crangon crangon* (L.)	**136** *Nereis virens* (M. Sars) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Lanice conchilega* (Pallas) *Carcinus maenas* (Pennant) *Eurydice pulchra* (Leach)	**137** *Nereis virens* (M. Sars) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Tellina fabula* (Gmelin)
139 *Phyllodoce* sp. *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Macoma balthica* (L.) *Crangon crangon* (L.)	**140** *Nereis virens* (M. Sars) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.)	**141** *Tubifex costatus* (Claparede) *Nereis virens* (M. Sars) *Nereis diversicolor* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Crangon crangon* (L.)
142 *Nereis diversicolor* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Tellina tenuis* (da Costa)	**143** *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.)	**144** *Nereis virens* (M. Sars) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Macoma balthica* (L.) *Abra alba* (Wood) *Crangon crangon* (L.) *Carcinus maenas* (Pennant) *Melita palmata* (Montagu) *Corophium volutator* (Pallas)
145 *Nereis virens* (M. Sars) *Nereis diversicolor* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Cerastoderma edule* (L.)	**146** *Nereis virens* (M. Sars) *Nereis diversicolor* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Crangon crangon* (L.)	**147** *Tubifex costatus* (Claparede) *Nereis virens* (M. Sars) *Nereis diversicolor* (O.F. Muller) *Mytilus edulis* (L.) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Carcinus maenas* (Pennant)

Table 5 con't. Species recorded by Wilson *et al*, 1982 Tolka and Liffey estuarine area (Fig. 5)

148 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Macoma balthica* (L.)	**149** *Nereis virens* (M. Sars) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Macoma balthica* (L.)	**150** *Tubifex costatus* (Claparede) *Nereis virens* (M. Sars) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Tonicella rubra* (L.) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Crangon crangon* (L.) *Orchestia gammarella* (Pallas) *Gammarus locusta* (L.)
151 *Nereis virens* (M. Sars) *Notomastus latericeus* (Sars) *Cerastoderma edule* (L.)	**152** *Nereis virens* (M. Sars) *Nepthys hombergi* (Lamarck) *Notomastus latericeus* (Sars) *Cerastoderma edule* (L.) *Crangon crangon* (L.) *Carcinus maenas* (Pennant)	**153** *Nereis virens* (M. Sars) *Nereis diversicolor* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Littorina rudis* (Maton) *Littorina littorea* (L.) *Mytilus edulis* (L.) *Cerastoderma edule* (L.) *Balanus balanoides* (L.) *Carcinus maenas* (Pennant) *Orchestia gammarella* (Pallas) *Melita palmata* (Montagu)
154 *Nereis virens* (M. Sars) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.)	**155** *Nereis virens* (M. Sars) *Nepthys hombergi* (Lamarck) *Notomastus latericeus* (Sars)	**156** *Nereis virens* (M. Sars) *Nereis diversicolor* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Crangon crangon* (L.) *Carcinus maenas* (Pennant)
157 *Nereis virens* (M. Sars) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller)	**158** *Nereis virens* (M. Sars) *Nepthys hombergi* (Lamarck)	

Table 6. Mean levels of heavy metals (μg/g) from sites in the inner Tolka Estuary in comparison to previous work. (Nairn, 1995)

Metal	**1973**	**1981**	**1989**	**1995**
As	nd	nd	nd	<0.10
Cd	nd	2.18	1.0	0.60
Cr	nd	34.0	43.7	19.3
Cu	46.4	149.0	65.7	27.1
Hg	nd	nd	nd	0.28
Ni	nd	nd	nd	12.1
Pb	72.0	495.0	153.3	39.8
Sn	nd	nd	nd	5.00
Zn	375.0	452.0	277.9	111.2
Reference	Jeffrey *et al*, 1978	Jeffrey *et al*, 1985	Jeffrey et al, 1991	Nairn, 1995

nd – No data available

Table 7. Species recorded by Wilson *et al*, 1982 and Nairn 1995.

Taxa	**Author**
Arenicola marina (L.)	Wilson *et al*, 1982
Balanus balanoides (L.)	Wilson *et al*, 1982
Capitella capitata (Fabricius)	Wilson *et al*, 1982
Carcinus maenas (Pennant)	Wilson *et al*, 1982
Cerastoderma edule (L.)	Wilson *et al*, 1982
Cirratulidae juv. Indet.	Nairn, 1995
Collembola indet.	Nairn, 1995
Crangon crangon (L.)	Wilson *et al*, 1982
Enchytraeidae indet.	Nairn, 1995
Hydrobia ulvae	Nairn, 1995
Janira maculosa	Nairn, 1995
Littorina rudis (Maton)	Wilson *et al*, 1982
Macoma balthica (L.)	Wilson *et al*, 1982
Manayunkia aestuarina	Nairn, 1995
Melita palmata (Montagu)	Wilson *et al*, 1982
Modiolus modiolus (L.)	Wilson *et al*, 1982
Mya arenaria (L.)	Wilson *et al*, 1982
Mytilus edulis (L.)	Wilson *et al*, 1982
Nepthys hombergi (Lamarck)	Wilson *et al*, 1982
Nereis diversicolor (O.F. Muller)	Wilson *et al*, 1982 Nairn, 1995
Nereis virens (M. Sars)	Wilson *et al*, 1982
Pomatoceros triqueter (L.)	Wilson *et al*, 1982
Scrobicularia plana (da Costa)	Wilson *et al*, 1982
Streblospio shrubsolii	Nairn, 1995
Tonicella rubra (L.)	Wilson *et al*, 1982
Tubifex costatus (Claparède)	Wilson *et al*, 1982 Nairn, 1995
Tubificoides benedii	Nairn, 1995
Tubificoides pseudogaster	Nairn, 1995

Table 8. Species occurring in the Bull island lagoons, Wilson *et al*, (1982), Goodwillie *et al*, (1970), Submarine pipeline EIS, (1997)

Taxa	**Author**
Amage adspersa (Grube)	Wilson lagoons 1982
Ampharete grubei (Malmgren)	Wilson lagoons 1982
Amphiporus lactifloreus (Johnstone)	Wilson lagoons 1982
Anemonia sulcata (Pennant)	Wilson lagoons 1982
Anopeles	Goodwillie et al, 1970
Arenicola marina (L.)	Goodwillie et al, 1970; Wilson south bull only
Arenicola marina (L.) as *A. marina*	Submarine pipeline EIS
B. pulchella	Submarine pipeline EIS
Bathyporeia guilliamsoniana (Bate)	Wilson south bull only
B. guilliamsoniana	Submarine pipeline EIS
B. nana	Submarine pipeline EIS
Bathyporeia pelagica (Bate)	Wilson south bull only
B. pelagica	Submarine pipeline EIS
C. captella	Submarine pipeline EIS
Carcinus maenas (Pennant)	Goodwillie et al, 1970; Wilson lagoons 1982
Cerastoderma edule (L.)	Goodwillie et al, 1970; Wilson south bull only
C. edule	Submarine pipeline EIS
Corophium volutator (Pallas)	Goodwillie et al, 1970; Wilson lagoons 1982
Crangon crangon (L.)	Wilson south bull only
C. crangon	Submarine pipeline EIS
Crangon vulgaris	Goodwillie et al, 1970; ? *C. crangon*
Dipterous larvae	Goodwillie et al, 1970
Dosinia exoleta (L.)	Wilson lagoons 1982
Eteone longa as *E. longa*	Submarine pipeline EIS
Hydrobia ulvae (Pennant)	Goodwillie et al, 1970; Wilson lagoons 1982
Lanice conchilega (Pallas)	Wilson south bull only
L. conchilega	Submarine pipeline EIS
Lineus spp	Wilson lagoons 1982
Lipura maritima	Goodwillie et al, 1970
Littorina littorea (Linneaus)	Goodwillie et al, 1970
Littorina rudis (Maton)	Wilson lagoons 1982
Littorina sp	Goodwillie et al, 1970
Macoma balthica (L.)	Goodwillie et al, 1970; Wilson lagoons 1982
Melita palmata (Montagu)	Wilson lagoons 1982
Mya arenaria (L.)	Goodwillie et al, 1970; Wilson lagoons 1982
Mytilus edulis (L.)	Goodwillie et al, 1970; Wilson lagoons 1982
Nematocera	Goodwillie et al, 1970
Nemertini	Wilson lagoons 1982
Nepthys caeca (O.F. Muller)	Wilson south bull only
N. caeca	Submarine pipeline EIS
Nepthys hombergii (Lamarck)	Wilson south bull only
Nepthys incisa Malmgrem	Goodwillie et al, 1970
N. hombergi	Submarine pipeline EIS
Nereis diversicolor (O.F. Muller)	Goodwillie et al, 1970; Wilson lagoons 1982
Nereis pellagica (L.)	Goodwillie et al, 1970; Wilson lagoons 1982
Nereis virens (M.Sars)	Wilson lagoons 1982
Nerine foliosa (Audouin and Edwards)	Wilson lagoons 1982

Table 8 con't. Species occurring in the Bull island lagoons, Wilson *et al*, (1982), Goodwillie *et al*, (1970), Submarine pipeline EIS, (1997)

Taxa	Author
Notomastus latericeus (Sars)	Wilson south bull only
N. latericeus	Submarine pipeline EIS
Phyllodoce laminosa Savigny	Goodwillie et al, 1970
Phyllodoce sp.	Wilson lagoons 1982
P. latipes	Submarine pipeline EIS
Scoloplos armiger (O.F. Muller)	Goodwillie et al, 1970 Wilson south bull only
S. armiger	Submarine pipeline EIS
Scrobicularia plana (da Costa)	Goodwillie et al, 1970 Wilson lagoons 1982
Spio filicornis (Fabricius)	Wilson lagoons 1982
Symplecta stictica (Meigen)	Wilson lagoons 1982
Tapes rhomboides (Pennant)	Wilson lagoons 1982
T. fabula	Submarine pipeline EIS
Tellina tenuis (da Costa)	Wilson south bull only
T. tenuis	Submarine pipeline EIS
Tubifex benedini	Goodwillie et al, 1970
Tubifex costatus (Claparede)	Wilson lagoons 1982
Urothoe marina (Bate)	Wilson south bull only
Urothoe marina (Bate) as *U. marina*	Submarine pipeline EIS

Note *Nereis diversicolor* = *Hediste diversicolor*

Table 9. Species recorded by Wilson, 1982 at stations 3, 6, 13, 21 and those recorded in the Dublin Bay Pipeline EIS, 1997 stations D24, D25 and D26 (Figs 6 & 7)

Taxa	Station
Ampharete grubei (Malmgren)	6
Arenicola marina (L.)	6
B. nana	**24D**
Carcinus maenas (Pennant)	13
C. maenas (Pennant)	**25D**
Cerastoderma edule (L.)	3, 6
Crangon crangon (L.)	3, 6
Dosinia exoleta (L.)	3,
E. longa	**25D**
E. pulchra	**25D**
G.lapidum	**25D**
Macoma balthica (L.)	3, 6, 21
Mytilus edulis (L.)	13
N. nucleus	**25D**
Nepthys caeca (O.F. Muller)	6, 13, 21
N. hombergi	**24D, 25D, 26D**
N. diversicolor	**25D**
Nereis virens (M.Sars)	6
Nerine foliosa (Audouin and Edwards)	21
Notomastus latericeus (Sars)	13
P. pulchra	**25D**
Phyllodoce sp.	3, 6
Scoloplos armiger (O.F. Muller)	3, 6, 21
Scrobicularia plana (da Costa)	3
Tapes rhomboides (Pennant)	13
T. tenuis	**25D**
T. benedini	**26D**

Note *Nereis diversicolor* = *Hediste diversicolor*

Table 10. Comparison of sampling stations as per Wilson *et al*, 1982 and Submarine pipeline EIS, 1997. (Figs. 6 & 7)

Taxa	Station				
Ampharete grubei (Malmgren)		20			
Ampharete sp	29D				
Anemonia sulcata (Pennant)		26			
Arenicola marina (L.)		12	32		
C. capitata	29D,	30D			
C.maenas	28D.	29D,	30D		
Carcinus maenas (Pennant)		12	20	26	32
Cerastoderma edule (L.)		12	20	26	32
C. edule	30D				
Cirratulidae sp	29D				
Corophium volutator (Pallas)		32			
Crangon crangon (L.)		12	20	26	
G. lapidum	30D				
Macoma balthica (L.)		12	20	26	
M. balthica	28D,	29D			
M. edulis	30D				
Melita palmata (Montagu)		12			
N. diversicolor	28D,	29D,	30D		
Nepthys hombergi (Lamarck)		20	32		
Notomastus latericeus (Sars)		12	20	26	32
Oligochaeta sp	29D,	30D			
Phyllodoce sp.		12	20		
Scoloplos armiger (O.F. Muller)		12	20	26	32
Scrobicularia plana (da Costa)		26			
U.brevicornis	28D				

Note *N. diversicolor* = possibly *Hediste diversicolor*

Table 11. Taxa at each station, North Bull Lagoon Wilson *et al*, 1982. (Fig.6)

3 *Phyllodoce* sp. *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Dosinia exoleta* (L.) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Crangon crangon* (L.)	**6** *Phyllodoce* sp. *Neries virens* (M.Sars) *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Ampharete grubei* (Malmgren) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Crangon crangon* (L.)	**12** *Phyllodoce* sp. *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Crangon crangon* (L.) *Carcinus maenas* (Pennant) *Melita palmata* (Montagu)
13 *Nepthys caeca* (O.F. Muller) *Notomastus latericeus* (Sars) *Mytilus edulis* (L.) *Tapes rhomboides* (Pennant) *Carcinus maenas* (Pennant)	**20** *Phyllodoce* sp. *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Ampharete grubei* (Malmgren) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Crangon crangon* (L.) *Carcinus maenas* (Pennant)	**21** *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Nerine foliosa* (Audouin and Edwards) *Macoma balthica* (L.)
26 *Anemonia sulcata* (Pennant) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Crangon crangon* (L.) *Carcinus maenas* (Pennant)	**27** *Tubifex costatus* (Claparede) *Nereis diversicolor* (O.F. Muller) *Nepthys caeca* (O.F. Muller) *Spio filicornis* (Fabricius) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Macoma balthica* (L.)	**32** *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Carcinus maenas* (Pennant) *Corophium volutator* (Pallas)
33 *Tubifex costatus* (Claparede) *Spio filicornis* (Fabricius) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Corophium volutator* (Pallas)	**38** *Nereis virens* (M.Sars) *Nereis pellagica* (L.) *Notomastus latericeus* (Sars) *Cerastoderma edule* (L.) *Crangon crangon* (L.) *Carcinus maenas* (Pennant)	**39** *Nereis virens* (M.Sars) *Mytilus edulis* (L.) *Macoma balthica* (L.) *Crangon crangon* (L.) *Carcinus maenas* (Pennant) *Corophium volutator* (Pallas)
44 *Lineus* spp *Nereis pellagica* (L.) *Nepthys hombergi* (Lamarck) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.)	**45** *Nereis virens* (M.Sars) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Crangon crangon* (L.) *Carcinus maenas* (Pennant) *Corophium volutator* (Pallas)	**50** *Nepthys hombergi* (Lamarck) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa)
51 *Nereis virens* (M.Sars) *Notomastus latericeus* (Sars) *Hydrobia ulvae* (Pennant) *Crangon crangon* (L.) *Corophium volutator* (Pallas)	**56** *Nepthys hombergi* (Lamarck) *Spio filicornis* (Fabricius) *Amage adspersa* (grube) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Carcinus maenas* (Pennant)	**57** *Tubifex costatus* (Claparede) *Nereis diversicolor* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Arenicola marina* (L.) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Mya arenaria* (L.) *Carcinus maenas* (Pennant) *Corophium volutator* (Pallas)

Table 11 con't. Taxa at each station, North Bull Lagoon Wilson *et al*, 1982. (Fig.6)

58 Nemertini *Tubifex costatus* (Claparede) *Nereis diversicolor* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Carcinus maenas* (Pennant) *Corophium volutator* (Pallas)	**63** *Tubifex costatus* (Claparede) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Crangon crangon* (L.)	**64** *Lineus* spp *Tubifex costatus* (Claparede) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Carcinus maenas* (Pennant) *Corophium volutator* (Pallas) *Symplecta stictica* (Meigen)
70 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.)	**71** *Tubifex costatus* (Claparede) *Nereis diversicolor* (O.F. Muller) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Symplecta stictica* (Meigen)	**76** *Lineus* spp *Tubifex costatus* (Claparede) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Mya arenaria* (L.) *Symplecta stictica* (Meigen)
77 *Tubifex costatus* (Claparede) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Carcinus maenas* (Pennant)	**83** *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Carcinus maenas* (Pennant)	**84** *Tubifex costatus* (Claparede) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Littorina rudis* (Maton) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Carcinus maenas* (Pennant)
90 *Phyllodoce* sp. *Amphiporus lactifloreus* (Johnstone) *Tubifex costatus* (Claparede) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Mya arenaria* (L.) *Carcinus maenas* (Pennant)	**95** *Nereis diversicolor* (O.F. Muller) *Hydrobia ulvae* (Pennant) *Scrobicularia plana* (da Costa) *Symplecta stictica* (Meigen)	

Note *Nereis diversicolor* = *Hediste diversicolor*

Table 12. Species at each station, South Bull Lagoon, Wilson et al, 1982. (Fig. 6)

96 *Tubifex costatus* (Claparede) *Nereis diversicolor* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Corophium volutator* (Pallas)	**97** *Hydrobia ulvae* (Pennant)	**104** *Tubifex costatus* (Claparede) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Mya arenaria* (L.) *Corophium volutator* (Pallas)
105 *Lineus* spp *Amphiporus lactifloreus* (Johnstone) *Notomastus latericeus* (Sars) *Capitella capitata* (Fabricius) *Arenicola marina* (L.) *Littorina littorea* (L.) *Hydrobia ulvae* (Pennant) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Mya arenaria* (L.) *Carcinus maenas* (Pennant) *Corophium volutator* (Pallas)	**112** *Nereis diversicolor* (O.F. Muller) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Carcinus maenas* (Pennant) *Corophium volutator* (Pallas)	**113** *Etone longa* (Fabricius) *Nereis virens* (M.Sars) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Scrobicularia plana* (da Costa) *Corophium volutator* (Pallas)
119 *Phyllodoce* sp. *Lineus* spp *Tubifex costatus* (Claparede) *Etone longa* (Fabricius) *Nereis diversicolor* (O.F. Muller) *Pygospio elegans* (Claparede) *Capitella capitata* (Fabricius) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Gammarus locusta* (L.) *Melita palmata* (Montagu) *Corophium volutator* (Pallas)	**120** *Tubifex costatus* (Claparede) *Etone longa* (Fabricius) *Nereis diversicolor* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Scrobicularia plana* (da Costa) *Mya arenaria* (L.) *Corophium volutator* (Pallas)	**125** *Phyllodoce* sp. *Tubifex costatus* (Claparede) *Etone longa* (Fabricius) *Nereis virens* (M.Sars) *Nepthys hombergi* (Lamarck) *Capitella capitata* (Fabricius) *Arenicola marina* (L.) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Mya arenaria* (L.) *Carcinus maenas* (Pennant) *Gammarus locusta* (L.) *Gammarus salinus* (Spooner) *Corophium volutator* (Pallas)
126 *Tubifex costatus* (Claparede) *Etone longa* (Fabricius) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Corophium volutator* (Pallas)	**131** *Lineus* spp *Tubifex costatus* (Claparede) *Nereis virens* (M.Sars) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Capitella capitata* (Fabricius) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Mya arenaria* (L.) *Carcinus maenas* (Pennant) *Corophium volutator* (Pallas)	**132** *Tubifex costatus* (Claparede) *Etone longa* (Fabricius) *Capitella capitata* (Fabricius) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Corophium volutator* (Pallas)
138 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.)		

Note *Nereis diversicolor* = *Hediste diversicolor*

Table 13. Salt marsh fauna of Bull Island lagoons, Healy 1975

Taxa	Taxa
Coleophora obtusella Stainton	*Leioseius salinus* Halbert
Copromyza unicata (Duda)	*Lepthyphantes tenuis* (Blackwall)
Acidota crenata (Fabricius)	*Leptoterna ferrugata* (Fallen)
Acmaea testudinalis Muller	*Leucania impura* Hübner
Agriotes lineatus (L.)	*Liebstadia similis* (Michael)
Agriphila coluellus L.	*Limapontia nigra* Johnson
Akera bullata Muller	*Limnephilus affinis* Curtis
Alderia modesta (Loren)	*Limnodrilus hoffmeisteri* Claparede
Amara aenea (Degeer)	*Lissonota bellator* (Gravenhorst)
Ameronothrus bilineatus (Michael)	*Littorina littoralis* (L.)
Ameronothrus lineatus s.sp. *brevipes*	*Littorina* littorea (L.)
Angitia cerophaga (Gravenhorst)	*Littorina saxatilis* (Olivi)
Angitia exareolata (Gravenhorst)	*Lycosa pullata* (Clerck)
Anguilla anguilla (L.)	*Lycosa purbeckensis* (F.O.P.-Cambridge)
Anthocoris nemorum (L.)	*Machaetium maritimae* Haliday
Anurida maritima Laboulbene	*Macrocheles scutatus* (Berlese)
Apanteles triangualator (Wesmael)	*Macrodolichopus diadema* (Haliday)
Aphaerata minuta var. *cephalota* (Haliday)	*Macrosiphoniella asteris* (Walker)
Aphidius matricariae Haliday	*Macrosiphum avenae* (Fabricius)
Aphis tripolii (Laing)	*Macrosiphum euphorbiae* (Thomas)
Aphrodes bicinctus s. sp. *aestuarinus* (Edwards)	*Macrosiphum fragariae* (Walker)
Apis mellifera L.	*Macrosteles horvathi* (Wagner)
Apium fiavipes (Paykull)	*Manyunkia aestuarina* (Bourne)
Aploneura lentisci Passerini	*Megarthrus depressus* (Paykull)
Aprostocetus canon Walker	*Melanum lateralis* Haliday
Aptinothrips nitidulus Haliday	*Mengea scopigera* (Grube)
Aptinothrips stylifer Trybom	*Meraporus graminicola* (Walker)
Araneus cornutus Clerck	*Mesochra lilljeborgi* Boeck
Araneus diadematus Clerck	*Mesochra. heldti* Monard
Araneus quadratus Clerck	*Mesopolobus incultum* (Walker)
Arenicola marina (L.)	*Metalophium dirhodum* (Walker)
Argenna sub *nigra* (O.P.-Cambridge)	*Metasyrphus latifasciatus* (Macquart)
Armadillidium vulgare Latreille	*Microgaster globata* Nees
Arthaldeus pascuellus (Fallen)	*Microplitis xanthopus* (Ruthe)
Asaphes vulgaris Walker	*Microterys tessellatus* (Dalman)
Aspilota concolor (Nees)	*Monopylephorus rubroniveus* Levinson
Atheta atramentaria (Gyllenhal)	*Morpholeria kerteszi* (Czerny)
Atheta fungi (Gravenhorst)	*Mugillabrosus Risso*
Atheta hypnorum (Kiesenwetter)	*Mycetoporus splendidus* (Gravenhorst)
Atheta vestita (Gravenhorst)	*Myrmica laevinodes* Nylander
Atractodes tenebriodes Gravenhorst	*Mytilus edulis* L
Bathyphantes gracilis (Blackwall)	*Myzus cerasi* (Fabricius)
Bdella longicornis (L.)	*Nannopus palustris* Brady
Bethylus fuscicornis (Jurine)	*Necrophorus vespillo* (L.)
Bibio johannis (L.)	*Nemoteles uliginosus* (L.)
Blattisocius dentriticus (Berlese)	*Neophilaenus lineatus* (L.)
Bledius spectabilis Kraatz	*Nereis diversicolor* O. F. Muller
Bombilius minor L.	*Ochthebius impressicollis* Castelnau
Bombus lucorum (L.)	*Ochthebius marinus* Paykull
Brachycaudus helichrysi (Kaltenbach)	*Ochthebius punctatus* Stephens
Bracon anthracinus Nees	*Oedothorax fuscus* (Blackwall)
Bythinia tentaculata (L.)	*Omalium laeviusculum* Gyllenhal

Table 13 con't. Salt marsh fauna of Bull Island lagoons, Healy 1975

Taxa	Taxa
Caecilius burmeisteri Bauer	*Omosita discoidea* (Fabricius)
Calathus cisteloides (Panzer)	*Onychiurus debilis* (Moniez)
Calathus melanocephalus (L.)	*Oppia clavipectinata* (Michael)
Calliphora erythrocephala (Meigen)	*Orchestia gammarella* (Pallas)
Calocoris norvegicus (Gmelin)	*Oscinella frit* (L.)
Campsicnemus armatus (Zetterstedt)	*Oscinella pusilla* (Meigen)
Cantharis bicolor Herbst	*Oscinella vastator* Curt
Cantharis darwiniana (Sharp)	*Otiorhyncus ligneus* (Olivier)
Cantharis fulvicollis var. fiavilabris Fallen	*P. orchestiidarum* (Barrois)
Capitella capitata (Fabricius)	*Pachygnatha clercki* Sundevall
Carcinas maenas (L.)	*Pachygnatha degeeri*
Cardium edule L.	*Palaemonetes varians* (Leach)
Chaetocnema concinna (Marsham)	*Paragnathia formica* (Hesse)
Chamaemyia herbarum (Robineau-Desvoidy)	*Paranychocamptus curticaudatus* Boeck
Cheiroseius necorniger -(Oudmans)	*Parathalestris intermedia* Gurney
Cheylostigmaeus salinus Evans	*Paroxyna plantaginis* (Haliday)
Cheylostigmaeus scutatus (Halbert)	*Pediobius epigonus* (Walker)
Chiloxanthus pilosus (Fallen)	*Tubificoides benedeni* (Udekem)
Chirothrips manicatus Haliday	*Pergamasus longicornis* Berlese
Chloropisca glabra (Meigen)	*Phaeogenes fuscicornis* Wesmael
Chlorops troglodytes (Zetterstedt)	*Phaeogenes planifrons* Wesmael
Chrysocharis pubicornis (Zetterstedt)	*Phalangium opilio* (L.)
Clitellio arenarius 0. F. Muller	*Phalonia affinitana* Douglas
Clubiona stagnalis Kulczynski	*Phaonia incana* (Wiedemann)
Coccinella septempunctata L.	*Phaulodinychus minor* (Halbert)
Coelopa frigida Meigen	*Philia febrilis* (L.)
Coenosia descipiens Meigen	*Philia femorata* (Meigen)
Coenosia geniculata (Fallen)	*Philonthus fuscipennis* (Mannerheim)
Coenosia pulicaria (Zetterstedt)	*Philonthus marginatus* (Fabricius)
Coenosia salinarum Stein	*Philonthus varians* (Paykull)
Coenosia tigrina Fabricius	*Philoscia muscorum* Scopoli
Coleophora alticollella (Zeller)	*Phytia myosotis* Draparnaud
Copidosoma dius (Walker)	*Pieris brassicae* (L.)
Copidosoma filicorne (Dalman)	*Pimpla turionellae* (L.)
Corophium volutator Pallas	*Pirata piratica* Clerck
Crambus hortuellus (Hi.ibner)	*Platychelipes littoralis* Brady T
Crambus perlellus (Scopoli)	*Platychirus clypeatus* (Meigen)
Cricotopus vitripennis var. *halophilus* (Kieffer)	*Platychirus manicatus* (Meigen)
Cylindroiulus latestriatus Curtis	*Platynothrus peltifer* (C. L. Koch)
Cyrtogaster vulgaris Walker	*Poecilus coerulescens* L.
Dacnusa anasella Stelfox	*Polydrusus chrysomela* (Olivier)
Dacnusa senilis (Nees)	*Pomatoschistus microps* Krøyer
Dasyhelia fiavoscutellata (Zetterstedt)	*Porcellio scaber* Latreille
Delphacodes dubia (Kirschbaum)	*Psilothrix cyaneus* (Olivier)
Dexiopsis minutalis (Zetterstedt)	*Pterostichus strenua* (Panzer)
Dichirotrichus gustavii Crotch	*Punctoribates quadrivertex* Halbert
Dicranomyia sera (Walker)	*Pygospio elegans* Claparede
Dicyclus circulus Walker	*Pyrophaena granditarsa* (Forster)
Digamasellus halophilus Willman	*Rhagonycha fulva* (Scopoli)
Diglyphus isaca (Walker)	*Rhamphomyia tarsata* Meigen
Diplazon laetatorius (Fabricius)	*Rhizarcha areolaris* (Nees)
Diplazon. signatus (Gravenhorst)	*Rhodacarus pallidus* Hull

Table 13 con't. Salt marsh fauna of Bull Island lagoons, Healy 1975

Taxa	Taxa
Dolichopus brevipennis Meigen	*Robertus lividus* (Blackwall)
Dolichopus nubilis Meigen	*Ropalosiphum padi* (Schrank)
Dolichopus plumipes (Scopoli)	*Salda littoralis* (L.)
Dolichopus urbanus Meigen	*Salda orthochila* (Fieber)
Drapetis curvipes (Meigen)	*Salda pilosus* (Fallen)
Dromius linearis (Olivier)	*Saldula palustris* (Douglas and Scott)
Dyschirius globosus (Herbst)	*Salticella fasciata* (Meigen)
Ectopsocus briggsi (McLacklan)	*Savignia frontata* (Blackwall)
Eluma purpurascens Budde-Lund	*Scaeva pyrastri* (L.)
Empis femorata Fabricius	*Scatophaga litorea* (Fallen)
Enhydrosoma buchholtzi (Boeck)	*Scheloribates laevigatus* (C. L. Koch)
Entedon diotimis Walker	*Sciara carbonaria* Meigen
Ephialtes brevicornis (Gravenhorst)	*Scopeuma stercorarium* (L.)
Erigone longipalpis (Sundevall)	*Scrobicularia plana* (da Costa)
Erirrhinus bimaculatus (Fabricius)	*Scrobipalpa Plantaginella* (Stainton)
Eteone longa (Fabricius)	*Segestria senoculata* (L.)
Euderus viridis Thomson	*Sepsis violacea* Meigen
Eupelops torulosus (C. L. Koch)	*Silpha rugosa* (L.)
Eupodes halophilus Halbert	*Silpha tristis* Illiger
Euridice pulchra Leach	*Smittia thalassophilus* (Goetghebuer)
Eurytoma tibialis (Boheman)	*Sphaerophoria menthastri* I(L.)
Euscelis obsoletus (Kirschbaum)	*Staphilinus ater* Gravenhorst
Fabricia sabella (Ehrenberg)	*Staticobium limonii* (Contarini)
Fieberocapsus flaveolus (Reuter)	*Stenhelia palustris* Brady
Folsomia sexoculata Tullberg	*Stenus clavicornis* (Scopoli)
Forficula auricularia L.	*Stygnocoris rusticus* (Fallen)
Friesia mirabilis (Tullberg)	*Stylodrilus heringianus* Claparede
Fucus sp and *Pelvetia* sp	*Symplecta stictica* (Meigen)
Gammarus zaddachi Sexton	*Sympycnus annulipes* (Meigen)
Gelis anthracina (Foerster)	*Syntormon pallipes* (Fabricius)
Glenanthe ripicola Haliday	*Syntormon pallipes* var. *pseudospicatus* Strobl
Habrocytis sp.	*Syrphus balteatus* Degeer
Hadena suasa Schifferrni.	*Tachidius discipes* Giesbrecht
Halobrecta fiavipes (Thomson)	*Tachinus rufipes* (Degeer)
Haplothrips statices Haliday	*Tachydromia notatus* (Meigen)
Haplothrips. *juncorum* Bagnall	*Tachydromia pallidiventris* (Meigen)
Harpacticus littoralis (T. and A. Scott)	*Tachyporus chrysomelinus* (L.)
Helophorus affinis Marsham	*Tachyporus hypnorum* (Fabricius)
Hemiptarsenus unguicellus (Zetterstedt)	*Tachyporus nitidulus* (Fabricius)
Hemiteles pedestris (Fabricius)	*Tachyporus pusillus* Gravenhorst
Hermannia reticulata Thorell	*Taeniothrips atratus* Haliday
Hermannia subglabra Berlese	*Tethina grisea* (Fallen)
Heterocerus fiexuosus Stephens	*Tethina illota* Haliday
Heterolaophonte littoralis (T. and A. Scott)	*Tetragnatha extensa* (L.)
Heterolaophonte minuta (Boeck)	*Tetramesa linearis* (Walker)
Heterothops binotatus (Gravenhorst)	*Thanatus striatus* C. L. Koch
Hyadina humeralis Becker	*Thaumatomyia notata* (Meigen)
Hydraecia lucens Freyer	*Thereva nobilitata* (Fabricius)
Hydrobia ulvae (Pennant)	*Thrips tabaci* Lindeman
Hydrobia ventrosa (Montagu)	*Tibellus oblongus* Walckenaer
Hydrophorus oceanus (Macquart)	*Tipula paludosa* Meigen

Table 13 con't. Salt marsh fauna of Bull Island lagoons, Healy 1975

Taxa	Taxa
Hygroribates bilineatus Bostock	*Trichoribates incisellus* (Kramer)
Hygroribates nigrofemoratus (L. Koch)	*Tricimba cincta* (Meigen)
Hygroribates spoofi (Oudmans)	*Trigonotylus ruficornis* (Geoffroy)
Hypomma tuberculatum (Wider)	*Trochosa terricola* Thorell
Ichneumon extensorius L.	*Tubifex costatus* Claparede
Isotoma maritima Tullberg	*Tullbergia krausbaueri* Earner
Isotoma viridis Eourlet	*Uteriporus vulgaris* Bergendal
Isotomiella minor Schiiffer	*Xenylla maritima* (Fabricius)
Itunella muelleri Gagern	*Xysticus cristatus* (Clerck}
Juncobium leegei (Borner)	*Zootrephas rufiventris* Thomson
Lamprinodes saginatus {Gravenhorst)	*Zygaena filipendulae* (L.)

Note *Nereis diversicolor* = *Hediste diversicolor*

Table 14. Taxa recorded along Sutton Creek. Wilson et al, 1982; Submarine pipeline EIS, 1997 and Lyons: Sutton Dinghy Club EIS, 1999

Taxa	Station /Author			
A. obtusata	**D21**			
Abra nitida	Lyons, 1999			
Actinia equina	Lyons, 1999			
Arenicola marina	Lyons, 1999			
A. marina	**D27**			
Arenicola marina (L.)	2, 4, 11			
B. pelagica	**D23**			
Bathyporeia pelagica (Bate)	10, 11, 15			
C. capitata	**D21**	**D27**		
Caprellidae sp.	**D21**			
Carcinus maenas	Lyons, 1999			
Cerastoderma edule	Lyons, 1999			
C. edule	**D27**			
Cerastoderma edule (L.)	1, 7, 8, 15			
Chaetogammarus marinus	Lyons, 1999			
Crangon crangon (L.)	1, 4, 7			
E. cf. bahusiensis	**D21**			
Eurydice pulchra (Leach)	8,		10	
Gammarus salinus	Lyons, 1999			
Haustorius arenarius (Slabber)		11		
Hyale nilssoni	Lyons, 1999			
Jassa falcata (Montagu)		7		
Lanice conchilega	Lyons, 1999			
Littorina littorea	Lyons, 1999			
Littorina littorea (L.)		4		
Littorina obtusata	Lyons, 1999			
Littorina saxitalis agg.	Lyons, 1999			
M. maculatus	**D21**			
M. balthica	**D27**			
Macoma balthica (L.)	7,		15	
Mytilus edulis	Lyons, 1999			
Mytilus edulis (L.)		7		
Nepthys caeca (O.F. Muller)		1 2, 5, 7, 9,	10, 15	
N. hombergi	**D21**	**D22**	**D23**	**D27**
Nepthys hombergi (Lamarck)	2 – shoreline			
Nereis diversicolor	Lyons, 1999			
N. diversicolor	**D21**	**D27**		
Nereis virens (M. Sars)	4,		7	
Notomastus latericeus (Sars)	7,		11	
Nucella lapillus	Lyons, 1999			
Obelia dichotoma	Lyons, 1999			
Oligochaeta spp	**D27**			
P. arenarius	**D21**			
P. groenlandica	**D21**			
Patella vulgata	Lyons, 1999			
Pomatoceros triquaeter	Lyons, 1999			

Note *Nereis diversicolor* = *Hediste diversicolor*

Table 14 con't. Taxa recorded along Sutton Creek. Wilson et al,1982; Submarine pipeline EIS, 1997 and Lyons: Sutton Dinghy Club EIS, 1999

Taxa	Station /Author			
Scolelepsis fulginosa (Claparede)		8		
S. armiger	**D22**	**D23**	**D27**	
Scoloplos armiger (O.F. Muller)		1 2,	4, 9, 10,	11, 15,
Scolopus arniger	Lyons, 1999			
S. plana	**D27**			
Scrobicularia plana (da Costa)		10		
Semibalanus balanoides	Lyons, 1999			
Spio filicornis (Fabricius)		4		
T. tenuis	**D22**	**D23**		
Tellina tenuis (da Costa)	1,	9, 10, 11,		15
Tubifex costatus	Lyons, 1999			
T. benedini	**D21**			
U. brevicornis	**D22**			
U. elegans	**D23**			
Urothoe marina (Bate)	10,		15	

The Sutton Dinghy Club Environmental Impact Survey included rocky shoreline accounting for the presence of fauna not listed for other surveys.

Table 15. Taxa recorded by Walker & Rees, 1980 (Group 1 stations) and the Dublin Bay submarine pipeline EIS, 1997

Taxa	**Stations**	
A. brevicornis		34
A.alba	5, 6, 8, 9, 10,11, 12	13, 15, 32,34
A.brevicornis	9, 32	
A.nitida		11
A.prismatica	5, 12, 33	
A.squamata		13
A.swammerdami	5, 6, 7, 8, 9, 10, 14, 15	32,33,34
Abra alba	Group 1	
Acrocnida brachiata	Group 1	
Ampharete acutifrons (grubei)	Group 1	
Ampharete sp.		15
B. elegans		32
B. nana	5, 8, 11, 12, 13	14, 32, 33
B. pelagica	15, 32	
B. pilosa		32
B. pulchella	10, 11, 15	33, 34, 14
B pelagica		12
B. pilosa		7
B.pulchella	5, 6, 8, 9	
Bathyporeia sp.		6
C. gallina	6, 8, 9, 10, 11, 12	14, 15, 33, 34
C. gibba	9, 10, 15, 34	
Caesicirrus neglectus	Group 1	
C.capitata		5
Caprellidae	7, 9, 13,15, 32, 5, 6, 8 10	12, 14, 33,34
Cirratulidae sp	12, 13, 32, 5, 10, 34, 8	
Cultellus pellucidus	Group 1	
D. bradyi		34
D. laevis		14
D. vittatus	11, 33	
E. cf bahusiensis	5, 11, 13, 5, 6, 7, 8, 9, 10, 14, 15, 33, 34	
E. longa	5, 6, 7, 9, 11, 12, 14, 15, 32, 33,	
Edwardsia sp.	Group 1	

Table 15 con't. Taxa recorded by Walker & Rees, 1980 (Group 1 stations) and the Dublin Bay submarine pipeline EIS, 1997

Taxa	Stations
Glycera convoluta	Group 1
Goniada maculata	Group 1
Harmothoe sp	5, 11, 10, 15, 33
I.trispinosa	5, 32
L. conchilega	5, 8, 9, 7, 13, 15
L. holsatus	8, 33
L. koreni	8
Lanice conshilega	Group 1
Lumbrineris gracilis	Group 1
M. edulis	32
M. ferruginosa	9, 11, 13, 15,
M. maculates	6
M. maculatum	14
M. maculatus	5, 8, 9, 10, 11, 12, 13, 15, 32, 33, 34
M. maculatus	8
M. oculata	7
M. palmata	5, 6, 10, 11, 33, 12, 14, 15,32
M. papillicornis	8
M. stultorum	8, 9, 14
M. vulgaris	5, 6, 9, 14, 34
Magelona sp	5, 11, 10, 14, 32
Melinna palmata	Group 1
N. hombergi	5, 6, 7,8, 9, 10, 11, 12, 13, 14, 15, 32, 33, 34
N. hombergi	10
N. nucleus	6, 7, 8, 9, 10 12, 13, 33
N. nucleus	7
Nepthys hombergii	Group 1
Nucula turgida	Group 1
O. fusiformis	7, 10, 11, 32
O. nana	32
O. texturata	8, 9, 11, 15, 32
Ophelina sp.	32
Ophiura albida	Group 1
Owenia fusiformis	Group 1
P. arenarius	5, 12, 7, 9, 10, 13, 32, 34
P. groenlandica	7
P. groenlandica	11
P. longicornis	6, 9, 12, 13, 15, 32, 33,
P. longimanus	5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 32, 3334
P. pellucidus	5, 6, 8, 9, 10, 12, 13, 15, 32, 33, 34
P. pellucidus	6
P. pisum	32
P. pulchra	6
P. similes	8
Phyllodoce maculata	Group 1
Pontocrates sp.	5, 10 ,11, 12, 32, 33

Table 15 con't. Taxa recorded by Walker & Rees, 1980 (Group 1 stations) and the Dublin Bay submarine pipeline EIS, 1997

Taxa	Stations
S. armiger	5, 8, 10, 12, 15, 33
S. boa	13
S. bombyx	13, 32
S. filicornis	5, 6, 10, 12, 14, 32
S. maculatus	13
S. mathildae	5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 33, 32
T. fabula	7, 6, 9, 10, 12, 13, 15, 32, 34
Tellina fibula	Group 1
T. tenuis	5
U. elegans	5
V. casina	13

Table 16. Wilson *et al*, 1982 stations outside Bull Island. Intertidal. (Fig. 6)

14 *Nereis diversicolor* (O.F. Muller) *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.) *Bathyporeia pilosa* (Lindstrom)	**16** *Amphiporus lactifloreus* (Johnstone) *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.) *Crangon crangon* (L.) *Urothoe marina* (Bate) *Bathyporeia pelagica* (Bate)	**17** *Nepthys caeca* (O.F. Muller) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.) *Haustorius arenarius* (Slabber)
18 *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa)	**19** *Scoloplos armiger* (O.F. Muller) *Donax vittatus* (da Costa) *Tellina tenuis* (da Costa) *Nepthys caeca* (O.F. Muller)	**22** *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.)
23 *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Urothoe marina* (Bate)	**24** *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa)	**25** *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Pygospio elegans* (Claparede) *Donax vittatus* (da Costa) *Tellina tenuis* (da Costa)
28 *Nemertopsis flavida* (McIntosh) *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Urothoe marina* (Bate)	**29** *Nepthys caeca* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Urothoe marina* (Bate) *Bathyporeia pelagica* (Bate)	**30** *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Venus striatula* (da Costa) *Tellina tenuis* (da Costa) *Tellina fabula* (Gmelin) *Crangon crangon* (L.)
31 *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Pygospio elegans* (Claparede) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Donax vittatus* (da Costa) *Tellina tenuis* (da Costa)	**34** *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.) *Bathyporeia pelagica* (Bate)	**35** *Nepthys caeca* (O.F. Muller) *Tellina tenuis* (da Costa) *Urothoe marina* (Bate) *Idotea linearis* (Pennant)
36 *Sthenelais boa* (Johnston) *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Arenicola marina* (L.) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa) *Tellina fabula* (Gmelin)	**37** *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Pygospio elegans* (Claparede) *Magelone papillicornis* (Fr. Muller) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa)	**40** *Nepthys caeca* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.) *Urothoe marina* (Bate)
41 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Lanice conchilega* (Pallas) *Thyasira flexuosa* (Montagu) *Tellina tenuis* (da Costa) *Bathyporeia guilliamsoniana* (Bate)	**42** *Phyllodoce* sp. *Nereis diversicolor* (O.F. Muller) *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Donax vittatus* (da Costa) *Tellina tenuis* (da Costa)	**43** *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa)

Table 16 con't. Wilson, 1982 stations outside Bull Island. Intertidal. (Fig. 6)

46 *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Carcinus maenas* (Pennant)	47 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Donax vittatus* (da Costa) *Tellina tenuis* (da Costa)	48 *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Pygospio elegans* (Claparede) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa) *Tellina fabula* (Gmelin)
49 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Pygospio elegans* (Claparede) *Lanice conchilega* (Pallas) *Donax vittatus* (da Costa) *Tellina tenuis* (da Costa)	52 *Nepthys caeca* (O.F. Muller) *Tellina tenuis* (da Costa)	53 *Nepthys caeca* (O.F. Muller) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa)
54 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Donax vittatus* (da Costa) *Tellina tenuis* (da Costa)	55 *Scoloplos armiger* (O.F. Muller) *Donax vittatus* (da Costa) *Tellina tenuis* (da Costa) *Lanice conchilega* (Pallas) *Tellina fabula* (Gmelin) *Idotea linearis* (Pennant)	59 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)
60 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)	61 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa) *Bathyporeia guilliamsoniana* (Bate)	62 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Pygospio elegans* (Claparede) *Lanice conchilega* (Pallas) *Tellina fabula* (Gmelin)
65 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)	66 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Notomastus latericeus* (Sars) *Owenia fusiformis* (Delle Chiaje) *Lanice conchilega* (Pallas) *Donax vittatus* (da Costa) *Tellina tenuis* (da Costa)	67 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Donax vittatus* (da Costa) *Tellina tenuis* (da Costa)
68 *Sthenelais boa* (Johnston) *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas)	69 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Owenia fusiformis* (Delle Chiaje) *Lanice conchilega* (Pallas) *Bathyporeia guilliamsoniana* (Bate)	72 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)
73 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Pygospio elegans* (Claparede) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Donax vittatus* (da Costa) *Tellina tenuis* (da Costa) *Haustorius arenarius* (Slabber) *Bathyporeia guilliamsoniana* (Bate)	74 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Pygospio elegans* (Claparede) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa) *Bathyporeia guilliamsoniana* (Bate)	75 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa)

Table 16 con't. Wilson, 1982 stations outside Bull Island. Intertidal. (Fig. 6)

78 *Nepthys caeca* (O.F. Muller) *Tellina tenuis* (da Costa)	79 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Tellina tenuis* (da Costa) *Idotea linearis* (Pennant)	80 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Tellina tenuis* (da Costa)
81 *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)	82 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Pygospio elegans* (Claparede) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Tellina fabula* (Gmelin)	85 *Nepthys caeca* (O.F. Muller) *Nerine foliosa* (Audouin & Edwards) *Arenicola marina* (L.) *Bathyporeia pelagica* (Bate) *Bathyporeia pilosa* (Lindstrom)
86 *Nepthys caeca* (O.F. Muller) *Pygospio elegans* (Claparede) *Tellina tenuis* (da Costa)	87 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Nerine foliosa* (Audouin & Edwards) *Pygospio elegans* (Claparede) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa) *Bathyporeia guilliamsoniana* (Bate)	88 *Nepthys caeca* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Donax vittatus* (da Costa) *Tellina tenuis* (da Costa)
89 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa) *Idotea linearis* (Pennant) *Ammodytes tobianus* (L.)	91 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Tellina tenuis* (da Costa) *Tellina fabula* (Gmelin)	92 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Tellina tenuis* (da Costa) *Tellina fabula* (Gmelin)
93 *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Lanice conchilega* (Pallas) *Donax vittatus* (da Costa) *Tellina tenuis* (da Costa) *Idotea linearis* (Pennant)	94 *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Crangon crangon* (L.)	98 *Nerine foliosa* (Audouin & Edwards) *Arenicola marina* (L.)
99 *Nepthys caeca* (O.F. Muller) *Pygospio elegans* (Claparede) *Tellina tenuis* (da Costa)	100 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa)	101 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)
102 *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa) *Bathyporeia guilliamsoniana* (Bate)	103 *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Magelone papillicornis* (Fr. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Donax vittatus* (da Costa) *Tellina fabula* (Gmelin) *Bathyporeia guilliamsoniana* (Bate) *Idotea linearis* (Pennant) *Ammodytes tobianus* (L.)	106 *Nerine foliosa* (Audouin & Edwards) *Arenicola marina* (L.)

Table 16 con't. Wilson, 1982 stations outside Bull Island. Intertidal. (Fig. 6)

107 *Nepthys caeca* (O.F. Muller) *Tellina tenuis* (da Costa)	**108** *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Tellina tenuis* (da Costa)	**109** *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Pygospio elegans* (Claparede) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)
110 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Pygospio elegans* (Claparede) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa)	111 *Nepthys caeca* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Crangon crangon* (L.) *Bathyporeia guilliamsoniana* (Bate)	**114** *Nerine foliosa* (Audouin & Edwards) *Bathyporeia pilosa* (Lindstrom)
115 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa)	116 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Tellina tenuis* (da Costa)	**117** *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Tellina tenuis* (da Costa) *Bathyporeia pelagica* (Bate)
121 *Nemertopsis flavida* (McIntosh) *Nepthys caeca* (O.F. Muller) *Spio filicornis* (Fabricius) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Bathyporeia pelagica* (Bate)	**122** *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Urothoe marina* (Bate)	

Table 17. Species found at stations of Wilson 1982, South Bull (Fig. 11)

182 *Nepthys hombergi* (Lamarck) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa)	**183** *Sthenelais boa* (Johnston) *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Owenia fusiformis* (Delle Chiaje) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)	**184** *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Tellina tenuis* (da Costa)
188 *Gammarus locusta* (L.)	189 *Nepthys caeca* (O.F. Muller) *Arenicola marina* (L.) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)	190 *Sthenelais boa* (Johnston) *Nepthys caeca* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Urothoe marina* (Bate)
191 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Scolelepsis fulginosa* (Claparede) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Donax vittatus* (da Costa)	192 *Nepthys caeca* (O.F. Muller) *Magelone papillicornis* (Fr. Muller) *Notomastus latericeus* (Sars)	193 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.)
194 *Nerine foliosa* (Audouin and Edwards) *Cirratulus cirratulus* (O.F. Muller) *Capitella capitata* (Fabricius) *Lanice conchilega* (Pallas) *Mytilus edulis* (L.) *Tapes saxitalis* (Fleurian) *Balanus balanoides* (L.) *Carcinus maenas* (Pennant) *Gammarus locusta* (L.)	195 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)	196 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Bathyporeia pelagica* (Bate)
197 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Bathyporeia pelagica* (Bate)	198 *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Crangon crangon* (L.)	199 *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)
200 *Nepthys caeca* (O.F. Muller) *Scolelepsis fulginosa* (Claparede) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)	201 *Sthenelais boa* (Johnston) *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Spio filicornis* (Fabricius) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Crangon crangon* (L.)	202 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Crangon crangon* (L.)
203 *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Magelone papillicornis* (Fr. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Donax vittatus* (da Costa) *Crangon crangon* (L.)	204 *Nepthys caeca* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Tellina fabula* (Gmelin)	205 *Sthenelais boa* (Johnston) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Magelone papillicornis* (Fr. Muller) *Lanice conchilega* (Pallas) *Venus striatula* (da Costa) *Donax vittatus* (da Costa) *Tellina fabula* (Gmelin)
206 *Sthenelais boa* (Johnston) *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Notomastus latericeus* (Sars) *Owenia fusiformis* (Delle Chiaje) *Lanice conchilega* (Pallas) *Donax vittatus* (da Costa) *Tellina fabula* (Gmelin)	207 *Sthenelais boa* (Johnston) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Owenia fusiformis* (Delle Chiaje) *Lanice conchilega* (Pallas) *Venus striatula* (da Costa) *Tellina fabula* (Gmelin) *Crangon crangon* (L.)	208 *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Bathyporeia guilliamsoniana* (Bate)

Table 17 con't. Species found at stations of Wilson *et al*,1982, South Bull (Fig. 12)

209 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Bathyporeia pelagica* (Bate)	210 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)	211 *Nemertopsis flavida* (McIntosh) *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Cerastoderma edule* (L.)
212 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Crangon crangon* (L.)	213 *Nemertopsis flavida* (McIntosh) *Magelone papillicornis* (Fr. Muller) *Lanice conchilega* (Pallas) *Crangon crangon* (L.)	214 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Crangon crangon* (L.)
215 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Lanice conchilega* (Pallas) *Donax vittatus* (da Costa) *Bathyporeia guilliamsoniana* (Bate)	216 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Crangon crangon* (L.) *Bathyporeia guilliamsoniana* (Bate)	217 *Sthenelais boa* (Johnston) *Arenicola marina* (L.) *Lanice conchilega* (Pallas) *Donax vittatus* (da Costa) *Tellina fabula* (Gmelin) *Gammarus locusta* (L.) *Ammodytes tobianus* (L.)
218 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Magelone papillicornis* (Fr. Muller) *Notomastus latericeus* (Sars) *Euclymene* spp *Lanice conchilega* (Pallas) *Tellina fabula* (Gmelin) *Crangon crangon* (L.)	219 *Sthenelais boa* (Johnston) *Scoloplos armiger* (O.F. Muller) *Magelone papillicornis* (Fr. Muller) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Lanice conchilega* (Pallas) *Donax vittatus* (da Costa) *Tellina fabula* (Gmelin)	220 *Sthenelais boa* (Johnston) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Ampharete grubei* (Malmgren) *Lanice conchilega* (Pallas) *Tellina fabula* (Gmelin) *Crangon crangon* (L.)
221 *Sthenelais boa* (Johnston) *Nepthys caeca* (O.F. Muller) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Owenia fusiformis* (Delle Chiaje) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa) *Tellina fabula* (Gmelin) *Crangon crangon* (L.)	222 *Sthenelais boa* (Johnston) *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)	223 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Urothoe marina* (Bate)
223 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Urothoe marina* (Bate)	224 *Nepthys caeca* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Carcinus maenas* (Pennant)	225 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Ampharete grubei* (Malmgren) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)
226 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Cerastoderma edule* (L.)	227 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.) *Urothoe marina* (Bate)	228 *Phyllodoce* sp. *Nepthys hombergi* (Lamarck) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)
229 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Spio filicornis* (Fabricius) *Magelone papillicornis* (Fr. Muller) *Tellina tenuis* (da Costa)	230 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Clymene oerstedii* (Claparede) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)	231 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Arenicola marina* (L.) *Clymene oerstedii* (Claparede) *Owenia fusiformis* (Delle Chiaje) *Lanice conchilega* (Pallas) *Tellina fabula* (Gmelin)

Table 17 con't. Species found at stations of Wilson *et al*, 1982, South Bull (Fig. 12)

232 *Sthenelais boa* (Johnston) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Euclymene* spp *Lanice conchilega* (Pallas) *Thyasira flexuosa* (Montagu) *Tellina fabula* (Gmelin) *Abra alba* (Wood) Ophiuiroid sp.	233 *Sthenelais boa* (Johnston) *Nepthys caeca* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Lanice conchilega* (Pallas) *Mactra corallina* (L.) *Donax vittatus* (da Costa) *Crangon crangon* (L.)	234 *Sthenelais boa* (Johnston) *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Notomastus latericeus* (Sars) *Capitella capitata* (Fabricius) *Owenia fusiformis* (Delle Chiaje) *Lanice conchilega* (Pallas) *Mactra corallina* (L.) *Tellina fabula* (Gmelin)
235 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Pygospio elegans* (Claparede) *Notomastus latericeus* (Sars) *Capitella capitata* (Fabricius) *Euclymene* spp *Lanice conchilega* (Pallas) *Tellina fabula* (Gmelin) *Crangon crangon* (L.)	236 *Sthenelais boa* (Johnston) *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Notomastus latericeus* (Sars) *Capitella capitata* (Fabricius) *Euclymene* spp *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa) *Tellina fabula* (Gmelin) *Crangon crangon* (L.) *Carcinus maenas* (Pennant)	237 *Phyllodoce* sp. *Nepthys hombergi* (Lamarck) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Tellina fabula* (Gmelin) *Carcinus maenas* (Pennant)
238 *Sthenelais boa* (Johnston) *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Notomastus latericeus* (Sars) *Tellina tenuis* (da Costa)	239 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Nerine foliosa* (Audouin and Edwards) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.) *Carcinus maenas* (Pennant) *Corophium volutator* (Pallas)	240 *Harmothoe lunulata* (Delle Chaije) *Nereis diversicolor* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Macoma balthica* (L.)
241 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Tellina fabula* (Gmelin)	242 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Bathyporeia pilosa* (Lindstrom)	243 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.) *Urothoe marina* (Bate)
244 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Urothoe marina* (Bate)	245 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Venus striatula* (da Costa) *Tellina tenuis* (da Costa) *Crangon crangon* (L.) *Bathyporeia pelagica* (Bate)	246 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)
247 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Euclymene* spp *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)	248 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Spio filicornis* (Fabricius) *Magelone papillicornis* (Fr. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.)	249 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Donax vittatus* (da Costa) *Tellina tenuis* (da Costa) *Urothoe marina* (Bate)

Table 17 con't. Species found at stations of Wilson 1982, South Bull (Fig. 12)

250 *Sthenelais boa* (Johnston) *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Notomastus latericeus* (Sars) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Urothoe marina* (Bate)	251 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)	252 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Donax vittatus* (da Costa) *Tellina tenuis* (da Costa)
253 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Spio filicornis* (Fabricius) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)	254 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Crangon crangon* (L.) *Carcinus maenas* (Pennant) *Gammarus locusta* (L.) *Corophium volutator* (Pallas)	255 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Carcinus maenas* (Pennant)
256 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)	257 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.) *Bathyporeia pelagica* (Bate) *Corophium volutator* (Pallas) *Eurydice pulchra* (Leach)	258 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.)
259 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)	260 *Phyllodoce* sp. *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)	261 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)
262 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)	263 *Phyllodoce* sp. *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Lanice conchilega* (Pallas) *Tellina tenuis* (da Costa)	264 *Phyllodoce* sp. *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)
265 *Nepthys hombergi* (Lamarck) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Pomatoschistus microps* (Pallas)	266 *Phyllodoce* sp. *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Spio filicornis* (Fabricius) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)	267 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)
268 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)	269 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.)	270 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Crangon crangon* (L.) *Carcinus maenas* (Pennant)

Table 17 con't. Species found at stations of Wilson 1982, South Bull (Fig. 12)

271 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Ampharete grubei* (Malmgren) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.) *Carcinus maenas* (Pennant)	272 *Cephalothrix linearis* (Rathke) *Phyllodoce* sp. *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Mytilus edulis* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Crangon crangon* (L.) *Carcinus maenas* (Pennant) *Corophium volutator* (Pallas)	273 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Tellina fabula* (Gmelin) *Macoma balthica* (L.) *Abra alba* (Wood) *Crangon crangon* (L.)
274 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)	275 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)	276 *Sthenelais boa* (Johnston) *Phyllodoce* sp. *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Crangon crangon* (L.)
277 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Tellina tenuis* (da Costa)	278 *Phyllodoce* sp. *Nepthys hombergi* (Lamarck) *Glycera convoluta* (Keferestein) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.)	279 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.)
280 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)	281 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa)	282 *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Tellina tenuis* (da Costa)
283 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Macoma balthica* (L.) *Crangon crangon* (L.) *Corophium volutator* (Pallas)	284 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Ampharete grubei* (Malmgren) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.)	285 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Tellina fabula* (Gmelin) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Carcinus maenas* (Pennant)
286 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.) *Crangon crangon* (L.)	287 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.) *Mya arenaria* (L.) *Carcinus maenas* (Pennant)	288 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.)
289 *Nereis diversicolor* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.) *Carcinus maenas* (Pennant) *Urothoe marina* (Bate)	290 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Notomastus latericeus* (Sars) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.) *Crangon crangon* (L.)	291 *Phyllodoce* sp. *Nepthys caeca* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.) *Crangon crangon* (L.)

Table 17 con't. Species found at stations of Wilson 1982, South Bull (Fig. 12)

292 *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.)	293 Nemertini *Nereis diversicolor* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Nerine foliosa* (Audouin and Edwards) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.) *Crangon crangon* (L.)	294 *Nereis diversicolor* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Orchestia gammarella* (Pallas)
295 *Nereis diversicolor* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Capitella capitata* (Fabricius) *Arenicola marina* (L.) *Lanice conchilega* (Pallas) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Carcinus maenas* (Pennant)	296 *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.)	297 *Cerastoderma edule* (L.) *Crangon crangon* (L.)
298 *Nemertopsis flavida* (McIntosh) *Scoloplos armiger* (O.F. Muller) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Mya arenaria* (L.) *Carcinus maenas* (Pennant)	299 *Arenicola marina* (L.) *Cerastoderma edule* (L.)	300 *Scoloplos armiger* (O.F. Muller) *Nerine foliosa* (Audouin and Edwards) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.)
301 *Nereis diversicolor* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Crangon crangon* (L.) *Carcinus maenas* (Pennant)	302 *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.) *Carcinus maenas* (Pennant)	303 *Scoloplos armiger* (O.F. Muller) *Spio filicornis* (Fabricius) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Macoma balthica* (L.)
304 *Nereis diversicolor* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Cerastoderma edule* (L.) *Macoma balthica* (L.)	305 *Nereis diversicolor* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Nerine foliosa* (Audouin and Edwards) *Arenicola marina* (L.) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Scrobicularia plana* (da Costa) *Carcinus maenas* (Pennant)	306 *Nereis diversicolor* (O.F. Muller) *Nepthys hombergi* (Lamarck) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Tellina tenuis* (da Costa) *Macoma balthica* (L.) *Carcinus maenas* (Pennant)
307 *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Corophium volutator* (Pallas) *Eurydice pulchra* (Leach)	308 *Nereis diversicolor* (O.F. Muller) *Scoloplos armiger* (O.F. Muller) *Arenicola marina* (L.) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.) *Carcinus maenas* (Pennant) *Corophium volutator* (Pallas)	309 *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.)
310 *Scoloplos armiger* (O.F. Muller) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.)	311 *Nepthys hombergi* (Lamarck) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.) *Macoma balthica* (L.)	312 *Hydrobia ulvae* (Pennant)
313 *Nereis diversicolor* (O.F. Muller) *Hydrobia ulvae* (Pennant) *Cerastoderma edule* (L.)		

Table 18. Faunal species recorded from Booterstown Marsh. R.G. – Goodwillie et al, 1970 ; K.M – Karen McGibney, 1989 ; J.R. – Julian Reynolds, 1988 (unpublished) ; M.O'N – Mary O'Neill, 1996

Taxa	**Author/s**
Protozoa	J.R.
Platyhelminthes	J.R.
Dendrocoelum sp (flatworm)	R.G.
Theromyzon tessulatum	R.G.
Glossiphonia heteroclita	R.G.
Diptera	
Chironomus sp.	R.G.; K.M.; J. R.; M. O'N.
Chironomid larvae (green)	M. O'N
Chironomid pupa	M.O'N.
Dipteran larvae	M.O'N. ; R.G.
Dipteran indet.	M.O'N.
Tipullidae larvae	M.O'N.; K.M.; J.R.
Tricoptera	K.M. ; J.R.
Ptychopteridae	J.R.
Dolichopodidae	K.M.; J.R.
Psychodidae	K.M.
Ceratopogonidae	K.M.
Stratiomyidae	K.M.
Muscidae	K.M.
Notonecta marmoreal viridis	M.O'N.
Coxidae indet.	M.O'N.; R.G. ; J.R.
Gerridae inet.	J.R.
Crustacea	
Daphnia sp	R.G.
Cyclops viridis	R.G.
Podocopa	KM.
Amphipoda	
Indet.	M.O'N.
Bathyporeia sp.	M.O'N
Gammarus duebeni	M.O'N. ; J.R.
Gammarus lacustris	M.O'N.
Gammarus locusta	J.R.
Gammarus salinus	J.R.
Gammarus zaddachi	J.R.
Marinogammarus obtusa	J.R.
Orchestia gammarella	M.O'N.; K.M.
Orchestia mediterranea	M.O'N.
Isopoda	
Asellus aquaticus	R.G. ; K. M.
Oniscus asellus	K.M.
Porcellio scaber	M.O'N.

Table 18 (con't). Faunal species recorded from Booterstown Marsh.

Taxa	**Author/s**
Decapoda	
Mysidae	J.R.
Palaemonetes varians	M.O'N.; R.G. ; K.M. ; J.R.
Leander serratus	J.R.
Carcinus maenas	M.O'N. ; J.R.
Ostracoda	M.O'N.; J.R.
Cyprinotus sp	R.G.
Cyprinopsis sp	R.G.
Copepoda	J.R.
Lepidoptera	
Larva (Lepidopteran)	M.O'N.
Coleoptera	
Dytiscidae	K.M.
Hydrophiliidae	K.M.
Adult indet.(Hydrophiilid)	M. O'N.
Larva indet. .(Hydrophiilid)	M.O'N.
Hydraporus sp.	M.O'N.
Lice	M.O'N.
Annelida	
Oligochaeta indet.	M.O'N. ; J.R.
Eiseniella sp.	R.G.
Tubificidae	R.G. ; K.M.
Naididae	K.M.
Lumbricus sp.	M.O'N. ; K.M. ; J. R.
Polychaeta indet.	M.O'N.
Nereis diversicolor	J.R.
Hirundinae	K.M.
Platyhelminthes	
Nematoda indet.	M.O'N., J.R.
Collembolla	M.O'N. ; J.R.
Odonta	J.R.
Platycnemis pennipes	M.O'N.
Mesoveliidae (family)	M.O'N.
Orthoptrea	M.O'N.
Aranae	
Pirata piraticus	M.O'N.
Hypomma bituberculatum	M.O'N.
Gongylicium rufipes	M.O'N.
Lessertia dentichellis	M.O'N.
Erigone arctica	M.O'N.
Pachynatha clercki	M.O'N. ; J.R.
Tibellus oblongus	M.O'N.
Paradosa sp.	M.O'N.
Lycosidae (family)	M.O'N.

Table 18 (con't). Faunal species recorded from Booterstown Marsh.

Taxa	Author/s
Fish	
Anguillidae	K.M. ; J.R.
Gasterosteus aculeatus	*M.O'N. ; J.R.*
Flat fish juv indet.	M.O'N.
Gobiidae	R.G.; J.R.
Pleuronectidae	J.R.
Mullet	K.M.
Mollusca	
Alderia modesta	J.R.
Hydrobia neglecta	M.O'N.
Hydrobia ulvae	M.O'N.
Limapontia depressa	J.R.
Pisidium amnicum	R.G.
Potamopyrgus jenkinsi	M.O'N. ; J.R.
Sphaerium corneum	R.G.
Number of taxa	**62**

Table 19. Flora of Booterstown Marsh. * recorded by Reynolds only, *** recorded by Roger Goodwillie only, ** only known location in south Co. Dublin

Taxa	Synonym
Agrostis stolonifera	*Agrostis alba*
Alisma plantage-aquatica	
Alopecurus geniculatus	
Angelica sylvestris	
*Apium graveolens***	
Apium nodiflorum	
Aster tripolium	
Atriplex prostrata	*Atriplex hastata*
Beta vulgaris ss *maritima*	*B. maritima*
Calystegia sepium	
*Cardamine pratensis**	
Carex distans	
*Carex disticha**	
Carex hirta	
*Carex nigra**	*Carex goodenowii*
Carex otrubae	*Carex vulpina*
Cirsium arvense	*Cnicus arvensis*
Cirsium vulgare	*Cnicus lanceolata*
Clematis vitalba	
Crepis capillaris	
Dactylus glomerata	
Elymus repens	*Agropyron repens*
Epilobium hirsutum	
*Epilobium obscurum**	
Epilobium parviflorum	
Equisetum arvense	
Equisetum fluviatile	*Equisetum limosum*
Eupatorium cannabium	
Euphorbia peplus	
Festuca arundinacea	*F. elatior, Lolium arundinaceum*
Festuca rubra	
Filipendula ulmaria	*Spiraea ulmaria*
Galiu aparine	
Galium palustre ***	
Glaux maritima	
Glyceria notata	*Gliceria plicata**
Haliione portulacoides	*Atriplex portaculoides, Obione portaculoides*
Hippuris vulgaris ***	
*Holcus lanatus**	
Hyperium tetrapterum	
Iris pseudacorus ***	
Juncus articulatus	
Juncus bufonus	
Juncus gerardii	
Juncus inflexus	
Juncus ranarius	*Juncus ambiguus*

Table 19 (con't). Flora of Booterstown Marsh.

Taxa	Synonym
Lathryus pratensis	
Lemna minor	
Leontodon aurumnalis	
Lolium perenne	
*Mentha aquatica****	
Myosotis laxa	
Myosotis caespitosa	
Nasturtium hybrid ***	
Nasturtium microphyllum	*Rorippa microphyla*
Nasturtium officinale	*Rorippa nasturtium-aquaticum*
*Plantago coronopus**	
Plantago maritima	
*Poa trivalis**	
Polygonum amphibium	*Persicaria amphibia*
*Polygonum aviculare**	*Polygonum hetrophyllum*
Potentilla anserina	
Potentilla reptans	
*Puccinellia distans**	*Glyceria distans*
*Puccinellia fasciculata**	*Glyceria borreri, Puccinellia pseudodistans*
*Puccinellia maritime***	*Glyceria maritima*
Ranunculus acris	
Ranunculus scleratus	
Reseda luteola	
Rubus fruticosus agg	
Rumex conclomeratus	
Rumex crispus	
?Rumex hydrolapathum	
Salicornia doliostachya (DR)*	
Salicornia europaea	*Salicornia ramosissima*
Salix fragilis	
Samolus valerandi ***	
Schoenoplectus lacustris	*Schoenoplectus tabernaemontani (DR), Scirpus lacustris ss tabernaemontani*
Bolboschoenus maritimus (DR)	*Scirpus maritimus*
Senecio jacobaea	
Solanum dulcamara	
Sonchus oleraceus	
Spergularia marina	*Spergularia salina*
Suaeda maritima DR*	
Trifolium repens	
Triglochin maritima DR	
Triglochin palustris	
Tripleurospermum maritimum	*Matricaria maritima*
Tussilago farfara	
Typha latifolia	
Ulex europeaus	
Urtica diocia	
*Veronica beggabunga****	
Vicia cracca	
Zanichelia palustris ***	

FIGURES

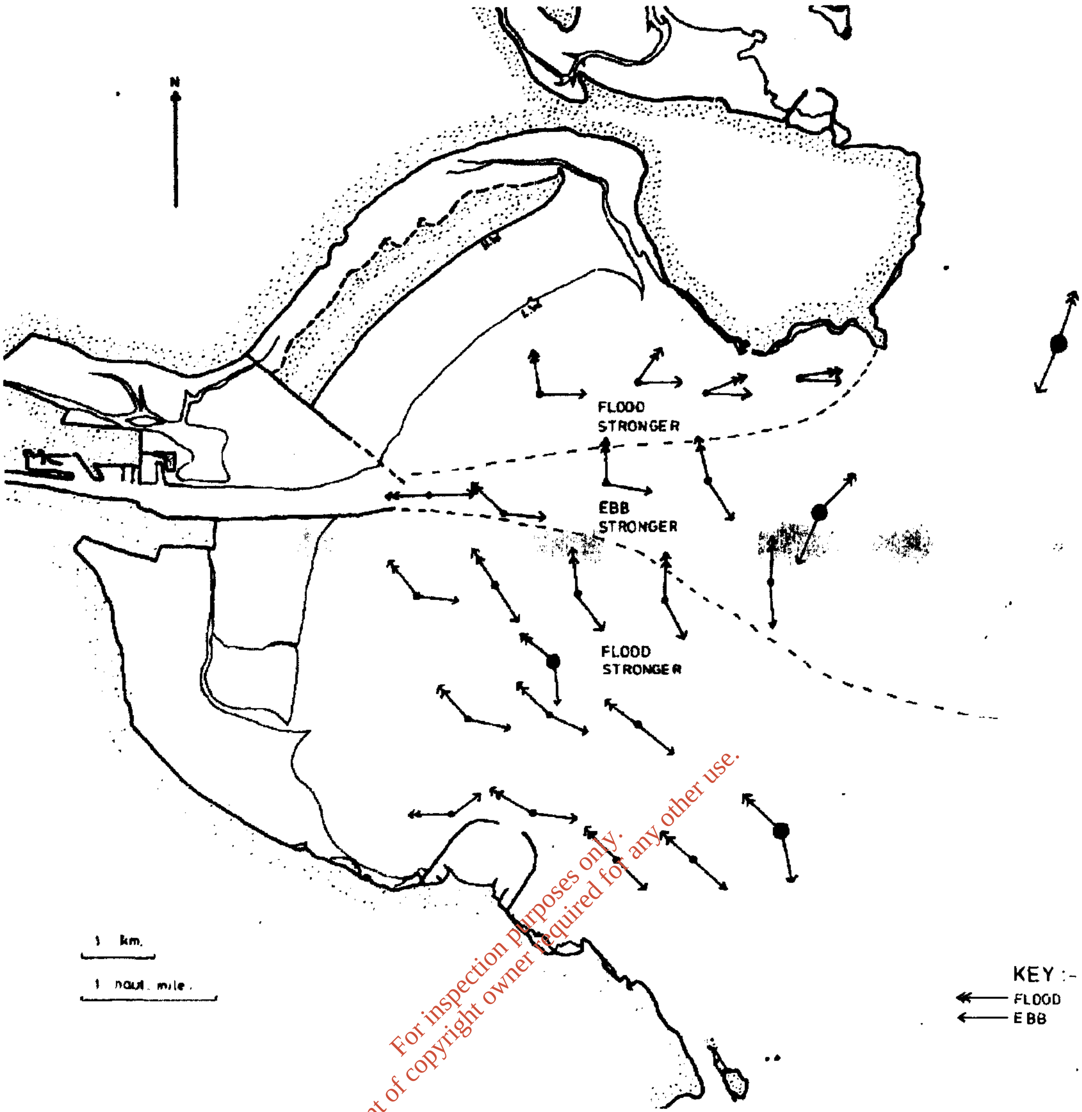

Fig. 1 Currents in Dublin Bay. Crisp 1976

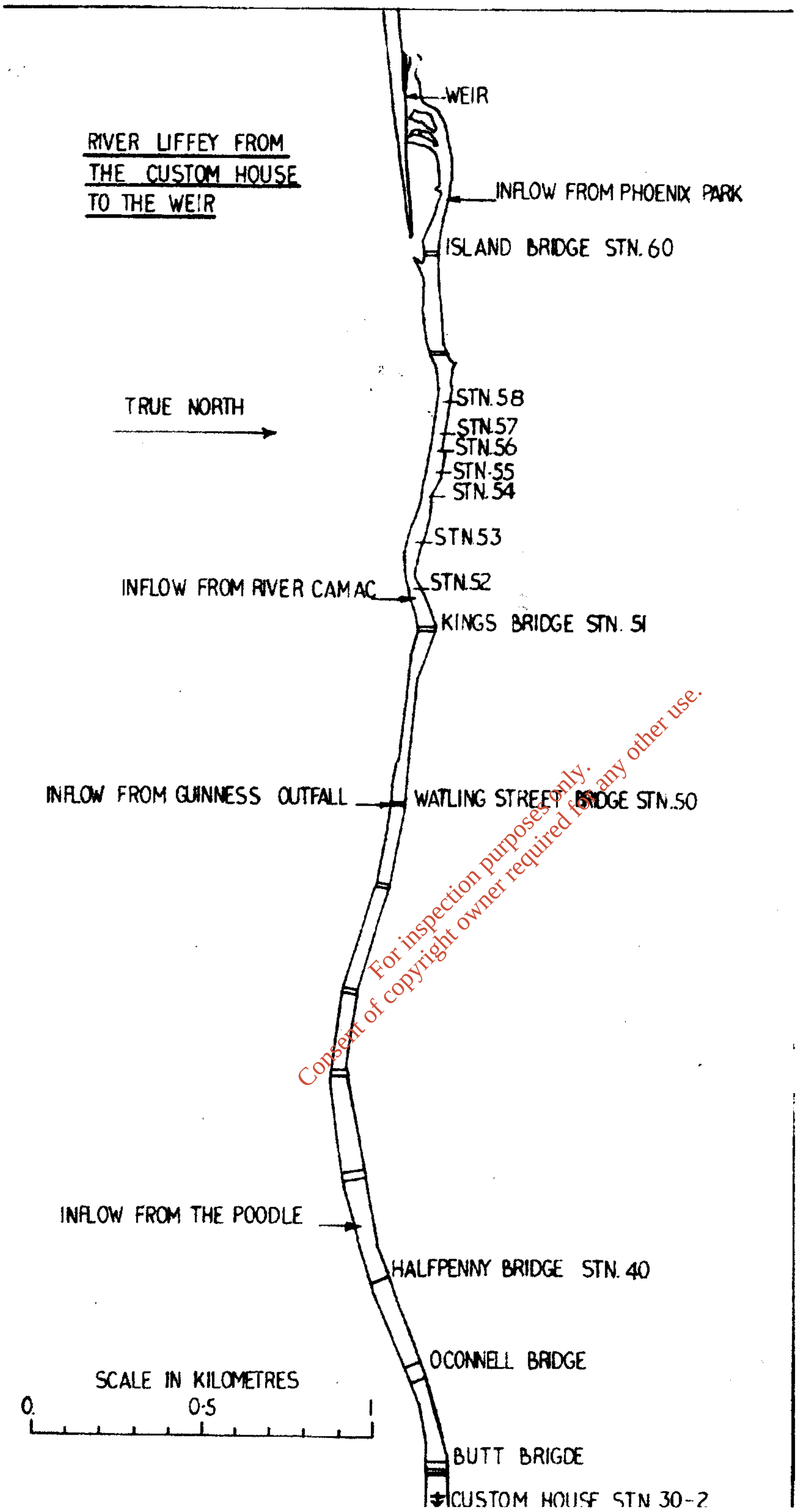

Fig. 2 River Liffey from the Weir to the Customs House showing sampling stations Crisp, 1976

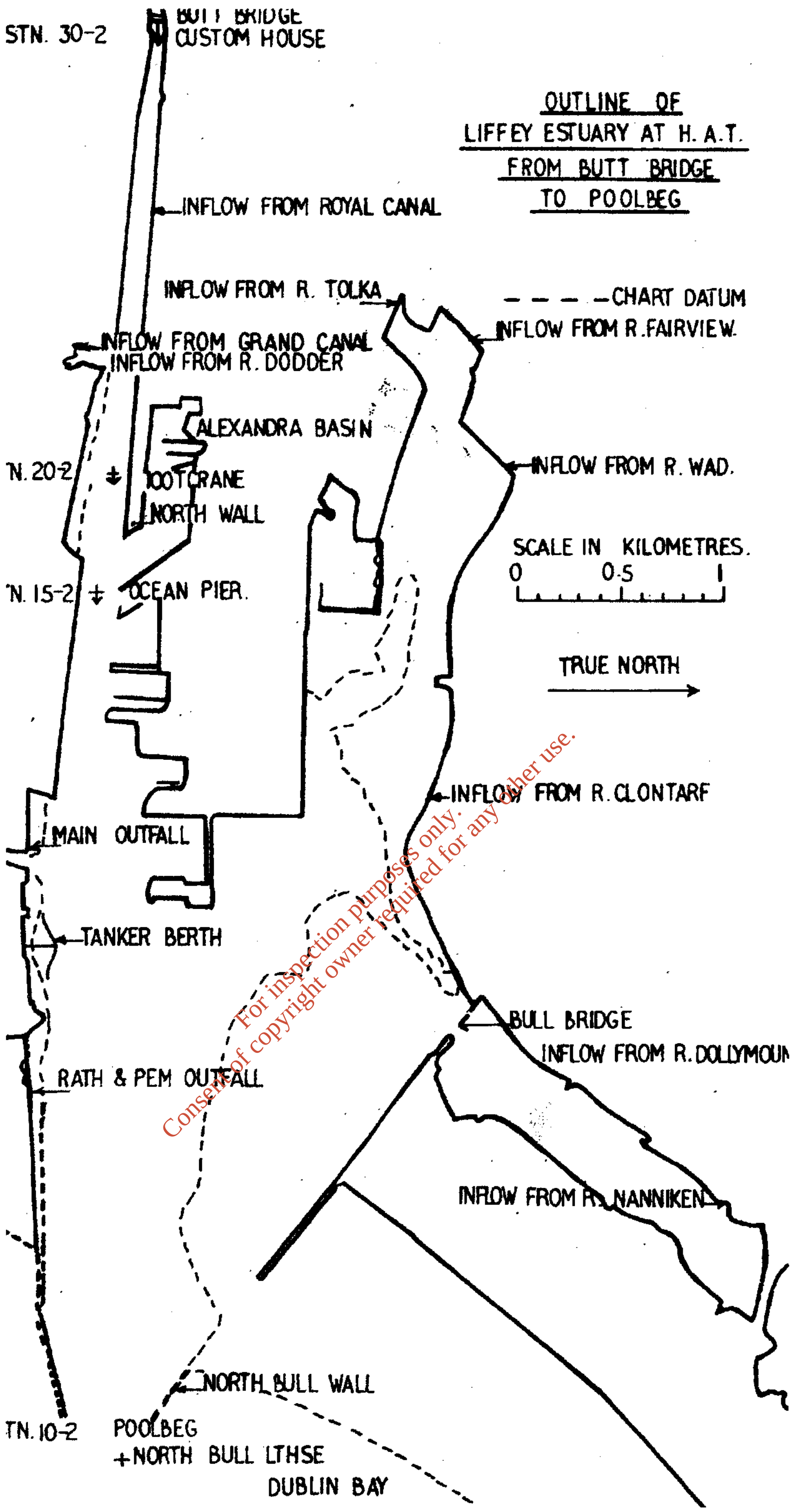

Fig. 3. Customs house to Poolbeg Lighthouse showing sampling stations Crisp 1976

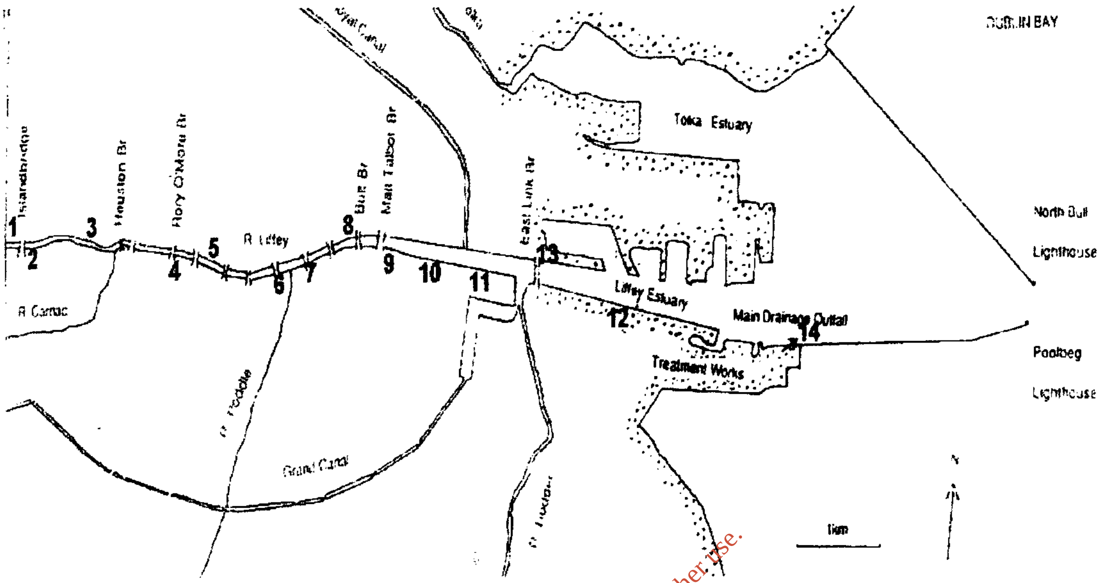

Fig. 4. Liffey estuary sampling sites of Britton 2001.

1 : Sarahs place
2 : Clancy's Barracks
3: Parkgate
4: Ushers Island
5: Arran Quay
6 Essex Quay
7. Aston Quay
8. Eden Quay
9. House Quay
10: City Quay
11: Sir John Rogerson Quay
12: East wall Toll Booth
13; East Wall Toll Bridge
14: South Bull Wall

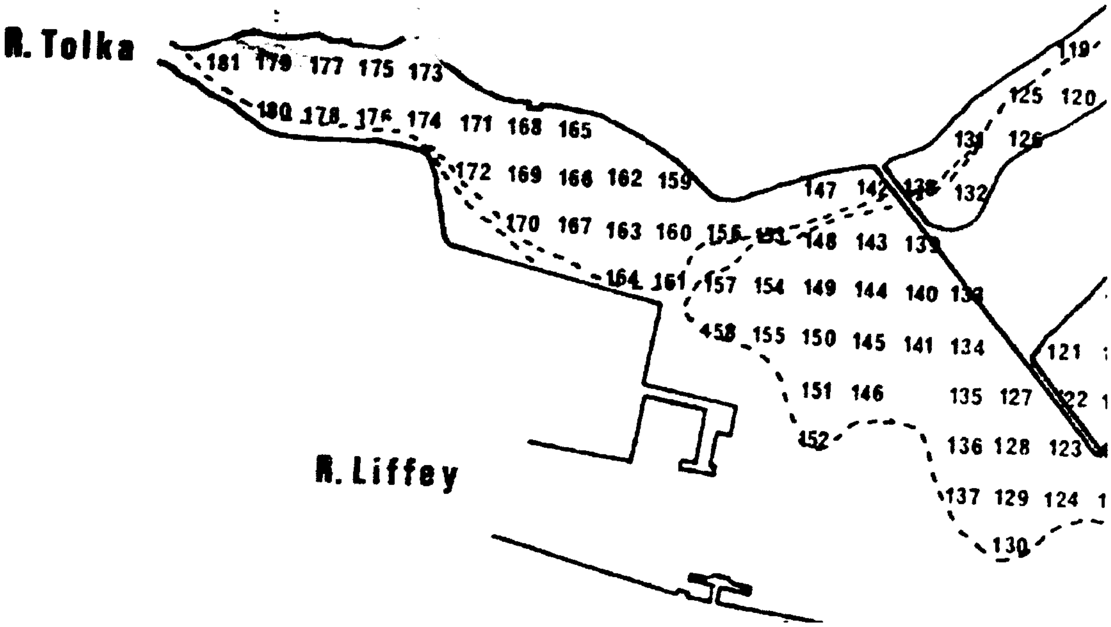

Fig. 5. Sampling sites Tolka and estuary, Wilson, 1982

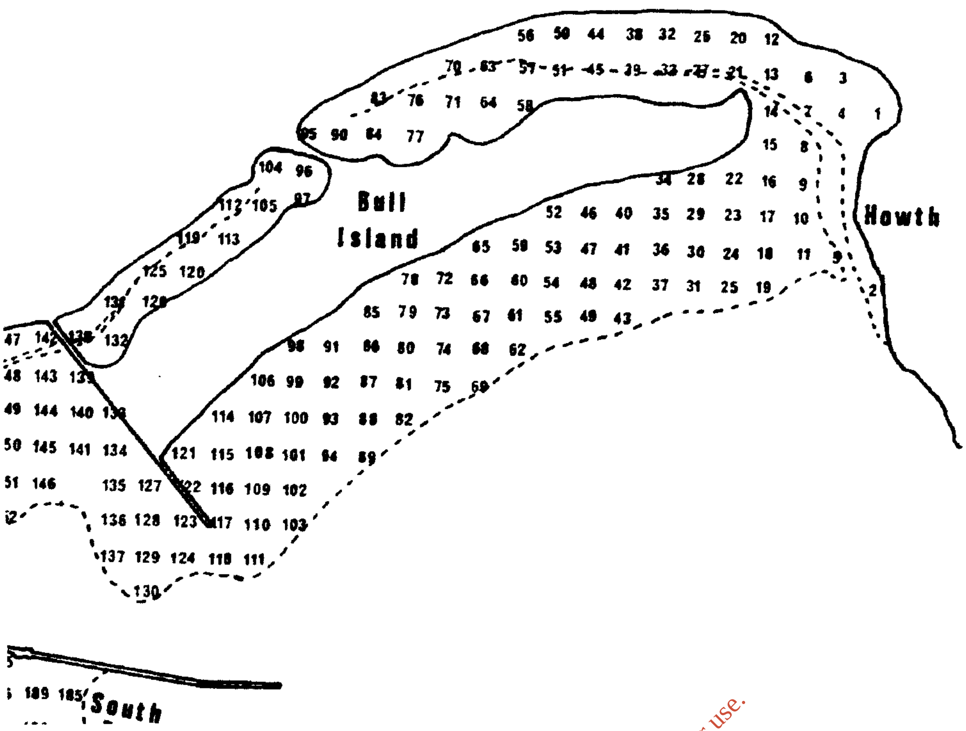

Fig. 6. Bull Lagoons Sampling stations of Wilson 1982.

North Bull Lagoon: 3, 6, 12, 13, 20, 21, 26, 27, 32, 33, 38, 39, 44, 45, 50, 51, 56, 57, 58, 63, 64, 70, 71, 76, 77, 83, 84, 90 and 95.

South Bull Lagoon: 96, 97, 104, 105, 112, 113, 119, 120, 125, 126, 131, 132 138

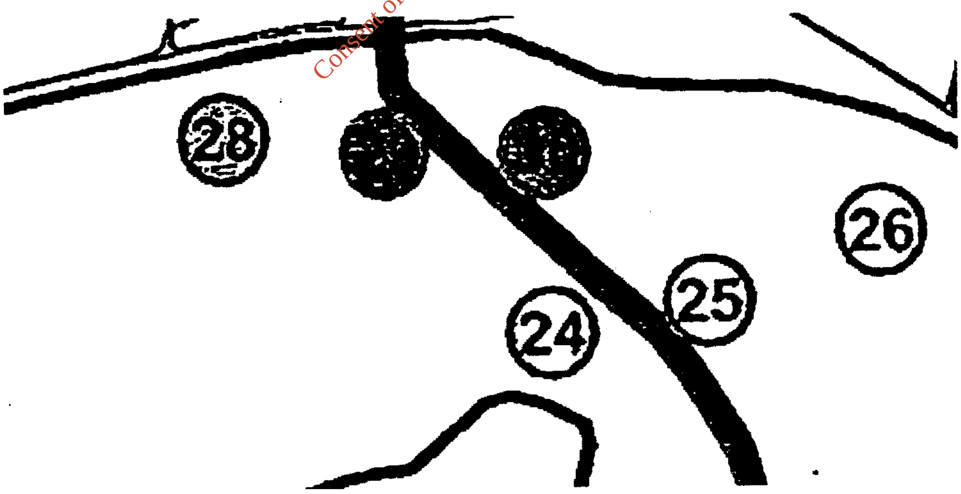

Fig. 7. Dublin Bay submarine pipeline sampling stations, North Bull.

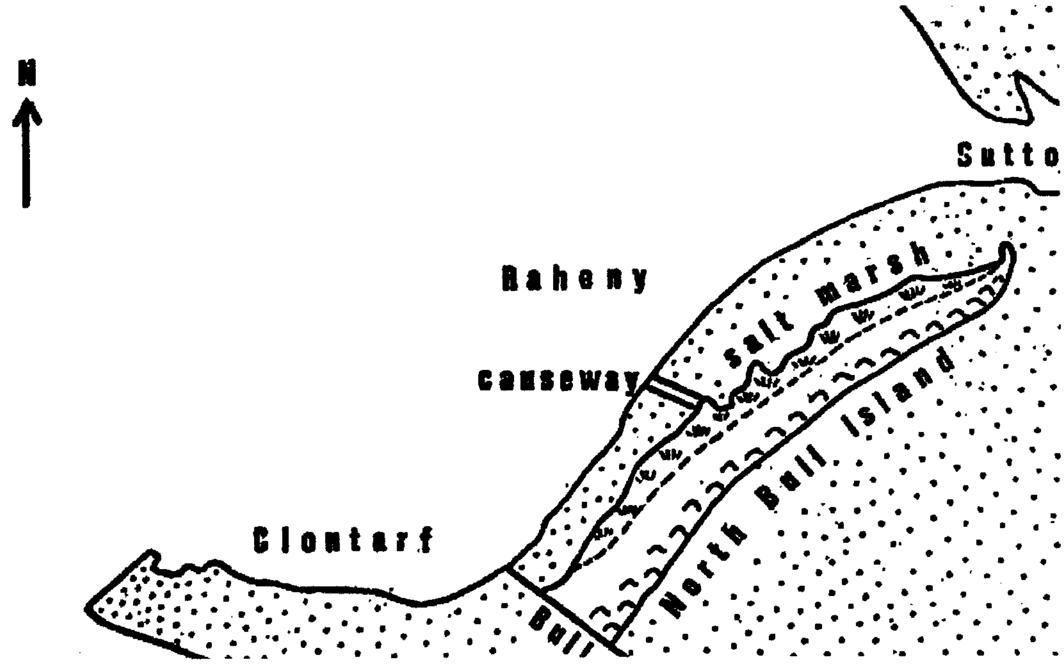

Fig. 8. Bull Island Salt Marsh, Healy 1972.

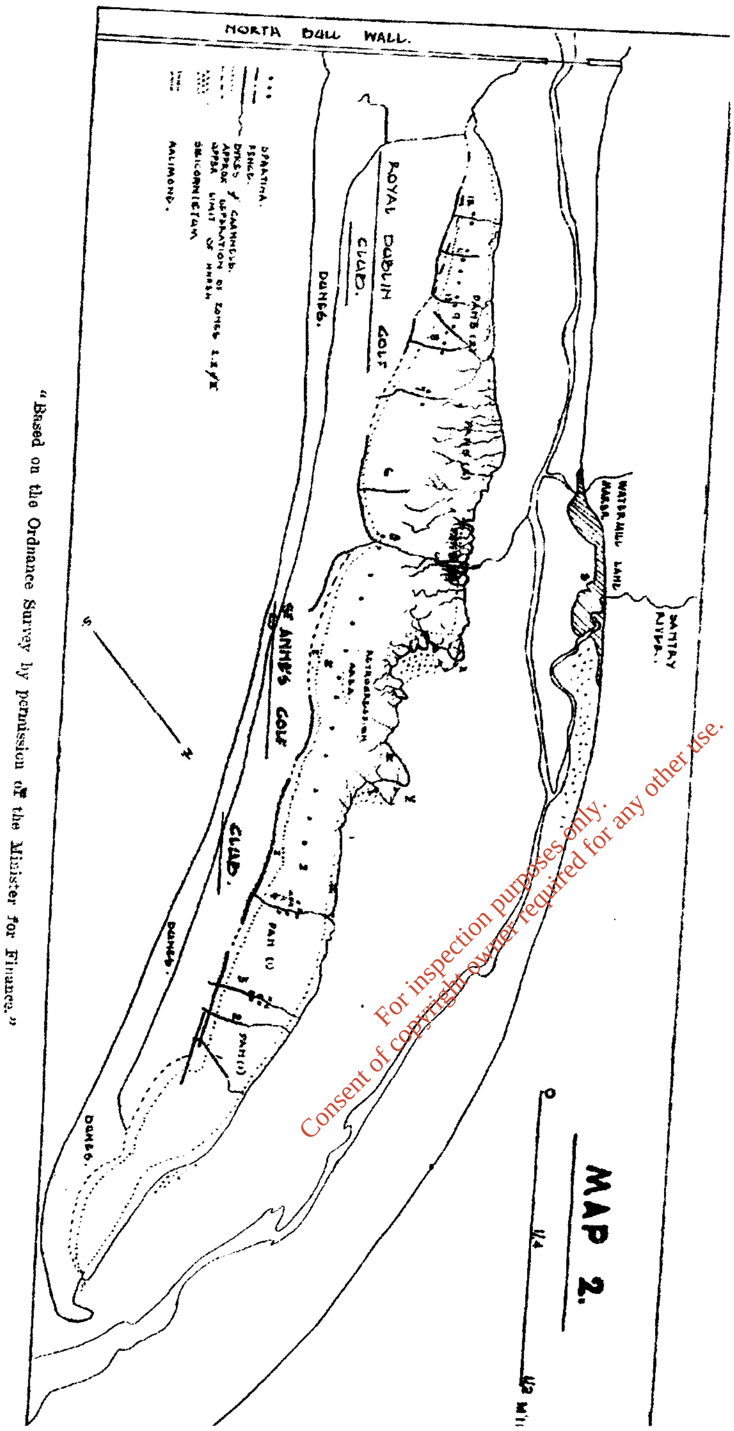

Fig. 9. from Some observations on the Salt marsh formation in Co. Dublin (O'Reilly, H. and G. Pantin, 1957)

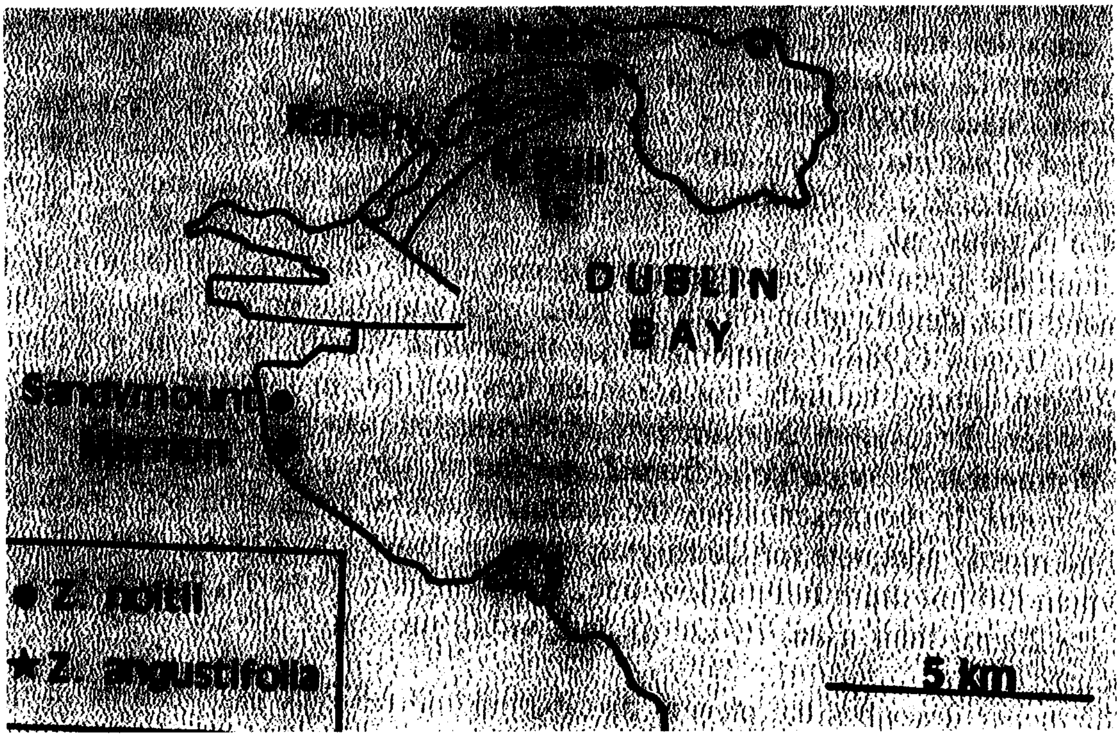

Fig 10. Distribution of *Zostera* spp in Dublin Bay (Madden et al, 1993)

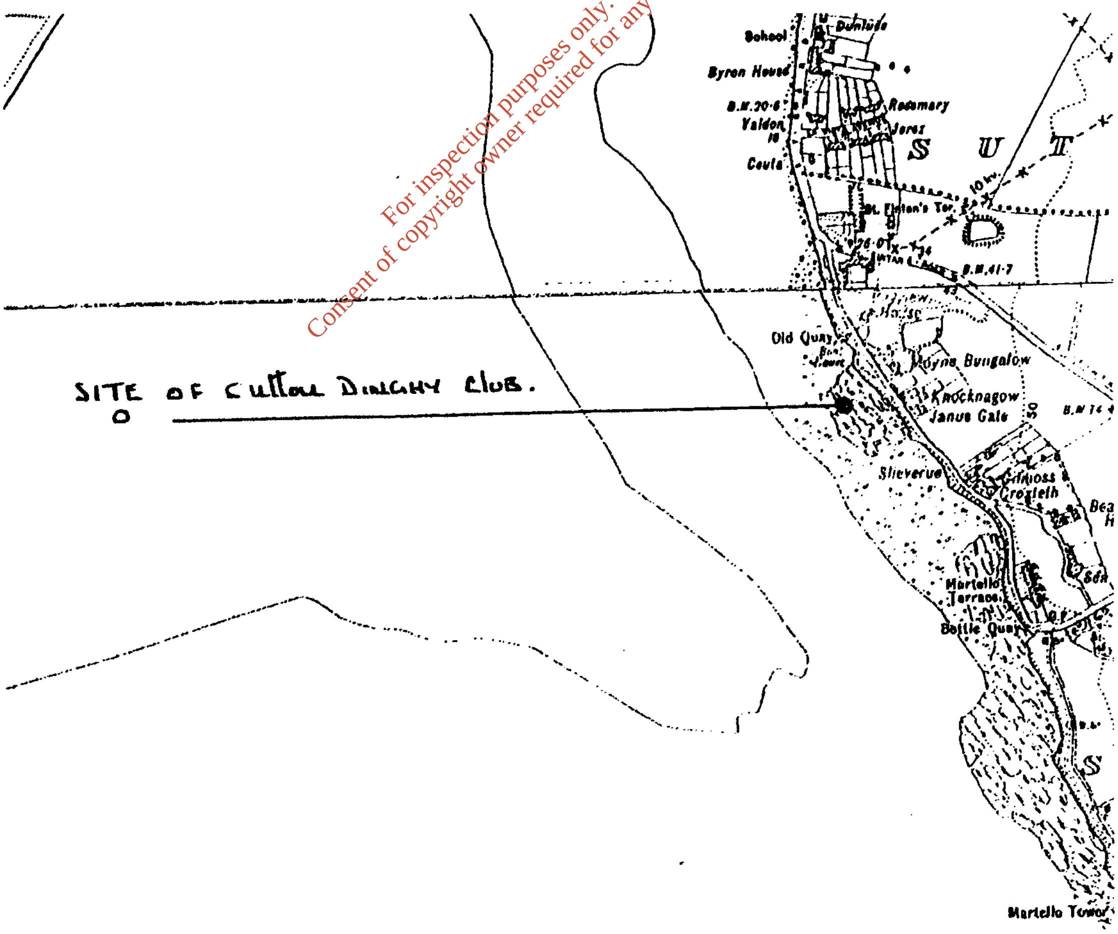

Fig. 11. Location of Sutton Dinghy Club.

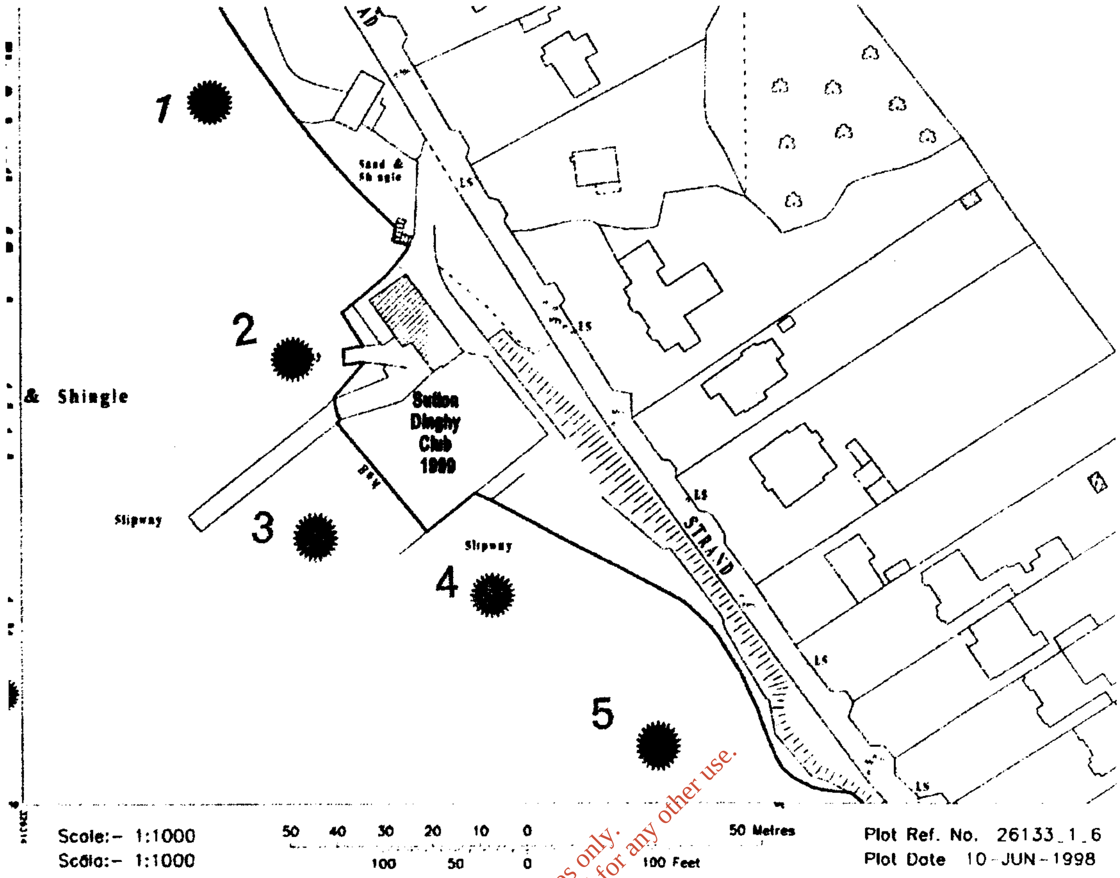

Fig. 12. Sutton Dinghy Club sampling sites, Lyons 1999

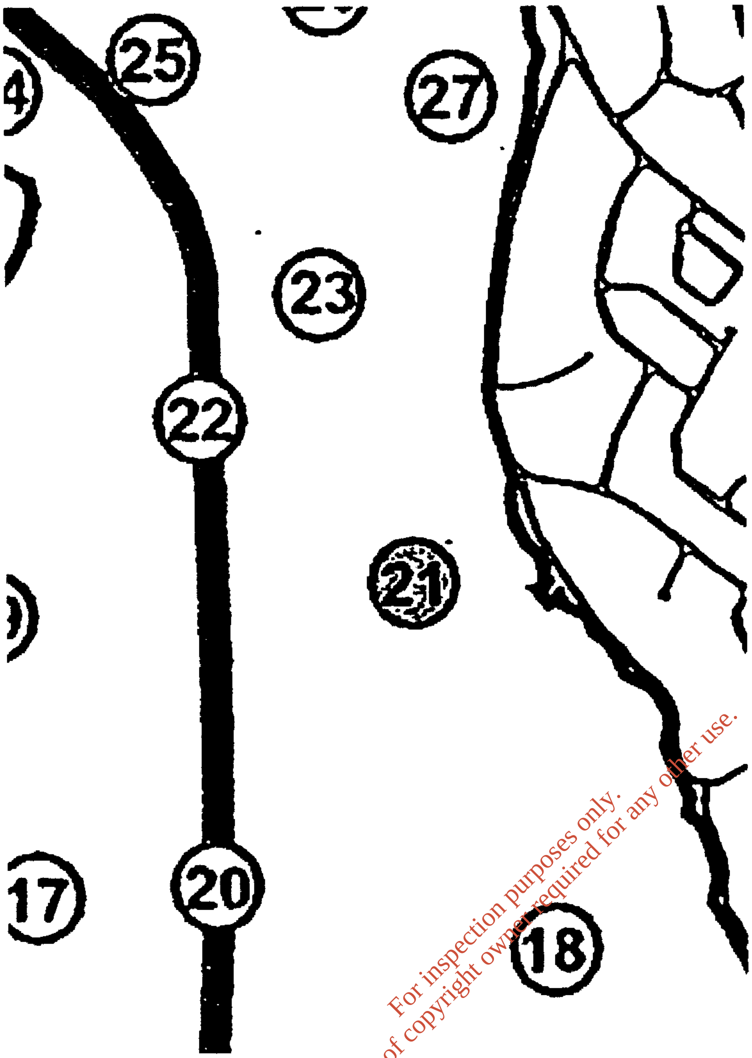

Fig. 13. Submarine pipeline EIS sampling sites, 1997 Sutton Creek

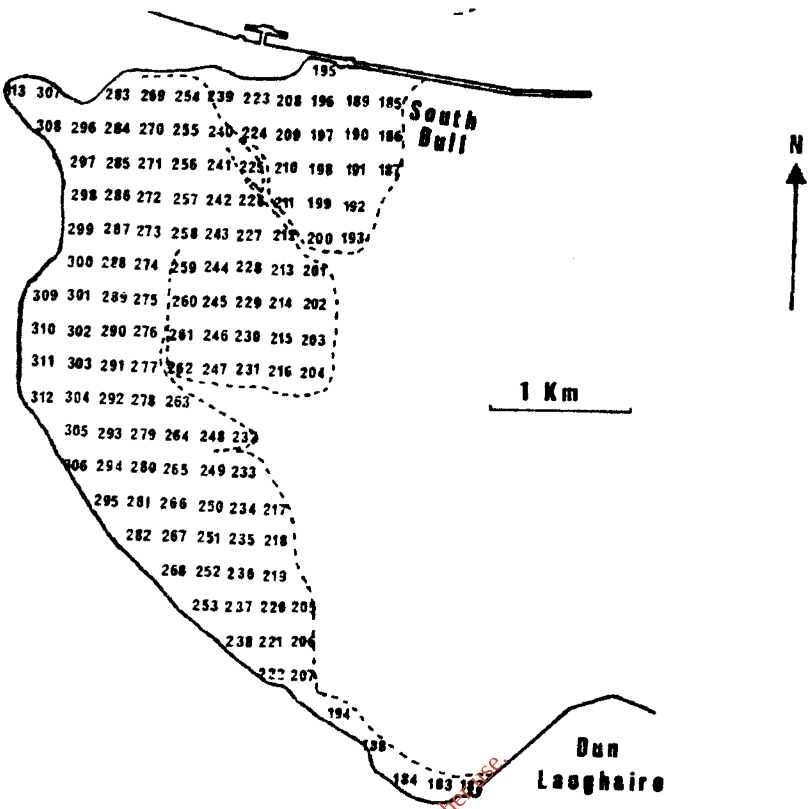

Fig. 14. Wilson, 1982 Sampling stations, South Bull

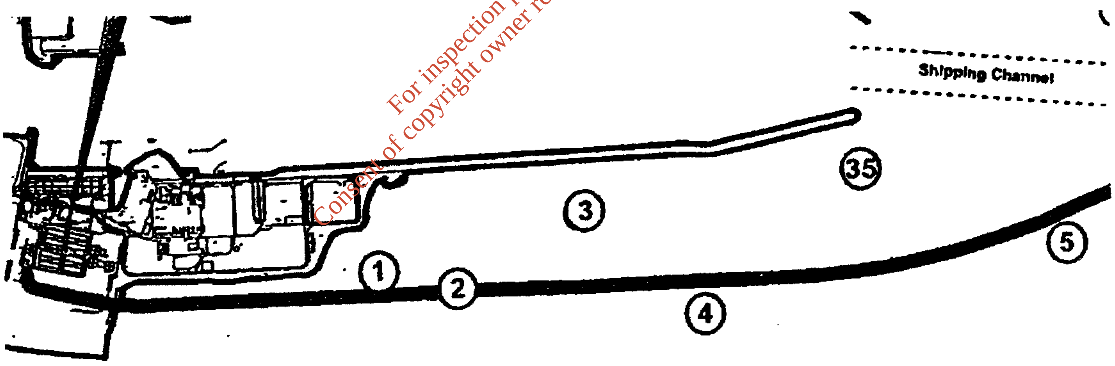

Fig. 15. Submarine pipeline, 1997 South Bull sampling sites

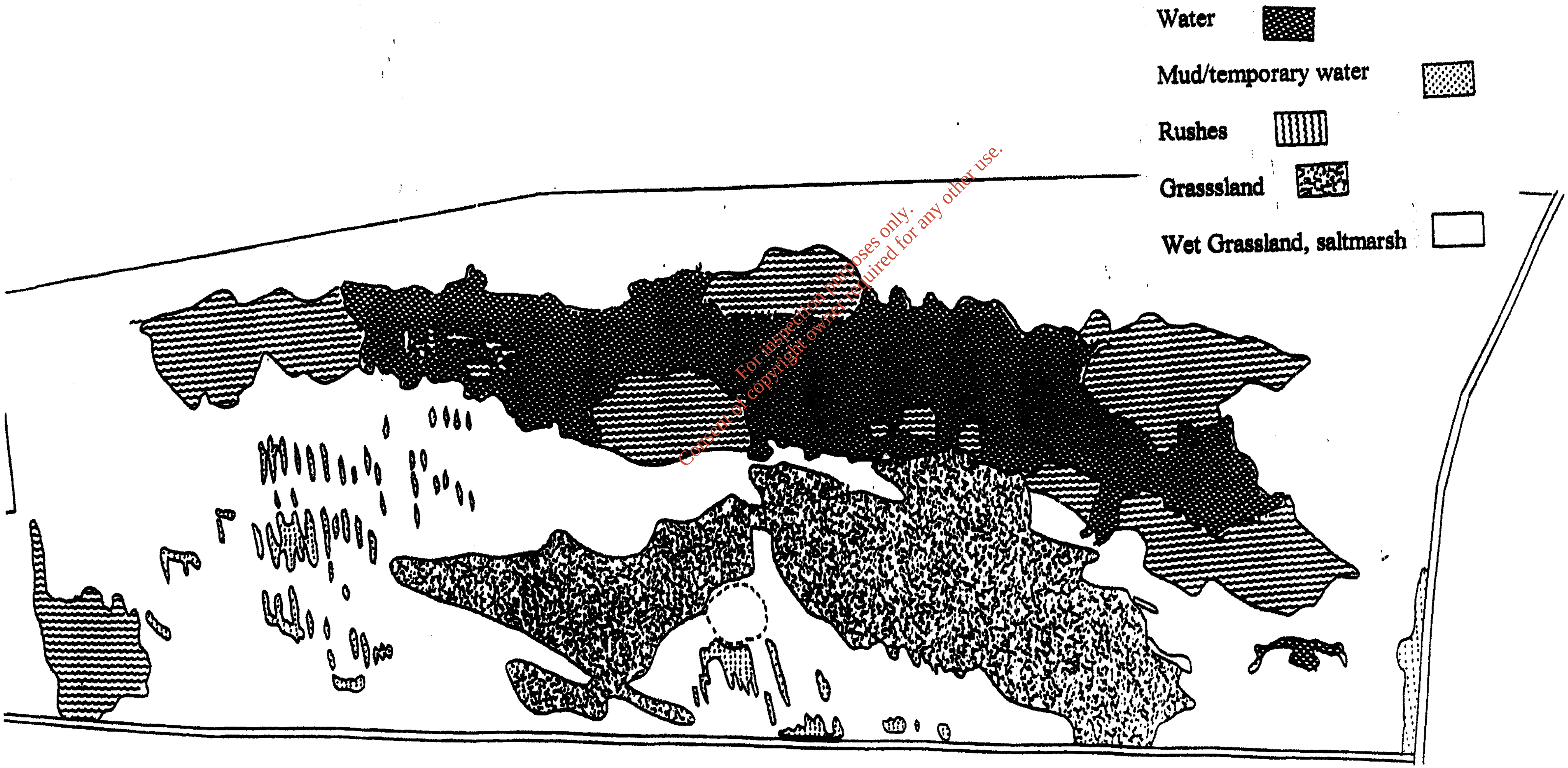

Fig. 16. Booterstown Marsh, vegetation and pond, August 1970. Goodwillie et al, 1971

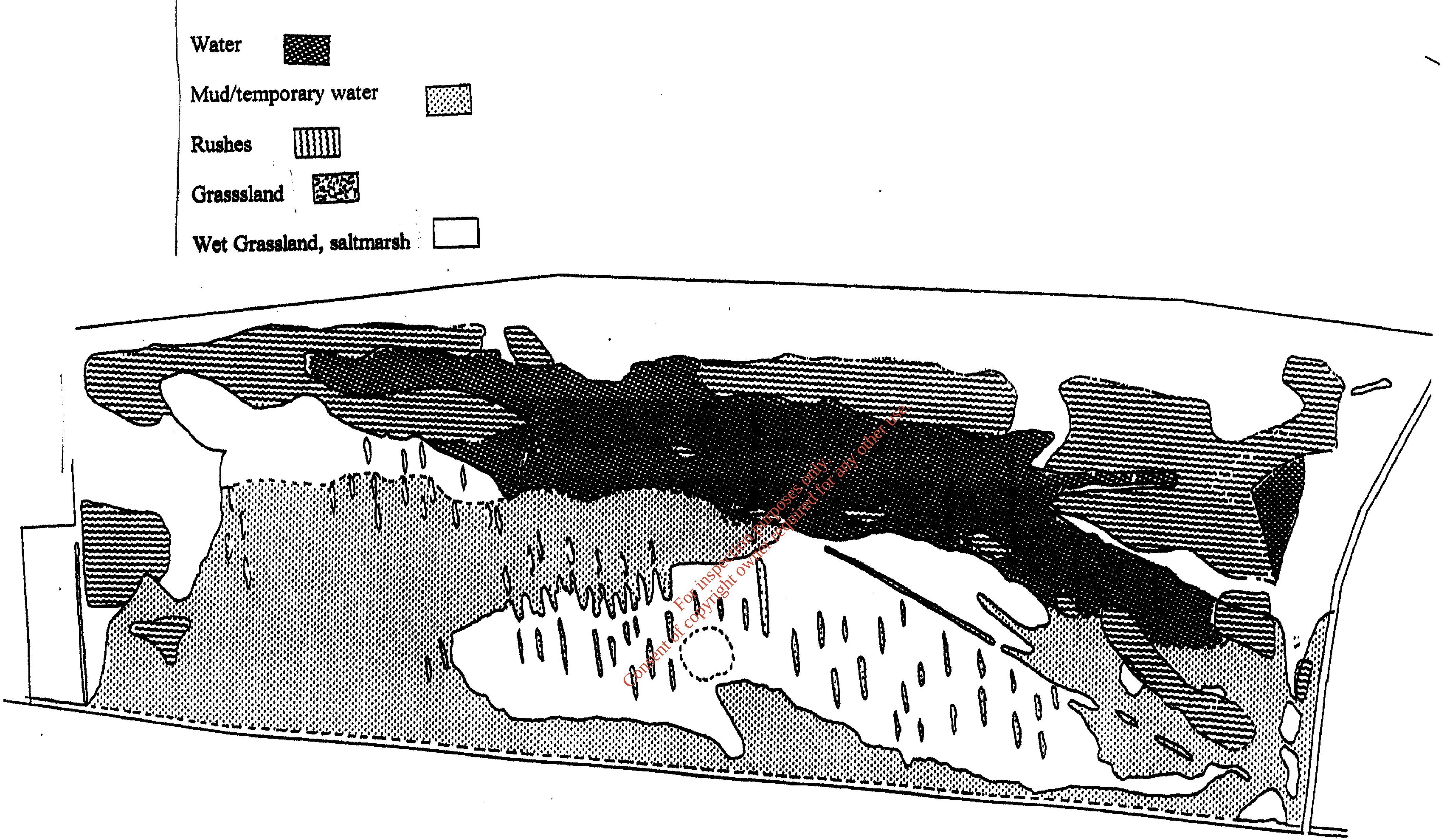

Fig. 17. Booterstown Marsh, May 1986. Goodwillie, 1986

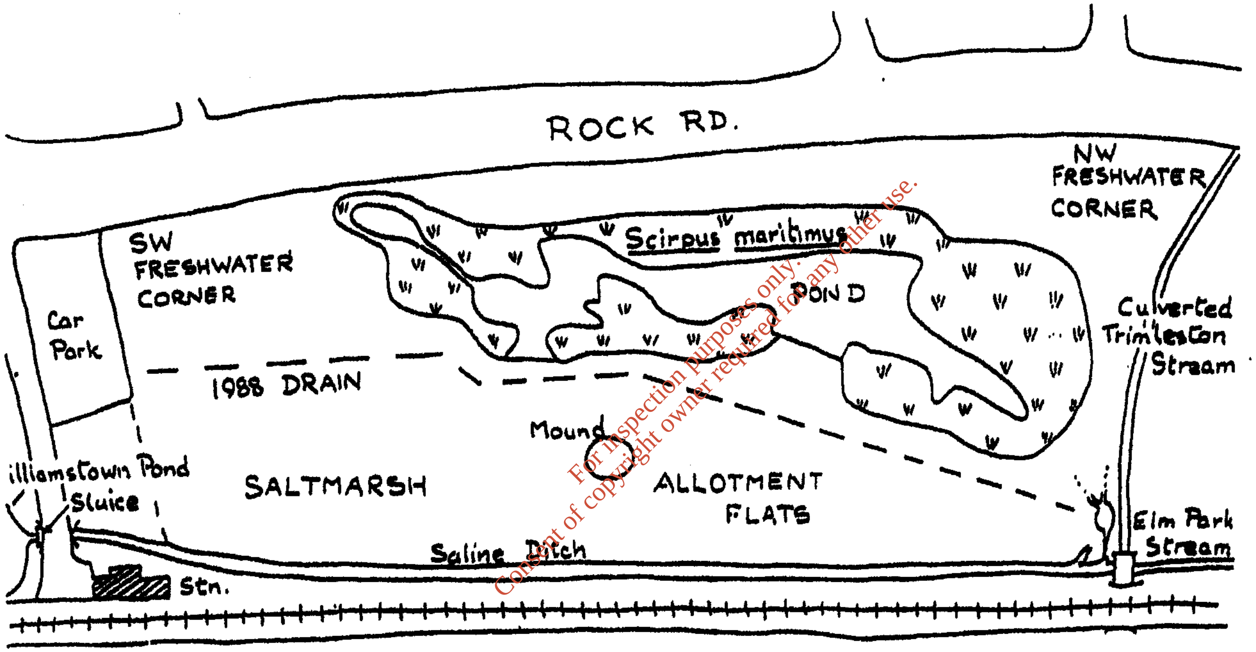

Fig. 18. Booterstown Marsh, 1989. Reynolds & Reynolds, 1990

Appendix C

Estuarine Ecology – Sampling

A baseline ecological study of the Marine and Estuarine Environments for the proposed Dublin Waste to Energy Project

Prepared for:
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1 September 2004

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Authorised by:	Chris Emblow	

TABLE OF CONTENTS

INTRODUCTION

It is proposed to develop a waste to energy plant on the Poolbeg peninsula in Ringsend, Co. Dublin. While the details of the development have not been finalised, the developers are in the process of gathering baseline data of the area. This data may be used for an Environmental Impact Assessment, the subsequent EIS and future monitoring programmes. As it is not known if or where waste water discharges into the marine and estuarine environments from the proposed development will occur, a broad survey area was examined. Ecological Consultancy Services Ltd (EcoServe) were commissioned by M.C. O'Sullivan Ltd to conduct a baseline marine and estuarine ecological study of the area.

The site of the proposed development on the Poolbeg peninsula in Ringsend, Co. Dublin allows for waste water discharges to be directed to two distinct areas. The area to the south of the site consists of Irishtown and the South Bull. The area to the north of the site is within the Bull Walls and thus within the River Liffey estuary. Waste water entering on the south side (the Irishtown area) would be washed out towards Poolbeg lighthouse with the tide where it would join the currents of Dublin Bay. Wastewater entering the Liffey estuary around Ringsend would disperse within the estuary depending on the tide. During certain stages of the tide, water discharges could be pushed up the Liffey and also into the Tolka estuary. On leaving the Liffey estuary, west of the Bull Walls, water would join the currents of Dublin Bay (Mansfield, 1992).

North Dublin Bay is a candidate Special Area of Conservation (cSAC) and supports good examples of ten habitats listed on Annex 1 of the EU Habitats Directive (Council Directive, 1992), one of which has priority status. Several bird species have populations of international importance while some invertebrates are of national importance and a number of rare and scarce plants occur there, some of which are legally protected (Appendix 7, Site code 000206).

North Bull Island has been designated a Special Protection Area (Site code 006) under the EU Birds Directive (Council Directive, 1979) and it is also a statutory Wildfowl Sanctuary, a Ramsar Convention site, a Biogenetic Reserve, a Biosphere Reserve and a Special Area Amenity Order site.

South Dublin Bay is also a candidate Special Area of Conservation (cSAC) and proposed National Heritage Area (NHA) because of its extensive intertidal sand and mud flats. The area around Irishtown is part of the South Dublin Bay cSAC (Appendix 7, Site code 000210).

METHODOLOGY

As a result of recommendations from the scoping report prepared for the Dublin Waste to Energy project (Browne, 1998), a baseline study of the marine and estuarine ecology was carried out. Sampling locations for this study were selected so as to correspond to those areas likely to be affected by any waste water discharge from the proposed development, while taking into consideration existing data so as not to undertake unnecessary replication. This included littoral and sublittoral surveys.

Littoral survey

Littoral sampling was conducted on the 13th and 14th August 2003, at low water spring tides. A total of 14 sites were examined in five broad areas (Irishtown, Tolka estuary, Liffey estuary, Dollymount Strand and Sutton). (Appendix 1, Figure 1.1; Appendix 2, Table 2.1). Different sampling approaches were taken in different areas due to the varied substratum types.

Irishtown area

The biotopes along the shore were mapped in accordance with the procedures detailed by Davies *et al*. (2001) and Emblow *et al*. (1998). Biotopes are habitats with their associated fauna and flora. Surveyors walked along the shore in order to identify and map the extent and distribution of biotopes. Biotope identification was carried out in the field and species lists for each biotope were compiled. Relative abundance of species was also recorded. Abundances were applied following the six point abundance scale in Hiscock (1996). Biotopes and species lists were then compared to existing data and interpreted using the biotope classification (Connor *et al*. 1997a). Algae that could not be identified in the field were transported fresh back to the laboratory for identification. Fauna that could not be identified in the field was preserved in 70% Industrial Methylated Spirits (IMS) and transported back to the laboratory for identification.

Four core samples were taken from the intertidal sediment areas of Irishtown. These were selected to be representative of the broad sediment biotopes in the area. Each sample consisted of four core samples, taken with a corer approximately 10 cm in diameter, to a depth of 20 cm. These were combined and passed through a 1 mm mesh sieve. Fauna was extracted and preserved in 70 % Industrial Methylated Spirits (IMS) before being returned to the laboratory for identification.

Liffey Estuary

The intertidal sections of two structures representative of hard substrata in the Liffey estuary were examined and the flora and fauna recorded, together with abundance. Site La was the old docking area in front of the Ringsend Power Station. Site Lb was a temporary docking area downstream of the container yard on the south bank. These structures were surveyed from a boat at low water.

Tolka Estuary and Dollymount Strand

The intertidal sediment sites of the Tolka estuary and Dollymount Strand were sampled in a similar manner to the sediment biotopes of the Irishtown area. Two sites on each side of the Tolka estuary, representative of habitats in the area were also selected for sampling. A single transect of three sites was taken down Dollymount Strand. Four cores were taken at each site, combined and passed through a 1 mm mesh sieve. Infauna was preserved in 70% IMS and returned to the laboratory for identification. Biotopes were assigned using the biotope classification (Connor *et al*. 1997a).

Sutton area

The sediments of the sampling area in Sutton were shallow and as such cores could not be taken. To compensate for this, digs were taken in the sediment and passed through the 1 mm mesh sieve and the residue examined for fauna. A brief species list was also taken of the epifauna on the hard substrata in the area.

Photographs were taken to illustrate the littoral sites, biotopes and the species present (Appendix 5, Plates 5.1-5.15).

Sublittoral survey
Sublittoral sampling was conducted on the 14th August 2003. A total of 11 sublittoral sites were examined (Appendix 1 Figure 1.1, Appendix 2 Table 2.2). Ecological samples were collected with a 0.1 m^2 van Veen grab (for soft sediments) or with a biological dredge (approximately 52 cm x 22 cm)(for hard substrata).

van Veen grab
The grab was deployed over the side of the boat, which was fitted with a pot-hauler for retrieval. A single grab was taken which was then washed through a 1 mm mesh sieve. Species which could not be identified on board were preserved in 70 % Industrial Methylated Spirits (IMS) along with the sample residue and returned to the laboratory for sorting and identification. Specimens were identified to the lowest possible taxonomic level and species lists compiled. The abundance of fauna was recorded and a voucher collection of representative specimens was retained. Notes on the substratum type were taken.

Biological dredge
Where the substratum was too hard for the grab to work effectively, the biological dredge was deployed (Appendix 5 Plate 5.17). The dredge was towed for three minutes before retrieval and sorting of the sample. Species that could not be identified *in situ* were preserved in 70 % IMS and returned to the laboratory for identification.

Species nomenclature follows Howson & Picton (1997). Photographs were taken to illustrate the sampling methods and the species present (Appendix 5, Plates 5.16-5.17). Literature used for the identification of fauna included Crothers and Crothers (1988) for crabs, Picton (1993) for echinoderms, and Hayward and Ryland (1995) for other fauna. Biotopes were assigned using the biotope classification (Connor *et al*. 1997b).

Sediment analysis

A total of five sediment samples were taken at C4, Le, G2, G3 and Df for granulometry, heavy metals and loss on ignition analysis. The littoral sites (C4 and Le) each consisted of a single core to a depth of 20 cm. The sublittoral sites were taken with the van Veen grab and a representative sampled retained. The sample was labelled and retained in an unpreserved state and returned to the laboratory. Sample analysis was subcontracted to City Analysts, Dublin. City Analysts are ILAB Accredited by the National Accreditation Board (NAB).

Granulometric analysis
Each sediment sample was dried, weighed and passed through a series of sieves of known mesh size, from 5.6 mm – 63 µm. The amount of material which passed through each sieve was weighed and the percentage of the total mass of the sample calculated. It was not possible to carry out the analysis on three of the samples (Le, G2 and G3). The methods of sample drying available hardened the fine mud sediment so that it did not pass through the sieves.

Loss on ignition
A sub sample of each dry sediment sample was taken and weighed. It was placed in an oven at 400°C to burn off all organic matter. The sample was then reweighed and the mass of organic matter calculated as a percentage of the total sub sample.

Heavy metal analysis
Samples were analysed for cadmium, chromium, copper, lead, mercury, nickel and zinc.

RESULTS

Littoral survey
Irishtown
During the survey, a total of 11 biotopes were recorded in the study area of Irishtown. These included five sediment biotopes and six hard or mixed substrata biotopes (Appendix 1, Figures 1.3-1.5, Appendix 2, Tables 2.3, 2.4). Four core samples were taken in total.

Core 1 was taken in muddy sand towards the west of the study area. The presence of the cockle *Cerastoderma edule* and polychaetes allowed for a biotope code of LMS.PCer to be assigned indicating *Cerastoderma edule* and polychaetes in fine sand or muddy sand shores. However, the polychaeta species recorded were not typical of this biotope.

Core 2 was taken in the sandier areas to the east of Core 1. Polychaetes and amphipods were recorded although species diversity and abundance was low, it was considered high enough to assign a biotope code of LGS.AP indicating burrowing amphipods and polychaetes to this site. However, it should be noted that this is not a good example of the biotope, primarily as the sand has a significant anoxic element just below the surface.

Core 3 was taken towards the eastern end of the study area near the start of the Bull Wall. Significant numbers of the bivalve *Angulus tenuis* were recorded. However, an absence of other significant fauna did not allow for the assignation of a lower biotope. A higher biotope of LGS was assigned indicating littoral gravels and sands.

Core 4 was taken from the sediments approximately half way along the Poolbeg peninsula where species abundance and diversity was again relatively low. A biotope code of LMU.HedMac was assigned using the principle of best fit. This indicates *Hediste diversicolor* and *Macoma balthica* in sandy mud shores.

A number of other sediment biotopes were observed during the study. On sandy areas above the high tide mark, the sand had no obvious infauna and a code of LGS.BarSnd indicating barren sand was assigned. Below areas of barren sand areas of decomposing drift algae occoured, supporting talitrid amphipods. A biotope code of LGS.Tal indicating talitrid amphipods in decomposing seaweed on the strandline was assigned. The extreme northwestern corner of the site consisted of a black anoxic mud covered with a grey pink coloured sewage fungus. There were also smaller patches of sewage fungus along the stream running beside the rock armour. No biotope could be assigned.

Overall the sediment biotopes of the Irishtown area varied from mud to sandy mud in places through muddy sand to fine sand. Boundaries between the sediment types were frequent and indistinct and as such beyond the scope of this report. General boundaries can be seen on the biotope map (Appendix 1 Figures 1.3-1.5).

An almost continuous band of "rock armour" stretched from the western end of the study area to the start of the Bull Wall to the east of the study area. The highest points of this were generally not intertidal and thus barren of marine life. They are shown on the map as "rock armour". The lower sections of this armour were colonised by various organisms and have been assigned biotopes. It should be noted that the hard substrata biotopes have become established on the rock armour itself and are such, in part, man-made habitats.

Two areas supported a biotope dominated by the channelled wrack *Pelvetia canaliculata*, and were assigned the biotope code SLR.Pel, indicating *P. canaliculata* on sheltered fringe rock. The areas supporting this biotope were an area at the western extreme of the study area and a significant length above the biotope SLR.Fves towards the centre of the study area. Other species present in this biotope included *Fucus spiralis* and *Enteromorpha* sp. SLR.Pel is found above the biotope SLR.Fspi.

An almost unbroken line of the biotope SLR.Fpi indicating *Fucus spiralis* on moderately exposed to very sheltered upper eulittoral rock, was recorded along the rock armour. The biotope was dominated by growths of *Fucus spiralis*, recorded as common, and also by the ephemeral green algae *Enteromorpha* sp. The barnacles *Semibalanus balanoides* were recorded a frequent as was the periwinkle *Littorina saxatilis*. The small gastropod *Hydrobia* sp. was also present in high numbers. While much of the length of this biotope was considered a good example of SLR.Fspi, there was an area on the corner about half way along the study area where the principle of best fit was applied. *F. spiralis* was sparse but was still the dominant algae present.

Two similar but competing biotopes when combined formed an almost continuous band below SLR.Fspi along the length of the rock armour where the stream flowed. SLR.Asc indicating *Ascophyllum nodosum* on very sheltered mid eulittoral rock dominated much of the western end of the study area. SLR.Fves indicating *Fucus vesiculosus* on sheltered mid eulittoral rock dominated the eastern side and an area in the northwest corner of the site. SLR.Asc was dominated by *A. nodosum* and also contained *F. spiralis*, *F. vesiculosus*, *Enteromorpha* sp., *Semibalanus balanoides*, *Mytilus edulis*, *Actinia equina* and amphipods. The epiphytic red algae *Polysiphonia lanosa* was present on the *A. nodosum*. SLR.Fves was dominated by the fucoid *Fucus vesiculosus* and also contained *Enteromorpha* sp., *A. nodosum*, *Ulva* sp., the periwinkle *Littorina littorea*, amphipods, the crab *Carcinus maenas* and *Mytilus edulis*.

Below the combined line of SLR.Asc and SLR.Fves towards the edge of the stream that runs along much of the study area, there was a continuous if at times narrow line of *Enteromorpha* sp. This was assigned a biotope code of SLR.EphX indicating ephemeral green and red seaweeds on variable salinity or disturbed eulittoral mixed substrata. There were a number of gravely / cobble areas scattered on the sediment biotopes. This slightly more stable substrata allowed for the growth of ephemeral algae such as *Enteromorpha* sp. and was also assigned a biotope code of SLR.EphX. The stream itself did not comprise a distinct biotope. However, cobbles contained within the stream supported growths of the red algae including *Ceramium* sp. One area of about 50 m on the beach side of the stream supported a narrow band of the sand mason *Lanice conchilega*. This was assigned a biotope code of LGS.Lan indicating dense *Lanice conchilega* in tide swept lower shore sand.

Along the western end of the rock armour away from the stream, the substrata was more exposed and dry. The dominant seaweeds along this area were the ephemeral algae *Enteromorpha* sp. and *Porphyra* sp. although both were sparse. Other species recorded as present included *Fucus spiralis*, *Fucus vesiculosus* and *Semibalanus balanoides*. A biotope code of MLR.EntPor was assigned indicating *Porphyra purpurea* or *Enteromorpha* spp. on sand scoured mid or lower eulittoral rock.

Liffey Estuary
The two littoral sites examined in the Liffey estuary were structures away from the actual shoreline and were hard substratum sites. A species list was taken for each site, which was also subdivided into obvious zones although a full biotope map was not produced.

Site La was located on a combined wooden and metal structure immediately downstream of the Ringsend Power Station. There were a number of obvious zones recorded. Reasonable water clarity allowed for the identification of abundant plumose anemones *Metridium senile* and red algae just below the surface, forming a distinct band below the low water mark to about 20 cm below. The zone immediately above this, extending above the low water mark was dominated by superabundant growths of the mussel *Mytilus edulis* which were covered with growths of hydroids, and barnacles *Semibalanus balanoides*. The ephemeral green algae *Enteromorpha* sp. and *Ulva* sp. were also present. A second littoral zone was dominated by healthy growths of the fucoids *Fucus spiralis* (frequent), *Fucus ceranoides* and *Fucus serratus* (both present) and a red algae in poor condition. A single crab *Cancer pagurus* was observed in a hollow. The flora and fauna of the lower littoral zone all extended up into the upper zone. There was a zone of green algae higher up the structure that corresponds to the splash zone.

Site Lb was located on a block structure downstream of the container facility on the south side of the estuary. Below the low watermark to about 20 cm, abundant red algae were observed, together with sessile fauna which were possibly tunicates. The zone extending up from the low water mark was dominated by bryozoan crusts and barnacles which were abundant, the occasional limpet *Patella vulgata*, and algae *Fucus serratus*, *Porphyra* sp., *Enteromorpha* sp. and *Ulva* sp., all of which were recorded as present. The zone above this was also dominated by algal species. *Fucus spiralis* was recorded as common, *Fucus ceranoides* was present, *Enteromorpha* sp. and *Porphyra* sp. were common. Barnacles were abundant beneath the algae. A number of isopods were also observed. Thin hydroid growths were recorded.

Tolka Estuary
Three of the four littoral sites within the Tolka estuary were low in both species diversity and abundance. Only one polychaeta or polychaeta fragment was recorded from each of the sites Lc, Ld and Le. This is only sufficient to assign a more general biotope. The biotope code of LMU.Mu was assigned to each of these sites, and indicates soft mud shores.

Site Lf on the Clontarf side of the estuary recorded significant numbers of both the ragworm *Hediste diversicolor* and the bivalve *Scrobicularia plana*. A biotope code of LMU.HedScr was assigned indicating *Hediste diversicolor* and *Scrobicularia plana* in reduced salinity mud shores.

The edge of the estuary on the south side was dominated by growths of the knotted wrack *Ascophyllum nodosum* where the substratum was coarse boulders and rubble. The ephemeral algae *Porphyra* sp. and *Enteromorpha* sp. were also present. The smoother surfaces were dominated by ephemeral algae or by fucoids. The hard substrata upper shore on the north side was also dominated by *Ascophyllum nodosum* with occasional growths of the channelled wrack *Pelvetia canaliculata*, *Fucus vesiculosus* and ephemeral green algae.

Dollymount Strand

The transect down the fine sandy beach of Dollymount Strand on Bull Island was divided into three biotopes. Site Lg on the upper shore did not contain any fauna and was assigned the biotope of LGS.BarSnd indicating barren sand.

Site Lh on the mid shore contained a number of polychaeta species including the catworm *Nephtys* sp. and the spionid *Scolelepis squamata*, and a single bivalve *Angulus tenuis*. While species abundance was low and no amphipods were recorded, a biotope code of LGS.AP was assigned indicating burrowing amphipods and polychaetes in clean sand.

Site Li on the lower shore contained significant numbers of the bivalve *Angulus tenuis*, a single amphipod *Bathyporeia* sp. and two polychaeta species, *Nephtys* sp. and *Magelona mirabilis*. A biotope code of LGS.AP.Pon was assigned. While the fauna recorded does not provide an exact fit for this biotope, the presence in significant numbers of *Angulus tenuis* in particular allows for its assignation.

Sutton area

The shallow, coarse, mobile sand of site Lj was found to contain only one crab, *Carcinus maenas*. The sediment had a patchy distribution around bedrock outcrops. The bedrock outcrops supported thick growths of the knotted wrack *Ascophyllum nodosum*, together with the fucoids *Fucus serratus*, *Fucus vesiculosus* and *Fucus spiralis*. The ephemeral green algae *Ulva* sp. and *Enteromorpha* sp. were also recorded. Fauna included abundant barnacles, together with the limpet *Patella vulgata* and the mussel *Mytilus edulis*. The dog whelk *Nucella lapillus* was also recorded.

Sublittoral survey

Liffey and Tolka estuaries (within the Bull Walls)

Five grab samples (G1-G5) were taken within the Liffey and Tolka estuaries.

Site G1 was located in the Liffey estuary just upstream of where the Tolka estuary joins. A single shore crab *Carcinus maenas* and a small number of the polychaeta *Capitella capitata* were recorded from the black anoxic mud of this site. A biotope code of IMU.EstMu was assigned, as the abundance of *Capitella capitata* was not high enough to assign the related biotope of IMS.Cap indicating *Capitella capitata* in enriched sublittoral muddy sediments.

Site G2 was located where the Liffey and Tolka estuaries join. The site consisted of thick black anoxic mud with a single specimen of the brittlestar *Amphiura chiajei* and a single amphipod recorded. A biotope code of IMS.EstMu was assigned.

Site G3 was located where the Liffey and Tolka estuaries join. The site consisted of thick black anoxic mud and no fauna were recorded. A biotope code of IMS.EstMu was assigned.

Site G4 was located just to the seaward side of where the Tolka estuary joins the Liffey estuary. The substratum was thick black anoxic mud and no fauna was recorded. A biotope code of IMU.EstMu was assigned indicating estuarine sublittoral muds.

Site G5 was located in the Tolka estuary a short distance upstream from the mouth. The substratum consisted of a coarse shell lying on a black mud, and species present consisted of calcareous tube building polychaeta *Pomatoceros triqueter*, anemones, the barnacle *Balanus crenatus*, bryozoan crusts and *Mytilus edulis*. A biotope code of IMX.EstMx was assigned to this area indicating estuarine sublittoral mixed sediments.

Outside the estuary
No sites outside the estuary were suitable for grab sampling as the fine compact sand was too hard for the grab to bite into. Therefore the biological dredge was used and sampled seven sites Da to Dg. As the dredge is towed along the seabed for approximately three minutes to obtain a sample, the area sampled is wider than that for the grab (Appendix 1 Figure 1.1, Appendix 2 Table 2.5). Dredge samples cannot be considered quantitative.

Site Da, located to the south west of the River Liffey estuary mouth (seaward extent of the Bull Walls) contained a fauna dominated by the common shrimp *Crangon crangon*. The brittle star *Ophiura offiura*, and the hermit crab *Pagurus bernhardus* were also recorded as frequent, while the crab *Liocarcinus holsatus*, the bivalves *Donax vittatus*, *Chamelea gallina* and *Nucula sulcata*, the star fish *Asterias rubens* and a number of juvenile plaice *Pleuronectes platessa* were all recorded. A biotope code of IGS.FaS indicating shallow sand faunal communities was assigned.

Site Db, located just to the west and south of the mouth of the Liffey estuary contained a dominant fauna of the common shrimp *Crangon crangon* and juvenile plaice. Other species present included the hermit crab *Pagurus bernhardus*, the porcelain crab *Pisidia longicornis*, a damaged *Liocarcinus* sp., *Ophiura ophiura* and small amphipod species. Site G6 was a partial grab sample that was rejected as the substrata was too hard. However, a number of species were recorded from the site, including the bivalve *Corbula gibba* and the polychaeta family *Sigalionidae*. Overall the site area Db/G6 was assigned a biotope code of IGS.FaS indicating shallow sand faunal communities.

Site Dc just to the north of the end of the north Bull Wall contained a dominant fauna of juvenile plaice and the common shrimp *Crangon crangon*. *Liocarcinus holsatus*, *Macropodia rostrata* and amphipods were also recorded. A biotope code of IGS.FaS was assigned.

Site Dd to the seaward side of the lower section of the Bull Island contained a dominant fauna of *Crangon crangon*. There was also a large amount of a green matted algae in the sample. Three crab species, amphipods, polychaetes, juvenile plaice and juvenile dab were also recorded in the sample. A biotope code of IGS.FaS was assigned.

Site De to the seaward side of the centre of Bull Island contained a dominant fauna of *Crangon crangon*. Amphipods, juvenile dab, juvenile plaice and a single sole were also present. The pipefish *Syngnathus typhle* were recorded from the matted algae contained in the sample. A biotope code of IGS.FaS was assigned.

Site Df to the seaward of Sutton and the Bull Island contained a dominant fauna of *Crangon crangon* while there appeared to be large amounts of ephemeral green algae on the surface of the seabed. The shore crab, *Carcinus maenas* was also recorded. A biotope code of IGS.FaS was assigned.

Site Dg to the south of Howth Head contained a dominant fauna of *Crangon crangon*. Also present were two bivalve species, a number of polychaeta species, amphipods, pipefish and plaice. The substratum here contained some mud but it was not determined if it was a single muddy patch or if the entire area contained mud. There was also a large amount of ephemeral green algae present. A biotope code of IMS.FaMS was assigned indicating shallow muddy sand faunal communities.

Granulomentry, heavy metals and loss on ignition

Results are tabulated in Appendix 6, Tables 6.1, 6.3-6.4.

DISCUSSION

It should be noted that this is not intended to be a comprehensive ecological survey of the littoral or sublittoral sites in Dublin Bay but is intended only as a baseline study. Further investigation would be necessary depending on the eventual proposed location of any discharge pipe and the potential impacts of any discharge. Areas which would merit particular attention may include the littoral sediment biotopes of Irishtown and the littoral biotopes of the Sutton area, both of which have not been covered extensively before and which were only investigated to a limited degree during the current survey.

Littoral survey
None of the species or biotopes recorded during the current survey were of specific nature conservation importance or interest. All the species, biotopes and habitats recorded are typical of the east coast of Ireland (Picton & Costello, 1998).

Sublittoral survey
None of the species or habitats recorded during the current survey were of specific nature conservation importance or interest. All the species and habitats recorded are typical of the east coast of Ireland (Picton & Costello, 1998). However, a number of noteworthy species were recorded outside the estuary walls and may merit further investigation. Significant numbers of the common shrimp *Crangon crangon*, and juvenile plaice *Pleuronectes platessa* were recorded. As both of these species are of commercial importance, any impact on them may in turn have an impact on the local fisheries.

Previous surveys
Substantial ecological investigations have been undertaken in the Dublin Bay area. A literature review compiled by Dr Jane Lyons gives an outline of this work (Lyons, 2003). (M.C. O'Sullivan is to compare results from the EcoServe report and the literature review of Dr Jane Lyons).

Species and higher taxa recorded during a sublittoral survey of the Liffey estuary in 1998 for the EIS for the combined cycle gas turbine power station at Ringsend (EcoServe, 1998) are comparable to those recorded during the present survey. Only sites within the estuary boundary were considered during the 1998 survey (Appendix 1 Figure 1.2, Appendix 3 Figure 3.2).

Ecological surveys of the Grand Canal docks (EcoServe, 2001a) and of the area in the vicinity of a proposed bridge linking Guild to Macken Street (EcoServe, 2001b) have also been undertaken. The results cannot be compared directly to the current survey as the areas are not directly related. However, no species or habitats of direct conservation importance were recorded during either of these surveys. Species lists and site locations of these surveys are available.

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APPENDIX 1. MAPS

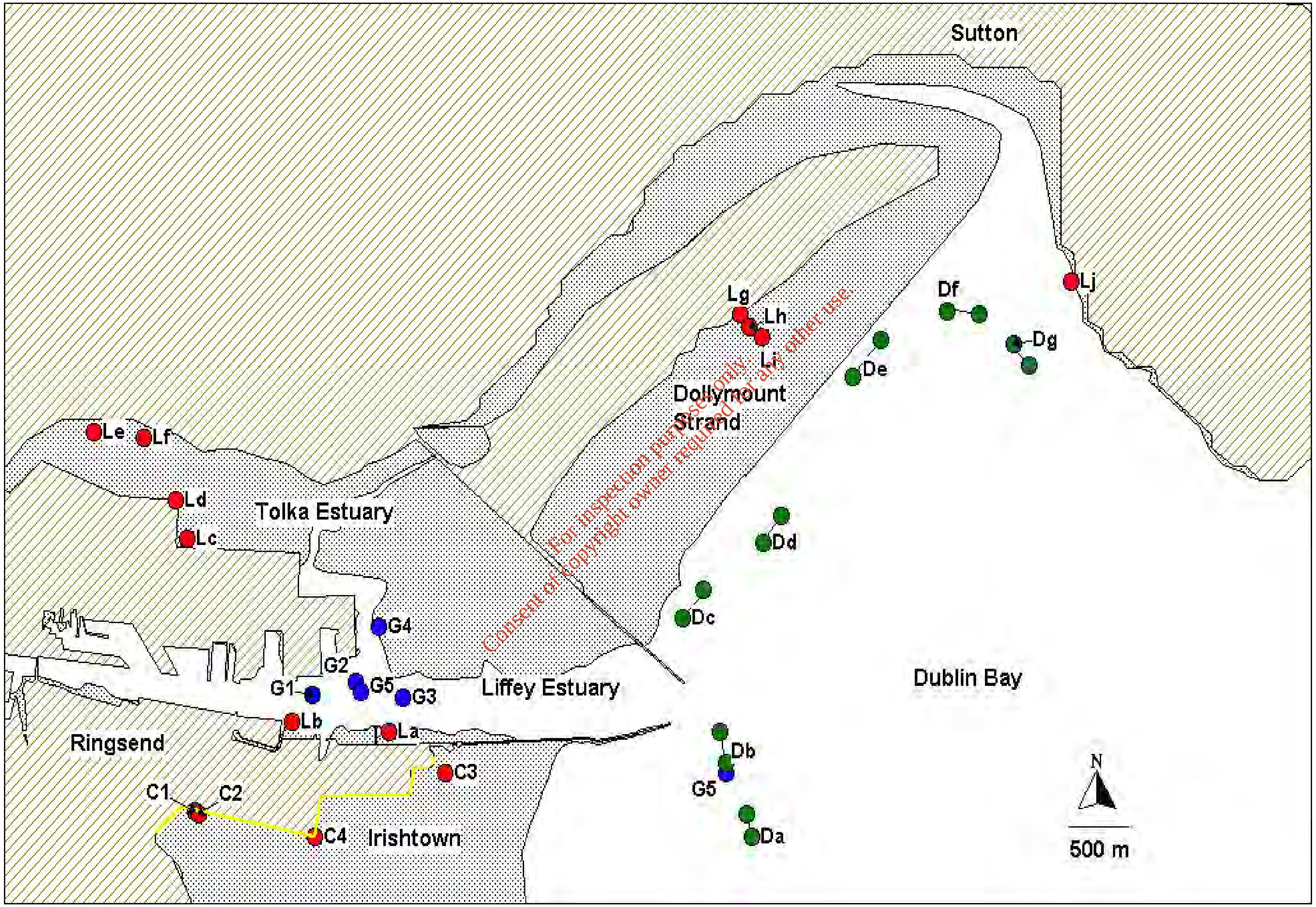

Figure 1.1 Locations of the littoral sites (La-Lj, C1-C4 red dots), the grab sample sites (G1-G6 blue dots) and the dredge sites (Da-Dg green dots) of the present survey. The extent of the Irishtown biotope survey area is shown as a yellow line.

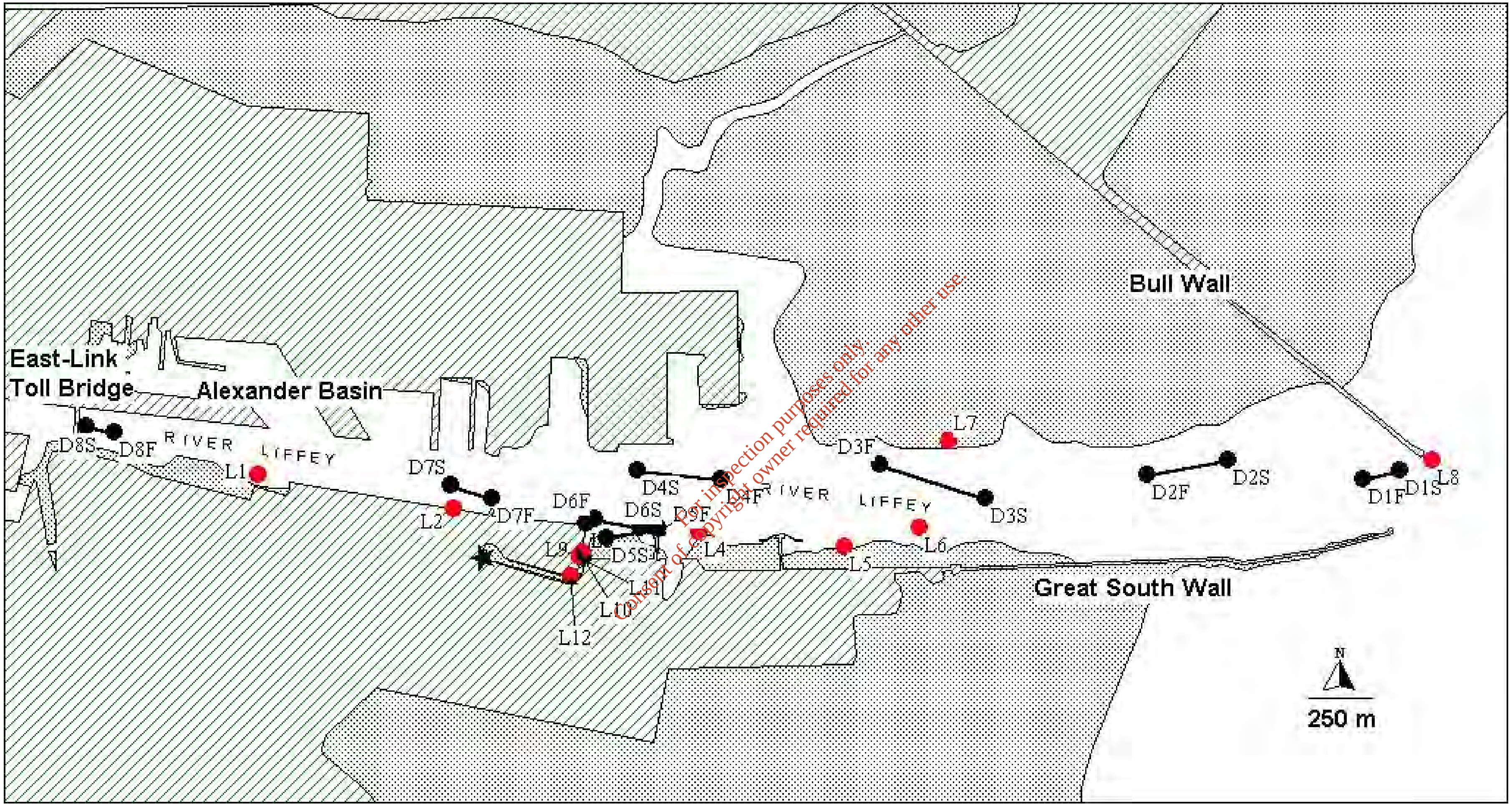

Figure 1.2 Locations of the sampling sites of the 1998 Liffey estuary survey for the combined cycle power station EIS. Littoral sites (L1-12 red dots), sublittoral dredges (D1-D8 black dots where S is start and F is finish point of dredge)

Figure 1.3 Biotopes of the western section of the Irishtown study area. Littoral core samples C1, C2, C4 are shown as red dots. Colours represent lower biotope codes. Biotopes are described in Appendix 4.

Figure 1.4 Biotopes of the eastern section of the Irishtown study area. Littoral core samples C3, C4 are shown as red dots. Colours represent lower biotope codes. Biotopes are described in Appendix 4.

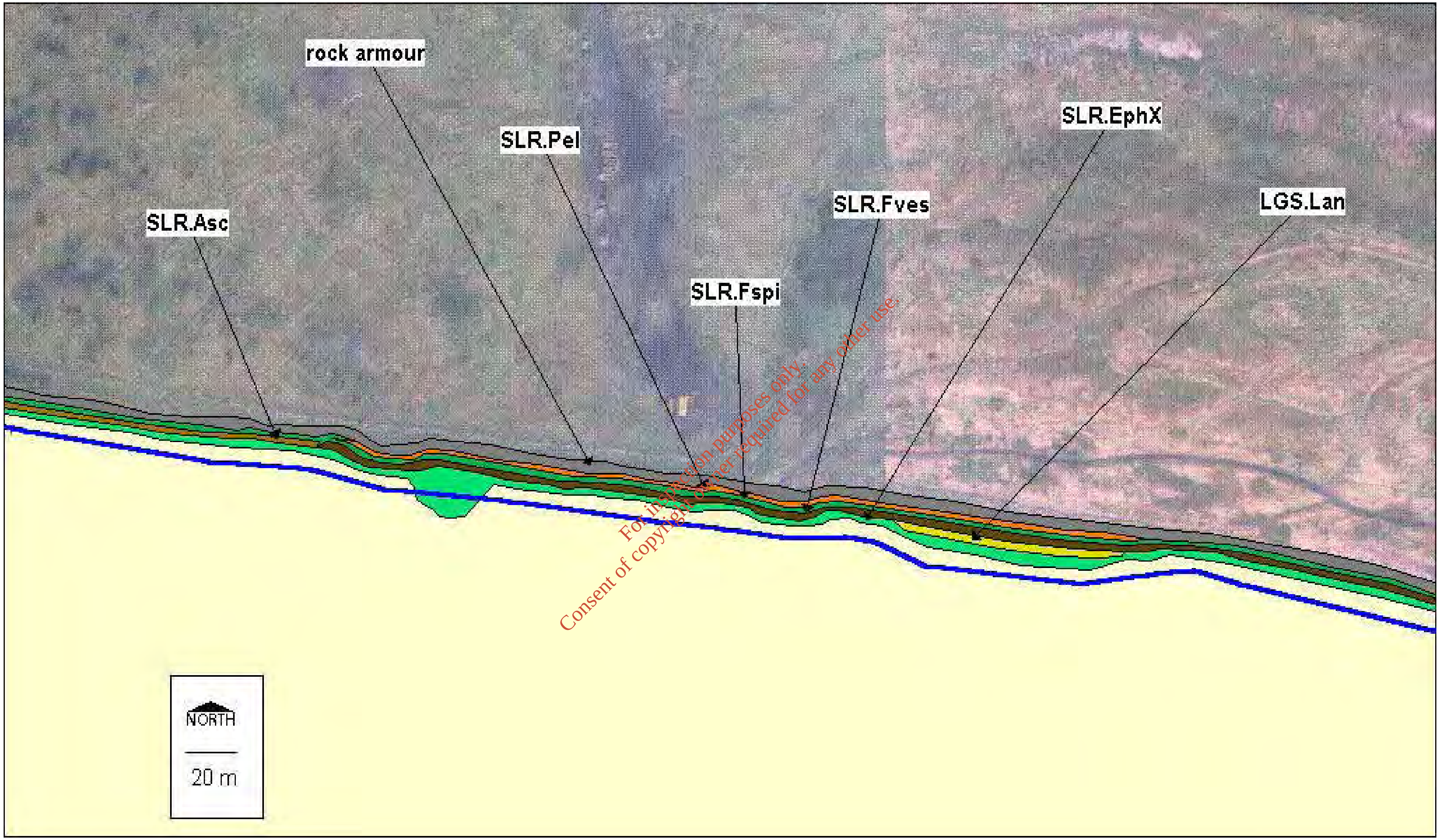

Figure 1.5 A close up of a section of biotopes illustrating typical biotopes present along the Irishtown study area. Colours represent lower biotope codes. Biotopes are described in Appendix 4.

APPENDIX 2. LITTORAL AND SUBLITTORAL FLORA AND FAUNA

Table 2.1. Site locations and details of littoral sites, August 2003.

Site no.	Latitude	Longitude	Location and substrata
C1	53.3365 N	6.2085 W	Muddy sand, northwest extreme of Irishtown.
C2	53.3363 N	6.2080 W	Fine compact sand, northwest extreme of Irishtown.
C3	53.3390 N	6.1783 W	Fine compact sand with *Arenicola marina* casts, north Irishtown.
C4	53.3348 N	6.1940 W	Fine muddy sand, north of Irishtown.
La	53.3417 N	6.1852 W	Structure in Liffey estuary, downstream of Ringsend power station.
Lb	53.3423 N	6.1968 W	Structure in Liffey estuary, downstream of south container yard.
Lc	53.3542 N	6.2094 W	Tolka estuary, south side, black anoxic mud.
Ld	53.3567 N	6.2108 W	Tolka estuary, south side, black anoxic mud.
Le	53.3625 N	6.2193 W	Tolka estuary, north side, black anoxic mud.
Lf	53.3607 N	6.2147 W	Tolka estuary, north side, black anoxic mud.
Lg	53.3687 N	6.1428 W	Dollymount strand, upper shore, fine sand.
Lh	53.3678 N	6.1417 W	Dollymount strand, mid shore, fine sand.
Li	53.3672 N	6.1402 W	Dollymount strand, lower shore, fine sand.
Lj	53.3727 N	6.0985 W	Sutton / south Howth Head, coarse sediment and bedrock.

Table 2.2. Site locations and details of sublittoral grab and dredge sites, August 2003. (BSL – Below Sea Level).

Site no.	Depth (metres BSL)	Latitude (start)	Longitude (finish)	Latitude (start)	Longitude (finish)	Location and substrata
G1	9	53.3440 N	6.1943 W			Liffey estuary, black anoxic mud
G2	5	53.3448 N	6.1892 W			Liffey estuary / Tolka estuary, Black anoxic mud
G3	9	53.3441 N	6.1184 W			Liffey estuary / Tolka estuary, Black anoxic mud
G4	9	53.3438 N	6.1835 W			Liffey estuary, black anoxic mud
G5	2	53.3485 N	6.1863 W			Tolka estuary, anoxic mud and broken shell
G6	5	53.3390 N	6.1445 W			Just west of Liffey mouth, fine compact sand
Da	6	53.3348 N	6.1413 W	53.3363 N	6.1420 W	South west of Liffey mouth, fine compact sand
Db	6	53.3397 N	6.1445 W	53.3417 N	6.1452 W	Just west of Liffey mouth, fine compact sand
Dc	4	53.3490 N	6.1497 W	53.3508 N	6.1472 W	North of north Bull Wall, fine compact sand
Dd	4	53.3538 N	6.1400 W	53.3557 N	6.1378 W	Seaward of south Bull Island, fine compact sand
De	2	53.3647 N	6.1292 W	53.3670 N	6.1258 W	Seaward of Bull Island, fine compact sand
Df	3	53.3688 N	6.1178 W	53.3687 N	6.1140 W	Seaward of north end Bull Island and Sutton, fine compact sand
Dg	5	53.3668 N	6.1097 W	53.3653 N	6.1080 W	Seaward side of Sutton, south of Howth Head, fine compact sand with some mud

Table 2.3. Abundance of flora and fauna recorded during the present littoral survey. P=Present; O=Occasional; F=Frequent; C=Common; A=Abundant, after Hiscock (1996). Biotope no. is the reference number for Biotope codes (Appendix 4 Table 4.1).

Species/higher taxa	C1	C2	C3	C4	La	Lb	Lc	Ld	Le	Lf	Lg	Lh	Li	Lj
Cnidarians (hydroids and sea anemones)														
Metridium senile	-	-	-	-	A	-	-	-	-	-	-	-	-	-
Polychaetes (worms)														
Polychaeta indet.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nereididae indet	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hediste diversicolor	6	-	-	6	-	-	-	-	1	16	-	-	-	-
Neanthes virens	-	-	-	-	-	-	1	1	-	-	-	-	-	-
Nephtys sp.	-	-	1	-	-	-	-	-	-	-	-	3	2	-
Scolelepis squamata	2	2	-	2	-	-	-	-	-	-	-	1	-	-
Magelona mirabilis	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Capitella capitata	-	4	-	8	-	-	-	-	-	-	-	-	-	-
Terebellidae indet.	-	-	-	-	-	-	-	-	-	-	-	1?	-	-
Crustaceans (crabs, barnacles and amphipods)														
Semibalanus balanoides	-	-	-	-	F	A	-	-	-	-	-	-	-	-
Amphipoda indet.	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Bathyporeia sp.	-	1	-	-	-	-	-	-	-	-	-	-	1	-
Corophium sp.	-	-	-	2	-	-	-	-	-	-	-	-	-	-
Cancer pagurus	-	-	-	-	P	-	-	-	-	-	-	-	-	-
Carcinus maenas	1	-	1	-	-	-	-	-	-	-	-	-	-	1
Molluscs (snails and bivalves)														
Hydrobia sp.	-	C	C	-	-	-	-	-	-	-	-	-	-	-
Patella vulgata	-	-	-	-	-	P	-	-	-	-	-	-	-	-
Mytilus edulis	-	-	-	-	SA	-	-	-	-	-	-	-	-	-
Cerastoderma edule	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Angulus tenuis	-	-	15	-	-	-	-	-	-	-	-	1	9	-
Macoma balthica	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Donax vittatus	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Scrobicularia plana	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Bryozoans (seamats)														
Bryozoan crust indet.	-	-	-	-	-	P	-	-	-	-	-	-	-	-
Echinoderms (urchins, seastars and seacucumbers)														
Amphiura chiajei	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Tunicata (sea squirts)														
Tunicata indet.	-	-	-	-	-	P	-	-	-	-	-	-	-	-
Rhodophycota (red algae)														
Rhodophycota indet.	-	-	-	-	P	A	-	-	-	-	-	-	-	-
Porphyra sp.	-	-	-	-	P	P	-	-	-	-	-	-	-	-
Chromophycota (brown algae)														
Fucus ceranoides	-	-	-	-	P	P	-	-	-	-	-	-	-	-
Fucus serratus	-	-	-	-	P	P	-	-	-	-	-	-	-	-
Fucus spiralis	-	-	-	-	P	C	-	-	-	-	-	-	-	-

Species/higher taxa	C1	C2	C3	C4	La	Lb	Lc	Ld	Le	Lf	Lg	Lh	Li	Lj
Chlorophycota (green algae)														
Enteromorpha sp.	-	-	-	-	P	P	-	-	-	-	-	-	-	-
Ulva sp.	-	-	-	-	P	P	-	-	-	-	-	-	-	-
Total no. species / higher taxa	5	4	4	5	11	11	1	1	1	2	0	4	6	1
No. individuals	13	7+	17+	19	-	-	1	1	1	20	0	6	15	1
Biotope number	13	10	7	16	-	-	14	14	14	17	9	10	11	-

Table 2.4. Abundance of flora and fauna recorded during the present littoral biotope survey of Irishtown. P=Present; O=Occasional, F=Frequent; C=Common; A=Abundant, after Hiscock (1996). Biotope no. is the reference number for Biotope codes (Appendix 4 Table 4.1).

Species / Higher taxa	**LGS.BarSnd**	**LGS.AP**	**LGS**	**LGS.Lan**	**LGS.Tal**	**LGS.HedMac**	**LMS.Pcer**	**MLR.EntPor**	**SLR.Asc**	**SLR.EphX**	**SLR.Fspi**	**SLR.Fves**	**SLR.Pel**
Cnidaria (hydroids and sea anemones)													
Actinia equina	-	-	-	-	-	-	-	-	O	-	-	-	-
Polychaetes (worms)													
Hediste diversicolor	-	-	-	-	-	P	P	-	-	-	-	-	-
Nephtys sp.	-	-	P	-	-	-	-	-	-	-	-	-	-
Scolelepis squamata	-	P	-	-	-	P	P	-	-	-	-	-	-
Capitella capitata	-	P	-	-	-	P	P	-	-	-	-	-	-
Lanice conchilega	-	-	-	C	-	-	-	-	-	-	-	-	-
Arenicola marina	-	P	P	-	-	P	-	-	-	-	-	-	-
Crustaceans (crabs, barnacles and amphipods)													
Semibalanus balanoides	-	-	-	-	-	-	-	C	O	-	F	-	-
Amphipoda indet.	-	-	-	-	-	-	P	-	O	-	-	O	-
Talitridae indet.	-	-	-	-	P	-	-	-	-	-	-	-	-
Bathyporeia sp.	-	P	-	-	-	-	-	-	-	-	-	-	-
Corophium sp.	-	-	-	-	-	-	P	-	-	-	-	-	-
Carcinus maenas	-	-	P	-	-	P	P	-	-	-	-	P	-
Molluscs (snails and bivalves)													
Littorina littorea	-	-	-	-	-	-	-	-	-	-	-	O	-
Littorina saxatilis	-	-	-	-	-	-	-	-	-	-	F	-	-
Hydrobia sp.	-	-	-	-	-	-	-	-	-	-	P	-	-
Mytilus edulis	-	-	-	-	-	-	-	-	O	-	-	C	-
Cerastoderma edule	-	-	-	-	-	-	P	-	-	-	-	-	-
Angulus tenuis	-	-	P	-	-	-	-	-	-	-	-	-	-
Macoma balthica	-	-	-	-	-	P	P	-	-	-	-	-	-
Rhodophycota (red algae)													
Porphyra sp.	-	-	-	-	-	-	-	F	-	-	-	-	-
Polysiphonia lanosa	-	-	-	-	-	-	-	-	O	-	-	-	-
Chromophycota (brown algae)													
Ascophyllum nodosum	-	-	-	-	-	-	-	-	C	-	-	F	-
Fucus spiralis	-	-	-	-	-	-	-	P	F	-	C	-	O
Fucus vesiculosus	-	-	-	F	-	-	-	P	O	-	-	A	-
Pelvetia canaliculata	-	-	-	-	-	-	-	-	-	-	-	-	F
Chlorophycota (green algae)													
Enteromorpha sp.	-	-	-	F	-	-	-	C	F	A	C	A	O
Ulva sp.	-	-	-	F	-	-	-	-	-	-	-	A	-
No. species / higher taxa	0	4	4	4	1	6	8	5	9	1	5	8	3
Biotope no.	9	10	7	12	8	16	13	6	3	5	1	2	4

Table 2.5. Abundance of flora and fauna recorded during the present sublittoral survey. P=Present; O=Occasional, F=Frequent; C=Common; A=Abundant, after Hiscock (1996). Biotope no. is the reference number for Biotope codes (Appendix 4 Table 4.1).

Species / higher taxa	**Da**	**Db**	**Dc**	**Dd**	**De**	**Df**	**Dg**	**G1**	**G2**	**G3**	**G4**	**G5**	**G6**
Cnidarians (hydroids and sea anemones)													
Hydractinia echinata	-	P	-	-	-	-	-	-	-	-	-	-	-
Actiniaria indet.	-	-	-	-	-	-	-	-	-	-	-	P	-
Polychaetes (worms)													
Polychaeta indet.	-	-	-	P	-	-	P	1	-	-	-	-	1
Polynoidae indet.	-	-	-	P	-	-	-	-	-	-	-	-	-
Sigalionidae indet.	-	-	-	-	-	-	-	-	-	-	-	-	1
Nephtys sp.	-	-	-	-	-	-	P	-	-	-	-	-	-
Capitella capitata	-	-	-	-	-	-	-	3	-	-	-	-	-
Pomatoceros triqueter	-	-	-	-	-	-	-	-	-	-	-	P	-
Crustaceans (crabs, barnacles and amphipods)													
Balanus crenatus	-	-	-	-	-	-	-	-	-	-	-	P	-
Amphipoda indet.	-	P	P	P	P	P	P	-	1	-	-	-	6
Decapoda indet.	P	-	-	-	-	-	-	-	-	-	-	-	-
Crangon crangon	F	F	C	A	A	-	C	-	-	-	-	-	-
Pagurus bernhardus	F	P	-	-	-	-	-	-	-	-	-	-	-
Pisidia longicornis	-	P	-	-	-	-	-	-	-	-	-	-	-
Macropodia rostrata	-	-	P	P	-	-	-	-	-	-	-	-	-
Liocarcinus sp.	-	P	-	-	P	-	-	-	-	-	-	-	-
Liocarcinus holsatus	P	-	P	P	-	-	-	-	-	-	-	-	-
Carcinus maenas	-	-	-	P	-	P	-	1	-	-	-	-	-
Molluscs (snails and bivalves)													
Nucula sulcata	P	-	-	-	-	-	-	-	-	-	-	-	-
Mytilus edulis	-	-	-	-	-	-	-	-	-	-	-	P	-
Parvicardium ovale	-	-	-	-	-	-	-	-	-	-	1	-	-
Fabulina fabula	-	-	-	-	-	-	P	-	-	-	-	-	-
Donax vittatus	P	-	-	-	-	-	-	-	-	-	-	-	-
Chamelea gallina	P	-	-	-	-	-	P	-	-	-	-	-	-
Corbula gibba	-	-	-	-	-	-	-	-	-	-	-	-	1
Bryozoans(sea mats)													
Bryozoa indet	-	-	-	-	-	-	-	-	-	-	-	P	-
Echinoderms (urchins, seastars and sea cucumbers)													
Asterias rubens	O	-	-	-	-	-	-	-	-	-	-	-	-
Amphiura chiajei	-	-	-	-	-	-	-	-	1	-	-	-	-
Ophiura ophiura	F	P	-	-	-	-	-	-	-	-	-	-	-
Pisces (fish)													
Syngnathus typhle	-	-	-	-	P	-	P	-	-	-	-	-	-
Limanda limanda	-	-	-	P	P	-	-	-	-	-	-	-	-
Pleuronectes platessa	P	C	C	P	P	-	P	-	-	-	-	-	-
Solea sp.	-	-	-	-	P	-	-	-	-	-	-	-	-
Chlorophycota (green algae)													
Ulva sp.	-	-	-	-	-	P	-	-	-	-	-	-	-

Species / higher taxa	Da	Db	Dc	Dd	De	Df	Dg	G1	G2	G3	G4	G5	G6
No. Species / higher taxa	10	8	5	9	7	3	8	3	2	0	1	5	4
No. individuals	-	-	-	-	-	-	-	5	2	0	1	-	9
Biotope no.*	18	18	18	18	18	18	19	20	20	20	20	21	18

APPENDIX 3. PREVIOUS STUDIES

Table 3.1 Abundance of littoral flora and fauna recorded in the Liffey estuary during the 1998 survey for the combined cycle gas power plant EIS. P=Present; O=Occasional, F=Frequent; C=Common; A=Abundant, after Hiscock (1996).

Species	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12
Chironomidae	-	-	-	2	-	-	P	-	-	-	-	-
Porifera (sponges)												
Halichondria panicea	-	A	A	F	-	-	-	F	-	-	-	-
Hymeniacidon perleve	-	A	C	F	-	-	F	F	-	-	-	-
Cnidarians (hydroids and sea anemones)												
Obelia dichotoma	-	-	-	P	-	-	P	-	-	P	-	-
Obelia geniculata	-	-	P	P	-	-	-	-	-	-	-	-
Metridium senile	-	-	-	-	O	-	C	-	-	-	-	-
Nematodes												
Nematoda indet.	-	-	-	P	-	-	-	-	-	-	-	-
Polychaetes (worms)												
Polychaeta indet.[4]	-	-	P	-	-	-	-	-	-	-	-	-
Pholoe sp.	-	-	-	P	-	-	-	-	-	-	-	-
Phyllodoce sp.	-	-	P	-	-	-	-	-	-	-	-	-
Syllidae sp.[2]	-	-	P	-	-	-	-	-	-	-	-	-
Syllis gracilis	-	-	P	-	-	-	-	-	-	-	-	-
Neanthes virens	-	-	-	-	-	-	-	-	P	-	-	-
Spionidae indet.	-	-	-	P	-	-	-	-	-	-	-	-
Cirratulus cirratulus	-	-	-	-	-	-	-	-	A	-	-	-
Capitella sp.	-	-	P	A	-	-	P	-	-	-	-	-
Arenicola marina	-	-	-	-	-	-	-	-	O	-	-	-
Fabricia sabella	-	-	-	P	-	-	-	-	-	-	-	-
Pomatoceros triqueter	-	-	-	-	-	-	-	-	O	P	-	P
Spirorbis sp.	-	-	-	-	-	-	-	-	-	P	-	-
Crustaceans (crabs, barnacles and amphipods)												
Elminius modestus	-	C	C	A	A	C	-	C	-	O	-	-
Semibalanus balanoides	O	O	C	C	A	O	A	C	-	C	-	P
Balanus crenatus	-	-	-	-	P	-	-	-	-	-	-	-
Rissoides desmaresti[3]	-	-	-	1	-	-	-	-	-	-	-	-
Corophium acherusicum	-	-	3	-	-	-	-	-	-	-	-	-
Carcinus maenas	-	-	1	1	-	-	-	-	O	-	-	P
Molluscs (snails and bivalves)												
Acanthochitona fascicularis	-	-	-	-	-	-	-	-	1	-	-	-
Patella sp.	-	-	-	O	-	-	O	O	-	-	-	P
Littorina littorea	-	-	-	-	-	-	-	-	O	-	-	P
Littorina obtusata	-	-	-	-	-	-	-	-	-	-	-	P
Melarhaphe neritoides	-	-	-	-	-	-	A	-	-	-	-	-
Mytilus sp.[2]	-	-	2	15	-	-	1	-	-	-	-	-
Mytilus edulis	-	-	O	O	S	-	S	-	O	-	P	P
Cerastoderma edule	-	-	-	-	-	-	-	-	O	-	P	-
Bryozoans (sea mats)												
Bryozoan crusts indet.	-	-	P	-	-	-	-	-	-	-	-	-
Bowerbankia sp.	-	-	-	-	-	-	-	-	-	P	-	-

[4] Juveniles

[2] Washed in

[3] Larvae

Species	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12
Tunicata (sea squirts)												
Ciona intestinalis	-	-	-	O	-	-	-	-	-	-	-	-
Pisces (fish)												
Gobius paganellus	-	-	-	-	-	R	-	-	-	-	C	-
Rhodophycota (red algae)												
Porphyra umbilicalis	O	O	O	O	O	-	O	-	O	-	-	-
Chondrus crispus	-	O	O	-	-	-	F	-	O	C	-	P
Ceramium sp.	O	O	-	-	-	-	-	-	-	-	-	-
Chromophycota (brown algae)												
Ectocarpus indet.	-	O	-	-	-	-	-	-	-	-	-	-
Laminaria digitata	-	-	-	-	-	-	-	O	-	-	-	-
Laminaria saccharina	-	-	-	-	-	-	-	F	-	-	-	-
Ascophyllum nodosum	-	-	-	-	-	-	-	-	-	O	-	-
Fucus serratus	C	-	O	O	-	-	-	-	O	A	-	P
Fucus spiralis	C	C	-	-	-	-	-	-	-	-	-	-
Fucus vesiculosus	C	O	F	O	O	-	-	-	-	-	-	P
Chlorophycota (green algae)												
Enteromorpha sp.	-	O	C	O	-	O	F	-	O	A	-	P
Ulva lactuca	C	C	C	C	C	-	F	-	O	A	-	P
Cladophora rupestris	O	O	-	O	-	-	F	-	O	-	-	P
No. of species recorded	**8**	**13**	**21**	**24**	**8**	**4**	**15**	**7**	**15**	**11**	**3**	**13**

Table 3.2. Abundance of sublittoral flora and fauna recorded during during the 1998 survey for the combined cycle gas power plant EIS. P=Present; O=Occasional, F=Frequent; C=Common; A=Abundant, after Hiscock (1996).

Species	D1	D2	D3	D4	D5	D6	D7	D8
Chironomidae indet.								
Cyrtolaelapidae indet.[1]	-	-	-	-	-	-	-	2
Erythracidae indet.	-	-	-	-	-	-	-	1
Cnidarians (hydroids and sea anemones)								
Hydrallmania falcata	P	-	-	-	-	-	-	-
Sertularia argentea[5]	P	-	-	-	-	-	-	-
Obelia dichotoma	-	-	-	-	-	P	-	-
Obelia longissima	P?	-	-	-	-	-	-	-
Metridium senile				1				
Polychaetes (worms)								
Harmothoe sp.	-	-	1	-	-	-	-	-
Eteone sp.	1	-	-	-	-	-	-	-
Anaitides maculata	8	-	-	-	-	-	-	-
Trypanosyllis coeliaca	4	-	-	-	-	-	-	-
Sphaerosyllis sp.	3	-	-	-	-	-	-	-
Nephtys sp.	-	-	-	-	-	-	1	-
Nephtys caeca?	-	-	20	-	-	-	-	-
Nephtys longosetosa	-	-	-	6	-	1	-	-
Spionidae indet.	-	-	2	-	-	-	-	-
Chaetopterus variopedatus	1	-	-	-	-	-	-	-
Ampharete grubii	-	-	1	-	-	-	-	-
Lanice conchilega	P	P	1	-	-	-	-	-
Fabricia sabella	-	-	-	-	-	-	-	-
Pomatoceros triqueter	P	-	-	-	-	-	2	-
Crustaceans (crabs, barnacles and amphipods)								
Elminius modestus	P	-	-	-	-	-	-	4
Balanus crenatus	P	-	-	-	-	-	-	-
Apherusa jurinei	1	-	-	-	-	-	-	-
Aora gracilis	1	-	-	-	-	-	-	-
Corophium sp.[3]	1	-	-	-	-	-	-	-
Crangon crangon	3	24	9	-	-	2	-	-
Pagurus bernhardus	-	10	-	1	-	-	-	-
Macropodia? Linaresi	1	-	-	-	-	-	-	-
Carcinus maenas	8	5	8	1	-	1	-	-
Molluscs (snails and bivalves)								
Juvenile bivalves	2	-	1	-	-	-	-	-
Buccinum undatum	1	1	-	-	-	-	-	-
Mytilus sp.[3]	P	-	-	-	-	-	-	-
Cerastoderma edule	-	-	-	-	-	-	3	-
Pharus legumen	-	-	1	-	-	-	-	-
Chamelea gallina[4]	-	-	-	1	-	-	-	-
Bryozoans (sea mats)								
Bryozoan crusts indet.	-	-	-	-	-	-	P	-
Alcyonidium parasiticum	P	-	-	-	-	-	-	-
Bugula plumosa	P	-	-	-	-	-	-	-
Echinoderms (starfish)								

[1] Washed in

[5] Drift

[3] Washed in

[4] Empty shell

Species	D1	D2	D3	D4	D5	D6	D7	D8
Ophiura albida	1	-	-	-	-	-	-	-
Ophiura ophiura	4	-	-	-	-	-	-	-
Pisces (fish)								
Pleuronectes platessa	-	1	-	-	-	-	-	-
Solea solea	-	1	-	-	-	-	-	-
No. of species recorded	**25**	**7**	**9**	**5**	**0**	**4**	**4**	**3**

APPENDIX 4. BIOTOPE DESCRIPTIONS

Table 4.1 Biotope numbers and codes

Biotope number	Biotope code
1	SLR.Fspi
2	SLR.Fves
3	SLR.Asc
4	SLR.Pel
5	SLR.EphX
6	MLR.EntPor
7	LGS
8	LGS.Tal
9	LGS.BarSnd
10	LGS.AP
11	LGS.AP.Pon
12	LGS.Lan
13	LMS.PCer
14	LMU
15	LMU.Mu
16	LMU.HedMac
17	LMU.HedScr
18	IGS.FaS
19	IMS.FaMS
20	IMU.EstMu
21	IMX

No. 1 SLR.Fspi *Fucus spiralis* on moderately exposed to very sheltered upper eulittoral rock
Moderately exposed to very sheltered upper eulittoral bedrock and boulders are typically characterised by a band of the spiral wrack *Fucus spiralis* overlying the black lichens *Verrucaria maura* and *V. mucosa*. Limpets *Patella vulgata*, winkles *Littorina* spp. and barnacles *Semibalanus balanoides* are usually present under the fucoid fronds and on open rock. During the summer months ephemeral green algae such as *Enteromorpha* spp. and *Ulva lactuca* may also be present. This zone usually lies below a *Pelvetia canaliculata* zone (Pel or PelB); occasional clumps of *Pelvetia* may be present (usually less than common) amongst the *F. spiralis*. In areas of extreme shelter, such as in Scottish sealochs, the *Pelvetia* and *F. spiralis* zones often merge together forming a very narrow band. Fspi occurs above the *Ascophyllum nodosum* (Asc) and/or *Fucus vesiculosus* (Fves) zones and these two fucoids may also occur, although *Fucus spiralis* always dominates. Vertical surfaces in this zone, especially on moderately exposed shores, often lack the fucoids and are characterised by a barnacle-*Patella* community (BPat.Sem).

No. 2 SLR.Fves *Fucus vesiculosus* on sheltered mid eulittoral rock
Moderately exposed to sheltered mid eulittoral rock characterised by a dense canopy of large *Fucus vesiculosus* plants (typically abundant to superabundant). Beneath the algal canopy the rock surface has a sparse covering of barnacles (typically rare-frequent) and limpets, with mussels confined to pits and crevices. *Littorina littorea* and *Nucella lapillus* are also found beneath the algae, whilst *Littorina obtusata* and *Littorina mariae* graze on the fucoid fronds. The fronds may be epiphytised by the filamentous brown alga *Elachista fucicola* and the small calcareous tubeworm *Spirorbis spirorbis*. In areas of localised shelter, *Ascophyllum nodosum* may also occur, though never at high abundance (typically rare to occasional) - (compare with Asc). Damp cracks and crevices often contain patches of the red seaweeds *Osmundea* (*Laurencia*) *pinnatifida*, *Mastocarpus stellatus* and encrusting coralline algae. This biotope usually occurs between the *Fucus spiralis* (Fspi) and the *Fucus serratus* (Fser) zones; both of these fucoids may be present in this biotope, though never at high abundance (typically less than frequent). In some sheltered areas *Fucus vesiculosus* forms a narrow zone above the *A. nodosum* zone (Asc). Where freshwater runoff occurs on more gradually sloping shores *F. vesiculosus* may be replaced by *Fucus ceranoides* (Fcer).

No. 3 SLR.Asc *Ascophyllum nodosum* on very sheltered mid eulittoral rock

Sheltered to very sheltered mid eulittoral rock with the knotted wrack *Ascophyllum nodosum*. Several variants of this biotope are described. These are: full salinity (Asc.Asc), tide-swept (Asc.T) and variable salinity (Asc.VS).

No. 4 SLR.Pel *Pelvetia canaliculata* on sheltered littoral fringe rock
Lower littoral fringe bedrock or stable boulders on sheltered shores are characterised by a dense cover of the fucoid *Pelvetia canaliculata*. The fucoid overgrows a crust of black lichens *Verrucaria maura* and *Verrucaria mucosa*, or *Hildenbrandia rubra* on very sheltered shores. This biotope lacks the density of barnacles found amongst the *Pelvetia* on more exposed shores (PelB). The littorinids *Littorina littorea* and *L. saxatilis* occur. The red alga *Catenella caespitosa* is characteristic of this biotope, as is the lichen *Lichina confinis*. Though not typical, this biotope may occur on moderately exposed shores where local topography provides shelter.

No. 5 SLR.EphX Ephemeral green and red seaweeds on variable salinity or disturbed eulittoral mixed substrata
Eulittoral mixed substrata (pebbles and cobbles overlying sand or mud) that is subject to variations in salinity and / or siltation are often characterised during the summer months by dense blankets of ephemeral green and red algae. The main species present are *Enteromorpha* spp., *Ulva lactuca* and *Porphyra* spp. Although fucoid algae occur in these areas they are typically rare. Small numbers of other species such as barnacles *Semibalanus balanoides* and *Elminius modestus* and keel worms *Pomatoceros* spp. are confined to any larger cobbles and pebbles. This biotope may be a summer variation of BLlit, in which ephemeral algal growth has exceeded the capacity of the grazing molluscs. In common with the other biotopes found on mixed substrata, patches of sediment are typically characterised by infaunal species including bivalves (*Cerastoderma edule* and *Macoma balthica*) and polychaetes (*Arenicola marina* and *Lanice conchilega*). Occasional clumps of *Mytilus edulis* may also occur, although at considerably lower density than in MytX.

No. 6 MLR.EntPor *Porphyra purpurea* or *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock
Moderately exposed mid-shore bedrock and boulders occurring adjacent to areas of sand which significantly affects the rock. As a consequence of sand-abrasion, fucoids are scarce and the community is typically dominated by ephemeral algae, particularly *Porphyra purpurea* and *Enteromorpha* spp. Under the blanket of ephemeral algae, barnacles and limpets occur in the less scoured areas. Few other species are present. In areas where sand abrasion is less severe, the sand-binding red alga *Rhodothamniella floridula* occurs with other sand-tolerant algae and fucoid algae (especially *Fucus serratus*) (Rho).

No. 7 LGS Littoral gravels and sands
Clean gravel and/or sand in the littoral zone (the area between high and low tides) with a particle diameter range from 16 mm to 0.063 mm; shingle shores comprising mobile cobbles, pebbles and coarse gravel are also included. The shore and substratum type can range from steep mobile shores that are typically of coarse material (gravel and coarse sand), through less steep shores of coarse, medium or fine sand to level sandflats of fine sand that remain water-saturated throughout the tidal cycle. Mud (particle diameter less than 0.063 mm) does not exceed 10%, and is usually totally absent.

No. 8 LGS.Tal Talitrid amphipods in decomposing seaweed on the strand-line
A community of talitrid amphipods may occur on any shore where decomposing seaweed accumulates on the extreme upper shore strand-line. The community occurs on a wide variety of sediment shores composed of shingle and mixed substrata through to fine sands, but may also occur on mixed and rocky shores in some circumstances. The decaying seaweed provides cover and humidity for *Talitrus saltator* and other components of the community. The amphipods *Orchestia* spp. are also often present, as well as enchytraeid oligochaetes. Polychaetes, molluscs and other crustaceans may be brought in on the tide, but are not necessarily associated with the infaunal community. Further analysis of the data may determine that *Orchestia* spp. are associated with a denser strand and that there are differences in the community dependant upon the substratum-type. *Talitrus saltator* may occur further down the shore, almost invariably accompanied by burrowing amphipods such as *Bathyporeia* spp. (LGS.AEur).

No. 9 LGS.BarSnd Barren coarse sand shores
Freely-draining coarse sandy beaches, particularly on the upper shore, which lack a macrofaunal community due to their continual mobility. Trial excavations are unlikely to reveal any macrofauna in these typically steep beaches on exposed coasts. Burrowing amphipods *Bathyporeia* spp. or *Pontocrates* spp. and the isopod *Eurydice pulchra* may be found in extremely low abundances, but if present in any quantity should be classed as LGS.AEur. Other species that may be found in low abundance may be left behind by the ebbing tide.

No. 10 LGS.AP Burrowing amphipods and polychaetes in clean sand shores
Mid and lower shore clean sandy shores on wave-exposed or moderately wave-exposed coasts support a community of burrowing amphipods and polychaetes, sometimes with bivalves such as *Angulus tenuis*. The medium to fine-grained sand remains damp throughout the tidal cycle. The community consists of burrowing amphipods (*Pontocrates altamarinus*, *P. arenarius*, *Bathyporeia elegans*, *B. guilliamsoniana*, *B. pelagica*, *B. pilosa* and *B. sarsi*), the isopod *Eurydice pulchra*, the cumacean *Cumopsis goodsiri* and polychaetes (including *Nephtys cirrosa*, *Scolelepis squamata*, *Paraonis fulgens* and *Arenicola marina*). The presence of polychaetes is seen as coloured burrows running down from the surface of the sediment. The sediment is often rippled and typically lacks an anoxic black sub-surface layer. This community differs from the community of burrowing amphipods (LGS.AEur) in its greater variety of polychaete species and the presence of bivalves. The two sub-types are LGS.AP.P and LGS.AP.Pon depending upon the proportion of amphipods and polychaetes and the specific species present in the sand. More stable sediment, such as is found in sandy inlets or extensive coastal sandflats are LMS.PCer or LMS.MacAre.

No. 11 LGS.AP.Pon Burrowing amphipods *Pontocrates* spp. and *Bathyporeia* spp. in lower shore clean sand
Lower shore clean sand on wave-exposed or moderately wave-exposed coasts support a community of burrowing amphipods and polychaetes. Amphipods make up the greater part of the community and are typically dominated by *Pontocrates altamarinus*, *P. arenarius*, *Bathyporeia elegans*, *B. pelagica*, *B. pilosa* the isopod *Eurydice pulchra* and the cumacean *Cumopsis goodsiri*. Polychaetes are dominated by *Nephtys cirrosa*, *Paraonis fulgens* and *Scolelepis squamata*. *Angulus tenuis* is also frequently found in this biotope. Although the characterising species are not found very frequently, they are faithful to this biotope. The medium and fine sand remains damp throughout the tidal cycle and contains little organic matter. The presence of polychaetes may be seen as coloured burrows running down from the surface of the sediment. The sediment is often rippled and typically lacks an anoxic black sub-surface layer. LGS.AP.Pon is distinguished from LGS.AP.P as being less stable sediment with a community dominated by amphipods, particularly *Pontocrates altamarinus*, *Bathyporeia elegans* and *Cumopsis goodsiri* or the bivalve *Angulus tenuis*. This community differs from the community of burrowing amphipods (LGS.AEur) in its greater variety of polychaete and amphipod species. More stable sediment, found in sandy inlets or extensive coastal sandflats are considered to be LMS.PCer or LMS.MacAre, depending upon the community present.

No. 12 LGS.Lan Dense *Lanice conchilega* in tide-swept lower shore sand
Medium to fine sand, which is usually clean but may contain some fines and supports dense populations of *Lanice conchilega*, usually on the lower shore but also sometimes on water-logged mid shores. The biotope occurs under tide-swept conditions in sheltered straits, sounds and fully marine sealochs or on shores moderately exposed to wave action. The biotope is distinguished from others in sandy beaches by the presence of *Lanice conchilega* at levels of common and above or as the main polychaete component. Other polychaetes present are tolerant of sand scour or mobility of the surface levels of the sediment and include glycerid polychaetes, *Anaitides mucosa*, *Nephtys cirrosa*, *Nephtys hombergii* and *Pygospio elegans*. Few crustaceans are found regularly and the bivalve component is restricted to cockles *Cerastoderma edule* and more rarely *Macoma balthica*. Pebbles and cobbles may also be mixed in with lower shore tide-swept sand with dense *Lanice conchilega* between the cobbles, but the infaunal component is rarely sampled. The infaunal community under these circumstances, provided that the cobbles are not packed very close together, will be similar to that in areas of purer sand. Dense *L. conchilega* also occurs in shallow sublittoral sediments (IGS.Lcon).

No. 13 LMS.PCer Polychaetes and *Cerastoderma edule* in fine sand or muddy sand shores
Fine sand on extensive moderately wave-exposed and sheltered shores, where the sediment is sufficiently stable to accommodate populations of *Cerastoderma edule* (at least occasional) and other bivalves. The community is found mainly on the mid and lower shore where the sediment is water-saturated most of the time. Slightly muddy conditions at some sites are reflected in a reduced amphipod population and a wider range of polychaetes compared to Amphipod-polychaete biotopes (LGS.AP). The community consists of polychaetes *Nephtys hombergii*, *Scoloplos armiger*, *Pygospio elegans*, *Spio filicornis* and *Capitella capitata*, oligochaetes, the amphipod *Bathyporeia sarsi*, and the bivalves *Cerastoderma edule* and *Macoma balthica*. This biotope carries commercially viable stocks of cockles *Cerastoderma edule*. It is therefore possible to find areas of this habitat where the infauna may have been changed through recent cockle dredging. Higher on the shore, adjacent to this biotope, LMS.BatCor is found with fewer polychaete and bivalve species due to the drier sediment found on the upper shore. LMS.PCer has broad transition areas with LMS.MacAre, LMU.HedMac.Pyg and LMU.HedMac.Are. LMS.MacAre and LMU.HedMac.Are are indicated by the presence of *Arenicola marina*, the latter also having *Hediste* (*Nereis*) *diversicolor*, oligochaetes and other species that indicate a more

sheltered, muddy sand biotope. LMU.HedMac.Pyg has a greater proportion of the polychaetes *Hediste diversicolor*, *Pygospio elegans* and *Eteone longa*, oligochaetes and the amphipod *Corophium volutator*. The species richness of LMS.PCer, particularly for polychaetes and bivalves, is greater than the more wave-exposed biotopes LGS.AP.

No. 14 LMU Littoral muds

Shores of fine particulate sediment with a particle size less than 0.063 mm in diameter that typically forms extensive mudflats. Dry compacted mud can form steep and even vertical structures, particularly at the top of the shore adjacent to saltmarshes. Also included in this higher division are sandy muds which have between 20% and 70% sand, the remainder being made up of mud with a particle size less than 0.063 mm. Small amounts of gravel or pebbles may be found within mud, having little effect upon the structure of the associated communities. Littoral muds support communities characterised by polychaetes, certain bivalves and oligochaetes. The ragworm *Hediste* (*Nereis*) *diversicolor*, the Baltic tellin *Macoma balthica* and the furrow shell *Scrobicularia plana* are conspicuous members of muddy shore communities.

No. 15 LMU.Mu Soft mud shores

Shores of soft mud, typically with over 80% silt/clay fraction, giving very or extremely soft sediment shores. These are typically restricted to the upper reaches of estuaries and subject to variable, reduced or low salinity conditions. Although not very species-rich, with increasingly lower salinity conditions the mud supports even more impoverished communities, characterised by oligochaete worms.

No. 16 LMU.HedMac *Hediste diversicolor* and *Macoma balthica* in sandy mud shores

Littoral sandy mud and mud in sheltered, often estuarine, conditions with a community of polychaetes together with the bivalve *Macoma balthica*. The most abundant large polychaete is typically *Hediste* (*Nereis*) *diversicolor*, which can be readily seen when digging over the sediment. Other smaller polychaetes include *Eteone longa*, *Nephtys hombergii*, *Aphelochaeta marioni*, *Pygospio elegans*, *Arenicola marina* and *Manayunkia aestuarina*. Oligochaete worms (e.g. *Tubificoides benedii*, *T. pseudogaster* and enchytraeids) are common or abundant and the amphipod *Corophium volutator* may be abundant. The mud snail *Hydrobia ulvae* is often common, with individuals or their fine tracks visible on the mud surface. The bivalve *Macoma balthica* may be accompanied by *Cerastoderma edule*, *Abra tenuis* and *Mya arenaria*. The surface of the mud may be covered with green algae such as *Enteromorpha* spp. or *Ulva lactuca*. There is usually a black anoxic layer close to the sediment surface. LMU.HedStr is a similar biotope that is associated with muddier sediment in reduced salinity conditions with *Streblospio shrubsolii*, *Manayunkia aestuarina* or *Tharyx killariensis* and with fewer bivalves. Three variations of this biotope are recognised: HedMac.Are, HedMac.Pyg and HedMac.Mare.

No. 17 LMU.HedScr *Hediste diversicolor* and *Scrobicularia plana* in reduced salinity mud shores

Mid and upper shore sandy mud and mud that is subject to variable and reduced salinity is typically colonised by the polychaete *Hediste* (*Nereis*) *diversicolor* and the bivalve *Scrobicularia plana*. The polychaetes *Eteone longa*, *Pygospio elegans* and *Streblospio shrubsolii*, oligochaetes, particularly *Tubificoides benedii* and the isopod *Cyathura carinata* are all characteristic of the infaunal assemblage. Other bivalves, such as the Baltic tellin *Macoma balthica* and cockle *Cerastoderma edule*, are also frequently recorded. The mud snail *Hydrobia ulvae* is usually common. The green alga *Ulva lactuca* may colonise the surface of the mud in the summer months or it may be covered by a mat of filamentous algae such as *Enteromorpha* spp. Typically, the sediment is wet in appearance and has an anoxic layer below 1 cm depth. The surface of the mud has the distinctive 'crow's foot' pattern formed by *Scrobicularia plana*. The biotope LMU.HedStr is very similar, but with some differences in the polychaetes and bivalves recorded. In LMU.HedStr, the frequency and abundance of *Eteone longa* is lower, whilst the frequency of the polychaetes *Nephtys hombergii*, *Streblospio shrubsolii*, *Aphelochaeta marioni* and *Melinna palmata* is greater. The bivalve richness in LMU.HedScr is typically higher with a greater frequency of *Cerastoderma edule*, *Macoma balthica*, *Scrobicularia plana* and *Abra tenuis*. LMU.HedScr may be intermediate between LMU.HedStr and LMU.HedMac or LMU.HedMac.Mare. It is muddier and is subject to a lower salinity level than LMU.HedMac. The diversity of species recorded is much greater than in LMU.HedOl.

No. 18 IGS.FaS Shallow sand faunal communities

Clean sands which occur in shallow water, either on the open coast or in tide-swept channels of marine inlets. The habitat typically lacks a significant seaweed component and is characterised by robust fauna, particularly venerid bivalves, amphipods and robust polychaetes.

No. 19 IMS.FaMS Shallow muddy sand faunal communities

Muddy sand habitats in the infralittoral zone, extending from the extreme lower shore down to more stable circalittoral zone at about 15-20 m. The habitat supports a variety of animal-dominated communities, particularly of polychaetes, bivalves and the urchin *Echinocardium cordatum*.

No. 20 IMU.EstMu Estuarine sublittoral muds
Shallow sublittoral muds, extending from the extreme lower shore to about 15 m depth in estuarine conditions. Such habitats typically support communities of oligochaetes, polychaetes, and bivalves such as *Aphelochaeta marioni*. In lowered salinity conditions the sediments may include a proportion of coarser material, where the silt content is sufficient to yield a similar community to that found in purer muds.

IMX Estuarine sublittoral mixed sediments
Shallow sublittoral mixed sediments in estuarine conditions, often with surface shells or stones enabling the development of epifaunal communities, e.g. *Crepidula fornicata* (IMX.CreAph) and mussel *Mytilus edulis* beds (IMX.MytV), as well as infaunal communities. The habitat is therefore often quite species rich, compared with purer sediments.

APPENDIX 5. PHOTOGRAPHS

Plate 5.1 Northwest Irishtown.

Plate 5.2 *Ascophyllum nodosum* with *Fucus spiralis* on the rock armour.

Plate 5.3 Various hard substrate biotopes on the rock armour of Irishtown.

Plate 5.4 Sandy biotope around Irishtown.

Plate 5.5 Muddy sand biotope around Irishtown.

Plate 5.6 Sandy biotope with lug worm casts around Irishtown.

Plate 5.7 Shore crab with mussels in Irishtown.

Plate 5.8 *Fucus spiralis* with mussels around Irishtown.

Plate 5.9 The area of site Lc in the Tolka estuary.

Plate 5.10 The area of site Ld in the Tolka estuary.

Plate 5.11 The sediment biotopes of Dollymount Strand, Bull Island.

Plate 5.12 The core sample from site Lc prior to sieving.

Plate 5.13 Site La showing various biotope zones.

Plate 5.14 The area of site La.

Plate 5.15 The structure of site Lb.

Plate 5.16 The contents of dredge Dd showing shrimp, shore crab, plaice, dab and matted algae.

Plate 5.17 The biological dredge with the contents of site Dg.

APPENDIX 6. GRANULOMETRY, LOI, HEAVY METALS

Table 6.1 Data from granulometric analysis of sediment samples showing the percentage of the total sample which passed through each sieve size.

Sieve size µm	C4 Irishtown	Le Tolka estuary	G2 Liffey/Tolka estuary	G3 Liffey/Tolka estuary	Df Off Bull Island
5600	100	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	99.89
4000	100				99.79
2800	100				99.65
2000	99.94				99.55
1180	99.85				99.32
850	99.75				99.13
600	99.63				98.96
425	99.42				98.78
300	98.52				97.29
212	95.85				95.40
150	56.57				65.66
63	3.48				0.74

Table 6.2. Granulometric scales used in classifying sediments after Wentworth (1922) and Folk (1954).

phi	mm	µm	Wentworth	Folk
-8	256	256000	Boulders	Gravel
-7	128	128000	Cobbles	Gravel
-6	64	64000	Cobbles	Gravel
-5	32	32000	Pebbles	Gravel
-4	16	16000	Pebbles	Gravel
-3	8	8000	Pebbles/granules	Gravel
-2	4	4000	Granules	Gravel
-1	2	2000	Granules	Gravel
0	1	1000	Very coarse sand	Sand
1	0.5	500	Coarse sand	Sand
2	0.25	250	Medium sand	Sand
3	0.125	125	Fine sand	Sand
4	0.0625	63	Very fine sand	Sand
5	0.0312	31	Silt	Mud
6	0.0156	16	Silt	Mud
7	0.0078	8	Silt	Mud
8	0.0039	4	Silt	Mud
>8	<0.0039	<4	Clay	Mud

Table 6.3 Data from Heavy Metal analysis of sediments expressed as mg/Kg of metal to sediment.

Metal	**C4** **Irishtown**	**Le** **Tolka estuary**	**G2** **Liffey/Tolka estuary**	**G3** **Liffey/Tolka estuary**	**Df** **Off Bull Island**
Mercury	<0.3	<0.3	<0.3	<0.3	<0.3
Lead	12.9	78.4	30.9	22.4	3.2
Cadmium	0.6	2.0	1.3	0.9	0.3
Chromium	10.5	23.7	25.7	23.4	7.7
Copper	6.8	64.9	28.8	18.0	1.2
Zinc	37.6	272.8	117.3	74.8	11.5
Nickel	12.47	19.42	22.59	16.41	5.55
Manganese	149.2	299.7	303.3	270.8	141.1

Table 6.4 Data from the Loss On Ignition analysis of sediments.

Loss on ignition **(LOI) at 440 °C**	**C4** **Irishtown**	**Le** **Tolka estuary**	**G2** **Liffey/Tolka estuary**	**G3** **Liffey/Tolka estuary**	**Df** **Off Bull Island**
As % weight	93.56	96.42	96.32	95.62	89.64

APPENDIX 7. DÚCHAS SITE SYNOPSIS

SITE NAME : NORTH DUBLIN BAY

SITE CODE : 000206

This site covers the inner part of north Dublin Bay, the seaward boundary extending from the Bull Wall lighthouse across to the Martello Tower at Howth Head.

The North Bull Island is the focal point of this site. The island is a sandy spit which formed after the building of the South Wall and Bull Wall in the 18th and 19th centuries. It now extends for about 5 km in length and is up to 1 km wide in places. A well-developed and dynamic dune system stretches along the seaward side of the island. Various types of dunes occur, from fixed dune grassland to pioneer communities on foredunes. Marram Grass (*Ammophila arenaria*) is dominant on the outer dune ridges, with Lyme Grass (*Leymus arenarius*) and Sea Couchgrass (*Elymus farctus*) on the foredunes. Behind the first dune ridge, plant diversity increases with the appearance of such species as Wild Pansy (*Viola tricolor*), Kidney Vetch (*Anthyllis vulneraria*), Bird's-foot Trefoil (*Lotus corniculatus*), Rest Harrow (*Ononis repens*), Yellow Rattle (*Rhinanthus minor*) and Pyramidal Orchid (*Anacamptis pyramidalis*). In these grassy areas and slacks, the scarce Bee Orchid (*Ophrys apifera*) occurs.

About 1 km from the tip of the island, a large dune slack with a rich flora occurs, usually referred to as the 'Alder Marsh' because of the presence of Alder trees (*Alnus spp*). The water table is very near the surface and is only slightly brackish. Saltmarsh Rush (*Juncus maritimus*) is the dominant species, with Meadow Sweet (*Filipendula ulmaria*) and Devil's-bit (*Succisa pratensis*) being frequent. The orchid flora is notable and includes Marsh Helleborine (*Epipactis palustris*), Common Twayblade (*Listera ovata*), Autumn Lady's-tresses (*Spiranthes spiralis*) and Marsh orchids (*Dactylorhiza* spp.).

Saltmarsh extends along the length of the landward side of the island. The edge of the marsh is marked by an eroding edge which varies from 20 cm to 60 cm high. The marsh can be zoned into different levels according to the vegetation types present. On the lower marsh, Glasswort (*Salicornia europaea*), Saltmarsh Grass (*Puccinellia maritima*), Annual Sea-blite (*Suaeda maritima*) and Greater Sea-spurrey *(Spergularia media*) are the main species. Higher up in the middle marsh Sea Plantain (*Plantago maritima*), Sea Aster (*Aster tripolium*), Sea Arrowgrass (*Triglochin maritima*) and Sea Pink (*Armeria maritima*) appear. Above the mark of the normal high tide, species such as Scurvy Grass (*Cochlearia officinalis*) and Sea Milkwort (*Glaux maritima*) are found, while on the extreme upper marsh, Sea Rushes (*Juncus maritimus* and *J. gerardii*) are dominant. Towards the tip of the island, the saltmarsh grades naturally into fixed dune vegetation.

The island shelters two intertidal lagoons which are divided by a solid causeway. The sediments of the lagoons are mainly sands with a small and varying mixture of silt and clay. The north lagoon has an area known as the "Salicornia flat", which is dominated by *Salicornia dolichostachya*, a pioneer Glasswort species, and covers about 25 ha. Tassel Weed (*Ruppia maritima*) occurs in this area, along with some Eelgrass (*Zostera angustifolia*). Eelgrass (*Z. noltii*) also occurs in Sutton Creek. Cordgrass (*Spartina anglica*) occurs in places but its growth is controlled by management. Green algal mats (*Enteromorpha* spp., Ulva lactuca) cover large areas of the flats during summer. These sediments have a rich macrofauna, with high densities of Lugworms (*Arenicola marina*) in parts of the north lagoon. Mussels (*Mytilus edulis*) occur in places, along with bivalves such as *Cerastoderma edule*, *Macoma balthica* and *Scrobicularia plana*. The small gastropod *Hydrobia ulvae* occurs in high densities in places, while the crustaceans *Corophium volutator* and *Carcinus maenas* are common. The sediments on the seaward side of North Bull Island are mostly sands. The site extends below the low spring tide mark to include an area of the sublittoral zone.

Three Rare plant species legally protected under the Flora Protection Order 1987 have been recorded on the North Bull Island. These are Lesser Centaury (*Centaurium pulchellum*), Hemp Nettle (*Galeopsis angustifolia*) and Meadow Saxifrage (*Saxifraga granulata*). Two further species listed as threatened in the Red Data Book, Wild Sage (*Salvia verbenaca*) and Spring Vetch (*Vicia lathyroides*), have also been recorded. A rare liverwort, *Petalophyllum ralfsii*, was first recorded from the North Bull Island in 1874 and has recently been confirmed as being still present there. This species is of high conservation value as it is listed on Annex II of the E.U. Habitats Directive. The North Bull is the only known extant site for the species in Ireland away from the western seaboard.

North Dublin Bay is of international importance for waterfowl. During the 1994/95 to 1996/97 period the following species occurred in internationally important numbers (figures are average maxima): Brent Geese 2,333; Knot 4,423; Bar-tailed Godwit 1,586. A further 14 species occurred in nationally important concentrations - Shelduck 1505; Wigeon 1,166; Teal 1,512; Pintail 334; Shoveler 239; Oystercatcher 2,190; Ringed Plover 346; Grey Plover 816; Sanderling 357; Dunlin 6,238; Black-tailed Godwit 156; Curlew 1,193; Turnstone 197 and Redshank 1,175. Some of these species frequent South Dublin Bay and the River Tolka Estuary for feeding and/or roosting purposes (mostly Brent Goose, Oystercatcher, Ringed Plover, Sanderling, Dunlin).

The tip of the North Bull Island is a traditional nesting site for Little Tern. A high total of 88 pairs nested in 1987. However, nesting attempts have not been successful since the early 1990s. Ringed Plover, Shelduck, Mallard, Skylark, Meadow Pipit and Stonechat also nest. A well-known population of Irish Hare is resident on the island

The invertebrates of the North Bull Island have been studied and the island has been shown to contain at least seven species of regional or national importance in Ireland (Orders Diptera, Hymenoptera, Hemiptera).

The main land uses of this site are amenity activities and nature conservation. The North Bull Island is the main recreational beach in Co Dublin and is used throughout the year. Much of the land surface of the island is taken up by two golf courses. Two separate Statutory Nature Reserves cover much of the island east of the Bull Wall and the surrrounding intertidal flats. The site is used regularly for educational purposes. North Bull Island has been designated a Special Protection Area under the E.U. Birds Directive and it is also a statutory Wildfowl Sanctuary, a Ramsar Convention site, a Biogenetic Reserve, a Biosphere Reserve and a Special Area Amenity Order site.

This site is an excellent example of a coastal site with all the main habitats represented. The holds good examples of ten habitats that are listed on Annex I of the E.U. Habitats Directive; one of these is listed with priority status. Several of the wintering bird species have populations of international importance, while some of the invertebrates are of national importance. The site contains a numbers of rare and scarce plants including some which are legally protected. Its proximity to the capital city makes North Dublin Bay an excellent site for educational studies and research.

SITE NAME: SOUTH DUBLIN BAY

SITE CODE: 000210

This site lies south of the River Liffey and extends from the South Wall to the west pier at Dun Laoghaire. It is an intertidal site with extensive areas of sand and mudflats, a habitat listed on Annex I of the E.U. Habitats Directive. The sediments are predominantly sands but grade to sandy muds near the shore at Merrion gates. The main channel which drains the area is Cockle Lake.

There is a bed of Eelgrass (*Zostera noltii*) below Merrion Gates which is the largest stand on the east coast. Green algae (*Enteromorpha* spp. and *Ulva lactuca*) are distributed throughout the area at a low density. Fucoid algae occur on the rocky shore in the Maretimo to Dún Laoghaire area. Species include *Fucus spiralis, F. vesiculosus, F. serratus, Ascophyllum nodosum* and *Pelvetia canaliculata*.

Lugworm (*Arenicola marina*) and Cockles (*Cerastoderma edule*) and other annelids and bivalves are frequent throughout the site. The small gastropod *Hydrobia ulvae* occurs on the muddy sands off Merrion Gates.

South Dublin Bay is an important site for waterfowl. Although birds regularly commute between the south bay and the north bay, recent studies have shown that certain populations which occur in the south bay spend most of their time there. The principal species are Oystercatcher (1215), Ringed Plover (120), Sanderling (344) and Dunlin (2628), Redshank (356) (average winter peaks 1996/97 and 1997/98). Up to 100 Turnstones are usual in the south bay during winter. Brent Geese regularly occur in numbers of international importance (average peak 299). Bar-tailed Godwit (565), a species listed on Annex I of the EU Birds Directive, also occur.

Large numbers of gulls roost in South Dublin Bay, e.g. 4,500 Black-headed Gulls in February 1990; 500 Common Gulls in February 1991. It is also an important tern roost in the autumn, regularly holding 2000-3000 terns including Roseate Terns, a species listed on Annex I of the E.U. Birds Directive. South Dublin Bay is largely protected as a Special Protection Area.

At low tide the inner parts of the south bay are used for amenity purposes. Bait-digging is a regular activity on the sandy flats. At high tide some areas have wind-surfing and jet-skiing.

This site is a fine example of a coastal system with extensive sand and mudflats, a habitat listed on Annex I of the E.U. Habitats Directive. South Dublin Bay is also an internationally important bird site.

25.2.2000

Appendix D

Estuarine Ecology – Avian Fauna

DUBLIN WASTE TO ENERGY PROJECT

BASELINE BIRD STUDY OF DUBLIN BAY

DECEMBER 2003

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DUBLIN WASTE TO ENERGY PROJECT

BASELINE BIRD STUDY OF DUBLIN BAY

TABLE OF CONTENTS.

1. INTRODUCTION.

It is proposed to develop a Waste to Energy Project on an existing terrestrial site on the Poolbeg peninsula, Ringsend, Dublin. Eleanor Mayes, Ecological Consultant, was retained by RPS-MCOS to provide baseline information on bird fauna in Dublin Bay, in connection with the proposed development. Details of the proposal have not yet been finalised, and no assessment of potential impacts on the bird fauna of Dublin Bay is provided at this stage. This report presents the existing environment in Dublin Bay with regard to:

- conservation designations
- the implications of these designations for development planning
- existing numbers of wintering waterfowl and breeding terns in Dublin Bay, population trends, and their use of different parts of Dublin Bay

Some recommendations on invertebrate and waterfowl monitoring are included.

2. CONSERVATION DESIGNATIONS.

There are four separate areas subject to conservation designations in Dublin Bay:

- North Dublin Bay (Site Code 0206)
- South Dublin Bay (Site Code 0210)
- Dolphins, Dublin Docks (Site Code 0201)
- Booterstown Marsh (Site Code 1205).

The site synopses for these designated areas, prepared by the National Parks and Wildlife Service of the Department of the Environment, Heritage and Local Government, are given in Appendix 1.

2.1. North Dublin Bay.

Bull Island and the North Bull Lagoons were the first parts of Dublin Bay to be designated for nature conservation. The first designation was of the North Bull Lagoons, which were listed as a **Wildfowl Sanctuary** in 1931, with the purpose of prohibiting shooting. A number of other conservation designations were made subsequently, under both national and EU legislation, and also under international conventions, as listed below. These designations cover the sand dune and salt meadow habitats on Bull Island, as well as the intertidal habitats of the North Bull Lagoons and

Dollymount Strand, which support internationally important numbers of wintering waterfowl.

Bull Island and the North Bull Lagoons were listed as an **Area of Scientific Interest** by An Foras Forbartha (1981), as being of international importance for their ecological (botanical, ornithological and zoological), geological and geomorphological interest.

A **Unesco Biosphere Reserve** listing in 1981 included the North Bull Lagoons, Dollymount Strand, and Bull Island but excluded the area occupied by the Royal Dublin and St. Anne's golf clubs.

Special Protection Area (SPA) in 1986, under the Birds Directive 79/409/EU, for the purpose of protecting the habitat and preventing excessive disturbance to internationally important numbers of waterfowl. This designation applies to the area enclosed by a line joining the seaward tip of the North Bull Wall to Sutton Martello Tower, the coast road and North Bull Wall, thus including the lagoons, Bull Island and Dollymount Strand. Further areas of intertidal sand and mudflats have been designated more recently in the Tolka Estuary and in South Dublin Bay (see below).

National Nature Reserve designation in 1988, under the 1976 Wildlife Act. An Establishment Order which applies to the foreshore and sub-littoral areas in State ownership around the island, including the lagoons and Dollymount Strand, and with the seaward boundary defined by a line between the tip of the North Bull Wall and Sutton Martello Tower.

Ramsar site, 1988, under the Ramsar Convention on Wetlands of International Importance especially as Waterfowl habitat. The boundaries of the Ramsar designation are the same as for the 1986 Special Protection Area designation.

Natural Heritage Area (Site Code 206), proposed designation, now under the Wildlife (Amendment) Act 2000. Bull Island, the lagoons and Dollymount Strand are proposed for inclusion in the Dublin Bay Complex Natural Heritage Area, by the National Parks and Wildlife Service.

Candidate Special Area of Conservation (cSAC), under the Habitats Directive 92/43/EEC, North Dublin Bay cSAC, Site Code 206. The site is listed as a cSAC because of the presence of the following habitats, which are listed in Annex 1 of the Directive:

Fixed dune (priority habitat)
Marram dunes
Embryonic shifting dunes
Dunes with creeping willow
Dune slack
Drift lines
Salicornia mud
Atlantic salt meadow
Mediterranean salt meadow
Tidal sand and mudflats.

North Dublin Bay cSAC is also listed because of its international importance for waterfowl, including Brent geese and wader species. The current status of the different species is discussed elsewhere in this report.

2.2. South Dublin Bay.

Sandymount Strand and the Tolka Estuary were designated as a Special Protection Area (SPA) under the Birds Directive in 1994 (S.I No. 59 of 1994). The boundaries of this site have been revised to cover more extensive areas of intertidal habitat. South Dublin Bay was listed as a candidate Special Area of Conservation under the Habitats Directive in 1999, and is also a proposed Natural Heritage Area; these listings cover the intertidal habitats of the South Bay.

The main habitat in South Dublin Bay is tidal sand and mudflats, a habitat listed in Annex 1 of the Habitats Directive. It supports internationally important numbers of Brent geese, and other wintering waterfowl species also occur. There is an important tern roost in the south bay in autumn, used by 2,000 to 3,000 terns including roseate terns. All five tern species occurring in Ireland are listed in Annex 1 of the Habitats Directive: sandwich, roseate, common, arctic, and little tern.

2.3. Dolphins, Dublin Docks.

Two mooring dolphins in Dublin Docks are proposed for Natural Heritage Area designation because of the colony of common and arctic terns that nests on them. All five tern species occurring in Ireland are listed in Annex 1 of the Habitats Directive: sandwich, roseate, common, arctic, and little tern.

2.4. Booterstown Marsh.

Booterstown Marsh was listed as an Area of Scientific Interest in 1981, and is a proposed Natural Heritage Area under the Wildlife (Amendment) Act of 2000. A protected plant species tufted salt-marsh grass *Puccinellia fasciculata* occurs, in habitats which are currently mainly brackish/saline. The marsh is used by birds, current bird species using the marsh are discussed elsewhere in this report.

2.5. Implications of the conservation designations in Dublin Bay for the proposed Waste to Energy Project.

Article 6 of the Habitats Directive provides the legislative framework for the consideration of developments which could have an adverse impact on sites which are protected under both the Habitats and the Birds Directives. Legal obligations under Article 4 of the Birds Directive are now superseded by Article 6 of the Habitats Directive. Article 6(3) of the Habitats Directive requires that a plan or project (which is not directly connected with or necessary to the ecological management of a site protected under the Directive) can be approved only if it will not adversely affect the integrity of the site concerned. Article 6(4) qualifies this by requiring that if a plan must proceed for imperative reasons of overriding public interest, and if there are no alternatives to the plan, then compensatory measures must be adopted. However, if the site concerned hosts priority habitats or species, the only considerations which may be raised are those relating to human health or public safety, or beneficial consequences of primary importance for the environment. The Birds Directive requires that migratory waterfowl and internationally important wetlands are treated as priority species (Article 4).

The Habitats Directive does not prohibit development in sites protected under the Directive. It does require that plans and projects can only be permitted where they have been shown not to damage the integrity of the site in question. An assessment must be carried out for a proposed plan or project, to assess the implications of the proposed development in the context of the conservation objectives for the protected site. Environmental Impact Assessment is the recognised means of providing this assessment.

At this stage, it is not clear whether, or how, the proposed Dublin Waste to Energy Project would have the potential to have an adverse impact on the conservation objectives which apply in Dublin Bay under the Birds and Habitats Directives. The site under consideration for the proposal lies close to, but not within any of the existing designated areas. Issues could arise with regard to any emissions to air, aquatic discharges, or the potential for accidental spillages or other releases to the environment which could impact on environmental quality. Heavy metals and toxic organic substances such as dioxins persist in the environment, and if discharged would tend to accumulate in the muddier sediments in Dublin Bay, where they have the potential to enter the food chain and cause habitat deterioration under the terms of the Habitats Directive.

3. SOURCES OF INFORMATION ON WINTERING WATERFOWL IN DUBLIN BAY.

The North Bull Lagoons, lying between Bull Island and the shore between Clontarf and Sutton, have been noted for waterfowl since the 19th century, but count data are much more recent. Many of the early records were published by Fr. P.G Kennedy, S.J., and these date from the mid-1930s to the 1950s. The early records concentrated on duck species; although waders were present in greater numbers, duck were believed to be under more threat and the area was designated as a Wildfowl Sanctuary in 1931. Some of Kennedy's records of duck are collated in Chapter 8 of Jeffrey (1977).

Systematic counts of waterfowl (geese, ducks and waders) were carried out from 1971 to 1975 in the Wetlands Enquiry, organised by the Irish Wildbird Conservancy (now BirdWatch Ireland). The results of this survey are reported in Hutchinson (1979). The North Bull Lagoons and salt meadow were identified as being internationally important[1] (according to criteria in use at the time) for Brent geese, shoveler, knot, bar-tailed godwit, curlew, and redshank, and as nationally important[2] for shelduck, pintail, oystercatcher, ringed plover, grey plover, sanderling, and dunlin.

The next series of systematic counts were carried out over three winter seasons, from 1984/85 to 1986/87, by the Winter Wetlands Survey, again organised by the Irish Wildbird Conservancy, and reported in Sheppard (1993). This survey identified Dublin Bay as the 10th most important site in Ireland for wildfowl (geese and duck), and the 6th most important site in Ireland for waders. In this survey, South Dublin Bay was counted in addition to the North Bull Lagoons, although most of the birds were recorded in the lagoons. Dublin Bay as a whole was listed as internationally important for Brent geese, knot, bar-tailed godwit and redshank, and nationally important for shelduck, wigeon, teal, pintail, shoveler, oystercatcher, ringed plover, grey plover, sanderling, dunlin, black-tailed godwit, curlew, and turnstone. South Dublin Bay was listed as internationally important for Brent geese, and was also noted as being the area of the bay most frequently used by sanderling, a species which occurs in nationally important numbers in Dublin Bay.

The Irish Wetland Bird Survey (I-WeBS) is a joint project of BirdWatch Ireland (formerly the Irish Wildbird Conservancy), the National Parks and Wildlife Service of the Department of the Environment, Heritage and Local Government, and the Wildfowl and Wetlands Trust. The project commenced in 1994 and is ongoing, with the aim of monitoring the numbers and distribution of waterfowl during the non-breeding season. Counts are carried out in Dublin Bay monthly from September to March inclusive, typically at high tide.

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[1] Internationally important wetlands are defined under the Ramsar Convention as wetlands which regularly support at least 20,000 waterfowl, or for species where population data are available, wetlands which support at least 1% of the total number of individuals of a species or subspecies. Threshold numbers for international importance are reviewed at meetings of the contracting countries every three years. Dublin Bay qualifies for international importance under both definitions cited above.

[2] In Ireland, a site is defined as nationally important if it regularly holds 1% of the estimated all-Ireland population of a species. Currently, where the estimated Irish wintering population of a species is 5,000 or less, the threshold for national importance is set at 20 (Colhoun, 2001).

Other sources of data on waterfowl numbers and distribution in Dublin Bay are mainly the bird fauna sections of Environmental Impact Statements accompanying planning applications for developments affecting the bay. Significantly, these include data on mid and low tide feeding distribution of waterfowl within the bay and North Bull Lagoons. The Dublin Bay Project has generated an important data-set on Brent geese and waders, as species potentially impacted by the installation of a pipeline between Sutton and Ringsend. The results of waterfowl counts carried out for the EIS are given in Chapter 6 of Volume 3 (1997). The certification for the project required a monitoring programme to be put in place, and this commenced in 1997. The programme is ongoing, and is to continue until 3 years after pipeline construction is complete. The results of the monitoring programme to date have been made available for reference in this study by the Dublin Bay Project Office of Dublin City Council. The Bull Island Causeway Study (2002, commissioned by Dublin City Council Parks Department and made available for reference in this study) provides information on use by all wintering waterfowl species of the area close to the causeway in both the North and South Bull Lagoons.

A further EIS with information on waterfowl use of part of Dublin Bay (the Liffey Estuary, including the Tolka Basin and the Bull Wall Sands) is the EIS for the Dublin Port proposed 21 Hectare Reclamation (1997). A revised EIS was prepared in 2002, which contains some additional information on bird use of the area proposed for reclamation.

4. WINTERING WATERFOWL NUMBERS AND POPULATION TRENDS IN DUBLIN BAY.

The numbers of migratory waterfowl recorded at a wetland site vary between years, in response to a variety of factors including breeding success, mortality, food resources, and weather conditions. These factors operate on a number of sites within the range of each individual species - Arctic Canada, Greenland, Iceland and Ireland in the case of light-bellied Brent geese.

4.1. Species occurring in internationally important numbers.

Four waterfowl species have been recorded in internationally important numbers in Dublin Bay since systematic counts were first carried out in the 1970s: light-bellied Brent geese, knot, bar-tailed godwit, and redshank. Knot have occurred in internationally important numbers during most of this period, although peak counts were below the international threshold for four consecutive years in the late 1990s early 2000s. Black-tailed godwit are a recent addition to the wader species recorded in internationally important numbers in Dublin Bay, and exceeded the threshold number for the first time in 2000/01. Currently, therefore, five species occur in internationally important numbers in Dublin Bay, based on the running mean peak count for the five seasons 1998/99 to 2002/03 (Table 1).

Light-bellied Brent geese are the most important species in Dublin Bay in terms of conservation, as up to 15% of the world population uses the bay. Dublin Bay is the second most important wintering site, after Strangford Lough. About 1% of the west European/Canadian population of knot winters in Dublin Bay, the third most important site for this species in Ireland (after Dundalk Bay and Strangford Lough). The Icelandic breeding population of black-tailed godwit winters in Ireland, with 1% in Dublin Bay. This population has been increasing throughout its range in recent years. The bay holds c. 2% of the western European population of bar-tailed godwit, and is the top 5 sites in Ireland for this species. Just over 1% of the Europe/ West African wintering population of redshank occurs in Dublin Bay, which is in the top 7 sites for redshank in Ireland.

4.2. Species occurring in nationally important numbers.

In addition to the five internationally important species, fourteen species of wintering waterfowl occur in nationally important numbers in Dublin Bay (Table 1). Duck species occurring in nationally important numbers are shelduck, teal, pintail, shoveler, and red-breasted merganser. Great-crested grebe also occur in nationally important numbers. Waders occurring in nationally important numbers are oystercatcher, ringed plover, golden plover, grey plover, sanderling, dunlin, curlew and turnstone.

With regard to the duck species, shelduck, pintail and shoveler are the most important species. Dublin Bay is the third most important site in Ireland for shelduck (after Strangford Lough and Cork Harbour), and holds 0.5% of the Northwest European population of this species. The bay is usually the most important site in Ireland for pintail, and in the top five for shoveler. The number of wigeon and teal have declined in Dublin Bay in recent years, wigeon no longer reach the threshold for national importance.

Table 1. Peak numbers of wintering waterfowl in Dublin Bay.

	Mean peak 98/99-2002/03	Mean peak 1994/95-1998/99	Mean peak mid 1980s	Mean peak early 1970s	Short term trend	Long term trend where apparent	Threshold	
							Nat.	Inter nat.
Great-grested grebe	*62*	32			-	-	35	
Cormorant	62	29			-	-	105	
Grey heron	34	27			-	-	105	
Light-bellied Brent goose	***2,907***	***1,930***	***2,229***	***1,000***	Increase	Increase	200	200
Duck								
Shelduck	*1,287*	*1,261*	*607*	*400*	Stable	Increase	125	3,000
Wigeon	785	*924*	*2,919*	*2,600*	Decrease	Decrease	1,000	12,500
Teal	*870*	*1,157*	*1,868*	*1,200*	Decrease	Decrease	500	4,000
Mallard	135	90			-	-	500	20,000
Pintail	*204*	*296*	*517*	*300*	Decrease	Decrease	20	600
Shoveler	*128*	*191*	*308*	*300*	Decrease	Decrease	40	400
Goldeneye	13	34			-	-	100	3,000
Red-breasted merganser	*40*	*35*			-	-	25	1,250
Waders								
Oystercatcher	*4,177*	*2,526*	*3,787*	*3,800*	Increase	Stable	700	9,000
Ringed plover	*365*	*302*	*152*	*101-150*	Increase	Increase	100	500
Golden plover	*2,174*	*3,118*	*42*	*200*	Decrease	Increase	1,500	18,000
Grey plover	*629*	*705*	*478*	*201-500*	Decrease	Increase	50	1,500
Lapwing	68	60	-	-	-	-	2,000	20,000
Knot	**3,503**	**3,575**	**9,287**	**6,700**	Stable	Decrease	250	3,500
Sanderling	*386*	*402*	*184*	*251-300*	Stable	Increase	40	1,000
Dunlin	*6,141*	*6,810*	*10,038*	*7,900*	Decrease	Decrease	1,200	14,000
Black-tailed godwit	**752**	*397*	*109*	*85*	Increase	Increase	80	700
Bar-tailed godwit	**1,901**	**1,669**	**2,173**	**2,300**	Increase	Decrease	175	1,000
Curlew	*1,091*	*1,056*	*1,865*	*1,900*	Stable	Decrease	1,000	3,500
Redshank	**2,056**	**1,679**	**1,721**	**2,400**	Increase	?	250	1,500
Greenshank	17	14	10	5-15	Increase	?	20	3,000
Turnstone	*255*	*206*	*300*	?	Increase	?	100	700

Notes: Internationally important species are in boldface, nationally important species in italics

- Short term trends are indicated as increases or decreases where the difference between the 1998/99-2002/03 and the 1994/95-1998/99 running means is more than 10%
- Long term trends compare the 1998/99 to 2002/03 data with the 1970s and 1980s, indicating differences of more than 10% as increases or decreases
- Data for Brent geese and waders for 1998/99 to 2002/03 are the combined results of the Dublin Bay Project and I-WeBS data. Data for the other species including duck for these years are I-WeBS data. Data for 1994/95-1998/99 are from I-WeBS, the mid-1980s are from Sheppard (1993), and data for the early 1970s are from Hutchinson (1979).
- The 1% population thresholds for national and international importance are taken from Colhoun 2001.

Wader populations in Dublin Bay are important in an all-Ireland context, the bay is usually the most important site for sanderling, the second most important site for grey plover, and the third most important site for ringed plover. Dublin Bay is generally the fifth most important site for oystercatcher, dunlin and turnstone, and about the tenth most important site for curlew.

4.3. Waterfowl population trends in Dublin Bay.

Population trends in waterfowl wintering in Dublin Bay are given in Table 1 above, in both the short term (mid 1990s compared with late 1990s/ early 2000s), and in the longer term. A review of waterfowl population trends within Ireland generally is in preparation by I-WeBS at present, and is expected to be complete in early 2004 (Crowe, pers. comm.). Until this review is available, it is not possible to set population changes in Dublin Bay in the context of overall changes in population levels in Ireland and further afield. Analysis of population trends for a single site should be treated with some caution, because count methodology has improved through time. Some species were not counted in the earlier surveys (great-crested grebe, cormorant, heron, mallard, goldeneye, red-breasted merganser and lapwing), and trends are not included for these species.

Brent geese.
The Dublin Bay population of light-bellied Brent geese has increased during the last thirty years, the mean peak number has almost trebled during this period. This population trend is evident in both the short and long term.

Duck.
With the exception of shelduck, the most important duck species for which data are available from the 1970s to the present have declined in Dublin Bay. Wigeon, teal, pintail and shoveler have all declined since the 1970s, and in all four species this trend has continued with further declines evident between the mid 1990s and the 1998/99 to 2002/03 period. Teal, pintail and shoveler still occur in nationally important numbers, but wigeon have fallen below the threshold for national importance since the mid 1980s. Declining duck numbers have also been observed at other east coast sites in Ireland (Crowe, pers. comm.; I-WeBS report in prep.).

Shelduck numbers in Dublin Bay have increased substantially, particularly since the mid 1980s, but have been relatively stable since I-WeBS counts started in 1994 with only a slight increase since then (Table 1).

Waders.
Wader numbers have increased, or remained stable in the short term for most of the species that use Dublin Bay (Table 1). Numbers have increased in the short term in seven species: oystercatcher, ringed plover, black-tailed godwit, bar-tailed godwit, redshank, greenshank and turnstone. With the exception of bar-tailed godwit, these populations have also increased, or been stable, in the long term.

The numbers of three species have been stable in the short term: knot, sanderling and curlew. Sanderling numbers appear to have increased since the 1970s, while knot and curlew numbers have declined since the 1970s.

Three wader species have declined in number in the short term: golden plover, grey plover, and dunlin. Large roosting flocks of golden plover were recorded in Dublin Bay in the mid to late 1990s, more recently substantially smaller flocks have been present, less frequently. These birds appear to make little or no feeding use of Dublin Bay, and were recorded only in small numbers during the 1970s and 1980s. Numbers of grey plover have increased since the 1970s and 1980s, but have declined slightly in recent years. Higher numbers of dunlin were recorded during the 1980s than in any other period for which there are data, dunlin numbers have also declined in recent years in Dublin Bay.

Long term population declines appear to have occurred in four wader species in Dublin Bay: knot, dunlin, bar-tailed godwit, and curlew. As noted above, the significance of these changes is best considered in the context of changes within Ireland generally, when information on these is published.

5. WINTERING WATERFOWL USE OF DUBLIN BAY.

Detailed information on feeding use of Dublin Bay by waterfowl has all been collected during the last ten years, as part of impact assessment studies for several projects. Data of waterfowl use of different areas of Dublin Bay have been collected for the Dublin Bay Project EIS and ecological monitoring programme. These sources provide information on high, mid and low tide distribution of Brent geese and waders in the North Bull Lagoon and South Dublin Bay, and mid to high tide use of the South Bull Lagoon. These data also yield total counts of Brent geese and waders in the bay. Information on the distribution of duck is taken mainly from the draft Causeway Study prepared for Dublin City Council in 2002.

In general, birds feeding and roosting in the South Lagoon during the higher stages of the tidal cycle, feed in the Liffey Estuary where littoral habitats are exposed during the lower half of the tidal cycle. Because of this, general assumptions can be made about low tide distribution in Dublin Bay by reference to the proportion of the total number of birds using the South Lagoon. Data on the use of the Liffey Estuary (including the Tolka Basin and Bull Wall Sands, to the west of the North Bull Wall) are also taken from the 1997 EIS for the proposed 21 Hectare Reclamation at Dublin Port.

Waterfowl distribution in Dublin Bay is determined by the availability of roosting areas, preferred feeding habitat, fresh water preening and loafing areas (important particularly for geese and duck), and by disturbance. The availability of food and its comparative abundance in different parts of the bay is likely to be an important determinant of waterfowl feeding distribution (Yates et al, 1993).

The habitats present in Dublin Bay are described in detail elsewhere in this baseline report. A summary of the main habitat types and their broad relevance to birds is given in Table 2 below. It should be noted that habitats on the Bull Wall Sands and in South Dublin Bay have not been surveyed in detail. Both areas appear to be predominately sandy, but with varying degrees of mud also present. The cleanest sands occur on Dollymount Strand. Littoral muds and soft muds are largely restricted to the Bull Lagoons, and also occur extensively in the Tolka Basin where they lie below mid-tide level.

The salt meadow habitats on Bull Island are the main high tide roosting area for waders in Dublin Bay. In the south bay, the main high tide roost is on a recently developing sand bar between Merrion Gates and Booterstown.

Table 2. Summary of habitat distribution and use by waterfowl in Dublin Bay.

Habitat	Main distribution	Use by waterfowl
Sand dune habitats	Bull Island	Dune slack areas used as high tide roosts during spring high tides
Salt meadow	Bull Island, adjoining the intertidal sand and mudflats of the Bull Lagoons	High tide wader roosts. Most of the waders in Dublin Bay roost here at high tide. High tide feeding habitat for duck. Spring feeding habitat for Brent geese.
Barren sands above high tide	Dollymount Strand. Smaller areas of barren sand above high tide occur in South Dublin Bay, arising from recently accelerated sediment accumulation. The main area of barren sand is the sand bar between Merrion Gates and Booterstown, which has developed considerably since 1998/99.	The upper shore on Dollymount Stand in little used by waterfowl, probably due to a combination of human disturbance, and to the limited number of species which feed on the mid and lower shore at Dollymount. The sand bar between Merrion Gates and Booterstown is now the main wader roost in South Dublin Bay.
Rock-armoured shore	Throughout the bay, apart from areas where vertical sea wall is present at the South Bull Lagoon and Liffey Estuary	Rock armoured shore in South Dublin Bay (including the West Pier at Dun Laoghaire) is used for roosting by waders - less used in recent years since the sand bar near Merrion Gates has developed. Some feeding use by turnstone in the south bay.
Rocky shore	Outcropping rock occurs at Sutton, and in South Dublin Bay between Blackrock and Dun Laoghaire	Feeding habitat of turnstone.
Mixed substrate shore (Cobble/gravel with finer sediments)	North Dublin Bay distribution. Extends in varying width from the base of the sea wall in the Liffey Estuary and South Bull Lagoon - supports a small mussel bed near the Wooden Bridge. Also occurs on the mid to low shore in the North Bull Lagoon from Kilbarrack to Sutton, where it supports extensive mussel beds. This habitat supports attached species of green algae *Enteromorpha* and *Ulva* spp.	Brent geese and wigeon feed on green algae in this habitat. Feeding habitat of oystercatcher, grey plover, curlew and turnstone.
Littoral sands	Dollymount Strand. Parts of the lower shore, central South Dublin Bay?	Sanderling

Littoral sand - muddy sand	South Dublin Bay, Bull Wall Sands, much of South Bull Lagoon, part of North Bull Lagoon	Oystercatcher, ringed plover, grey plover, knot, dunlin, bar-tailed godwit, curlew and redshank feeding habitat
Littoral mud	Tolka Basin, part of South Bull lagoon, c. half of North Bull Lagoon. Mat-forming green algae (*Enteromorpha* spp.) grow in this habitat in sheltered conditions near Bull Island Causeway.	Duck feeding habitat, particularly near Bull Island Causeway. Mat-forming green algae eaten by Brent geese and wigeon. Feeding habitat of ringed plover, grey plover, dunlin, black-tailed godwit and redshank. Soft muds are preferred by duck, dunlin, black-tailed godwit and redshank.
Salicornia mud	North Bull Lagoon, near causeway.	Duck feeding habitat. Low tide curlew roost.

The total intertidal area of Dublin Bay is c. 2,000 ha:

- South Dublin Bay 840ha (41.7%)
- North Bull Lagoon 310ha (15.4%)
- South Bull Lagoon 75ha (3.8%)
- Liffey Estuary 288ha (14.4%)
- Dollymount Strand 500ha (25%)

The low tide feeding distribution of waders in Dublin Bay reflects the distribution of preferred habitats (Table 3). Hunter's index of preference (1962) provides a way of assessing whether birds make indiscriminate (random) use of different areas of the bay, or whether they selectively use some areas in preference to others:

$$Pi = \frac{Ui}{Ai}$$

Pi is the preference index value, Ui is the percentage of the total population of a species recorded in area i, and Ai is the area occupied by area i expressed as a percentage of the total area, in this case the total intertidal area of Dublin Bay. If birds use an area in proportion to the size of the area, the Pi value is close to 1.0. If birds are rarely seen in an area, the Pi value is close to 0. The maximum possible value of Pi for any area i, depends on the percentage of the total area occupied by area i. For example, if area i covers 50% of the total area, but 100% of the birds are recorded there, Pi is 2. If area I covers 5% of the total area and 100% of the birds are recorded there, Pi is 20.

Table 3. Percentage low tide feeding use of different areas of Dublin Bay by waders. Preference indices are also given.

	Percentage use at low tide				Preference index (Pi)			
	South Dublin Bay	North Bull Lagoon	South Bull Lagoon/ Liffey Estuary	Dolly-mount Strand	South Dublin Bay	North Bull Lagoon	South Bull Lagoon/ Liffey Estuary	Dolly-mount Strand
Total area (%)	41.7	15.4	18.2	25	41.7	15.4	18.2	25
Oystercatcher	35	35	30	-	0.84	**2.23**	1.65	-
Ringed pplover	42.3	40.8	17	-	1.01	**2.65**	0.93	-
Grey plover	0.6	77.4	22	-	0.01	**5.03**	1.21	-
Knot	26.4	28.3	45.3	-	0.6	1.84	**2.49**	-
Sanderling	40.6	-	-	59.4	0.97	-	-	2.38
Dunlin	19.4	46.6	34.0	-	0.46	**3.03**	1.87	-
Black-tailed godwit	0.5	29.3	70.2	-	0.01	1.90	**3.86**	-
Bar-tailed godwit	25.7	17.4	56.9	-	0.62	1.13	**3.13**	-
Curlew	6.8	52.4	40.8	-	0.16	**3.40**	**2.24**	-
Redshank	11.1	32.2	56.7	-	0.27	**2.09**	**3.12**	-
Turnstone	11.0	19.6	69.4	-	0.26	1.27	**3.81**	-
Maximum possible value of Pi					2.4	6.49	5.49	4.0

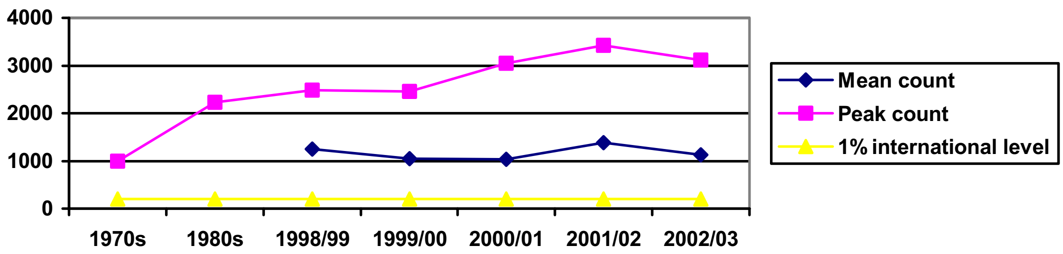
Note: Pi values of 2.0 or more are highlighted, indicating that birds make at least twice the expected use of the area

Accounts of individual species and groups of species are given below, with maps indicating their main distribution within Dublin Bay. The maps illustrate a high degree of selection of feeding area, varying between individual species.

5.1. Light-bellied Brent geese.

Internationally important species.

Mean and peak counts of Brent geese in Dublin Bay



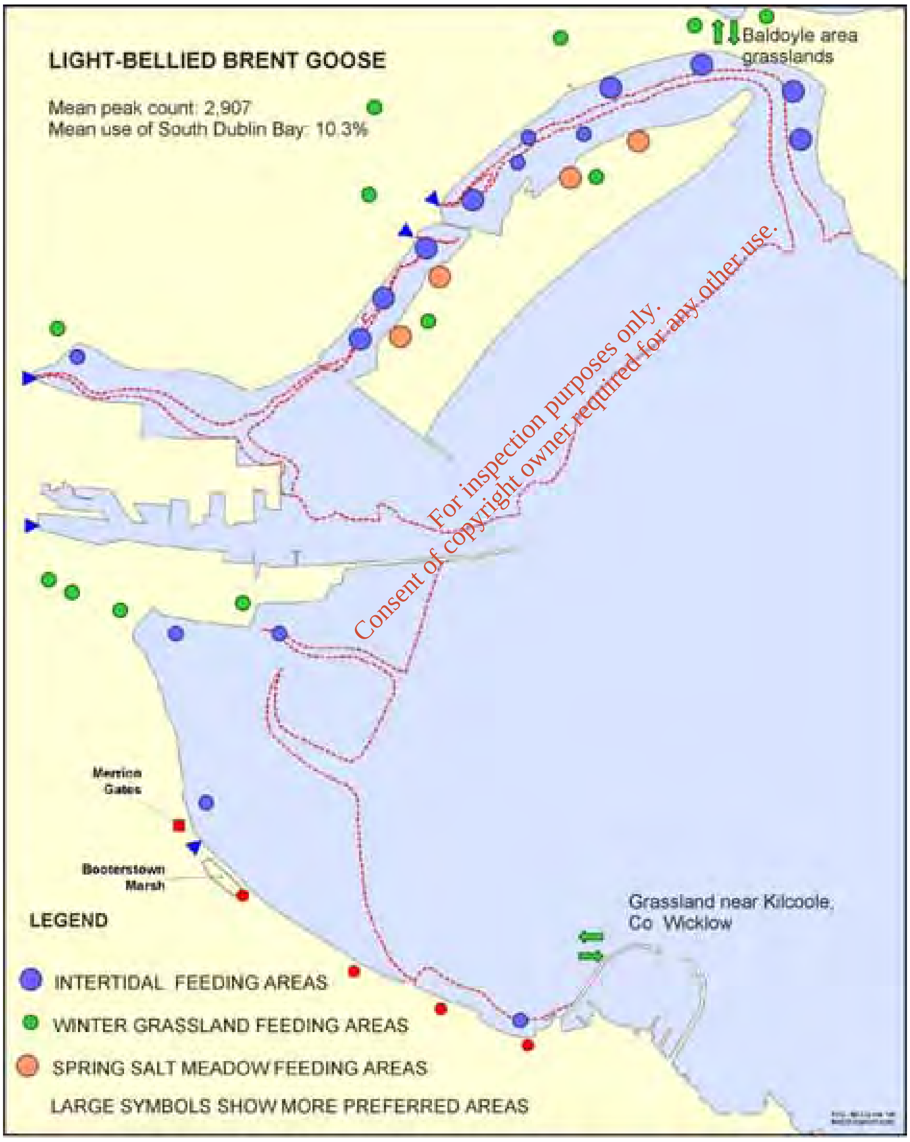
The highest counts of Brent geese are generally recorded in mid-winter at dawn, before the birds disperse from roosting areas in the Bull lagoons and South Dublin Bay to feed during the day. The highest count of Brent geese to date was recorded in January 2002, when 3,429 geese were recorded.

The habitats used for feeding by Brent geese vary during the winter season. The geese are herbivorous. The main autumn foods taken are eelgrass *Zostera noltii*, and green algae *Enteromorpha* and *Ulva* spp. The main bed of eelgrass is located on the upper shore near Merrion Gates, and geese feed intensively on this in autumn. Most of the biomass of green algae in Dublin Bay occurs in the Bull Lagoons (Jeffrey et al, 1992), where both attached and mat-forming species of *Enterpmorpha* grow, and *Ulva lactuca* dominates the green algal flora on the mussel beds. Lower biomass of attached *Enteromorpha* species occurs in the Tolka Basin and in patches in South Dublin Bay, and geese feed on these also. When the intensity of use of intertidal habitats is compared, on average, 10% of the Brent geese use South Dublin Bay, 60% use the North Bull Lagoon, and 30% use the South Bull Lagoon with some use of the Liffey Estuary also. Stocks of *Zostera* and green algae in Dublin Bay are largely eaten out (and broken up by winter weather) by early December, and geese switch to feeding extensively on grassland habitats around Dublin Bay.

Intensively managed grasslands, both amenity and agricultural, provide the main feeding habitat for Brent geese from December to February. Geese disperse from Dublin Bay to farmland near Kilcoole in Co. Wicklow and at Baldoyle Estuary, and to amenity grasslands around Dublin Bay soon after dawn, returning to roost at night. Amenity grasslands used by the geese include golf courses, sports fields, parks, and public open space adjoining the Liffey Estuary in Fairview and Clontarf. In South Dublin Bay, availability of different grassland areas has varied over the last number of years because of development work. Prior to 1999, the most intensively used grassland was the area within the Wastewater Treatment Works site at Ringsend. When this site was unavailable because of the construction of the upgraded Dublin Bay Project treatment works, geese made increased use of Sean Moore Park, Irishtown Stadium and Ringsend Park. A 2 hectare area of replacement grassland for Brent geese has been provided as part of the ecological mitigation for the Dublin Bay

Project on land lying between the Wastewater Treatment Works and Irishtown Nature Park, and adjoining the proposed site of the Dublin Waste to Energy Project. The entire 2 ha replacement grassland area is available for the first time in the winter of 2003/04, sparse grass cover on c. 40% of the area attracted some goose use during the winter of 2002/03. Drainage work at Sean Moore Park, and construction work at Irishtown Stadium, has restricted goose use of these grasslands from 2001 to 2003.

Spring re-growth of attached species of *Enteromorpha* is generally evident by mid-February, and geese start feeding on it when cover values are still very low. The salt meadows at Bull Island are an important feeding habitat for the geese in spring (O'Briain and Healy, 1991).



5.2. Duck.

Nationally important species: shelduck, teal, pintail, shoveler, red-breasted merganser.

Most of the duck species occurring in Dublin Bay use the intertidal and saltmarsh habitats in North Dublin Bay, and are almost entirely restricted to the Bull Lagoons close to the causeway.

Shelduck.
Shelduck feed over littoral muddy sand and mud, with almost all birds recorded in the Bull Lagoons, although some use is made of the Tolka Basin. Very small numbers (<10) are recorded occasionally in Booterstown Marsh and South Dublin Bay. Unlike the other duck species, shelduck feed extensively on exposed intertidal sediments at low tide. Shelduck feed mainly on small molluscs including *Hydrobia*, and on small crustaceans including *Corophium*.

Dabbling duck.
Dabbling duck species (wigeon, teal, mallard, pintail and shoveler) generally loaf on the channel of the Santry River in the North Bull Lagoon, and the Naniken Stream in the South Bull Lagoon at low tide. From mid tide level, they feed actively in shallow water over the littoral muds, and move into the salt meadow habitats on Bull Island with the rising tide, continuing to feed there. Mallard, pintail and shoveler remain close to the causeway throughout the winter. Most of the pintail occur to the north of the causeway, where the *Salicornia* flats in the North Bull Lagoon provide an important feeding habitat. All three species are omnivorous, taking both plant and animal food, with shoveler adapted to filter very small food items including planktonic crustaceans, small molluscs, seeds and plant debris.

Wigeon and teal use a rather larger area of Dublin Bay, both species feed over mixed substrate shore in the South Bull Lagoon and in the Tolka Estuary, as well as over littoral muds and muddy sands. Wigeon are herbivorous, and feed extensively on green algae growing on littoral habitats, and also on salt meadow vegetation. Teal are omnivorous; seeds are an important part of the winter diet.

Small numbers of mallard and teal use South Dublin Bay. Teal use Booterstown Marsh, while mallard feed in the intertidal near rock outcrops between Blackrock and Salthill as well as in Booterstown Marsh.

Diving duck.
The diving duck species, goldeneye and red-breasted merganser, occur offshore in Dublin Bay, although they do feed over littoral habitats when these are submerged at high tide. Red-breasted merganser feed on fish, while goldeneye feed on molluscs and crustaceans.

5.3. Oystercatcher.

Nationally important species.

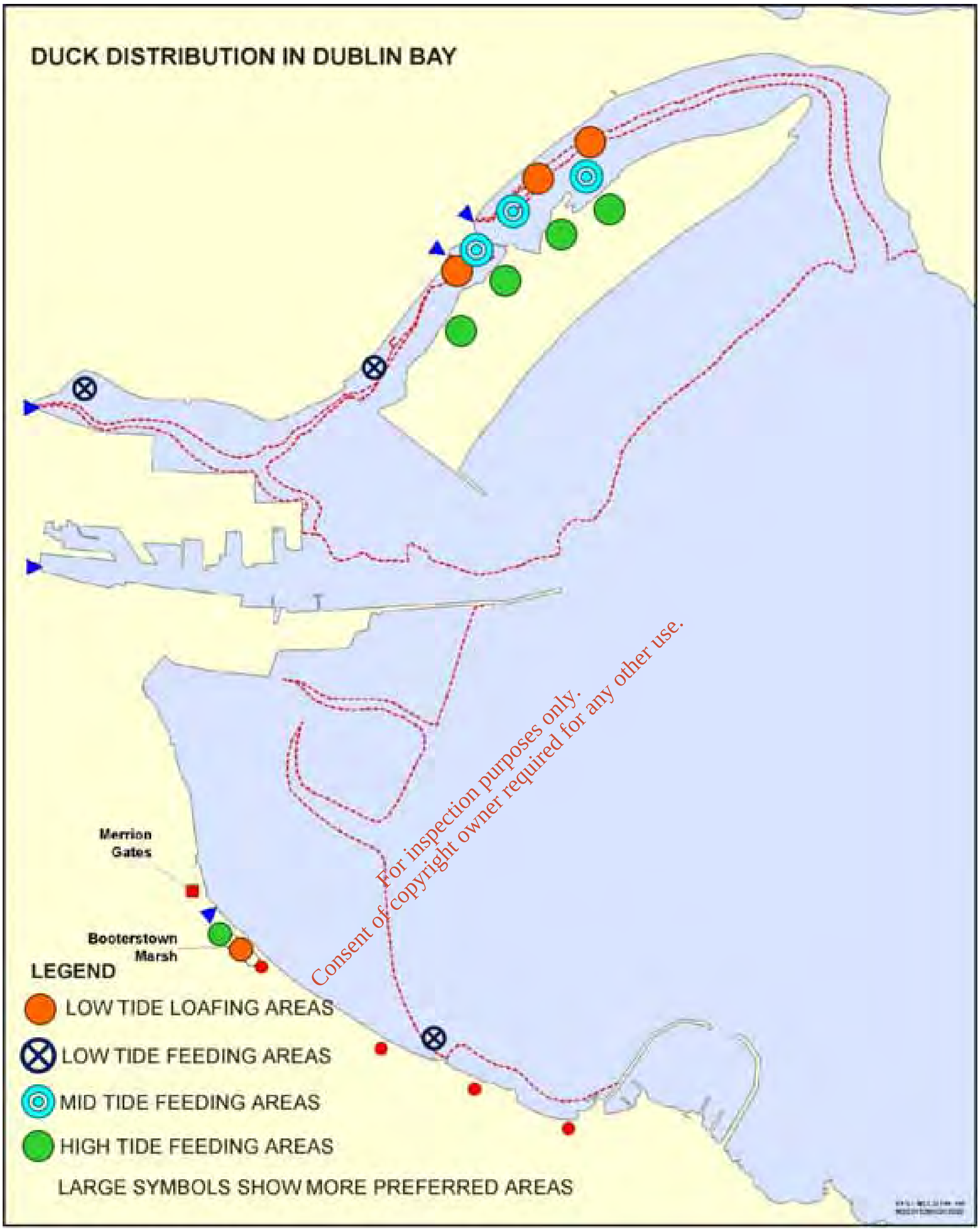
Oystercatcher are widely distributed in Dublin Bay, with 35% of the total recorded in the North Lagoon, 30% in the South Lagoon and Liffey Estuary, and 35% in South Dublin Bay (Table 3). They are present throughout the year, but only in small numbers during the summer months. Numbers build up from July/August, and remain high through the winter, declining sharply in April as birds leave to breed elsewhere.

Table 3 shows that overall, the North Bull Lagoon is more preferred for feeding than other parts of Dublin Bay. Dublin Bay Project monitoring data show that the most preferred area of the North Bull Lagoon is the Sutton area, where oystercatchers feed on the mussel beds in Sutton Creek. The density of oystercatcher feeding here at low tide is the highest recorded in Dublin Bay, at up to 34 birds per hectare. They also feed on mussel bed near the wooden bridge, and on mixed substrates in the Liffey Estuary. Oystercatcher feeding in lower densities on muddy sands are likely to be taking cockles and Baltic tellins.

Cockles *Cerastoderma edule* and mussels *Mytilus edulis* are the preferred prey species of oystercatcher. The abundance of these species varies with tidal level, cockles are most abundant around mid-tide level, while mussels are most abundant on the lower shore (Yates et al, 1993). *Macoma balthica*, which occurs in the same habitats as cockle, are also eaten by oystercatchers.

The main oystercatcher roosts are on the salt meadow habitats at Bull Island, and the sand bar near Merrion Gates in South Dublin Bay. They also roost in smaller numbers on the rock-armoured railway embankment in South Dublin Bay. Sub-roosts often form 2 to 3 hours before high tide, birds stop feeding and gather on exposed littoral sands, gradually move to high tide roost areas as the tide rises.

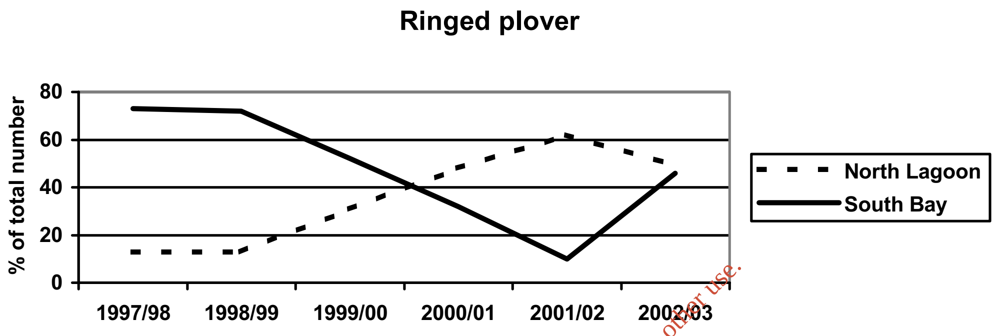
Oystercatchers feed on terrestrial as well as littoral habitats, particularly in the middle of winter. They are often seen on amenity grasslands in Dublin, as well as on coastal agricultural land, where they feed on earthworms.


DUCK DISTRIBUTION IN DUBLIN BAY
Merrion Gates
Booterstown Marsh
LEGEND
LOW TIDE LOAFING AREAS
LOW TIDE FEEDING AREAS
MID TIDE FEEDING AREAS
HIGH TIDE FEEDING AREAS
LARGE SYMBOLS SHOW MORE PREFERRED AREAS

5.4. Ringed plover.

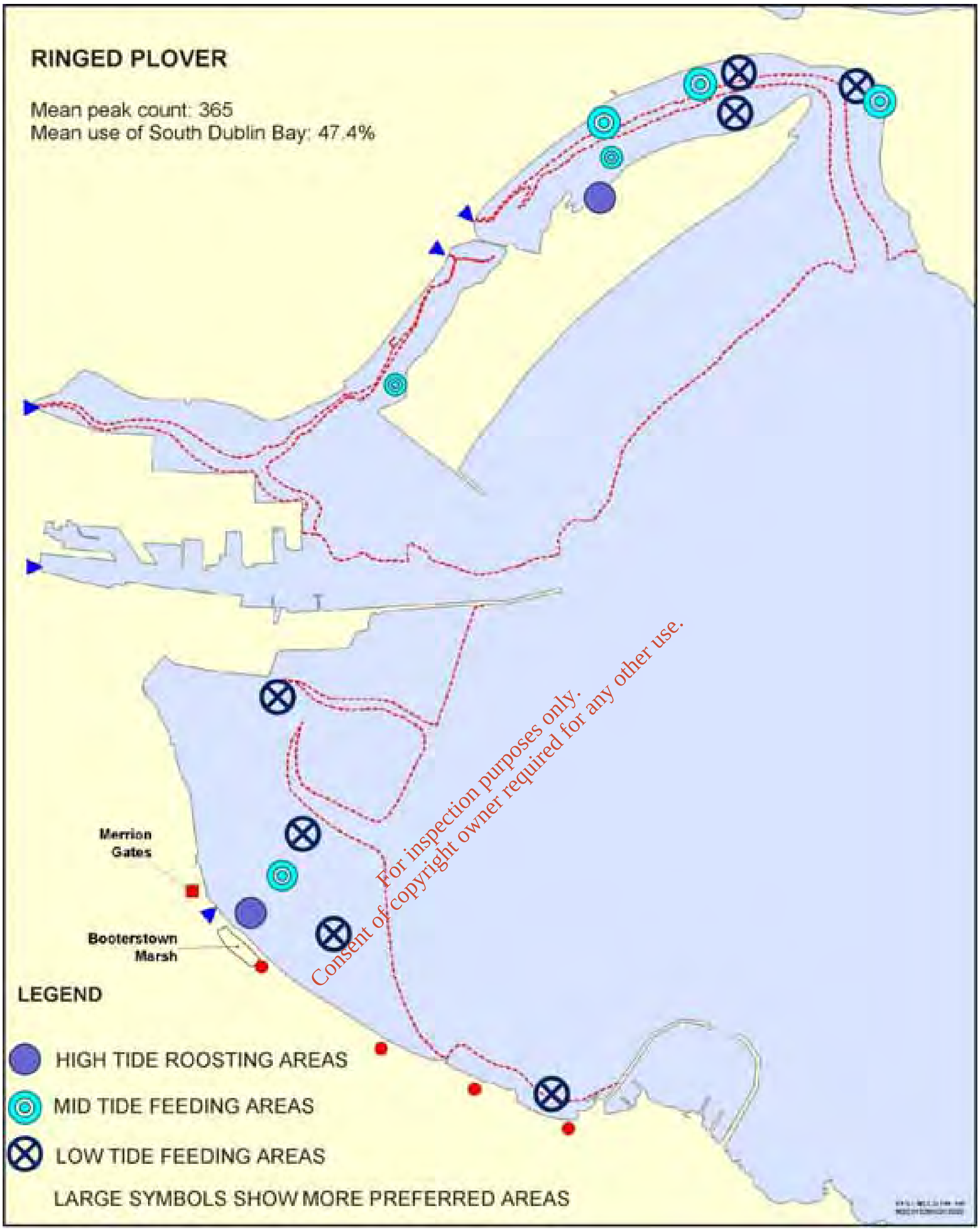
Nationally important species.

Ringer plover occur mainly in the North Bull Lagoon and in South Dublin Bay, with little use of the South Bull Lagoon and Liffey Estuary. The proportion of birds using South Dublin Bay and the North Bull Lagoon varies between years, with some evidence of a cyclic variation, as shown on the graph below. The preference indices in Table 3 show that the North Bull Lagoon is preferred overall, with use of the South Bay and South Bull Lagoon/Liffey Estuary being in proportion to their area (i.e. random use). However, this overall pattern is complicated by the fact that ringed



plover tend to have a favoured feeding area in the North Lagoon and South Bay in any given winter season, where a flock will be found on most count dates. These areas are relatively small in comparison with the feeding distributions of other species, and include littoral sand and muddy sand habitats. Prey species taken are variable, and ringed plover become less selective of prey type when availability is low. Prey species recorded for ringed plover are isopod and amphipod crustaceans including *Corophium* and *Talitrus*, small oligochaete and polychaete worms including *Hediste* (*Nereis) diversicolor*, and gastropods including *Littorina, Macoma balthica*, and *Hydrobia ulvae* (Cramp and Simmons).

Ringed plover use both soft and hard substrates for high tide roosting. In South Dublin Bay they roost on the sand bar near Merrion Gates, but will also roost on the west pier in Dun Laoghaire. Birds feeding in the North Bull Lagoon roost in salt meadow vegetation on Bull Island.


RINGED PLOVER
Mean peak count: 365
Mean use of South Dublin Bay: 47.4%
Merrion Gates
Booterstown Marsh
LEGEND
HIGH TIDE ROOSTING AREAS
MID TIDE FEEDING AREAS
LOW TIDE FEEDING AREAS
LARGE SYMBOLS SHOW MORE PREFERRED AREAS

5.5. Grey plover.

Nationally important species.

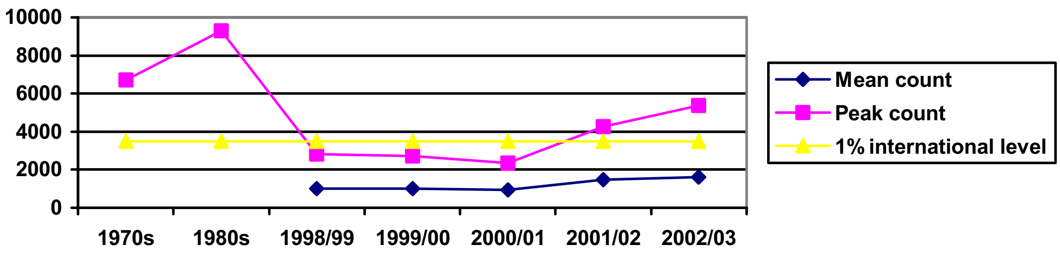
Grey plover occur mainly in the North Bull Lagoon, with some use of the South Bull Lagoon and Liffey Estuary. The preference indices for grey plover show strong selection of the North Bull Lagoon (Table 3). They occur on muddy sand and mixed substrate habitats, with minor use of mussel beds, and avoid soft muds. The diet has been found to be varied, and the density of feeding grey plover most strongly correlated with the density of prey species *Nephtys hombergii*, *Scoloplos armiger*, *Lanice conchilega*, with cirratulid density, with *Corophium* density, and with the density of small cockle *Cerastoderma edule* and Baltic tellin *Macoma balthica* (Yates et al, 1993). Another study confirmed that grey plover took lugworn *Arenicola marina*, ragworm *Nereis diversicolor*, sea slug *Alderia modesta*, and the opisthobranch *Retusa obtusa* (Le V. Dit Durrell and Kelly, 1990). Goss-Custard et al (1977) reported that grey plover expoloited all the dense Lanice beds, but did not feed extensively in other areas where other prey species were abundant. All three studies were carried out on the Wash in south-east England.

Grey plover roost in saltmarsh near the causeway, with roosts in both the North and South Bull Lagoons.

5.6. Knot.

Internationally important species.

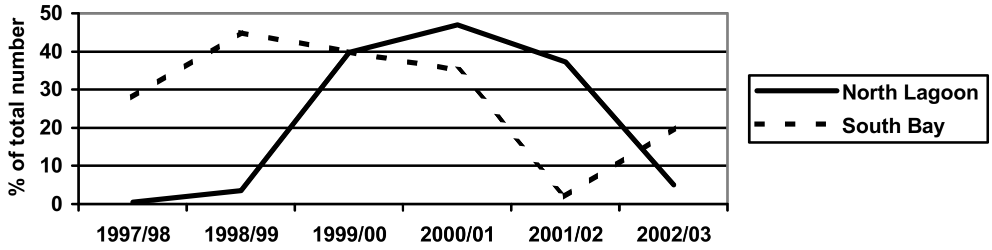
Mean and peak counts of knot in Dublin Bay



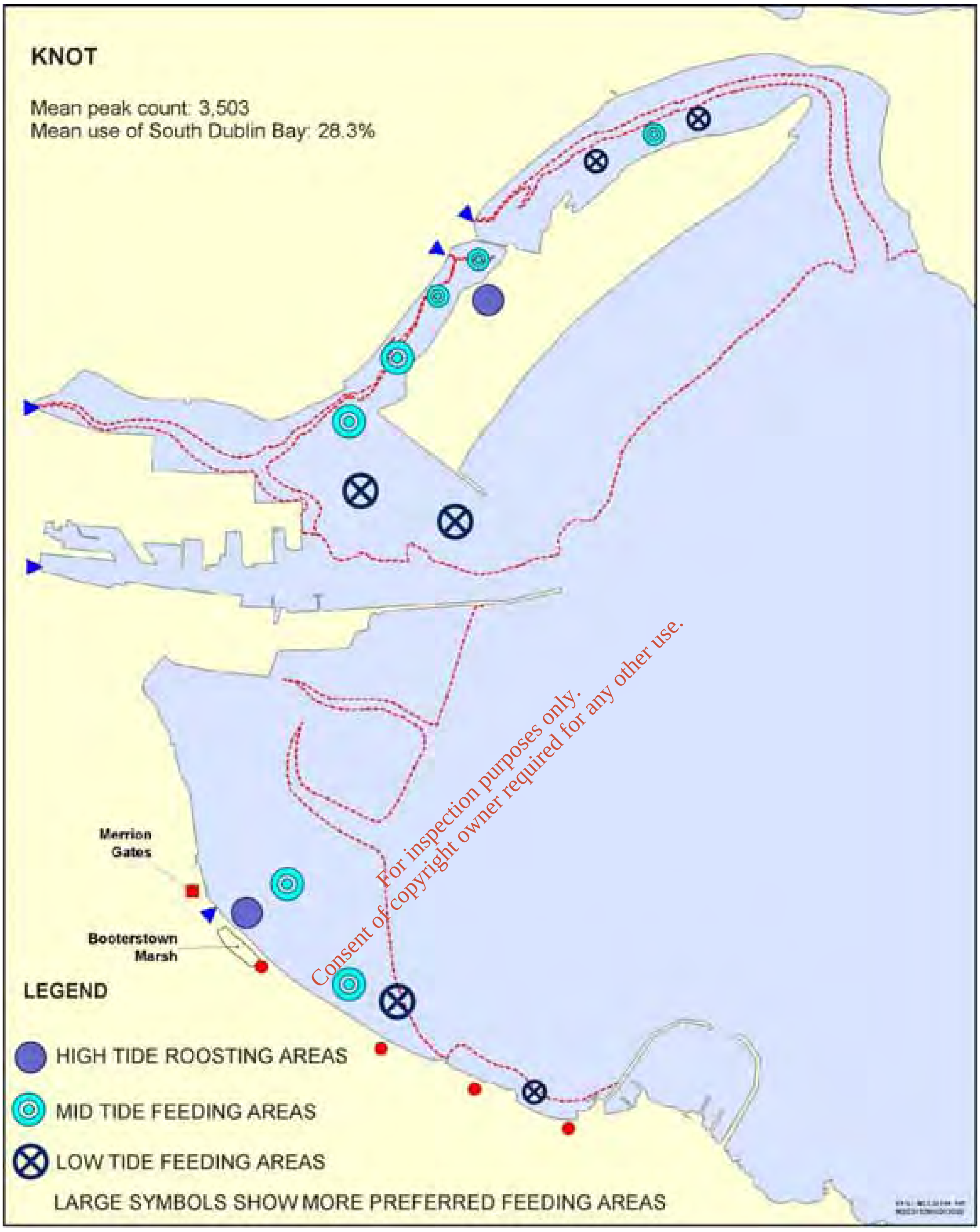
Knot numbers have increased above the 1% international threshold in the last two winters, following some seasons with historically low numbers for this species in Dublin Bay (see graph above). The South Bull Lagoon/Liffey Estuary is the preferred area of Dublin Bay for knot, use of the North Lagoon has varied over time but on average is also preferred (Table 3).

Knot are often found feeding in the same area as bar-tailed godwit, and the two species often form mixed roosting flocks. Knot feed on the sandier habitats in Dublin Bay, on littoral sands and muddy sands. Their main low tide feeding areas are in South Dublin Bay, where they are generally found between Booterstown and Dun Laoghaire, and on the Bull Wall Sands in North Dublin Bay. Smaller flocks occur less regularly in the North Bull Lagoon, the graph below shows that there is evidence of cyclic variation in use of the North Bull Lagoon and South Dublin Bay as feeding areas. Use of the South Bull Lagoon and Bull Wall Sands is more constant.

Knot



Knot feed mainly by touch while probing in the sediment, but also feed by sight. The wintering diet is dominated by a small number of mollusc species (bivalves and snails). Knot diet has been observed to vary seasonally, with small cockles (<10mm) important in the diet in autumn, and Baltic tellin (6-15mm) more important in winter. *Hydrobia* in the 2-7mm size range were also eaten frequently; ragworms and small crustaceans were taken occasionally (Goss-Custard et al, 1977). Other studies have shown that knot feed almost entirely on molluscs during the non-breeding season, but will feed opportunistically on temporary abundances of other foods such as horse-shoe crab and dipteran larvae (Masero, 2002).

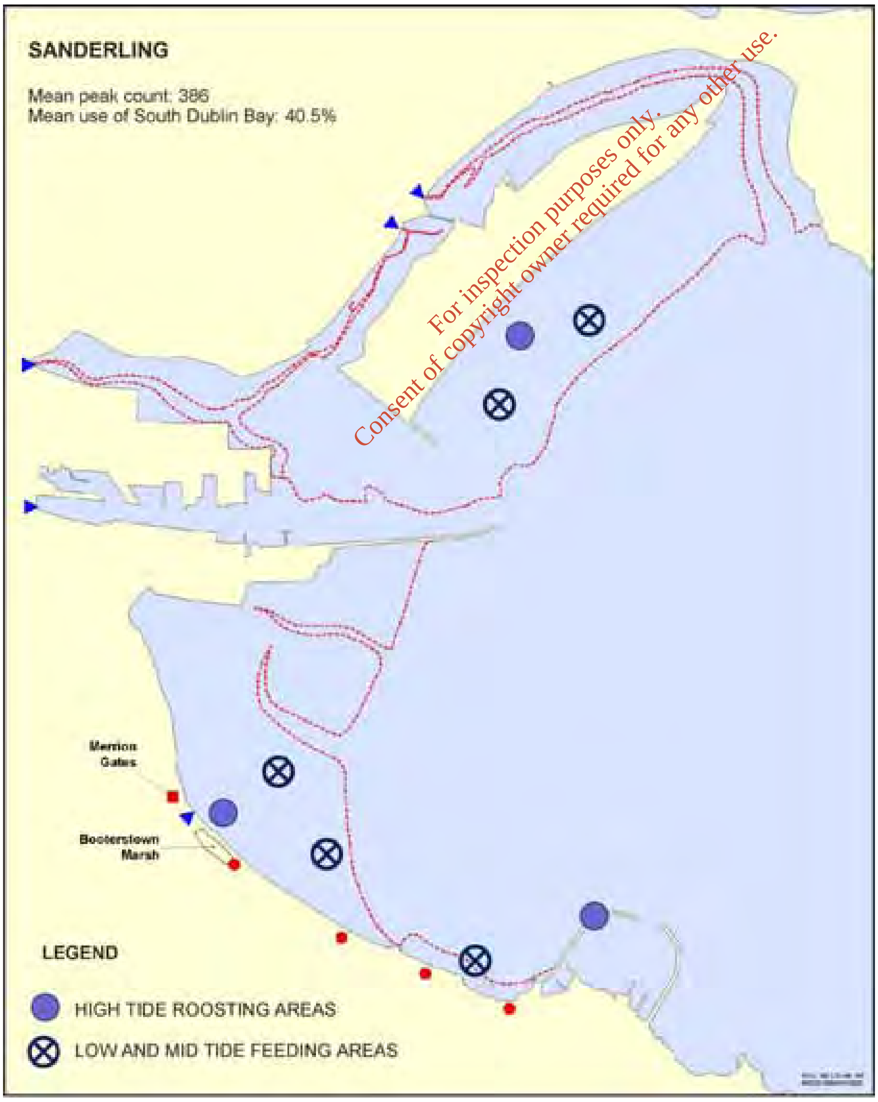

KNOT
Mean peak count: 3,503
Mean use of South Dublin Bay: 28.3%
Merrion Gates
Booterstown Marsh
LEGEND
HIGH TIDE ROOSTING AREAS
MID TIDE FEEDING AREAS
LOW TIDE FEEDING AREAS
LARGE SYMBOLS SHOW MORE PREFERRED FEEDING AREAS

5.7. Sanderling.

Nationally important species.

In Dublin Bay, Sanderling feed on the littoral sands on Dollymount Strand and in South Dublin Bay. They occasionally also feed in small numbers along the drift line in other habitats, where they probably feed on dipteran flies (including adults, larvae and pupae), and on amphipod crustaceans like sand-hoppers *Talitris saltator*. Generally, sanderlings are associated with open sandy coasts rather that estuaries, and their diet is less well studied than other waders. The main prey groups are given as dipteran flies, beetles, and small crustaceans, with molluscs and polychaete worms also taken (Snow and Perrins, 1998). Small amphipod crustaceans such as *Bathyporeia* and *Corophium* spp. seem likely to be the main prey species in Dublin Bay.

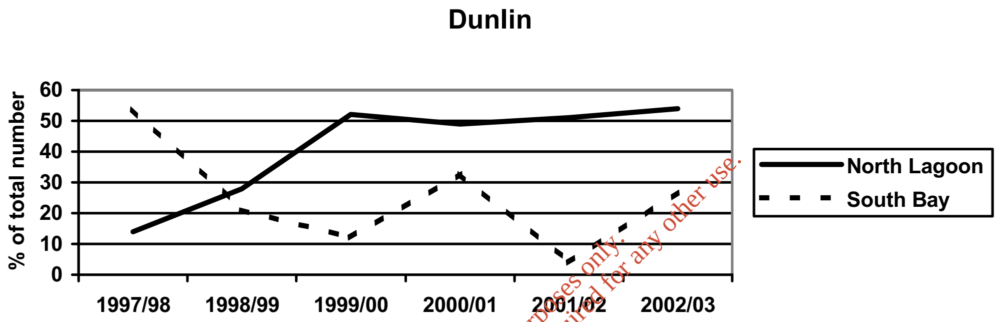
Sanderling in South Dublin Bay roost on the sand bar near Merrion Gates, and on hard substrates; on the west pier in Dun Laoghaire and on the rock-armoured railway embankment.



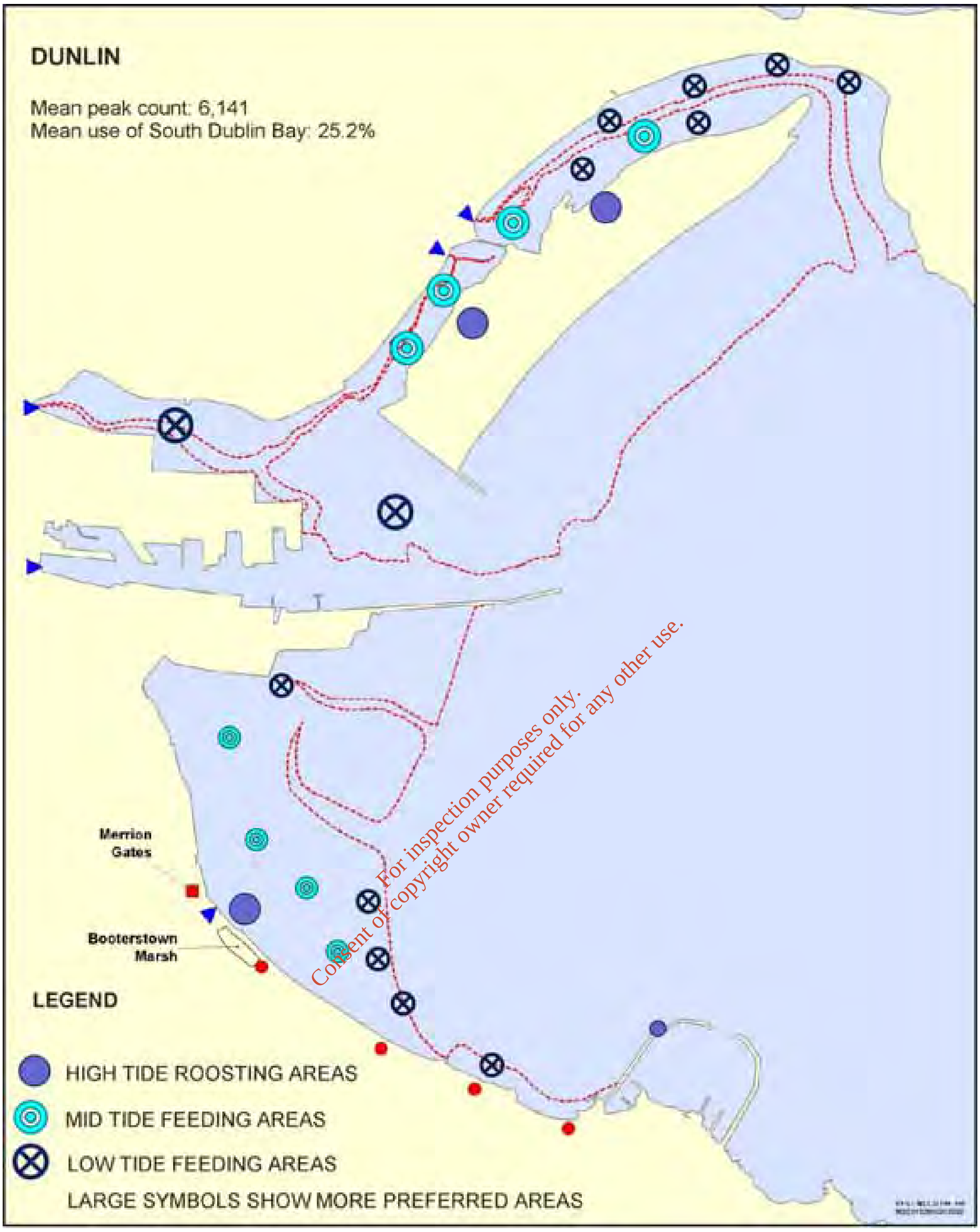
5.8. Dunlin.

Nationally important species.

Dunlin have a wide low tide feeding distribution in Dublin Bay. They are among the more mobile wader species and large flocks can move between different habitats at low tide, although they tend to favour the muddier habitats. The highest preference value in Dunlin is for the North Bull Lagoon, with almost half of the total population recorded here (Table 3). The graph below indicates that substantial variation in use of different parts of the bay occurs, although some of this variation is due to the mobile nature of particularly large flocks which are only recorded occasionally during each winter season.



Dunlin take a wide range of mollusc and worm prey species. *Hydrobia*, cockle *Cerastoderma edule* and Baltic tellin *Macoma balthica* are the main mollusc species taken, the opisthobranch mollusc *Retusa obtusa* was also confirmed as being eaten by Dunlin on the Wash (le V. Dit Durrell and Kelly, 1990). This study also showed that the cockles taken by dunlin were often cockle spat (juveniles <4mm). Worms confirmed as dunlin prey are *Nephtys hombergii*, *Hediste diversicolor*, the Phyllodocid worms *Etone longa* and *Phyllodoce maculata*, and the Spionid worms *Pygospio elegans* and *Spio filicornis*. Dunlin are also thought to eat oligochaete worms (le V. Dit Durrell and Kelly, 1990), which can be abundant in muddy sediments, and provide much of the biomass of invertebrate infauna in sediments with a high pollution loading.

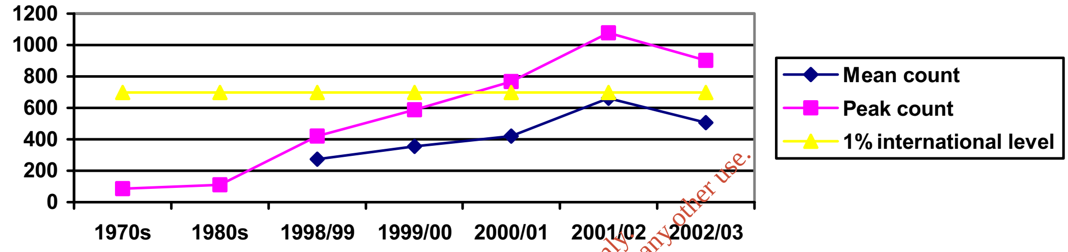

DUNLIN
Mean peak count: 6,141
Mean use of South Dublin Bay: 25.2%
Merrion Gates
Booterstown Marsh
LEGEND
HIGH TIDE ROOSTING AREAS
MID TIDE FEEDING AREAS
LOW TIDE FEEDING AREAS
LARGE SYMBOLS SHOW MORE PREFERRED AREAS

5.9. Black-tailed godwit.

Internationally important species.

Following a steady increase in population in Dublin Bay during the 1990s, black-tailed godwit occurred in internationally important numbers for the third year in succession in 2002/03, with a peak count of 902 birds in October 2002, and 893 in March 2003. The five year running mean count for the species currently exceeds the international threshold of 700 birds, and was 752 for the five years 1998/99-2002/03. The Icelandic breeding population of black-tailed godwit winters in Ireland, Britain, France and Portugal, and has increased substantially in number since the 1970s (Gill et al, 2001), although the reasons for the increase remain unclear.

Mean and peak counts of black-tailed godwit in Dublin Bay



Black-tailed godwit have a limited feeding distribution in Dublin Bay, reflecting the preference by this species for soft mud habitats. The main low tide feeding habitats are the soft muds in the Tolka Basin, and between Kilbarrack and the causeway in the North Bull Lagoon. As the tide rises, birds feed on mixed substrate shore and patches of littoral mud along the Clontarf Road shore of the Liffey Estuary and South Bull Lagoon, often gathering in a sub-roost at the inflow of the Naniken Stream to the South Lagoon before moving to roost in salt meadow on Bull Island. Birds feeding on soft muds in the North Bull Lagoon often move to the South Lagoon salt meadow to roost.

Black-tailed godwit feed on bivalves and polychaete worms in littoral habitats, with bivalves preferred, and worms taken mainly if bivalve density drops below a threshold density (Gill et al, 2001a). Bivalve species taken are *Scrobicularia plana*, *Macoma balthica* and *Mya arenaria*, in the 4 - 20mm size range. These accounted for 74% of the prey items taken by black-tailed godwit in six estuaries studied in south east england. The main polychaete species taken was *Hediste diversicolor* (Gill et al, 2001a).

Black-tailed godwit also feed on wet grassland habitats in winter, where earthworms are the main prey taken.

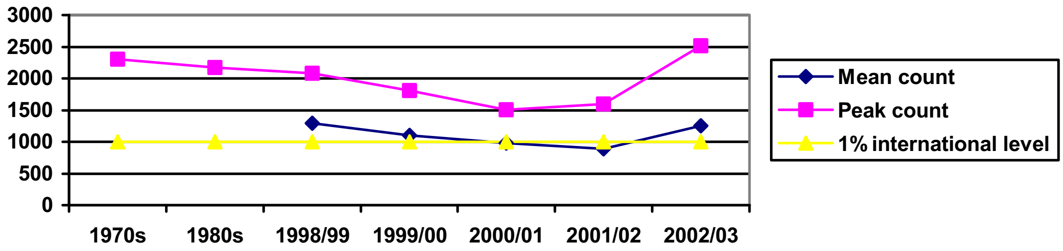

BLACK-TAILED GODWIT
Mean peak count: 752
Mean use of South Dublin Bay: 0.4%
Merrion Gates
Booterstown Marsh
LEGEND
HIGH TIDE ROOSTING AREAS
MID TIDE FEEDING AREAS
LOW TIDE FEEDING AREAS
LARGE SYMBOLS SHOW MORE PREFERRED AREAS

5.10. Bar-tailed godwit.

Internationally important species.

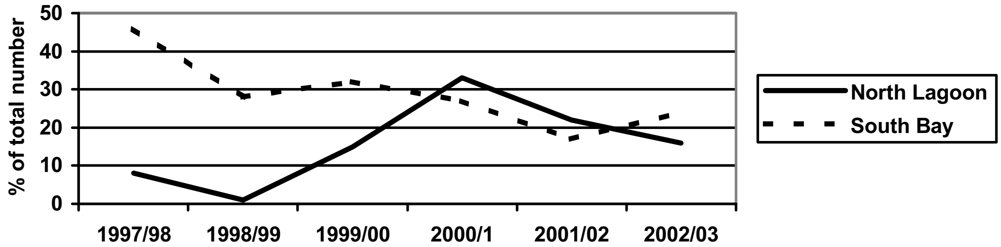
Bar-tailed godwit occurred in record numbers in Dublin Bay in 2002/03, with 2,511 birds recorded in November 2002, and 2,055 in February 2003, the highest counts recorded since the start of the I-WeBS programme in 1994. These counts are similar to those recorded in Dublin Bay during the 1970s and 1980s.

Mean and peak counts of bar-tailed godwit in Dublin Bay

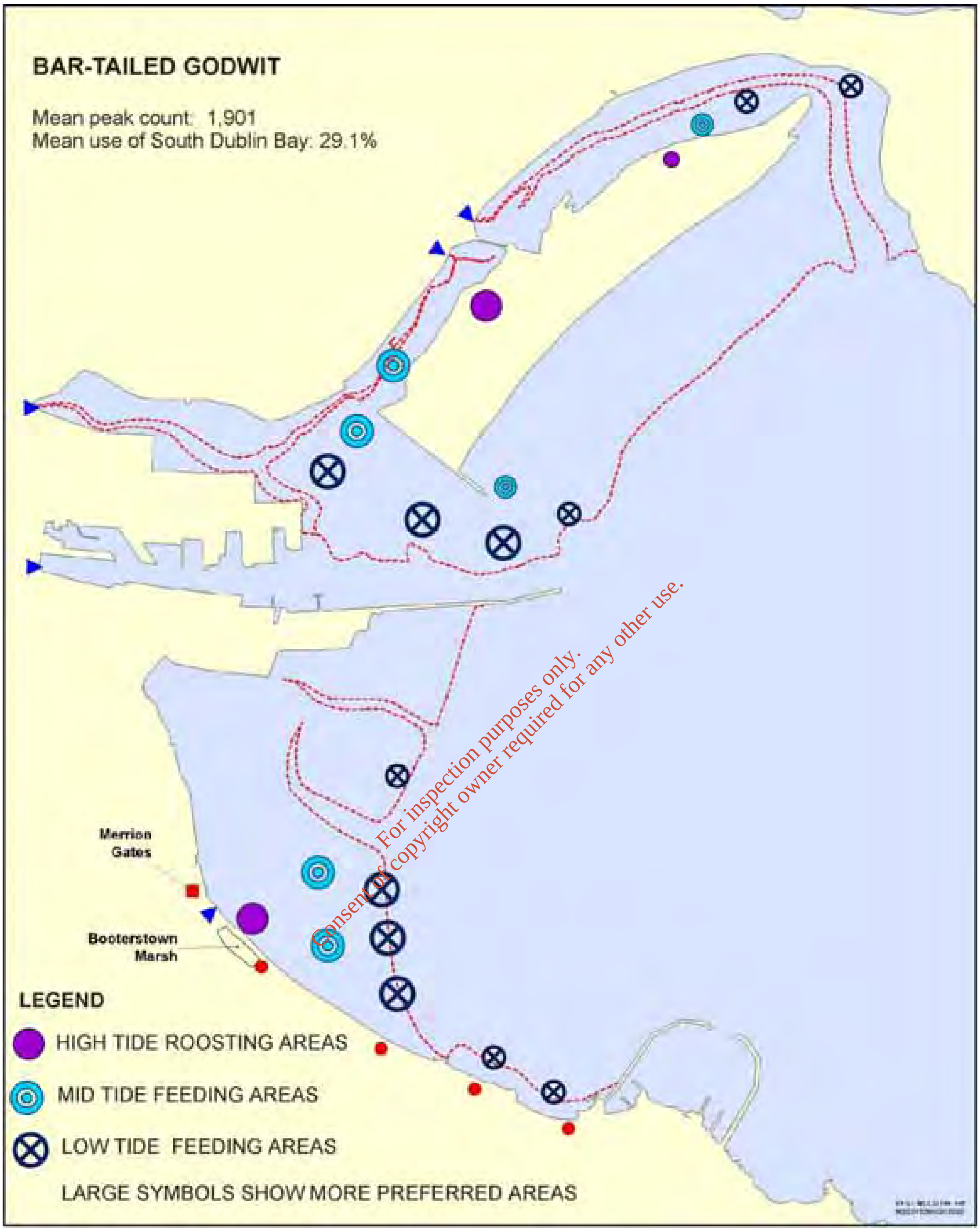


Bar-tailed godwit show a strong preference for the South Bull Lagoon and Liffey Estuary. As noted in section 5.6. above, bar-tailed godwit often feed in association with knot, and the two species often form mixed roosting flocks. Both species also show evidence of cyclic variation in use of the North Bull Lagoon and South Dublin Bay. Their distribution in Dublin Bay is therefore very similar, with the main low tide feeding areas located on the Bull Wall Sands in North Dublin Bay, and the littoral sands and muddy sands of South Dublin Bay between Booterstown and Dun Laoghaire. Both species make some use of the southern end of Dollymount Strand, close to the North Bull Wall, where muddy sands are exposed at low tide, but do not use the clean sands which are the main habitat cover on Dollymount Strand.

Bar-tailed godwit



The main invertebrate prey species taken by bar-tailed godwit are *Lanice conchilega*, *Macoma balthica* and *Hediste diversicolor*. *Lanice* occur on the lower shore and are generally not available during neap low tides, the birds were found to feed on *Macoma* and *Nereis* when Lanice beds were submerged (Goss-Custard et al, 1977). Yates et al (1993) found that bar-tailed godwit low-tide feeding densities were also correlated with the densities of *Arenicola marina*. Other prey reported for bar-tailed godwit are small crustaceans including *Corophium, Crangon* and *Carcinus*, the molluscs *Hydrobia* and *Littorina*, and the polychaete worm *Scoloplos*.

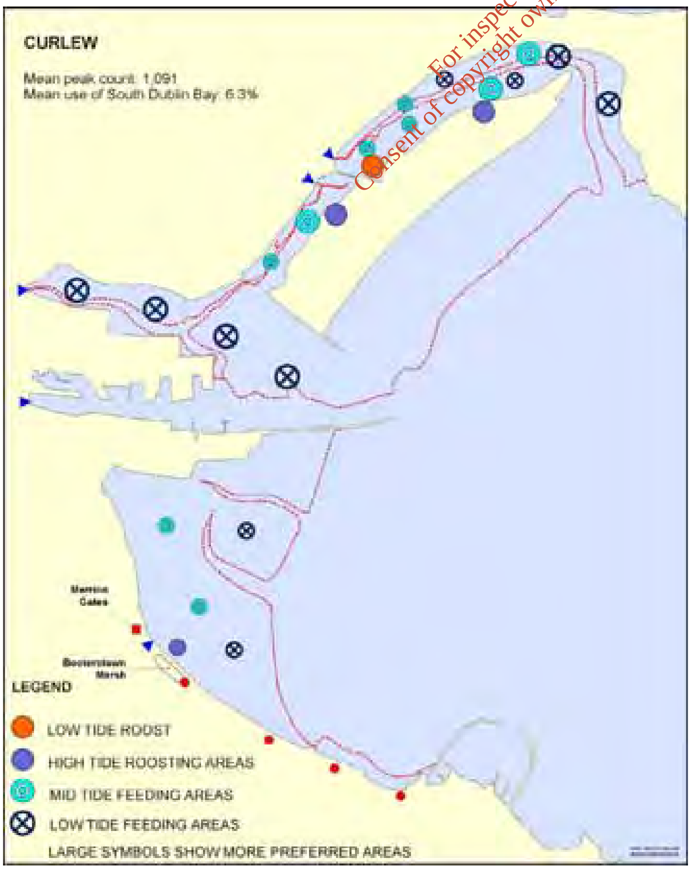

BAR-TAILED GODWIT
Mean peak count: 1,901
Mean use of South Dublin Bay: 29.1%
Merrion Gates
Booterstown Marsh
LEGEND
HIGH TIDE ROOSTING AREAS
MID TIDE FEEDING AREAS
LOW TIDE FEEDING AREAS
LARGE SYMBOLS SHOW MORE PREFERRED AREAS

5.11. Curlew.

Nationally important species.

Curlew are widely distributed in Dublin Bay, but occur in substantially higher densities in the North Bay where over 90% of the birds are recorded. They are present throughout the year, but occur only in small numbers from April to July. Curlew tend to spend more time roosting than other wader species. The *Salicornia* flat near the causeway in the North Bull Lagoon is used for roosting at mid or low tide, between 100 and 200 birds are often present here. Curlew sub-roost on the upper shore as the tide rises in both of the Bull Lagoons, and in much smaller numbers on sand bars in South Dublin Bay. The salt meadow on Bull Island is used for high tide roosting.

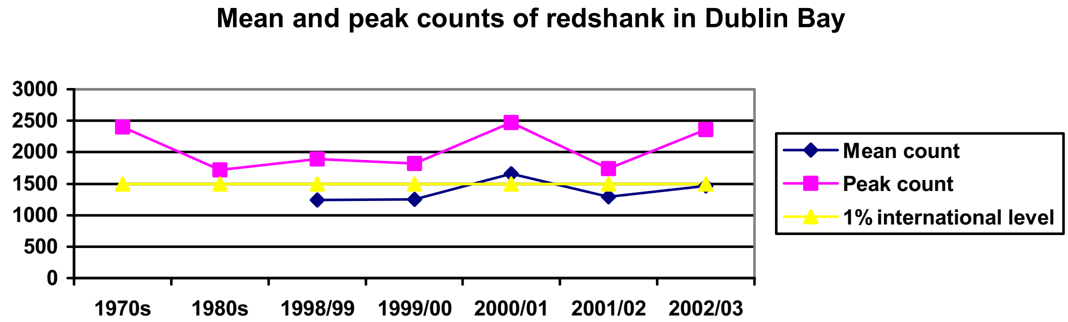
Curlew diet is varied, and includes crustaceans, polychaete worms, and bivalves. In general, curlew are found in higher densities on muddy sediments (Austin et al, 1996). In Dublin Bay, they feed on muddy sands, muds, and mixed littoral sediments including mussel beds. Crabs are an important part of the diet, curlew were found to take crabs with a carapace width of up to 35mm, much larger than the biggest ones taken by redshank, the other wader species which was found to eat crabs (Goss-Custard et al, 1977). Curlew also eat the polychaete species *Lanice*, *Arenicola*, and *Hediste*, and occur in higher densities where *Nephtys* spp. are abundant suggesting that they also take these species. (Yates et al, 1993). Bivalve species eaten by curlew include *Macoma balthica*, *Cerastoderma edule*, and *Scrobicularia plana*. Curlew generally eat the larger size classes of all prey species, which are too big for smaller waders to handle.



5.12. Redshank.

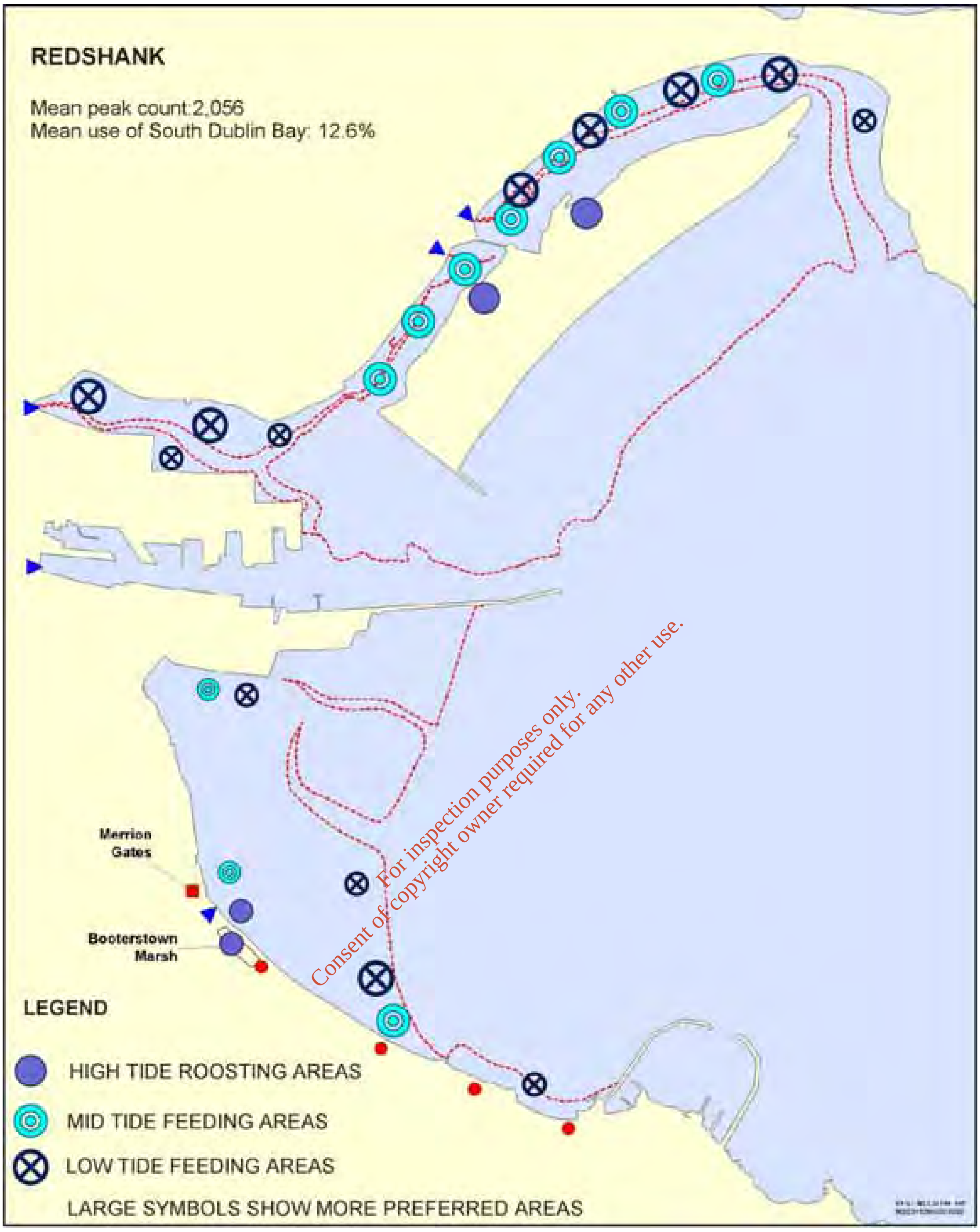
Internationally important species.

Redshank occur in internationally important numbers in Dublin Bay, and the population in Dublin Bay has been relatively stable through the 30 years for which at least some data are available. The population has increased somewhat in the last few years.



Redshank show strong preference for North Dublin Bay, consistent with their preference for muddy habitats (Table 3). They make little use of the Bull Wall Sands, most use of the Liffey Estuary at low tide is of mixed substrates and littoral muds in the Tolka Basin. Similarly in the North Bull Lagoon, most of the redshank feed on muds and mixed sediments, but with some use of muddy sand. In South Dublin Bay, redshank feed on relatively small areas of muddy sand which occur in channels and depressions of the shore. They also make some feeding use of Booterstown Marsh, particularly during windy conditions when the marsh is relatively sheltered. A small island in Booterstown Marsh has come into use as a high tide roost by redshank feeding in South Dublin Bay in the last few years, they also use the sand bar near Merrion Gates, and occasionally use the railway embankment.

Redshank diet is varied, with seasonal variation in the prey species taken which may be related to availability. The amphipod crustacean *Corophium* is a preferred prey species which may be relatively inactive at low temperatures and less detectable by the birds (Goss-Custard 1977). Redshank were found to take the polychaete worms *Hediste diversicolor* and *Nephtys hombergii*, and the bivalves *Macoma balthica* and *Scrobicularia plana*, when *Corophium* was not present. *Cerastoderma edule* and *Hydrobia* were also found to be taken by redshank, and also crabs, *Crangon* shrimps, and small fish (Goss-Custard et al, 1997). In another study, redshank low tide feeding density was found to be positively correlated with the density of *Nephtys* species, *Lanice, Corophium, Scoloplos armiger*, and *Hydrobia* (Yates et al, 1993). Redshank are reported to be the only wader that makes extensive feeding use of salt meadow creeks (Goss-Custard et al, 1977).

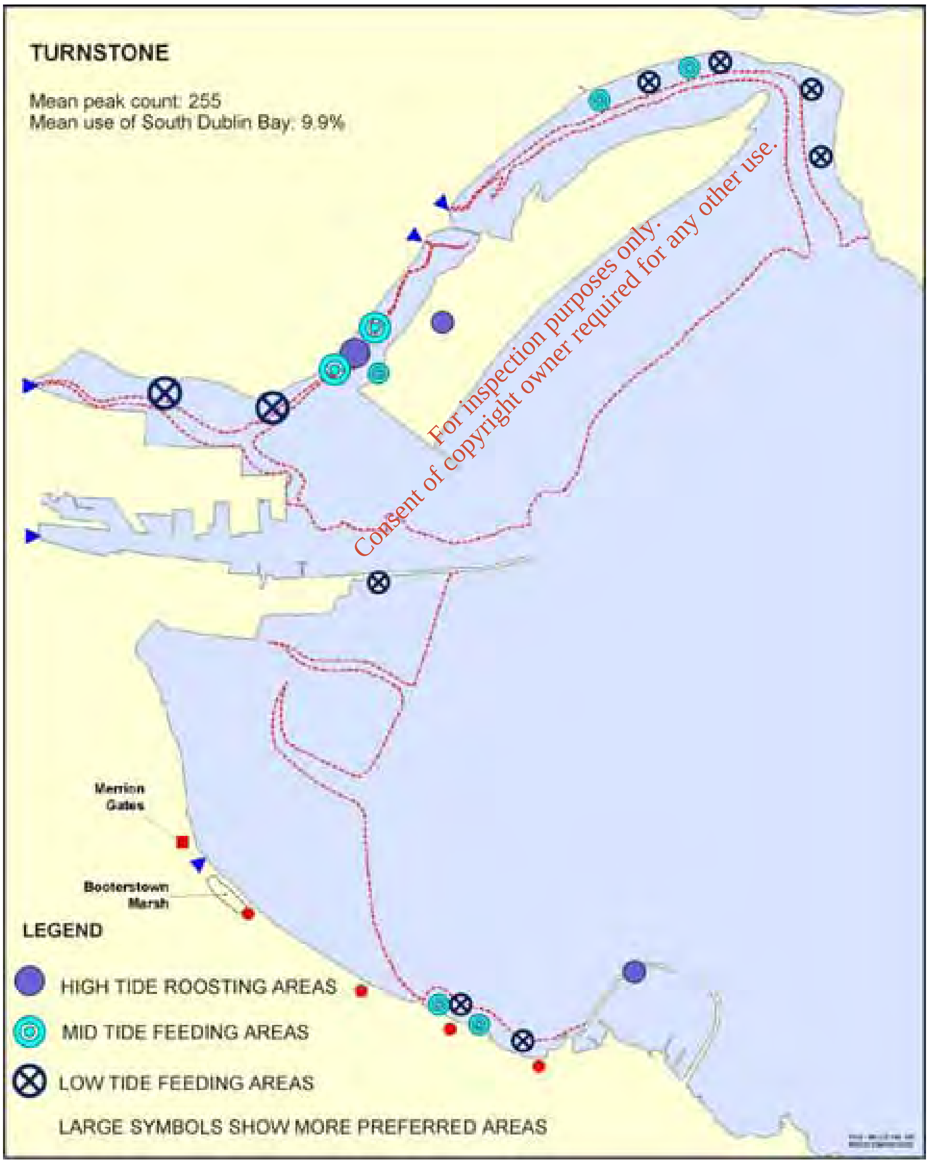

REDSHANK
Mean peak count:2,056
Mean use of South Dublin Bay: 12.6%
Merrion Gates
Booterstown Marsh
LEGEND
HIGH TIDE ROOSTING AREAS
MID TIDE FEEDING AREAS
LOW TIDE FEEDING AREAS
LARGE SYMBOLS SHOW MORE PREFERRED AREAS

5.13. Turnstone.

Nationally important species.

Turnstone show the highest preference for the South Bull Lagoon and Liffey Estuary, followed by the North Bull Lagoon. Small numbers occur in South Dublin Bay, where most of the use occurs between Blackrock and Dun-Laoghaire. Turnstone are sometimes recorded on the Great South Wall. In general, turnstone distribution in Dublin Bay is correlated with the presence of mixed littoral sediments and rock supporting a flora of brown algae. Turnstone feed on epifauna in these habitats, searching under stones and brown algae as their name implies.

The largest turnstone roost in Dublin Bay is in the South Bull Lagoon. In South Dublin Bay, turnstone roost on the west pier in Dun Laoghaire, or on the railway embankment.



6. SUMMARY OF INVERTEBRATE PREY SPECIES TAKEN BY WINTERING WATERFOWL.

Studies of shorebird ecology have shown that, in general, the main feeding areas of waders coincide with the areas where prey density is highest (Goss-Custard et al, 1977; Yates et al, 1993; Holloway et al, 1996). There is substantial overlap in the prey species taken, although different size classes of individual prey species are taken by the different wader species. Prey species taken can vary seasonally, and also during different stages of the tidal cycle and different tidal ranges. For example, the sand mason worm *Lanice conchilega* occurs on sandy lower shores, where it is accessible to waders during spring low tides, but not during neap low tides. Lanice was found to be an important prey species of grey plover, bar-tailed godwit and curlew on the Wash (Goss-Custard et al, 1977).

The prey species recorded for waterfowl, which are likely to include the species taken in Dublin Bay, are summarised in Table 4 below. The information available in the

Table 4. Prey species reported for shelduck and waders.

	Shelduck	Oystercatcher	Ringed plover	Grey plover	Knot	Sanderling	Dunlin	Black-tailed godwit	Bar-tailed godwit	Curlew	Redshank
Polychaete worms											
Arenicola marina				+					+	+	
Hediste diversicolor			+	+	+		+	+	+	+	+
Lanice conchilega				+					+	+	
Nephtys spp.				+			+			+	+
Scoloplos armiger				+					+		+
Other polychaetes				+			+				
Oligochaete worms			+				+	?			?
Molluscs - gastropods											
Hydrobia ulvae	+		+		+		+		+		+
Littorina spp.			+						+		
Molluscs - bivalves											
Cerastoderma edule		+		+	+		+			+	+
Macoma balthica		+	+	+	+		+	+	+	+	+
Mya arenaria								+			
Mytilus edulis		+									
Scrobicularia plana								+		+	+
Crustaceans											
Crabs									+	+	+
Amphipods	+		+	+	+	+			+		+
Diptera - flies					+	+					

literature and cited in this study above relates extensively to the Wash, a large coastal site in south east England. No comprehensive studies of wader diets in Dublin Bay have been published, although some undergraduate studies have been carried out.

Some consideration has been given to the suitability of different invertebrate prey species in Dublin Bay for monitoring of bio-accumulation of toxic substances, as a baseline for the proposed Waste to Energy Project EIS. Existing information indicates that the most heavily polluted parts of Dublin Bay are the Tolka Basin, the northern part of the South Bull Lagoon, and the southern part of the North Bull Lagoon (listed in descending order of pollution loading, Jeffrey et al, 1992). The sheltered conditions in these areas, together with tidal currents, lead to the deposition of fine sediments with a high capacity to accumulate pollutants. Any pollutants arising from discharges from the Waste to Energy Project would also be likely to accumulate in these areas. Recent sediment accumulation in South Dublin Bay seem likely to increase the capacity of the westernmost part of the bay at Irishtown to accumulate pollutants.

The invertebrate fauna communities in the most polluted areas of Dublin Bay are dominated by more tolerant forms: oligochaete worms, and cirratulid, spionid and capitellid polychaete worms (Dublin Port EIS, 1997, data for mixed littoral sediments and muds/muddy sands). These groups do not feature extensively in the literature on waterfowl diet, but this may be partly due to methodological difficulties; oligochate worms are small, and have no parts that persist through digestion by birds that can subsequently be identified by examination of pellets and droppings. They may be an important part of the diet of birds feeding in the Tolka Basin. The polychaete *Capitella capitata* is sufficiently abundant and widespread to be suitable for monitoring. Oligochates could be monitored as unsorted samples, as it would not be practical to identify and segregate samples to species level.

Other invertebrate species suitable for monitoring include cockle *Cerastoderma edule* and Baltic tellin *Macoma balthica*, which are widely distributed around mid-tide level and are eaten by a number of different wader species. The lower shore mussel *Mytilus edulis* is also suitable for monitoring as it occurs in two distinct areas in which pollution loadings differ, it is also a species consumed by humans. *Hydrobia* is relatively widespread in the bay and is a food species of three of the internationally important waterfowl species using Dublin Bay. Hediste diversicolor is a predatory polychaete taken by all four of the internationally important wader species in Dublin Bay, and has a wide distribution. *Arenicola marina* is also widespread in muddy sand habitats and is easily sampled. In general, invertebrate sampling should be carried out during fixed periods of the annual cycle, prior to spawning when the lipid content of body tissues is maximal.

7. BREEDING TERNS.

There is a breeding tern colony on mooring dolphins proposed Natural Heritage Area in Dublin Docks. The main colony is on the ESB Poolbeg dolphin, and has increased from 34 nesting pairs in 1995 to 222 pairs in 2001. Most of the terns present are common terns, with a small number of arctic terns. The colony has increased in size as a result of positive management: the division of the dolphin surface into compartments allows terns to nest at higher densities by reducing nesting birds view of other pairs, hence reducing aggressive interactions. The provision of boards around the edge of the dolphin has also increased breeding success by preventing chicks from falling off the structure. Common and arctic terns feed mainly on marine fish and crustaceans. They often follow ships in Dublin Bay and the Dublin Port navigation channel, presumably catching fish disturbed by propellors (Dublin Port EIS, 2002).

Large roosts (thousands) of post-breeding terns assemble near Merrion Gates in late summer/early autumn, and include roseate, common and arctic terns.

8. PRELIMINARY RECOMMENDATIONS ON WATERFOWL MONITORING.

Changes in the numbers of waterfowl in Dublin Bay may arise in a 'do nothing' scenario, i.e. in which the proposed Waste to Energy Project does not proceed, or proceeds at a location other than Ringsend. The most likely factors which could lead to changes in the short, medium and long term would seem to be as follows:

- Climate change has the potential to alter the numbers of waterfowl wintering in Dublin Bay, if as predicted winters become milder and Siberian breeding populations no longer migrate as far west as they do currently. There is some evidence that this is already happening with in the UK, but comparable analysis of waterfowl data in Ireland is not complete and may not provide a clear trend yet (I-WeBS data). Waterfowl breeding success may also alter, changing total population size for some species.

- The commissioning of the Dublin Bay Project Sewage Treatment Works in late 2002/early 2003 has resulted in reduced nutrient inputs to Dublin Bay. This could impact on green algal distribution and biomass, and on invertebrate fauna distribution in terms of diversity and biomass, with consequences for wintering waterfowl arising from altered food availability. Any such changes are likely to be slow, because of existing high nutrient loadings in sediments, particularly in the fine sediments present in the Tolka Basin and near the causeway in the South Bull Lagoon. In addition, other nutrient and pollution inputs to the bay (e.g. nutrient re-cycling in the Bull Lagoons, riverine inputs) will be unchanged.

- Other infrastructure projects, and possible increased recreational uses in Dublin Bay have the potential to impact on waterfowl populations or on the way they use Dublin Bay.

- Sedimentation/erosion processes within Dublin Bay could alter the nature and extent of habitats present. Some of these changes are likely to arise from climate change impacts.

It is not possible at this stage to assess what a 'worst case' scenario for the Dublin Waste to Energy Project could constitute, but it could arise from equipment failure, accidental spillages or unlicensed discharges. It is important that waterfowl and ecological monitoring is able to distinguish between the 'do nothing' scenario, the potential impacts of licensed discharges, and the 'worst case' scenario. The numbers of different waterfowl species using Dublin Bay vary in response to factors operating throughout their range (breeding and wintering areas, as well as sites used on migration). Changes in bird use of localised intertidal areas in Dublin Bay can only be identified with reference to the entire area of the Bay, and in the context of general population trends of individual species.

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Appendix E

Air Quality – Preliminary Dispersion Modelling

1.0 PRELIMINARY MODELLING FOR DUBLIN WASTE TO ENERGY SCHEME

1.1 Modelling Methodology

Preliminary modelling of emissions from the Dublin Waste to Energy Facility was carried out using the ISCST3 dispersion model, which has been developed by the U.S. Environmental Protection Agency (USEPA)[(1)]. The model is a steady-state Gaussian plume model used to assess pollutant concentrations associated with industrial sources. The model has been designated the regulatory model by the USEPA for modelling emissions from industrial sources in both flat and rolling terrain[(2)]. The Model is a steady state bi-Gaussian plume model used to assess pollutant concentrations from a wide variety of sources.

The ISCST3 model, in common with most dispersion models, deals separately with plume rise and diffusion. The treatment of diffusion is based on the Pasquill-Gifford system (updated by Turner) in which meteorological conditions are classified into a set of stability categories, defined by solar radiation, cloud cover and wind speed, with values of plume spread given for each category. The plume spread is based on a Gaussian distribution in both the horizontal and vertical.

Plume Rise and Behaviour

The core of the plume rise equations use algorithms developed by Briggs (1969, 1971 and 1975). The height of the final plume rise is dependant on the prevailing wind speed, atmospheric stability and momentum and buoyancy associated with the plume. The plume is also influenced by stack tip and building downwash, the equations of which used in this study have been calculated by Briggs (1974) and Schulman Scrire (1980) and subsequently refined by the USEPA. Downwash is a function of the structure dimensions, wind speed, wind-direction and emission height[(1)].

The plume is assumed to rise initially due to momentum and buoyancy and gradually rise to its maximum height above ground level once the heat and subsequent buoyancy of the plume has equilibrated with the surrounding air. Once the maximum plume height has been reached, the model assumes that the centre of the plume remains at this height while the plume is dispersed both horizontally and vertically.

Gaussian Dispersion

When the height of the plume has stabilised, the dispersion of pollutants is then based on Gaussian dispersion horizontally and vertically from the plume centreline. A number of dispersion coefficients are available to the model. In this study dispersion coefficients corresponding to densely populated areas have been used.

The plume is confined within a body of air defined by the mixing height, the height of which is dependant upon the atmospheric stability and extent of sun-radiation reaching the ground, wind speed and surface roughness. Mixing height measurements by radiosonde are only carried out by Met Eireann in Valentia and therefore the mixing heights used in this study have been inferred for each hour from the fore-mentioned parameters.

Due to the proximity to surrounding buildings, the Building Profile Input Program (BPIP) has been incorporated into the model to determine the influence (wake effects) of these buildings on dispersion in each direction considered.

The ISCST3 model incorporated the following features:

- Two nested receptor grids were identified at which concentrations would be modelled. Receptors were mapped with sufficient resolution to ensure all localised "hot-spots" were identified without adding unduly to processing time. Each grid was based on a Cartesian grid with the site at the centre. The first grid extended to 1500m from the site, with concentrations calculated at 200m intervals and the second grid extended to 10km with concentrations calculated at 1km intervals. In addition, boundary receptor locations were also placed along the boundary of the site, giving a total of 889 calculation points for each model case.

- All on-site buildings and significant process structures were mapped into the computer to create a three dimensional visualisation of the site and its emission points. Buildings and process structures can influence the passage of airflow over the emission stacks and draw plumes down towards the ground (termed building downwash). The stacks themselves can influence airflow in the same way as buildings by causing low pressure regions behind them (termed stack tip downwash). Both building and stack tip downwash were incorporated into the modelling.

- Hourly-sequenced meteorological information has been used in the model. Meteorological data over a five year period was selected for use in the model. A site-specific surface roughness factor was developed for the site.

- Detailed terrain has been mapped into the model. The site is located adjacent to several terrain features which have been mapped into the model out to a radius of 10 km with the site at the centre.

1.2 Meteorological Considerations

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

The selection of the appropriate meteorological data has followed the guidance issued by the USEPA(2). A primary requirement is that the data used should have a data capture of greater than 90% for all parameters. The additional requirements of the selection process depend on the representativeness of the data. The representativeness can be defined as "the extent to which a set of measurements taken in a space-time domain reflects the actual conditions in the same or different space-time domain taken on a scale appropriate for a specific application"(3). Thus, the meteorological data should be representative of conditions affecting the transport and dispersion of pollutants in the area of interest as determined by the location of the sources and receptors being modelled.

The representativeness of the data is dependent on(2):

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

2) the complexity of the terrain

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

4) the period of time during which data is collected.

The nearest meteorological stations to the site, which record data in the correct format for input into the model, are Casement Aerodrome and Dublin Airport. The surface characteristics around Dublin Airport are more representative of those in Ringsend, and therefore real meteorological data collected at Dublin Airport from 1998-2002 has been used as input to the model.

1.3 Air Dispersion Modelling

Emissions from the proposed site has been modelled using the ISCST3 dispersion model which is the USEPA's regulatory model used to assess pollutant concentrations associated with industrial sources(1). Emissions were assessed under the maximum emissions limits of the EU Directive 2000/76/EC.

Stack Emissions

The modelling will have one main process emission point which was initially assumed to have a stack height of 40m. The operating details of this emission point has been taken from information supplied by COWI, based on a 400,000 tonnes incinerator and are outlined in Table 1.1.

Table 1.1 Process Emission Design Details

Stack Reference	Stack Height (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temp (K)	Volume Flow (Nm^3/hr)	Exit Velocity (m/sec actual)
Stack	40	3.0	7.07	373	275,000	14.5

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

No detail designs are available for the building layout. The building layout may have a significant influence on dispersion due to building downwash. In the absence of this information, it was assumed that the building layout was similar to a proposed commercial incinerator recently granted planning permission in Carranstown, Co. Meath.

Identification of Hot Spots

Nitrogen dioxide was identified as one of the key pollutants to be emitted from the site with both short-term and longer-term implications. Due to the likely significant background levels and relatively large emissions from the facility, NO_X was selected as a suitable parameter to help determine hot-spots due to the proposed facility for use in the monitoring survey.

Emissions of NO_X were assessed using the maximum emissions limits of the EU Directive 2000/76/EC. Five years of meteorological data from Dublin Airport was assessed from 1998 – 2002 using the process emission data in Table 1.1. The purpose of this preliminary modelling was to identify potential hot spots in order to aid in identifying suitable monitoring locations for the diffusive sampling and the fixed monitoring station.

The details of the actual ground level concentrations (GLCs) were not of concern at this stage due to the uncertainty over:

- emission details,
- siting of the facility within the site boundary,

- and uncertainty over the building layout.

Figure 1 and 3 show the concentration contour pattern for the 99.8th%ile of hourly NO_x concentrations within 2km radius of the site using Dublin Airport 1999 meteorological station. This area is the main focus of concern from the point of view of identifying the most suitable permanent monitoring station and 6 locations for the diffusive sampling.

The 40m stack (Figure 1) shows a very local maximum near the boundary of the site with a contour pattern influenced not only by meteorological conditions but also building downwash considerations. The 50m (Figure 3) decreases less rapidly away from the site and has some local maxima near the East Link bridge and the North Docks.

Of more significance in relation to the diffusion tube monitoring is the longer term average concentration. Figure 2 and 4 show the concentration contour pattern for the annual average NO_x concentrations within 2km radius of the site using Dublin Airport 1999 meteorological station.

The 40m stack (Figure 2) shows a very local maximum near the north-eastern boundary of the site with a contour pattern influenced not only by the prevailing south-westerly wind but also building downwash considerations. The 50m stack (Figure 4) decreases less rapidly away from the site but again shows the dominant influence of the prevailing wind with the maxima to the north-east of the site. Some local maxima occur near Irishtown Park and the North Docks.

Of primary consideration in selecting suitable monitoring locations, is the sensitivity of areas near the proposed incinerator. Of most concern are residential areas, schools, public open spaces such as parks and ecologically significant areas such as Bull Island.

In order to ensure that the maxium GLC had been identified and that other sensitive areas were investigated, the modelling was re-assessed using a radius of 10km from the site. Figures 5, 7, 9, 11, 13 indicate the 99.8th%Ile of NO_X concentrations for each respective year from 1998 – 2002 at a stack height of 40m. The maximum GLC is within the 2km radius of the site in all years. Some variations are apparent year-on-year with an occasional local maximum extending south of the site to the general Sandymount / Blackrock area.

Figures 6, 8, 10, 12, 14 indicate the annual average NO_X concentrations for each respective year from 1998 – 2002 at a stack height of 40m out to a radius of 10km from the site. The maximum GLC is within the 2km radius of the site in all years. Some variations are apparent year-on-year with an occasional local maximum extending south of the site to Sandymount.

Figure 15 indicate the 99.8th%Ile of NO_X concentrations for 1999 at a stack height of 80m. The maximum GLC is again within 2km radius of the site. There are some local maxima including Stillorgan and Howth. Figure 16 indicates the annual average NO_X concentrations for 1999 at a stack height of 80m. The maximum GLC is again within 2km radius of the site.

Monitoring Locations

The selection of the fixed monitoring location was primarily focussed on identifying the residential receptors within 1-2km of the site, which will be impacted most by the facility. Figure 2 indicated that the annual average concentration from the facility decreased sharply away from the site to approximately 800m. Thereafter, the concentration gradient is not particularly significant. The nearest residential area to the site is west of the Sean Moore Rd approximately 1km from the site. This area was identified as the residential area most impacted by the facility and with an already significant background concentration due to the main road. The fixed monitoring site was located at Irish Glass Ltd across the Sean Moore

Rd from the residential area due to logistical reasons. The station was located at approximately the same distance from the road source as the surrounding residential receptors. As the fixed monitoring station is downwind of the prevailing SW wind, the data would be expected to overestimate the existing long-term ambient air quality at the receptors which are upwind of the prevailing wind relative to the Sean Moore Road (see Figure 17).

In terms of diffusion tube monitoring, the focus was on obtaining a significant geographical spread in the monitoring and to focus on the most significant sensitive environments in the area (see Figure 17 and Table 1.2). Bull Island (M6), to the north-east of the site, was identified as a sensitive ecological area. In addition, the nearest residential area north of the site, Clontarf (M7), was also identified as the most suitable residential receptor in this area.

South of the site, Irishtown Nature Reserve (M5) is also an area of significant ecological importance and thus was selected as a monitoring location. In terms of amenity, both Sean Moore Park (M3) and Ringsend Park (M5) are important in the local community and thus were selected as monitoring sites. Finally, Sandymount Green was selected as an appropriate location for residential receptors south of the site. The use of areas of grassland also allows a comparison with the soil monitoring data.

Locations	Monitoring Parameters
M1 – Irish Glass (Fixed Monitoring Station)	Continuous NO_X, PM_{10}, $PM_{2.5}$, Dioxins, Acid Gases, Metals, Diffusion Tubes (NO_2, SO_2, Benzene)
M2 – Irishtown Nature Reserve	Diffusion Tubes (NO_2, SO_2)
M3 – Sean Moore Park	Diffusion Tubes (NO_2, SO_2)
M4 – Sandymount Green	Diffusion Tubes (NO_2, SO_2)
M5 – Ringsend Park	Diffusion Tubes (NO_2, SO_2)
M6 – Bull Island	Diffusion Tubes (NO_2, SO_2)
M7 – Belgrove Road, Clontarf	Diffusion Tubes (NO_2, SO_2)

Table 1.2 Air monitoring locations

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(1) USEPA (1995) User's Guide for the Industrial Source Complex (ISC3) Dispersion Model Vol I & II
(2) USEPA (2003) Guidelines on Air Quality Models, Appendix W to Part 51, 40 CFR Ch.1
(3) USEPA (1998) Minimum Meteorological Data Requirements For AERMOD – Study & Recommendations", 1998, USEPA.

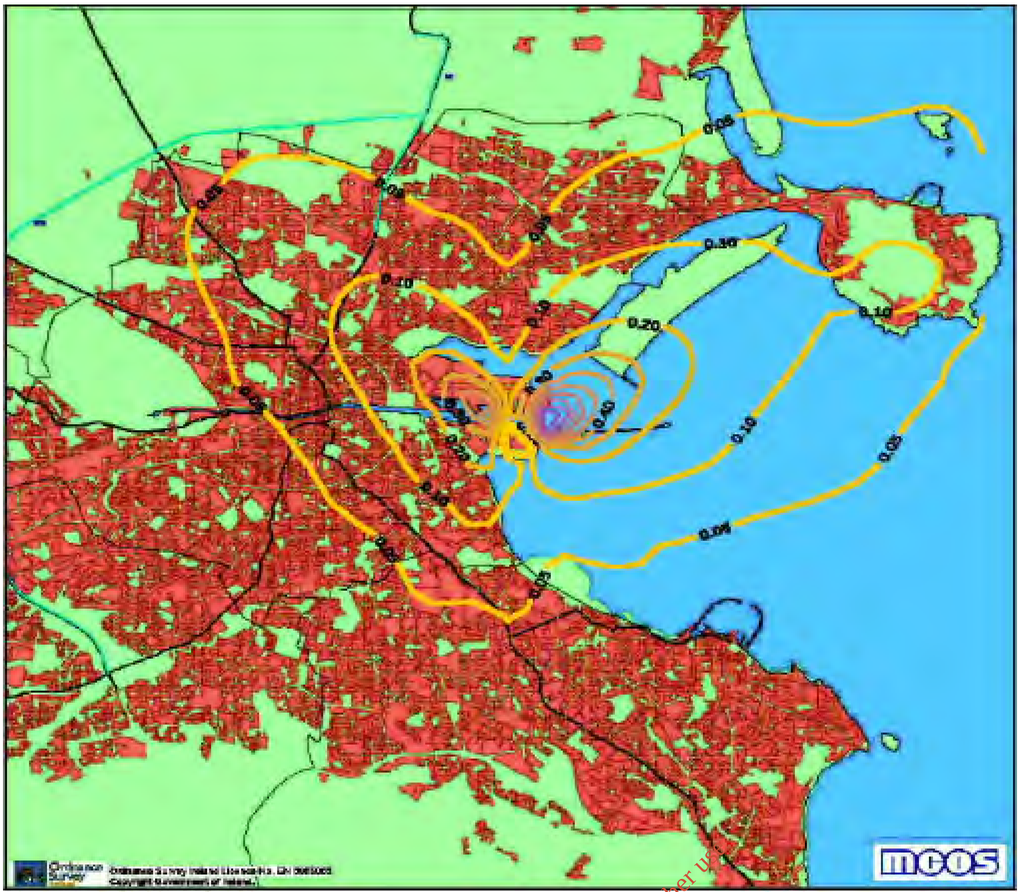

Figure 1: Predicted Annual Dioxin Concentrations (fg/m3)
Proposed Poolbeg Incinerator, 80m Stack

Scale: 1:140000 approx

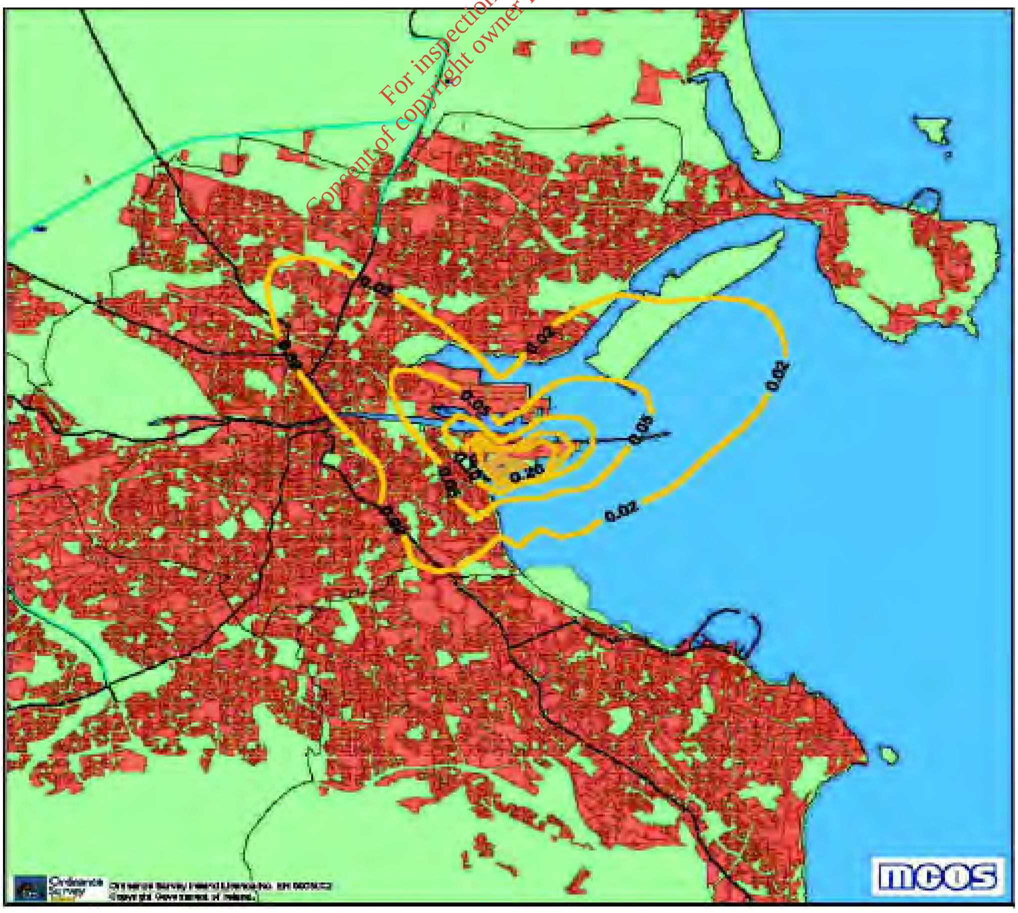

Figure 2: Predicted Annual Average Dioxin Total Deposition (ng/m2/annum).
Proposed Poolbeg Incinerator, 80m Stack

Scale: 1:140000 approx

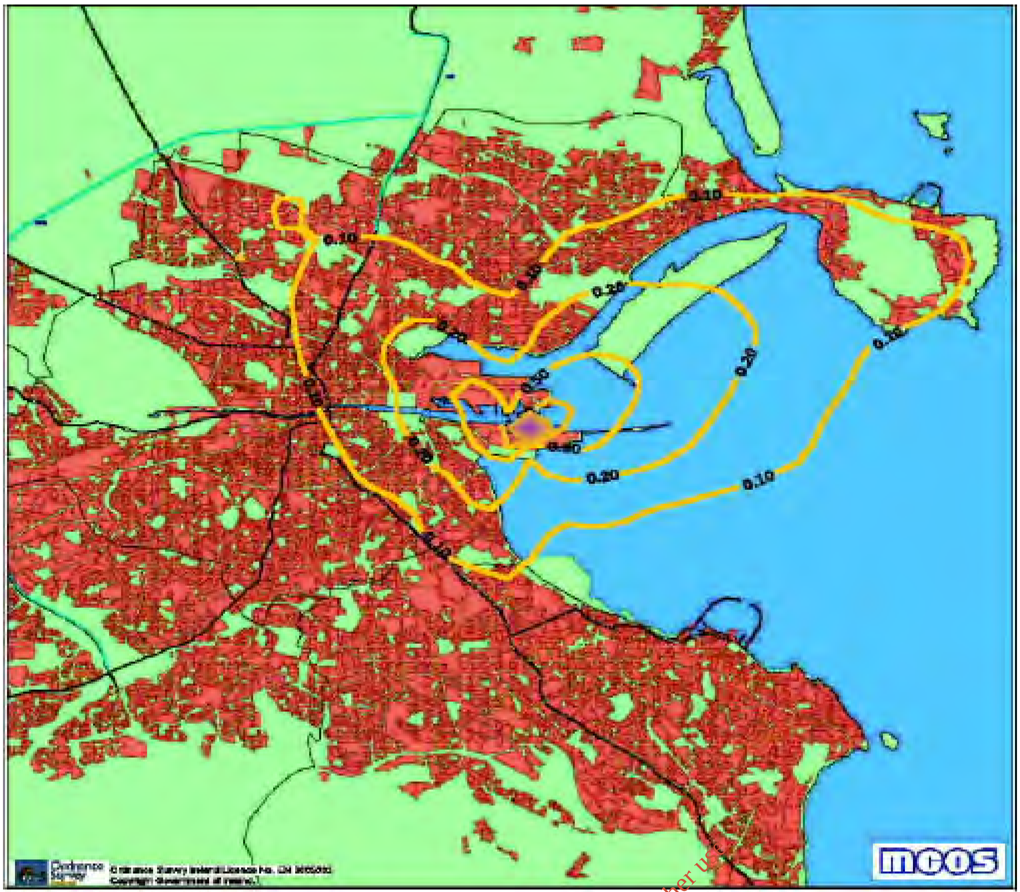

Figure 3: Predicted Annual Average Dioxin Concentrations (fg/m3).
Proposed Poolbeg Incinerator, 40m Stack

Scale: 1:140000 approx

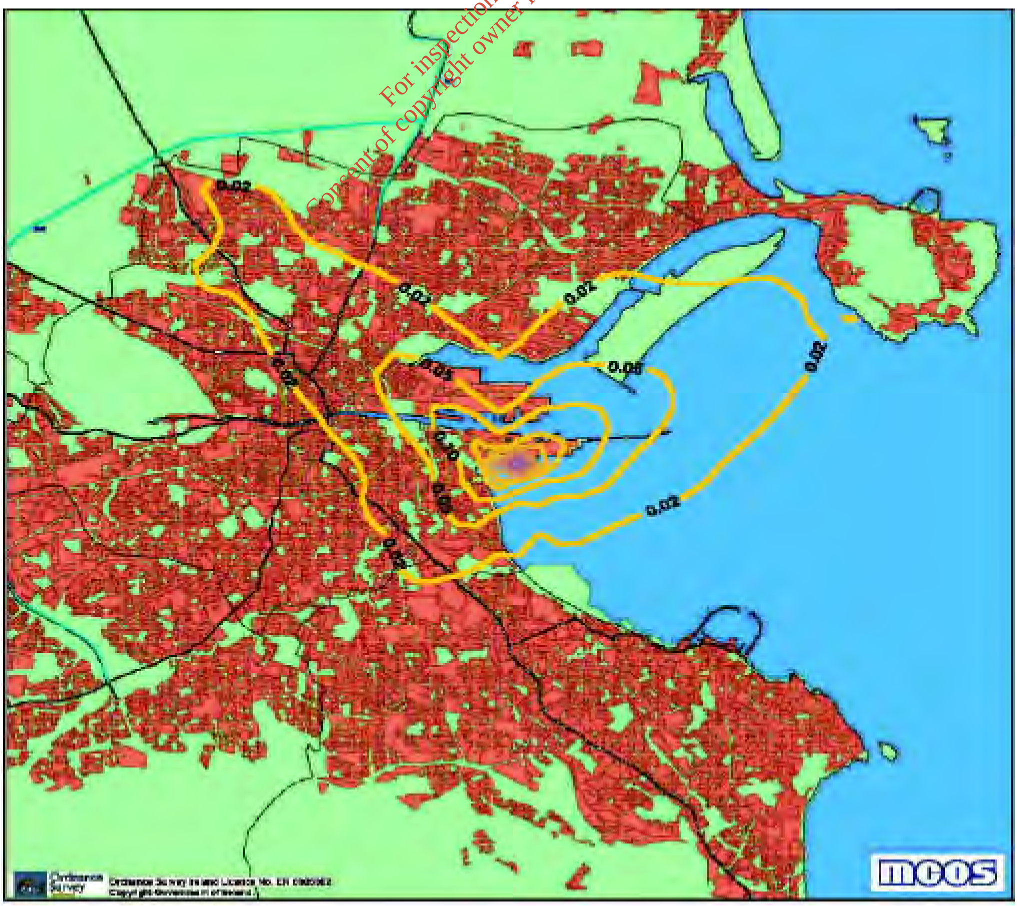

Figure 4: Predicted Annual Average Dioxin Total Depositions (ng/m2/annum).
Proposed Poolbeg Incinerator, 40m Stack

Scale: 1:140000 approx

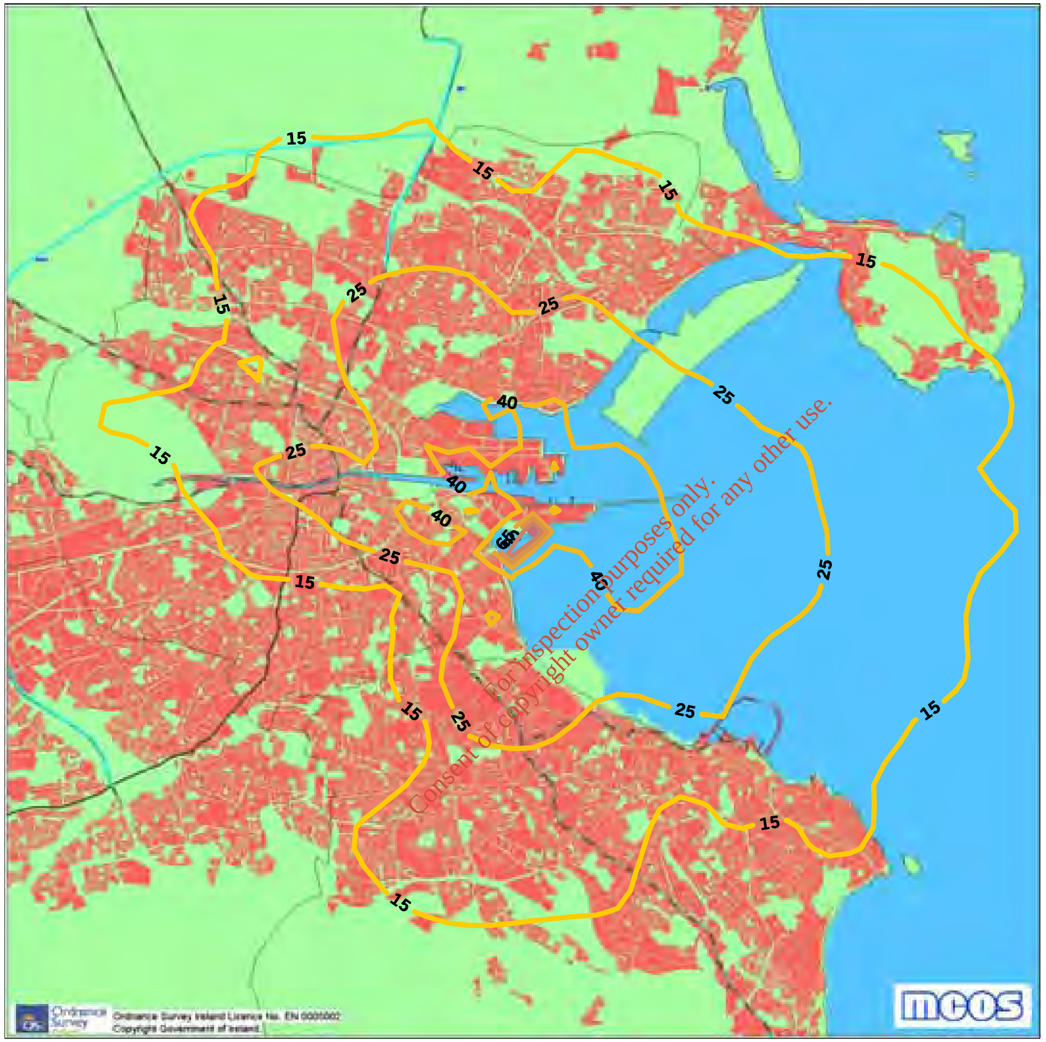

Figure 5: Predicted 99.8th%ile maximum nitrogen dioxide concentrations microg/m3.
Proposed Poolbeg Incinerator, 40m stack, 1998

Reproduced from Ordnance Survey Ireland Permit No: EN 0007503

Scale 1:27000 approx

Project

Incinerator Facility, Poolbeg

Reference

03_1774AR01

Figure 5

Predicted 99.8th%ile of Maximum NO_2 Concentrations ($\mu g/m^3$)

awn consulting

The Tecpro Building, Clonshaugh Industrial Estate, Dublin 17. Tel: +353 (0)1 847 4220 Fax: +353 (0)1 847 4257

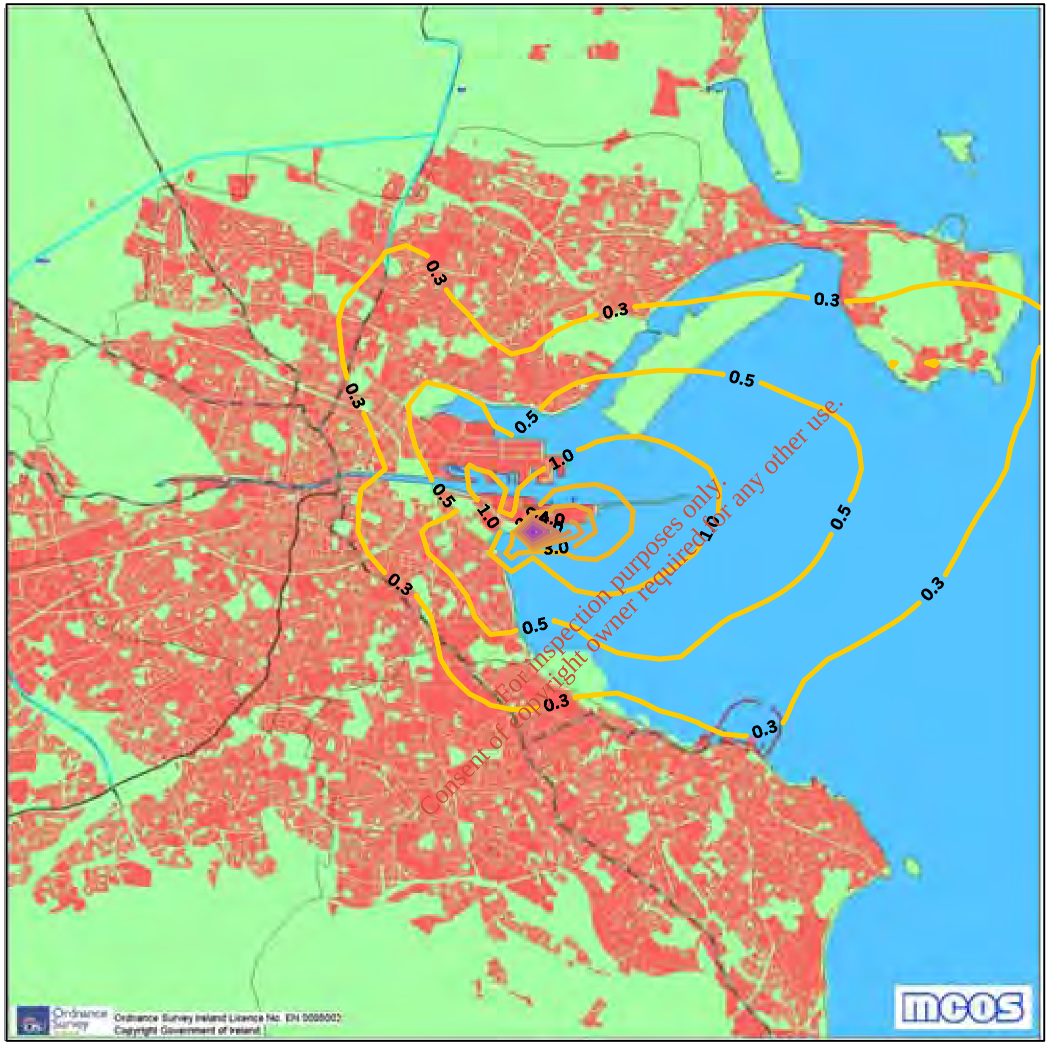

**Figure 6: Predicted annual average nitrogen dioxide concentrations microg/m3.
Proposed Poolbeg Incinerator, 40m stack, 1998**

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Scale 1:27000 approx

Project

Incinerator Facility,
Poolbeg

Reference

03_1774AR01

Figure 6

Predicted NO_2 Annual
Average Concentrations
($\mu g/m^3$)

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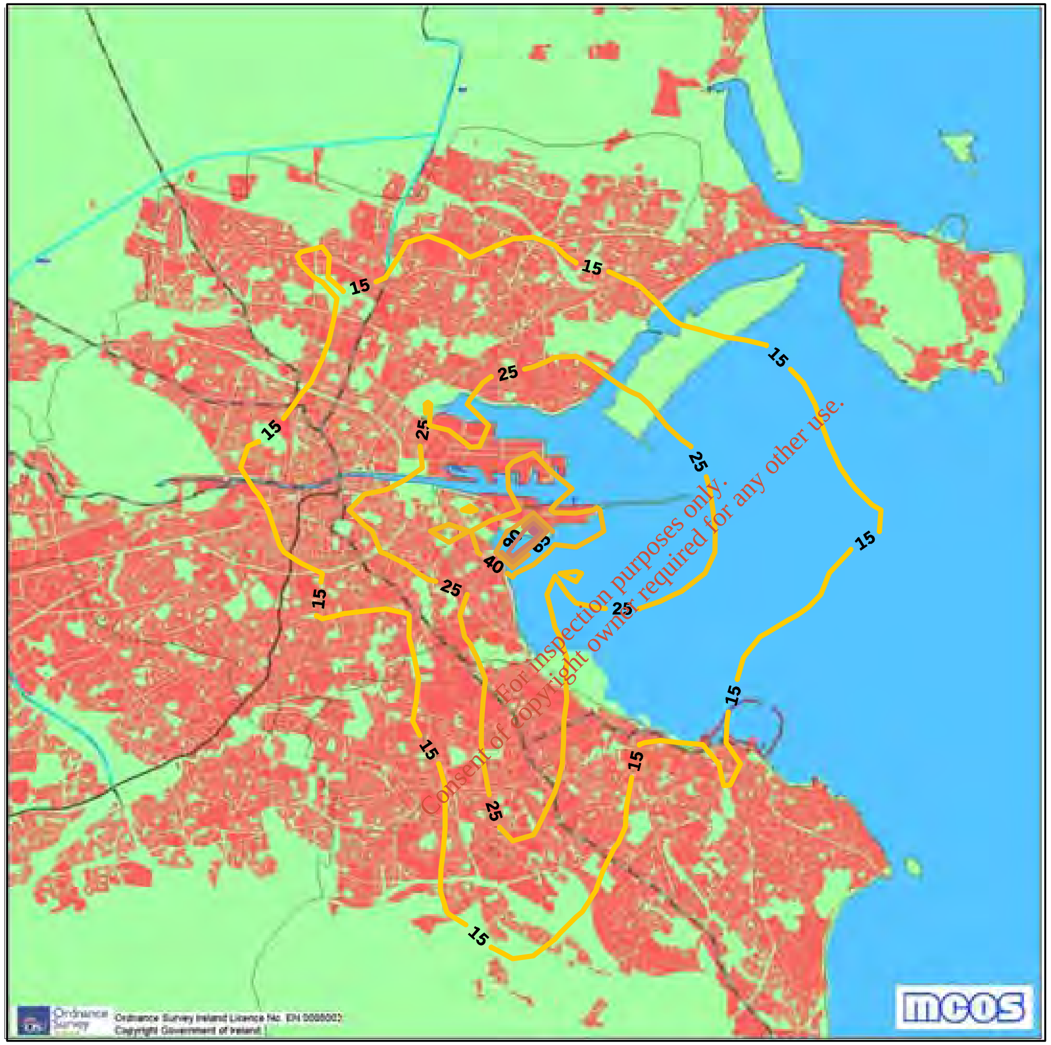

**Figure 7: Predicted 99.8th%ile maximum nitrogen dioxide concentrations microg/m3.
Proposed Poolbeg Incinerator, 40m stack, 1999**

Scale 1:27000 approx

Project

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Reference

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Figure 7

Predicted 99.8th%ile of Maximum NO_2 Concentrations ($\mu g/m^3$)

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Figure 8: Predicted annual average nitrogen dioxide concentrations microg/m3.
Proposed Poolbeg Incinerator, 40m stack, 1999

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Figure 8

Predicted NO_2 Annual Average Concentrations ($\mu g/m^3$)

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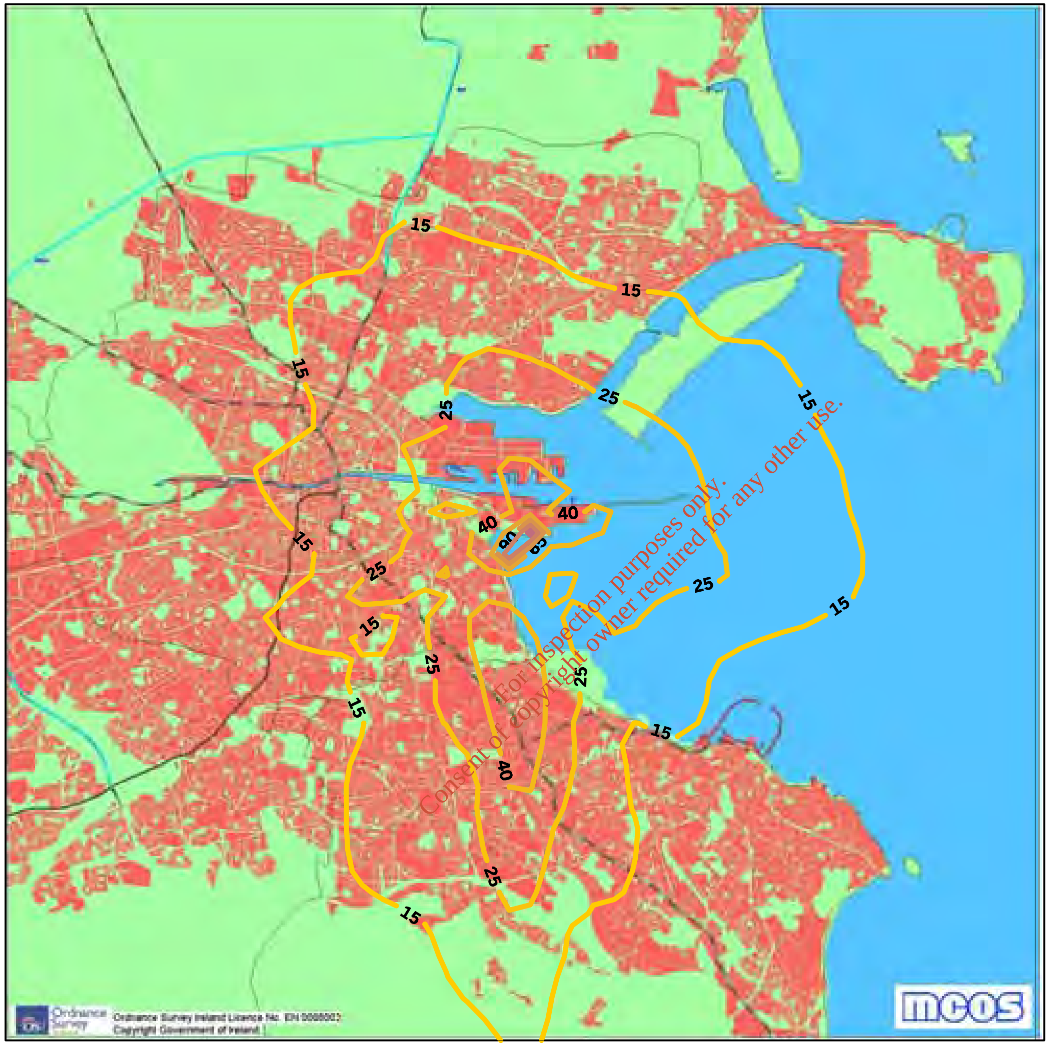

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Figure 9: Predicted 99.8th%ile maximum nitrogen dioxide concentrations microg/m3. Proposed Poolbeg Incinerator, 40m stack, 2000

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Figure 9

Predicted 99.8th%ile of Maximum NO_2 Concentrations ($\mu g/m^3$)

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**Figure 10: Predicted annual average nitrogen dioxide concentrations microg/m3.
Proposed Poolbeg Incinerator, 40m stack, 2000**

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Reference

03_1774AR01

Figure 10

Predicted NO_2 Annual Average Concentrations ($\mu g/m^3$)

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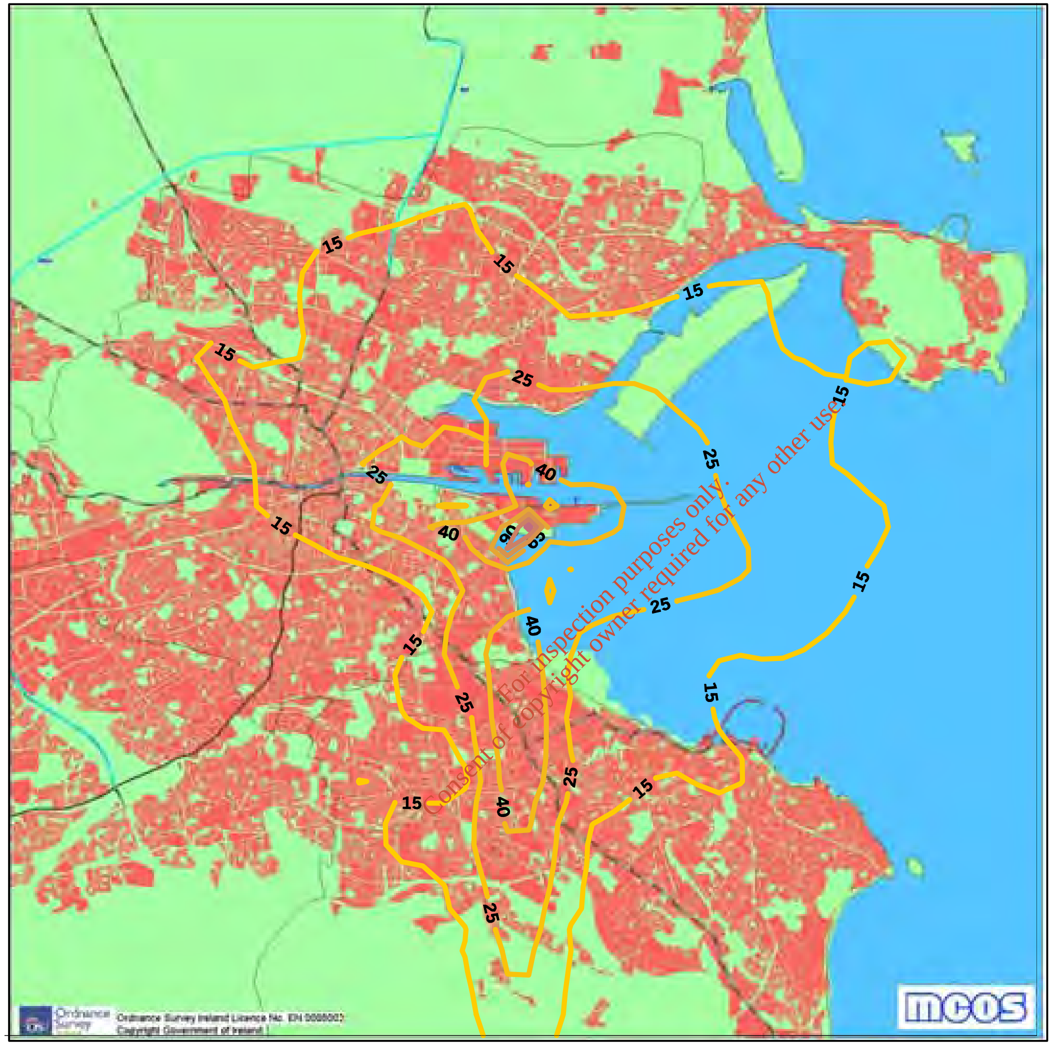

Figure 11: Predicted 99.8th%ile maximum nitrogen dioxide concentrations microg/m3. Proposed Poolbeg Incinerator, 40m stack, 2001

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Scale 1:27000 approx

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Incinerator Facility, Poolbeg

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03_1774AR01

Figure 11

Predicted 99.8th%ile of Maximum NO_2 Concentrations ($\mu g/m^3$)

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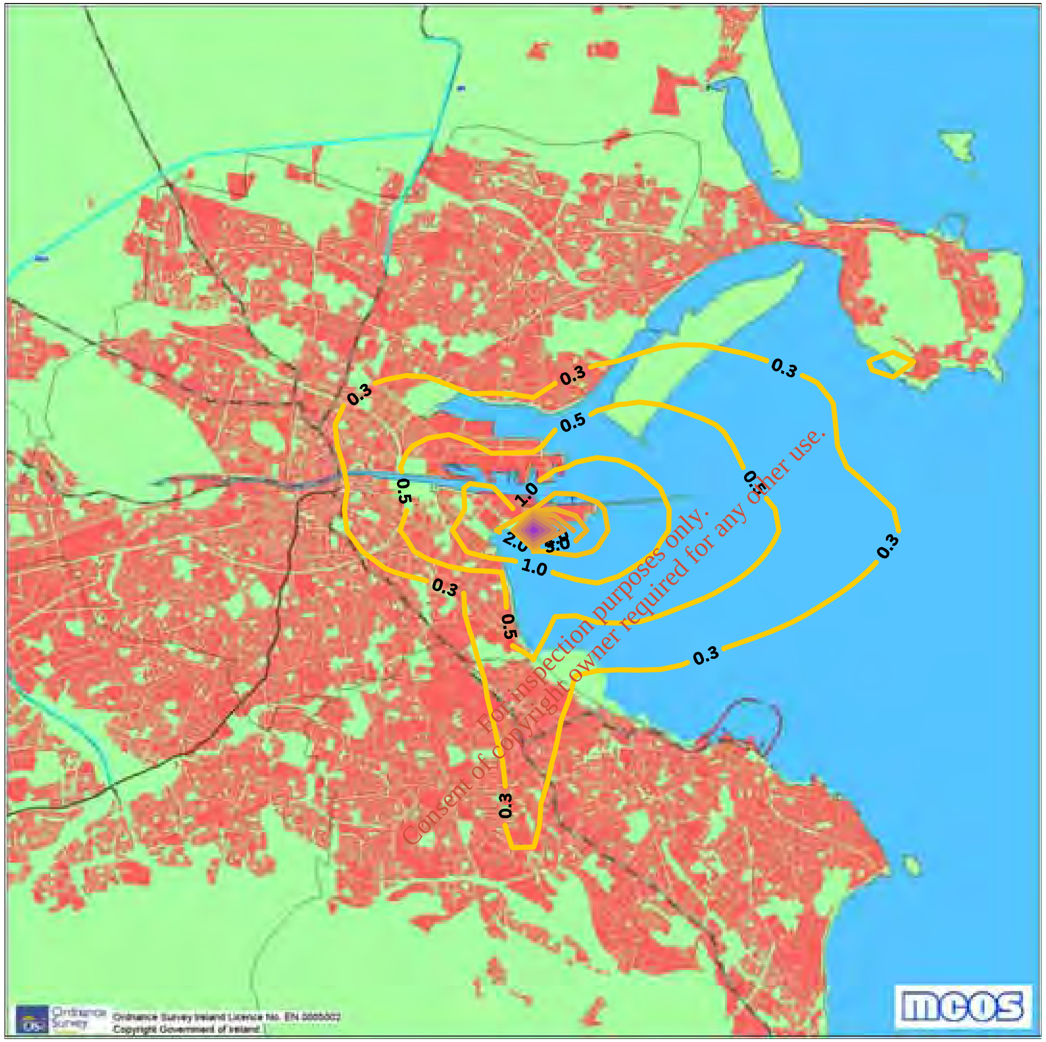

Figure 12: Predicted annual average nitrogen dioxide concentrations microg/m3. Proposed Poolbeg Incinerator, 40m stack, 2001

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Incinerator Facility, Poolbeg

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Figure 12

Predicted NO_2 Annual Average Concentrations ($\mu g/m^3$)

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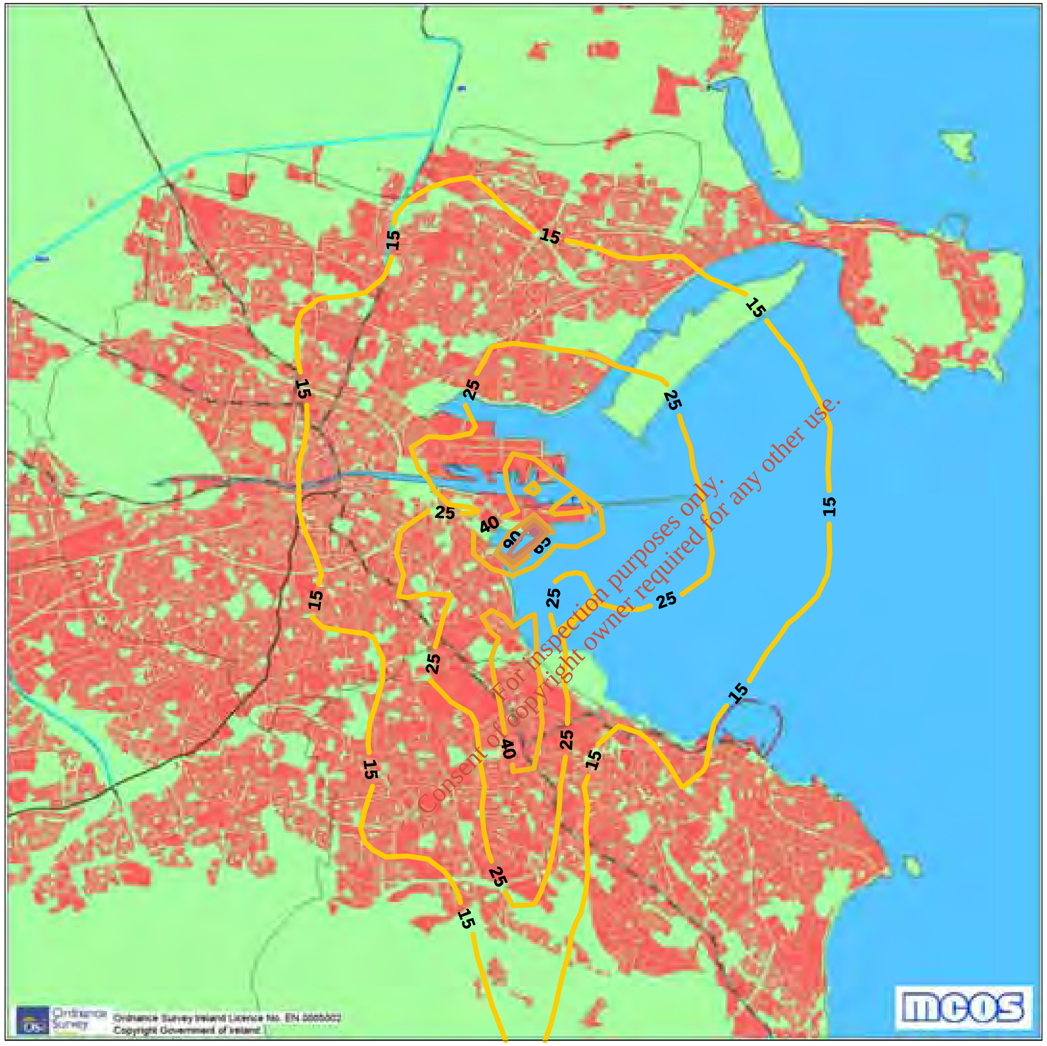

**Figure 13: Predicted 99.8th%ile maximum nitrogen dioxide concentrations microg/m3.
Proposed Poolbeg Incinerator, 40m stack, 2002**

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Incinerator Facility, Poolbeg

Reference

03_1774AR01

Figure 13

Predicted 99.8th%ile of Maximum NO_2 Concentrations ($\mu g/m^3$)

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Figure 14: Predicted annual average nitrogen dioxide concentrations microg/m3.
Proposed Poolbeg Incinerator, 40m stack, 2002

Project

Incinerator Facility, Poolbeg

Reference

03_1774AR01

Figure 14

Predicted NO_2 Annual Average Concentrations ($\mu g/m^3$)

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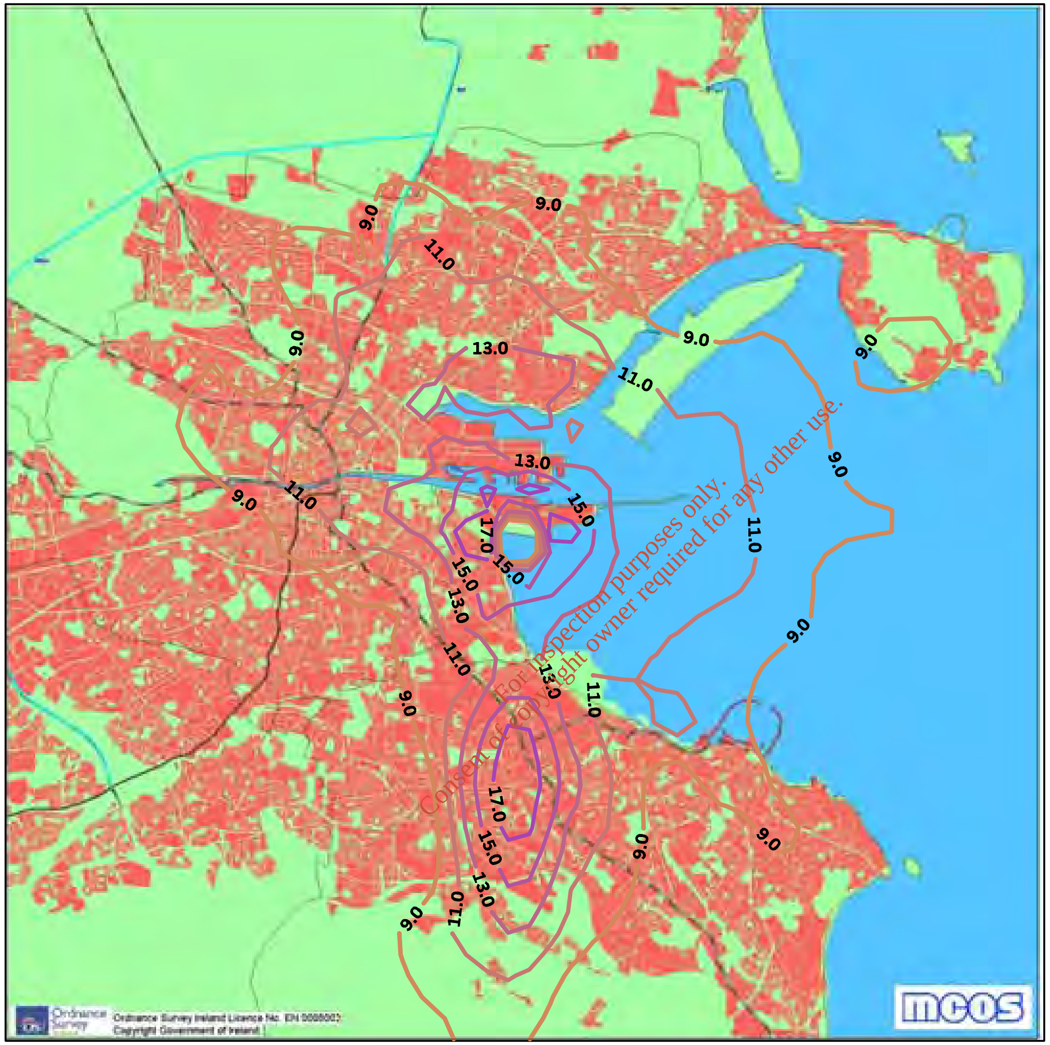

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Scale 1:27000 approx

Figure 15: Predicted 99.8th%ile maximum nitrogen dioxide concentrations microg/m3. Proposed Poolbeg Incinerator, 80m stack, 1999

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Incinerator Facility, Poolbeg

Reference

03_1774AR01

Figure 15

Predicted 99.8th%ile of Maximum NO_2 Concentrations ($\mu g/m^3$)

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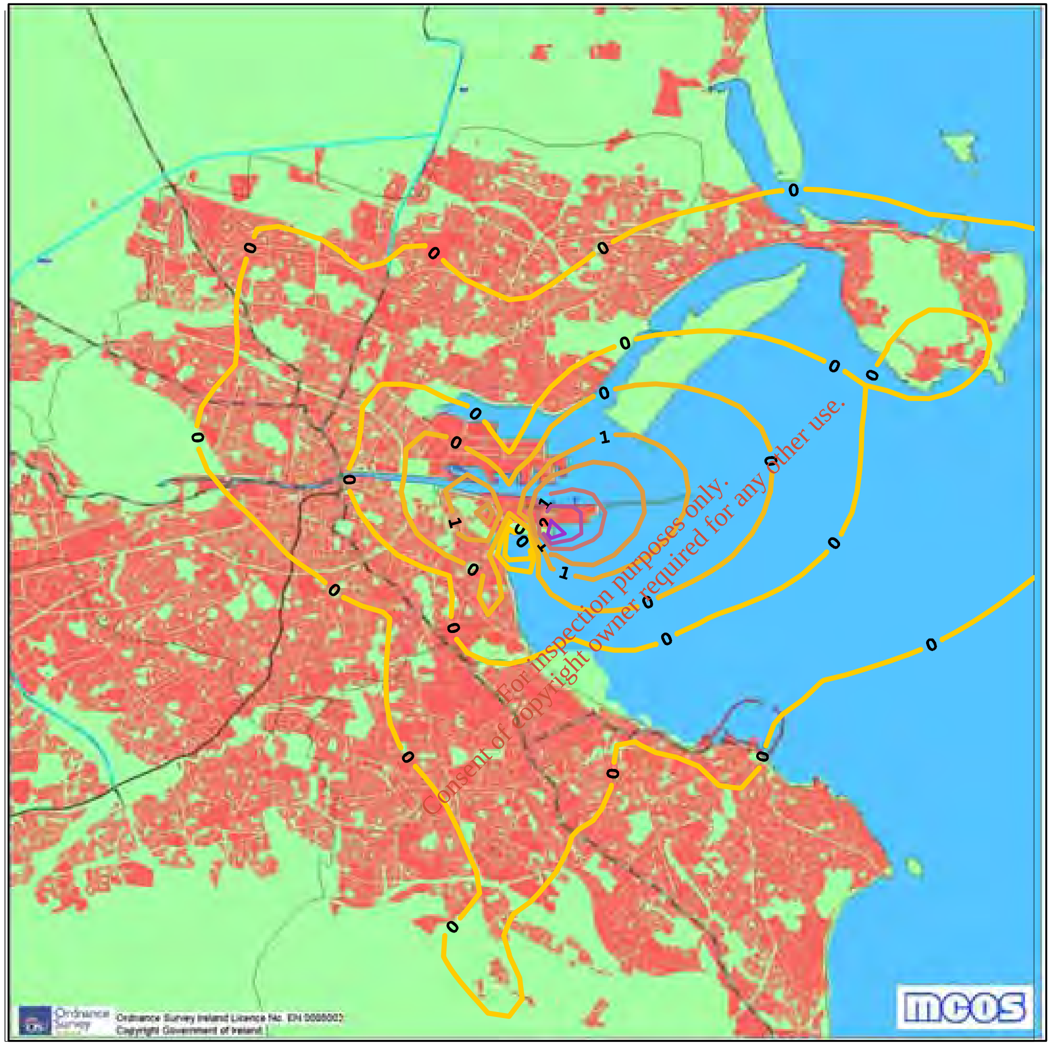

Figure 16: Predicted annual average nitrogen dioxide concentrations microg/m3.
Proposed Poolbeg Incinerator, 80m stack, 1999

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Incinerator Facility, Poolbeg

Reference

03_1774AR01

Figure 16

Predicted NO_2 Annual Average Concentrations ($\mu g/m^3$)

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Appendix F

Air Quality – Baseline Air Monitoring

SUMMARY ASSESSMENT OF BASELINE AIR QUALITY AT POOLBEG

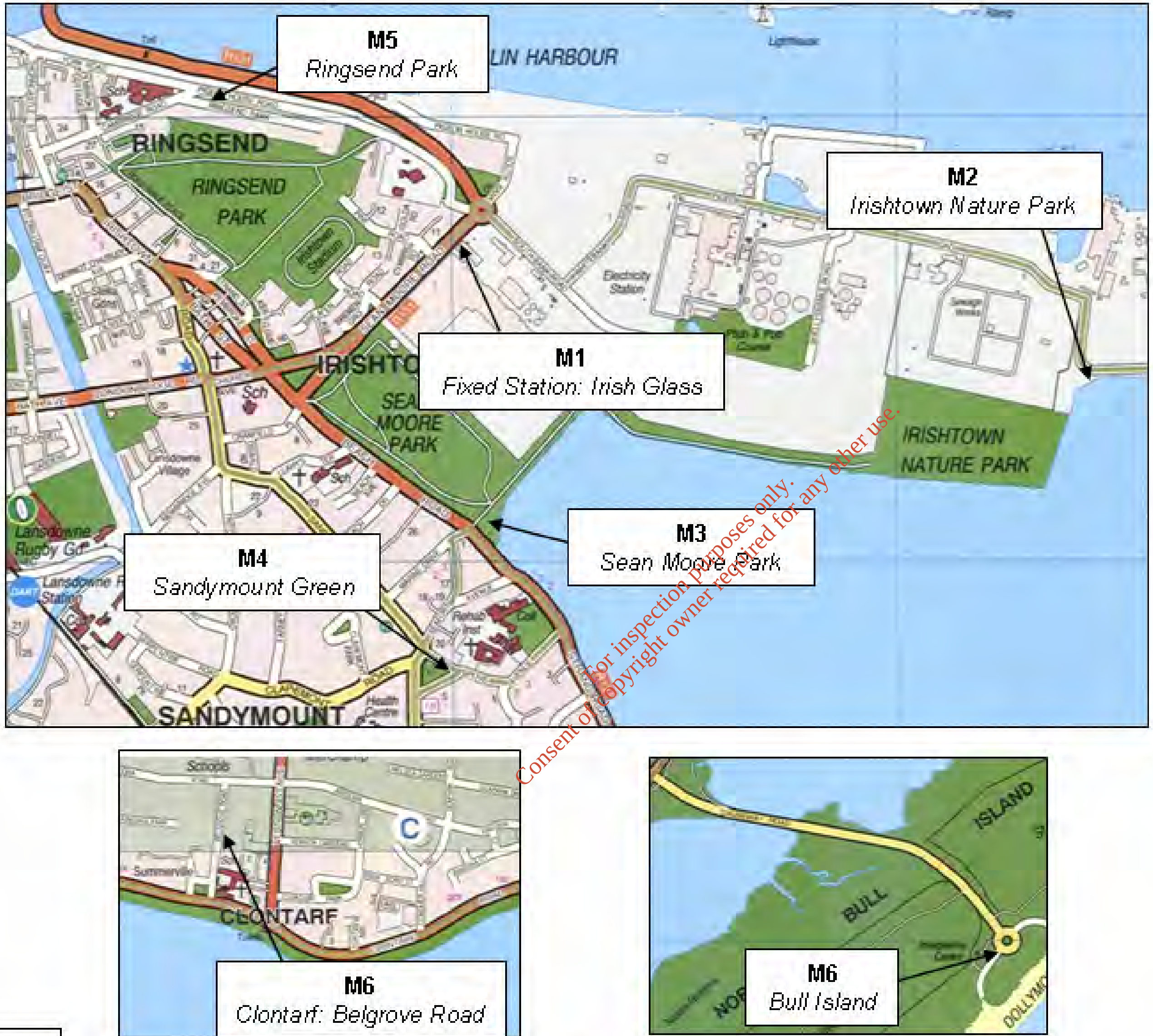
An extensive baseline survey was carried out in the region of the proposed Dublin Waste To Energy (WTE) site over the period July 2003 to December 2005. The survey focused on the significant pollutants likely to be emitted from the facility and which have been regulated in Council Directive 2000/76/EC. The substances monitored were NO_2, NO_X, PM_{10}, $PM_{2.5}$, benzene, SO_2, heavy metals, HCl, HF and PCDDs/PCDFs. The air monitoring program was used to determine long-term average concentrations for these pollutants in order to help quantify the existing ambient air quality in the Poolbeg region of Dublin. NO_2 and SO_2 were also monitored at a number of additional locations to give some spatial representation of the levels of these species. Full details of the baseline monitoring are contained in AWN Consulting report entitled "03_1744AR02[13] (Baseline Air Monitoring)".

Sampling for all species was carried out at a monitoring station located at the Irish Glass Bottle Co. Ltd., Ringsend, Dublin 4. The fixed monitoring station was located approximately 12 metres east of the Sean Moore Road. The fixed monitoring station (M1) and the additional monitoring stations (M2 - M7) selected for the spatial assessment of NO_2 and SO_2 is shown in Figure A1.1.

A summary of the baseline results is shown in Figure A1.2 and compares the results to the relevant ambient air quality standards. The results indicate that levels of HCl, HF, SO_2, Benzene, mercury (Hg), Cadmium (Cd), Nickel (Ni) and Arsenic (As) are significantly below the ambient air quality standards for these compounds.

The data does however indicate that levels of NO_2, PM_{10} and $PM_{2.5}$ do approach the limit value and thus have been further explored below. Indeed, in regards to the maximum 24-hour PM_{10}, levels exceeded the 24-hour limit value (50 $\mu g/m^3$ not to be exceeded more than the 35 days per annum (90^{th}%ile)) with 48 exceedence over the 314 monitoring days (85^{th}%ile). Outlined below is detailed results and assessments for these parameters. The assessment also investigated correlations between the data for the key parameters outlined below:

- correlation between hourly NO_2 concentrations and wind speed & direction
- correlation between hourly NO_2 and NO_X concentrations
- correlation between PM_{10} daily average and average wind speed
- trends in NO_2 by hour of day and day of week.



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Project
Dublin WTE Air Quality Assessment

Reference
06/3018AR01

Figure A1.1
Approximate location of air monitoring stations

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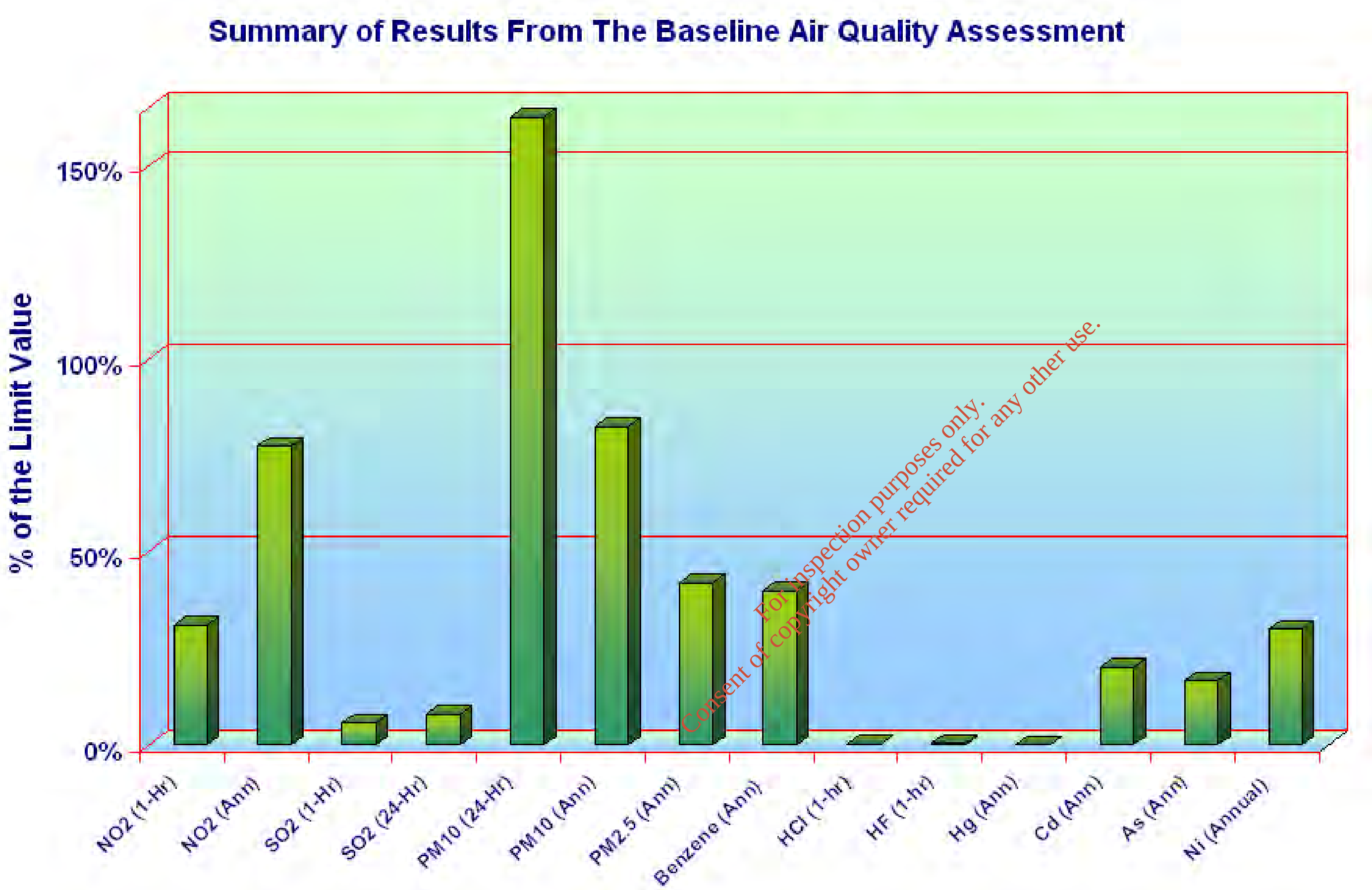

Project
Dublin Waste To Energy
Air Quality Assessment

Reference
06_3018AR01

Figure A1.2
Results of the
Baseline Air Quality
Assessment

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NO_2

A plot of the hourly NO and NO_2 concentrations measured over period July 2003 - August 2005 at the fixed monitoring station at Poolbeg are shown in Figure A1.3. The 99.8th%ile of the hourly concentrations measured during the July 2003 to July 2004 period was 108 $\mu g/m^3$, and during the August 2004 to August 2005 period was 93.8 $\mu g/m^3$. These levels reach 54% and 47% respectively of the EU limit value of 200 $\mu g/m^3$. The average NO_2 concentration measured over the July 2003 to July 2004 period monitoring period was 33.3 $\mu g/m^3$, and during the August 2004 to August 2005 period was 27.3 $\mu g/m^3$, both of which are below the annual EU limit value of 40 $\mu g/m^3$. Thus, the concentration over the period averaged 30 $\mu g/m^3$.

A passive diffusion tube survey was also carried out to determine the spatial variation in NO_2 levels in the region of the proposed scheme (see Figure A1.4). An examination of the variation in NO_2 concentration between stations indicates that the highest recorded annual NO_2 concentrations were measured at roadside locations in the region of Poolbeg (M1, M3, M4 & M5). Average levels at these locations were similar, ranging from 31.8 - 32.8 $\mu g/m^3$. As expected, Bull Island (M6) was significantly lower than the other six locations averaging around 17 $\mu g/m^3$. The results indicate that a general background level across Dublin accounts for a significant fraction of the measured level. The roadside increment, due to road traffic in the immediate vicinity of the monitoring station, leads to a relative minor increase in concentration when compared to urban background locations. For example, both M7 (Belgrove Road) and M2 (Irishtown Nature Reserve) would be considered urban background locations and both recorded similar annual average NO_2 concentrations of approximately 27 $\mu g/m^3$. The four stations in closer proximity to road traffic (of varying magnitude) had an additional roadside increment of between 5 – 6 $\mu g/m^3$ indicating that the roadside increment would account for between 16 – 18% of the total measured annual average NO_2 concentration at these locations.

The variation in the NO_2 continuous analyser concentration by day of week is outlined in Figures A1.5 – 1.6. Figure A1.5 shows the pattern of annual average NO_2 concentration for each hour of the week. Some trends are clearly evident. An observable pattern of weekday (Monday – Friday) peaks in the morning rush hours is evident (7:00 – 10:00, averaging 40 – 45 $\mu g/m^3$) with a gradual decrease during the late morning and early afternoon followed by a secondary peak of reduced magnitude (averaging 35 – 40 $\mu g/m^3$) occurring during the evening peak (17:00 –19:00). Following the secondary peak, levels decline gradually back to a background level of approximately 17 - 18 $\mu g/m^3$ during the late evening and early morning. On a daily comparison, morning peak levels are similar from Monday to Friday, although Tuesday, Wednesday and Friday levels are slightly higher. Weekend NO_2 levels are significantly lower as would be expected. The Saturday and Sunday morning peak levels reaches 34 and 21 $\mu g/m^3$ respectively, with a significant dip to almost background levels in the mid-afternoon. The late evening peak levels on Saturday and Sunday (21:00 - 22:00), may correspond with truck movements from the nearby Dublin Port or the gradual build-up of traffic during the evening due to returning commuters to Dublin.

Figure A1.6 shows the hourly pattern of annual average NO_2 concentration for four scenarios: weekly average (Sunday – Saturday), weekday (Monday – Friday), Saturday and Sunday. Some trends are again evident. As expected, a weekday peak in the morning rush hours is evident (7:00 – 9:00, averaging 44 $\mu g/m^3$) with a gradual decrease prior to a secondary peak of reduced magnitude (averaging 36 $\mu g/m^3$) occurring in the evening peak (16:00 –18:00). After this secondary peak, levels drop back to background levels during the early morning (03:00 - 04:00). Interestingly, the base level recorded at this time (03:00, average 17.9 $\mu g/m^3$) is only slightly higher than the general background level across Dublin measured at Bull Island (M6) of 15 - 17 $\mu g/m^3$. Saturday NO_2 pattern is quite similar to the weekday pattern although reduced in magnitude as would be expected. Sunday however has a markedly different pattern with little variation above background during the day until early evening when concentrations increase gradually peaking at 22:00.

The relationship between NO_2 and NO_X (NO + NO_2 combined) has been investigated in Figure A1.7. As expected, the ratio is a function of the NO_X concentration. At very low concentrations, NO_X is present almost exclusively as NO_2. At low NO_X concentrations, ozone reacts quickly with NO to form NO_2 with the availability of NO the limiting factor. At higher NO_X concentrations, ozone is depleted through this reaction and the efficiency of the conversion reduces. The crossover point (when NO_2 = NO) typically occurs at 60ppb (approx. 120 $\mu g/m^3$)[(A1)] and the current data also shows a similar crossover point (see Figure A1.7). At very high levels, the NO_2/NO_X ratio converges to approximately 0.2.

The on-site meteorological data has been investigated to help determine whether there is a significant correlation between measurement hourly NO_2 and NO_X concentrations and wind speed over the period December 2003 - July 2004 and January - August 2005 (see Figures A1.8 – A1.9). In relation to NO_2, there is a significant (correlation coefficient (r) =0.35, sample size > 10,000, critical value for significance = 0.20) negative correlation (i.e. at high wind speeds, NO_2 concentration are reduced and vice versa). Similarly, NO_X displays a negative correlation with wind speed although the correlation is less pronounced but still significant (r=0.26, sample size > 10,000, critical value for significance = 0.20).

The correlation between measurement hourly NO_2 and NO_X concentrations and wind direction over the period December 2003 – July 2004 and January - August 2005 (see Figure A1.10) has been explored. In relation to NO_2, no major pattern is apparent although there is a small increase in concentration compared to the annual mean when northerly to easterly winds are experienced. However, winds from this direction are generally of low frequency and may experience unusually low average wind speeds. In relation to NO_X, again northerly to easterly winds lead to higher concentrations with the pattern somewhat more pronounced than for NO_2.

The relationship between both NO_2/NO_X and PM_{10} has been investigated in Figures A1.11 – A1.12. The available data has been investigated to help determine whether there is a significant correlation between measurement 24-hourly NO_2/NO_X and PM_{10} concentrations. In relation to NO_2, there is a significant positive correlation (r=0.37, sample size = 320, critical value for significance = 0.20). Similarly, NO_X displays a significant positive correlation (r=0.36, sample size = 320, critical value for significance = 0.20). Thus, the correlation suggests that similar source emission characteristics (such as road traffic levels) and/or meteorological conditions lead to similar trends in NO_2/NO_X and PM_{10} concentrations.

PM_{10}

The complete set of daily average PM_{10} concentrations measured at the fixed monitoring station is given in Figure A1.13. A total of 314 24-hour measurements of PM_{10} were recorded during the 2003/04 and 2004/05 monitoring campaigns. The monitored concentrations ranged from 4 to 148 $\mu g/m^3$ with 48 exceedences of the 24-hour EU limit value of 50 $\mu g/m^3$. The average level of PM_{10} measured over the complete monitoring period was 33 $\mu g/m^3$, which is below the EU annual limit value of 40 $\mu g/m^3$. The 90.4^{th}%ile of daily PM_{10} concentrations for the complete monitoring period is 57 $\mu g/m^3$, which exceeds the limit vale of 50 $\mu g/m^3$.

The temporal variation in PM_{10} is not marked, with average concentrations measured in 2003/04 similar to those measured in 2005. A slight seasonal variation in levels is shown in the 2005 data, with an average of 37 $\mu g/m^3$ over the January - April 2005 period compared to 31 $\mu g/m^3$ in September - December 2005. With regard to the 90^{th}%ile of daily concentrations, peak levels were measured in the months of November and February in the 2003/04 monitoring campaign and February, March and November in the 2004/05 monitoring campaign (see "03_1744AR02[13] (Baseline Air Monitoring)" for set of monthly data). This indicates that exceedences of the 24-hour limit value are more likely in the winter and spring months.

Meteorological data (wind speed, wind direction, temperature, humidity) have been recorded at the site of the proposed WTE facility at Pigeon House Road since December 2003. The available data has been investigated to help determine whether there is a significant correlation between measurement of 24-hour PM_{10} concentrations and wind speed over the period December 2003 – February 2004 (see Figure A1.14). The correlation is weak (correlation coefficient (r) =0.26) but of significance (sample size = 232, critical value for significance = 0.20).

$PM_{2.5}$

$PM_{2.5}$ concentrations were measured at the fixed monitoring station located in Poolbeg over a 60 day period. The average level of $PM_{2.5}$ measured over the complete 60-day sampling set was 11 $\mu g/m^3$, which is significantly lower than the proposed concentration cap of 25 $\mu g/m^3$.

A plot of the daily $PM_{2.5}$ concentration against PM_{10} concentration for the complete data set is given in Figure A1.15, and shows a positive correlation between $PM_{2.5}$ and PM_{10} concentrations. The daily ratio of $PM_{2.5}$ to PM_{10} varied significantly over each monitoring period ranging from 0.19 - 0.47, and with an average ratio of 0.33.

PCDDs & PCDFs

Background levels of PCDD/PCDFs occur everywhere and existing levels in the Poolbeg region have been extensively monitored over two one-month periods as part of the 2003/04 and 2004/05 monitoring campaigns. Monitoring was carried out over four 4-5 (approx.) day periods spread over each one month monitoring period. No ambient air quality concentration or deposition standards currently exist for PCDD/PCDFs.

Caution should be exercised in comparing data between monitoring sites due to varying detection limits and the methodologies employed in assigning non-detects. Non-detects (i.e. levels below the limit of detection) may be assigned a value of either zero, half the limit of detection or the limit of detection. Depending on the number of congeners below the limit of detection and the approach to non-detects, significant variations may be perceived in inter-comparison exercises of samples. Furthermore, historically, a number of systems for assessing the toxicity of PCDD/F were developed, all using the concept of Toxic Equivalence Factors (TEQ)[(A1)]. This concept assesses the toxicity of other PCDD/F congeners and assigns a weighting compared to the known toxicity of 2,3,7,8 TCDD. These systems applied slightly different weighting factors for calculating TEQ expressed as units of 2,3,7,8 TCDD. These differences meant that it was not possible in many instances to directly compare TEQ data from different countries. The NATO/CCMS system began to be more widely used through the early 1990's and the WHO also introduced a similar system. The US EPA, NATO/CCMS and the EC systems now use the same TEF Factors and the World Health Organisation has also adopted a similar system, allowing direct comparability of TEQ values[(A2)]. The NATO/CCMS TEFs (giving a result which is defined as I-TEQ), which correspond exactly with the EC and US EPA TEFs, have been used to calculate TEQs for the PCDD/Fs measured during this study.

Historically, measurements of PCDDs in Ireland have been limited. Table A1.7 shows the range of concentrations measured in ambient air in Ireland and elsewhere in recent years. Levels at Poolbeg show significant variations between monitoring periods with mean results a factor of ten - twenty higher in winter. A similar variation has been report in the literature for monitoring carried out in Germany in the 1990s[(A3)]. The mean PCDD/PCDF concentration measured over the four one-month periods during 2003 - 2005 indicates that results are slightly higher than measurements elsewhere in Ireland, with an upper limit of 56.2 fg/m^3 compared to previous measurements ranging from 2.8 – 46 fg/m^3 (see Table A1.8). However, previous measurements have been in rural or industrial zoned land whereas the current site is urban with vehicle, home heating & power stations in close proximity. Data from other urban locations through Europe is available (see Table A1.7)[A4-A5]. The mean ambient concentration over the eight-week period is similar to results obtained in Germany, Austria and Italy over the last decade. Furthermore, measured average levels are equivalent to those measured recently at an urban site in UK in Middlesbrough, and significantly lower than those measured in Manchester over the period 2000 - 2003.

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(A2) WHO (1989) Polychlorinated dibenzo-p-dioxins and dibenzofurans, EHC 88.

(A3) Van den Berg et al.,(1998) Toxic Equivalency Factors (TEFs) for PCBS, PCDDs, PCDFs, for humans and wildlife, Environmental Health Perspective, 106 (12) 775 – 792.

(A4) European Commission (1999) Compilation of EU Dioxin Exposure & Health Data Task 2 Environmental Levels - Technical Annex.

(A5) Trace Organic Micro-Pollutants (TOMPS) Network Website, http://www.aeat.co.uk/netcen/airqual/

Table A1.7 I-TEQ values derived from measurements of airborne dioxins in various locations.

Location	Site Type	I-TEQ[1] (fg/m^3)
Poolbeg (2003 - 2005)	*Urban*	*Lower Limit – 54.6*[2] *Upper Limit – 56.2*[3]
Kilcock , Co. Meath (1998)[4]	Rural	Range 2.8 – 7
Ireland[4]	Baseline	Mean – 26
	Potential Impact Areas	Mean – 49
Ringaskiddy (2001)[5]	Industrial	Lower Limit – 4.0[2] Upper Limit – 16.4[3]
Carranstown (2001)[6]	Rural	Lower Limit – 28[2] Upper Limit – 46[3]
Germany (1992)[7,8]	Rural	< 70
	Urban	71 – 350
	Close to Major Source	351 – 1600
Bavaria, Germany (1997)[9]	Rural Mean	Range 3.3 – 88.4
	Augsburg, Before MWI	Range 14 – 120
	Augsburg, After MWI	Range 7.6 – 206
Thuringia, Germany (1997)[9]	Urban 1993 - 1997	Range 9 – 231, Mean = 71
	Urban 1993 - 1997	Range 11 – 169, Mean = 52
	Urban 1993 - 1997	Range 18 – 210, Mean = 92
Austria[9]	Wien-14 (urban) 1992 - 1997	Range 9.3 – 129, Mean = 37
	Graz-Ost (urban) 1993 - 1997	Range 139 – 302, Mean = 198
	Linz-Ursulinenhof (urban) 1994 - 1997	Range 69 – 179, Mean = 120
	Leoben-BFI (urban) 1995 - 1998	Range 69 – 262, Mean = 150
Italy[9]	Florence (Urban)	Range 72 – 200
	Rome (Urban)	Range 48 – 277, Mean = 85
Manchester [10]	Urban (2000 - 2003)	Range – 61 - 92
Middlesbrough[10]	Urban (2000 - 2003)	Range – 31 - 52
Hazelrigg[10]	Semi-rural (2000 - 2003)	Range – 8 - 11
Stoke Ferry[10]	Rural (2000 - 2003)	Range – 18 - 21
High Muffles[10]	Rural (2000 - 2003)	Range – 6 - 8

(1) I-TEQ$_{DF}$ values based on NATO/CCMS (1988) and as used in Annex 1, Council Directive 2000/76/EC.
(2) Lower limit TEQ calculated assuming non-detects are equal to zero.
(3) Upper limit assuming non-detects are equal to limit of detection.
(4) Taken from Chapter 8 of Thermal Waste Treatment Plant, Kilcock EIS, Air Environment (1998)
(5) Taken from Chapter 9 of Waste Management Facility, Indaver Ireland Ringaskiddy EIS, Baseline Dioxin Survey (2001)
(6) Taken from Chapter 9 of Waste Management Facility, Indaver Ireland Carranstown EIS, Baseline Dioxin Survey (2001)
(7) Raffe, C (1996) Sources and environmental concentrations of dioxins and related compounds, *Pure & Appl. Chem* **Vol. 68**, No. 9, pp 1781-1789
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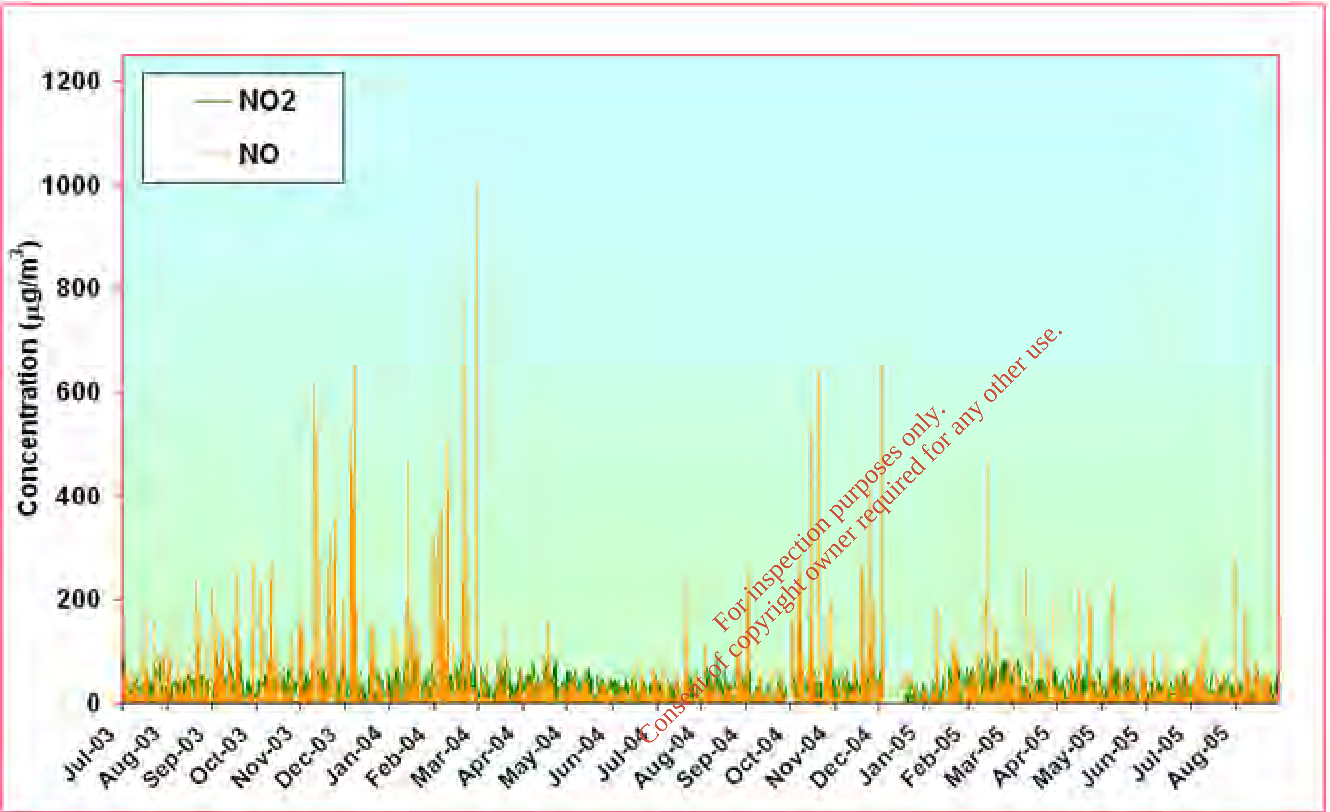
(9) European Commission (1999) Compilation of EU Dioxin Exposure & Health Data Task 2 Environmental Levels - Technical Annex.
(10) Taken from TOMPS Network website, www.airquality.co.uk.

Table A1.8 Summary of Baseline PCCD/PCDFs Ambient Air Concentrations.

Pollutant	Averaging Period	Minimum PCDDs/PCDFs (I-TEQ) (fg/m^3)	Maximum PCDDs/PCDFs (I-TEQ) (fg/m^3)
July 2003 - July 2004 Monitoring			
PCCD/PCDFs	28/08/03 – 31/08/03	1.4	7.1
PCCD/PCDFs	03/09/03 – 08/09/03	3.3	3.3
PCCD/PCDFs	08/09/03 – 12/09/03	14.3	14.3
PCCD/PCDFs	15/09/03 – 19/09/03	12.1	12.1
PCCD/PCDFs	11/02/04 – 16/02/04	157.9	157.9
PCCD/PCDFs	16/02/04 – 20/02/04	75.3	75.3
PCCD/PCDFs	23/02/04 – 27/02/04	304.6	304.6
PCCD/PCDFs	03/03/04 – 08/03/04	175.6	175.6
PCCD/PCDFs	**8-Week Average**	**93.1**	**93.8**
October / November 2004 Monitoring			
PCCD/PCDFs	15/10/04 - 18/10/04	17.5	19.0
PCCD/PCDFs	20/10/04 - 24/10/04	6.8	9.1
PCCD/PCDFs	26/10/04 - 29/10/04	0.60	8.1
PCCD/PCDFs	05/11/04 - 09/11/04	10.6	12.4
PCCD/PCDFs	**4-Week Average**	**8.9**	**12.2**



Project

Dublin Waste To Energy
Air Quality Assessment

Reference

06_3018AR01

Figure A1.3

Baseline NO_x Results
2003 – 2005 (µg/m³)

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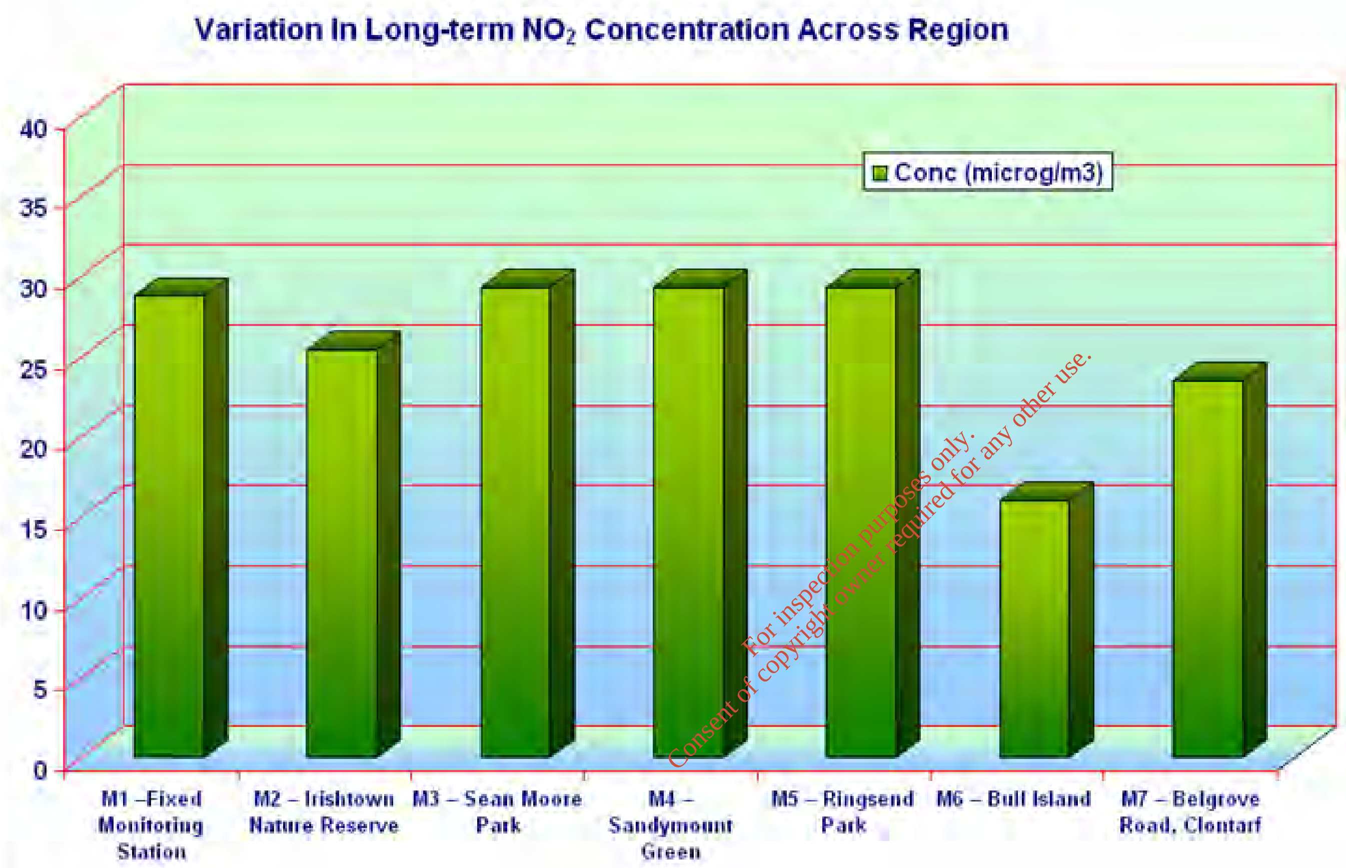
Tel: +353 (0)1 847 4220 Fax: +353 (0)1 847 4257



Project
Dublin Waste To Energy Air Quality Assessment

Reference
06_3018AR01

Figure A1.4
Baseline NO_2 Diffusion Tube Results 2003 – 2005 (µg/m³)

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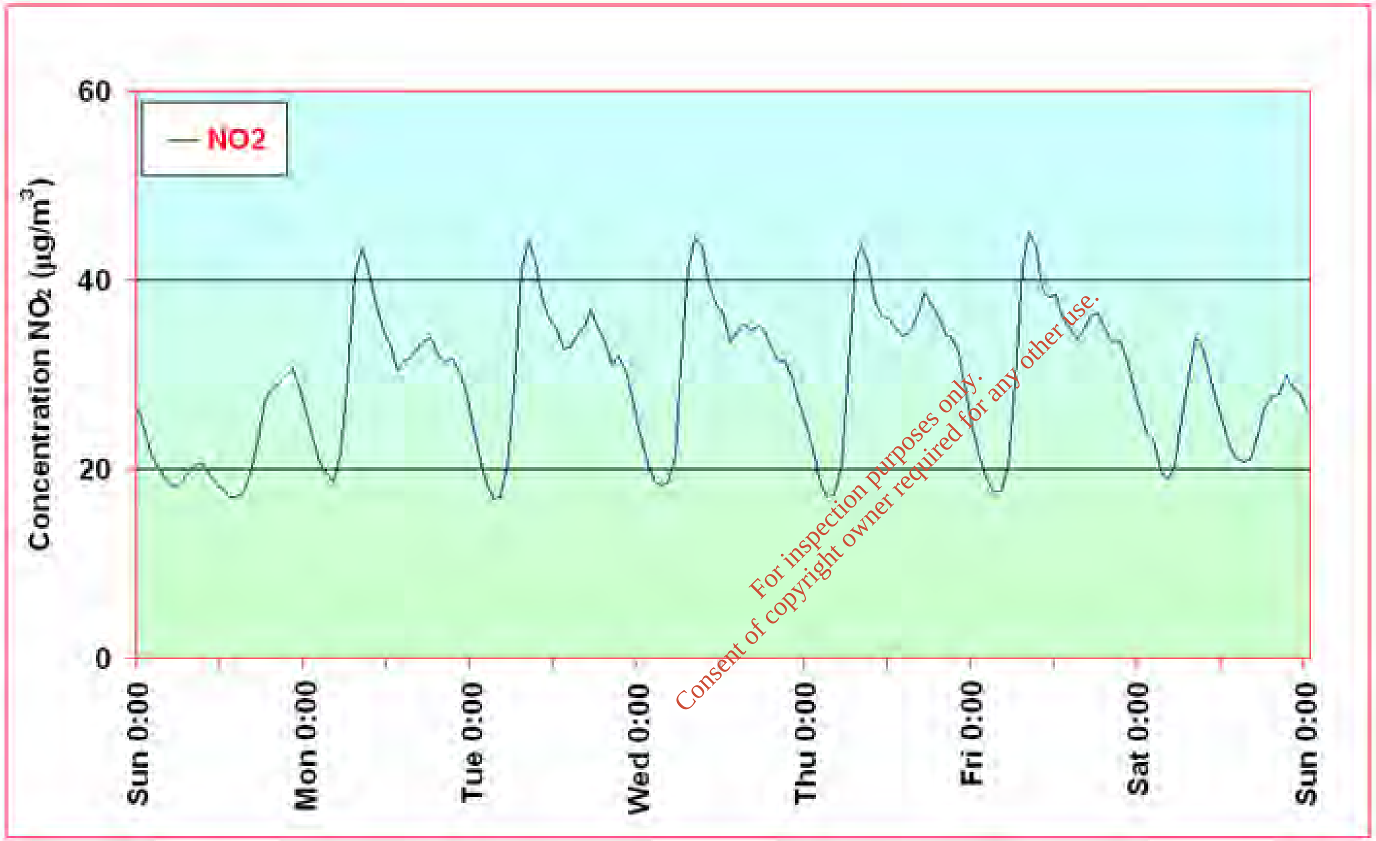

Project

Dublin Waste To Energy
Air Quality Assessment

Reference

06_3018AR01

Figure A1.5

Variation In Baseline NO2 By Time of Day and Day of Week

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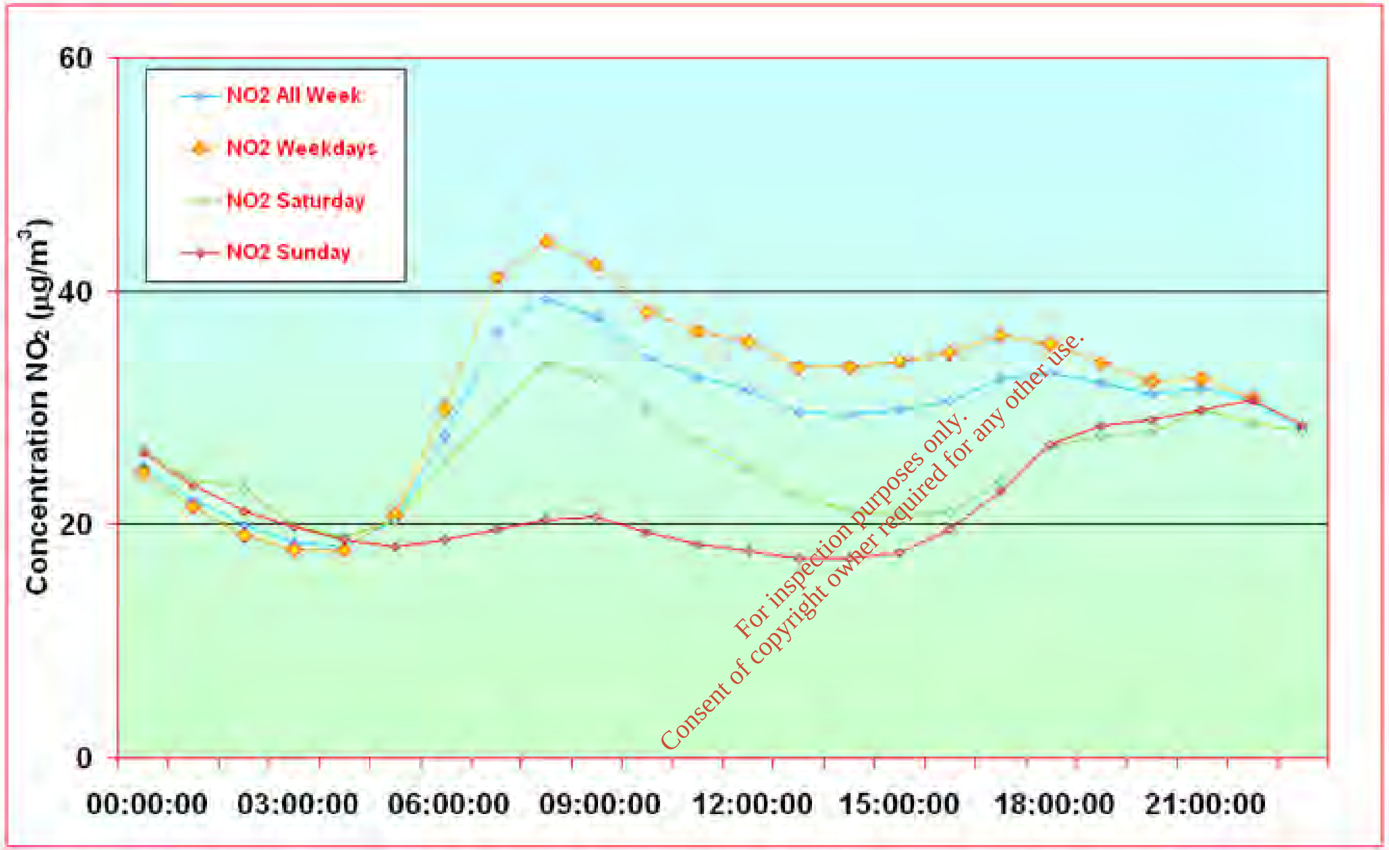

Project

Dublin Waste To Energy Air Quality Assessment

Reference

06_3018AR01

Figure A1.6

Variation In Baseline NO_2 By Time of Day For Four Scenarios ($\mu g/m^3$)

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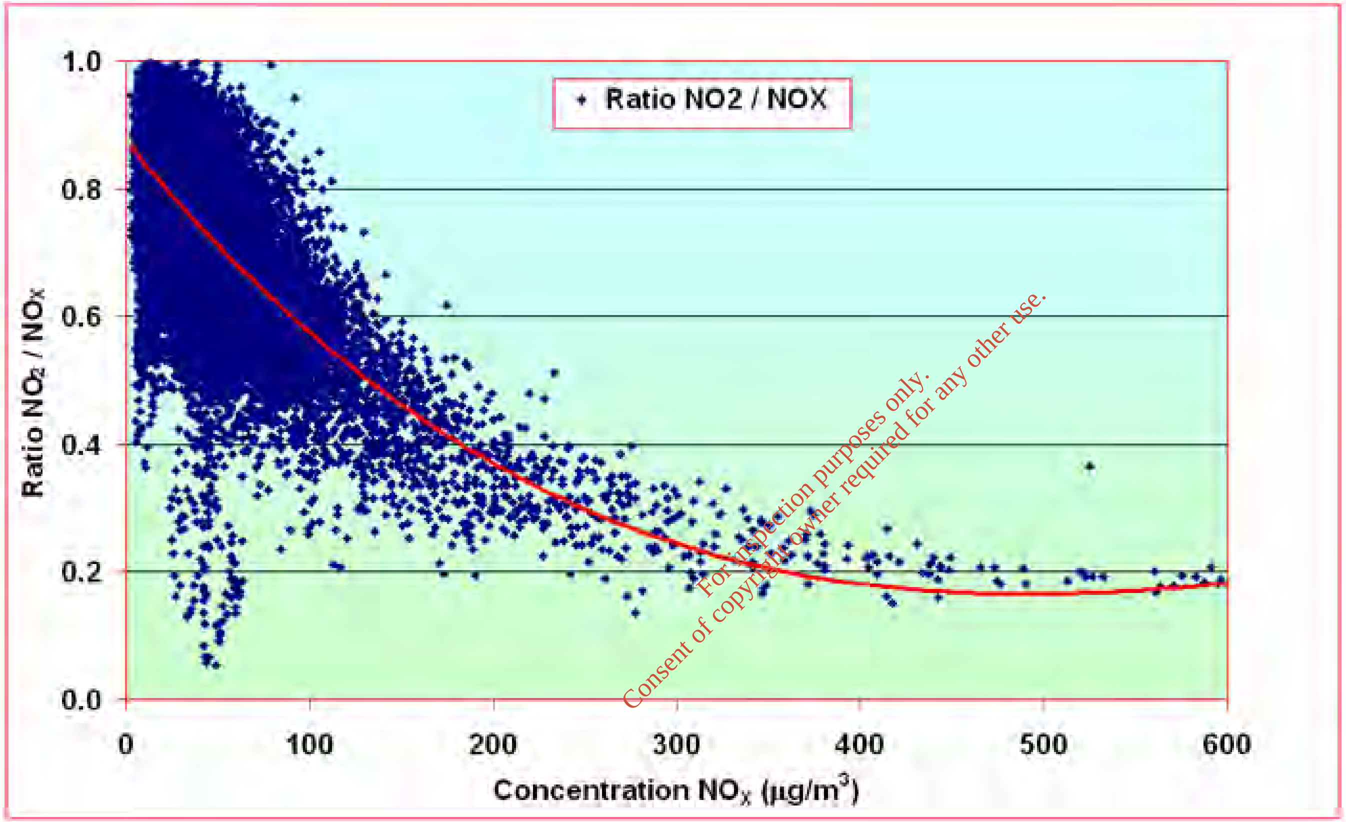

Project

Dublin Waste To Energy
Air Quality Assessment

Reference

06_3018AR01

Figure A1.7

Ratio of NO_2 / NO_x at Varying Concentrations of NO_x ($\mu g/m^3$)

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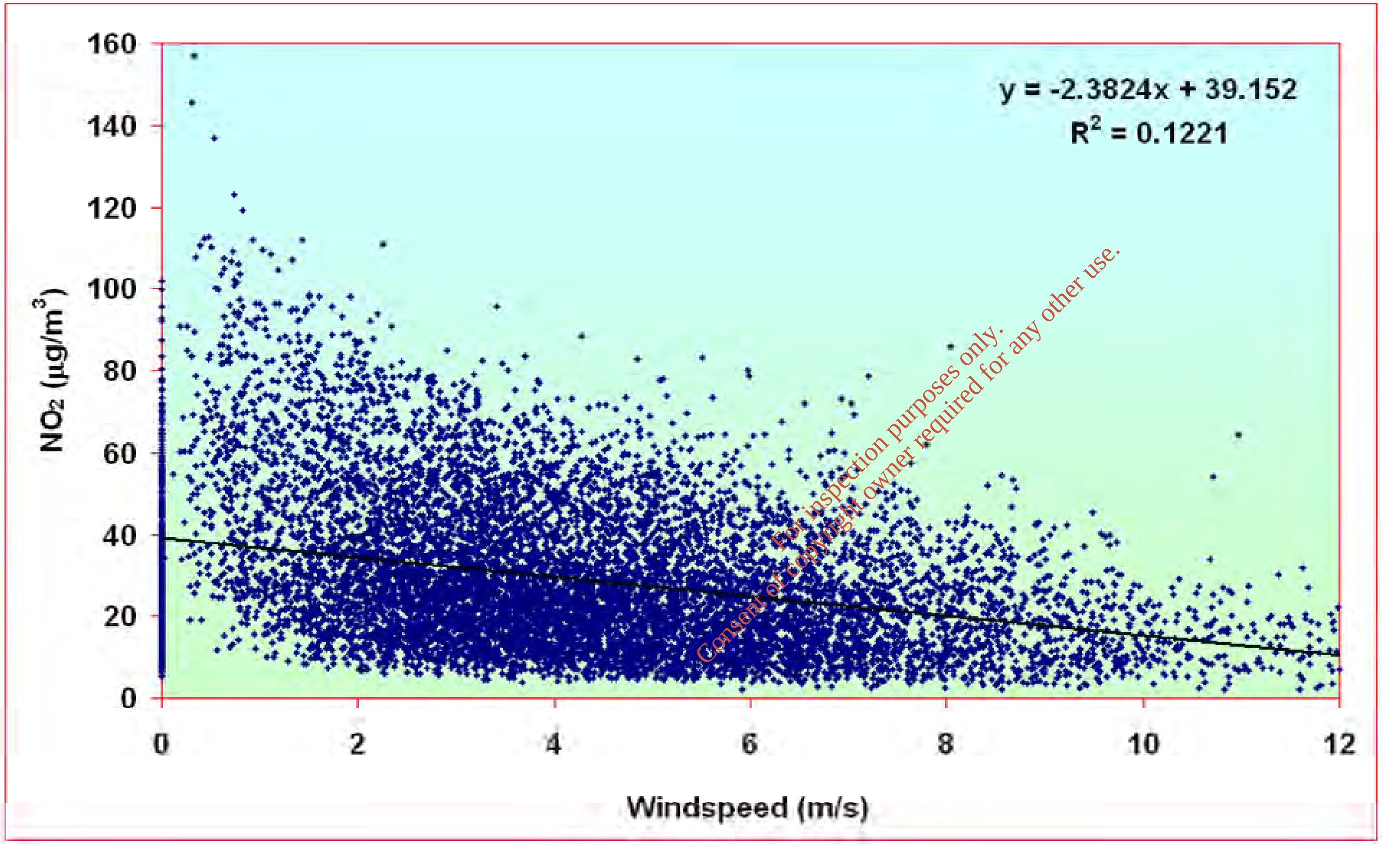

Project

Dublin Waste To Energy
Air Quality Assessment

Reference

06_3018AR01

Figure A1.8

Correlation of NO_2 with Windspeed (m/s)

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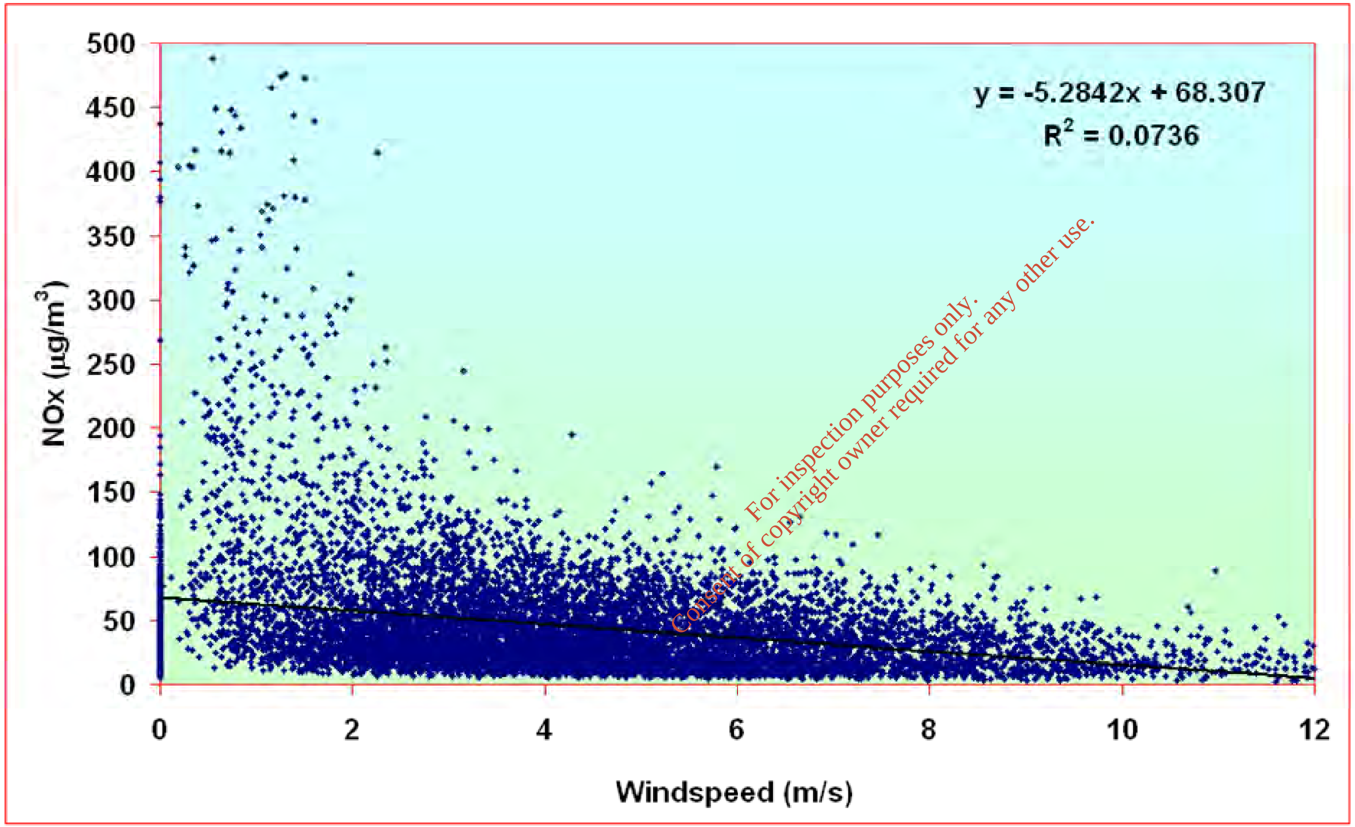

Project

Dublin Waste To Energy
Air Quality Assessment

Reference

06_3018AR01

Figure A1.9

Correlation of NO_x
with Windspeed (m/s)

awn
consulting

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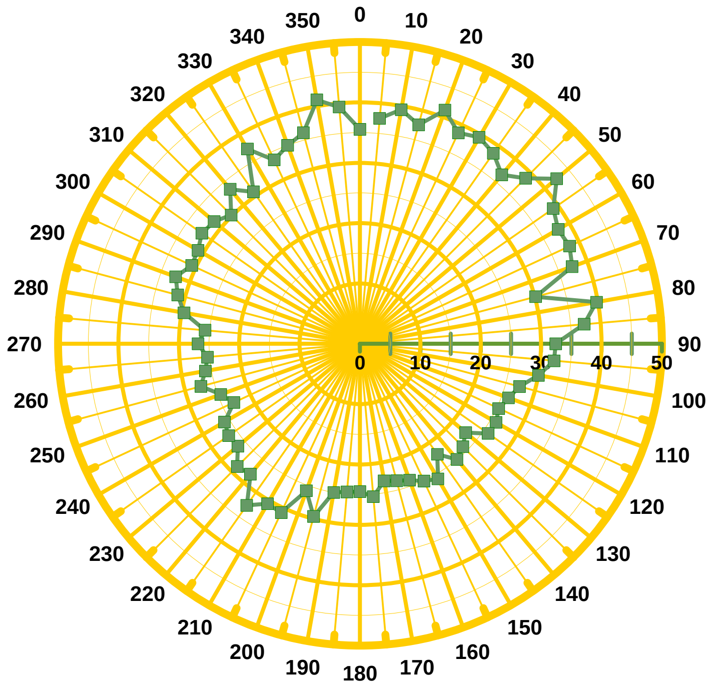
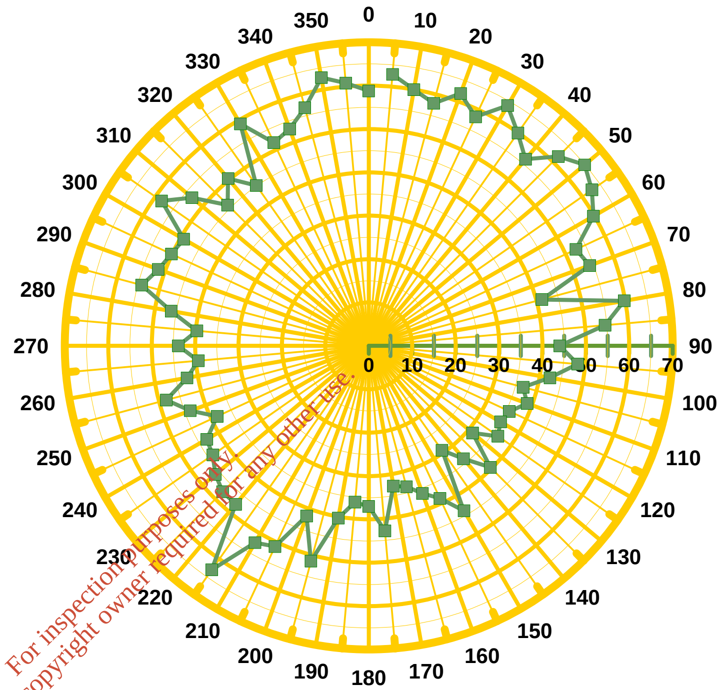


NO_2 (µg/m³) vs Wind Direction



NO_X (µg/m³) vs Wind Direction

Project
Poolbeg WTE – Baseline Air Monitoring

Reference
03_1744AR02

Figure A1.10
NO_2 and NO_X Concentrations, (µg/m³) vs Wind Direction

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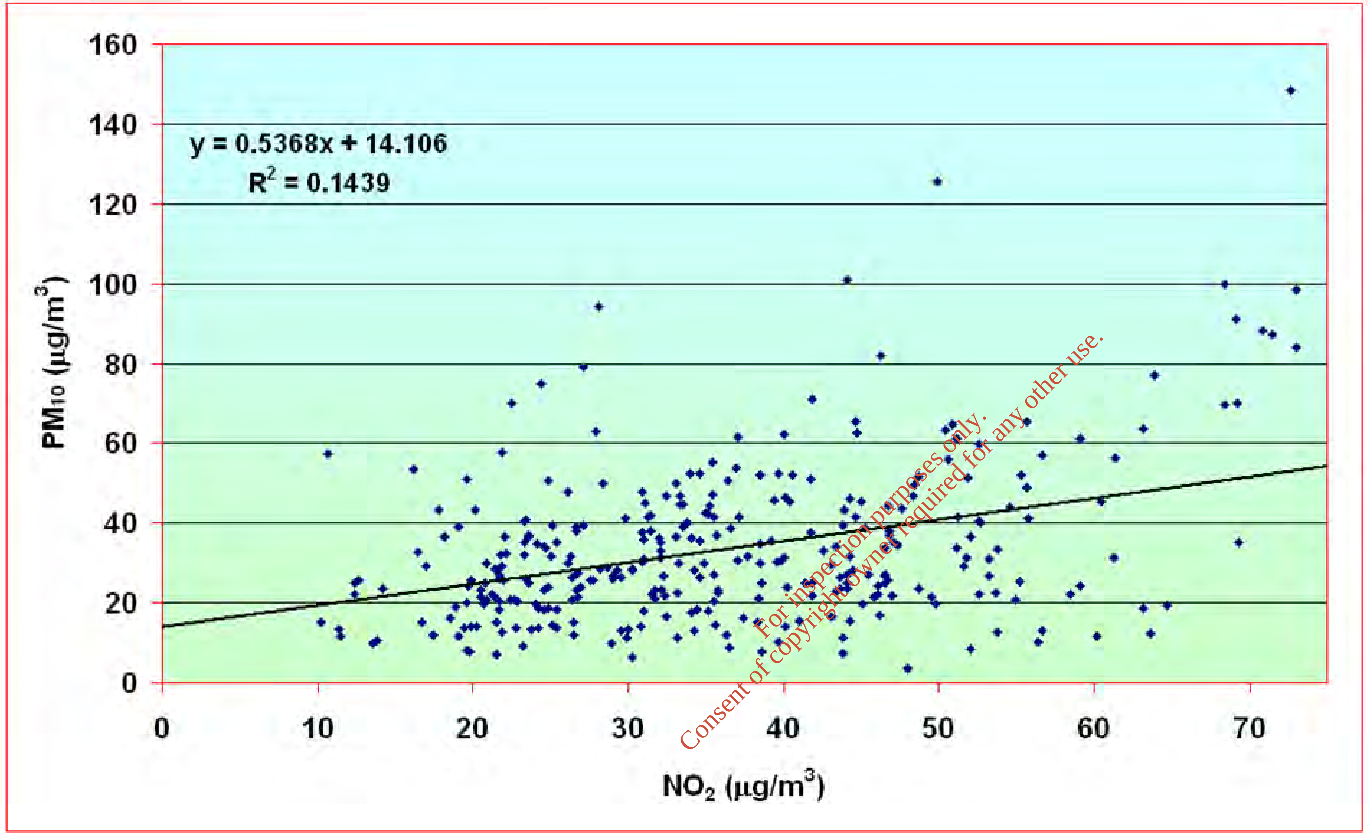

Project

Poolbeg WTE – Baseline Air Monitoring

Reference

03_1744AR02

Figure A1.11

Correlation Between 24-Hour NO_2 (µg/m³) and PM_{10} (µg/m³) Concentrations,

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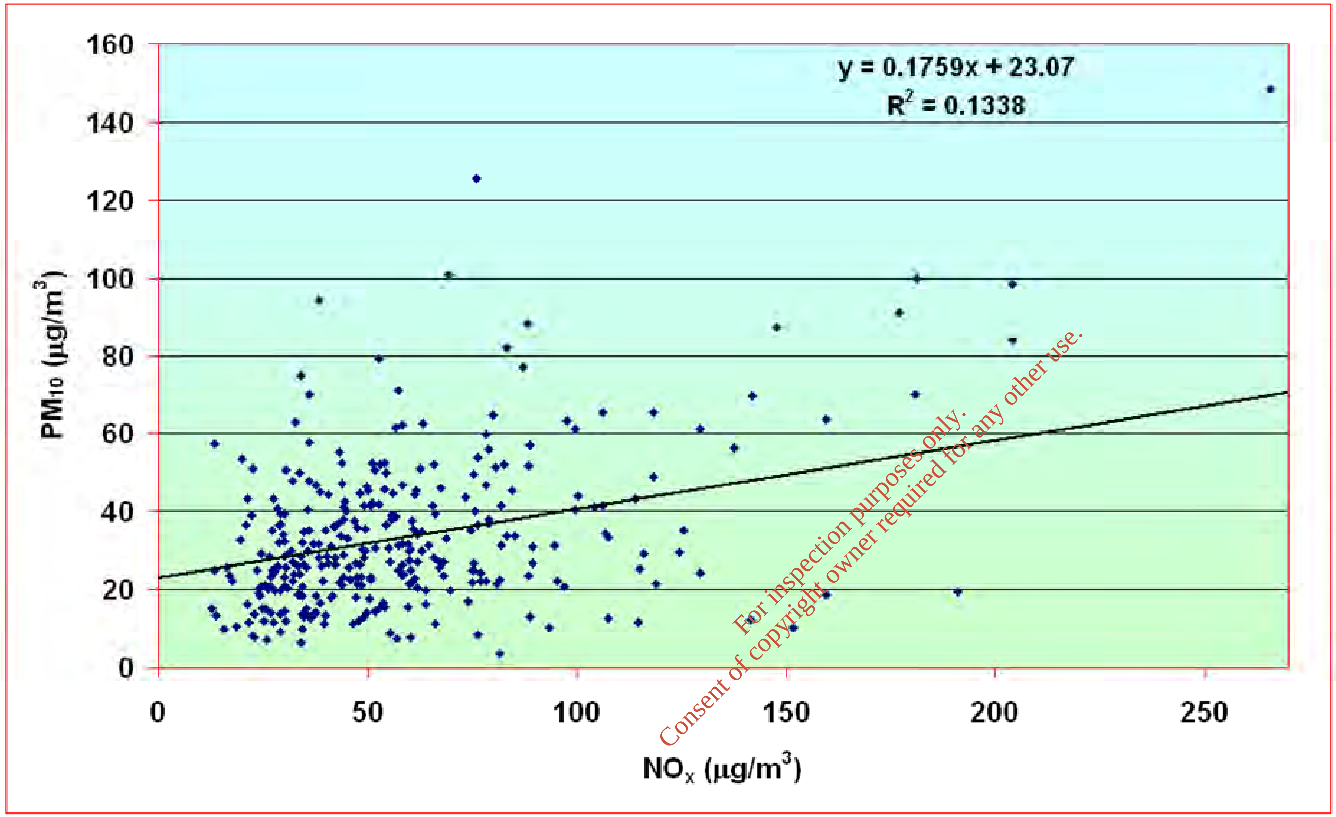

Project

Poolbeg WTE – Baseline Air Monitoring

Reference

03_1744AR02

Figure A1.12

Correlation Between 24-Hour NO_x (µg/m³) and PM_{10} (µg/m³) Concentrations,

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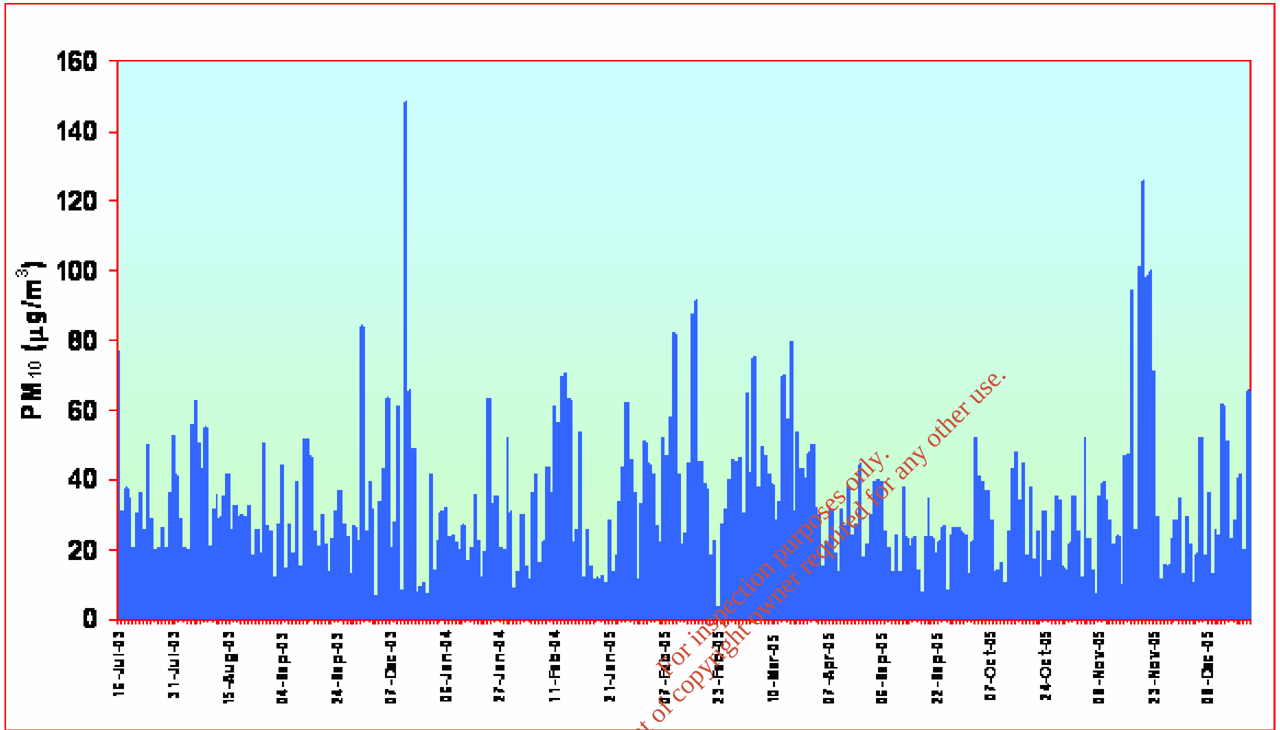

Project
Poolbeg Monitoring

Reference
06/3018AR01

Figure A1.13
PM_{10} Daily Averages ($\mu g/m^3$)

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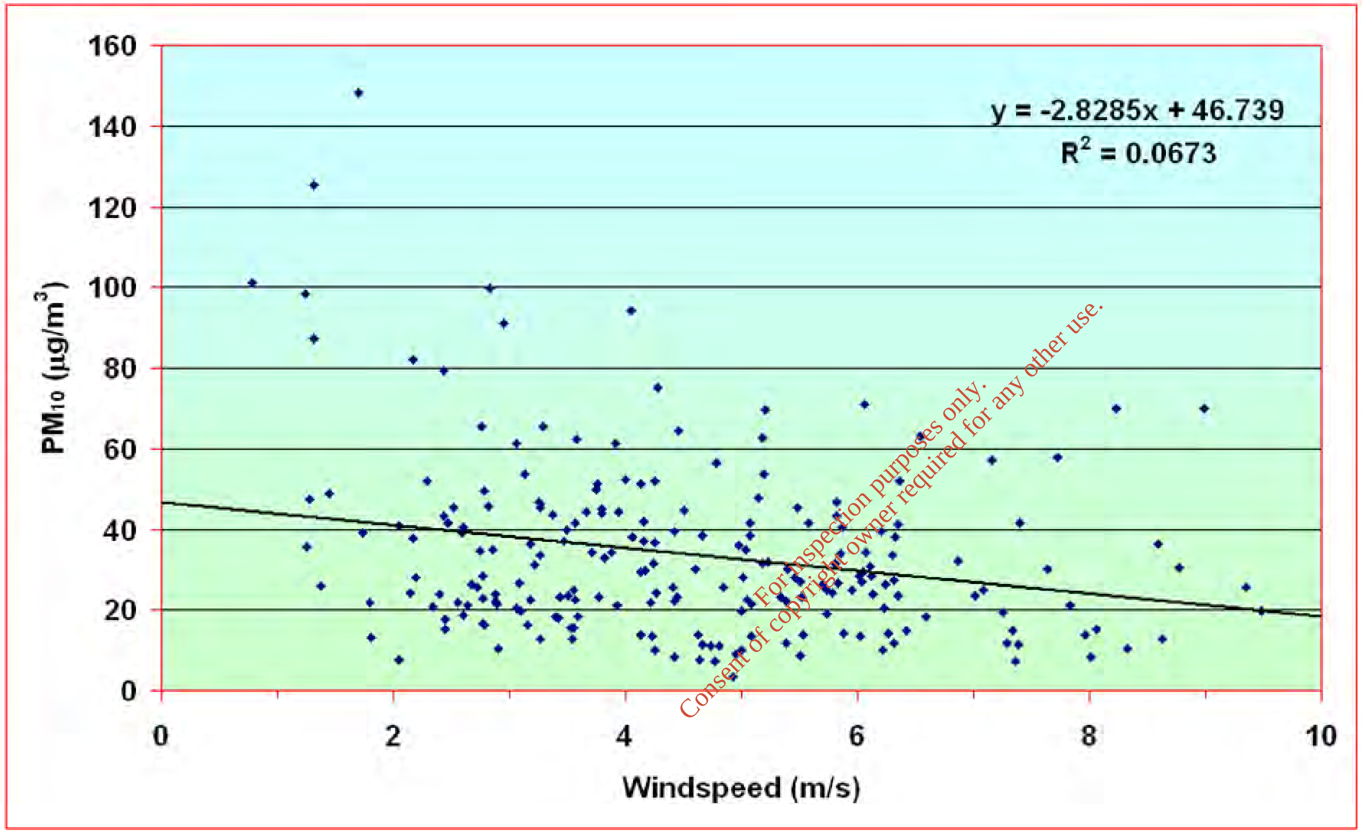

Project

Poolbeg WTE – Baseline Air Monitoring

Reference

03_1744AR02

Figure A1.14

Correlation Between PM_{10} Daily Averages (µg/m³) & Wind Speed (m/s)

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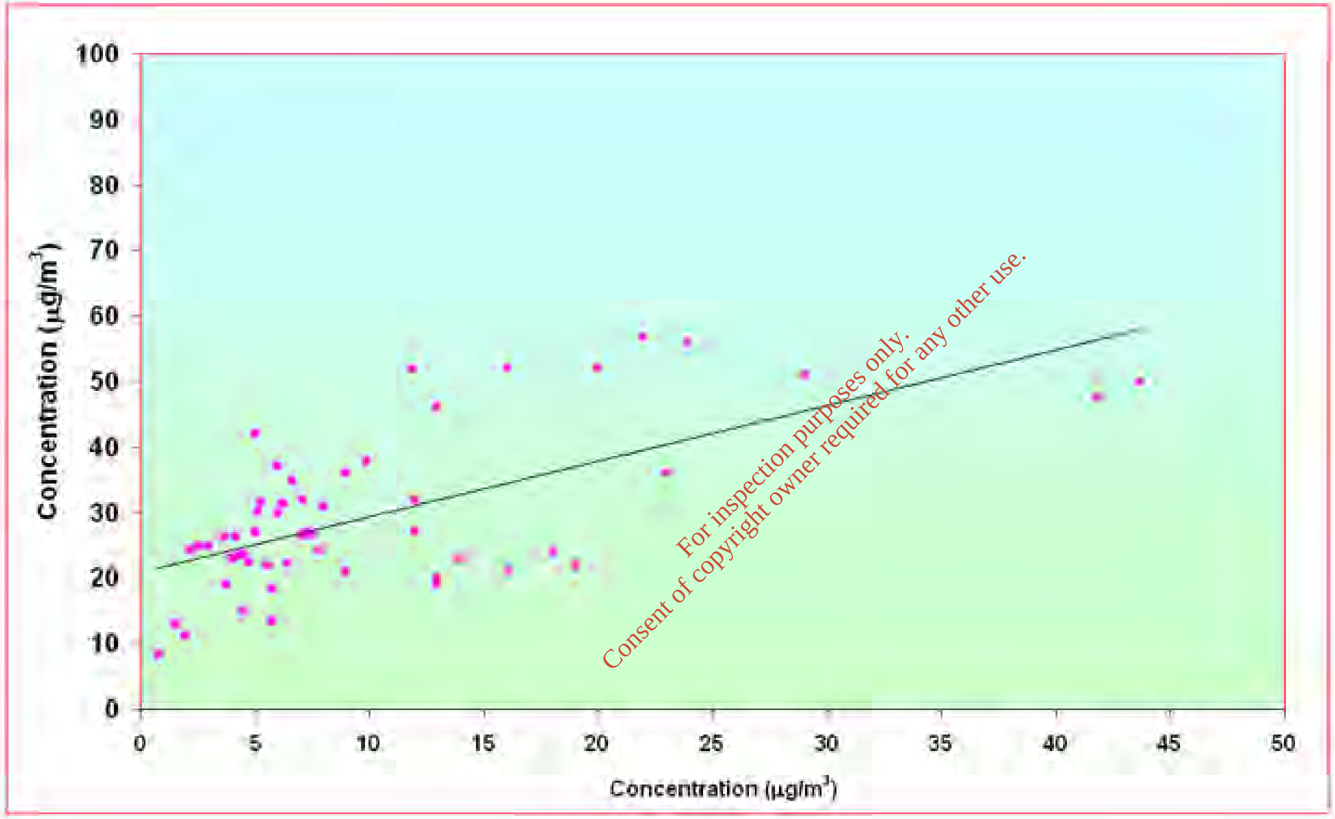

Project
Poolbeg WTE – Baseline Air Monitoring

Reference
03_1744AR02

Figure A1.15
Correlation Between PM_{10} Daily Averages (µg/m³) & $PM_{2.5}$ (mg/m3)

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1.0 AIR QUALITY STUDY

EXECUTIVE SUMMARY

Baseline Air Quality Review

An extensive baseline survey was carried out in the region of the proposed Poolbeg Waste To Energy (WTE) site over two one-year periods from July 2003 to July 2004 and August 2004 to December 2005. The survey focused on the significant pollutants likely to be emitted from the facility and which have been regulated in Council Directive 2000/76/EC. Details of the monitoring results are presented in this report.

PM_{10} concentrations measured during both the 2003/04 and 2004/05 monitoring campaigns averaged 33 $\mu g/m^3$, which is below the annual limit value of 40 $\mu g/m^3$. Analysis of the data by comparison with long-term PM_{10} monitoring at other sites in Dublin indicate that the 24-hour average PM_{10} levels in Poolbeg reached 73 $\mu g/m^3$ in 2003/04 and 49 $\mu g/m^3$ in 2004/05. The results of $PM_{2.5}$ measurement carried out over four two-week periods indicated that levels were below the proposed annual concentration cap which may be applicable in 2010.

Nitrogen dioxide (NO_2) concentrations measured over the July 2003 to July 2004 and August 2004 to August 2005 monitoring periods were below both the 1-hour and annual EU limit values. The annual average NO_2 concentration reached 33 $\mu g/m^3$ in 2003/04 and 27 $\mu g/m^3$ in 2004/05, and the 99.8^{th}%ile of 1-hour concentrations reaching 108 $\mu g/m^3$ in 2003/04 and 94 $\mu g/m^3$ in 2004/05. Both the annual average and 1-hour NO_2 concentrations were reduced during the second year of monitoring. Annual average NO_2 concentrations at a further six locations in the region of Poolbeg were significantly lower than the annual average limit value.

Levels of sulphur dioxide (SO_2), benzene, hydrogen fluoride (HF) and hydrogen chloride (HCl) were all significantly below their respective limit values.

Average concentrations of antimony (Sb), arsenic (As), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), mercury (Hg), manganese (Mn), nickel (Ni), lead (Pb), thallium (Tl) and vanadium (V) measured were significantly below their respective annual limit values.

Background levels of PCDD / PCDFs cannot be compared to ambient air quality concentration or deposition standards. However, levels of PCDDs and PCDFs can be compared to existing levels measured sporadically in Ireland and continuously in the UK as part of the TOMPS network. Levels at Poolbeg showed significant variations between monitoring periods, particularly those measured in February / March 2004, which were a factor of 10 - 20 higher than those measured during the remaining three one-month monitoring periods. A similar variation has been reported in the literature for monitoring carried out in Germany in the 1990s. The mean PCDD/PCDF concentration measured over the four one-month periods during 2003 - 2005 indicates that results are slightly higher than measurements elsewhere in Ireland, with an upper limit of 56.2 fg/m^3 compared to previous measurements ranging from 2.8 – 46 fg/m^3. However, previous measurements have been generally in rural or industrial zoned land in suburban areas whereas the current site is urban with vehicle emissions, home heating & power stations in close proximity. The mean ambient concentration measured at Poolbeg is at the lower end of the range of mean urban levels obtained in Germany, Austria and Italy over the last decade. Furthermore, measured average levels are equivalent to those measured recently at an urban site in UK in Middlesbrough, and significantly lower than those measured in Manchester over the period 2000 - 2003.

1.1 BASELINE MONITORING REPORT

1.1.1 Introduction

A detailed air monitoring program has been carried out to assess baseline levels of the significant substances which will be potentially released during process operations from the proposed WTE facility at Poolbeg, Dublin 4. The substances monitored were NO_2, PM_{10}, $PM_{2.5}$, benzene, SO_2, heavy metals, HCl, HF and PCDDs/PCDFs. The air monitoring program was used to determine long-term average concentrations for these pollutants in order to help quantify the existing ambient air quality in the Poolbeg region. NO_2 and SO_2 were also monitored at a number of additional locations to give some spatial representation of the levels of these species. Sampling for all species was carried out at a monitoring station located at the Irish Glass Bottle Co. Ltd., Ringsend, Dublin 4 (hereafter referred to as the fixed monitoring station). The location chosen was approximately 12 metres east of the Sean Moore Road.

1.1.2 Description of Monitoring Sites

Site Selection

A preliminary modelling study of the proposed Dublin Waste to Energy Facility identified the areas of potential impact in the region of Poolbeg and Dublin Bay. The modelling focussed on identifying long-term (annual average) “hot-spots” based on an assumed stack height, emission characteristic and building layout. As all these factors are likely to vary, the identified “hot-spots” are indicative only. Furthermore, the location of each hot-spot will also vary annually due to meteorological variations.

Seven baseline monitoring locations were then chosen based on the results of this study and additional factors including ecological and soil monitoring considerations, the location of residential areas and the geographical spread of the sites (see Figure 1.1). A suitable location in the Poolbeg area was selected as a fixed station for monitoring of PM_{10} and $PM_{2.5}$, dioxins/furans, metals and acid gases, diffusion tube monitoring for NO_2 and SO_2, and continuous NO_X monitoring. The remaining six locations were selected for diffusion tube NO_2 and SO_2 monitoring. The seven monitoring sites chosen are discussed in detail below.

Irish Glass Ltd (Fixed Monitoring Station) (M1)

The fixed monitoring location was located near the residential receptors within 1-2km of the site, which will be impacted most by the facility. Preliminary modelling of the Waste to Energy Facility indicated that the annual average concentration resulting from the facility decreased sharply away from the site to approximately 800m. Thereafter, the concentration gradient is not particularly significant. The nearest residential area to the site is west of the Sean Moore Road, approximately 1km from the site. This area was identified as the residential area most impacted by the facility and with an already significant background concentration due to Sean Moore Road. Due to the lack of a suitable monitoring location in the immediate residential area, the fixed monitoring site was located at Irish Glass Bottling Company Ltd, which is located on the opposite (east) side of the Sean Moore Rd from the residential area. The station was located at approximately the same distance from the road source as the surrounding residential receptors (see Figure 1.1). The Sean Moore Road can experience relatively high traffic levels, particularly during the morning and evening rush hours due to the close proximity of the East Link Toll Bridge. The prevailing wind is from a westerly and south-westerly direction. As the fixed monitoring station is to the east and north-east of the Sean Moore Road, the measured long-term concentration at this location would be expected to be somewhat higher than that experienced at the residential receptors which are upwind (i.e. west) of the Sean Moore Road. The location may be viewed as intermediate between a roadside and urban background location.

Irishtown Nature Reserve (M2)

Irishtown Nature Reserve is located at the southeast corner of the site of the proposed facility and is an urban background location. It was selected as a monitoring location because it is expected to be directly impacted by the proposed facility and also because it is an area of significant ecological importance. Although the area is not subject to high traffic levels, NO_2 levels may be influenced by the close proximity of Poolbeg Generating Station.

Sean Moore Park (M3)

Sean Moore Park is located approximately 600m southwest of the site of the proposed facility and may be viewed as intermediate between a roadside and urban background location. Again, the monitoring location is identified as within the zone of direct impact by the proposed facility and because it is an important amenity for the local community. Ambient pollutant levels in Sean Moore Park are representative of the residential housing along the Beach Road. Significant traffic levels which are experienced along Beach Road during the morning and evening rush hours are expected to influence the NO_2 levels at this monitoring location.

Sandymount Green (M4)

Sandymount Green is located approximately 800m southwest of the site of the proposed facility and may be viewed as intermediate between a roadside and urban background location. The location has a high proportion of residential housing, and ambient pollutant levels at Sandymount Green are representative of this region. Increased traffic levels in Sandymount Village during the morning and evening rush hours are expected to influence the NO_2 levels at this monitoring location.

Ringsend Park (M5)

Ringsend Park is located approximately 900m west of the site of the proposed facility and may be viewed as intermediate between a roadside and urban background location. It is in an area which is an important amenity for the local community. Ambient pollutant levels in Ringsend Park are expected to be representative of the residential area in this region of Ringsend. The monitoring site is located approximately 50m south of the R131 road leading to the East Link Toll Bridge. Increased traffic levels on the R131 during the morning and evening rush hours are expected to influence the NO_2 levels at this monitoring location.

Bull Island (M6)

Bull Island is located approximately 1600m northeast of the site of the proposed facility and the station would be termed a rural location. It was selected as a monitoring location as it is a sensitive ecological area. The island is used as a local amenity and is associated with low traffic levels. As the island is not affected by local sources of pollution, it is therefore considered as representative of background levels in the Dublin Bay area.

Clontarf (Belgrove Road) (M7)

Clontarf is located approximately 1500m north of the site of the proposed facility and the station would be termed an urban background location. It was selected as a monitoring location because it is the nearest residential area north of the proposed facility. Ambient pollutant levels at this location are expected to be representative of the Clontarf area. Increased traffic levels in the Clontarf area in general during the morning and evening rush hours will influence the NO_2 levels at this monitoring location.

1.1.3 Sampling Details

The sampling heights and exact location of monitoring sites were generally chosen based on security and logistical considerations. In terms of sampling height, the ideal height is 1.8m which represents the breathing zone of an adult. However, security concerns dictate that diffusion tubes were located between 2m – 3m above ground level. The effect on measured concentrations, due to variations from the breathing zone height, will be insignificant for all locations greater than a few metres from a major road.

Details of the sampling intake levels and distance to local sources of pollution are given below.

Irish Glass Ltd (M1)

The fixed monitoring station is located approximately 12m east of the Sean Moore Road in Ringsend (see Figure 1.1). The location was selected as it is a similar distance from the Sean Moore Road as the worst-case receptors. The station is approximately 1.0m from a 8m high building. Although not ideal, this was dictated by power supply requirements whilst avoiding obstruction of essential site traffic. Sampling for dioxins/furans, heavy metals and acid gases was at a height of 1.5m. Monitoring for PM_{10} was at 3m, and $PM_{2.5}$ at 2m. Diffusion tube monitoring for NO_2 and SO_2 was at a height of 3m. Continuous NO_X monitoring was at a height of 6m as the access point from the enclosed monitoring station was at a height of 7m. The effect on the measured NO_2 level may be to slightly under-estimate the concentration relative to sampling at a height of 1.8m.

Irishtown Nature Reserve (M2)

The NO_2 and SO_2 diffusion tube monitoring site is located on the northeast corner of the Irishtown Nature Reserve (see Figure 1.1). The site is 150m south of the Poolbeg Generating Station. The sampling height was 2.5m.

Sean Moore Park (M3)

The NO_2 and SO_2 diffusion tube monitoring site is located in the southern corner of Sean Moore Park (see Figure 1.1). The site is approx. 10m from the kerbside of the Beach Road and the sampling height was 3m.

Sandymount Green (M4)

The NO_2 and SO_2 diffusion tube monitoring site is located in the eastern corner of Sandymount Green (see Figure 1.1). The site is approx. 5m from the kerbside of the Gilford Road and the sampling height was 2.5m.

Ringsend Park (M5)

The NO_2 and SO_2 diffusion tube monitoring site is located on a residential road at the northern boundary of Ringsend Park (see Figure 1.1). The site is approx. 50m from the R131, which leads to the East Link Toll Bridge. The sampling height was 3m.

Bull Island (M6)

The NO_2 and SO_2 diffusion tube monitoring site is located near the centre of Bull Island. It is removed from significant local sources of pollution (see Figure 1.1). The sampling height was 3m.

Clontarf (Belgrove Road) (M7)

The NO_2 and SO_2 diffusion tube monitoring site is located in a residential area on the Belgrove Road in Clontarf (see Figure 1.1). The site is approx. 2m from the kerbside of the Belgrove Road, although the road experiences relatively low volumes of traffic. The sampling height was 3m.

1.1.4 Methodology

PM_{10} & $PM_{2.5}$

The PM_{10} monitoring program, using a continuous PM_{10} sampler, focused on assessing 24-hour average concentrations at the fixed monitoring station (Location M1, see Figure 1.1) over three three-month (approx.) periods (July - October 2003, November 2003 - February 2004, January - April 2005 and September - December 2005). PM_{10} sampling was carried out by means of an R&P Partisol®-Plus Sequential Air Sampler (Model 2025). The sampler is a manual air sampling platform which has been designed to meet US EPA Reference Designation (RFPS-1928-127). Approximately 24 m^3 of air was sampled over 24-hour periods through a size selective inlet containing an impactor. This removed particles with a diameter >10 μg, with the remaining particles collected on pre-weighed 47mm diameter glass fibre filters. The Partisol® sampler was programmed to begin and end sampling onto a pre-weighed filter at midnight, which ensured that each filter represented a sampling period of exactly 24 hours.

For the first six weeks of the July - October 2003 sampling, the sampler was programmed to automatically replace each sampled filter every 24 hours. Thereafter sampling was carried out every 48 hours in order to reduce costs without affecting significantly the long-term average. For the November 2003 - February 2004 monitoring period, sampling was carried out every 48 hours, except for the period of overlap with $PM_{2.5}$ sampling. For the January - April 2005 and September - December 2005 monitoring periods, sampling was carried out every 24 hours. Gravimetric determination was carried out pre- and post-sampling at a UKAS accredited laboratory (Casella SEAL, Runcorn, UK, which is part of the Department of the Environment, Food & Rural Affairs (DEFRA) UK Monitoring Network). The monitoring results allow an indicative comparison with both the 24-hour and annual limit values.

The $PM_{2.5}$ monitoring program focused on assessing 24-hour average concentrations at the fixed monitoring station (Location M1, see Figure 1.1) over four two-week periods (September / October 2003, January / February 2004, April / May 2005 and September / October 2005). $PM_{2.5}$ sampling in 2003/2004 was carried out by means of an Airmetrics MiniVol® Air Sampler which has been designed by the US EPA. $PM_{2.5}$ sampling in 2005 was carried out using an R&P Partisol®-Plus Sequential Air Sampler (Model 2025). Approximately 7 m^3 (MiniVol® Air Sampler) or 24 m^3 (Partisol Plus Air Sampler) of air was sampled over 24-hour periods through a size selective inlet containing an impactor.

This removed particles with a diameter >2.5 μg, with the remaining particles collected on pre-weighed 47mm diameter glass fibre filters. The samplers were programmed to begin and end sampling onto a pre-weighed filter at midnight, which ensured that each filter represented a sampling period of exactly 24 hours.

Gravimetric determination was carried out pre- and post-sampling at a UKAS accredited laboratory (Casella SEAL, Runcorn, UK, which is part of the Department of the Environment, Food & Rural Affairs (DEFRA) UK Monitoring Network).

NO_2

Monitoring of nitrogen dioxide in the vicinity of Poolbeg was carried out using two sampling methods: chemiluminescent analysis and passive diffusion. Continuous monitoring of NO_2 was performed using a chemiluminescent analyser (Thermo Environmental Instruments, Model 42C) over the 2-year period from July 2003 - August 2005 at the fixed monitoring station (see Figure 1.1). In this method, the NO_x ($NO + NO_2$) concentration is determined based on its direct relationship with the level of energy emitted by chemiluminescent NO_2, which is formed when nitric oxide (NO) is reacted with ozone (O_3) in an evacuated chamber within the analyser. One of the major advantages of this monitoring method is that it provides high resolution continuous measurement of NO_2, and hence the results can be used to compare with the hourly limit value. In addition, the average NO_2 level measured over the one-year monitoring period allows a comparison with the annual limit value.

The spatial variation in NO_2 levels away from sources is particularly important, as a complex relationship exists between NO, NO_2 and O_3 leading to a non-linear variation of NO_2 concentrations with distance from sources. In order to assess the spatial variation in NO_2 levels in the region around Poolbeg, NO_2 was monitored using passive diffusion tubes over 24 one-month periods (from July 2003 - July 2004 and August 2004 - August 2005) at seven locations in the area (see Figure 1.1). Passive sampling of NO_2 involves the molecular diffusion of NO_2 molecules through a polycarbonate tube and their subsequent adsorption onto a stainless steel disc coated with triethanolamine. Following sampling, the tubes were analysed using UV spectrophotometry, at a UKAS accredited laboratory (Casella SEAL).

Benzene

In order to assess the spatial variation in benzene levels at Poolbeg, benzene was monitored using passive diffusion tubes over four one-month periods in August / September 2003, February / March 2004, October / November 2004 and August / September 2005 (see Figure 1.1). Passive sampling of benzene involves the molecular diffusion of benzene molecules through a stainless steel tube and their subsequent adsorption onto a stainless steel gauze coated with Chromasorb 106. Following sampling, the tubes were analysed using Gas Chromatography, at a UKAS accredited laboratory (Casella SEAL).

SO_2

In order to assess the spatial variation in sulphur dioxide levels in the area, SO_2 was monitored using passive diffusion tubes over 24 one-month periods (from July 2003 - July 2004 and August 2004 - August 2005) and also for two months at six additional locations in January / February 2004 and February / March 2005 (see Figure 1.1). Passive sampling of SO_2 involves the molecular diffusion of SO_2 molecules through a tube fabricated of PTFE and their subsequent adsorption onto a stainless steel gauze coated with sodium carbonate. Following sampling, the adsorbed sulphate is removed from the tubes with deionised water and analysed using ion chromatography. Analysis was carried out at a UKAS accredited laboratory (Casella SEAL).

HCl & HF

Gaseous HF and HCl were monitored over four one-month periods in August/September 2003, February/March 2004, October/November 2004 and August/September 2005 at the fixed monitoring station (see Figure 1.1). HF and HCl were sampled using sequential filtration onto pre-cleaned 47mm diameter, 0.45μm nominal pore size nylon membrane filters. Particles and aerosols, including salt which may interfere with the gaseous measurement, were removed from the airstream using a 47mm diameter, 1μm pore size teflon filter. The filters were housed in a single multi-stage open-face teflon holder designed to minimise any losses onto the sampler surfaces. The teflon cassette contained a Teflon filter upstream of two nylon filters to ensure quantitative collection of the acid gases.

Ambient air was sampled through the cassette assembly using a sampling pump set at a flowrate of approximately 5 litres per minute (l/min). The actual volume sampled was recorded on a digital dry gas meter (DGM). Following sampling, the nylon filters were extracted with eluent in a sonic bath and chloride (Cl^-) and fluoride (F^-) concentrations determined on the solution by ion chromatography (IC). An equivalent mass of HCl and HF was then determined from the molecular masses. The methodology therefore assumes that all the gaseous chloride and fluoride present in the air is in the form of HCl and HF respectively. Analysis was carried out by Scientific Analysis Laboratories, Manchester.

Metals

Sampling for heavy metals was carried out over four one-month periods in August/September 2003, February/March 2004, October/November 2004 and August & October 2005 at the fixed monitoring station. Sampling was carried out in accordance with the requirements of US EPA methodology at the fixed monitoring station (see Figure 1.1). The method was taken from the Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air (IO series). Method IO-3 describes a method for chemical species analysis of filter-collected suspended particulate matter.

Sampling of ambient air was achieved using a high volume air sampler manufactured by Graseby Anderson. Metals were captured by drawing air through a pre-weighed fine porosity quartz fibre filter (203 x 254mm). Quartz filters were utilised as they have low background heavy metal concentrations. The filter used in the tests had a pore size capable of attaining a >99.95 percent efficiency of capture of smoke particles as determined by a DOP smoke test. Following sampling and re-weighing, the quartz filters were acid digested and the metals suite determined by inductively coupled plasma (ICP) by Scientific Analysis Laboratories, Manchester.

PCDDs & PCDFs

Sampling for PCDDs and PCDFs was carried out over four one-month periods in August/September 2003, February/March 2004, October/November 2004 and August/September 2005 at the fixed monitoring station. Sampling was carried out in accordance with the requirements of the United States Environmental Protection Agency (US EPA) methodology. Monitoring was carried out at the fixed monitoring station (see Figure 1.1). The sampling method was taken from the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. Method TO9 describes a method for the sampling of PCDDs and PCDFs in ambient air using high resolution gas chromatography/mass spectrometry.

Sampling of the ambient air was achieved using a high volume air sampler (General Metal Works Model PS-1). Air was drawn through a fine porosity quartz filter and adsorbent cartridge containing polyurethane foam (PUF) to trap the particulate and volatile fractions respectively. In order to obtain a detection limit in ambient air of approximately one femtogram (fg), a sample volume of at least 500m^3 was required.

The calibrated sampler was assembled with a pre-cleaned quartz fibre filter and PUF trap. The filter used in the tests had a pore size of 0.45 microns, capable of attaining a > 99.5 percent efficiency of capture of 0.3 micron particles. The filter composite comprised a PUF plug retained in a glass sampling cartridge. The PUF foam trap was spiked with ^{13}C labelled isomers in order to allow a recovery experiment to be performed.

The flow through the system was monitored using a Venturi/Magnehelic assembly. From the calibration graph the gauge reading was then used to calculate an average flowrate in cubic metres per minute (m^3/min) over the sampling period. From the known sampling period a sampling volume in m^3 was then calculated.

Analysis for PCDDs and PCDFs was by high-resolution gas chromatography/mass spectrometry (GC/MS) and was carried out by Scientific Analysis Laboratories (SAL), Manchester. SAL Ltd are UKAS accredited for the analysis of PCDDs and PCDFs. Extraction, clean-up and analysis procedures followed USEPA protocols and the full quality assurance and quality control regime set out in EPA Method 1613 was followed.

1.1.5 Ambient Air Quality Compliance Criteria

PM_{10} & $PM_{2.5}$

EU Directive 1999/30/EC, which has been adopted into Irish Legislation as S.I. 271 of 2002 (Air Quality Standards Regulations 2002), has set 24-hour and annual limit values for PM_{10} and 50 μg/m^3 and 40 μg/m^3 respectively. The 24-hour limit of 50 μg/m^3 is set as a 90th%ile, which means it must not be exceeded more than 35 times per year. EU Directive 1999/30/EC has also set an annual limit value of 40 μg/m^3. In addition, an indicative limit value of 20 μg/m^3 may be applicable in 2010. However, proposed EU Directive COM(2005) 447 on Ambient Air Quality and Cleaner Air for Europe (21/09/2005) includes a recommendation to *"replace the indicative limit values for PM_{10} for the year 2010 by a legally binding "cap" for the annual average concentrations of $PM_{2.5}$ of 25 μg/m^3 to be attained by 2010"*. This proposed directive followed on from previous studies on particulate matter in Europe carried out by the CAFÉ working group[(1)].

Proposed Directive COM(2005) 447 has also outlined proposals to establish a $PM_{2.5}$ concentration cap of 25 μg/m^3, as an annual average (to be attained by 2010), coupled with a non-binding target to reduce human exposure generally to $PM_{2.5}$ between 2010 and 2020. This exposure reduction target is currently proposed at 20% of the average exposure indicator (AEI). The AEI is based on measurements taken in urban background locations averaged over a three year period.

NO_2

EU Directive 1999/30/EC has set 1-hour and annual limit values for NO_2. An hourly limit of 200 $\mu g/m^3$ has been set which must not be exceeded more than 18 times per year (99.8^{th}%ile). The annual limit value is 40 $\mu g/m^3$ (see Table 1.1).

An annual average limit for NO_x (NO and NO_2) is applicable for the protection of vegetation in highly rural areas away from major sources of NO_x such as large conurbations, factories and high road vehicle activity such as a dual carriageway or motorway. Annex VI of EU Directive 1999/30/EC identifies that monitoring to demonstrate compliance with the NO_X limit for the protection of vegetation should be carried out distances greater than:

- 5 km from the nearest motorway or dual carriageway
- 5 km from the nearest major industrial installation
- 20 km from a major urban conurbation

As a guideline, a monitoring station should be indicative of approximately 1000 km^2 of surrounding area. Thus, based on the above it would be inappropriate to apply this standard in the current region due to the present of a major conurbation and major industrial installations nearby. However, due to the presence of a Special Area of Conservation (SAC) nearby, the annual NOx limit value has been applied in the current study.

Benzene

EU Directive 2000/69/EC, which has been adopted into Irish Legislation as S.I. 271 of 2002 (Air Quality Standards Regulations 2002), has set an annual limit value of 5 $\mu g/m^3$ for benzene (see Table 1.2). A margin of tolerance of 100% applied during the monitoring study. This will reduce linearly from 2006 to reach 0% by 2010.

SO_2

EU Directive 1999/30/EC has set hourly, daily and annual limit values for SO_2 (see Table 1.1). The hourly limit value is 350 $\mu g/m^3$ which must not be exceeded more than 25 times per year (99.7^{th}%ile). The 24-hour limit value, which is expressed as a 98.9%ile, is 125 $\mu g/m^3$. The annual limit value for the protection of ecosystems is 20 $\mu g/m^3$.

HCl and HF

An ambient air quality limit for hydrogen chloride (HCl) of 100 $\mu g/m^3$ has been defined in the TA Luft guidelines[(2)] (see Table 1.3). The standard is expressed as a 98^{th} percentile. Concentrations must therefore be below the limit concentration for 98 percent of the time as measured on an hourly basis. An ambient air quality limit for hydrogen fluoride (HF) of 3 $\mu g/m^3$ (as a 98^{th}%ile) has also been defined in the TA Luft guidelines (see Table 1.3). The WHO has also set an annual limit value of 0.3 $\mu g/m^3$[(3)].

Guidance has recently issued by the UK Environment Agency entitled "IPPC Environmental Assessment for BAT" (Environment Agency, 2002)[(4)]. The guidance outlines the approach for deriving both short-term and long-term environmental assessment levels (EAL). In relation to the long-term (annual) EAL, this can be derived by applying a factor of 100 to the 8-hour OEL. The factor of 100 allows for both the greater period of exposure and the greater sensitivity of the general population. For short-term (1-hour) exposure, the EAL is derived by applying a factor of 10 to the short term exposure limit (STEL). In this case, only the sensitivity of the general population need be taken into account as there is no need for additional safety factors in terms of the period of exposure. Where STELs are not listed then a value of 3 times the 8-hour time weighted average occupational exposure limit may be used. Using the above methodology, the derived EAL for HF is 250 $\mu g/m^3$ (short-term only) whereas HCl has both a short-term (20 $\mu g/m^3$) and long-term (800 $\mu g/m^3$) EAL.

PCDDs/PCDFs

Currently, no internationally recognised ambient air quality concentration or deposition standards exist for PCDD/PCDFs. Both the USEPA and World Health Organisation (WHO) recommended approach to assessing the risk to human health from PCDD/PCDFs entails a detailed risk assessment analysis involving the determination of the impact of PCDD/PCDFs in terms of the TDI (Tolerable Daily Intake) approach. The WHO currently proposes a maximum TDI of between 1-4 pgTEQ/kg of body weight per day(3).

Metals

Ambient air quality guidelines and limits for various metals have been set by the European Union, the WHO and in the TA Luft Guidelines. In the absence of statutory standards, ambient air quality guidelines can also be derived from occupational exposure limits (OEL). As outlined above, short-term and long-term environmental assessment levels (EAL) can be derived by applying appropriate factors to the OEL. Annual average limit values for the metals studied in this monitoring program are listed in Table 1.4.

1.1.6 Results

PM_{10}

Daily concentrations of PM_{10} measured at the fixed monitoring station are shown in Figure 1.2 and Tables 1.5 - 1.9. A summary of the PM_{10} data obtained is detailed in Tables 1.10 - 1.11.

A total of 126 24-hour measurements of PM_{10} were recorded over the first year of monitoring (2003/04) (see Table 1.10). The monitored concentrations showed 22 exceedences of the 24-hour EU limit value of 50 $\mu g/m^3$. The average level of PM_{10} measured over the complete monitoring period was 33 $\mu g/m^3$, which is below the EU annual limit value of 40 $\mu g/m^3$. The 90^{th}%ile of 24-hour averages was 61 $\mu g/m^3$, which is above the limit value of 50 $\mu g/m^3$.

A total of 188 24-hour measurements of PM_{10} were recorded over the second year of monitoring (2005) (see Table 1.11). The monitored concentrations showed 48 exceedences of the 24-hour EU limit value of 50 $\mu g/m^3$. The average level of PM_{10} measured over the complete monitoring period was 34 $\mu g/m^3$, which is below the EU annual limit value of 40 $\mu g/m^3$. The 90^{th}%ile of 24-hour averages was 57 $\mu g/m^3$, which is above the limit value of 50 $\mu g/m^3$.

Overall, a total of 314 24-hour measurements of PM_{10} were recorded over the monitoring campaign (see Table 1.11). The monitored concentrations showed 48 exceedences of the 24-hour EU limit value of 50 $\mu g/m^3$. The average level of PM_{10} measured over the complete monitoring period was 33 $\mu g/m^3$, which is below the EU annual limit value of 40 $\mu g/m^3$. The 90^{th}%ile of 24-hour averages was 57 $\mu g/m^3$, which is above the limit value of 50 $\mu g/m^3$.

Although the PM_{10} results for 2003/04 and 2004/05 detailed above have been indicatively compared with the annual average and 24-hour limit values, comparison of monitoring data with the annual average and 24-hour limit values should be based on a full year of monitoring data. A methodology for comparing results of monitoring programs of less than a year with annual average and 24-hour limit values is detailed below.

The temporal variation in PM_{10} is not marked, with average concentrations measured in 2003/04 similar to those measured in 2005. A slight seasonal variation in levels is shown in the 2005 data, with an average of 37 $\mu g/m^3$ over the January - April 2005 period compared to 31 $\mu g/m^3$ in September - December 2005. With regard to the 90^{th}%ile of daily concentrations, peak levels were measured in the months of November and February in the 2003/04 monitoring campaign and February, March and November in the 2004/05 monitoring campaign. This indicates that exceedences of the 24-hour limit value are more likely in the winter and spring months.

Although the monitoring survey did not sample for a full year, guidance is available from the UK DEFRA[(5)], in relation to estimating the long-term (annual) averages from a shorter-term monitoring survey. The approach is based on the fact that patterns in pollutant concentrations usually affect a wide region. Thus a one-month peak at one location is usually replicated at similar sites up to 50km away. The adjustment procedure is outlined below:

- 2 - 4 long-term monitoring sites are used to obtain annual means (in this case EPA / Local Authority operator sites Winetavern St, Coleraine St, Rathmines & Marino have been used).
- The average over the 2003/04 and 2004/05 survey periods is then calculated at each of these sites.
- The ratio of the mean during the 2003/04 survey period to the 2003 annual mean and the 2004/05 survey period to the 2005 annual mean is then determined for each site.
- The average ratio derived from these sites is then applied to the shorter-term monitoring site (fixed monitoring station) to obtain an estimate of the annual average for 2003 and 2005 for the site. The results for the fixed site are outlined in Tables 1.12 and 1.13.

For the 2003/04 monitoring data, good agreement between the four EPA / Local Authority continuous monitoring stations was obtained in terms of the ratio used to derive the annual average, and to a lesser extent the 90^{th}%ile. Using the derived ratio, the data from the fixed monitoring station at Poolbeg indicates that the annual average is just below the limit value (derived annual average of 37 $\mu g/m^3$). The derived 90^{th}%ile of 24-hour concentrations indicates an exceedence of the 24-hour limit value.

For the 2005 monitoring data, good agreement between the four EPA / Local Authority continuous monitoring stations was obtained in terms of the ratio used to derive both the annual average and the 90^{th}%ile. Using the derived ratio, the data from the fixed monitoring station at Poolbeg indicates that the annual average is below the limit value (derived annual average of 30 $\mu g/m^3$). The derived 90^{th}%ile of 24-hour concentrations is also just below the 24-hour limit value.

Meteorological data (wind speed, wind direction, temperature, humidity) have been recorded at the proposed site at Pigeon House Road since December 2003. The available data (December 2003 - July 2004 & January - August 2005) has been investigated to help determine whether there is a significant correlation between measurement of 24-hour PM_{10} concentrations and wind speed using the full set of monitoring data (see Figure 1.3). The graph indicates the correlation is weak (correlation coefficient (r) =0.26) but of significance (sample size = 232, critical value for significance = 0.20).

$PM_{2.5}$

Daily concentrations of $PM_{2.5}$ measured at the fixed monitoring station located in Poolbeg are shown in Tables 1.14 - 1.15, with a summary of the results detailed in Table 1.16. The 24-hour concentrations of $PM_{2.5}$ ranged from 1 to 44 $\mu g/m^3$ over the full monitoring campaign. The average level of $PM_{2.5}$ measured in 2003/04 was 13 $\mu g/m^3$, and that in 2004/05 was 8 $\mu g/m^3$.

A plot of the daily $PM_{2.5}$ concentration versus PM_{10} concentration for the complete data set is given in Figure 1.4, and indicates the daily $PM_{2.5}/PM_{10}$ ratio varied significantly. Indeed the average ratio over each monitoring period ranged from 0.19 - 0.46, with an overall average of 0.33. A plot of the $PM_{2.5}$ / PM_{10} ratio versus $PM_{2.5}$ concentration shows a significant trend for an increasing $PM_{2.5}$ / PM_{10} ratio with $PM_{2.5}$ concentration (see Figure 1.5). This indicates a trend for variations in PM_{10} to be driven more by variations in $PM_{2.5}$, as is likely for a location which is heavily influenced by nearby traffic.

Some data from comparable sites in Ireland is available and shows that for an EPA survey over a one year period (Year 2002) in Crumlin, Dublin (an urban background station) a ratio of $PM_{2.5}$ to PM_{10} of 0.34 was measured[(6)]. Recent data from Cork City in 2004 (urban centre station) found a ratio of $PM_{2.5}$ to PM_{10} of 0.45[(7)]. EPA monitoring data at the smaller urban centres of Mountrath, Carlow, Clonmel and Tralee in 2004 gave $PM_{2.5}/PM_{10}$ ratios ranging from 0.34 to 0.50. Thus, the current study is in good agreement with these findings.

The recent EU *"Second Position Paper on Particulate Matter"*[(1)] has indicated that the typical annual ratio of $PM_{2.5}$ to PM_{10} varied between 0.40 – 0.80 with an average of roughly two-thirds. Hence, the results of the monitoring survey indicate a relatively low $PM_{2.5}/PM_{10}$ ratio in comparison to annual average ratios across Europe.

NO_2

A plot of the hourly NO_2 concentration, a comparison hourly NO and NO_2 concentrations, and a plot of hourly NOx concentrations measured over period July 2003 - August 2005 at the fixed monitoring station at Poolbeg are shown in Figures 1.6 - 1.8 respectively. Summaries of the daily maximum 1-hour and average NO_2 concentrations measured over the monitoring period are listed in Tables 1.17 - 1.25. The monthly results are also summarised in Tables 1.26 - 1.27. The 99.8th%ile of the hourly concentrations measured during the July 2003 to July 2004 period was 108 $\mu g/m^3$, and during the August 2004 to August 2005 period was 93.8 $\mu g/m^3$. These levels reach 54% and 47% respectively of the EU limit value of 200 $\mu g/m^3$. The average NO_2 concentration measured over the July 2003 to July 2004 period monitoring period was 33.3 $\mu g/m^3$, and during the August 2004 to August 2005 period was 27.3 $\mu g/m^3$, both of which are below the annual EU limit value of 40 $\mu g/m^3$.

A passive diffusion tube survey was also carried out to determine the spatial variation in NO_2 levels in the region of the proposed scheme (see Tables 1.28 - 1.29). The monitoring locations were chosen as outlined previously (see Site Selection). Recent studies carried out for the UK DEFRA[(5)] have shown that procedures specific to individual analysis laboratories can lead to a systematic bias in diffusion tube results when compared to the continuous chemiluminescent analyser. It is therefore necessary to allow for this bias when reporting diffusion tube results. In order to calculate this bias, diffusion tubes were co-located with the continuous analyser at the fixed monitoring station on a monthly basis. Duplicate sampling of diffusion tubes was also carried out at the fixed monitoring station to assess the precision of the laboratory results. Co-located diffusion tube results were generally in good agreement with the exception of the May – June 2004 co-located samples (duplicate results of 20 and 45 $\mu g/m^3$) and the January – February 2005 co-located samples (duplicate results of 49 and 38 $\mu g/m^3$). An examination of the continuous analyser results during these periods (see Tables 1.26 - 1.27) indicates that the 45 and 49 $\mu g/m^3$ results are likely to be outliers and have been rejected. For the 2003/04 results, a negative bias is indicated in the annual average diffusion tube results at the fixed monitoring station when compared to the continuous analyser (diffusion tube conc. / continuous analyser conc. = bias = 0.85), whereas this bias is slightly positive for the 2004/05 monitoring results (bias = 1.03). This indicates the suitability of diffusion tube data to give a good estimate of long-term average concentrations. The diffusion tube bias for the 2003/04 and 2004/05 data has been applied to the average monitoring results to determine the adjusted average concentrations at each of the long-term monitoring sites (see Tables 1.28 - 1.29). The 12-month adjusted average diffusion tube results for the 2003/04 and 2004/05 monitoring periods is shown in Figure 1.9.

An examination of the variation in NO_2 concentration between stations for the 2003/04 monitoring period indicates that the highest recorded annual NO_2 concentrations were measured at roadside locations in the region of Poolbeg (M1, M3, M4 & M5). Average levels at these locations were similar, ranging from 30.3 - 33.3 $\mu g/m^3$ in 2003/04. Levels measured at these roadside locations for the 2004/05 monitoring period were slightly lower, ranging from 27.6 - 30.5 $\mu g/m^3$.

As expected, Bull Island (M6) was significantly lower than the other six locations averaging around 16.9 $\mu g/m^3$ in 2003/04 and 15.1 $\mu g/m^3$ in 2004/05. The results indicate that a general background level across Dublin accounts for a significant fraction of the measured level.

The roadside increment, due to road traffic in the immediate vicinity of the roadside monitoring station, leads to a relative minor increase in concentration when compared to urban background locations. For example, location M7 (Belgrove Road) is considered an urban background location as it is removed from major road sources. Location M7 recorded annual average concentrations in 2003/04 and 2004/05 respectively of 24.2 and 22.5 $\mu g/m^3$. Locations M1, M3, M4 and M5 are in closer proximity to road traffic (of varying magnitude) and showed an additional roadside increment of between 5 - 9 $\mu g/m^3$ indicating that the roadside increment would account for between 13 and 23% of the total measured annual average NO_2 concentration at these locations.

Location M2 (Irishtown Nature Reserve) would also be considered an urban background location and NO_2 levels in 2003/04 were similar to those at location M7. However, for the 2004/05 monitoring period, the average NO_2 levels were similar to those at the roadside locations M1, M3, M4 and M5. The reason for this is not apparent at this stage.

The variation in the NO_2 continuous analyser concentration by day of week is outlined in Figures 1.10 – 1.11. Figure 1.10 shows the pattern of annual average NO_2 concentration for each hour of the week. Some trends are clearly evident. An observable pattern of weekday (Monday – Friday) peaks in the morning rush hours is evident (8:00 – 9:00, averaging 40 – 45 $\mu g/m^3$) with a gradual decrease during the late morning and early afternoon followed by a secondary peak of reduced magnitude (averaging 35 – 40 $\mu g/m^3$) occurring during the evening peak (17:00 –19:00). Following the secondary peak, levels decline gradually back to a background level of 17 - 18 $\mu g/m^3$ during the late evening and early morning. This background level derived for the fixed monitoring station (M1) is in excellent agreement with the general background level across Dublin measured at Bull Island (M6) of 15 - 17 $\mu g/m^3$.

On a daily comparison, morning peak levels are similar from Monday to Friday, although Tuesday, Wednesday and Friday levels are slightly higher. Weekend NO_2 levels are significantly lower as would be expected. The Saturday and Sunday morning peak levels reaches 34 and 21 $\mu g/m^3$ respectively, with a significant dip to almost background levels in the mid-afternoon. The late evening peak levels on Saturday and Sunday (21:00 - 22:00), may correspond with truck movements from the nearby Dublin Port or the gradual build-up of traffic during the evening due to returning commuters to Dublin.

Figure 1.11 shows the hourly pattern of annual average NO_2 concentrations for four scenarios: weekly average (Sunday – Saturday), weekday (Monday – Friday), Saturday and Sunday. Some trends are again evident. As expected, a weekday peak in the morning rush hours is evident (7:00 – 09:00, averaging 44 $\mu g/m^3$) with a gradual decrease prior to a secondary peak of reduced magnitude (averaging 36 $\mu g/m^3$) occurring in the evening peak (16:00 –18:00). After this secondary peak, levels drop back to background levels during the early morning (03:00 - 04:00). Interestingly, the base level recorded at this time (03:00, average 17.9 $\mu g/m^3$) is slightly above the general background level across Dublin measured at Bull Island (M6) of 15 - 17 $\mu g/m^3$. Saturday NO_2 pattern is quite similar to the weekday pattern although reduced in magnitude as would be expected. Sunday however has a markedly different pattern with little variation above background during the day until early evening when concentrations increase gradually peaking at 22:00.

The relationship between NO_2 and NO_X ($NO + NO_2$ combined) has been investigated in Figure 1.12. As expected, the ratio is a function of the NO_X concentration. At very low concentrations, NO_X is present almost exclusively as NO_2. At low NO_X concentrations, ozone reacts quickly with NO to form NO_2 with the availability of NO the limiting factor. At higher NO_X concentrations, ozone is depleted through this reaction and the efficiency of the conversion reduces. The crossover point (when NO_2 = NO) typically occurs at 60ppb (approx. 120 $\mu g/m^3$)[8] and the current data also shows a similar crossover point (see Figure 1.12). At very high levels, the NO_2/NO_X ratio converges to approximately 0.2.

The actual ratio is also a function of time of day and day of the week (see Figure 1.13). The ratio is lowest during the morning weekday rush hours (averaging 0.46) corresponding with highest NO_2 and NO_X levels. This also corresponds with the greatest emission of primary NO_2 from road traffic whilst the ratio is highest during Sunday and in the early morning reflecting the lower NO_2 and NO_X concentrations.

The on-site meteorological data has been investigated to help determine whether there is a significant correlation between measurement hourly NO_2 and NO_X concentrations and wind speed over the period December 2003 - July 2004 and January - August 2005 (see Figures 1.14 – 1.15). In relation to NO_2, there is a significant (correlation coefficient (r) =0.35, sample size > 10,000, critical value for significance = 0.20) negative correlation (i.e. at high wind speeds, NO_2 concentrations are reduced and vice versa). Similarly, NO_X displays a negative correlation with wind speed although the correlation is less pronounced but still significant (r=0.26, sample size > 10,000, critical value for significance = 0.20).

An examination of the NO_X concentration versus wind speed data (see Figure 1.15) indicates that at high levels of NO_X (>200 $\mu g/m^3$) the correlation is poor suggesting that other factors are important in determining NO_X concentrations under low wind speeds (< 2 m/s). This may be due in part to the termolecular reaction of NO and O_2 (reaction (1)) which is strongly dependent on the NO concentration and thus is much more rapid at high concentrations typical of pollution episodes[8]. Reaction (1) has been reported in the literature to be important under wintertime pollution episode conditions[8]:

(1) $2NO + O_2 \rightarrow 2NO_2$

During the survey period, several very high NO_X levels were recorded. One such episode occurred during the period 15 December – 19 December 2003 when levels of NO_X peaked at 762 $\mu g/m^3$ as shown in Figure 1.16 (NO_2) and Figure 1.17 (NO_X). Over this period very low wind speeds (< 1 m/s) and low temperatures were typical. Figures 1.16 and 1.17 also highlight that at two EPA / Local Authority continuous analysers in Dublin, similar high levels of NO_X and NO_2 were experienced indicating that the pollution episode was a city-wide phenomenon.

The correlation between measured hourly NO_2 and NO_X concentrations and wind direction over the period December 2003 - July 2004 and January - August 2005 (see Figure 1.18) has been explored. In relation to NO_2, no major pattern is apparent although there is a small increase in concentration compared to the annual mean when northerly to easterly winds are experienced. However, winds from this direction are generally of low frequency and may experience unusually low average wind speeds. In relation to NO_X, again northerly to easterly winds lead to higher concentrations with the pattern somewhat less pronounced than for NO_2.

The relationship between both NO_2/NO_X and PM_{10} has been investigated in Figures 1.19 – 1.20. The available data has been investigated to help determine whether there is a significant correlation between measurement 24-hourly NO_2/NO_X and PM_{10} concentrations. In relation to NO_2, there is a significant positive correlation (r=0.37, sample size = 314, critical value for significance = 0.20). Similarly, NO_X displays a significant positive correlation (r=0.36, sample size = 314, critical value for significance = 0.20). Thus, the correlation suggests that similar source emission characteristics (such as road traffic levels) and/or meteorological conditions lead to similar trends in NO_2/NO_X and PM_{10} concentrations.

As described above, the annual NOx limit value for the protection of ecosystems has been applied to the monitoring locations at Bull Island (M6) and Irishtown Nature Reserve (M2). The average NO_2 concentration measured at both locations over the two-year monitoring period was 21 $\mu g/m^3$. This can be converted to a background NOx concentration using a NOx/NO_2 ratio of 0.8, which is derived from the fixed monitoring station results (see Figure 1.12). Thus the average NOx concentration for Bull Island and Irishtown Nature Reserve is 26 $\mu g/m^3$, which is below the annual NOx limit value of 30 $\mu g/m^3$.

Benzene

Average concentrations of benzene were measured over two sets of one-month periods (each divided into four one-week periods) at the fixed monitoring location (see Figure 1.1) during both the 2003/04 and 2004/05 monitoring campaigns. The results show that weekly levels over each of the four one-month periods ranged from 1.0 to 5.8 $\mu g/m^3$ (see Table 1.30). The average monthly concentrations measured in 2003/04 were 1.3 and 3.8 $\mu g/m^3$, while those measured in 2004/05 were 1.1 and 1.7 $\mu g/m^3$. Hence average monthly benzene concentrations were significantly lower than the EU annual limit value of 5 $\mu g/m^3$.

SO_2

Average concentrations of SO_2 measured at the fixed monitoring station (see Figure 1.1) are shown in Table 1.31. The results show that monthly SO_2 levels at Poolbeg ranged from 2.5 - 7.8 $\mu g/m^3$ over the period July 2003 - July 2004, with an average level for the monitoring period of 5.3 $\mu g/m^3$. SO_2 concentrations over the period August 2004 -

August 2005 averaged 4.2 μg/m^3. Hence measured levels reach only 27% and 21% respectively of the EU annual limit value for the protection of ecosystems of 20 μg/m^3, although as described in Section 1.1.5 this limit value is not applicable for the current region. Additionally, SO_2 measurements were carried out at Locations M1-M7 over a one-month period during the 2003/04 and 2004/05 monitoring campaigns (see Table 1.32). The results show some minor variations in SO_2 with all results ranging from 5.2 - 10.0 μg/m^3 in 2004 and 3.2 - 13.3 μg/m^3 in 2005.

HCl & HF

HCl and HF were measured over two sets of four 3-8 day periods spread over one-month at the fixed monitoring station during both the 2003/04 and 2004/05 monitoring campaigns. The results are detailed in Table 1.33. The average concentrations measured during the two one-month periods in 2003/04 were 0.21 and 0.01 μg/m^3 for HCl and HF respectively, while those measured in 2003/04 were 0.15 and 0.01 μg/m^3 respectively. The average HCl levels can be indicatively compared to the hourly TA Luft Imission Limit value for HCl of 100 μg/m^3 and the long-term of EAL of 20 μg/m^3 whereas the average HF level can be indicatively compared to the annual WHO Limit value for HF of 0.3 μg/m^3. Hence, measured levels of HCl and HF were considerably lower than the relevant limit values.

Metals

Ambient concentrations of a suite of metals were measured over two sets of 4-5 (approx.) day periods spread over one-month at the fixed monitoring station during both the 2003/04 and 2004/05 monitoring campaigns. The results for each sample are detailed in Table 1.34 - 1.37, with an overall summary of results detailed in Table 1.38. The average concentrations of antimony (Sb), arsenic (As), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), mercury (Hg), manganese (Mn), nickel (Ni), lead (Pb), thallium (Tl) and vanadium (V) were significantly below their respective annual limit values, with upper range average levels reaching only 0.06 - 17% of these limits (see Table 1.38).

PCDDs & PCDFs

Background levels of PCDD/PCDFs occur everywhere and existing levels in the Poolbeg region have been extensively monitored over two one-month periods as part of the 2003/04 and 2004/05 monitoring campaigns. Monitoring was carried out over four 4-5 (approx.) day periods spread over each one month monitoring period, the results of which are detailed in Tables 1.39 - 1.46. A summary of the results for each one-month period is detailed in Table 1.47. As described in Section 1.3.3, no ambient air quality concentration or deposition standards currently exist for PCDD/PCDFs.

Caution should be exercised in comparing data between monitoring sites due to varying detection limits and the methodologies employed in assigning non-detects. Non-detects (i.e. levels below the limit of detection) may be assigned a value of either zero, half the limit of detection or the limit of detection. Depending on the number of congeners below the limit of detection and the approach to non-detects, significant variations may be perceived in inter-comparison exercises of samples. Furthermore, historically, a number of systems for assessing the toxicity of PCDD/F were developed, all using the concept of Toxic Equivalence Factors (TEQ)(9). This concept assesses the toxicity of other PCDD/F congeners and assigns a weighting compared to the known toxicity of 2,3,7,8 TCDD. These systems applied slightly different weighting factors for calculating TEQ expressed as units of 2,3,7,8 TCDD. These differences meant that it was not possible in many instances to directly compare TEQ data from different countries. The NATO/CCMS system began to be more widely used through the early 1990's and the WHO also introduced a similar system. The US EPA, NATO/CCMS and the EC systems now use the same TEF Factors and the World Health Organisation has also adopted a similar system, allowing direct comparability of TEQ values[10]. The NATO/CCMS TEFs (giving a result which is defined as I-TEQ), which correspond exactly with the EC and US EPA TEFs, have been used to calculate TEQs for the PCDD/Fs measured during this study.

Historically, measurements of PCDDs in Ireland have been limited. Table 1.48 shows the range of concentrations measured in ambient air in Ireland and elsewhere in recent years. Levels at Poolbeg showed significant variations between monitoring periods, particularly those measured in February / March 2004, which were a factor of 10 - 20 higher than those measured during the remaining three one-month monitoring periods. A similar variation has been reported in the literature for monitoring carried out in Germany in the 1990s[11].

The mean PCDD/PCDF concentration measured over the four one-month periods during 2003 - 2005 indicates that results are slightly higher than measurements elsewhere in Ireland, with an upper limit of 56.2 fg/m^3 compared to previous measurements ranging from 2.8 – 46 fg/m^3 (see Table 1.48). However, previous measurements have been in rural or industrial zoned land whereas the current site is in an urban area with vehicle, home heating & power stations in close proximity. Data from other urban locations throughout Europe is also shown in Table 1.48[11-12]. The mean ambient concentration measured at Poolbeg is at the lower end of the range of mean levels obtained in Germany, Austria and Italy over the last decade. Furthermore, measured average levels are equivalent to those measured recently at an urban site in UK in Middlesbrough, and significantly lower than those measured in Manchester over the period 2000 - 2003.

Data on deposition is limited. Shown in Table 1.49 are a range of deposition data from the UK, Belgium and Germany. No data is available in Ireland, but based on the measured ambient PCDD and PCDF concentrations, baseline deposition levels would be expected to be similar to urban areas of Germany (6-36 pg/m^2/day).

1.1.7 Validation of Results

Where available, sampling and analysis for all species was carried out using methodologies recommended by the WHO[3], the UK DEFRA[5] and the USEPA[13-14]. In addition, only UKAS accredited laboratories were used for analysis of the samples. The NO_2 diffusion tube monitoring study (discussed above) involved duplicate sampling at the fixed monitoring station, with the results showing good agreement. In addition a comparison of the NO_2 diffusion tube and continuous NOx analyser results at the fixed monitoring station allowed a diffusion tube bias to be calculated[5] and applied to the remaining six monitoring sites.

1.1.8 REFERENCES

(1) European Commission (2004) Second Position Paper On Particulate Matter (CAFE Working Group)
(2) Technical Instructions on Air Quality Control (1986)
(3) World Health Organisation (1999) Guidelines For Air Quality
(4) Environmental Agency, 2002: "IPPC Environmental Assessment for BAT", The Stationary Office
(5) UK DEFRA (2003) Part IV of the Environment Act 1995: Local Air Quality Management, LAQM. TG(03)
(6) EPA Website (2006) http://www.epa.ie/OurEnvironment/Air/AccessMaps/
(7) Cork City Council (2005) Air Pollution In Cork City 2004
(8) DEFRA (2004) Air Quality Expert Group – Nitrogen Dioxide In The UK
(9) WHO (1989) Polychlorinated dibenzo-p-dioxins and dibenzofurans, EHC 88.
(10) Van den Berg et al.,(1998) Toxic Equivalency Factors (TEFs) for PCBS, PCDDs, PCDFs, for humans and wildlife, Environmental Health Perspective, 106 (12) 775 – 792.
(11) European Commission (1999) Compilation of EU Dioxin Exposure & Health Data Task 2 Environmental Levels - Technical Annex.
(12) Trace Organic Micro-Pollutants (TOMPS) Network Website, http://www.aeat.co.uk/netcen/airqual/
(13) USEPA (1999) Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air
(14) USEPA (1999) Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air

Table 1.1 Air Quality Standards Regulations S.I. 271 of 2002 (based on Council Directive 1999/30/EC)

Pollutant	Regulation	Limit Type	Margin of Tolerance	Value
Particulate Matter (PM_{10}) Stage 1	1999/30/EC	24-hour limit for protection of human health - not to be exceeded more than 35 times/year	50% until 2001 reducing linearly to 0% by 2005	50 $\mu g/m^3$
		Annual limit for protection of human health	20% until 2001 reducing linearly to 0% by 2005	40 $\mu g/m^3$
Particulate Matter (PM_{10}) Stage 2[1]	1999/30/EC	24-hour limit for protection of human health - not to be exceeded more than 7 times/year	To be derived from data and to be equivalent to Stage 1 limit value	50 $\mu g/m^3$
Particulate Matter ($PM_{2.5}$)	COM(2005)447	Annual concentration cap for protection of human health	None. Limit value applicable in 2010.	25 $\mu g/m^3$
Nitrogen Dioxide	1999/30/EC	Hourly limit for protection of human health - not to be exceeded more than 18 times/year	50% until 2001 reducing linearly to 0% by 2010	200 $\mu g/m^3$ NO_2
		Annual limit for protection of human health	50% until 2001 reducing linearly to 0% by 2010	40 $\mu g/m^3$ NO_2
		Annual limit for protection of vegetation	None	30 $\mu g/m^3$ $NO + NO_2$
Sulphur Dioxide	1999/30/EC	Hourly limit for protection of human health - not to be exceeded more than 24 times/year	43% until 2001 reducing linearly until 0% by 2005	350 $\mu g/m^3$
		Daily limit for protection of human health - not to be exceeded more than 3 times/year	None	125 $\mu g/m^3$
		Annual & Winter limit for the protection of ecosystems	None	20 $\mu g/m^3$

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

Table 1.2 Air Quality Standards Regulations S.I. 271 of 2002 (based on Council Directive 2000/69/EC)

Pollutant	Regulation	Limit Type	Margin of Tolerance	Value
Benzene	2000/69/EC	Annual limit for protection of human health	100% until 2006 reducing linearly to 0% by 2010	5 $\mu g/m^3$

Table 1.3 Air Standards for TOC, HCl and HF

Pollutant	Regulation	Limit Type	Value
HCl	TA Luft	Hourly limit for protection of human health – expressed as a 98th%ile	100 $\mu g/m^3$
HCl	EAL	Annual average	20 $\mu g/m^3$
HF	TA Luft	Hourly limit for protection of human health – expressed as a 98th%ile	3 $\mu g/m^3$
HCl	EAL	Maximum 1-Hour	800 $\mu g/m^3$
HF	WHO	Gaseous fluoride (as HF) as an annual average	0.3 $\mu g/m^3$
HF	Dutch	Mean fluoride (as HF) concentration during the growing season (April to September)	0.4 $\mu g/m^3$
HF	Dutch	Ambient gaseous fluoride (as HF) as a 24-hour average concentration	2.8 $\mu g/m^3$
HF	EAL	Maximum 1-Hour	250 $\mu g/m^3$

Table 1.4 Ambient Air Quality Standards & Guidelines for Metals

Pollutant	Regulation(2)	Limit Type	Value
Inorganic Mercury (as Hg)	EAL	Annual Average	0.25 $\mu g/m^3$
Cd	EU	Annual Average	0.005 $\mu g/m^3$(1)
Tl	EAL	Annual Average	1.0 $\mu g/m^3$
Sb (organic compounds)	EAL	Annual Average	5 $\mu g/m^3$
As	EU	Annual Average	0.006 $\mu g/m^3$(1)
Pb	EU	Annual Average	0.5 $\mu g/m^3$
Cr (except VI)	EAL	Annual Average	5.0 $\mu g/m^3$
Cr (VI)	EAL	Annual Average	0.1 $\mu g/m^3$
Co	EAL	Annual Average	0.2 $\mu g/m^3$
Cu (fumes)	EAL	Annual Average	2.0 $\mu g/m^3$
Cu (dust & mists)	EAL	Annual Average	10 $\mu g/m^3$
Mn	WHO	Annual Average	0.15 $\mu g/m^3$
Ni	EU	Annual Average	0.02 $\mu g/m^3$(1)
V	EAL	Annual Average	5 $\mu g/m^3$
V	WHO	24-Hour Average	1.0 $\mu g/m^3$

(1) Council Directive 2004/107/EC
(2) EAL derived from Environmental Agency, 2002: "IPPC Environmental Assessment for BAT", The Stationary Office.

Table 1.5 PM_{10} ambient concentrations measured at the fixed monitoring station, Poolbeg (July 2003 - October 2003).

Sampling Date	PM_{10} ($\mu g/m^3$)	Sampling Date	PM_{10} ($\mu g/m^3$)	Sampling Date	PM_{10} ($\mu g/m^3$)
15-Jul-03	88	9-Aug-03	55	12-Sep-03	39
16-Jul-03	77	10-Aug-03	21	14-Sep-03	15
17-Jul-03	31	11-Aug-03	32	15-Sep-03	51
18-Jul-03	38	12-Aug-03	36	16-Sep-03	52
19-Jul-03	35	13-Aug-03	29	17-Sep-03	46
20-Jul-03	21	14-Aug-03	35	18-Sep-03	25
21-Jul-03	30	15-Aug-03	42	19-Sep-03	21
22-Jul-03	36	16-Aug-03	26	20-Sep-03	30
23-Jul-03	26	17-Aug-03	33	21-Sep-03	22
24-Jul-03	50	18-Aug-03	29	22-Sep-03	14
25-Jul-03	29	19-Aug-03	30	23-Sep-03	23
26-Jul-03	20	20-Aug-03	29	24-Sep-03	31
27-Jul-03	20	21-Aug-03	32	25-Sep-03	37
28-Jul-03	26	22-Aug-03	18	26-Sep-03	27
29-Jul-03	21	23-Aug-03	26	27-Sep-03	24
30-Jul-03	36	24-Aug-03	19	28-Sep-03	13
31-Jul-03	52	25-Aug-03	51	29-Sep-03	27
1-Aug-03	41	27-Aug-03	27	30-Sep-03	22
2-Aug-03	29	29-Aug-03	25	1-Oct-03	57
3-Aug-03	21	31-Aug-03	12	2-Oct-03	60
4-Aug-03	20	2-Sep-03	27	4-Oct-03	26
5-Aug-03	56	4-Sep-03	45	6-Oct-03	37
6-Aug-03	63	6-Sep-03	14	18-Oct-03	45
7-Aug-03	51	8-Sep-03	27	19-Oct-03	31
8-Aug-03	43	10-Sep-03	19	20-Oct-03	37
PM_{10} Limit Values	**40(1), 50(2)**	**PM_{10} Limit Values**	**40(1), 50(2)**	**PM_{10} Limit Values**	**40(1), 50(2)**

(1) EU Council Directive 1999/30/EC - Limit value to be enforced in 2005 (as an annual average).
(2) EU Council Directive 1999/30/EC - Limit value to be enforced in 2005 (as a 90th percentile of 24 hour averages).

Table 1.6 PM_{10} ambient concentrations measured at the fixed monitoring station, Poolbeg (November 2003 - February 2004).

Sampling Date	PM_{10} (µg/m³)	Sampling Date	PM_{10} (µg/m³)	Sampling Date	PM_{10} (µg/m³)
21-Nov-03	84	31-Dec-03	14	28-Jan-04	20
23-Nov-03	25	2-Jan-04	22	29-Jan-04	52
25-Nov-03	39	4-Jan-04	31	30-Jan-04	31
27-Nov-03	32	6-Jan-04	32	31-Jan-04	9
29-Nov-03	6	8-Jan-04	23	1-Feb-04	14
1-Dec-03	33	10-Jan-04	24	2-Feb-04	30
3-Dec-03	43	12-Jan-04	22	3-Feb-04	15
5-Dec-03	63	13-Jan-04	20	4-Feb-04	11
7-Dec-03	20	14-Jan-04	27	5-Feb-04	37
9-Dec-03	28	15-Jan-04	17	6-Feb-04	42
11-Dec-03	61	16-Jan-04	21	7-Feb-04	16
13-Dec-03	8	17-Jan-04	36	8-Feb-04	22
15-Dec-03	148	18-Jan-04	23	9-Feb-04	44
17-Dec-03	65	19-Jan-04	12	10-Feb-04	36
19-Dec-03	49	20-Jan-04	19	11-Feb-04	61
21-Dec-03	8	21-Jan-04	63	12-Feb-04	56
23-Dec-03	9	22-Jan-04	33	13-Feb-04	70
25-Dec-03	10	23-Jan-04	35	14-Feb-04	70
27-Dec-03	7	27-Jan-04	21	15-Feb-04	63
29-Dec-03	41				
PM_{10} Limit Values	**40(1), 50(2)**	**PM_{10} Limit Values**	**40(1), 50(2)**	**PM_{10} Limit Values**	**40(1), 50(2)**

(1) EU Council Directive 1999/30/EC - Limit value to be enforced in 2005 (as an annual average).
(2) EU Council Directive 1999/30/EC - Limit value to be enforced in 2005 (as a 90th percentile of 24 hour averages).

Table 1.7 PM_{10} ambient concentrations measured at the fixed monitoring station, Poolbeg (January 2005 - April 2005 & May 2005).

Sampling Date	PM_{10} ($\mu g/m^3$)	Sampling Date	PM_{10} ($\mu g/m^3$)	Sampling Date	PM_{10} ($\mu g/m^3$)
11-Jan-05	22	09-Feb-05	58	09-Mar-05	42
12-Jan-05	26	10-Feb-05	82	10-Mar-05	39
13-Jan-05	54	11-Feb-05	42	11-Mar-05	28
14-Jan-05	12	12-Feb-05	21	15-Mar-05	34
15-Jan-05	26	13-Feb-05	25	16-Mar-05	70
16-Jan-05	15	14-Feb-05	44	17-Mar-05	57
17-Jan-05	12	15-Feb-05	87	18-Mar-05	79
18-Jan-05	12	16-Feb-05	91	19-Mar-05	31
19-Jan-05	13	17-Feb-05	45	20-Mar-05	54
20-Jan-05	10	18-Feb-05	39	21-Mar-05	43
21-Jan-05	28	19-Feb-05	37	22-Mar-05	40
22-Jan-05	13	20-Feb-05	18	02-Apr-05	48
23-Jan-05	18	21-Feb-05	22	03-Apr-05	50
24-Jan-05	34	23-Feb-05	4	04-Apr-05	32
27-Jan-05	43	24-Feb-05	27	05-Apr-05	30
28-Jan-05	62	25-Feb-05	31	06-Apr-05	15
29-Jan-05	46	26-Feb-05	40	07-Apr-05	22
30-Jan-05	37	27-Feb-05	45	08-Apr-05	31
31-Jan-05	11	28-Feb-05	45	09-Apr-05	19
01-Feb-05	33	01-Mar-05	46	10-Apr-05	13
02-Feb-05	51	02-Mar-05	30	11-Apr-05	32
03-Feb-05	45	03-Mar-05	65	12-Apr-05	27
04-Feb-05	42	04-Mar-05	42	20-Apr-05	14
05-Feb-05	26	05-Mar-05	75	04-May-05	38
06-Feb-05	22	06-Mar-05	38	05-May-05	24
07-Feb-05	52	07-Mar-05	49	06-May-05	27
08-Feb-05	47	08-Mar-05	47		
PM_{10} Limit Values	**40(1), 50(2)**	**PM_{10} Limit Values**	**40(1), 50(2)**	**PM_{10} Limit Values**	**40(1), 50(2)**

(1) EU Council Directive 1999/30/EC - Limit value to be enforced in 2005 (as an annual average).
(2) EU Council Directive 1999/30/EC - Limit value to be enforced in 2005 (as a 90th percentile of 24 hour averages).

Table 1.8 PM_{10} ambient concentrations measured at the fixed monitoring station, Poolbeg (August/September 2005 - November 2005).

Sampling Date	PM_{10} ($\mu g/m^3$)	Sampling Date	PM_{10} ($\mu g/m^3$)	Sampling Date	PM_{10} ($\mu g/m^3$)
31-Aug-05	44	01-Oct-05	13	01-Nov-05	35
01-Sep-05	18	02-Oct-05	22	02-Nov-05	25
02-Sep-05	21	03-Oct-05	52	03-Nov-05	12
03-Sep-05	30	04-Oct-05	41	04-Nov-05	52
04-Sep-05	39	05-Oct-05	39	05-Nov-05	23
05-Sep-05	40	06-Oct-05	37	06-Nov-05	14
06-Sep-05	40	07-Oct-05	28	07-Nov-05	7
07-Sep-05	26	08-Oct-05	14	08-Nov-05	35
08-Sep-05	21	09-Oct-05	14	09-Nov-05	39
09-Sep-05	14	10-Oct-05	16	10-Nov-05	34
10-Sep-05	24	11-Oct-05	10	11-Nov-05	28
11-Sep-05	13	12-Oct-05	25	12-Nov-05	21
12-Sep-05	38	13-Oct-05	43	13-Nov-05	24
13-Sep-05	23	14-Oct-05	48	14-Nov-05	10
14-Sep-05	21	15-Oct-05	34	15-Nov-05	47
16-Sep-05	23	18-Oct-05	45	16-Nov-05	47
17-Sep-05	14	19-Oct-05	18	17-Nov-05	94
18-Sep-05	8	20-Oct-05	38	18-Nov-05	26
19-Sep-05	23	21-Oct-05	17	19-Nov-05	101
20-Sep-05	35	22-Oct-05	25	20-Nov-05	126
21-Sep-05	23	23-Oct-05	12	21-Nov-05	98
22-Sep-05	18	24-Oct-05	31	22-Nov-05	100
23-Sep-05	22	25-Oct-05	17	23-Nov-05	71
24-Sep-05	27	26-Oct-05	25	24-Nov-05	29
25-Sep-05	8	27-Oct-05	35	25-Nov-05	11
26-Sep-05	24	28-Oct-05	34	26-Nov-05	16
27-Sep-05	26	29-Oct-05	15	27-Nov-05	15
28-Sep-05	26	30-Oct-05	14	28-Nov-05	23
29-Sep-05	25	31-Oct-05	22	29-Nov-05	28
30-Sep-05	24			30-Nov-05	34
PM_{10} Limit Values	**40(1), 50(2)**	**PM_{10} Limit Values**	**40(1), 50(2)**	**PM_{10} Limit Values**	**40(1), 50(2)**

(1) EU Council Directive 1999/30/EC - Limit value to be enforced in 2005 (as an annual average).
(2) EU Council Directive 1999/30/EC - Limit value to be enforced in 2005 (as a 90^{th} percentile of 24 hour averages).

Table 1.9 PM_{10} ambient concentrations measured at the fixed monitoring station, Poolbeg (December 2005).

Sampling Date	PM_{10} ($\mu g/m^3$)
01-Dec-05	13
02-Dec-05	30
03-Dec-05	21
04-Dec-05	10
05-Dec-05	19
06-Dec-05	52
07-Dec-05	18
08-Dec-05	36
09-Dec-05	13
10-Dec-05	26
11-Dec-05	24
12-Dec-05	61
13-Dec-05	51
14-Dec-05	23
15-Dec-05	28
16-Dec-05	40
17-Dec-05	42
18-Dec-05	20
19-Dec-05	65
PM_{10} Limit Values	**40(1), 50(2)**

(1) EU Council Directive 1999/30/EC - Limit value to be enforced in 2005 (as an annual average).
(2) EU Council Directive 1999/30/EC - Limit value to be enforced in 2005 (as a 90th percentile of 24 hour averages).

Table 1.10 Summary of results of PM_{10} monitoring carried out at the fixed monitoring station, Poolbeg (Year 1).

Monitoring Period	Details	
15 July 2003 - 31 July 2003	Total No. Days Sampling	17
	No. Days >50 $\mu g/m^3$	3
	July Average	37 $\mu g/m^3$
August 2003	Total No. Days Sampling	28
	No. Days >50 $\mu g/m^3$	5
	August Average	33 $\mu g/m^3$
September 2003	Total No. Days Sampling	23
	No. Days >50 $\mu g/m^3$	2
	September Average	28 $\mu g/m^3$
1 October 2003 - 20 October 2003	Total No. Days Sampling	7
	No. Days >50 $\mu g/m^3$	2
	October Average	42 $\mu g/m^3$
July 2003 - October 2003 Monitoring Period	*Total No. Days Sampling*	*75*
	No. Days >50 $\mu g/m^3$	*12*
	90^{th}%ile of 24-hour Averages	*52*
	3-Month Average	*33 $\mu g/m^3$*
21 November 2003 - 31 November 2003	Total No. Days Sampling	5
	No. Days >50 $\mu g/m^3$	1
	November Average	37 $\mu g/m^3$
December 2003	Total No. Days Sampling	16
	No. Days >50 $\mu g/m^3$	4
	December Average	38 $\mu g/m^3$
January 2004	Total No. Days Sampling	22
	No. Days >50 $\mu g/m^3$	2
	January Average	26 $\mu g/m^3$
February 2004	Total No. Days Sampling	15
	No. Days >50 $\mu g/m^3$	5
	February Average	39 $\mu g/m^3$
November 2003 - February 2004 Monitoring Period	*Total No. Days Sampling*	*58*
	No. Days >50 $\mu g/m^3$	*12*
	90^{th}%ile of 24-hour Averages	*63*
	3-Month Average	*34 $\mu g/m^3$*
Year 1 - 2003/04 Monitoring Data	***Total No. Days Sampling***	***126***
	No. Days >50 $\mu g/m^3$	***22***
	90^{th}%ile of 24-hour Averages	***61***
	2003/04 Average	***33 $\mu g/m^3$***
PM_{10} Limit Values		**$40^{(1)}$, $50^{(2)}$**

(1) EU Council Directive 1999/30/EC - Annual average limit value.
(2) EU Council Directive 1999/30/EC - 24-Hr limit of 50 $\mu g/m^3$ as a 90^{th} %ile (i.e. 35 days >50 $\mu g/m^3$ permitted per year).

Table 1.11 Summary of results of PM_{10} monitoring carried out at the fixed monitoring station, Poolbeg (Year 2).

Monitoring Period	Details	
11 January 2005 - 31 January 2005	Total No. Days Sampling	19
	No. Days >50 $\mu g/m^3$	1
	January Average	26 $\mu g/m^3$
February 2005	Total No. Days Sampling	27
	No. Days >50 $\mu g/m^3$	6
	August Average	42 $\mu g/m^3$
March 2005	Total No. Days Sampling	19
	No. Days >50 $\mu g/m^3$	6
	September Average	48 $\mu g/m^3$
April 2005	Total No. Days Sampling	12
	No. Days >50 $\mu g/m^3$	0
	October Average	28 $\mu g/m^3$
January 2005 - April 2005 Monitoring Period	*Total No. Days Sampling*	*77*
	No. Days >50 $\mu g/m^3$	*14*
	90^{th}%ile of 24-hour Averages	*61*
	3-Month Average	*37 $\mu g/m^3$*
September 2005	Total No. Days Sampling	30
	No. Days >50 $\mu g/m^3$	0
	September Average	25 $\mu g/m^3$
October 2005	Total No. Days Sampling	29
	No. Days >50 $\mu g/m^3$	1
	October Average	27 $\mu g/m^3$
November 2005	Total No. Days Sampling	30
	No. Days >50 $\mu g/m^3$	7
	November Average	41 $\mu g/m^3$
December 2005	Total No. Days Sampling	19
	No. Days >50 $\mu g/m^3$	4
	December Average	31 $\mu g/m^3$
September 2005 - December 2005 Monitoring Period	*Total No. Days Sampling*	*108*
	No. Days >50 $\mu g/m^3$	*12*
	90^{th}%ile of 24-hour Averages	*52*
	Average	*31 $\mu g/m^3$*
Year 2 - 2004/05 Monitoring Data	***Total No. Days Sampling***	***188***
	No. Days >50 $\mu g/m^3$	***26***
	90^{th}%ile of 24-hour Averages	***54***
	Average	***33 $\mu g/m^3$***
All Monitoring Data (Years 1 & 2)	***Total No. Days Sampling***	***314***
	No. Days >50 $\mu g/m^3$	***48***
	90^{th}%ile of 24-hour Averages	***57***
	2004/05 Average	***33 $\mu g/m^3$***
PM_{10} Limit Values		**40[(1)], 50[(2)]**

(1) EU Council Directive 1999/30/EC - Annual average limit value.
(2) EU Council Directive 1999/30/EC - 24-Hr limit of 50 $\mu g/m^3$ as a 90^{th} %ile (i.e. 35 days >50 $\mu g/m^3$ permitted per year).

Table 1.12 Derivation of Annual Average and 90th%ile of PM_{10} concentrations for the fixed monitoring station, Poolbeg (Year 1).

Location Description	Mean During 2003/04 Monitoring ($\mu g/m^3$)(1)	Ratio	Annual Mean ($\mu g/m^3$)(2)
Winetavern Street	24	1.08	26
Coleraine Street	25	1.00	25
Rathmines	20	1.15	23
Marino	20	1.15	23
Average Ratio (4-weeks)		**1.10**	
Fixed Monitoring Station	**33**		**37(3)**
EU Limit Value ($\mu g/Nm^3$)			**40(4)**
Location Description	**90th%ile During 2003/04 Monitoring ($\mu g/m^3$)(1)**	**Ratio**	**90th%ile ($\mu g/m^3$)(2)**
Winetavern Street	44	1.07	47
Coleraine Street	42	1.29	54
Rathmines	40	1.20	48
Marino	35	1.23	43
Average Ratio (4-weeks)		**1.20**	
Fixed Monitoring Station	**61**		**73(3)**
EU Limit Value ($\mu g/Nm^3$)			**50(5)**

(1) 126 24-hour measurement data points included in the analysis during this period.
(2) Annual average and 90th%ile of 24-hr PM_{10} concentrations measured in 2003 at Dublin City Council monitoring sites.
(3) For Poolbeg, annual average and 90th%ile of 24-hr PM_{10} concentrations estimated from ratios of long-term monitoring stations as outlined in UK DEFRA (2003) Part IV of the Environment Act 1995: Local Air Quality Management, LAQM. TG(03)
(4) EU Ambient Air Standard (1999/30/EC) (as an annual average)
(5) EU Ambient Air Standard (1999/30/EC) (as a 90th%ile)

Table 1.13 Derivation of Annual Average and 90th%ile of PM_{10} concentrations for the fixed monitoring station, Poolbeg (Year 2).

Location Description	Mean During 2004/05 Monitoring ($\mu g/m^3$)(1)	Ratio	Annual Mean ($\mu g/m^3$)(2)
Winetavern Street	21	0.90	19
Coleraine Street	22	0.91	20
Rathmines	18	0.94	17
Marino	15	0.93	14
Average Ratio (4-weeks)		**0.92**	
Fixed Monitoring Station	**33**		**30**(3)
EU Limit Value ($\mu g/Nm^3$)			**40**(4)
Location Description	**90th%ile During 2004/05 Monitoring ($\mu g/m^3$)(1)**	**Ratio**	**90th%ile ($\mu g/m^3$)(2)**
Winetavern Street	33	0.94	31
Coleraine Street	41	0.88	36
Rathmines	30	0.93	28
Marino	27	0.89	24
Average Ratio (4-weeks)		**0.91**	
Fixed Monitoring Station	**54**		**49**(4)
EU Limit Value ($\mu g/Nm^3$)			**50**(5)

(1) 188 24-hour measurement data points included in the analysis during this period.
(2) Annual average and 90th%ile of 24-hr PM_{10} concentrations measured in 2005 at Dublin City Council monitoring sites.
(3) For Poolbeg, annual average and 90th%ile of 24-hr PM_{10} concentrations estimated from ratios of long-term monitoring stations as outlined in UK DEFRA (2003) Part IV of the Environment Act 1995: Local Air Quality Management, LAQM. TG(03)
(4) EU Ambient Air Standard (1999/30/EC) (as an annual average)
(5) EU Ambient Air Standard (1999/30/EC) (as a 90th%ile)

Table 1.14 Summary of results of $PM_{2.5}$ monitoring carried out at the fixed monitoring station, Poolbeg (Year 1 - 2003/04).

Sampling Period	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	Ratio
15-Sep-03	29	51	0.56
16-Sep-03	20	52	0.39
17-Sep-03	13	46	0.28
18-Sep-03	3	25	0.12
19-Sep-03	9	21	0.41
23-Sep-03	4	23	0.16
24-Sep-03	8	31	0.27
25-Sep-03	6	37	0.17
26-Sep-03	12	27	0.44
29-Sep-03	5	27	0.18
30-Sep-03	19	22	0.85
1-Oct-03	22	57	0.38
2-Oct-03	19	(2)	(2)
	Average: 13 $\mu g/m^3$	Average: 35 $\mu g/m^3$	Average: 0.35
6-Jan-04	12	32	0.37
8-Jan-04	14	23	0.60
10-Jan-04	18	24	0.76
13-Jan-04	13	20	0.65
17-Jan-04	23	36	0.65
20-Jan-04	13	19	0.70
27-Jan-04	16	21	0.78
29-Jan-04	16	52	0.30
2-Feb-04	6	30	0.20
4-Feb-04	2	11	0.21
6-Feb-04	5	42	0.13
10-Feb-04	9	36	0.25
12-Feb-04	24	56	0.43
	Average: 13 $\mu g/m^3$	Average: 31 $\mu g/m^3$	Average: 0.46
Year 1 Monitoring	*Average: 13 $\mu g/m^3$*	*Average: 33 $\mu g/m^3$*	*Average: 0.41*
Limit Value	**Annual - 25(1)**	**Annual - 40** **Maximum 1-Hour - 50**	

(1) Proposed EU Directive COM(2005) 447 - Annual concentration cap
(2) PM_{10} data not available.

Table 1.15 Summary of results of $PM_{2.5}$ monitoring carried out at the fixed monitoring station, Poolbeg (Year 2 - 2004/05).

Sampling Period	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	Ratio
02-Apr-05	42	48	0.88
03-Apr-05	44	50	0.87
04-Apr-05	7	32	0.22
05-Apr-05	5	30	0.17
06-Apr-05	5	15	0.30
07-Apr-05	6	22	0.25
08-Apr-05	6	31	0.20
09-Apr-05	4	19	0.19
10-Apr-05	6	13	0.43
11-Apr-05	5	32	0.17
12-Apr-05	7	27	0.27
04-May-05	10	38	0.26
05-May-05	8	24	0.32
06-May-05	7	27	0.27
	Average: 12 $\mu g/m^3$	*Average: 29 $\mu g/m^3$*	*Average: 0.34*
20-Sep-05	7	35	0.19
21-Sep-05	4	23	0.18
22-Sep-05	6	18	0.31
23-Sep-05	5	22	0.21
24-Sep-05	7	27	0.28
25-Sep-05	1	8	0.09
26-Sep-05	5	24	0.19
27-Sep-05	4	26	0.16
28-Sep-05	4	26	0.14
29-Sep-05	3	25	0.10
30-Sep-05	2	24	0.09
01-Oct-05	2	13	0.12
02-Oct-05	6	22	0.29
03-Oct-05	12	52	0.23
	Average: 5 $\mu g/m^3$	*Average: 25 $\mu g/m^3$*	*Average: 0.19*
Year 2 Monitoring	*Average: 8 $\mu g/m^3$*	*Average: 27 $\mu g/m^3$*	*Average: 0.26*
Limit Value	**Annual - 25(1)**	**Annual - 40** **Maximum 1-Hour - 50**	

(1) Proposed EU Directive COM(2005) 447 - Annual concentration cap

Table 1.16 Summary of results of $PM_{2.5}$ monitoring carried out at the fixed monitoring station, Poolbeg (2003/04 & 2004/05 Monitoring Campaign).

Monitoring Period	**Details**	
September / October 2003	Total No. Days Sampling	13
	Average	13 µg/m^3
	$PM_{2.5}$ / PM_{10} Ratio	0.35
January / February 2004	Total No. Days Sampling	13
	Average	13 µg/m^3
	$PM_{2.5}$ / PM_{10} Ratio	0.47
April / May 2005	Total No. Days Sampling	20
	Average	11 µg/m^3
	$PM_{2.5}$ / PM_{10} Ratio	0.34
September / October 2005	Total No. Days Sampling	14
	Average	5 µg/m^3
	$PM_{2.5}$ / PM_{10} Ratio	0.19
Overall Monitoring Period (Year 1 & 2)	*Total No. Days Sampling*	*60*
	Average	*11 µg/m^3*
	$PM_{2.5}$ / PM_{10} Ratio	*0.33*
$PM_{2.5}$ Limit Value		25(1)

(1) Proposed EU Directive COM(2005) 447 - Annual concentration cap.

Table 1.17 Maximum 1-hour and daily average NO_2 concentrations measured at the fixed monitoring station, Poolbeg (July 2003 - October 2003)

Date	Max 1-Hr($\mu g/m^3$)	Average ($\mu g/m^3$)	Date	Max 1-Hr($\mu g/m^3$)	Average ($\mu g/m^3$)	Date	Max 1-Hr($\mu g/m^3$)	Average ($\mu g/m^3$)
15-Jul-03	84.2	70.9	14-Aug-03	43.1	23.3	13-Sep-03	24.3	14.2
16-Jul-03	94.6	63.9	15-Aug-03	51.6	31.4	14-Sep-03	37.7	21.5
17-Jul-03	52.8	40.1	16-Aug-03	49.0	27.8	15-Sep-03	77.4	51.9
18-Jul-03	41.4	30.9	17-Aug-03	31.3	16.5	16-Sep-03	75.8	48.7
19-Jul-03	28.8	24.1	18-Aug-03	40.1	21.9	17-Sep-03	89.1	40.1
20-Jul-03	27.6	22.8	19-Aug-03	41.4	26.1	18-Sep-03	60.9	38.5
21-Jul-03	45.9	30.9	20-Aug-03	44.6	28.7	19-Sep-03	56.1	31.7
22-Jul-03	49.9	33.8	21-Aug-03	36.0	22.2	20-Sep-03	56.3	38.5
23-Jul-03	40.2	22.0	22-Aug-03	44.1	24.6	21-Sep-03	44.2	20.5
24-Jul-03	51.3	33.1	23-Aug-03	43.8	21.7	22-Sep-03	49.3	25.3
25-Jul-03	49.1	28.2	24-Aug-03	38.4	24.2	23-Sep-03	53.1	35.7
26-Jul-03	32.1	20.7	25-Aug-03	40.9	24.8	24-Sep-03	119.4	53.2
27-Jul-03	33.0	19.6	26-Aug-03	44.7	24.9	25-Sep-03	77.0	52.0
28-Jul-03	41.4	26.4	27-Aug-03	45.6	32.3	26-Sep-03	69.2	44.1
29-Jul-03	36.0	22.7	28-Aug-03	55.9	43.3	27-Sep-03	61.0	43.7
30-Jul-03	82.5	33.1	29-Aug-03	55.0	41.4	28-Sep-03	42.6	29.6
31-Jul-03	55.8	34.6	30-Aug-03	52.4	27.9	29-Sep-03	95.0	46.5
1-Aug-03	58.7	29.8	31-Aug-03	47.8	26.5	30-Sep-03	73.9	46.1
2-Aug-03	33.6	21.6	1-Sep-03	50.3	34.1	1-Oct-03	70.0	56.7
3-Aug-03	44.5	20.9	2-Sep-03	49.4	26.8	2-Oct-03	86.0	52.6
4-Aug-03	34.5	24.0	3-Sep-03	57.2	33.2	3-Oct-03	75.7	40.6
5-Aug-03	107.8	50.6	4-Sep-03	85.7	33.5	4-Oct-03	42.5	23.4
6-Aug-03	75.2	44.7	5-Sep-03	54.1	33.8	5-Oct-03	26.5	19.1
7-Aug-03	65.7	36.5	6-Sep-03	51.4	25.1	6-Oct-03	39.4	23.6
8-Aug-03	67.4	35.0	7-Sep-03	51.9	27.6	7-Oct-03	50.7	29.2
9-Aug-03	80.3	35.5	8-Sep-03	60.1	35.5	8-Oct-03	36.1	22.8
10-Aug-03	33.9	22.4	9-Sep-03	41.6	24.2	9-Oct-03	31.0	20.3
11-Aug-03	54.3	37.7	10-Sep-03	45.2	24.8	10-Oct-03	63.8	37.4
12-Aug-03	60.4	34.6	11-Sep-03	33.0	23.8	11-Oct-03	71.1	39.7
13-Aug-03	30.8	17.0	12-Sep-03	67.4	26.7	12-Oct-03	17.6	12.4

Table 1.18 Maximum 1-hour and daily average NO_2 concentrations measured at the fixed monitoring station, Poolbeg (October 2003 - January 2004)

Date	Max 1-Hr(µg/m^3)	Average (µg/m^3)	Date	Max 1-Hr(µg/m^3)	Average (µg/m^3)	Date	Max 1-Hr(µg/m^3)	Average (µg/m^3)
13-Oct-03	26.0	17.8	13-Nov-03	78.3	40.2	14-Dec-03	53.3	26.6
14-Oct-03	46.0	26.1	14-Nov-03	41.5	28.9	15-Dec-03	119.1	75.8
15-Oct-03	44.0	24.6	15-Nov-03	52.3	32.5	16-Dec-03	104.7	52.6
16-Oct-03	58.0	27.3	16-Nov-03	61.5	35.5	17-Dec-03	98.2	44.7
17-Oct-03	59.8	37.3	17-Nov-03	41.9	28.1	18-Dec-03	136.8	79.7
18-Oct-03	56.8	31.1	18-Nov-03	46.1	29.0	19-Dec-03	84.6	55.7
19-Oct-03	53.3	31.0	19-Nov-03	79.6	44.1	20-Dec-03	45.8	20.1
20-Oct-03	70.5	46.8	20-Nov-03	69.3	49.8	21-Dec-03	33.4	19.8
21-Oct-03	78.2	46.1	21-Nov-03	126.9	73.0	22-Dec-03	61.8	39.0
22-Oct-03	100.2	55.2	22-Nov-03	106.7	68.4	23-Dec-03	37.6	23.2
23-Oct-03	97.2	63.6	23-Nov-03	61.3	41.9	24-Dec-03	24.7	15.0
24-Oct-03	66.2	51.7	24-Nov-03	85.2	51.6	25-Dec-03	35.2	13.5
25-Oct-03	45.3	32.5	25-Nov-03	64.2	43.8	26-Dec-03	19.3	10.5
26-Oct-03	85.2	45.0	26-Nov-03	61.2	41.0	27-Dec-03	54.1	22.3
27-Oct-03	66.3	46.6	27-Nov-03	66.3	44.2	28-Dec-03	66.4	27.1
28-Oct-03	60.2	50.2	28-Nov-03	64.6	43.3	29-Dec-03	78.1	56.3
29-Oct-03	59.7	38.4	29-Nov-03	45.8	30.3	30-Dec-03	67.0	38.5
30-Oct-03	42.8	30.7	30-Nov-03	84.2	47.4	31-Dec-03	53.1	19.8
31-Oct-03	68.3	47.2	01-Dec-03	72.9	53.8	01-Jan-04	21.1	13.3
1-Nov-03	52.9	32.1	02-Dec-03	80.8	43.1	02-Jan-04	58.9	33.1
2-Nov-03	37.4	23.6	03-Dec-03	66.3	45.8	03-Jan-04	60.3	35.5
3-Nov-03	66.4	36.3	04-Dec-03	80.1	56.4	04-Jan-04	52.9	39.8
4-Nov-03	63.9	39.7	05-Dec-03	82.8	63.2	05-Jan-04	40.2	26.3
5-Nov-03	34.5	24.6	06-Dec-03	51.2	33.9	6-Jan-04	44.4	21.8
6-Nov-03	70.2	35.6	07-Dec-03	39.3	21.7	7-Jan-04	26.1	13.0
7-Nov-03	69.3	43.8	08-Dec-03	44.5	34.0	8-Jan-04	66.3	32.2
8-Nov-03	41.8	25.4	09-Dec-03	61.0	34.3	9-Jan-04	51.7	33.9
9-Nov-03	38.6	27.1	10-Dec-03	70.8	46.7	10-Jan-04	52.9	26.9
10-Nov-03	76.6	43.4	11-Dec-03	88.0	59.1	11-Jan-04	31.1	18.9
11-Nov-03	54.4	30.3	12-Dec-03	64.3	37.0	12-Jan-04	66.2	32.3
12-Nov-03	92.5	49.5	13-Dec-03	26.7	19.6	13-Jan-04	43.4	27.7

Table 1.19 Maximum 1-hour and daily average NO_2 concentrations measured at the fixed monitoring station, Poolbeg (January 2004 - April 2004)

Date	Max 1-Hr(µg/m^3)	Average (µg/m^3)	Date	Max 1-Hr(µg/m^3)	Average (µg/m^3)	Date	Max 1-Hr(µg/m^3)	Average (µg/m^3)
14-Jan-04	80.1	45.1	14-Feb-04	96.1	69.2	15-Mar-04	50.1	28.6
15-Jan-04	61.4	33.2	15-Feb-04	71.8	50.4	16-Mar-04	43.5	24.2
16-Jan-04	68.3	45.4	16-Feb-04	69.4	54.1	17-Mar-04	36.8	14.6
17-Jan-04	61.1	54.9	17-Feb-04	82.9	56.2	18-Mar-04	31.4	22.0
18-Jan-04	56.8	43.1	18-Feb-04	109.2	71.2	19-Mar-04	33.0	20.0
19-Jan-04	39.7	26.4	19-Feb-04	110.9	66.3	20-Mar-04	18.5	11.3
20-Jan-04	65.6	39.3	20-Feb-04	54.7	30.4	21-Mar-04	25.4	11.8
21-Jan-04	78.3	53.7	21-Feb-04	57.3	36.9	22-Mar-04	40.3	25.2
22-Jan-04	93.3	60.2	22-Feb-04	54.7	33.1	23-Mar-04	73.1	41.2
23-Jan-04	101.9	64.7	23-Feb-04	81.1	46.5	24-Mar-04	69.9	46.6
24-Jan-04	45.1	28.0	24-Feb-04	76.2	42.3	25-Mar-04	58.1	39.1
25-Jan-04	83.3	42.5	25-Feb-04	66.3	41.1	26-Mar-04	68.2	43.4
26-Jan-04	95.5	68.9	26-Feb-04	61.4	37.6	27-Mar-04	53.7	32.2
27-Jan-04	77.7	53.5	27-Feb-04	72.6	40.8	28-Mar-04	65.3	25.7
28-Jan-04	79.9	50.8	28-Feb-04	78.7	45.5	29-Mar-04	82.2	40.7
29-Jan-04	88.2	54.3	29-Feb-04	106.7	45.8	30-Mar-04	86.2	45.4
30-Jan-04	69.1	40.8	1-Mar-04	176.8	68.2	31-Mar-04	42.5	31.3
1-Feb-04	34.7	19.4	2-Mar-04	59.1	35.5	1-Apr-04	43.8	27.8
2-Feb-04	55.7	34.9	3-Mar-04	104.8	51.9	2-Apr-04	30.6	16.2
3-Feb-04	38.7	26.5	4-Mar-04	94.3	63.8	3-Apr-04	34.9	19.1
4-Feb-04	53.4	29.9	5-Mar-04	78.8	64.7	4-Apr-04	20.0	11.1
5-Feb-04	36.0	22.0	6-Mar-04	56.0	35.3	5-Apr-04	27.8	17.9
6-Feb-04	60.1	35.6	7-Mar-04	76.6	31.3	6-Apr-04	41.4	24.2
7-Feb-04	29.6	18.6	8-Mar-04	67.3	28.8	7-Apr-04	60.2	34.7
8-Feb-04	72.7	31.6	9-Mar-04	**203.3**	58.7	8-Apr-04	67.9	39.8
9-Feb-04	93.1	54.6	10-Mar-04	26.5	18.8	9-Apr-04	52.5	33.4
10-Feb-04	50.0	32.0	11-Mar-04	20.9	15.7	10-Apr-04	42.3	24.0
11-Feb-04	98.2	51.2	12-Mar-04	72.3	33.3	11-Apr-04	51.5	24.4
12-Feb-04	93.2	61.4	13-Mar-04	56.9	33.3	12-Apr-04	45.4	28.4
13-Feb-04	96.2	68.4	14-Mar-04	25.4	16.2	13-Apr-04	54.9	31.7

Table 1.20 Maximum 1-hour and daily average NO_2 concentrations measured at the fixed monitoring station, Poolbeg (April 2004 - July 2004)

Date	Max 1-Hr(μg/m^3)	Average (μg/m^3)	Date	Max 1-Hr(μg/m^3)	Average (μg/m^3)	Date	Max 1-Hr(μg/m^3)	Average (μg/m^3)
14-Apr-04	54.6	25.1	16-May-04	58.1	31.7	18-Jun-04	53.0	34.2
15-Apr-04	54.7	31.8	17-May-04	44.6	26.5	19-Jun-04	38.0	25.1
16-Apr-04	86.2	30.8	18-May-04	39.9	24.6	20-Jun-04	35.0	22.4
17-Apr-04	70.3	35.9	19-May-04	28.4	17.4	21-Jun-04	39.4	26.2
18-Apr-04	33.2	16.4	20-May-04	49.2	28.6	22-Jun-04	49.1	25.1
19-Apr-04	45.2	26.8	21-May-04	59.2	33.6	23-Jun-04	45.8	31.4
20-Apr-04	54.6	20.2	22-May-04	48.8	25.4	24-Jun-04	34.3	23.8
21-Apr-04	35.5	22.5	23-May-04	64.3	31.1	25-Jun-04	40.5	22.4
22-Apr-04	44.2	24.0	24-May-04	69.6	37.6	26-Jun-04	21.5	14.1
23-Apr-04	65.8	30.5	25-May-04	55.5	19.8	27-Jun-04	18.1	13.9
24-Apr-04	69.5	26.0	26-May-04	46.8	24.9	28-Jun-04	45.5	28.1
25-Apr-04	78.7	28.4	27-May-04	42.8	24.8	29-Jun-04	39.8	26.7
26-Apr-04	71.6	37.5	28-May-04	17.0	12.3	30-Jun-04	37.9	21.6
27-Apr-04	53.9	31.5	29-May-04	55.6	24.0	01-Jul-04	36.0	23.7
28-Apr-04	50.8	35.1	30-May-04	37.0	15.8	02-Jul-04	30.1	19.7
29-Apr-04	51.0	33.4	31-May-04	47.0	24.3	03-Jul-04	27.8	16.9
30-Apr-04	77.5	42.8	01-Jun-04	44.3	30.9	04-Jul-04	37.4	20.9
01-May-04	70.3	32.0	02-Jun-04	47.0	28.6	05-Jul-04	40.6	31.0
02-May-04	79.7	23.0	03-Jun-04	35.8	25.7	06-Jul-04	53.0	26.3
03-May-04	20.0	12.1	04-Jun-04	31.4	20.0	07-Jul-04	48.7	34.2
04-May-04	30.5	19.2	05-Jun-04	26.1	16.5	08-Jul-04	52.0	34.7
05-May-04	38.2	21.3	06-Jun-04	32.7	21.3	09-Jul-04	39.5	28.5
06-May-04	44.0	24.7	07-Jun-04	39.6	26.1	10-Jul-04	37.6	22.8
07-May-04	35.0	26.0	08-Jun-04	48.4	34.1	11-Jul-04	33.1	15.1
08-May-04	42.1	24.5	09-Jun-04	43.3	29.8	12-Jul-04	39.2	19.9
09-May-04	64.5	33.1	10-Jun-04	46.6	31.8	13-Jul-04	61.9	26.8
10-May-04	60.3	32.5	11-Jun-04	35.6	22.8	14-Jul-04	34.3	19.3
11-May-04	63.4	37.0	12-Jun-04	37.5	21.3	15-Jul-04	45.0	23.5
12-May-04	60.7	35.7	13-Jun-04	44.1	25.2	16-Jul-04	44.5	27.3
13-May-04	39.2	31.8	14-Jun-04	29.6	21.3	17-Jul-04	36.5	19.1
14-May-04	53.2	30.1	15-Jun-04	27.3	20.3	18-Jul-04	28.1	13.9
15-May-04	64.8	31.6	16-Jun-04	31.1	20.9	19-Jul-04	29.9	17.4

Table 1.21 Maximum 1-hour and daily average NO_2 concentrations measured at the fixed monitoring station, Poolbeg (July 2004 - October 2004)

Date	Max 1-Hr(μg/m³)	Average (μg/m³)	Date	Max 1-Hr(μg/m³)	Average (μg/m³)	Date	Max 1-Hr(μg/m³)	Average (μg/m³)
20-Jul-04	27.1	14.2	21-Aug-04	34.0	21.2	22-Sep-04	30.3	14.1
21-Jul-04	48.8	22.2	22-Aug-04	27.2	8.2	23-Sep-04	34.1	18.0
22-Jul-04	43.3	27.4	23-Aug-04	67.1	21.2	24-Sep-04	46.6	28.4
23-Jul-04	38.6	21.5	24-Aug-04	45.5	28.9	25-Sep-04	18.7	13.1
24-Jul-04	26.7	14.6	25-Aug-04	33.1	21.8	26-Sep-04	9.5	7.0
25-Jul-04	13.1	8.7	26-Aug-04	40.1	21.9	27-Sep-04	22.1	13.7
26-Jul-04	36.6	24.2	27-Aug-04	38.4	20.7	28-Sep-04	49.2	22.6
27-Jul-04	40.9	24.5	28-Aug-04	32.9	19.5	29-Sep-04	31.8	15.7
28-Jul-04	46.6	22.8	29-Aug-04	14.4	7.8	30-Sep-04	45.4	25.1
29-Jul-04	68.4	21.1	30-Aug-04	52.3	27.6	01-Oct-04	34.8	20.1
30-Jul-04	47.7	20.4	31-Aug-04	58.0	30.2	02-Oct-04	19.2	12.7
31-Jul-04	41.8	23.5	01-Sep-04	53.8	33.9	03-Oct-04	30.0	13.8
01-Aug-04	47.1	19.1	02-Sep-04	59.0	29.2	08-Oct-04	59.0	45.4
02-Aug-04	40.8	21.4	03-Sep-04	35.3	22.0	09-Oct-04	49.4	21.8
03-Aug-04	49.2	29.5	04-Sep-04	51.8	23.0	10-Oct-04	35.1	17.6
04-Aug-04	47.2	33.0	05-Sep-04	46.2	26.0	11-Oct-04	71.7	36.7
05-Aug-04	35.0	19.2	06-Sep-04	58.7	40.3	12-Oct-04	69.2	58.5
06-Aug-04	46.2	20.0	07-Sep-04	52.6	27.8	13-Oct-04	69.1	30.6
07-Aug-04	38.6	16.0	08-Sep-04	61.3	46.2	14-Oct-04	55.8	39.0
08-Aug-04	11.5	8.7	09-Sep-04	64.7	47.1	15-Oct-04	80.8	38.7
09-Aug-04	35.1	16.8	10-Sep-04	62.0	34.1	16-Oct-04	49.0	33.6
10-Aug-04	58.5	27.8	11-Sep-04	24.6	13.5	17-Oct-04	47.0	25.0
11-Aug-04	68.6	36.1	12-Sep-04	17.8	9.5	18-Oct-04	60.3	35.2
12-Aug-04	50.2	30.6	13-Sep-04	28.9	13.8	19-Oct-04	72.2	38.0
13-Aug-04	61.4	37.3	14-Sep-04	31.7	18.4	20-Oct-04	76.5	57.6
14-Aug-04	53.0	21.8	15-Sep-04	48.6	27.5	21-Oct-04	**225.7**	54.9
15-Aug-04	30.4	13.2	16-Sep-04	36.5	22.0	22-Oct-04	95.9	61.5
16-Aug-04	54.0	22.4	17-Sep-04	41.6	24.0	23-Oct-04	63.0	37.9
17-Aug-04	43.4	20.5	18-Sep-04	20.7	11.8	24-Oct-04	39.2	14.8
18-Aug-04	85.1	40.7	19-Sep-04	13.5	8.7	25-Oct-04	44.5	19.1
19-Aug-04	78.6	43.6	20-Sep-04	18.3	11.6	26-Oct-04	103.8	38.1
20-Aug-04	46.1	30.5	21-Sep-04	29.3	16.6	27-Oct-04	36.4	20.2

Table 1.22 Maximum 1-hour and daily average NO_2 concentrations measured at the fixed monitoring station, Poolbeg (October 2004- January 2005)

Date	Max 1-Hr(μg/m^3)	Average (μg/m^3)	Date	Max 1-Hr(μg/m^3)	Average (μg/m^3)	Date	Max 1-Hr(μg/m^3)	Average (μg/m^3)
28-Oct-04	40.1	15.4	29-Nov-04	95.3	51.1	14-Jan-05	23.8	11.5
29-Oct-04	69.8	41.2	30-Nov-04	68.6	44.1	15-Jan-05	29.3	12.7
30-Oct-04	57.6	41.6	01-Dec-04	68.1	58.9	16-Jan-05	13.8	10.2
31-Oct-04	62.0	38.7	02-Dec-04	87.1	61.9	17-Jan-05	30.6	17.4
01-Nov-04	77.9	55.2	03-Dec-04	60.6	38.5	18-Jan-05	52.1	19.1
02-Nov-04	61.7	31.0	04-Dec-04	44.8	28.0	19-Jan-05	64.6	21.8
03-Nov-04	77.7	38.2	05-Dec-04	52.4	26.6	20-Jan-05	20.6	13.9
04-Nov-04	46.7	29.1	06-Dec-04	62.7	33.5	21-Jan-05	72.0	44.4
05-Nov-04	61.3	37.1	07-Dec-04	132	59.8	22-Jan-05	65.3	30.0
06-Nov-04	37.5	22.6	08-Dec-04	84.0	40.1	23-Jan-05	48.3	35.2
07-Nov-04	25.9	18.2	23-Dec-04	15.7	5.9	24-Jan-05	70.3	46.6
08-Nov-04	63.4	37.1	24-Dec-04	18.9	12.2	25-Jan-05	73.7	43.6
09-Nov-04	49.8	29.6	25-Dec-04	12.6	8.4	26-Jan-05	67.2	46.6
10-Nov-04	63.2	36.3	26-Dec-04	45.3	19.4	27-Jan-05	76.3	47.4
11-Nov-04	44.9	28.2	27-Dec-04	25.0	11.5	28-Jan-05	23.8	11.5
12-Nov-04	42.4	26.2	28-Dec-04	19.6	12.4	29-Jan-05	29.3	12.7
13-Nov-04	64.9	40.1	29-Dec-04	27.3	12.9	30-Jan-05	13.8	10.2
14-Nov-04	42.2	19.5	30-Dec-04	17.3	10.9	31-Jan-05	30.6	17.4
15-Nov-04	42.9	23.0	31-Dec-04	35.8	19.7	14-Jan-05	52.1	19.1
16-Nov-04	34.8	20.3	01-Jan-05	8.9	6.5	15-Jan-05	64.6	21.8
17-Nov-04	35.5	20.9	02-Jan-05	17.2	9.1	16-Jan-05	20.6	13.9
18-Nov-04	73.4	42.7	03-Jan-05	15.5	9.0	17-Jan-05	72.0	44.4
19-Nov-04	68.2	45.9	04-Jan-05	36.0	16.9	18-Jan-05	65.3	30.0
20-Nov-04	57.4	14.4	05-Jan-05	29.0	17.5	19-Jan-05	48.3	35.2
21-Nov-04	41.7	16.2	06-Jan-05	26.0	15.6	20-Jan-05	70.3	46.6
22-Nov-04	33.4	20.8	07-Jan-05	23.5	11.4	21-Jan-05	73.7	43.6
23-Nov-04	61.5	38.6	08-Jan-05	14.6	9.0	22-Jan-05	67.2	46.6
24-Nov-04	75.2	42.4	09-Jan-05	12.4	7.3	23-Jan-05	76.3	47.4
25-Nov-04	54.4	30.9	10-Jan-05	48.5	21.8	24-Jan-05	23.8	11.5
26-Nov-04	73.5	44.1	11-Jan-05	21.2	12.4	25-Jan-05	29.3	12.7
27-Nov-04	61.8	38.3	12-Jan-05	36.7	19.9	26-Jan-05	13.8	10.2
28-Nov-04	50.3	27.9	13-Jan-05	79.2	37.0	27-Jan-05	30.6	17.4

Table 1.23 Maximum 1-hour and daily average NO_2 concentrations measured at the fixed monitoring station, Poolbeg (January 2005 - May 2005)

Date	Max 1-Hr(μg/m^3)	Average (μg/m^3)	Date	Max 1-Hr(μg/m^3)	Average (μg/m^3)	Date	Max 1-Hr(μg/m^3)	Average (μg/m^3)
28-Jan-05	67.0	40.0	01-Mar-05	78.3	44.2	02-Apr-05	62.1	31.9
29-Jan-05	65.9	39.5	02-Mar-05	76.6	39.6	03-Apr-05	72.4	29.3
30-Jan-05	25.7	17.7	03-Mar-05	79.2	50.9	04-Apr-05	54.5	24.0
31-Jan-05	57.9	34.1	04-Mar-05	57.3	35.1	05-Apr-05	38.5	21.6
01-Feb-05	55.5	32.1	05-Mar-05	49.2	24.4	06-Apr-05	33.5	17.3
02-Feb-05	71.5	41.7	06-Mar-05	85.7	41.7	07-Apr-05	38.1	22.0
03-Feb-05	51.7	33.3	07-Mar-05	71.2	48.4	08-Apr-05	50.7	27.2
04-Feb-05	60.5	31.3	08-Mar-05	79.7	48.3	09-Apr-05	31.4	19.5
05-Feb-05	61.1	34.7	09-Mar-05	84.4	51.3	10-Apr-05	21.0	11.7
06-Feb-05	70.3	41.8	10-Mar-05	63.6	36.6	11-Apr-05	57.7	25.9
07-Feb-05	59.0	38.5	11-Mar-05	32.5	21.4	12-Apr-05	50.2	30.0
08-Feb-05	59.6	33.3	12-Mar-05	32.6	18.9	13-Apr-05	71.7	36.8
09-Feb-05	43.6	21.9	13-Mar-05	32.2	20.4	14-Apr-05	71.2	42.1
10-Feb-05	87.4	46.3	14-Mar-05	95.0	33.1	15-Apr-05	55.7	36.1
11-Feb-05	73.0	37.1	15-Mar-05	50.5	24.7	16-Apr-05	42.0	24.7
12-Feb-05	86.0	38.4	16-Mar-05	38.3	22.5	17-Apr-05	50.9	14.8
13-Feb-05	31.1	20.8	17-Mar-05	18.2	10.6	18-Apr-05	68.4	39.1
14-Feb-05	72.6	46.7	18-Mar-05	60.6	27.1	19-Apr-05	76.2	54.3
15-Feb-05	98.0	71.5	19-Mar-05	54.4	32.0	20-Apr-05	83.2	43.1
16-Feb-05	122.9	69.1	20-Mar-05	39.3	16.2	21-Apr-05	44.6	20.1
17-Feb-05	84.7	60.5	21-Mar-05	33.8	20.1	22-Apr-05	50.7	24.3
18-Feb-05	57.6	45.3	22-Mar-05	42.3	23.3	23-Apr-05	54.7	27.8
19-Feb-05	54.5	35.6	23-Mar-05	50.1	18.2	24-Apr-05	68.5	33.8
20-Feb-05	70.8	34.4	24-Mar-05	44.1	19.5	25-Apr-05	81.5	49.5
21-Feb-05	109.5	58.4	25-Mar-05	62.7	27.7	26-Apr-05	57.7	19.8
22-Feb-05	68.9	45.1	26-Mar-05	48.0	26.2	27-Apr-05	51.6	25.9
23-Feb-05	87.7	48.0	27-Mar-05	40.5	32.8	28-Apr-05	37.3	18.2
24-Feb-05	65.2	46.5	28-Mar-05	28.9	19.7	29-Apr-05	50.7	27.8
25-Feb-05	82.7	61.3	29-Mar-05	58.3	44.2	30-Apr-05	42.3	18.5
26-Feb-05	83.0	52.7	30-Mar-05	57.6	41.0	01-May-05	40.6	17.1
27-Feb-05	83.3	40.4	31-Mar-05	51.3	24.8	02-May-05	16.2	10.0
28-Feb-05	77.4	45.0	01-Apr-05	71.8	26.6	03-May-05	67.9	29.9

Table 1.24 Maximum 1-hour and daily average NO_2 concentrations measured at the fixed monitoring station, Poolbeg (May 2005 - August 2005)

Date	Max 1-Hr(μg/m³)	Average (μg/m³)	Date	Max 1-Hr(μg/m³)	Average (μg/m³)	Date	Max 1-Hr(μg/m³)	Average (μg/m³)
04-May-05	57.5	31.4	04-Jun-05	15.4	9.9	05-Jul-05	36.3	20.5
05-May-05	31.1	19.7	05-Jun-05	17.8	8.4	06-Jul-05	21.3	17.0
06-May-05	35.8	21.7	06-Jun-05	41.6	21.9	07-Jul-05	38.2	23.4
07-May-05	22.4	14.9	07-Jun-05	42.9	21.1	08-Jul-05	38.1	19.2
08-May-05	30.9	15.2	08-Jun-05	74.7	38.0	09-Jul-05	49.7	32.3
09-May-05	53.2	37.5	09-Jun-05	78.1	50.9	10-Jul-05	44.4	21.8
10-May-05	77.5	35.2	10-Jun-05	44.2	30.2	11-Jul-05	48.9	30.2
11-May-05	82.3	40.1	11-Jun-05	41.9	22.6	12-Jul-05	58.7	37.7
12-May-05	83.4	45.6	12-Jun-05	39.0	16.8	13-Jul-05	34.9	21.5
13-May-05	61.9	28.2	13-Jun-05	30.2	19.4	14-Jul-05	47.3	27.7
14-May-05	58.9	22.7	14-Jun-05	32.9	19.7	15-Jul-05	32.5	19.9
15-May-05	68.6	24.3	15-Jun-05	48.9	22.7	16-Jul-05	34.3	16.8
16-May-05	53.4	36.7	16-Jun-05	24.8	16.6	17-Jul-05	57.2	19.9
17-May-05	54.9	27.2	17-Jun-05	48.1	24.7	18-Jul-05	21.5	14.3
18-May-05	39.6	18.9	18-Jun-05	30.9	17.2	19-Jul-05	23.2	13.2
19-May-05	48.5	22.6	19-Jun-05	26.1	14.7	20-Jul-05	24.7	14.9
20-May-05	55.0	24.1	20-Jun-05	43.1	24.1	21-Jul-05	45.7	20.8
21-May-05	46.3	18.4	21-Jun-05	39.9	22.7	22-Jul-05	32.6	24.4
22-May-05	49.8	19.5	22-Jun-05	34.7	22.6	23-Jul-05	34.5	17.1
23-May-05	36.9	17.8	23-Jun-05	45.4	29.7	24-Jul-05	31.1	19.0
24-May-05	61.4	29.0	24-Jun-05	59.1	38.9	25-Jul-05	44.6	24.1
25-May-05	39.4	21.7	25-Jun-05	46.5	29.5	26-Jul-05	52.3	23.0
26-May-05	30.5	20.3	26-Jun-05	31.2	16.4	27-Jul-05	47.5	25.3
27-May-05	52.1	38.4	27-Jun-05	50.9	27.0	28-Jul-05	54.2	30.3
28-May-05	19.4	10.5	28-Jun-05	60.9	34.8	29-Jul-05	36.2	22.8
29-May-05	26.8	8.8	29-Jun-05	55.1	21.9	30-Jul-05	34.3	23.9
30-May-05	63.0	36.3	30-Jun-05	45.1	27.2	31-Jul-05	31.0	16.9
31-May-05	57.3	32.9	01-Jul-05	58.8	24.8	01-Aug-05	25.9	12.6
01-Jun-05	48.6	22.5	02-Jul-05	31.3	18.3	02-Aug-05	57.3	29.0
02-Jun-05	41.0	23.7	03-Jul-05	35.3	12.0	03-Aug-05	20.8	14.5
03-Jun-05	40.3	22.3	04-Jul-05	34.5	20.4	04-Aug-05	37.9	18.2

Table 1.25 Maximum 1-hour and daily average NO_2 concentrations measured at the fixed monitoring station, Poolbeg (August 2005)

Date	Max 1-Hr(μg/m^3)	Average (μg/m^3)
05-Aug-05	32.0	19.2
06-Aug-05	37.8	19.3
07-Aug-05	33.0	18.1
08-Aug-05	73.7	37.0
09-Aug-05	44.6	30.2
10-Aug-05	49.7	28.3
11-Aug-05	38.2	22.3
12-Aug-05	34.5	23.0
13-Aug-05	21.2	13.0
14-Aug-05	25.1	12.0
15-Aug-05	43.2	23.6
16-Aug-05	48.8	20.6
17-Aug-05	48.2	28.9
18-Aug-05	59.8	33.8
19-Aug-05	33.6	21.3
20-Aug-05	41.3	16.6
21-Aug-05	44.3	20.2
22-Aug-05	32.7	18.0
23-Aug-05	32.4	18.3
24-Aug-05	46.7	20.3
25-Aug-05	33.1	19.5
26-Aug-05	39.2	24.6
27-Aug-05	39.7	21.3
28-Aug-05	15.3	11.1
29-Aug-05	34.5	21.3
30-Aug-05	43.1	21.8
31-Aug-05	57.9	35.2

Table 1.26 Summary of monthly results of NO_2 monitoring at the fixed monitoring station (July 2003 – July 2004).

Monitoring Period	Details	
15 July 2003 - 31 July 2003	Total No. Days Sampling	17
	No. Hourly Averages >200 μg/m³	0
	Monthly Average	31 μg/m³
August 2003	Total No. Days Sampling	31
	No. Hourly Averages >200 μg/m³	0
	Monthly Average	28 μg/m³
September 2003	Total No. Days Sampling	30
	No. Hourly Averages >200 μg/m³	0
	Monthly Average	33 μg/m³
October 2003	Total No. Days Sampling	31
	No. Hourly Averages >200 μg/m³	0
	Monthly Average	35 μg/m³
November 2003	Total No. Days Sampling	30
	No. Hourly Averages >200 μg/m³	0
	Monthly Average	38 μg/m³
December 2003	Total No. Days Sampling	31
	No. Hourly Averages >200 μg/m³	0
	Monthly Average	36 μg/m³
January 2004	Total No. Days Sampling	30
	No. Hourly Averages >200 μg/m³	0
	Monthly Average	32 μg/m³
February 2004	Total No. Days Sampling	29
	No. Hourly Averages >200 μg/m³	0
	Monthly Average	41 μg/m³
March 2004	Total No. Days Sampling	30
	No. Hourly Averages >200 μg/m³	1
	Monthly Average	32 μg/m³
April 2004	Total No. Days Sampling	31
	No. Hourly Averages >200 μg/m³	0
	Monthly Average	26 μg/m³
May 2004	Total No. Days Sampling	31
	No. Hourly Averages >200 μg/m³	0
	Monthly Average	26 μg/m³
June 2004	Total No. Days Sampling	30
	No. Hourly Averages >200 μg/m³	0
	Monthly Average	24 μg/m³
July 2004	Total No. Days Sampling	31
	No. Hourly Averages >200 μg/m³	0
	Monthly Average	22 μg/m³
July 2003 - July 2004 Monitoring Period	*Total No. Days Sampling*	*366*
	No. Hourly Averages >200 μg/m³	*1*
	99.8th %ile of 1-hour Averages	*108 μg/m³*
	Monitoring Period Average	*33.3 μg/m³*
	Limit Values	**200 μg/m³ (1), 40 μg/m³ (2)**

(1) EU Council Directive 1999/30/EC - 1-hour limit of 200 μg/m³ as a 99.8th%ile (i.e. 18 hours >200 μg/m³ permitted per year).
(2) EU Council Directive 1999/30/EC - Annual average limit value.

Table 1.27 Summary of monthly results of NO_2 monitoring at the fixed monitoring station (August 2004 to August 2005).

Monitoring Period	Details	
August 2004	Total No. Days Sampling	31
	No. Hourly Averages >200 μg/m^3	0
	Monthly Average	24 μg/m^3
September 2004	Total No. Days Sampling	30
	No. Hourly Averages >200 μg/m^3	0
	Monthly Average	22 μg/m^3
October 2004	Total No. Days Sampling	27
	No. Hourly Averages >200 μg/m^3	1
	Monthly Average	34 μg/m^3
November 2004	Total No. Days Sampling	30
	No. Hourly Averages >200 μg/m^3	0
	Monthly Average	32 μg/m^3
December 2004	Total No. Days Sampling	17
	No. Hourly Averages >200 μg/m^3	0
	Monthly Average	27 μg/m^3
January 2005	Total No. Days Sampling	31
	No. Hourly Averages >200 μg/m^3	0
	Monthly Average	23 μg/m^3
February 2005	Total No. Days Sampling	28
	No. Hourly Averages >200 μg/m^3	0
	Monthly Average	43 μg/m^3
March 2005	Total No. Days Sampling	31
	No. Hourly Averages >200 μg/m^3	0
	Monthly Average	30 μg/m^3
April 2005	Total No. Days Sampling	30
	No. Hourly Averages >200 μg/m^3	0
	Monthly Average	28 μg/m^3
May 2005	Total No. Days Sampling	31
	No. Hourly Averages >200 μg/m^3	0
	Monthly Average	25 μg/m^3
June 2005	Total No. Days Sampling	30
	No. Hourly Averages >200 μg/m^3	0
	Monthly Average	24 μg/m^3
July 2005	Total No. Days Sampling	31
	No. Hourly Averages >200 μg/m^3	0
	Monthly Average	22 μg/m^3
August 2005	Total No. Days Sampling	31
	No. Hourly Averages >200 μg/m^3	0
	Monthly Average	22 μg/m^3
August 2004 - August 2005 Monitoring Period	*Total No. Days Sampling*	*378*
	No. Hourly Averages >200 μg/m^3	*1*
	99.8th%ile of 1-hour Averages	*93.8 μg/m^3*
	Monitoring Period Average	*27.3 μg/m^3*
	Limit Values	**200 μg/m^3 (1), 40 μg/m^3 (2)**

(1) EU Council Directive 1999/30/EC - 1-hour limit of 200 μg/m^3 as a 99.8th%ile (i.e. 18 hours >200 μg/m^3 permitted per year).
(2) EU Council Directive 1999/30/EC - Annual average limit value.

Table 1.28 Average NO_2 concentrations in the region of Poolbeg, during the period July 2003 - July 2004, as measured by passive diffusion tubes.

Location	**NO_2 (µg/m^3) 15/7/03 - 12/8/03**	**NO_2 (µg/m^3) 12/8/03 - 12/9/03**	**NO_2 (µg/m^3) 12/9/03 - 17/10/03**	**NO_2 (µg/m^3) 17/10/03 – 14/11/03**	**NO_2 (µg/m^3) 14/11/03 – 15/12/03**	**NO_2 (µg/m^3) 15/12/03 –16/01/04**	**NO_2 (µg/m^3) 16/01/04 –17/02/04**
M1 –Fixed Monitoring Station(1)	27	22	33 / 35	30 / 28	38	25 / 30	36
M1- Chemiluminescent Analyser	31.9	27.7	33.7	39.3	42.7	32.2	44.5
M2 – Irishtown Nature Reserve	13	16	26	22	33	23	23
M3 – Sean Moore Park	19	14	29	24	40	29	29
M4 – Sandymount Green	24	19	32	24	45	27	27
M5 – Ringsend Park	(2)	18	31	(2)	38	14	14
M6 – Bull Island	14	10	17	9	24	16	16
M7 – Belgrove Road, Clontarf	18	12	25	21	(2)	27	27
Location	**NO_2 (µg/m^3) 17/02/04 – 16/03/04**	**NO_2 (µg/m^3) 16/03/04 – 20/04/04**	**NO_2 (µg/m^3) 20/04/04 – 14/05/04**	**NO_2 (µg/m^3) 14/05/04 – 17/06/04**	**NO_2 (µg/m^3) 17/06/04 – 20/07/04**	**2003/04 Average (µg/m^3)**	***2003/04 Adjusted Average (µg/m^3)(4)***
M1 –Fixed Monitoring Station(1)	31	29 / 24	28 / 29	20 / 45(3)	20	28.3	*33.3*
M1- Chemiluminescent Analyser	41.7	27.7	28.4	25.2	23.4	33.3	*N/A*
M2 – Irishtown Nature Reserve	25	(2)	23	16	4	20.4	*24.0*
M3 – Sean Moore Park	35	25	22	(2)	17	25.7	*30.3*
M4 – Sandymount Green	30	30	23	21	(2)	27.5	*32.3*
M5 – Ringsend Park	40	25	32	26	18	26.0	*30.6*
M6 – Bull Island	15	20	10	10	11	14.3	*16.9*
M7 – Belgrove Road, Clontarf	29	22	17	16	12	20.5	*24.2*
					Limit Value		**40 µg/m^3(5)**

(1) Where two results are reported, duplicate sampling was carried out.
(2) Sample lost in the field.
(3) Chemiluminescent analyser recorded an average of 25.2 µg/m^3 during this period. Thus, the 45 µg/m^3 result was rejected as an outlier.
(4) Diffusion tube monitoring bias adjustment carried out based on UK DEFRA methodology (Chemiluminescent Average = 33.3 µg/m^3. Thus the diffusion tube bias is 33.3/28.3 = 1.17)(5).
(5) EU Council Directive 1999/30/EC (as an annual average).

Table 1.29 Average NO_2 concentrations in the region of Poolbeg, during the period August 2004 - August 2005, as measured by passive diffusion tubes.

Location	NO_2 ($\mu g/m^3$) 09/08/04 – 15/09/04	NO_2 ($\mu g/m^3$) 15/09/04 – 15/10/04	NO_2 ($\mu g/m^3$) 15/10/04 - 17/11/04	NO_2 ($\mu g/m^3$) 17/11/04 - 16/12/04	NO_2 ($\mu g/m^3$) 16/12/04 - 19/01/05	NO_2 ($\mu g/m^3$) 19/01/05 - 16/02/05	NO_2 ($\mu g/m^3$) 16/02/05 - 15/03/05
M1 –Fixed Monitoring Station[1]	21 / 17	24 / 22	34 / 29	43 / 41	23 / 16	49[2] / 38	41 / 43
M1- Chemiluminescent Analyser	25.9	22.8	33.1	[3]	[3]	37.9	42.2
M2 – Irishtown Nature Reserve	[4]	22	37	43	30	51	41
M3 – Sean Moore Park	[4]	19	35	47	28	57	44
M4 – Sandymount Green	21	23	38	43	34	37	47
M5 – Ringsend Park	21	26	37	46	26	53	49
M6 – Bull Island	11	14	17	29	22	24	15
M7 – Belgrove Road, Clontarf	16	18	33	46	29	31	31

Location	NO_2 ($\mu g/m^3$) 15/03/05 - 19/04/05	NO_2 ($\mu g/m^3$) 19/04/05- 17/05/05	NO_2 ($\mu g/m^3$) 17/05/05- 15/06/05	NO_2 ($\mu g/m^3$) 15/06/05- 18/07/05	NO_2 ($\mu g/m^3$) 18/07/05- 23/08/05	2004/05 Average ($\mu g/m^3$)	*2004/05 Adjusted Average ($\mu g/m^3$)[5]*
M1 –Fixed Monitoring Station[1]	28 / 27	26 / 29	23 / 25	20 / 18	23 / 23	28.5	*27.6*
M1- Chemiluminescent Analyser	26.8	28.1	23.0	23.4	21.4	27.6	*N/A*
M2 – Irishtown Nature Reserve	18	19	17	16	19	28.5	*27.6*
M3 – Sean Moore Park	24	18	21	17	18	29.8	*28.9*
M4 – Sandymount Green	30	25	22	16	21	29.8	*28.9*
M5 – Ringsend Park	27	28	22	19	24	31.5	*30.5*
M6 – Bull Island	14	11	12	8	10	15.6	*15.1*
M7 – Belgrove Road, Clontarf	21	16	15	11	12	23.3	*22.5*
						Limit Value	**40 $\mu g/m^3$[6]**

(1) Where two results are reported, duplicate sampling was carried out.
(2) Chemiluminescent analyser recorded an average of 37.9 $\mu g/m^3$ during this period. Thus, the 49 $\mu g/m^3$ result was rejected as an outlier.
(3) Direct overlap not available as Chemiluminescent analyser was removed for service during monitoring period.
(4) Sample not retrieved.
(5) Diffusion tube monitoring bias adjustment carried out based on UK DEFRA methodology (Chemiluminescent Average = 27.6 $\mu g/m^3$. Thus the diffusion tube bias is 28.5/27.6 = 1.03)[5].
(6) EU Council Directive 1999/30/EC (as an annual average).

Table 1.30 Average benzene concentrations at the fixed monitoring station, Poolbeg, as measured by passive diffusion tubes.

Sampling Period	Benzene (μg/m³)
27/08/03 - 03/09/03	2.1
03/09/03 - 08/09/03	2.7
08/09/03 - 15/09/03	5.8
15/09/03 - 24/09/03	4.4
	Average: 3.8 μg/m³
11/02/04 - 17/02/04	1.6
71/02/04 - 25/02/04	1.3
25/02/04 - 03/03/04	1.1
03/03/04 - 13/03/04	1.1
	Average: 1.3 μg/m³
20/10/04 - 28/10/04	1.0
28/10/04 - 04/11/04	1.5
04/11/04 - 10/11/04	1.0
10/11/04 - 17/11/04	1.0
	Average: 1.1 μg/m³
16/08/05 - 23/08/05	1.8
23/08/05 - 01/09/05	2.0
01/09/05 - 08/09/05	1.3
19/09/05 - 26/09/05	1.5
	Average: 1.7 μg/m³
Limit Value	**5.0(1)**

(1) EU Council Directive 2000/69/EC (as an annual average).

Table 1.31 Average sulphur dioxide concentrations at the fixed monitoring station, Poolbeg during the period July 2003 to July 2004 and August 2004 to August 2005, as measured by passive diffusion tubes.

Sampling Period	SO_2 ($\mu g/m^3$)
15/07/03 - 12/08/03	5.9
12/08/03 - 12/09/03	7.4
12/09/03 - 17/10/03	6.4
17/10/03 - 14/11/03	7.8
17/10/03 - 15/12/03	5.8
15/12/03 - 16/01/04	4.9
16/01/04 - 17/02/04	7.6
17/02/04 - 16/03/04	3.6
16/03/04 - 20/04/04	2.5
20/04/04 - 14/05/04	3.3
14/05/04 - 17/06/04	-(1)
17/06/04 - 20/07/04	3.0
July 2003 - July 2004	*Average : 5.3 $\mu g/m^3$*
12/08/04 - 15/09/04	6.2
15/09/04 - 16/10/04	4.8
16/10/04 - 17/11/04	7.0
17/11/04 - 16/12/04	(2)
16/12/04 - 19/01/05	2.1
19/01/05 - 16/02/05	1.6
16/02/05 - 15/03/05	3.6
15/03/05 - 19/04/05	4.5
19/04/05 - 17/05/05	4.3
17/05/05 - 15/06/05	3.3
15/06/05 - 18/07/05	(2)
18/07/05 - 23/08/05	4.9
August 2004 - August 2005	*Average : 4.2 $\mu g/m^3$*
Limit Value	**20(3)**

(1) A value of 240 $\mu g/m^3$ recorded for this period was rejected as an outlier.
(2) Laboratory error - data not available
(3) EU Council Directive 1999/30/EC (as an annual average) For The Protection of Vegetation.

Table 1.32 Average sulphur dioxide concentrations in the region of Poolbeg as measured by passive diffusion tubes.

Location	SO_2 (µg/m^3) (16/01/04 – 17/02/04)	SO_2 (µg/m^3) (16/02/05 – 15/03/05)
M1 – Fixed Monitoring Station	7.6	3.6
M2 – Irishtown Nature Reserve	10.0	13.3
M3 – Sean Moore Park	6.0	4.0
M4 – Sandymount Green	6.2	6.2
M5 – Ringsend Park	9.3	7.9
M6 – Bull Island	5.2	5.3
M7 – Belgrove Road, Clontarf	6.1	3.2
Limit Value	**20(1)**	**20(1)**

(1) EU Council Directive 1999/30/EC (as an annual average) For The Protection of Vegetation.

Table 1.33 Levels of HCl and HF measured at the fixed monitoring station, Poolbeg.

Sampling Period	HCl (µg/m³)	HF (µg/m³)
28/08/03 - 03/09/03	0.15	<0.01
03/09/03 - 08/09/03	0.17	<0.01
08/09/03 - 12/09/03	0.10	0.02
15/09/03 - 19/09/03	0.28	0.01
	Average: 0.18 µg/m³	*Average: 0.01 µg/m³⁽¹⁾*
11/02/03 - 16/02/04	0.24	0.01
12/02/03 - 20/02/04	0.41	0.01
23/02/03 - 27/02/04	0.07	< 0.01
03/03/03 - 08/03/04	0.27	0.01
	Average: 0.25 µg/m³	*Average: 0.01 µg/m³⁽¹⁾*
2003/04 Monitoring Period	***Average: 0.21 µg/m³***	***Average: 0.01 µg/m³***
20/10/04 - 24/10/04	0.11	< 0.01
26/10/04 - 29/10/04	0.46	< 0.01
29/10/04 - 01/11/04	0.24	< 0.01
05/11/04 - 09/11/04	0.29	< 0.01
	Average: 0.28 µg/m³	*Average: 0.01 µg/m³⁽¹⁾*
19/08/05 - 23/08/05	0.02	< 0.01
23/08/05 - 26/08/05	0.03	< 0.01
26/08/05 - 30/08/05	0.03	< 0.01
01/09/05 - 05/09/05	0.03	< 0.01
	Average: 0.03 µg/m³	*Average: 0.01 µg/m³⁽¹⁾*
2004/05 Monitoring Period	***Average: 0.15 µg/m³***	***Average: 0.01 µg/m³***
Limit Value (µg/Nm³)	**20⁽²⁾, 100⁽³⁾**	**0.3⁽⁴⁾**

(1) Average calculated assuming non-detect is equal to the detection limit.
(2) EAL derived from Environmental Agency, 2002: "IPPC Environmental Assessment for BAT", The Stationary Office
(3) TA Luft Imission Limit (Maximum 1-hour as a 98th%ile)
(4) WHO Annual Limit Value

Table 1.34 Levels of metals measured at the fixed monitoring station, Poolbeg during the period 28/8/03 – 19/9/03.

Species	Period 1 28/8/03 - 3/9/03 (μg/m^3)	Period 2 3/9/03 - 8/9/03 (μg/m^3)	Period 3 8/9/03 - 12/9/03 (μg/m^3)	Period 4 15/9/03 - 19/9/03 (μg/m^3)	Lower Range Average (μg/m^3)(1)	Upper Range Average (μg/m^3)(2)	Limit Values (μg/m^3)(3)
Antimony	0.004	0.003	0.006	0.007	0.005	0.005	5.0
Arsenic	<0.001	<0.001	0.001	0.001	0.001	0.001	0.006(4)
Cadmium	<0.001	<0.001	0.002	<0.001	0.001	0.002	0.005(4)
Chromium	0.002	0.001	0.002	0.003	0.002	0.002	5.0
Cobalt	0.001	<0.001	<0.001	0.001	0.001	0.001	0.2
Copper	0.041	0.031	0.031	0.060	0.041	0.041	2.0
Lead	0.016	0.009	0.021	0.020	0.017	0.017	0.5
Manganese	0.023	0.015	0.016	0.030	0.021	0.021	0.15
Mercury	0.001	<0.001	<0.001	<0.001	0.001	0.001	1.0
Nickel	0.003	0.001	<0.001	0.003	0.002	0.002	0.020(4)
Thallium	<0.001	<0.001	<0.001	<0.001	N.D.	0.001	1.0
Vanadium	0.008	0.002	0.001	0.006	0.004	0.004	1.0

(1) Values at detection limit have been taken to equal to zero.
(2) Values at detection limit have been taken to equal to the detection limit
(3) Annual average limit values set by the EU, WHO, TA Luft Guidelines or a derived as an Environmental Assessment Level.
(4) EU Directive 2004/107/EC

Table 1.35 Levels of metals measured at the fixed monitoring station, Poolbeg during the period 11/02/04 – 08/03/04.

Species	Period 1 11/02/04 - 16/02/04 ($\mu g/m^3$)	Period 2 16/02/04 - 20/02/04 ($\mu g/m^3$)	Period 3 23/02/04 - 27/02/04 ($\mu g/m^3$)	Period 4 03/03/04 - 08/03/04 ($\mu g/m^3$)	Lower Range Average ($\mu g/m^3$)(1)	Upper Range Average ($\mu g/m^3$)(2)	Limit Values ($\mu g/m^3$)(3)
Antimony	0.003	0.001	0.002	0.002	0.002	0.002	5.0
Arsenic	0.001	0.001	0.001	<0.001	0.001	0.001	0.006(4)
Cadmium	<0.001	<0.001	<0.001	<0.001	N.D.	0.001	0.005(4)
Chromium	0.002	0.003	0.002	0.001	0.002	0.002	5.0
Cobalt	<0.001	0.001	<0.001	<0.001	0.001	0.001	0.2
Copper	0.046	0.045	0.033	0.121	0.061	0.061	2.0
Lead	0.014	0.036	0.014	0.009	0.018	0.018	0.5
Manganese	0.019	0.033	0.019	0.013	0.021	0.021	0.15
Mercury	<0.001	<0.001	<0.001	<0.001	N.D.	0.001	1.0
Nickel	0.002	0.003	0.001	0.001	0.002	0.002	0.020(4)
Thallium	<0.001	<0.001	<0.001	<0.001	N.D.	0.001	1.0
Vanadium	0.003	0.054	0.002	0.002	0.015	0.015	1.0

(1) Values at detection limit have been taken to equal to zero.
(2) Values at detection limit have been taken to equal to the detection limit
(3) Annual average limit values set by the EU, WHO, TA Luft Guidelines or a derived as an Environmental Assessment Level.
(4) EU Directive 2004/107/EC

Table 1.36 Levels of metals measured at the fixed monitoring station, Poolbeg during the period 26/10/04 – 09/11/04.

Species	Period 1 26/10/04 - 29/10/04 (μg/m³)	Period 2 29/10/04 - 01/11/04 (μg/m³)	Period 3 01/11/04 - 04/11/04 (μg/m³)	Period 4 05/11/04 - 09/11/04 (μg/m³)	Lower Range Average (μg/m³)(1)	Upper Range Average (μg/m³)(2)	Limit Values (μg/m³)(3)
Antimony	<0.001	0.002	<0.001	<0.001	0.001	0.001	5.0
Arsenic	<0.001	<0.001	<0.001	<0.001	N.D.	0.001	0.006(4)
Cadmium	<0.001	<0.001	<0.001	<0.001	N.D.	0.001	0.005(4)
Chromium	<0.001	<0.001	<0.001	<0.001	N.D.	0.001	5.0
Cobalt	<0.001	<0.001	<0.001	<0.001	N.D.	0.001	0.2
Copper	0.004	0.006	<0.001	0.003	0.003	0.004	2.0
Lead	<0.001	0.009	0.001	<0.001	0.003	0.003	0.5
Manganese	<0.001	0.002	0.001	0.001	0.001	0.001	0.15
Mercury	<0.001	<0.001	<0.001	<0.001	N.D.	0.001	1.0
Nickel	<0.001	0.001	<0.001	<0.001	0.001	0.001	0.020(4)
Thallium	<0.001	<0.001	<0.001	<0.001	N.D.	0.001	1.0
Vanadium	<0.001	0.002	<0.001	<0.001	0.001	0.001	1.0

(1) Values at detection limit have been taken to equal to zero.
(2) Values at detection limit have been taken to equal to the detection limit
(3) Annual average limit values set by the EU, WHO, TA Luft Guidelines or a derived as an Environmental Assessment Level.
(4) EU Directive 2004/107/EC

Table 1.37 Levels of metals measured at the fixed monitoring station, Poolbeg during the period 16/08/05 – 26/08/05 & 17/10/05 - 26/10/05.

Species	Period 1 16/08/05 - 19/08/05 (μg/m^3)	Period 2 23/08/05 - 26/08/05 (μg/m^3)	Period 3 17/10/05 - 21/10/05 (μg/m^3)	Period 4 25/10/05 - 26/10/05 (μg/m^3)	Lower Range Average (μg/m^3)(1)	Upper Range Average (μg/m^3)(2)	Limit Values (μg/m^3)(3)
Antimony	<0.001	0.001	0.002	0.002	0.002	0.002	5.0
Arsenic	<0.001	<0.001	0.001	<0.001	0.001	0.001	0.006(4)
Cadmium	<0.001	<0.001	<0.001	<0.001	N.D.	0.001	0.005(4)
Chromium	0.001	0.001	0.052	0.092	0.037	0.037	5.0
Cobalt	<0.001	<0.001	0.001	0.001	0.001	0.001	0.2
Copper	0.002	0.003	0.140	0.019	0.041	0.041	2.0
Lead	0.001	0.002	0.008	0.002	0.003	0.003	0.5
Manganese	0.001	0.004	0.016	0.012	0.008	0.008	0.15
Mercury	<0.001	<0.001	<0.001	<0.001	N.D.	0.001	1.0
Nickel	<0.001	0.001	0.027	0.048	0.025	0.019	0.020(4)
Thallium	<0.001	<0.001	<0.001	<0.001	N.D.	0.001	1.0
Vanadium	<0.001	<0.001	0.002	0.001	0.002	0.001	1.0

(1) Values at detection limit have been taken to equal to zero.
(2) Values at detection limit have been taken to equal to the detection limit
(3) Annual average limit values set by the EU, WHO, TA Luft Guidelines or a derived as an Environmental Assessment Level.
(4) EU Directive 2004/107/EC

Table 1.38 Summary of upper range average levels of metals measured at Poolbeg.

Sampling Period	Sb (μg/m^3)	As (μg/m^3)	Cd (μg/m^3)	Cr (μg/m^3)	Co (μg/m^3)	Cu (μg/m^3)	Pb (μg/m^3)	Mn (μg/m^3)	Hg (μg/m^3)	Ni (μg/m^3)	Tl (μg/m^3)	Vn (μg/m^3)
August / September 2003	0.005	0.001	0.002	0.002	0.001	0.041	0.017	0.021	0.001	0.002	0.001	0.004
February / March 2004	0.002	0.001	0.001	0.002	0.001	0.061	0.018	0.021	0.001	0.002	0.001	0.015
October / November 2004	0.001	0.001	0.001	0.001	0.001	0.004	0.003	0.001	0.001	0.001	0.001	0.001
August & October 2005	0.002	0.001	0.001	0.037	0.001	0.041	0.003	0.008	0.001	0.019	0.001	0.001
Average	*0.003*	*0.001*	*0.001*	*0.011*	*0.001*	*0.037*	*0.010*	*0.013*	*0.001*	*0.006*	*0.001*	*0.005*
Limit Value (μg/m^3)	**5.0**	**0.006**	**0.005**	**5.0**	**0.2**	**2.0**	**0.5**	**0.15**	**1.0**	**0.02**	**1.0**	**1.0**

(1) Annual average limit values set by the EU, WHO, TA Luft Guidelines or a derived as an Environmental Assessment Level.

Table 1.39 Levels of PCDDs and PCDFs measured at the fixed monitoring station, Poolbeg during the period 28/8/03 – 08/09/03 ($1x10^3$ fg/m^3 = 1 pg/m^3)

PCDD Congeners	I-TEF(1)	Sampling Period 1: 28/08/03 - 31/08/03			Sampling Period 2: 03/09/03 - 08/09/03		
		Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)	Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)
2,3,7,8-TCDD	1.0	<3.1133		3.1133	0.5533	0.5533	0.5533
1,2,3,7,8-PeCDD	0.5	<2.8827		1.4414	0.5533	0.2767	0.2767
1,2,3,4,7,8-HxCDD	0.1	0.8072	0.0807	0.0807	1.4524	0.1452	0.1452
1,2,3,6,7,8-HxCDD	0.1	<2.6521		0.2652	0.4150	0.0415	0.0415
1,2,3,7,8,9-HxCDD	0.1	<2.6521		0.2652	0.9683	0.0968	0.0968
1,2,3,4,6,7,8-HpCDD	0.01	5.7654	0.0577	0.0577	13.833	0.1383	0.1383
OCDD	0.001	16.143	0.0161	0.0161	30.432	0.0304	0.0304
PCDF Congeners	**I-TEF(1)**						
2,3,7,8-TCDF	0.1	0.6919	0.0692	0.0692	1.2450	0.1245	0.1245
1,2,3,7,8-PeCDF	0.05	0.9225	0.0461	0.0461	0.7608	0.0380	0.0380
2,3,4,7,8-PeCDF	0.5	0.9225	0.4612	0.4612	2.1441	1.0720	1.0720
1,2,3,4,7,8-HxCDF	0.1	1.8449	0.1845	0.1845	1.8674	0.1867	0.1867
1,2,3,6,7,8-HxCDF	0.1	1.3837	0.1384	0.1384	1.6599	0.1660	0.1660
1,2,3,7,8,9-HxCDF	0.1	<2.0756		0.6227	0.8300	0.0830	0.0830
2,3,4,6,7,8-HxCDF	0.1	6.2267	0.2076	0.2076	2.7666	0.2767	0.2767
1,2,3,4,6,7,8-HpCDF	0.01	6.2267	0.0623	0.0623	8.9913	0.0899	0.0899
1,2,3,4,7,8,9-HpCDF	0.01	<5.0736		0.0507	1.3141	0.0131	0.0131
OCDF	0.001	3.8052	0.0038	0.0038	9.6830	0.0097	0.0097
		Total TEQ	**1.4**	**7.1**	**Total TEQ**	**3.3**	**3.3**

(1) Annex 1, Council Directive 2000/76/EC.
(2) Ambient concentration of congener (values in italics indicate levels below the limit of detection).
(3) Lower Limit TEQ calculated assuming non-detects are equal to zero (i.e. congeners with ambient levels below the limit of detection not included in Total TEQ)
(4) Upper Limit TEQ calculated assuming non-detects are equal to the limit of detection (i.e. congeners with ambient levels below the limit of detection included in Total TEQ).

Table 1.40 Levels of PCDDs and PCDFs measured at the fixed monitoring station, Poolbeg during the period 08/09/03 – 19/09/03 ($1x10^3$ fg/m^3 = 1 pg/m^3)

PCDD Congeners	I-TEF(1)	Sampling Period 3: 08/09/03 - 12/09/03			Sampling Period 4: 15/09/03 - 19/09/03		
		Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)	Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)
2,3,7,8-TCDD	1.0	1.1757	1.1757	1.1757	0.9701	0.9701	0.9701
1,2,3,7,8-PeCDD	0.5	3.2751	1.6376	1.6376	2.4252	1.2126	1.2126
1,2,3,4,7,8-HxCDD	0.1	7.978	0.7978	0.7978	5.0120	0.5012	0.5012
1,2,3,6,7,8-HxCDD	0.1	3.1072	0.3107	0.3107	2.3443	0.2344	0.2344
1,2,3,7,8,9-HxCDD	0.1	5.0386	0.5039	0.5039	4.6078	0.4608	0.4608
1,2,3,4,6,7,8-HpCDD	0.01	18.475	0.1847	0.1847	17.785	0.1778	0.1778
OCDD	0.001	50.386	0.0504	0.0504	55.779	0.0558	0.0558
PCDF Congeners	**I-TEF(1)**						
2,3,7,8-TCDF	0.1	4.7867	0.4787	0.4787	2.9102	0.2910	0.2910
1,2,3,7,8-PeCDF	0.05	37.790	1.8895	1.8895	6.6288	0.3314	0.3314
2,3,4,7,8-PeCDF	0.5	10.917	5.4585	5.4585	8.8923	4.4462	4.4462
1,2,3,4,7,8-HxCDF	0.1	4.955	0.4955	0.4955	9.7007	0.9701	0.9701
1,2,3,6,7,8-HxCDF	0.1	4.955	0.4955	0.4955	9.7007	0.9701	0.9701
1,2,3,7,8,9-HxCDF	0.1	2.8552	0.2855	0.2855	2.1827	0.2183	0.2183
2,3,4,6,7,8-HxCDF	0.1	5.542	0.5542	0.5542	9.7007	0.9701	0.9701
1,2,3,4,6,7,8-HpCDF	0.01	10.917	0.1092	0.1092	16.168	0.1617	0.1617
1,2,3,4,7,8,9-HpCDF	0.01	1.3436	0.0134	0.0134	1.9401	0.0194	0.0194
OCDF	0.001	8.230	0.0082	0.0082	13.743	0.0137	0.0137
		Total TEQ	**14.3**	**14.3**	**Total TEQ**	**12.1**	**12.1**

(1) Annex 1, Council Directive 2000/76/EC.
(2) Ambient concentration of congener (values in italics indicate levels below the limit of detection).
(3) Lower Limit TEQ calculated assuming non-detects are equal to zero (i.e. congeners with ambient levels below the limit of detection not included in Total TEQ)
(4) Upper Limit TEQ calculated assuming non-detects are equal to the limit of detection (i.e. congeners with ambient levels below the limit of detection included in Total TEQ).

Table 1.41 Levels of PCDDs and PCDFs measured at the fixed monitoring station, Poolbeg during the period 11/02/04 – 20/02/04 ($1x10^3$ fg/m^3 = 1 pg/m^3)

PCDD Congeners	I-TEF(1)	Sampling Period 1: 11/02/04 - 16/02/04			Sampling Period 2: 16/02/04 - 20/02/04		
		Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)	Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)
2,3,7,8-TCDD	1.0	1.6923	1.6923	1.6923	1.0954	1.0954	1.0954
1,2,3,7,8-PeCDD	0.5	6.7691	3.3846	3.3846	7.5310	3.7655	3.7655
1,2,3,4,7,8-HxCDD	0.1	31.5892	3.1589	3.1589	9.5849	0.9585	0.9585
1,2,3,6,7,8-HxCDD	0.1	6.2050	0.6205	0.6205	3.6970	0.3697	0.3697
1,2,3,7,8,9-HxCDD	0.1	28.7687	2.8769	2.8769	8.9003	0.8900	0.8900
1,2,3,4,6,7,8-HpCDD	0.01	242.560	2.4256	2.4256	82.156	0.8216	0.8216
OCDD	0.001	394.865	0.3949	0.3949	198.544	0.1985	0.1985
PCDF Congeners	**I-TEF(1)**						
2,3,7,8-TCDF	0.1	24.820	2.4820	2.4820	75.310	7.5310	7.5310
1,2,3,7,8-PeCDF	0.05	25.3841	1.2692	1.2692	82.1563	4.1078	4.1078
2,3,4,7,8-PeCDF	0.5	214.355	107.1775	107.1775	82.156	41.0782	41.0782
1,2,3,4,7,8-HxCDF	0.1	84.6138	8.4614	8.4614	41.7628	4.1763	4.1763
1,2,3,6,7,8-HxCDF	0.1	73.3320	7.3332	7.3332	36.9703	3.6970	3.6970
1,2,3,7,8,9-HxCDF	0.1	101.5366	3.2717	3.2717	47.9245	1.3693	1.3693
2,3,4,6,7,8-HxCDF	0.1	32.7173	10.1537	10.1537	13.6927	4.7925	4.7925
1,2,3,4,6,7,8-HpCDF	0.01	434.351	4.3435	4.3435	130.081	1.3008	1.3008
1,2,3,4,7,8,9-HpCDF	0.01	53.5888	0.5359	0.5359	30.1240	0.3012	0.3012
OCDF	0.001	242.560	0.2426	0.2426	56.825	0.0568	0.0568
		Total TEQ	**157.9**	**157.9**	**Total TEQ**	**75.3**	**75.3**

(1) Annex 1, Council Directive 2000/76/EC.
(2) Ambient concentration of congener (values in italics indicate levels below the limit of detection).
(3) Lower Limit TEQ calculated assuming non-detects are equal to zero (i.e. congeners with ambient levels below the limit of detection not included in Total TEQ)
(4) Upper Limit TEQ calculated assuming non-detects are equal to the limit of detection (i.e. congeners with ambient levels below the limit of detection included in Total TEQ).

Table 1.42 Levels of PCDDs and PCDFs measured at the fixed monitoring station, Poolbeg during the period 23/02/04 – 08/03/04 ($1x10^3$ fg/m^3 = 1 pg/m^3)

PCDD Congeners	I-TEF(1)	Sampling Period 3: 23/02/04 - 27/02/04			Sampling Period 4: 03/03/04 - 08/03/04		
		Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)	Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)
2,3,7,8-TCDD	1.0	2.5386	2.5386	2.5386	1.5960	1.5960	1.5960
1,2,3,7,8-PeCDD	0.5	48.5958	24.2979	24.2979	6.3841	3.1920	3.1920
1,2,3,4,7,8-HxCDD	0.1	123.3028	12.3303	12.3303	29.7925	2.9792	2.9792
1,2,3,6,7,8-HxCDD	0.1	27.5618	2.7562	2.7562	5.8521	0.5852	0.5852
1,2,3,7,8,9-HxCDD	0.1	101.5435	10.1543	10.1543	27.1324	2.7132	2.7132
1,2,3,4,6,7,8-HpCDD	0.01	797.841	7.9784	7.9784	228.764	2.2876	2.2876
OCDD	0.001	1087.966	1.0880	1.0880	372.406	0.3724	0.3724
PCDF Congeners	**I-TEF(1)**						
2,3,7,8-TCDF	0.1	11.605	1.1605	1.1605	23.408	2.3408	2.3408
1,2,3,7,8-PeCDF	0.05	94.2904	4.7145	4.7145	23.9404	1.1970	1.1970
2,3,4,7,8-PeCDF	0.5	210.340	105.17	105.1700	202.16	101.08	101.08
1,2,3,4,7,8-HxCDF	0.1	304.6304	30.4630	30.4630	79.8012	7.9801	7.9801
1,2,3,6,7,8-HxCDF	0.1	253.8587	25.3859	25.3859	69.1611	6.9161	6.9161
1,2,3,7,8,9-HxCDF	0.1	130.5559	43.5186	43.5186	95.7615	3.0856	3.0856
2,3,4,6,7,8-HxCDF	0.1	435.1863	13.0556	13.0556	30.8565	9.5761	9.5761
1,2,3,4,6,7,8-HpCDF	0.01	1595.683	15.9568	15.9568	409.646	4.0965	4.0965
1,2,3,4,7,8,9-HpCDF	0.01	224.8462	2.2485	2.2485	50.5408	0.5054	0.5054
OCDF	0.001	797.841	0.7978	0.7978	228.764	0.2288	0.2288
		Total TEQ	**304.6**	**304.6**	**Total TEQ**	**175.6**	**175.6**

(1) Annex 1, Council Directive 2000/76/EC.
(2) Ambient concentration of congener (values in italics indicate levels below the limit of detection).
(3) Lower Limit TEQ calculated assuming non-detects are equal to zero (i.e. congeners with ambient levels below the limit of detection not included in Total TEQ)
(4) Upper Limit TEQ calculated assuming non-detects are equal to the limit of detection (i.e. congeners with ambient levels below the limit of detection included in Total TEQ).

Table 1.43 Levels of PCDDs and PCDFs measured at the fixed monitoring station, Poolbeg during the period 15/10/04 - 24/10/04 ($1x10^3$ fg/m^3 = 1 pg/m^3)

PCDD Congeners	I-TEF(1)	Sampling Period 1: 15/10/04 - 18/10/04			Sampling Period 2: 20/10/04 - 24/10/04		
		Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)	Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)
2,3,7,8-TCDD	1.0	<1.573		1.5735	<0.9820		0.9820
1,2,3,7,8-PeCDD	0.5	2.459	1.2293	1.2293	<1.209		0.6043
1,2,3,4,7,8-HxCDD	0.1	8.654	0.8654	0.8654	<1.511		0.1511
1,2,3,6,7,8-HxCDD	0.1	3.147	0.3147	0.3147	<1.511		0.1511
1,2,3,7,8,9-HxCDD	0.1	6.687	0.6687	0.6687	<1.511		0.1511
1,2,3,4,6,7,8-HpCDD	0.01	72.77	0.7277	0.7277	30.22	0.3022	0.3022
OCDD	0.001	177.0	0.1770	0.1770	61.94	0.0619	0.0619
PCDF Congeners	**I-TEF(1)**						
2,3,7,8-TCDF	0.1	9.834	0.9834	0.9834	6.345	0.6345	0.6345
1,2,3,7,8-PeCDF	0.05	7.671	0.3835	0.3835	4.306	0.2153	0.2153
2,3,4,7,8-PeCDF	0.5	12.78	6.3922	6.3922	6.345	3.1726	3.1726
1,2,3,4,7,8-HxCDF	0.1	15.73	1.5735	1.5735	10.58	1.0575	1.0575
1,2,3,6,7,8-HxCDF	0.1	9.834	0.9834	0.9834	3.550	0.3550	0.3550
1,2,3,7,8,9-HxCDF	0.1	18.68	0.6786	0.6786	<6.421		0.2795
2,3,4,6,7,8-HxCDF	0.1	6.786	1.8685	1.8685	2.795	0.6421	0.6421
1,2,3,4,6,7,8-HpCDF	0.01	51.14	0.5114	0.5114	27.95	0.2795	0.2795
1,2,3,4,7,8,9-HpCDF	0.01	6.392	0.0639	0.0639	<3.701		0.0370
OCDF	0.001	38.35	0.0384	0.0384	32.48	0.0325	0.0325
		Total TEQ	**17.7**	**19.7**	**Total TEQ**	**6.8**	**9.1**

(1) Annex 1, Council Directive 2000/76/EC.
(2) Ambient concentration of congener (values in italics indicate levels below the limit of detection).
(3) Lower Limit TEQ calculated assuming non-detects are equal to zero (i.e. congeners with ambient levels below the limit of detection not included in Total TEQ)
(4) Upper Limit TEQ calculated assuming non-detects are equal to the limit of detection (i.e. congeners with ambient levels below the limit of detection included in Total TEQ).

Table 1.44 Levels of PCDDs and PCDFs measured at the fixed monitoring station, Poolbeg during the period 26/10/04 - 09/11/04 (1x10^3 fg/m^3 = 1 pg/m^3)

PCDD Congeners	I-TEF(1)	Sampling Period 3: 26/10/04 - 29/10/04			Sampling Period 4: 05/11/04 - 09/11/04		
		Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)	Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)
2,3,7,8-TCDD	1.0	<2.394		2.3938	<0.9715		0.9715
1,2,3,7,8-PeCDD	0.5	<2.394		1.1969	<1.121		0.5605
1,2,3,4,7,8-HxCDD	0.1	<2.850		0.2850	6.053	0.6053	0.6053
1,2,3,6,7,8-HxCDD	0.1	<2.850		0.2850	1.719	0.1719	0.1719
1,2,3,7,8,9-HxCDD	0.1	<2.850		0.2850	5.381	0.5381	0.5381
1,2,3,4,6,7,8-HpCDD	0.01	28.50	0.2850	0.2850	50.82	0.5082	0.5082
OCDD	0.001	43.32	0.0433	0.0433	112.1	0.1121	0.1121
PCDF Congeners	**I-TEF(1)**						
2,3,7,8-TCDF	0.1	<2.394		0.2394	6.800	0.6800	0.6800
1,2,3,7,8-PeCDF	0.05	<2.508		0.1254	3.512	0.1756	0.1756
2,3,4,7,8-PeCDF	0.5	<2.508		1.2539	10.46	5.2311	5.2311
1,2,3,4,7,8-HxCDF	0.1	<2.736		0.2736	9.715	0.9715	0.9715
1,2,3,6,7,8-HxCDF	0.1	<2.736		0.2736	5.530	0.5530	0.5530
1,2,3,7,8,9-HxCDF	0.1	<2.736		0.5471	<7.473		0.2466
2,3,4,6,7,8-HxCDF	0.1	<5.471		0.2736	2.466	0.7473	0.7473
1,2,3,4,6,7,8-HpCDF	0.01	23.94	0.2394	0.2394	25.41	0.2541	0.2541
1,2,3,4,7,8,9-HpCDF	0.01	<4.674		0.0467	<3.213		0.0321
OCDF	0.001	36.48	0.0365	0.0365	8.220	0.0082	0.0082
		Total TEQ	**0.60**	**8.1**	**Total TEQ**	**10.5**	**12.0**

(1) Annex 1, Council Directive 2000/76/EC.
(2) Ambient concentration of congener (values in italics indicate levels below the limit of detection).
(3) Lower Limit TEQ calculated assuming non-detects are equal to zero (i.e. congeners with ambient levels below the limit of detection not included in Total TEQ)
(4) Upper Limit TEQ calculated assuming non-detects are equal to the limit of detection (i.e. congeners with ambient levels below the limit of detection included in Total TEQ).

Table 1.45 Levels of PCDDs and PCDFs measured at the fixed monitoring station, Poolbeg during the period 19/08/05 - 26/08/05 ($1x10^3$ fg/m^3 = 1 pg/m^3)

PCDD Congeners	I-TEF(1)	Sampling Period 3: 19/08/05 - 23/08/05			Sampling Period 4: 23/08/05 - 26/08/05		
		Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)	Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)
2,3,7,8-TCDD	1.0	<1.440		1.4399	<1.784		1.7836
1,2,3,7,8-PeCDD	0.5	3.908	1.9542	1.9542	1.090	0.5450	0.5450
1,2,3,4,7,8-HxCDD	0.1	5.245	0.5245	0.5245	1.090	0.1090	0.1090
1,2,3,6,7,8-HxCDD	0.1	14.40	1.4399	1.4399	2.973	0.2973	0.2973
1,2,3,7,8,9-HxCDD	0.1	9.257	0.9257	0.9257	1.090	0.1090	0.1090
1,2,3,4,6,7,8-HpCDD	0.01	77.14	0.7714	0.7714	23.78	0.2378	0.2378
OCDD	0.001	133.7	0.1337	0.1337	69.36	0.0694	0.0694
PCDF Congeners	**I-TEF(1)**						
2,3,7,8-TCDF	0.1	<1.954		0.1954	3.072	0.3072	0.3072
1,2,3,7,8-PeCDF	0.05	20.57	1.0285	1.0285	2.576	0.1288	0.1288
2,3,4,7,8-PeCDF	0.5	39.08	19.5417	19.5417	3.765	1.8827	1.8827
1,2,3,4,7,8-HxCDF	0.1	27.77	2.7770	2.7770	3.4681	0.3468	0.3468
1,2,3,6,7,8-HxCDF	0.1	26.74	2.6741	2.6741	3.4681	0.3468	0.3468
1,2,3,7,8,9-HxCDF	0.1	44.23	1.2342	1.2342	<4.855		0.4360
2,3,4,6,7,8-HxCDF	0.1	12.34	4.4226	4.4226	4.360	0.4855	0.4855
1,2,3,4,6,7,8-HpCDF	0.01	113.1	1.1314	1.1314	14.86	0.1486	0.1486
1,2,3,4,7,8,9-HpCDF	0.01	16.46	0.1646	0.1646	2.081	0.0208	0.0208
OCDF	0.001	164.6	0.1646	0.1646	23.78	0.0238	0.0238
		Total TEQ	**39.1**	**40.1**	**Total TEQ**	**5.1**	**7.3**

(1) Annex 1, Council Directive 2000/76/EC.

(2) Ambient concentration of congener (values in italics indicate levels below the limit of detection).

(3) Lower Limit TEQ calculated assuming non-detects are equal to zero (i.e. congeners with ambient levels below the limit of detection not included in Total TEQ)

(4) Upper Limit TEQ calculated assuming non-detects are equal to the limit of detection (i.e. congeners with ambient levels below the limit of detection included in Total TEQ).

Table 1.46 Levels of PCDDs and PCDFs measured at the fixed monitoring station, Poolbeg during the period 26/08/05 - 05/09/05 ($1x10^3$ fg/m^3 = 1 pg/m^3)

PCDD Congeners	I-TEF(1)	Sampling Period 3: 26/08/05 - 30/08/05			Sampling Period 4: 01/09/05 - 05/09/05		
		Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)	Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)
2,3,7,8-TCDD	1.0	<1.400		1.4000	<1.453		1.4534
1,2,3,7,8-PeCDD	0.5	3.290	1.6450	1.6450	9.944	4.9720	4.9720
1,2,3,4,7,8-HxCDD	0.1	3.080	0.3080	0.3080	5.966	0.5966	0.5966
1,2,3,6,7,8-HxCDD	0.1	8.400	0.8400	0.8400	29.83	2.9832	2.9832
1,2,3,7,8,9-HxCDD	0.1	6.370	0.6370	0.6370	21.42	2.1418	2.1418
1,2,3,4,6,7,8-HpCDD	0.01	59.50	0.5950	0.5950	99.44	0.9944	0.9944
OCDD	0.001	119.0	0.1190	0.1190	114.7	0.1147	0.1147
PCDF Congeners	**I-TEF(1)**						
2,3,7,8-TCDF	0.1	5.670	0.5670	0.5670	12.24	1.2239	1.2239
1,2,3,7,8-PeCDF	0.05	4.410	0.2205	0.2205	9.179	0.4590	0.4590
2,3,4,7,8-PeCDF	0.5	6.790	3.3950	3.3950	25.24	12.6212	12.6212
1,2,3,4,7,8-HxCDF	0.1	8.400	0.8400	0.8400	24.48	2.4478	2.4478
1,2,3,6,7,8-HxCDF	0.1	7.000	0.7000	0.7000	19.89	1.9888	1.9888
1,2,3,7,8,9-HxCDF	0.1	10.50	0.2590	0.2590	46.66	1.0709	1.0709
2,3,4,6,7,8-HxCDF	0.1	2.590	1.0500	1.0500	10.71	4.6660	4.6660
1,2,3,4,6,7,8-HpCDF	0.01	32.90	0.3290	0.3290	91.79	0.9179	0.9179
1,2,3,4,7,8,9-HpCDF	0.01	4.060	0.0406	0.0406	9.179	0.0918	0.0918
OCDF	0.001	27.30	0.0273	0.0273	64.25	0.0643	0.0643
		Total TEQ	**11.9**	**13.3**	**Total TEQ**	**37.5**	**39.0**

(1) Annex 1, Council Directive 2000/76/EC.
(2) Ambient concentration of congener (values in italics indicate levels below the limit of detection).
(3) Lower Limit TEQ calculated assuming non-detects are equal to zero (i.e. congeners with ambient levels below the limit of detection not included in Total TEQ)
(4) Upper Limit TEQ calculated assuming non-detects are equal to the limit of detection (i.e. congeners with ambient levels below the limit of detection included in Total TEQ).

Table 1.47 Summary of Baseline PCCD/PCDFs Ambient Air Concentrations.

Pollutant	Averaging Period	Minimum PCDDs/PCDFs (I-TEQ) (Fg/m^3)	Maximum PCDDs/PCDFs (I-TEQ) (Fg/m^3)
August / September 2003 Monitoring			
PCCD/PCDFs	28/08/03 – 31/08/03	1.4	7.1
PCCD/PCDFs	03/09/03 – 08/09/03	3.3	3.3
PCCD/PCDFs	08/09/03 – 12/09/03	14.3	14.3
PCCD/PCDFs	15/09/03 – 19/09/03	12.1	12.1
PCCD/PCDFs	**4-Week Average**	**7.8**	**9.2**
February/ March 2004 Monitoring			
PCCD/PCDFs	11/02/04 – 16/02/04	157.9	157.9
PCCD/PCDFs	16/02/04 – 20/02/04	75.3	75.3
PCCD/PCDFs	23/02/04 – 27/02/04	304.6	304.6
PCCD/PCDFs	03/03/04 – 08/03/04	175.6	175.6
PCCD/PCDFs	**4-Week Average**	**178.4**	**178.4**
October / November 2004 Monitoring			
PCCD/PCDFs	15/10/04 - 18/10/04	17.7	19.7
PCCD/PCDFs	20/10/04 - 24/10/04	6.8	9.1
PCCD/PCDFs	26/10/04 - 29/10/04	0.60	8.1
PCCD/PCDFs	05/11/04 - 09/11/04	10.5	12.0
PCCD/PCDFs	**4-Week Average**	**8.9**	**12.2**
August / September 2005 Monitoring			
PCCD/PCDFs	19/08/05 - 23/08/05	39.1	40.1
PCCD/PCDFs	23/08/05 - 26/08/05	5.1	7.3
PCCD/PCDFs	26/08/05 - 30/08/05	11.9	13.3
PCCD/PCDFs	01/09/05 - 05/09/05	37.5	39.0
PCCD/PCDFs	**4-Week Average**	**23.4**	**24.9**
2003 - 2005 Monitoring Data Average		***54.6***	***56.2***

Table 1.48 I-TEQ values derived from measurements of airborne dioxins in various locations.

Location	**Site Type**	**I-TEQ[1] (fg/m^3)**
Poolbeg (2003 - 2005)	*Urban*	*Lower Limit – 54.6[2]* *Upper Limit – 56.2[3]*
Kilcock , Co. Meath (1998)[4]	Rural	Range 2.8 – 7
Ireland[4]	Baseline	Mean – 26
	Potential Impact Areas	Mean – 49
Ringaskiddy (2001)[5]	Industrial	Lower Limit – 4.0[2] Upper Limit – 16.4[3]
Carranstown (2001)[6]	Rural	Lower Limit – 28[2] Upper Limit – 46[3]
Germany (1992)[7,8]	Rural	< 70
	Urban	71 – 350
	Close to Major Source	351 – 1600
Bavaria, Germany (1997)[9]	Rural Mean	Range 3.3 – 88.4
	Augsburg, Before MWI	Range 14 – 120
	Augsburg, After MWI	Range 7.6 – 206
Thuringia, Germany (1997)[9]	Urban 1993 - 1997	Range 9 – 231, Mean = 71
	Urban 1993 - 1997	Range 11 – 169, Mean = 52
	Urban 1993 - 1997	Range 18 – 210, Mean = 92
Austria[9]	Wien-14 (urban) 1992 - 1997	Range 9.3 – 129, Mean = 37
	Graz-Ost (urban) 1993 - 1997	Range 139 – 302, Mean = 198
	Linz-Ursulinenhof (urban) 1994 - 1997	Range 69 – 179, Mean = 120
	Leoben-BFI (urban) 1995 - 1998	Range 69 – 262, Mean = 150
Italy[9]	Florence (Urban)	Range 72 – 200
	Rome (Urban)	Range 48 – 277, Mean = 85
Manchester [10]	Urban (2000 - 2003)	Range – 61 - 92
Middlesbrough[10]	Urban (2000 - 2003)	Range – 31 - 52
Hazelrigg[10]	Semi-rural (2000 - 2003)	Range – 8 - 11
Stoke Ferry[10]	Rural (2000 - 2003)	Range – 18 - 21
High Muffles[10]	Rural (2000 - 2003)	Range – 6 - 8

(1) I-TEQ$_{DF}$ values based on NATO/CCMS (1988) and as used in Annex 1, Council Directive 2000/76/EC.
(2) Lower limit TEQ calculated assuming non-detects are equal to zero.
(3) Upper limit assuming non-detects are equal to limit of detection.
(4) Taken from Chapter 8 of Thermal Waste Treatment Plant, Kilcock EIS, Air Environment (1998)
(5) Taken from Chapter 9 of Waste Management Facility, Indaver Ireland Ringaskiddy EIS, Baseline Dioxin Survey (2001)
(6) Taken from Chapter 9 of Waste Management Facility, Indaver Ireland Carranstown EIS, Baseline Dioxin Survey (2001)
(7) Raffe, C (1996) Sources and environmental concentrations of dioxins and related compounds, *Pure & Appl. Chem* **Vol. 68**, No. 9, pp 1781-1789
(8) Duarte-Davidson et al (1994) Polychlorinated Dibenzo-*p*-Dioxins (PCDDs) and Furans (PCDFs) in Urban Air and Deposition, *Environ. Sci. & Pollut. Res.*, **1 (4)**, 262-270
(9) European Commission (1999) Compilation of EU Dioxin Exposure & Health Data Task 2 Environmental Levels - Technical Annex.
(10) Taken from TOMPS Network website, www.airquality.co.uk.

Table 1.49 Mean I-TEQ Deposition Fluxes Of Dioxins In Various Locations

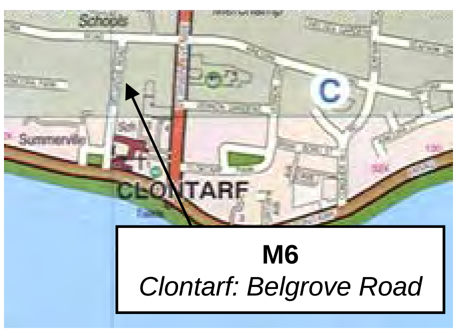
Location	Site Type	Mean I-TEQ[(1)] (pg/m^2/ day)
Germany (1992)[(2)]	Rural	5 -22
	Urban	10 – 100
	Close to Major Source	123 - 1293
Germany (1998)[(4)]	Hamburg 1995 (Urban Background)	6
	Rheinland-Palatinate 1994 (Urban)	9
	Thuringia 1993-97 (Urban)	29
	Brandenburg 1993 (Conurbation)	36
Belgium (1997)[(4)]	Eksel (Background)	3.1
	Mol (Background)	0.7
	Merksem (Urban)	12.0
	Antwerpen (Urban)	0.9
UK[(3)]	Stevenage	3.2
	London	5.3
	Cardiff	12
	Manchester	28

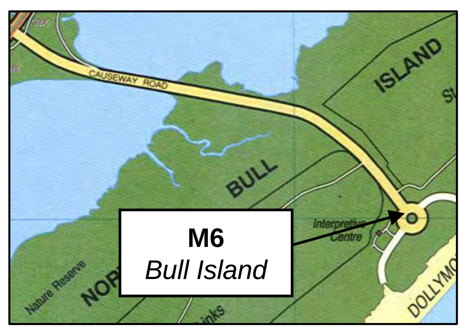
(1) I-TEQDF values based on NATO/CCMS (1988) and as used in Annex 1, Council Directive 2000/76/EC.

(2) Raffe, C (1996) Sources and environmental concentrations of dioxins and related compounds, *Pure & Appl. Chem* Vol. 68, No. 9, pp 1781-1789

(3) Duarte-Davidson et al (1994) Polychlorinated Dibenzo-*p*-Dioxins (PCDDs) and Furans (PCDFs) in Urban Air and Deposition, *Environ. Sci. & Pollut. Res.*, 1 (4), 262-270

(4) European Commission (1999) Compilation of EU Dioxin Exposure & Health Data Task 2 Environmental Levels - Technical Annex.





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Project

Poolbeg Monitoring

Reference

03/1744AR02

Figure 1.1

Approximate location of air monitoring stations

awn consulting

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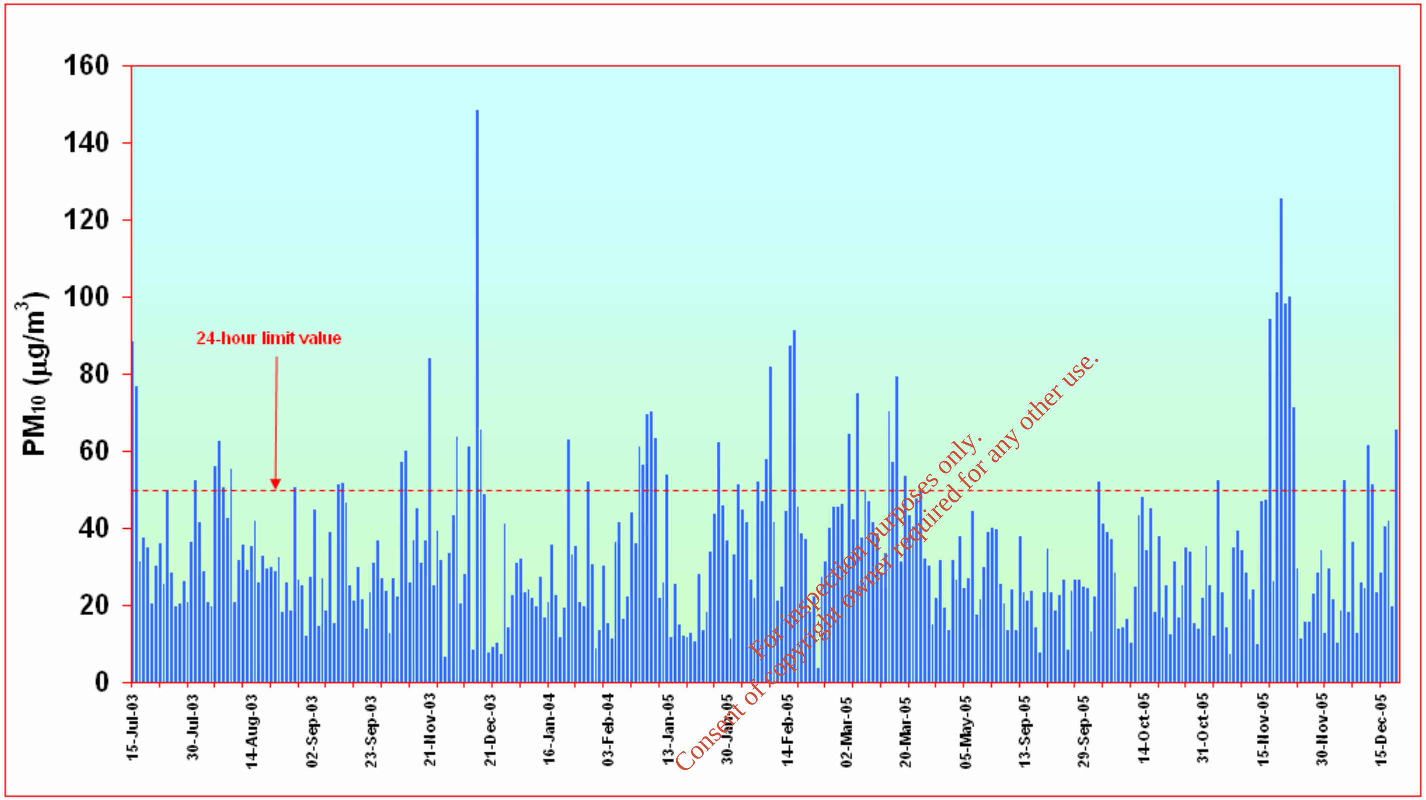

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Reference

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Figure 1.2

PM_{10} Daily Averages ($\mu g/m^3$)

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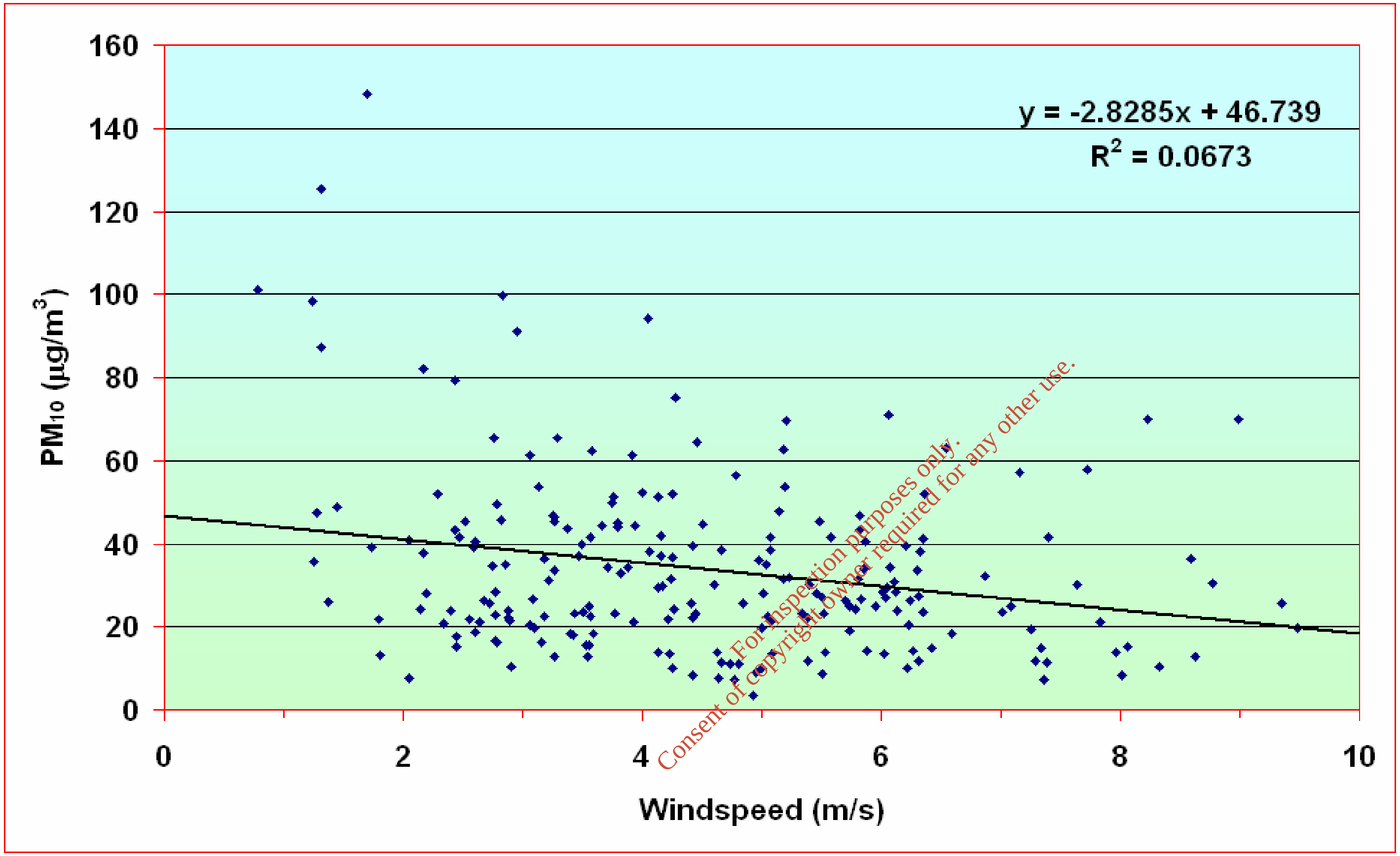

Project

Poolbeg WTE – Baseline Air Monitoring

Reference

03/1744AR02

Figure 1.3

Correlation Between PM_{10} Daily Averages (µg/m^3) & Wind Speed (m/s)

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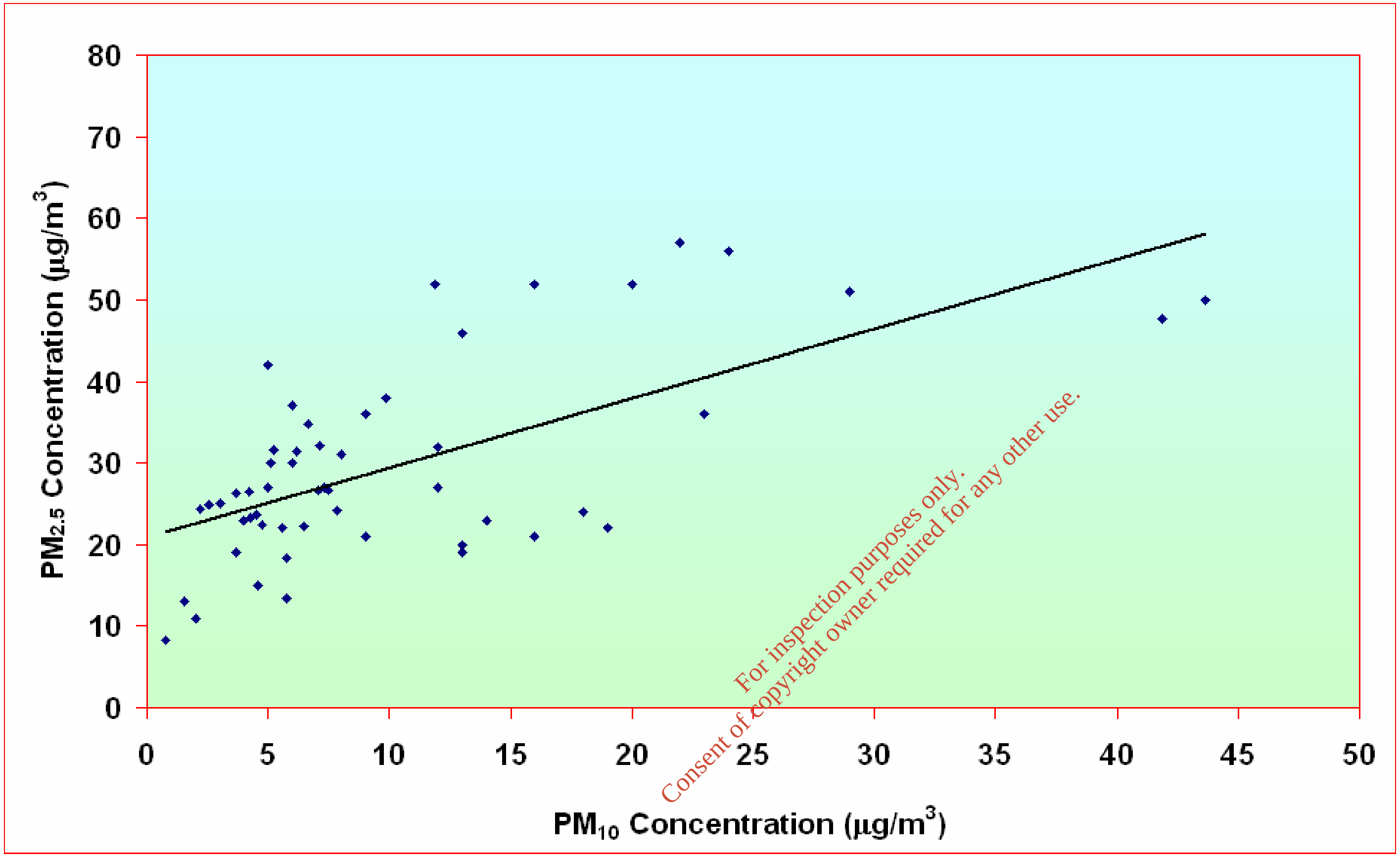

Project

Poolbeg WTE – Baseline Air Monitoring

Reference

03_1744AR02

Figure 1.4

Plot of Daily $PM_{2.5}$ Concentration Vs Daily PM_{10} Concentration ($\mu g/m^3$)

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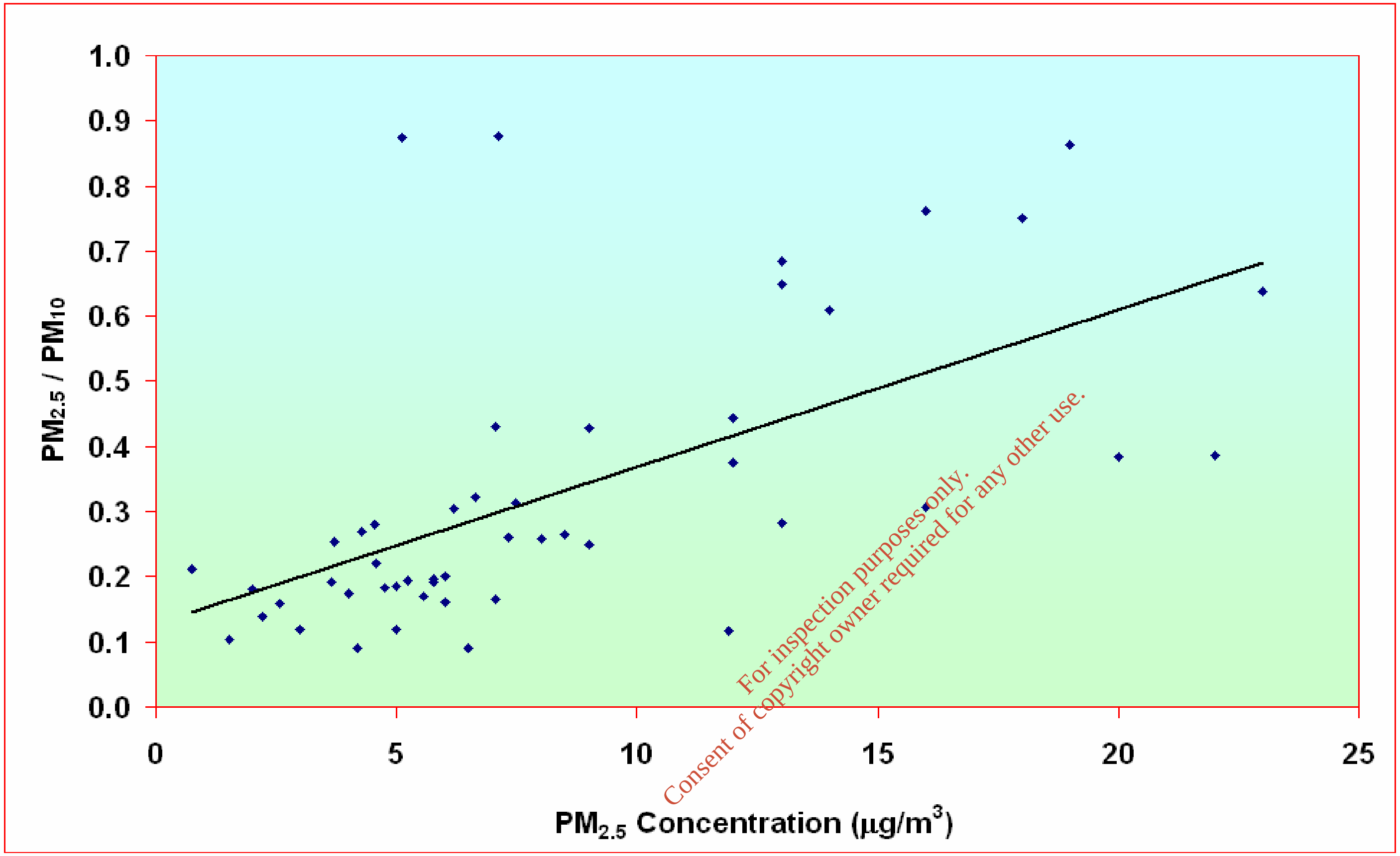

Project

Poolbeg WTE – Baseline Air Monitoring

Reference

03_1744AR02

Figure 1.5

Plot of Daily $PM_{2.5}$ / PM_{10} Ratio vs Daily PM_{10} Concentration ($\mu g/m^3$)

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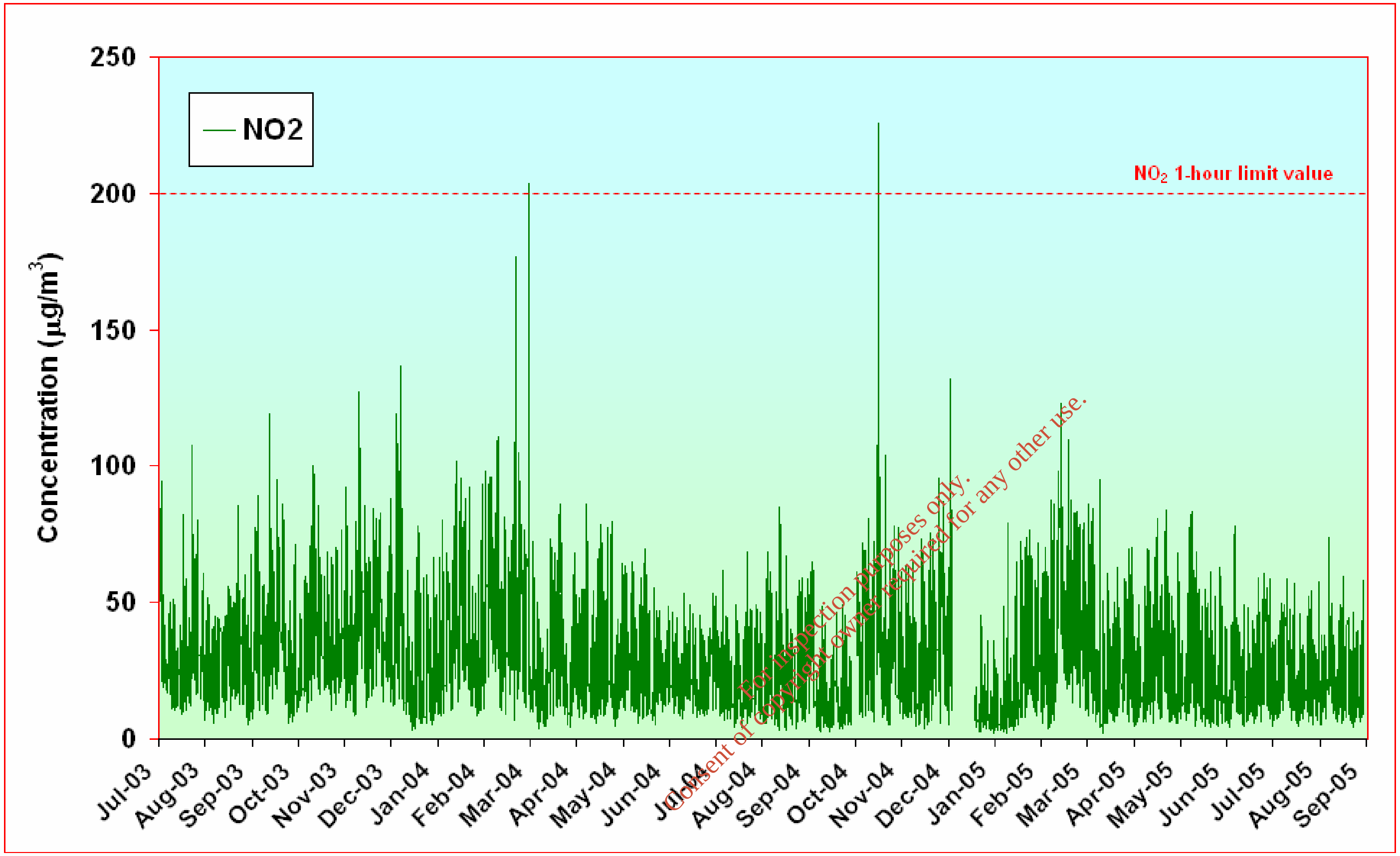

Project

Poolbeg WTE – Baseline Air Monitoring

Reference

03_1744AR02

Figure 1.6

NO_2 1-Hour Averages (µg/m³)

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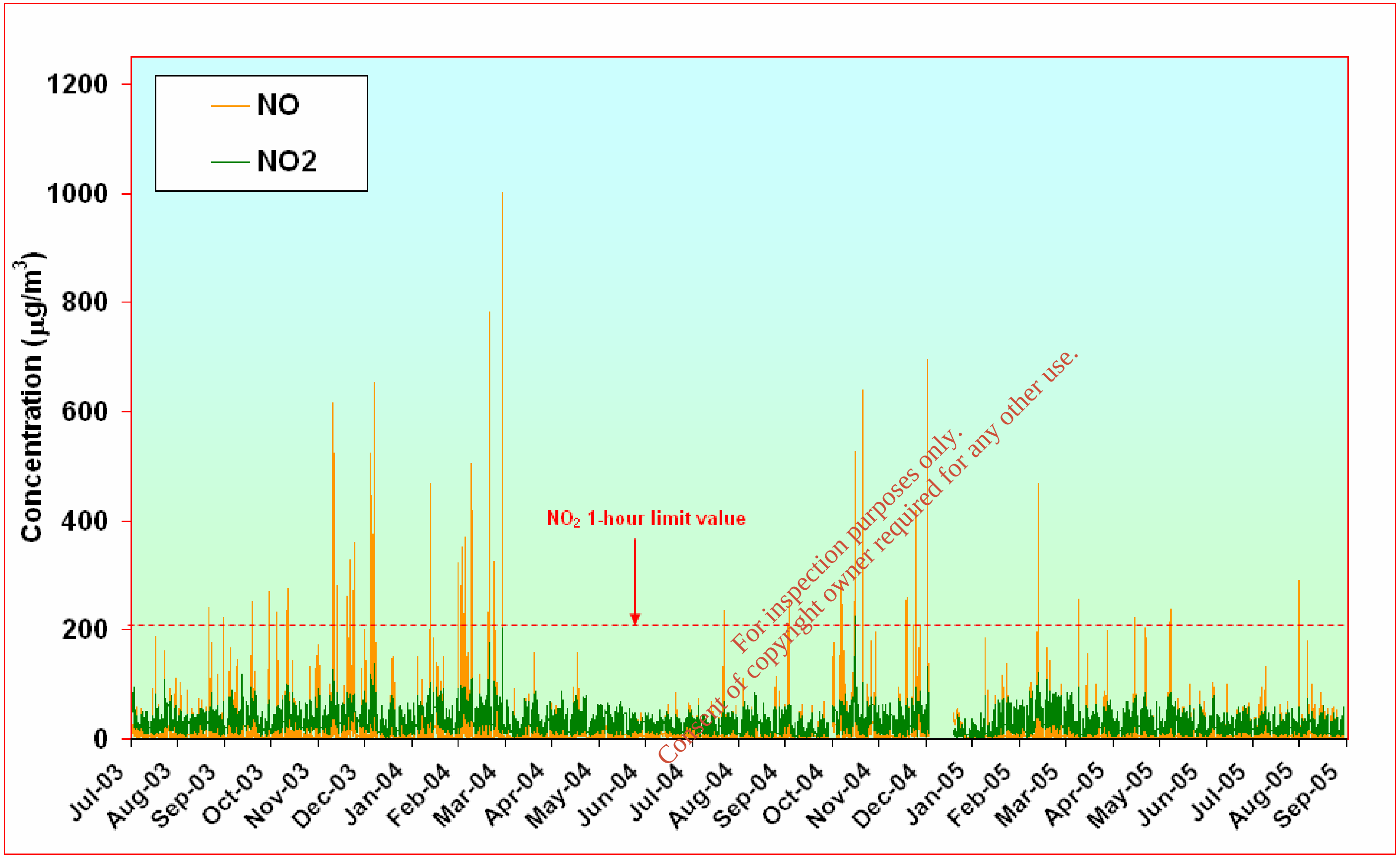

Project

Poolbeg Monitoring

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Figure 1.7

NO_2 & NO Concs. July 2003 - August 2005 ($\mu g/m^3$)

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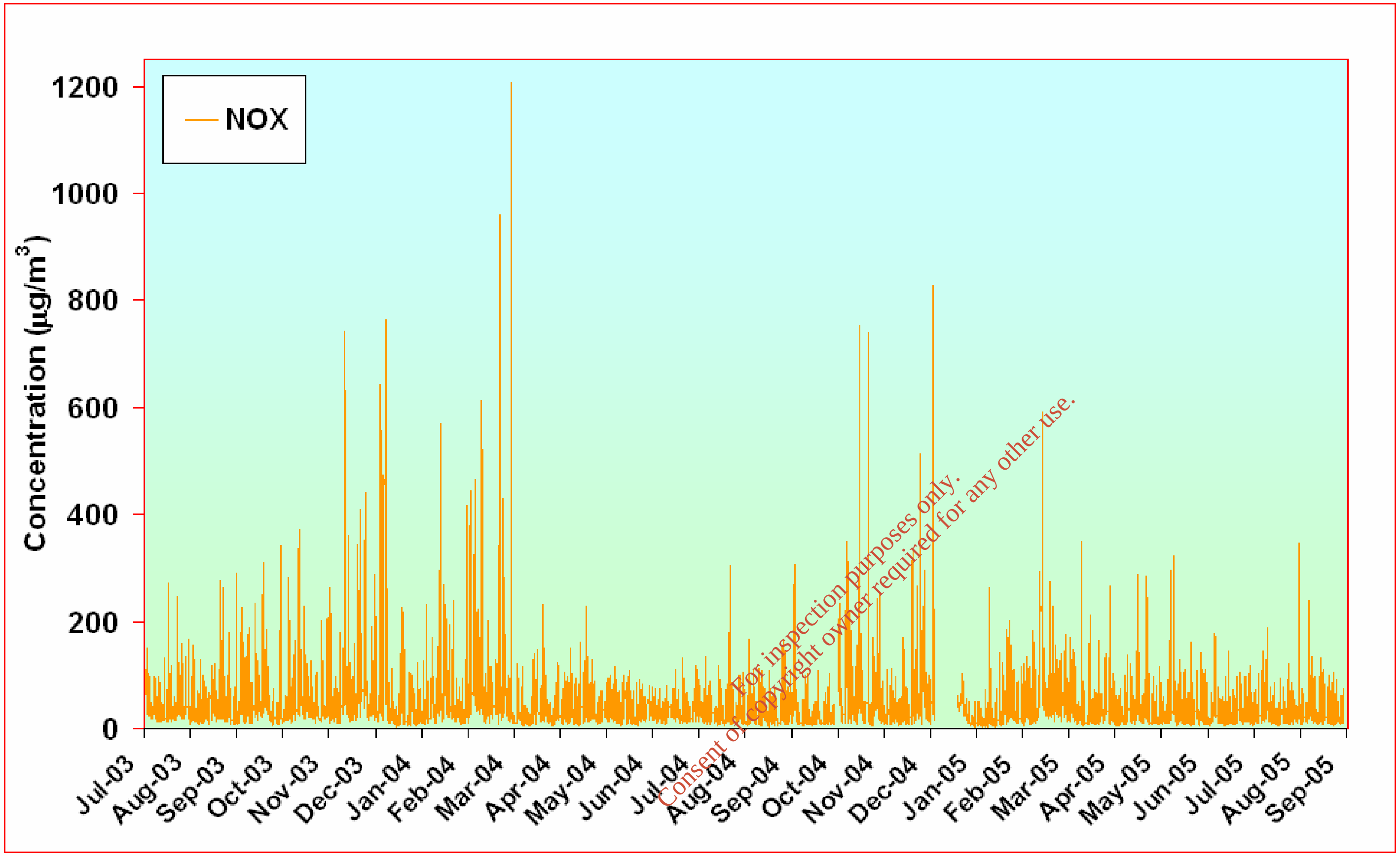

Project

Poolbeg WTE – Baseline Air Monitoring

Reference

03_1744AR02

Figure 1.8

NO_X 1-Hour Averages ($\mu g/m^3$)

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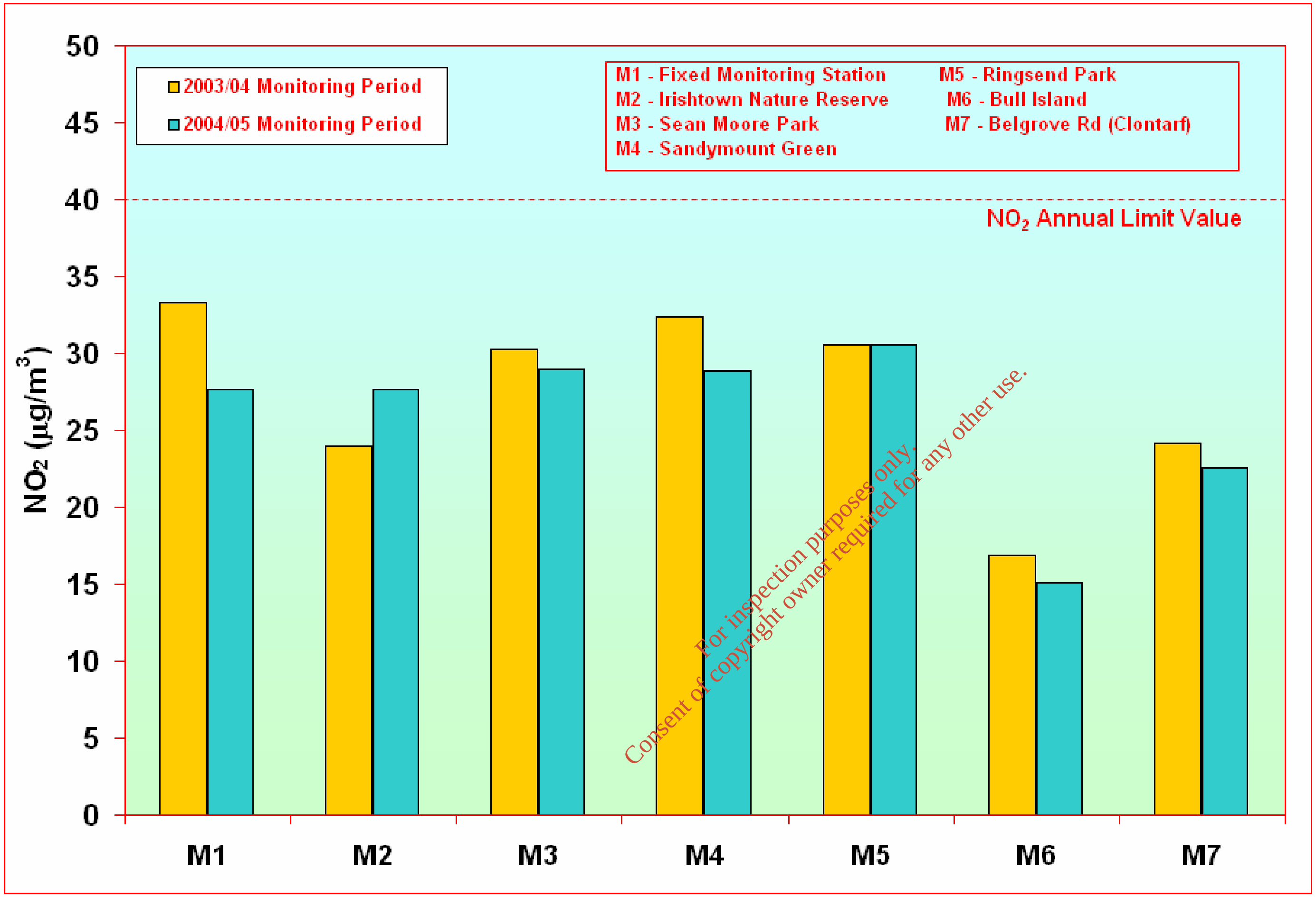

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Figure 1.9

NO_2 Monthly Diffusion Tube Concentration ($\mu g/m^3$) For Each Location (Uncorrected)

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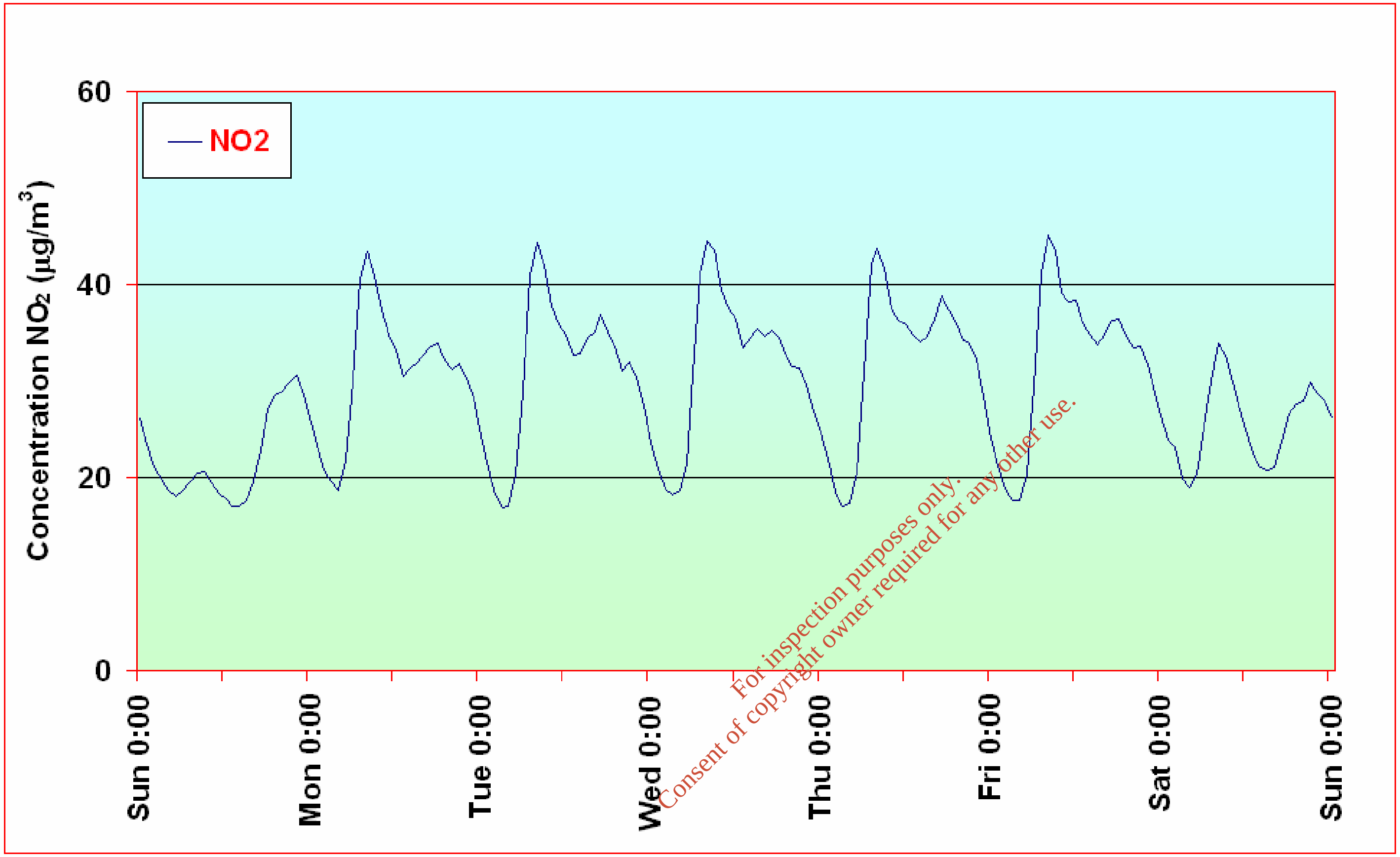

Project

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Figure 1.10

NO_2 Annual Average Concentration (µg/m³) For Each Hour of Week

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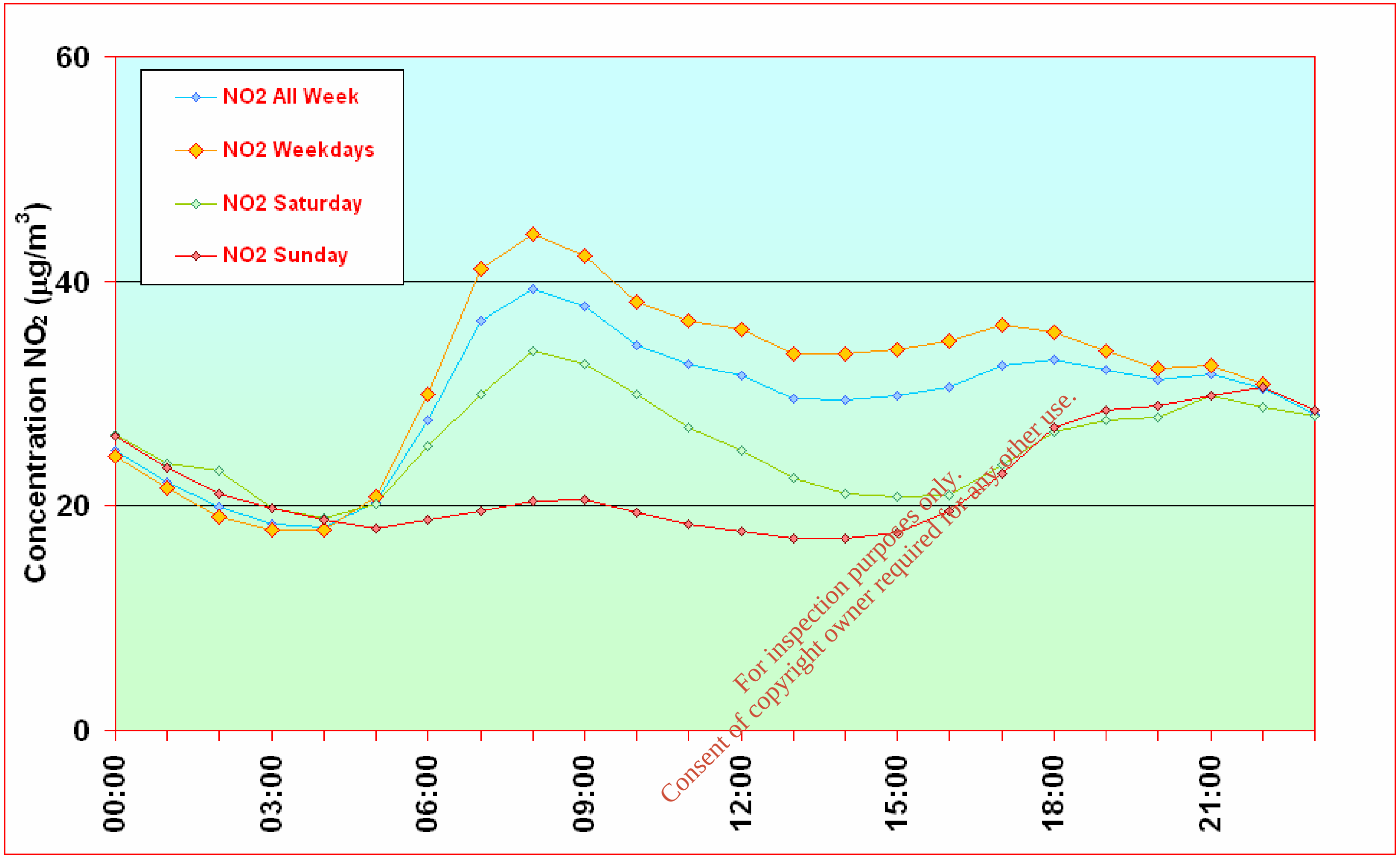

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Figure 1.11

NO_2 Annual Average Concentration (µg/m³) For Each Hour of Day

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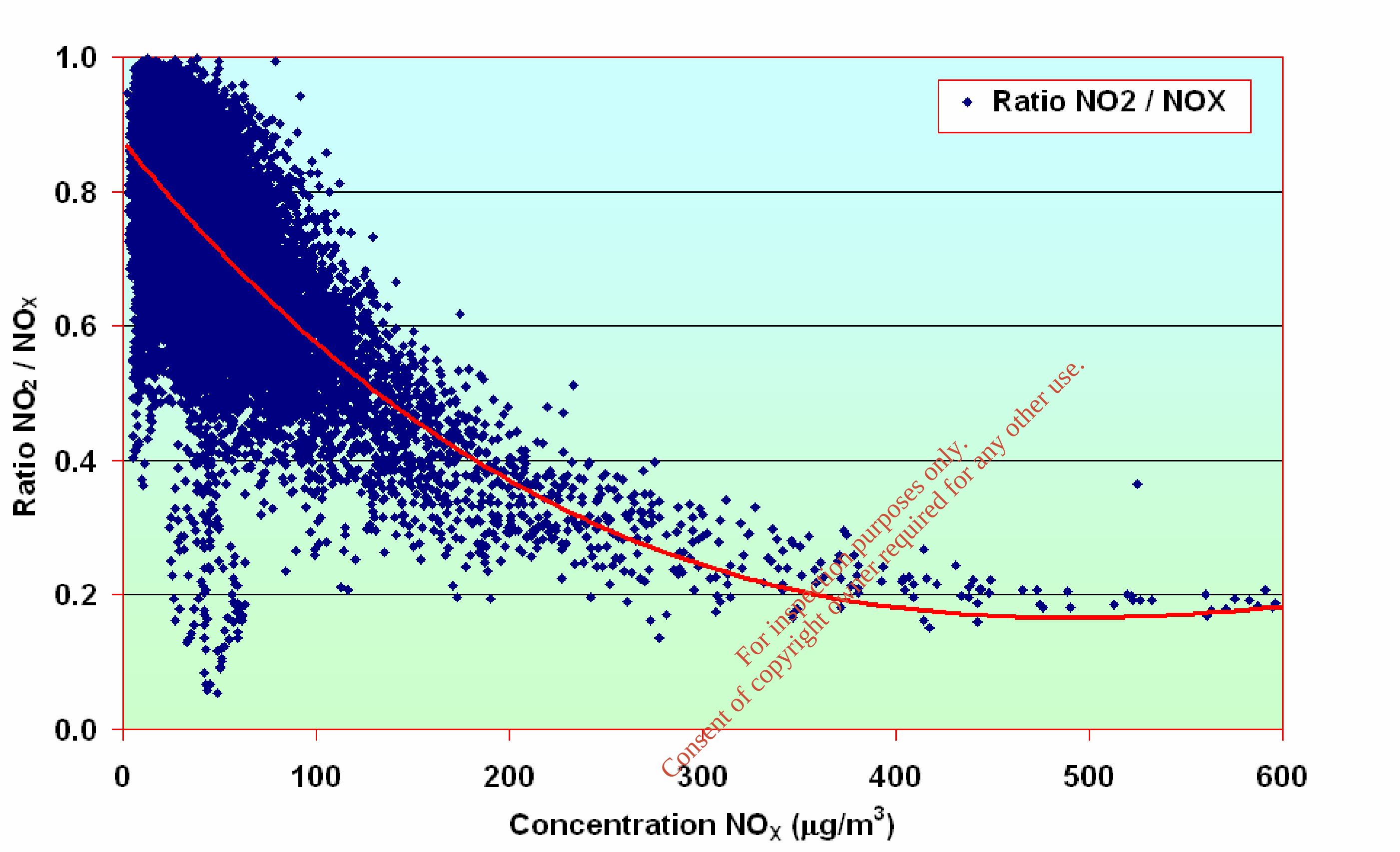

Project

Poolbeg WTE – Baseline Air Monitoring

Reference

03_1744AR02

Figure 1.12

Ratio of NO_2 to NO_X 1-Hour Concentrations, Fixed Station, Poolbeg

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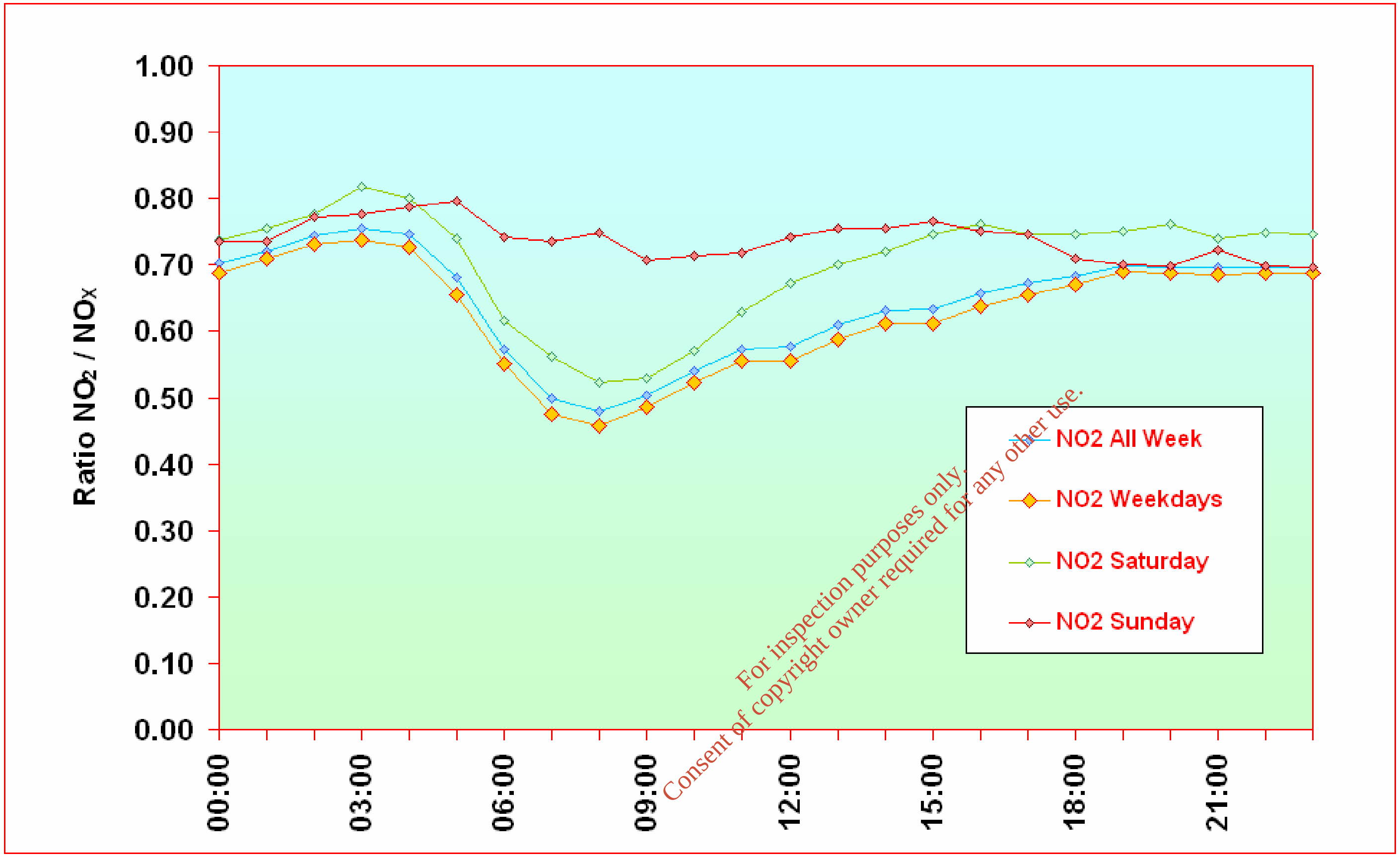

Project

Poolbeg WTE – Baseline Air Monitoring

Reference

03_1744AR02

Figure 1.13

Ratio of NO_2 to NO_X 1-Hour Concentrations, Fixed Station, Poolbeg By Hour of Day

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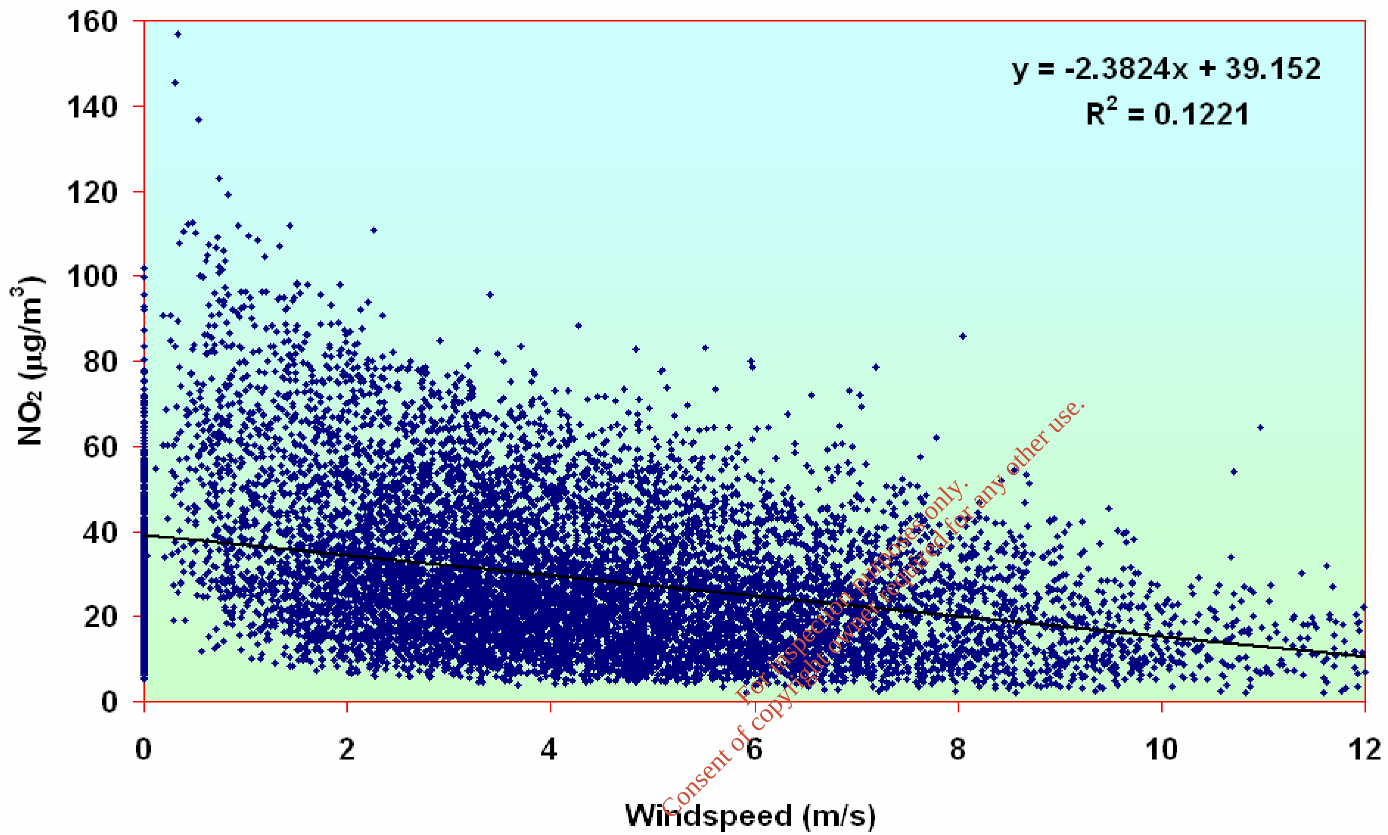

Project

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Figure 1.14

Correlation Between NO_2 Concentrations, (µg/m^3) and Windspeed (m/s)

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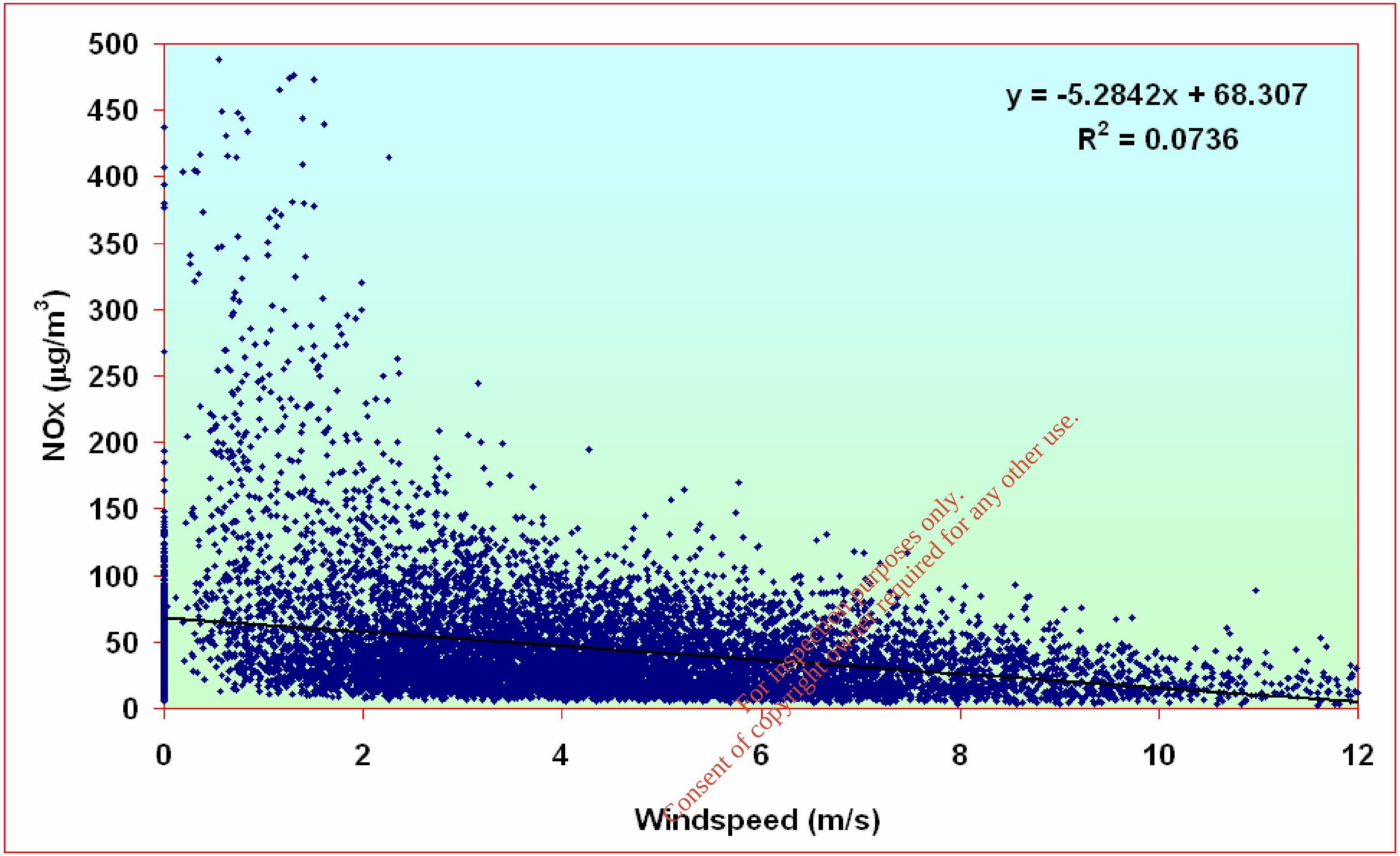

Project

Poolbeg WTE – Baseline Air Monitoring

Reference

03_1744AR02

Figure 1.15

Correlation Between NO_x Concentrations, (µg/m³) and Windspeed (m/s)

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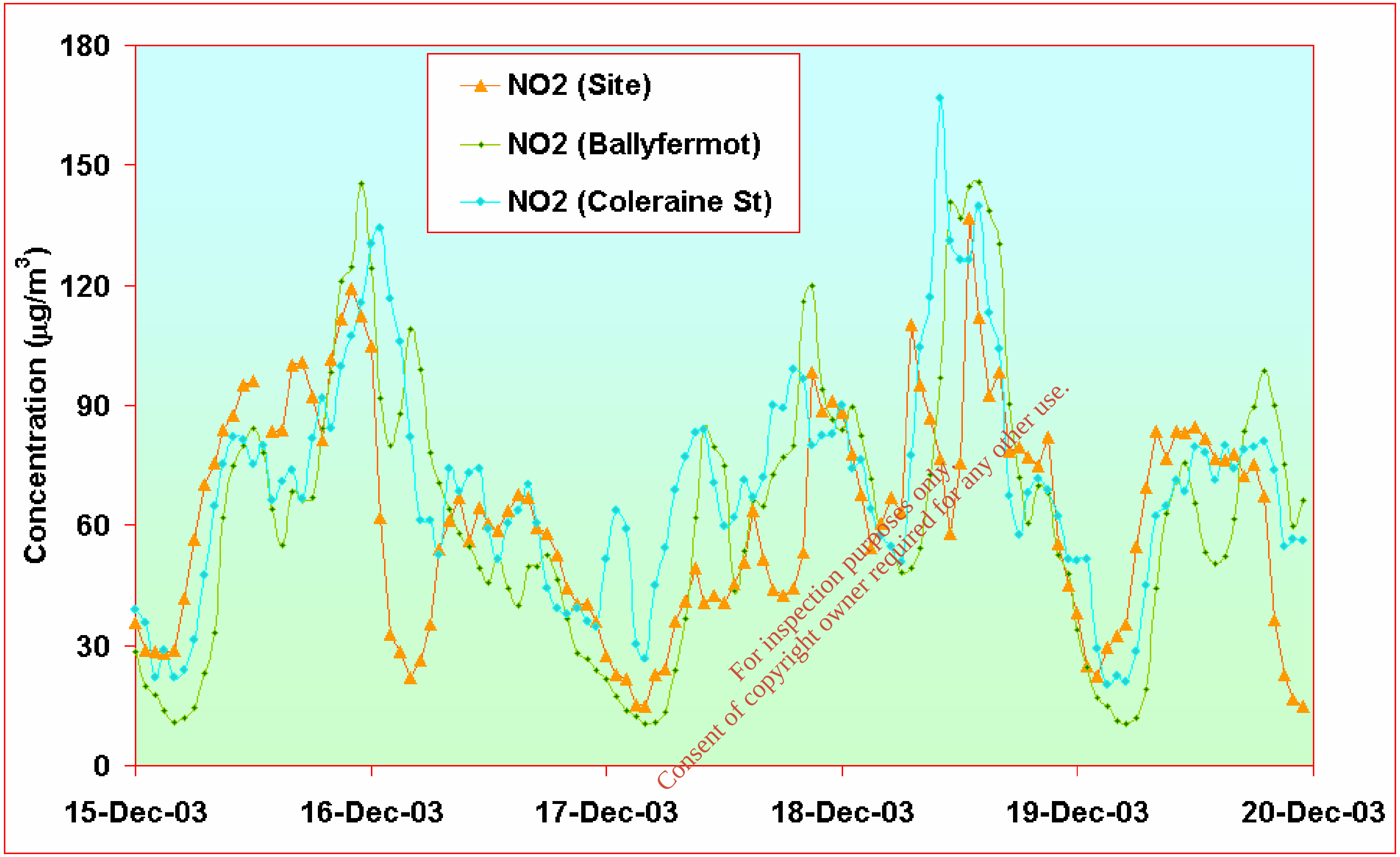

Project

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Reference

03_1744AR02

Figure 1.16

NO_2 Concentrations, ($\mu g/m^3$) During A Pollution Episode (15/12/03 – 19/12/03)

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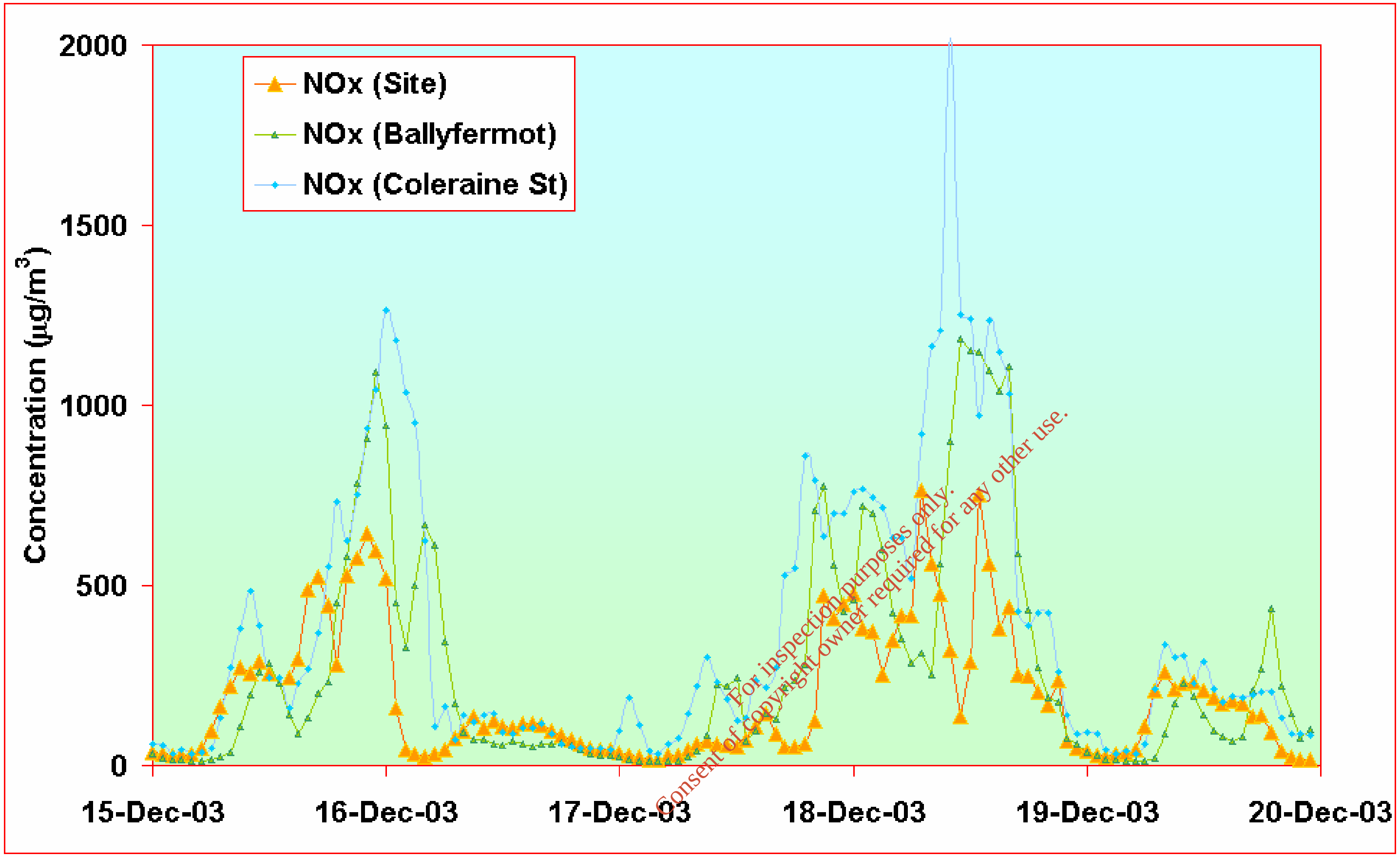

Project

Poolbeg WTE – Baseline Air Monitoring

Reference

03_1744AR02

Figure 1.17

NO_X Concentrations, (µg/m³) During A Pollution Episode (15/12/03 – 19/12/03)

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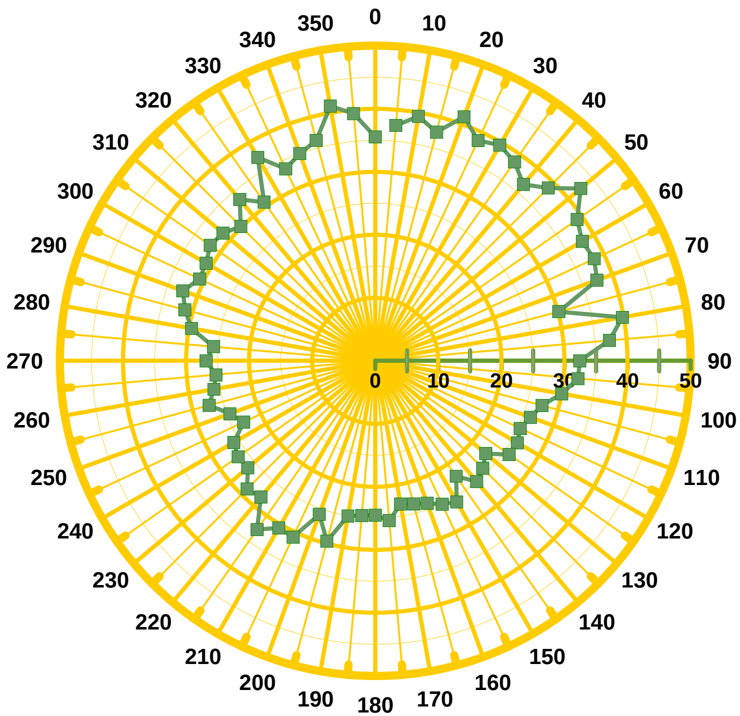

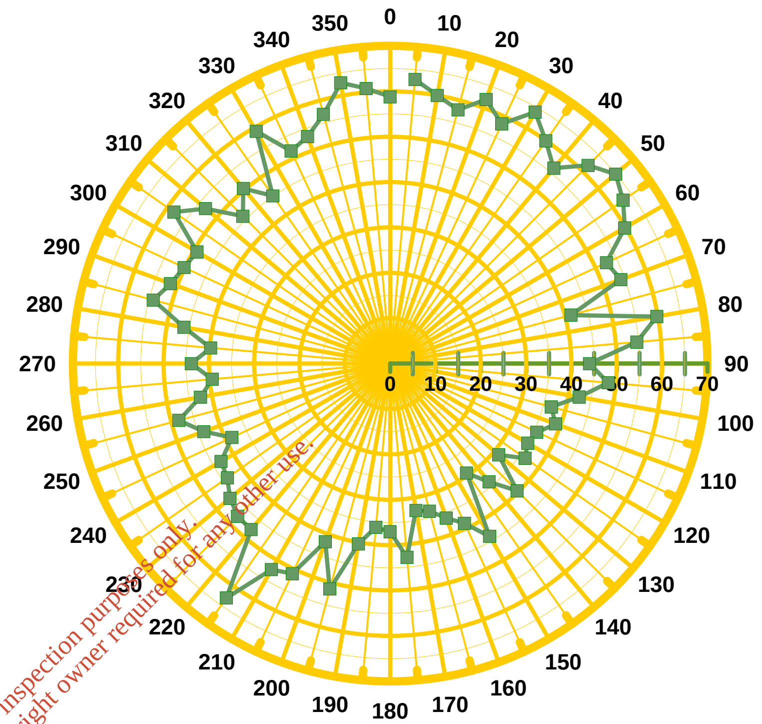

NO_2 (µg/m³) vs Wind Direction

NO_X (µg/m³) vs Wind Direction

Project
Poolbeg WTE – Baseline Air Monitoring

Reference
03_1744AR02

Figure 1.18
NO_2 and NO_X Concentrations, (µg/m³) vs Wind Direction

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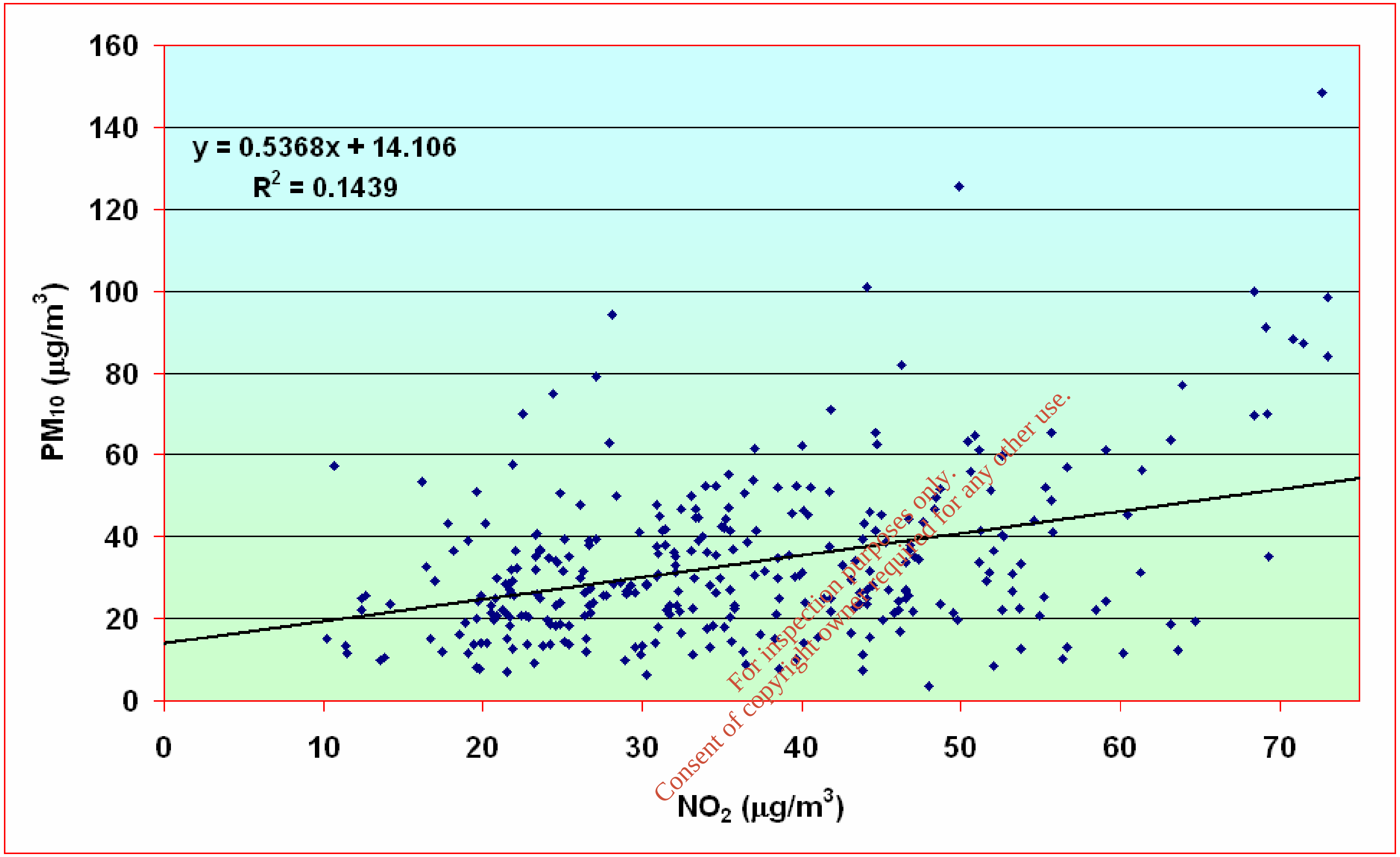

Project
Poolbeg WTE – Baseline Air Monitoring

Reference
03_1744AR02

Figure 1.19

Correlation Between 24-Hour NO_2 ($\mu g/m^3$) and PM_{10} ($\mu g/m^3$) Concentrations,

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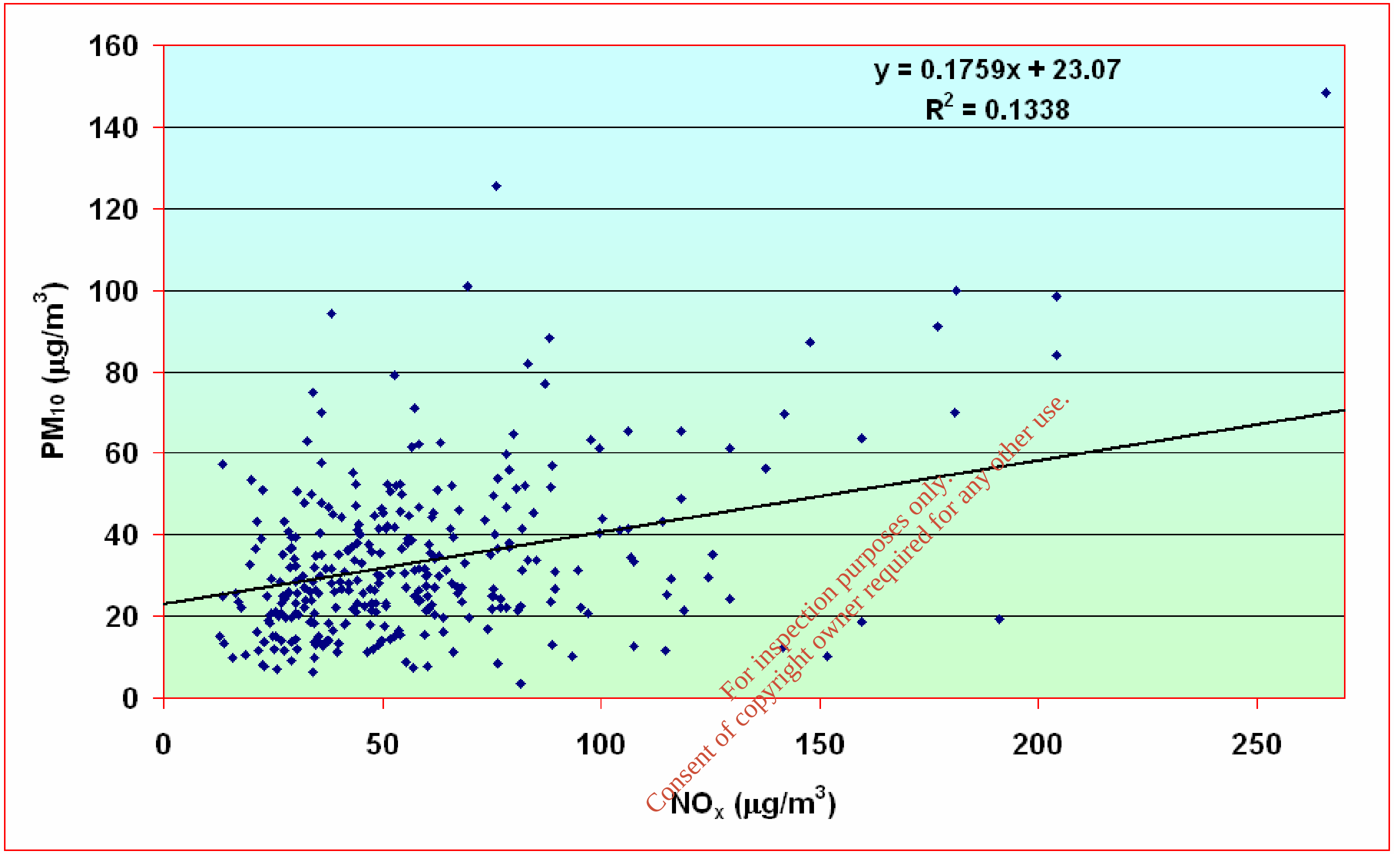

Project

Poolbeg WTE – Baseline Air Monitoring

Reference

03_1744AR02

Figure 1.20

Correlation Between 24-Hour NO_x (µg/m³) and PM_{10} (µg/m³) Concentrations,

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Appendix G

Air Quality – Emissions Inventory

ENVIROCON

Air Pollution and Environmental Consultancy

Old Road, Kilcarn Bridge
Navan, Co. Meath
Phone: 046 9074135
Fax: 046 9074055
e-mail: info@envirocon.ie

TO: MR MARC WALSHE, RPS-MCOS DUBLIN
FROM: MICHAEL BAILEY
DATE: 12 MARCH 2004

RE: DUBLIN WASTE TO ENERGY PROJECT

Following our discussions in relation to collating emission data necessary to undertake an air quality impact study of the planned thermal waste treatment plant at Ringsend it was agreed that data on the principal point emission sources in the area would be collated. These are the ESB power stations near the mouth of the River Liffey. There are no other significant point emission sources in the locality. It was agreed that emission estimates for road traffic and area sources would not be collected. A spreadsheet containing the relevant data was prepared (ThermalTP-EmissionInventory.xls e-mail 20/2/04).

There are 3 power stations in the Dublin Bay area – Poolbeg, Ringsend and North Wall that are major emission sources in terms of nitrogen oxides and to a lesser extent sulphur dioxide. Details on the emission characteristics of the principal exhaust stacks at each of these power stations was obtained from information submitted to the EPA as part of applications for IPC licences. In addition, details on building configurations for each power station was obtained so that the main geometry of the relevant building structures could be calculated. The site plans for each of the three power stations were used to determine the main buildings and the effective building dimensions, relevant for use in an air dispersion model. These parameters include the height of the main building structure, angle between North and Length and the National Grid Coordinates of the 4 corners and building structure midpoint.

The locations of each of the principal exhaust stacks at the three power stations were obtained and these are presented in the inventory spreadsheet as National Grid Coordinates. The stack heights specified in the spreadsheet are the height of the stacks above local grade. The emission characteristics of the stacks (exit velocity and exit temperature) are based on maximum hourly exhaust flows, derived from the IPC submissions.

The emission rates for SO_2, NO_x and PM_{10} are based on maximum hourly rates, in terms of g/s and are based on information obtained from the ESB. The SO_2 emission rates for Poolbeg A and B stacks are based on the maximum hourly consumption of fuel oil with a 1% sulphur. In the case of the Poolbeg CCGT plant, the SO_2 emission rate refers to the emergency use of distillate oil. In 2004 the maximum permitted sulphur content for this type of fuel is 0.2%. However, from 1st January 2008 the maximum sulphur content for distillate oil will reduce to 0.1%, resulting from the implementation of EU Council Directive (1999/32/EC, relating to a reduction in the sulphur content of certain liquid fuels). SO_2 emissions are estimated to be about 44g/s, in 2004 and 22 g/s in 2010 when the CCGT plant is operating at full load on distillate oil.

Emissions of PM_{10} were calculated for the Poolbeg main units burning fuel oil. These emission rates are based on the emission limits of 200 mg/Nm^3 to 2007 and a reduction to 50 mg/Nm^3 post-2007 specified in the IPC Licence No 557. Given the infrequent use of distillate oil and the burning of natural gas in the CCGT plant at Poolbeg, Ringsend and North Wall, emissions are assumed negligible for these sources.

Estimates of emissions for 2010 are calculated based on the assumption that these are worst-case hourly emission rates. No projections on plant operation for 2010 are currently available from the ESB as they are in negotiations with the Department of Energy in relation to the Kyoto objectives. However, it may be assumed that maximum load would still be required on all plant and so the emission characteristics for 2004 will apply, as a worst-case estimate. In the case of sulphur dioxide emissions, these have been reduced in 2010 arising from the implementation of the EU Directive on sulphur in gas oil. There are no reductions in NO_x emissions for any of the power stations in 2010.

The generating plant at each of the power stations is as follows: -

- Poolbeg – Two main fuel oil/natural gas fired conventional units of 120MW capacity and one unit of 270 MW.
  The two 120 MW plant emissions are emitted from one of the main 207m stacks,
  with the 270 MW plant emissions exiting through the other 207m stack.
  There are two 243.5 MW Combined Cycle Gas Turbines (CCGT) to the east of the main station building.
  The emissions from these two natural gas fired units are emitted via two separate 75 m stacks.

- North Wall –One natural gas fired CCGT unit of 155 MW capacity and a GT unit of 104 MW capacity.
  Emissions from these units are emitted via a 70m and 65m stack respectively.

- Ringsend – One natural gas fired CCGT unit of 417 MW capacity. Emissions are emitted via a single 70m stack.

Maximum Emission Characteristics

2004

STACK		X	Y	Ht (m)	Diam(m)	Temp(K)	Exit Vel (m/s)	SO2(g/s)	NOx (g/s)	PM10(g/s)
Poolbeg A	Natural Gas	320612	233723	207	4.1	378	22	0	86.0	0
Poolbeg B	Natural Gas	320693	233726	207	6.2	407	11.3	0	115.0	0
Poolbeg CCGT 1	Natural Gas	320839	233690	75	5.2	353	26.3	0	21.0	0
Poolbeg CCGT 2	Natural Gas	320862	233691	75	5.2	353	26.3	0	21.0	0
Poolbeg A	Fuel Oil (1%S)	320612	233723	207	4.1	402	22	307	115.0	39
Poolbeg B	Fuel Oil (1%S)	320693	233726	207	6.2	416	10.7	334	177.0	43
Poolbeg CCGT 1	Distillate Oil (0.2%S)	320839	233690	75	5.2	378	26.9	44	284.0	0
Poolbeg CCGT 2	Distillate Oil (0.2%S)	320862	233691	75	5.2	378	26.9	44	284.0	0

2010

STACK		X	Y	Ht (m)	Diam(m)	Temp(K)	Exit Vel (m/s)	SO2(g/s)	NOx (g/s)	PM10(g/s)
Poolbeg A	Natural Gas	320612	233723	207	4.1	378	22	0	86.0	0
Poolbeg B	Natural Gas	320693	233726	207	6.2	407	11.3	0	115.0	0
Poolbeg CCGT 1	Natural Gas	320839	233690	75	5.2	353	26.3	0	21.0	0
Poolbeg CCGT 2	Natural Gas	320862	233691	75	5.2	353	26.3	0	21.0	0
Poolbeg A	Fuel Oil (1%S)	320612	233723	207	4.1	402	22	307	115.0	10
Poolbeg B	Fuel Oil (1%S)	320693	233726	207	6.2	416	10.7	334	177.0	11
Poolbeg CCGT 1	Distillate Oil (0.1%S)	320839	233690	75	5.2	378	26.9	22	284.0	0
Poolbeg CCGT 2	Distillate Oil (0.1%S)	320862	233690	75	5.2	378	26.9	22	284.0	0

Note: PM10 emissions based on IPC Licence limits of 200 mg/Nm3 to 2007 and 50 mg/Nm3 post 2007 for Poolbeg A and B.
CCGT Distillate oil usage only permitted one hour every second month for each unit (ref IPC Licence No 577)

Building Configurations

	Height (m)	x1	y1	x2	y2	L(m)	W(m)	Angle	Building Midpoint (x)	Midpoint (y)
Boiler (Main)	55	320592	233620	320702	233720	110	100	90	320647	233670
Gas Turbine	25	320827	233630	320876	233707	49	77	90	320851	233669

Note: Other Building Structures < 30% of stack height
Angle is between north and building length (L), measured clockwise from north.

Maximum Emission Characteristics

2004

STACK		X	Y	Ht (m)	Diam(m)	Temp(K)	Exit Vel (m/s	SO2(g/s)	NOx (g/s)	PM10(g/s)
CCGT	Natural Gas	319142	234794	70	5.5	473	23.8	0	9.0	0
GT	Natural Gas	319216	234791	65	5.7	753	33.8	0	81.0	0

2010

STACK		X	Y	Ht (m)	Diam(m)	Temp(K)	Exit Vel (m/s	SO2(g/s)	NOx (g/s)	PM10(g/s)
CCGT	Natural Gas	319142	234794	70	5.5	473	23.8	0	9.0	0
GT	Natural Gas	319216	234791	65	5.7	753	33.8	0	15.0	0

Building Configurations

	Height (m)	x1	y1	x2	y2	L(m)	W(m)	Angle	Building Midpoint (x)	Midpoint (y)
Boiler (Main)	35	319135	234783	319150	234802	15	19	90	319142	234792

Note: Other Building Structures < 30% of stack height

Angle is between north and building length (x direction), measured clockwise from north.

Maximum Emission Characteristics

2004										
STACK		X	Y	Ht (m)	Diam(m)	Temp(K)	Exit Vel (m/s	SO2(g/s)	NOx (g/s)	PM10(g/s)
CCGT	Natural Gas	319604	233633	70	6.5	363	25.9	0	34.0	0

2010										
STACK		X	Y	Ht (m)	Diam(m)	Temp(K)	Exit Vel (m/s	SO2(g/s)	NOx (g/s)	PM10(g/s)
CCGT	Natural Gas	319604	233633	70	6.5	363	25.9	0	34.0	0

Building Configurations

									Building	
	Height (m)	x1	y1	x2	y2	L(m)	W(m)	Angle	Midpoint (x)	Midpoint (y)
Boiler (Main)	37.5	319594	233628	319619	233650	20	36	100	319607	233641
Turbine Hall	23.5	319596	233656	319641	233743	30	92	100	319618	233700

Note: Other Building Structures < 30% of stack height

Angle is between north and building length (L), measured clockwise from north.

Appendix H

Noise and Vibration

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TECHNICAL REPORT

BASELINE NOISE & VIBRATION MONITORING IN RELATION TO PROPOSED THERMAL TREATMENT PLANT, RINGSEND, CO. DUBLIN

FOR

RPS – MCOS
Consulting Engineers
Carnegie House
Library Road
Dun Laoghaire
Co. Dublin

Report prepared by: **Andy Irwin**, BSc (Hons), MIOA
Our reference: AI/03/1804NR01a
Date: 27 May 2004

E-mail: awn.info@awnconsulting.com Website: www.awnconsulting.com

EXECUTIVE SUMMARY

Baseline noise monitoring has been undertaken at a number of locations in the vicinity of the proposed waste to energy plant in Ringsend, Dublin 2. The surveys were conducted generally in accordance with ISO 1996: 1982: *Acoustics – Description and measurement of environmental noise*. The details of the baseline monitoring conducted are detailed in the various sections and appendices of this report.

In summary, the results of the traffic noise surveys indicate that traffic noise levels were very similar at the three measurement locations. The derived $L_{A10(18hour)}$ noise levels at all three locations were in the range 67 to 71dB. This is consistent with traffic noise levels expected at the measurement locations, i.e. in close proximity to busy local roads.

The range of average results for Phase 1 and 2 of the continuous noise monitoring are summarised in the table below. The table includes the two main descriptors of environmental noise: L_{Aeq} is representative of the average ambient noise level and L_{A90} is representative of the background noise level.

Location	Period	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)	
		L_{Aeq}	L_{A90}
A	Day	50 to 59	43 to 47
	Night	48 to 60	38 to 42
B	Day	62 to 65	53 to 58
	Night	59 to 60	45 to 49
C	Day	59 to 62	49 to 55
	Night	55 to 58	39 to 46

The noise levels measured at Locations A, B and C is typical of what is expected for the environments under consideration. Locations B and C are located adjacent to busy roads and this results in higher measured levels when compared to Location A that is not located adjacent to any busy roads.

ANDY IRWIN
Senior Acoustic Consultant

DAMIAN KELLY
Senior Acoustic Consultant

CONTENTS

1.0 INTRODUCTION

AWN Consulting Limited has been commissioned by RPS – MCOS to conduct noise and vibration measurements at selected locations in the vicinity of the proposed waste to energy plant at Ringsend, Dublin 2.

The main purpose of this body of work is in order to have a significant portion of baseline monitoring available for the preparation of the noise and vibration chapter to be included in the Environmental Impact Statement that will be prepared in relation to this project.

2.0 SURVEY PROCEDURE

Environmental noise surveys were conducted generally in accordance with ISO 1996: 1982: *Acoustics – Description and measurement of environmental noise*. Specific details are set out below.

2.1 Personnel and Instrumentation

Terry Donnelly, Brian Fitzpatrick, Andy Irwin, Mike Simms and Louis Smith[1] (AWN Consulting Ltd) conducted the noise level measurements during the survey periods.

The measurements were performed using Brüel & Kjær Type 2260 and Type 2238 Sound Level Analysers. Before and after the surveys, the measurement apparatus was check calibrated using a Brüel & Kjær Type 4231 Sound Level Calibrator.

The continuous measurements were performed using a Brüel & Kjær Type 3592 Environmental Kit, a Larson Davis 812 SLM and Larson Davis 824 System.

[1] In relation to identifying personnel involved in survey work the following abbreviations will be used. Terry Donnelly (TD), Brian Fitzpatrick (BF), Andy Irwin (AI), Mike Simms (MS) and Louis Smith (LS).

2.2 Sample Periods

During the noise surveys, the sound level meter was set to measure noise levels over consecutive 15-minute sample periods[2]. The survey personnel noted all primary noise sources contributing to noise build-up.

2.3 Measurement Parameters

The noise survey results are presented in terms of the following five parameters:

$L_{Aeq,T}$ is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period (T).

L_{Amax} is the instantaneous maximum sound level measured during the sample period.

L_{Amin} is the instantaneous minimum sound level measured during the sample period.

L_{A10} is the sound level that is exceeded for 10% of the sample period. It is typically used as a descriptor for traffic noise.

L_{A90} is the sound level that is exceeded for 90% of the sample period. It is typically used as a descriptor for background noise.

The "A" suffix denotes the fact that the sound levels have been "A-weighted" in order to account for the non-linear nature of human hearing. All sound levels in this report are expressed in terms of decibels (dB) relative to 2×10^{-5} Pa.

2 For the Phase 1 Continuous Monitoring at Location B, the sound level meter was set to measure noise levels over consecutive 1-hour sample periods.

3.0 NOISE MONITORING

Noise monitoring details and a review of the monitoring results are detailed in the following sections. Due to the volume of the monitored data this information is contained in detail in the relevant Appendices attached to this document.

3.1 Choice of Measurement Locations

Six measurement locations were chosen following discussions with RPS - MCOS. The locations were chosen in order to be representative of residential and/or commercial receptors whose operations may be sensitive to noise or vibration. The measurement positions are described below and their approximate locations are shown on Figure 1. Indicative photos showing several monitoring locations are given in Figure 2.

Location A is located on South Bank road, approximately three quarters of the way between the Sean Moore Road roundabout and the Roadstone plant. This is the approximate location of a proposed hotel development.

Location B is located within the grounds of the Irish Bottlers Plant, at the northern corner of the site near the pump house facing the roundabout on Sean Moore Road.

Location C is located at the front of the Rehab School, Beach Road, Sandymount. The equipment was located behind the 2-metre high wall between the School grounds and Beach Road. This location is representative of noise sensitive locations in the vicinity of the site.

Location i is located in the vicinity of the roundabout on Sean Moore Road. This location is representative of noise sensitive locations in the vicinity of the site.

Location ii is located at the corner of Bridge Street and Irishtown Bath Street, opposite the public library. This location is representative of noise sensitive locations in the vicinity of the site.

Location iii is located at the corner of Seafort Avenue and Beach Road. This location is representative of noise sensitive locations in the vicinity of the site.

3.2 Survey Periods

Baseline environmental noise surveys have been undertaken at monitoring Locations A, B and C. Surveys consisted of continuous monitoring over a 7-day period during Phase 1 of the monitoring programme (3 weeks of continuous monitoring in total). In conjunction with the continuous monitoring, short-term manned noise surveys were undertaken over a 3-hour period during the daytime, i.e. 07:00hrs to 19:00hrs, and a 3-hour period during the night-time, i.e. 23:00hrs to 07:00hrs (6 x three-hour surveys in total).

Baseline traffic noise surveys have been undertaken at monitoring Locations i, ii and iii in accordance with the "Shortened Measurement Procedure" as laid down in *Calculation of Road Traffic Noise* (Department of Transport Welsh Office). Two separate traffic noise surveys were undertaken during the summer months.

This scope of work was repeated for Phase 2 of the monitoring programme. Tables 1 and 2 detail the relevant information for the various noise survey periods undertaken for this monitoring assessment.

Location	Survey Type	Date & Time	Consultant
A	Continuous	12:00hrs 18 May to 12:00hrs 25 May 2004	–
	Short-term – Day	12:08hrs to 15:08hrs, 18 May 2004	BF
	Short-term - Night	00:00hrs to 03:00hrs, 19 May 2004	BF
B	Continuous	10:40hrs 31 July to 08:40hrs 6 Aug 2003	–
	Short-term – Day	10:43hrs to 13:44hrs, 31 July 2003	TD
	Short-term - Night	23:28hrs to 02:28hrs, 14 Oct 2003	LS
C	Continuous	12:55hrs 3 July to 23:40hrs 9 July 2003	–
	Short-term – Day	13:20hrs to 16:20hrs, 11 July 2003	TD
	Short-term - Night	23:13hrs to 01:58hrs, 10 July 2003	TD
i, ii, iii	Traffic noise	12:00hrs to 15:00hrs, 26 June 2003	AI
i, ii, iii	Traffic noise	13:35hrs to 16:35hrs, 30 July 2003	TD

Table 1 Details of Monitoring Periods Phase 1

Location	Survey Type	Date & Time	Consultant
A	Continuous	16:15hrs 15 Jan to 11:30hrs 22 Jan 2004	–
	Short-term – Day	10:19hrs to 13:19hrs, 20 January 2004	LS
	Short-term - Night	02:26hrs to 05:26hrs, 21 January 2004	LS
B	Continuous	15:15hrs 14 Jan to 18:35hrs 21 Jan 2004	–
	Short-term – Day	10:02hrs to 13:02hrs, 20 January 2004	BF
	Short-term - Night	02:15hrs to 05:17hrs, 21 January 2004	BF
C	Continuous	19:45hrs 3 Feb to 22:00hrs 10 Feb 2004	–
	Short-term – Day	10:05hrs to 13:05hrs, 20 January 2004	MS
	Short-term - Night	02:00hrs to 05:05hrs, 21 January 2004	MS
i, ii, iii	Traffic noise	11:00hrs to 13:40hrs, 10 December 2003	BF

Table 2 Details of Monitoring Periods Phase 2

3.3 Difficulties Encountered During Surveys

The following difficulties were encountered during the baseline noise surveys:

The Phase 1 continuous noise monitoring at Location A was initially undertaken in summer 2003 on vacant land to the east of the Irish Glass Bottlers site. Due to security issues, it was only possible to obtain 24-hours survey results during Phase 1. For the Phase 2 continuous noise monitoring, Location A was moved into the secure grounds of the Irish Glass Bottlers site and the full 7-day survey was undertaken. The Phase 1 continuous noise monitoring for Location A was subsequently repeated in summer 2004 at the same position as for Phase 2 over the full 7-day period and this is the set of results presented in this report.

The continuous noise monitoring at Location C was undertaken inside the grounds of the Rehab School. There was a 2 metre high wall between the survey position and Beach Road and this provided attenuation of noise levels at the monitoring location. For the short-term day and night noise surveys during Phase 1, it was not possible to get access to the Rehab School grounds therefore the measurements were undertaken at the front of the Rehab School boundary wall facing Beach Road. This results in higher noise levels for the short-term measured levels when compared to the continuous noise monitoring measured level. We note that the short-term noise surveys during Phase 2 were undertaken at the same position as the continuous noise monitoring location.

3.4 Results and Discussion

The following sections of the report review the results of noise monitoring periods at the various locations assessed.

3.4.1 Location A

Phase 1 attended noise survey data at this location are detailed in Table 3.

Time		Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
Day	12:08 – 12:23	54	76	42	50	44
	12:23 – 12:38	50	67	44	51	47
	12:38 – 12:53	55	87	45	54	47
	12:53 – 13:08	49	60	46	51	47
	13:08 – 13:23	50	63	46	52	47
	13:23 – 13:38	48	64	43	50	45
	13:38 – 13:53	47	59	42	49	44
	13:53 – 14:08	51	78	43	53	46
	14:08 – 14:23	49	60	44	51	46
	14:23 – 14:38	63	88	43	56	46
	14:38 – 14:53	50	79	42	49	45
	14:53 –15:08	55	82	43	54	45
Night	00:00 – 00:15	50	69	41	51	44
	00:15 – 00:30	46	63	41	48	43
	00:30 – 00:45	48	60	42	50	44
	00:45 – 01:00	47	65	41	49	43
	01:00 – 01:15	48	75	41	50	43
	01:15 – 01:30	48	64	41	51	44
	01:30 – 01:45	48	64	40	51	42
	01:45 – 02:00	48	75	40	50	42
	02:00 – 02:15	50	72	41	53	44
	02:15 – 02:30	49	65	39	52	42
	02:30 – 02:45	45	57	40	48	41
	02:45 – 03:00	48	75	38	51	41

Table 3 Phase 1 Short-term Measurements at Location A

During daytime periods, distant traffic noise from local roads aas the dominant noise source at this location. HGV movements on local roads, along with associated body slaps from trailers also contributed to noise build up at this location. Noise from nearby industry was also noted during the survey periods. Noise levels were in the range of 47 to 63dB L_{Aeq} and 44 to 47dB L_{A90}.

During the night-time period, traffic noise on local roads was again the significant source of noise. Noise levels were also influenced by distant plant noise from a waste-water treatment plant. Noise levels were in the range 45 to 50dB L_{Aeq} and 41 to 44dB L_{A90}.

Details of Phase 1 continuous monitoring conducted at Location A are detailed in Appendix A. A summary of the continuous monitoring for Phase 1 is given in Table 4.

Period	Statistic	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
Day	Average	50	-	-	58	43
	Max	62	85	51	86	51
	Min	39	41	34	41	35
Night	Average	48	-	-	58	38
	Max	61	67	51	83	48
	Min	30	31	28	39	26

Table 4 Phase 1 Continuous Noise Measurements Review at Location A

Phase 2 attended noise survey data at this location are detailed in Table 5.

Time		Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
Day	10:19 – 10:34	50	67	47	51	49
	10:34 – 10:49	52	68	48	53	49
	10:49 – 11:04	52	69	48	53	50
	11:04 – 11:19	60	81	48	57	50
	11:19 – 11:34	52	67	48	54	50
	11:34 – 11:49	55	75	47	57	50
	11:49 – 12:04	62	84	48	54	49
	12:04 – 12:19	51	62	47	52	49
	12:19 – 12:34	56	75	47	53	49
	12:34 – 12:49	74	97[3]	47	76	49
	12:49 – 13:04	50	66	46	52	48
	13:04 – 13:19	51	79	45	52	47
Night	02:26 – 02:41	37	52	34	38	36
	02:41 – 02:56	38	54	35	39	36
	02:56 – 03:11	38	55	35	39	37
	03:11 – 03:26	37	46	34	38	36
	03:26 – 03:41	38	53	35	38	36
	03:41 – 03:56	39	56	35	40	36
	03:56 – 04:11	39	47	35	41	36
	04:11 – 04:26	39	52	35	42	36

3 Dump tuck tipping bottles onto ground on Irish Glass site some 20m from the monitoring location.

	04:26 – 04:41	39	47	35	42	37
	04:41 – 04:56	40	56	36	42	37
	04:56 – 05:11	41	56	36	42	38
	05:11 – 05:26	42	59	37	44	39

Table 5 Phase 2 Short-term Measurements at Location A

Due to security issues the noise monitoring location was moved to the opposite side of the road from the original location on to lands owned by Irish Glass. As with the previous monitoring traffic noise was again the dominant noise source during survey periods. Noise levels during daytime periods were influenced also by activities within the Irish Glass site. Noise levels were in the range of 50 to 74dB L_{Aeq} and 47 to 50dB L_{A90}.

Night time noise levels were dominated by traffic noise. During lulls in traffic birdsong was noted at this location. Noise levels were in the range of 37 to 42dB L_{Aeq} and 36 to 39dB L_{A90}.

Details of Phase 2 continuous monitoring conducted at Location A are detailed in Appendix A. A summary of the continuous monitoring for Phase 2 is given in Table 6.

Period	Statistic	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
Day	Average	59	–	–	55	47
	Max	74	106	52	76	57
	Min	43	51	37	45	40
Night	Average	60	–	–	52	42
	Max	77	100	50	79	55
	Min	38	45	32	39	34

Table 6 Phase 2 Continuous Noise Measurements Review at Location A

3.4.2 Location B

The Phase 1 attended noise survey data at this location are given in Table 7.

Time		Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
Day	10:43 – 10:58	65	77	50	68	56
	10:59 – 11:14	65	81	49	67	56
	11:14 – 11:29	65	80	53	67	59
	11:29 – 11:44	65	76	50	68	58
	11:44 – 11:59	70	99	51	68	57
	11:59 – 12:14	64	80	49	67	56
	12:14 – 12:29	64	75	53	67	58
	12:29 – 12:44	65	80	50	68	57
	12:44 – 12:59	64	76	51	67	58
	12:59 – 13:14	64	76	54	66	58
	13:14 – 13:29	65	79	50	67	58
	13:29 – 13:44	65	76	52	67	58
Night	23:28 – 23:43	58	89	51	60	52
	23:43 – 23:58	56	75	49	59	51
	23:58 – 00:13	55	66	50	57	51
	00:13 – 00:28	56	67	46	59	52
	00:28 – 00:43	56	70	51	58	52
	00:43 – 00:58	55	66	51	57	53
	00:58 – 01:13	55	68	47	59	51
	01:13 – 01:28	53	66	46	57	49
	01:28 – 01:43	54	69	47	56	50
	01:43 – 01:58	52	70	46	57	47
	01:58 – 02:13	51	66	45	53	46
	02:13 – 02:28	52	67	44	56	46

Table 7 Phase 1 Short-term Measurements at Location B

Traffic noise on local roads was again the dominant noise source at this location during the daytime. During very occasional lulls in traffic noise source associated with Dublin Port were also audible at this location. Noise levels were in the range of 64 to 70dB L_{Aeq} and 56 to 59dB L_{A90}.

Night time noise levels were influenced by traffic noise and activities within the nearby port dominated noise levels. Noise levels were in the range of 51 to 58dB L_{Aeq} and 46 to 53dB L_{A90}.

Details of Phase 1 of the continuous monitoring conducted at Location B are detailed in Appendix B. A summary of the continuous monitoring for Phase 1 is given in Table 8.

Period	Statistic	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
Day	Average	62	–	–	64	53
	Max	67	–	–	70	61
	Min	50	–	–	54	38
Night	Average	60	–	–	59	45
	Max	67	–	–	69	62
	Min	47	–	–	45	36

Table 8 Phase 1 Continuous Noise Measurements Review at Location B

The Phase 2 attended noise survey data at this location are given in Table 9.

Time		Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
Day	10:02 – 10:17	66	81	54	69	60
	10:17 – 10:32	67	84	56	69	62
	10:32 – 10:47	67	83	57	69	61
	10:47 – 11:02	67	81	57	70	63
	11:02 – 11:17	68	89	59	70	63
	11:17 – 11:32	67	77	57	70	62
	11:32 – 11:47	68	81	55	71	61
	11:47 – 12:02	67	86	57	69	61
	12:02 – 12:17	67	81	56	69	62
	12:17 – 12:32	68	78	58	70	62
	12:32 – 12:47	67	80	57	69	62
	12:47 – 13:02	67	82	55	69	62
Night	02:15 – 02:30	53	75	41	51	44
	02:30 – 02:47	53	70	41	52	45
	02:47 – 03:02	51	67	41	52	44
	03:02 – 03:17	49	64	40	50	43
	03:17 – 03:32	53	72	42	53	44
	03:32 – 03:47	49	68	41	50	43
	03:47 – 04:02	51	69	40	52	43
	04:02 – 04:17	52	66	40	54	44
	04:17 – 04:32	53	71	40	54	43
	04:32 – 04:47	50	66	40	51	44
	04:47 – 05:02	54	68	42	58	45
	05:02 – 05:17	58	78	42	60	46

Table 9 Phase 2 Manned Measurements at Location B

Again traffic noise levels were the dominant sources of noise at this location during daytime survey periods. Industrial noise from the nearby port was also audible during occasional lulls in traffic movements on the local roads. Noise levels were in the range of 66 to 68dB L_{Aeq} and 60 to 63dB L_{A90}.

The night time survey at this location was conducted during periods when traffic movements on the local road network were at a minimum. Traffic noise was still the dominant source of ambient noise in the area. Again noise from the nearby port was noted during this survey period. Noise levels were in the range of 49 to 58dB L_{Aeq} and 43 to 46dB L_{A90}.

Details of Phase 2 of the continuous monitoring conducted at Location B are detailed in Appendix B. A summary of the continuous monitoring for Phase 2 is given in Table 10.

Period	Statistic	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
Day	Average	65	-	-	68	58
	Max	69	98	67	89	67
	Min	57	63	45	61	47
Night	Average	59	-	-	61	49
	Max	69	99	61	85	64
	Min	47	50	39	46	39

Table 10 Phase 2 Continuous Noise Measurements Review at Location B

3.4.3 Location C

The Phase 1 attended noise survey data at this location are detailed in Table 11.

Time		Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
Day	13:20 – 13:35	71	92	49	74	56
	13:35 – 13:50	70	83	49	74	55
	13:50 – 14:05	70	83	50	73	56
	14:05 – 14:20	70	83	47	74	53
	14:20 – 14:35	71	86	50	74	56
	14:35 – 14:50	70	83	48	74	54
	14:50 – 15:05	70	86	47	73	55
	15:05 – 15:20	70	84	49	73	56
	15:20 – 15:35	70	85	48	74	57
	15:35 – 15:50	70	86	48	74	55
	15:50 – 16:05	71	88	49	74	57
	16:05 – 16:20	72	96	48	72	56
Night	23:13 – 23:28	67	82	41	72	46
	23:28 – 23:43	66	82	38	72	44
	23:43 – 23:58	65	81	38	70	43
	23:58 – 00:13	66	82	38	71	43
	00:13 – 00:28	65	82	36	69	40
	00:28 – 00:43	65	85	35	69	39
	00:43 – 00:58	61	80	34	60	36
	00:58 – 01:13	61	81	33	56	35
	01:13 – 01:28	64	96	32	62	34
	01:28 – 01:43	61	81	32	57	35
	01:43 – 01:58	63	89	31	55	33

Table 11 Phase 1 Short-term Measurements at Location C

Daytime noise levels at this location were dominated by traffic movements along the Strand Road and occasional vehicle and pedestrian activity entering and leaving the school grounds near the monitoring location. Noise levels were in the range of 70 to 72dB L_{Aeq} and 54 to 57dB L_{A90}.

Night time noise levels at this location were dominated by road traffic. There were no other significant sources of ambient noise noted during this survey period. Noise levels were in the range of 61 to 67dB L_{Aeq} and 33 to 46dB L_{A90}.

Details of Phase 1 of the continuous monitoring conducted at Location C are detailed in Appendix C. A summary of the continuous monitoring for Phase 1 is given in Table 12.

Period	Statistic	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
Day	Average	59	–	–	61	49
	Max	66	–	–	65	55
	Min	54	–	–	57	39
Night	Average	55	–	–	57	39
	Max	61	–	–	63	55
	Min	42	–	–	42	29

Table 12 Phase 1 Continuous Noise Measurements Review at Location C

Details of continuous monitoring conducted at Location C are detailed in Appendix C. Peak noise levels monitored at this location are lower than those detailed for the manned survey periods due to screening from local walls.

Time		Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
Day	10:05 – 10:20	59	70	45	62	49
	10:20 – 10:35	60	78	47	63	52
	10:35 – 10:50	60	77	47	62	52
	10:50 – 11:05	59	68	45	63	49
	11:05 – 11:20	60	70	46	62	51
	11:20 – 11:35	62	83	47	63	51
	11:35 – 11:50	60	75	46	63	51
	11:50 – 12:05	60	73	48	63	51
	12:05 – 12:20	59	70	45	63	50
	12:20 – 12:35	60	72	46	62	52
	12:35 – 12:50	60	70	47	63	50
	12:50 – 13:05	60	77	45	63	52
Night	02:00 – 02:15	49	67	30	49	32
	02:15 – 02:30	47	64	30	46	31
	02:30 – 02:45	48	70	30	44	31
	02:45 – 03:00	48	66	31	47	33
	03:00 – 03:15	43	65	32	41	33
	03:15 – 03:30	47	70	30	43	32
	03:35 – 03:50	44	66	30	41	32
	03:50 – 04:05	48	65	30	50	32
	04:05 – 04:20	47	64	30	46	32
	04:20 – 04:35	50	71	30	49	33
	04:35 – 04:50	48	70	31	48	33
	04:50 – 05:05	51	67	32	56	34

Table 13 Phase 2 Manned Measurements at Location C

Daytime noise levels at this location were dominated by traffic movements along the Strand Road and occasional vehicle and pedestrian activity entering and leaving the school grounds near the monitoring location. Noise levels were in the range of 59 to 62dB L_{Aeq} and 49 to 52dB L_{A90}.

Night time noise levels at this location were dominated by road traffic. There were no other significant sources of ambient noise noted during this survey period. Noise levels were in the range of 43 to 51dB L_{Aeq} and 31 to 34dB L_{A90}.

Details of Phase 2 of the continuous monitoring conducted at Location C are detailed in Appendix C. A summary of the continuous monitoring for Phase 2 is given in Table 14.

Period	Statistic	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
Day	Average	62	-	-	64	55
	Max	68	93	55	66	59
	Min	59	68	45	63	50
Night	Average	58	-	-	60	46
	Max	64	89	52	67	59
	Min	43	64	32	42	34

Table 14 Phase 2 Continuous Noise Measurements Review at Location C

3.4.4 Location i

The results for Position i are summarised in Table 15 below.

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)					Derived dB $L_{A10(18hour)}$[4]
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}	
26/06/03	12:45 – 13:00	65	83	56	68	60	67
	13:45 – 14:00	65	78	56	68	59	
	14:45 – 15:00	64	80	53	67	57	
30/07/03	13:32 – 13:47	63	75	54	66	57	66
	14:56 – 15:11	63	77	52	66	57	
	16:45 – 17:00	68	92	44	70	54	
10/12/03	11:19 – 11:34	67	93	56	70	60	71
	12:40 – 12:55	70	87	52	73	58	
	13:39 – 13:54	71	91	50	74	61	

Table 15 Traffic Noise Surveys Results at Location i

Traffic noise dominated at this location during all survey periods. Derived $L_{A10(18hour)}$ levels were in the range of 67 to 71dB[5].

3.4.5 Location iii

The results for Position ii are summarised in Table 16 below.

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)					Derived dB $L_{A10(18hour)}$
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}	
26/06/03	12:25 – 13:40	69	85	49	72	56	70
	13:25 – 13:40	68	91	50	71	56	
	14:25 – 14:40	67	82	51	70	56	
30/07/03	13:56 – 14:11	66	85	47	69	54	67
	15:19 – 15:34	67	83	45	70	55	
	16:21 – 16:36	62	76	52	66	56	
10/12/03	11:59 – 12:14	69	81	48	72	58	71
	13:01 – 13:16	70	83	47	73	59	
	13:58 – 14:13	69	79	46	72	55	

Table 16 Traffic Noise Surveys Results at Location ii

Traffic noise dominated at this location during all survey periods. Derived $L_{A10(18hour)}$ levels were in the range of 67 to 71dB

4 The derived $L_{A10(18hour)}$ for the location is derived by subtracting 1dB from the arithmetic average of the three hourly sample values, i.e. $L_{A10(18hour)} = ((\sum L_{A10(1hour)}) \div 3) - 1$ dB.

5 Due to local obstructions monitoring was conducted at a nearer location to the road than on previous surveys.

3.4.6 Location iii

The results for Position iii are summarised in Table 17 below.

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)					Derived dB $L_{A10(18hour)}$
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}	
26/06/2003	13:05 – 13:20	66	78	43	70	52	69
	13:05 – 13:20	69	91	45	71	56	
	14:05 – 14:20	67	90	43	71	54	
30/07/2003	14:26 – 14:41	67	80	48	70	55	68
	15:40 – 15:55	66	79	43	69	52	
	15:55 – 16:10	66	87	42	69	51	
10/12/03	12:21 – 12:36	70	86	57	74	62	71
	13:20 – 13:35	70	86	58	73	63	
	14:18 – 14:33	68	92	55	71	60	

Table 17 Phase 1 Traffic Noise Surveys Results at Location iii

Traffic noise dominated at this location during all survey periods. Derived $L_{A10(18hour)}$ levels were in the range of 68 to 71dB.

Indicative traffic numbers that passed the monitoring locations during traffic surveys in Table 18.

Date	Location	Number of Vehicles	Humber of HGV	%HGV
26/06/2003	i	380	40	10
	Ii	200	15	13
	Iii	300	30	10
30/07/2003	i	415	60	7
	Ii	225	19	12
	Iii	315	35	9
10/12/03	i	395	45	9
	Ii	220	20	11
	Iii	305	30	10

Table 18 Approximate Traffic Movements

4.0 VIBRATION MONITORING REVIEW

Vibration monitoring surveys were carried out at Locations A, B, C, i, ii, and iii. Appendix D details all vibration monitoring data. The tables in this section of the report review measured levels at each location.

No vibration limits have been set as part of this overall project; however, the following table has been collated from general guidance taken from BRE Digest 353 and BS7385[6]:

	Frequency (Hz) of vibration		
Type of structure	Less than 10Hz	10 to 50Hz	50 to 100Hz (and above)
Particularly sensitive / listed building	3 mm/s	3 to 8 mm/s	8 to 10 mm/s
Dwellings	5 mm/s	5 to 15 mm/s	15 to 20 mm/s
Light & flexible industrial / commercial	10 mm/s	10 to 30 mm/s	30 to 40 mm/s
Heavy and stiff buildings	20 mm/s	20 to 40 mm/s	40 to 50 mm/s

Table 19 Peak Particle Velocities (ppv in mm/s) Below Which Transient Vibration Should Not Cause Cosmetic Building Damage

All the measured vibration data is presented in Appendices D. Analysis of the vibration data suggests that existing levels of vibration are not sufficient in magnitude to cause concern.

6 It should be noted that these vibration levels are stated in this report for information purposes only and may or may not be applied at further stages of this assessment as deemed appropriate.

FIGURE 1

SITE MAP SHOWING MONITORING LOCATIONS

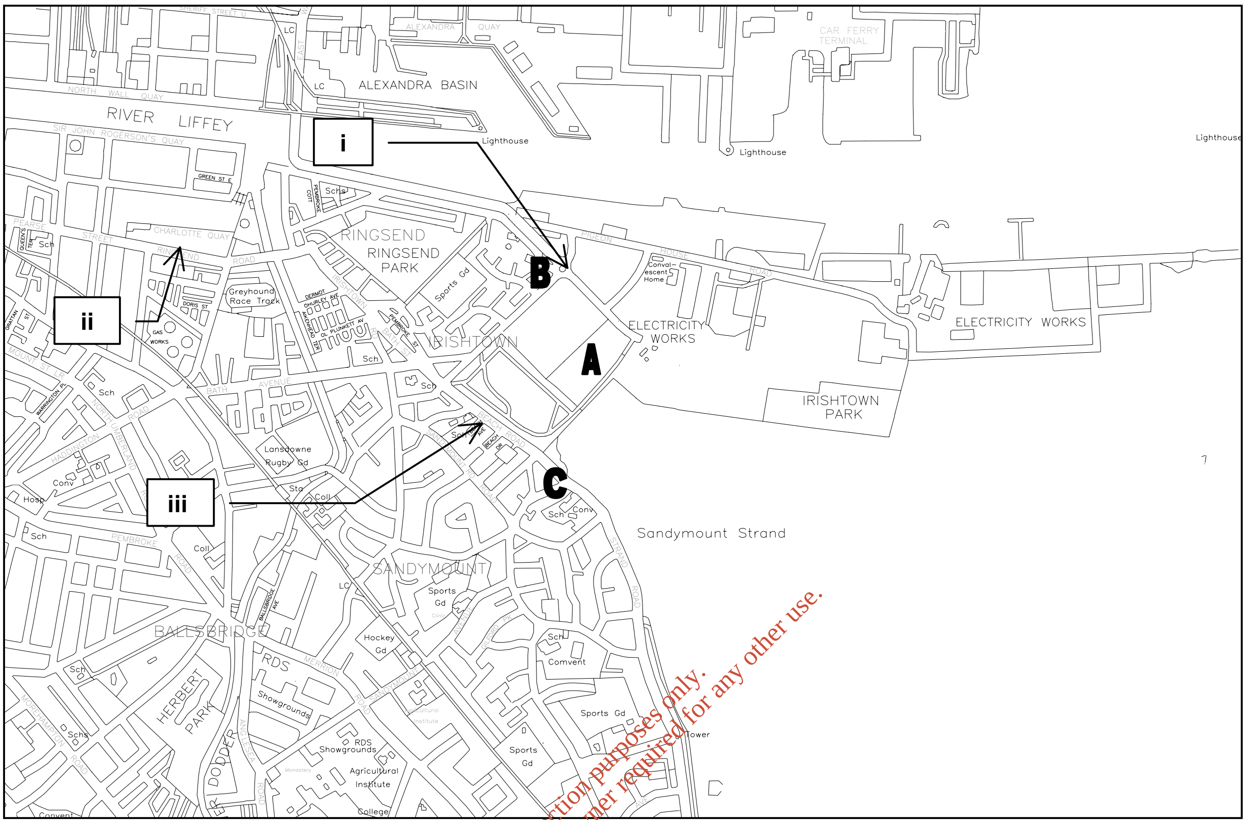


FIGURE 2

PHOTOS SHOWING MONITORING LOCATIONS

Pos A – 24-hour Monitoring Location (Irish Glass site in background)

Pos C – 24-hour Monitoring Location (2 photos)

Pos i – Short-term Monitoring Location

Pos ii – Short-term Monitoring Location

Pos iii – Short-term Monitoring Location

APPENDIX A
LOCATION A - CONTINUOUS MONITORING DATA

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
18 May 04	12:00	55	75	48	57	51
18 May 04	12:15	54	72	48	56	50
18 May 04	12:30	51	69	47	53	48
18 May 04	12:45	51	67	46	52	48
18 May 04	13:00	50	67	44	51	47
18 May 04	13:15	50	68	44	51	46
18 May 04	13:30	49	61	45	51	47
18 May 04	13:45	51	62	46	53	48
18 May 04	14:00	50	62	46	52	48
18 May 04	14:15	55	76	46	54	48
18 May 04	14:30	54	77	46	53	48
18 May 04	14:45	52	73	46	54	49
18 May 04	15:00	50	80	43	51	44
18 May 04	15:15	55	81	42	55	44
18 May 04	15:30	49	62	43	51	45
18 May 04	15:45	53	76	42	52	45
18 May 04	16:00	58	84	43	59	47
18 May 04	16:15	47	61	43	49	45
18 May 04	16:30	47	59	40	49	44
18 May 04	16:45	48	57	42	50	45
18 May 04	17:00	48	68	43	50	45
18 May 04	17:15	48	66	42	50	44
18 May 04	17:30	47	63	42	50	44
18 May 04	17:45	50	71	42	49	44
18 May 04	18:00	47	62	41	50	43
18 May 04	18:15	46	55	41	49	43
18 May 04	18:30	48	65	41	50	43
18 May 04	18:45	55	77	41	55	44
18 May 04	19:00	52	68	44	53	48
18 May 04	19:15	47	59	43	50	44
18 May 04	19:30	51	70	41	50	43
18 May 04	19:45	47	58	42	50	45
18 May 04	20:00	49	70	42	52	44
18 May 04	20:15	48	58	42	51	45
18 May 04	20:30	47	56	41	48	44
18 May 04	20:45	48	64	41	51	44
18 May 04	21:00	48	56	42	51	45
18 May 04	21:15	48	62	43	50	44
18 May 04	21:30	51	69	42	53	45
18 May 04	21:45	50	68	42	52	44
18 May 04	22:00	48	57	43	51	45
18 May 04	22:15	52	64	44	55	47
18 May 04	22:30	52	64	44	55	46
18 May 04	22:45	50	64	43	53	46
18 May 04	23:00	51	63	42	54	46
18 May 04	23:15	53	70	43	56	45
18 May 04	23:30	50	60	42	54	45
18 May 04	23:45	50	63	42	53	45
19 May 04	00:00	55	83	44	56	47

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
19 May 04	00:15	53	67	41	57	46
19 May 04	00:30	52	64	42	56	45
19 May 04	00:45	53	64	42	56	47
19 May 04	01:00	53	68	43	56	46
19 May 04	01:15	53	64	43	57	47
19 May 04	01:30	55	69	42	59	47
19 May 04	01:45	53	66	41	57	46
19 May 04	02:00	55	71	41	60	45
19 May 04	02:15	55	69	41	59	45
19 May 04	02:30	56	70	42	60	47
19 May 04	02:45	53	66	40	56	44
19 May 04	03:00	54	73	39	57	46
19 May 04	03:15	53	70	41	57	46
19 May 04	03:30	52	63	40	56	45
19 May 04	03:45	51	63	40	54	45
19 May 04	04:00	51	65	39	54	43
19 May 04	04:15	53	65	41	56	46
19 May 04	04:30	51	71	40	54	44
19 May 04	04:45	52	68	41	55	46
19 May 04	05:00	51	62	41	55	45
19 May 04	05:15	53	62	42	56	46
19 May 04	05:30	51	61	41	55	45
19 May 04	05:45	50	60	42	53	45
19 May 04	06:00	52	65	45	55	48
19 May 04	06:15	51	67	44	54	47
19 May 04	06:30	52	62	46	54	48
19 May 04	06:45	53	71	46	55	48
19 May 04	07:00	52	66	46	55	49
19 May 04	07:15	54	64	48	56	49
19 May 04	07:30	54	69	48	57	51
19 May 04	07:45	55	68	47	58	50
19 May 04	08:00	55	68	48	58	50
19 May 04	08:15	55	66	47	58	50
19 May 04	08:30	53	65	46	56	49
19 May 04	08:45	54	64	47	57	49
19 May 04	09:00	54	64	48	57	50
19 May 04	09:15	52	68	46	55	49
19 May 04	09:30	56	77	46	58	49
19 May 04	09:45	54	72	46	56	48
19 May 04	10:00	54	79	46	56	48
19 May 04	10:15	53	67	46	56	48
19 May 04	10:30	51	68	45	53	47
19 May 04	10:45	51	64	46	54	48
19 May 04	11:00	51	64	45	54	47
19 May 04	11:15	54	80	45	53	47
19 May 04	11:30	51	58	45	53	48
19 May 04	11:45	57	86	45	53	48
19 May 04	12:00	50	60	45	52	47
19 May 04	12:15	55	81	46	55	48
19 May 04	12:30	55	77	44	54	46
19 May 04	12:45	50	63	44	52	46
19 May 04	13:00	49	61	43	51	46

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
19 May 04	13:15	53	71	45	53	46
19 May 04	13:30	49	61	44	51	46
19 May 04	13:45	50	63	44	51	47
19 May 04	14:00	48	67	44	50	46
19 May 04	14:15	50	61	45	52	47
19 May 04	14:30	50	66	45	51	47
19 May 04	14:45	50	67	46	53	48
19 May 04	15:00	50	67	42	51	45
19 May 04	15:15	51	77	43	50	45
19 May 04	15:30	47	62	42	49	45
19 May 04	15:45	48	62	43	49	45
19 May 04	16:00	47	56	42	49	44
19 May 04	16:15	49	65	43	50	46
19 May 04	16:30	49	62	43	51	46
19 May 04	16:45	49	65	44	50	46
19 May 04	17:00	48	59	43	50	45
19 May 04	17:15	47	58	42	48	44
19 May 04	17:30	47	66	44	49	45
19 May 04	17:45	47	62	43	49	45
19 May 04	18:00	55	81	41	54	44
19 May 04	18:15	54	77	41	52	43
19 May 04	18:30	45	64	41	47	43
19 May 04	18:45	46	65	41	48	43
19 May 04	19:00	46	66	40	46	41
19 May 04	19:15	45	57	40	47	42
19 May 04	19:30	46	62	40	47	43
19 May 04	19:45	44	55	40	46	42
19 May 04	20:00	46	63	40	47	42
19 May 04	20:15	45	66	40	47	42
19 May 04	20:30	46	65	39	45	41
19 May 04	20:45	44	55	38	45	41
19 May 04	21:00	46	67	39	44	41
19 May 04	21:15	45	60	40	48	41
19 May 04	21:30	41	55	37	42	39
19 May 04	21:45	43	63	38	42	39
19 May 04	22:00	41	53	38	42	39
19 May 04	22:15	40	50	37	41	39
19 May 04	22:30	40	53	37	41	38
19 May 04	22:45	40	48	37	42	39
19 May 04	23:00	40	49	37	41	38
19 May 04	23:15	41	51	37	43	39
19 May 04	23:30	40	51	37	42	39
19 May 04	23:45	41	56	37	42	39
20 May 04	00:00	42	57	38	43	40
20 May 04	00:15	42	50	38	44	40
20 May 04	00:30	50	69	39	45	41
20 May 04	00:45	42	58	38	44	40
20 May 04	01:00	42	51	37	43	40
20 May 04	01:15	42	54	38	44	40
20 May 04	01:30	41	61	37	43	39
20 May 04	01:45	41	51	37	42	39
20 May 04	02:00	40	56	36	41	38

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
20 May 04	02:15	39	49	36	40	38
20 May 04	02:30	38	47	35	40	37
20 May 04	02:45	40	55	37	41	38
20 May 04	03:00	40	47	36	41	38
20 May 04	03:15	40	56	36	42	39
20 May 04	03:30	41	56	37	42	38
20 May 04	03:45	42	59	36	44	39
20 May 04	04:00	41	54	36	42	38
20 May 04	04:15	54	72	37	44	39
20 May 04	04:30	59	75	37	65	39
20 May 04	04:45	45	64	36	43	39
20 May 04	05:00	46	65	37	44	39
20 May 04	05:15	43	59	38	44	40
20 May 04	05:30	45	64	38	47	40
20 May 04	05:45	46	66	39	48	41
20 May 04	06:00	42	60	38	44	40
20 May 04	06:15	45	59	39	46	41
20 May 04	06:30	44	58	39	46	41
20 May 04	06:45	47	62	39	50	41
20 May 04	07:00	47	63	42	49	43
20 May 04	07:15	48	64	43	50	45
20 May 04	07:30	46	59	42	49	44
20 May 04	07:45	48	63	42	50	44
20 May 04	08:00	50	76	42	51	45
20 May 04	08:15	49	67	44	51	46
20 May 04	08:30	50	76	44	49	45
20 May 04	08:45	47	62	42	49	44
20 May 04	09:00	48	67	43	50	44
20 May 04	09:15	46	59	41	48	44
20 May 04	09:30	48	59	43	50	44
20 May 04	09:45	48	63	43	50	45
20 May 04	10:00	49	66	43	51	45
20 May 04	10:15	49	64	43	51	45
20 May 04	10:30	52	73	41	50	44
20 May 04	10:45	50	70	40	51	44
20 May 04	11:00	51	70	43	52	45
20 May 04	11:15	50	63	43	52	45
20 May 04	11:30	51	76	42	51	45
20 May 04	11:45	48	62	43	50	45
20 May 04	12:00	47	61	41	49	44
20 May 04	12:15	48	65	44	50	46
20 May 04	12:30	49	69	43	51	45
20 May 04	12:45	50	69	42	52	45
20 May 04	13:00	47	72	41	48	44
20 May 04	13:15	48	58	42	51	45
20 May 04	13:30	50	69	46	52	48
20 May 04	13:45	50	64	46	52	48
20 May 04	14:00	48	62	43	50	45
20 May 04	14:15	47	58	43	48	45
20 May 04	14:30	48	64	45	50	46
20 May 04	14:45	52	72	45	53	47
20 May 04	15:00	48	62	44	49	45

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
20 May 04	15:15	50	66	44	51	46
20 May 04	15:30	49	63	43	51	45
20 May 04	15:45	49	68	44	51	46
20 May 04	16:00	52	73	44	52	47
20 May 04	16:15	50	64	44	52	46
20 May 04	16:30	48	66	43	49	45
20 May 04	16:45	51	76	44	53	48
20 May 04	17:00	51	65	47	53	49
20 May 04	17:15	51	70	44	53	47
20 May 04	17:30	50	65	44	52	46
20 May 04	17:45	47	65	43	49	45
20 May 04	18:00	47	65	43	49	45
20 May 04	18:15	53	65	45	57	48
20 May 04	18:30	53	64	46	57	48
20 May 04	18:45	49	66	44	50	45
20 May 04	19:00	47	62	42	49	44
20 May 04	19:15	48	63	42	49	44
20 May 04	19:30	45	58	41	46	42
20 May 04	19:45	45	55	41	46	43
20 May 04	20:00	52	71	42	50	43
20 May 04	20:15	44	56	41	45	42
20 May 04	20:30	48	67	41	48	42
20 May 04	20:45	55	75	40	51	42
20 May 04	21:00	42	55	40	43	41
20 May 04	21:15	42	53	40	44	41
20 May 04	21:30	43	56	40	45	42
20 May 04	21:45	45	54	41	46	43
20 May 04	22:00	45	54	42	46	44
20 May 04	22:15	46	52	43	47	44
20 May 04	22:30	45	52	42	47	44
20 May 04	22:45	44	49	41	45	43
20 May 04	23:00	45	59	41	46	42
20 May 04	23:15	44	50	40	45	42
20 May 04	23:30	43	54	40	44	42
20 May 04	23:45	44	56	40	46	42
21 May 04	00:00	43	54	40	44	42
21 May 04	00:15	43	53	39	44	41
21 May 04	00:30	42	58	40	43	41
21 May 04	00:45	42	53	39	44	41
21 May 04	01:00	42	53	39	43	41
21 May 04	01:15	41	53	38	42	40
21 May 04	01:30	40	49	38	41	39
21 May 04	01:45	41	53	38	42	39
21 May 04	02:00	41	56	38	42	39
21 May 04	02:15	51	73	38	51	40
21 May 04	02:30	41	52	37	42	40
21 May 04	02:45	40	51	38	41	39
21 May 04	03:00	41	56	37	42	39
21 May 04	03:15	40	53	37	41	38
21 May 04	03:30	40	51	37	41	38
21 May 04	03:45	39	46	36	41	38
21 May 04	04:00	40	49	37	42	39

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
21 May 04	04:15	45	69	38	43	41
21 May 04	04:30	50	67	40	47	42
21 May 04	04:45	42	49	38	44	40
21 May 04	05:00	41	55	38	43	39
21 May 04	05:15	43	54	39	45	40
21 May 04	05:30	49	73	40	47	41
21 May 04	05:45	45	55	41	47	43
21 May 04	06:00	46	55	42	48	43
21 May 04	06:15	47	70	42	48	44
21 May 04	06:30	46	64	42	47	44
21 May 04	06:45	47	61	42	50	44
21 May 04	07:00	48	65	42	49	44
21 May 04	07:15	49	64	43	51	45
21 May 04	07:30	48	63	43	49	45
21 May 04	07:45	47	64	43	49	45
21 May 04	08:00	62	82	44	51	46
21 May 04	08:15	50	65	45	52	47
21 May 04	08:30	49	59	44	51	46
21 May 04	08:45	60	77	44	57	46
21 May 04	09:00	49	73	43	50	45
21 May 04	09:15	50	67	43	50	45
21 May 04	09:30	50	67	42	51	46
21 May 04	09:45	54	72	45	55	47
21 May 04	10:00	54	70	44	58	46
21 May 04	10:15	55	76	42	51	45
21 May 04	10:30	54	79	44	54	46
21 May 04	10:45	50	67	43	51	45
21 May 04	11:00	51	68	44	53	47
21 May 04	11:15	49	58	43	51	46
21 May 04	11:30	50	67	44	51	46
21 May 04	11:45	49	61	45	51	46
21 May 04	12:00	50	65	45	52	47
21 May 04	12:15	51	66	44	53	46
21 May 04	12:30	53	70	45	55	47
21 May 04	12:45	50	60	43	53	45
21 May 04	13:00	50	61	44	52	47
21 May 04	13:15	49	62	44	51	46
21 May 04	13:30	51	60	46	53	48
21 May 04	13:45	52	68	46	53	48
21 May 04	14:00	53	67	48	56	50
21 May 04	14:15	53	65	48	55	51
21 May 04	14:30	53	66	48	55	51
21 May 04	14:45	52	62	48	54	50
21 May 04	15:00	52	64	47	54	49
21 May 04	15:15	54	71	46	55	50
21 May 04	15:30	54	80	46	54	48
21 May 04	15:45	54	80	46	54	48
21 May 04	16:00	50	59	45	52	47
21 May 04	16:15	51	69	45	53	47
21 May 04	16:30	51	68	44	53	46
21 May 04	16:45	48	61	43	50	45
21 May 04	17:00	50	66	45	52	46

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
21 May 04	17:15	53	74	43	55	46
21 May 04	17:30	49	64	44	51	46
21 May 04	17:45	47	62	43	49	44
21 May 04	18:00	55	78	43	51	45
21 May 04	18:15	52	70	43	52	45
21 May 04	18:30	52	69	43	54	45
21 May 04	18:45	48	68	43	49	45
21 May 04	19:00	47	63	43	49	45
21 May 04	19:15	49	62	43	50	46
21 May 04	19:30	55	76	43	53	46
21 May 04	19:45	48	61	43	50	45
21 May 04	20:00	48	63	42	49	44
21 May 04	20:15	51	71	42	49	44
21 May 04	20:30	48	67	41	49	43
21 May 04	20:45	45	53	41	46	43
21 May 04	21:00	46	57	42	48	43
21 May 04	21:15	47	60	41	49	43
21 May 04	21:30	45	66	40	47	43
21 May 04	21:45	45	69	40	47	42
21 May 04	22:00	44	55	40	46	42
21 May 04	22:15	44	58	41	45	42
21 May 04	22:30	47	63	40	48	42
21 May 04	22:45	45	58	41	47	43
21 May 04	23:00	44	56	40	46	42
21 May 04	23:15	43	51	40	45	41
21 May 04	23:30	44	51	40	45	42
21 May 04	23:45	43	54	41	45	42
22 May 04	00:00	44	59	41	46	42
22 May 04	00:15	45	56	42	47	43
22 May 04	00:30	45	57	40	46	43
22 May 04	00:45	43	57	39	44	41
22 May 04	01:00	42	47	39	43	40
22 May 04	01:15	40	46	36	41	38
22 May 04	01:30	39	45	36	41	37
22 May 04	01:45	38	43	35	39	37
22 May 04	02:00	39	43	36	40	38
22 May 04	02:15	41	48	36	43	38
22 May 04	02:30	40	47	37	42	39
22 May 04	02:45	39	44	36	40	37
22 May 04	03:00	40	45	37	41	39
22 May 04	03:15	39	43	36	40	37
22 May 04	03:30	39	54	37	41	38
22 May 04	03:45	42	71	34	40	36
22 May 04	04:00	48	67	34	53	36
22 May 04	04:15	44	61	33	48	36
22 May 04	04:30	42	66	34	43	37
22 May 04	04:45	40	57	33	41	36
22 May 04	05:00	39	51	33	41	36
22 May 04	05:15	40	54	34	42	37
22 May 04	05:30	44	61	34	48	36
22 May 04	05:45	44	68	34	44	37
22 May 04	06:00	48	68	35	45	37

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
22 May 04	06:15	43	58	35	47	37
22 May 04	06:30	42	56	36	43	38
22 May 04	06:45	45	59	37	49	39
22 May 04	07:00	47	72	37	45	39
22 May 04	07:15	46	68	37	48	40
22 May 04	07:30	43	59	38	44	40
22 May 04	07:45	49	75	39	50	42
22 May 04	08:00	47	59	39	50	42
22 May 04	08:15	46	66	39	48	41
22 May 04	08:30	48	64	40	51	44
22 May 04	08:45	49	62	42	52	45
22 May 04	09:00	50	58	43	52	46
22 May 04	09:15	50	63	44	52	47
22 May 04	09:30	52	72	45	55	48
22 May 04	09:45	53	69	44	55	47
22 May 04	10:00	51	63	45	53	47
22 May 04	10:15	51	61	45	54	47
22 May 04	10:30	51	67	45	52	47
22 May 04	10:45	50	71	45	52	48
22 May 04	11:00	51	75	46	52	48
22 May 04	11:15	51	61	46	53	49
22 May 04	11:30	51	60	46	53	48
22 May 04	11:45	51	62	47	53	49
22 May 04	12:00	52	66	48	55	50
22 May 04	12:15	53	69	47	54	50
22 May 04	12:30	54	65	46	57	49
22 May 04	12:45	55	77	45	58	47
22 May 04	13:00	49	70	42	51	44
22 May 04	13:15	52	70	42	56	44
22 May 04	13:30	54	62	40	58	44
22 May 04	13:45	52	65	40	56	43
22 May 04	14:00	51	84	39	48	42
22 May 04	14:15	46	59	39	48	42
22 May 04	14:30	50	70	39	49	43
22 May 04	14:45	47	65	40	50	42
22 May 04	15:00	44	54	40	46	42
22 May 04	15:15	47	63	40	50	42
22 May 04	15:30	48	66	39	50	42
22 May 04	15:45	44	61	39	46	41
22 May 04	16:00	45	63	38	48	41
22 May 04	16:15	47	78	37	44	39
22 May 04	16:30	43	58	38	45	40
22 May 04	16:45	41	50	36	44	38
22 May 04	17:00	42	53	37	45	39
22 May 04	17:15	40	46	37	42	38
22 May 04	17:30	41	49	35	43	38
22 May 04	17:45	42	63	35	41	38
22 May 04	18:00	42	67	35	43	37
22 May 04	18:15	47	69	35	47	37
22 May 04	18:30	40	54	35	43	37
22 May 04	18:45	42	54	35	44	37
22 May 04	19:00	46	73	36	46	37

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
22 May 04	19:15	46	69	35	45	37
22 May 04	19:30	41	57	35	44	37
22 May 04	19:45	44	70	36	45	38
22 May 04	20:00	43	65	36	44	38
22 May 04	20:15	48	73	36	44	38
22 May 04	20:30	42	60	38	43	39
22 May 04	20:45	43	61	38	44	40
22 May 04	21:00	42	53	38	43	40
22 May 04	21:15	43	65	38	43	40
22 May 04	21:30	42	52	38	44	41
22 May 04	21:45	43	52	40	45	42
22 May 04	22:00	46	71	39	45	42
22 May 04	22:15	42	47	37	43	39
22 May 04	22:30	40	58	37	42	38
22 May 04	22:45	40	49	38	42	39
22 May 04	23:00	41	47	38	43	40
22 May 04	23:15	42	53	37	43	40
22 May 04	23:30	40	46	36	42	38
22 May 04	23:45	40	47	36	42	38
23 May 04	00:00	42	47	36	44	38
23 May 04	00:15	44	48	41	46	43
23 May 04	00:30	45	50	42	46	44
23 May 04	00:45	43	50	39	45	41
23 May 04	01:00	42	47	38	44	40
23 May 04	01:15	41	50	38	42	40
23 May 04	01:30	42	51	38	44	40
23 May 04	01:45	53	71	38	54	41
23 May 04	02:00	46	62	37	45	40
23 May 04	02:15	42	49	39	43	41
23 May 04	02:30	43	51	38	44	40
23 May 04	02:45	43	48	39	45	41
23 May 04	03:00	44	50	41	46	42
23 May 04	03:15	43	47	39	44	41
23 May 04	03:30	41	47	38	43	40
23 May 04	03:45	42	52	39	44	41
23 May 04	04:00	52	69	39	53	41
23 May 04	04:15	61	75	41	67	43
23 May 04	04:30	54	73	39	52	42
23 May 04	04:45	43	54	39	45	42
23 May 04	05:00	43	52	39	45	41
23 May 04	05:15	46	59	40	47	43
23 May 04	05:30	45	55	40	46	43
23 May 04	05:45	44	57	38	45	40
23 May 04	06:00	41	56	38	43	39
23 May 04	06:15	42	60	37	43	39
23 May 04	06:30	42	61	37	44	38
23 May 04	06:45	45	69	37	42	39
23 May 04	07:00	44	64	36	46	37
23 May 04	07:15	45	67	36	47	37
23 May 04	07:30	44	61	36	47	37
23 May 04	07:45	43	65	34	43	37
23 May 04	08:00	42	70	34	43	37

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
23 May 04	08:15	53	78	35	48	37
23 May 04	08:30	41	53	35	45	37
23 May 04	08:45	42	60	36	45	37
23 May 04	09:00	53	81	35	46	37
23 May 04	09:15	47	69	35	46	37
23 May 04	09:30	39	55	36	41	37
23 May 04	09:45	40	60	35	41	37
23 May 04	10:00	50	72	36	44	38
23 May 04	10:15	40	51	36	41	38
23 May 04	10:30	53	74	36	50	38
23 May 04	10:45	42	58	38	44	40
23 May 04	11:00	44	64	38	44	40
23 May 04	11:15	43	69	37	45	40
23 May 04	11:30	52	72	37	46	40
23 May 04	11:45	52	73	38	47	41
23 May 04	12:00	43	55	38	46	41
23 May 04	12:15	54	75	38	49	41
23 May 04	12:30	45	56	37	48	40
23 May 04	12:45	44	54	38	46	41
23 May 04	13:00	52	73	40	51	43
23 May 04	13:15	50	67	40	51	42
23 May 04	13:30	51	72	39	49	41
23 May 04	13:45	45	66	40	47	42
23 May 04	14:00	45	55	39	47	41
23 May 04	14:15	46	58	38	48	41
23 May 04	14:30	52	73	39	50	42
23 May 04	14:45	45	56	39	47	42
23 May 04	15:00	46	70	39	48	42
23 May 04	15:15	46	62	41	48	43
23 May 04	15:30	46	59	40	48	43
23 May 04	15:45	45	58	40	48	42
23 May 04	16:00	47	58	40	50	43
23 May 04	16:15	44	58	39	46	41
23 May 04	16:30	45	66	39	46	41
23 May 04	16:45	48	70	40	48	42
23 May 04	17:00	45	59	38	48	41
23 May 04	17:15	45	54	39	47	41
23 May 04	17:30	44	57	39	46	41
23 May 04	17:45	45	58	40	47	42
23 May 04	18:00	51	70	38	46	40
23 May 04	18:15	47	68	37	46	41
23 May 04	18:30	44	54	40	46	42
23 May 04	18:45	46	61	40	47	42
23 May 04	19:00	47	71	40	47	42
23 May 04	19:15	45	58	40	46	42
23 May 04	19:30	44	66	39	44	40
23 May 04	19:45	46	70	39	46	41
23 May 04	20:00	45	66	39	46	41
23 May 04	20:15	48	64	38	50	41
23 May 04	20:30	44	63	38	45	41
23 May 04	20:45	45	61	38	45	40
23 May 04	21:00	43	59	37	43	40

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
23 May 04	21:15	46	68	38	46	40
23 May 04	21:30	44	59	38	44	40
23 May 04	21:45	42	51	38	44	40
23 May 04	22:00	42	61	37	44	40
23 May 04	22:15	42	49	35	44	39
23 May 04	22:30	42	47	37	44	39
23 May 04	22:45	40	53	35	41	37
23 May 04	23:00	42	53	35	44	38
23 May 04	23:15	39	44	33	41	36
23 May 04	23:30	36	45	33	37	35
23 May 04	23:45	39	61	33	40	34
24 May 04	00:00	35	45	32	37	33
24 May 04	00:15	35	46	31	37	33
24 May 04	00:30	34	46	29	36	32
24 May 04	00:45	38	47	31	41	33
24 May 04	01:00	35	47	30	37	32
24 May 04	01:15	35	55	30	37	31
24 May 04	01:30	34	43	29	36	31
24 May 04	01:45	32	48	28	33	30
24 May 04	02:00	32	48	28	33	29
24 May 04	02:15	30	39	27	32	28
24 May 04	02:30	38	55	27	43	28
24 May 04	02:45	35	62	26	33	28
24 May 04	03:00	30	45	27	31	29
24 May 04	03:15	31	46	28	32	29
24 May 04	03:30	40	57	28	45	30
24 May 04	03:45	30	40	27	33	28
24 May 04	04:00	56	74	28	62	30
24 May 04	04:15	55	73	29	56	31
24 May 04	04:30	51	69	30	49	34
24 May 04	04:45	39	58	29	42	33
24 May 04	05:00	37	55	31	40	33
24 May 04	05:15	43	64	31	42	34
24 May 04	05:30	42	67	32	43	34
24 May 04	05:45	42	53	33	45	36
24 May 04	06:00	42	60	34	46	36
24 May 04	06:15	41	56	34	44	36
24 May 04	06:30	45	62	37	47	38
24 May 04	06:45	48	68	38	51	40
24 May 04	07:00	47	64	38	47	40
24 May 04	07:15	46	64	40	48	42
24 May 04	07:30	47	65	40	49	43
24 May 04	07:45	46	66	40	48	42
24 May 04	08:00	45	62	39	47	42
24 May 04	08:15	46	63	40	48	42
24 May 04	08:30	46	63	40	49	42
24 May 04	08:45	47	66	40	47	42
24 May 04	09:00	54	70	40	57	42
24 May 04	09:15	48	71	41	49	42
24 May 04	09:30	46	68	40	48	42
24 May 04	09:45	46	60	41	48	43
24 May 04	10:00	46	61	42	48	43

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
24 May 04	10:15	48	66	42	49	44
24 May 04	10:30	49	66	42	50	45
24 May 04	10:45	47	58	42	49	45
24 May 04	11:00	48	61	44	49	45
24 May 04	11:15	47	58	43	49	45
24 May 04	11:30	49	65	44	51	46
24 May 04	11:45	49	64	44	51	46
24 May 04	12:00	48	59	44	50	46
24 May 04	12:15	51	73	44	53	47
24 May 04	12:30	51	63	45	53	47
24 May 04	12:45	51	64	45	53	47
24 May 04	13:00	50	66	45	52	47
24 May 04	13:15	50	69	45	51	47
24 May 04	13:30	50	63	45	52	47
24 May 04	13:45	49	62	45	51	47
24 May 04	14:00	49	70	43	51	45
24 May 04	14:15	49	71	44	50	46
24 May 04	14:30	53	70	44	51	46
24 May 04	14:45	54	78	45	53	47
24 May 04	15:00	54	79	45	55	48
24 May 04	15:15	53	81	45	53	47
24 May 04	15:30	50	68	45	52	46
24 May 04	15:45	48	59	44	50	46
24 May 04	16:00	54	85	45	53	47
24 May 04	16:15	49	64	46	51	47
24 May 04	16:30	49	65	45	50	47
24 May 04	16:45	48	67	44	50	46
24 May 04	17:00	52	71	45	54	47
24 May 04	17:15	51	67	44	52	46
24 May 04	17:30	52	73	46	53	48
24 May 04	17:45	52	67	45	53	48
24 May 04	18:00	49	68	43	51	46
24 May 04	18:15	48	68	43	49	45
24 May 04	18:30	53	72	44	55	46
24 May 04	18:45	49	64	42	51	44
24 May 04	19:00	47	66	42	49	43
24 May 04	19:15	47	69	42	49	44
24 May 04	19:30	44	64	41	45	43
24 May 04	19:45	48	72	41	48	43
24 May 04	20:00	43	62	39	44	41
24 May 04	20:15	43	62	39	43	40
24 May 04	20:30	44	66	39	46	41
24 May 04	20:45	43	63	39	43	41
24 May 04	21:00	43	54	39	44	41
24 May 04	21:15	43	70	39	43	41
24 May 04	21:30	42	49	38	43	40
24 May 04	21:45	41	55	37	42	39
24 May 04	22:00	42	50	39	43	41
24 May 04	22:15	42	55	39	43	41
24 May 04	22:30	42	55	38	43	40
24 May 04	22:45	42	56	39	43	40
24 May 04	23:00	41	54	38	42	39

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
24 May 04	23:15	41	54	38	43	39
24 May 04	23:30	42	54	39	43	40
24 May 04	23:45	40	54	37	41	39
25 May 04	00:00	39	49	36	40	37
25 May 04	00:15	41	57	35	42	37
25 May 04	00:30	42	55	37	44	40
25 May 04	00:45	43	56	40	44	42
25 May 04	01:00	44	62	41	45	43
25 May 04	01:15	44	65	40	45	42
25 May 04	01:30	45	61	42	47	43
25 May 04	01:45	44	58	40	46	42
25 May 04	02:00	43	52	40	43	41
25 May 04	02:15	42	50	40	43	41
25 May 04	02:30	41	54	38	43	40
25 May 04	02:45	40	51	37	41	39
25 May 04	03:00	40	43	38	40	39
25 May 04	03:15	41	47	37	43	39
25 May 04	03:30	42	50	37	46	39
25 May 04	03:45	40	45	38	41	39
25 May 04	04:00	53	75	38	46	39
25 May 04	04:15	59	73	38	66	40
25 May 04	04:30	59	73	38	65	40
25 May 04	04:45	44	64	38	46	41
25 May 04	05:00	46	60	39	48	41
25 May 04	05:15	44	62	39	46	41
25 May 04	05:30	46	69	40	48	42
25 May 04	05:45	48	63	40	51	43
25 May 04	06:00	48	62	41	49	43
25 May 04	06:15	49	70	40	49	43
25 May 04	06:30	49	72	41	50	43
25 May 04	06:45	49	69	42	51	44
25 May 04	07:00	48	65	42	49	44
25 May 04	07:15	49	67	44	50	46
25 May 04	07:30	49	67	43	51	46
25 May 04	07:45	49	65	44	51	46
25 May 04	08:00	49	64	45	51	47
25 May 04	08:15	50	67	45	52	47
25 May 04	08:30	50	68	46	51	47
25 May 04	08:45	50	67	45	51	47
25 May 04	09:00	48	65	44	49	46
25 May 04	09:15	48	60	43	50	45
25 May 04	09:30	48	60	43	50	45
25 May 04	09:45	52	72	44	54	46
25 May 04	10:00	50	68	44	51	46
25 May 04	10:15	49	59	44	51	46
25 May 04	10:30	50	67	44	52	47
25 May 04	10:45	50	64	45	52	47
25 May 04	11:00	52	65	48	53	49
25 May 04	11:15	53	66	49	54	51
25 May 04	11:30	51	66	47	52	49
25 May 04	11:45	54	74	45	55	48

Table A1 Phase 1 Continuous Noise Monitoring Results Location A

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
15-Jan-04	16:15	50	63	46	51	48
15-Jan-04	16:30	50	56	46	51	48
15-Jan-04	16:45	50	59	47	52	49
15-Jan-04	17:00	50	69	46	51	48
15-Jan-04	17:15	50	63	47	51	48
15-Jan-04	17:30	49	53	46	51	48
15-Jan-04	17:45	51	65	47	52	49
15-Jan-04	18:00	58	80	46	60	49
15-Jan-04	18:15	53	77	47	52	49
15-Jan-04	18:30	52	74	47	52	48
15-Jan-04	18:45	51	67	47	52	48
15-Jan-04	19:00	51	70	46	52	48
15-Jan-04	19:15	60	83	47	53	48
15-Jan-04	19:30	54	85	46	53	48
15-Jan-04	19:45	53	78	46	53	48
15-Jan-04	20:00	51	71	46	52	48
15-Jan-04	20:15	52	70	46	52	48
15-Jan-04	20:30	53	76	46	54	48
15-Jan-04	20:45	52	73	46	53	48
15-Jan-04	21:00	54	79	46	55	49
15-Jan-04	21:15	54	81	47	55	50
15-Jan-04	21:30	54	66	50	56	51
15-Jan-04	21:45	55	66	50	57	52
15-Jan-04	22:00	56	73	50	58	51
15-Jan-04	22:15	59	76	50	62	52
15-Jan-04	22:30	63	86	49	66	53
15-Jan-04	22:45	57	73	47	60	50
15-Jan-04	23:00	53	73	44	56	46
15-Jan-04	23:15	54	71	43	58	45
15-Jan-04	23:30	51	72	42	54	44
15-Jan-04	23:45	51	74	43	53	45
16-Jan-04	00:00	53	69	43	56	46
16-Jan-04	00:15	56	74	44	60	48
16-Jan-04	00:30	55	74	43	59	47
16-Jan-04	00:45	54	76	44	55	46
16-Jan-04	01:00	53	72	42	56	45
16-Jan-04	01:15	65	90	43	63	45
16-Jan-04	01:30	77	100	46	79	55
16-Jan-04	01:45	71	92	41	75	50
16-Jan-04	02:00	74	92	43	78	53
16-Jan-04	02:15	68	90	39	71	46
16-Jan-04	02:30	68	89	38	71	44
16-Jan-04	02:45	70	89	40	73	48
16-Jan-04	03:00	64	85	39	68	43
16-Jan-04	03:15	67	93	39	70	45
16-Jan-04	03:30	65	87	39	69	44
16-Jan-04	03:45	69	91	39	72	45
16-Jan-04	04:00	66	85	39	70	44
16-Jan-04	04:15	65	88	38	68	43

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
16-Jan-04	04:30	64	89	39	67	43
16-Jan-04	04:45	64	85	40	66	43
16-Jan-04	05:00	61	86	39	61	42
16-Jan-04	05:15	61	85	40	64	43
16-Jan-04	05:30	61	90	41	63	44
16-Jan-04	05:45	60	85	40	63	44
16-Jan-04	06:00	61	85	42	64	45
16-Jan-04	06:15	59	80	43	61	45
16-Jan-04	06:30	61	85	45	63	47
16-Jan-04	06:45	63	85	46	65	48
16-Jan-04	07:00	62	82	47	66	49
16-Jan-04	07:15	61	82	48	64	50
16-Jan-04	07:30	58	83	48	61	49
16-Jan-04	07:45	56	80	47	58	48
16-Jan-04	08:00	59	86	47	58	48
16-Jan-04	08:15	58	81	47	60	49
16-Jan-04	08:30	59	80	48	61	49
16-Jan-04	08:45	60	81	48	64	50
16-Jan-04	09:00	58	78	48	62	50
16-Jan-04	09:15	60	85	48	63	49
16-Jan-04	09:30	60	79	48	63	49
16-Jan-04	09:45	58	78	48	61	49
16-Jan-04	10:00	60	84	46	62	48
16-Jan-04	10:15	58	79	46	60	48
16-Jan-04	10:30	56	80	46	58	48
16-Jan-04	10:45	56	73	46	59	47
16-Jan-04	11:00	57	83	45	59	47
16-Jan-04	11:15	57	76	45	59	47
16-Jan-04	11:30	53	73	46	55	48
16-Jan-04	11:45	54	75	46	57	48
16-Jan-04	12:00	55	75	44	54	47
16-Jan-04	12:15	53	74	44	53	46
16-Jan-04	12:30	54	70	44	56	47
16-Jan-04	12:45	56	78	44	58	46
16-Jan-04	13:00	53	73	43	56	46
16-Jan-04	13:15	56	79	44	59	46
16-Jan-04	13:30	59	80	45	61	46
16-Jan-04	13:45	56	78	44	58	46
16-Jan-04	14:00	57	82	44	59	45
16-Jan-04	14:15	55	77	44	57	46
16-Jan-04	14:30	54	74	44	56	46
16-Jan-04	14:45	57	78	44	59	46
16-Jan-04	15:00	60	80	45	62	47
16-Jan-04	15:15	56	76	45	58	47
16-Jan-04	15:30	59	86	44	59	46
16-Jan-04	15:45	55	76	44	56	46
16-Jan-04	16:00	56	77	45	57	46
16-Jan-04	16:15	57	81	44	58	46
16-Jan-04	16:30	52	73	45	53	46

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
16-Jan-04	16:45	49	70	44	51	45
16-Jan-04	17:00	48	63	45	50	46
16-Jan-04	17:15	48	69	44	49	45
16-Jan-04	17:30	49	63	44	51	45
16-Jan-04	17:45	49	69	45	49	45
16-Jan-04	18:00	48	64	44	48	45
16-Jan-04	18:15	50	72	45	50	46
16-Jan-04	18:30	48	61	44	49	46
16-Jan-04	18:45	49	62	45	50	46
16-Jan-04	19:00	47	60	44	48	46
16-Jan-04	19:15	50	69	44	52	46
16-Jan-04	19:30	52	73	44	53	45
16-Jan-04	19:45	51	75	44	52	45
16-Jan-04	20:00	53	82	44	54	45
16-Jan-04	20:15	54	78	44	55	46
16-Jan-04	20:30	52	73	44	54	45
16-Jan-04	20:45	52	72	43	53	46
16-Jan-04	21:00	54	78	44	56	45
16-Jan-04	21:15	51	69	43	54	45
16-Jan-04	21:30	53	75	43	55	44
16-Jan-04	21:45	54	79	43	56	44
16-Jan-04	22:00	49	71	42	50	44
16-Jan-04	22:15	48	69	42	49	43
16-Jan-04	22:30	48	70	41	48	43
16-Jan-04	22:45	48	70	41	50	43
16-Jan-04	23:00	49	77	41	48	42
16-Jan-04	23:15	46	65	41	48	42
16-Jan-04	23:30	47	67	40	48	42
16-Jan-04	23:45	48	69	41	49	42
17-Jan-04	00:00	47	64	40	48	41
17-Jan-04	00:15	47	65	40	50	42
17-Jan-04	00:30	46	66	39	48	41
17-Jan-04	00:45	45	68	39	46	40
17-Jan-04	01:00	46	67	38	48	40
17-Jan-04	01:15	44	65	39	44	40
17-Jan-04	01:30	45	62	38	47	40
17-Jan-04	01:45	42	59	38	44	39
17-Jan-04	02:00	42	62	38	42	39
17-Jan-04	02:15	42	61	37	42	39
17-Jan-04	02:30	41	63	38	42	39
17-Jan-04	02:45	41	58	37	42	39
17-Jan-04	03:00	41	59	37	42	38
17-Jan-04	03:15	40	62	37	42	38
17-Jan-04	03:30	43	59	38	45	40
17-Jan-04	03:45	42	61	38	43	40
17-Jan-04	04:00	43	53	39	45	41
17-Jan-04	04:15	43	54	39	44	41
17-Jan-04	04:30	42	48	39	44	41
17-Jan-04	04:45	42	49	38	44	40

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
17-Jan-04	05:00	40	54	37	41	39
17-Jan-04	05:15	41	59	37	42	39
17-Jan-04	05:30	42	57	38	44	39
17-Jan-04	05:45	42	58	38	44	40
17-Jan-04	06:00	44	60	38	43	40
17-Jan-04	06:15	43	54	39	45	41
17-Jan-04	06:30	44	64	39	45	41
17-Jan-04	06:45	48	62	40	51	41
17-Jan-04	07:00	43	61	40	44	41
17-Jan-04	07:15	45	58	41	47	42
17-Jan-04	07:30	47	64	42	48	43
17-Jan-04	07:45	47	68	44	48	45
17-Jan-04	08:00	49	61	45	51	47
17-Jan-04	08:15	48	57	44	49	46
17-Jan-04	08:30	47	65	44	48	46
17-Jan-04	08:45	50	63	46	52	47
17-Jan-04	09:00	48	64	45	49	46
17-Jan-04	09:15	48	64	45	49	47
17-Jan-04	09:30	49	60	46	50	47
17-Jan-04	09:45	49	62	45	50	47
17-Jan-04	10:00	48	64	44	49	46
17-Jan-04	10:15	47	59	43	48	45
17-Jan-04	10:30	48	62	43	51	45
17-Jan-04	10:45	48	64	44	50	45
17-Jan-04	11:00	50	72	45	50	46
17-Jan-04	11:15	53	72	46	55	48
17-Jan-04	11:30	53	71	46	55	47
17-Jan-04	11:45	51	70	46	53	47
17-Jan-04	12:00	53	72	46	54	48
17-Jan-04	12:15	55	79	47	56	49
17-Jan-04	12:30	56	86	46	59	48
17-Jan-04	12:45	49	64	44	51	45
17-Jan-04	13:00	47	64	43	48	44
17-Jan-04	13:15	51	71	44	52	45
17-Jan-04	13:30	52	71	43	52	45
17-Jan-04	13:45	50	69	44	53	45
17-Jan-04	14:00	53	72	43	56	45
17-Jan-04	14:15	56	79	43	58	45
17-Jan-04	14:30	52	73	44	55	45
17-Jan-04	14:45	52	69	42	55	44
17-Jan-04	15:00	50	71	42	53	44
17-Jan-04	15:15	52	71	41	55	45
17-Jan-04	15:30	50	70	43	51	44
17-Jan-04	15:45	50	73	42	51	44
17-Jan-04	16:00	52	72	44	55	46
17-Jan-04	16:15	48	68	43	50	45
17-Jan-04	16:30	54	78	44	56	45
17-Jan-04	16:45	55	73	45	58	46
17-Jan-04	17:00	55	75	45	58	46

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
17-Jan-04	17:15	52	73	45	54	46
17-Jan-04	17:30	48	64	44	50	45
17-Jan-04	17:45	47	62	44	48	45
17-Jan-04	18:00	46	55	43	47	45
17-Jan-04	18:15	46	57	43	47	44
17-Jan-04	18:30	47	55	44	48	45
17-Jan-04	18:45	46	59	43	47	44
17-Jan-04	19:00	47	63	44	48	46
17-Jan-04	19:15	49	62	46	50	47
17-Jan-04	19:30	48	63	44	50	46
17-Jan-04	19:45	47	62	42	48	43
17-Jan-04	20:00	48	67	43	49	45
17-Jan-04	20:15	45	56	43	46	44
17-Jan-04	20:30	45	60	42	47	43
17-Jan-04	20:45	46	59	43	47	44
17-Jan-04	21:00	48	62	41	47	43
17-Jan-04	21:15	47	80	41	45	43
17-Jan-04	21:30	45	53	42	47	43
17-Jan-04	21:45	44	53	41	46	42
17-Jan-04	22:00	43	53	40	45	42
17-Jan-04	22:15	46	56	40	49	42
17-Jan-04	22:30	53	60	43	55	49
17-Jan-04	22:45	49	60	40	53	42
17-Jan-04	23:00	44	52	40	46	42
17-Jan-04	23:15	46	61	40	49	42
17-Jan-04	23:30	44	62	40	46	42
17-Jan-04	23:45	42	49	39	43	41
18-Jan-04	00:00	42	59	39	43	40
18-Jan-04	00:15	42	63	38	43	40
18-Jan-04	00:30	42	60	39	43	40
18-Jan-04	00:45	41	56	38	42	40
18-Jan-04	01:00	42	57	39	43	40
18-Jan-04	01:15	41	55	38	42	39
18-Jan-04	01:30	43	63	38	43	39
18-Jan-04	01:45	41	59	38	42	39
18-Jan-04	02:00	42	56	38	43	39
18-Jan-04	02:15	42	60	38	43	40
18-Jan-04	02:30	42	60	38	43	39
18-Jan-04	02:45	41	55	37	42	39
18-Jan-04	03:00	41	55	37	42	39
18-Jan-04	03:15	40	57	37	42	39
18-Jan-04	03:30	40	50	38	41	39
18-Jan-04	03:45	41	49	38	42	39
18-Jan-04	04:00	40	46	37	41	39
18-Jan-04	04:15	40	51	37	41	38
18-Jan-04	04:30	41	53	38	42	39
18-Jan-04	04:45	41	46	38	42	39
18-Jan-04	05:00	40	52	38	41	39
18-Jan-04	05:15	41	51	38	42	39

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
18-Jan-04	05:30	41	50	38	42	40
18-Jan-04	05:45	41	48	39	42	40
18-Jan-04	06:00	42	47	40	43	41
18-Jan-04	06:15	40	45	38	42	39
18-Jan-04	06:30	42	49	38	43	40
18-Jan-04	06:45	41	50	38	43	40
18-Jan-04	07:00	44	58	39	43	41
18-Jan-04	07:15	43	55	39	46	40
18-Jan-04	07:30	44	56	40	46	41
18-Jan-04	07:45	45	53	41	46	42
18-Jan-04	08:00	44	52	40	46	42
18-Jan-04	08:15	44	53	40	45	42
18-Jan-04	08:30	44	57	40	46	42
18-Jan-04	08:45	49	73	41	46	43
18-Jan-04	09:00	48	68	41	47	43
18-Jan-04	09:15	45	57	41	46	43
18-Jan-04	09:30	46	63	42	47	44
18-Jan-04	09:45	46	68	43	47	44
18-Jan-04	10:00	45	57	43	47	44
18-Jan-04	10:15	46	56	43	47	44
18-Jan-04	10:30	46	57	43	47	44
18-Jan-04	10:45	46	60	42	47	44
18-Jan-04	11:00	46	62	42	47	44
18-Jan-04	11:15	46	69	42	47	44
18-Jan-04	11:30	55	78	41	47	43
18-Jan-04	11:45	46	66	42	47	43
18-Jan-04	12:00	46	59	43	48	45
18-Jan-04	12:15	47	62	44	48	45
18-Jan-04	12:30	48	71	42	48	44
18-Jan-04	12:45	46	63	42	47	44
18-Jan-04	13:00	49	73	43	49	44
18-Jan-04	13:15	54	76	42	56	45
18-Jan-04	13:30	53	76	42	54	45
18-Jan-04	13:45	51	76	43	53	45
18-Jan-04	14:00	49	69	43	50	45
18-Jan-04	14:15	50	70	43	51	45
18-Jan-04	14:30	51	71	43	53	45
18-Jan-04	14:45	51	72	44	53	46
18-Jan-04	15:00	50	71	44	51	46
18-Jan-04	15:15	50	69	44	52	46
18-Jan-04	15:30	49	64	44	50	46
18-Jan-04	15:45	48	64	44	49	45
18-Jan-04	16:00	49	72	43	49	45
18-Jan-04	16:15	51	72	44	52	46
18-Jan-04	16:30	50	75	43	49	45
18-Jan-04	16:45	48	64	43	50	45
18-Jan-04	17:00	49	70	43	51	45
18-Jan-04	17:15	51	74	43	52	45
18-Jan-04	17:30	51	70	43	53	45

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
18-Jan-04	17:45	53	73	43	55	45
18-Jan-04	18:00	55	78	43	57	46
18-Jan-04	18:15	57	88	44	58	47
18-Jan-04	18:30	56	80	44	59	46
18-Jan-04	18:45	53	74	44	55	46
18-Jan-04	19:00	57	88	43	57	46
18-Jan-04	19:15	56	76	43	58	45
18-Jan-04	19:30	56	80	43	56	46
18-Jan-04	19:45	55	78	44	57	46
18-Jan-04	20:00	56	77	44	59	46
18-Jan-04	20:15	55	77	45	57	46
18-Jan-04	20:30	58	81	45	59	47
18-Jan-04	20:45	62	84	44	63	47
18-Jan-04	21:00	61	87	45	63	48
18-Jan-04	21:15	61	86	43	63	46
18-Jan-04	21:30	60	85	43	62	46
18-Jan-04	21:45	60	85	43	62	46
18-Jan-04	22:00	59	81	43	61	46
18-Jan-04	22:15	56	76	42	59	44
18-Jan-04	22:30	61	81	42	63	45
18-Jan-04	22:45	60	85	42	63	45
18-Jan-04	23:00	62	82	42	65	45
18-Jan-04	23:15	63	84	44	65	47
18-Jan-04	23:30	61	83	44	65	47
18-Jan-04	23:45	65	86	42	68	47
19-Jan-04	00:00	63	82	42	66	46
19-Jan-04	00:15	65	95	43	68	47
19-Jan-04	00:30	63	86	41	66	46
19-Jan-04	00:45	63	86	41	65	45
19-Jan-04	01:00	64	87	41	67	47
19-Jan-04	01:15	67	96	42	68	46
19-Jan-04	01:30	65	90	41	67	45
19-Jan-04	01:45	66	87	41	68	45
19-Jan-04	02:00	64	88	40	66	44
19-Jan-04	02:15	65	92	40	66	43
19-Jan-04	02:30	60	82	39	63	42
19-Jan-04	02:45	61	84	40	63	43
19-Jan-04	03:00	62	86	39	64	43
19-Jan-04	03:15	64	88	40	66	45
19-Jan-04	03:30	65	89	40	67	45
19-Jan-04	03:45	61	83	39	63	42
19-Jan-04	04:00	63	86	39	64	43
19-Jan-04	04:15	62	83	41	64	45
19-Jan-04	04:30	64	88	42	66	46
19-Jan-04	04:45	67	98	43	67	45
19-Jan-04	05:00	66	89	42	67	47
19-Jan-04	05:15	70	92	43	73	48
19-Jan-04	05:30	68	89	43	70	49
19-Jan-04	05:45	68	93	44	69	47

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
19-Jan-04	06:00	69	92	44	72	48
19-Jan-04	06:15	66	86	44	69	48
19-Jan-04	06:30	68	91	46	70	49
19-Jan-04	06:45	66	91	46	68	50
19-Jan-04	07:00	70	95	48	72	51
19-Jan-04	07:15	68	89	49	71	51
19-Jan-04	07:30	69	95	49	71	51
19-Jan-04	07:45	63	85	47	66	50
19-Jan-04	08:00	64	88	48	67	50
19-Jan-04	08:15	64	87	48	66	50
19-Jan-04	08:30	66	89	49	69	51
19-Jan-04	08:45	69	89	49	71	51
19-Jan-04	09:00	67	90	49	70	51
19-Jan-04	09:15	67	87	49	70	51
19-Jan-04	09:30	69	92	49	71	52
19-Jan-04	09:45	67	91	49	70	51
19-Jan-04	10:00	63	83	48	66	50
19-Jan-04	10:15	65	92	48	66	50
19-Jan-04	10:30	65	94	48	67	50
19-Jan-04	10:45	65	95	48	64	49
19-Jan-04	11:00	66	91	48	67	50
19-Jan-04	11:15	71	106	47	68	50
19-Jan-04	11:30	62	83	47	65	49
19-Jan-04	11:45	63	90	47	64	50
19-Jan-04	12:00	65	84	48	68	50
19-Jan-04	12:15	63	85	48	65	50
19-Jan-04	12:30	64	85	48	67	50
19-Jan-04	12:45	62	81	47	65	50
19-Jan-04	13:00	64	88	48	66	50
19-Jan-04	13:15	67	93	48	68	50
19-Jan-04	13:30	69	92	47	72	52
19-Jan-04	13:45	70	93	52	73	54
19-Jan-04	14:00	72	95	51	74	54
19-Jan-04	14:15	70	90	51	72	57
19-Jan-04	14:30	66	89	48	69	53
19-Jan-04	14:45	66	88	49	69	52
19-Jan-04	15:00	71	106	44	72	49
19-Jan-04	15:15	60	84	43	63	46
19-Jan-04	15:30	66	96	43	65	46
19-Jan-04	15:45	60	87	44	59	46
19-Jan-04	16:00	62	87	42	61	45
19-Jan-04	16:15	61	84	43	61	45
19-Jan-04	16:30	57	83	43	57	44
19-Jan-04	16:45	57	84	43	57	44
19-Jan-04	17:00	61	88	43	60	45
19-Jan-04	17:15	65	94	43	64	45
19-Jan-04	17:30	58	83	41	57	44
19-Jan-04	17:45	59	84	41	58	44
19-Jan-04	18:00	65	90	42	65	44

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
19-Jan-04	18:15	59	84	42	58	44
19-Jan-04	18:30	62	87	42	62	44
19-Jan-04	18:45	59	81	42	59	44
19-Jan-04	19:00	58	82	41	58	43
19-Jan-04	19:15	59	88	42	58	44
19-Jan-04	19:30	61	87	42	61	44
19-Jan-04	19:45	58	88	41	57	43
19-Jan-04	20:00	60	86	41	58	42
19-Jan-04	20:15	58	81	39	59	43
19-Jan-04	20:30	55	80	39	54	41
19-Jan-04	20:45	55	81	39	56	41
19-Jan-04	21:00	53	79	39	52	41
19-Jan-04	21:15	53	77	39	52	41
19-Jan-04	21:30	52	78	37	50	40
19-Jan-04	21:45	55	81	38	54	40
19-Jan-04	22:00	57	83	38	52	39
19-Jan-04	22:15	48	73	37	49	39
19-Jan-04	22:30	51	77	37	52	39
19-Jan-04	22:45	51	78	37	50	39
19-Jan-04	23:00	56	79	36	56	39
19-Jan-04	23:15	53	81	36	53	39
19-Jan-04	23:30	56	80	36	54	38
19-Jan-04	23:45	52	75	36	52	38
20-Jan-04	00:00	50	74	35	48	37
20-Jan-04	00:15	54	78	35	52	37
20-Jan-04	00:30	55	81	35	51	37
20-Jan-04	00:45	43	68	34	42	35
20-Jan-04	01:00	47	71	33	46	35
20-Jan-04	01:15	52	82	33	48	35
20-Jan-04	01:30	47	72	32	46	35
20-Jan-04	01:45	52	82	32	50	35
20-Jan-04	02:00	47	69	33	47	35
20-Jan-04	02:15	54	79	32	54	35
20-Jan-04	02:30	51	76	32	51	34
20-Jan-04	02:45	52	75	33	52	35
20-Jan-04	03:00	52	77	33	52	35
20-Jan-04	03:15	51	73	33	52	35
20-Jan-04	03:30	52	76	33	50	35
20-Jan-04	03:45	48	76	34	48	35
20-Jan-04	04:00	50	75	32	50	34
20-Jan-04	04:15	54	83	33	50	35
20-Jan-04	04:30	52	77	34	49	36
20-Jan-04	04:45	55	81	35	50	37
20-Jan-04	05:00	49	72	36	48	38
20-Jan-04	05:15	50	73	36	49	38
20-Jan-04	05:30	49	78	36	49	39
20-Jan-04	05:45	52	78	37	48	40
20-Jan-04	06:00	48	72	37	49	40
20-Jan-04	06:15	51	75	38	50	41

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
20-Jan-04	06:30	54	83	39	50	42
20-Jan-04	06:45	51	75	41	51	43
20-Jan-04	07:00	56	81	41	55	43
20-Jan-04	07:15	53	77	42	53	44
20-Jan-04	07:30	53	79	42	53	44
20-Jan-04	07:45	51	77	42	51	44
20-Jan-04	08:00	51	76	42	49	44
20-Jan-04	08:15	48	69	42	49	43
20-Jan-04	08:30	52	83	41	51	43
20-Jan-04	08:45	54	78	42	54	44
20-Jan-04	09:00	53	82	42	51	44
20-Jan-04	09:15	54	78	43	53	44
20-Jan-04	09:30	52	72	43	52	46
20-Jan-04	09:45	54	80	44	54	46
20-Jan-04	10:00	61	80	48	59	50
20-Jan-04	10:15	51	60	49	53	50
20-Jan-04	10:16	51	78	47	52	49
20-Jan-04	10:30	52	69	48	53	50
20-Jan-04	10:45	53	78	48	54	50
20-Jan-04	11:00	61	81	49	58	50
20-Jan-04	11:15	55	72	49	57	51
20-Jan-04	11:30	55	74	49	57	51
20-Jan-04	11:45	54	71	48	56	50
20-Jan-04	12:00	61	83	47	54	50
20-Jan-04	12:15	51	68	47	53	49
20-Jan-04	12:30	74	97	48	76	50
20-Jan-04	12:45	60	80	47	64	49
20-Jan-04	13:00	55	78	47	54	48
20-Jan-04	13:15	55	78	46	54	48
20-Jan-04	13:30	50	65	47	51	48
20-Jan-04	13:45	49	60	47	51	48
20-Jan-04	14:00	51	65	47	52	48
20-Jan-04	14:15	59	83	47	57	48
20-Jan-04	14:30	66	84	46	70	48
20-Jan-04	14:45	56	71	46	60	49
20-Jan-04	15:00	57	75	47	60	49
20-Jan-04	15:15	58	76	46	58	49
20-Jan-04	15:30	51	67	47	53	48
20-Jan-04	15:45	52	77	46	51	47
20-Jan-04	16:00	49	62	46	50	47
20-Jan-04	16:15	49	62	45	51	47
20-Jan-04	16:30	48	60	45	50	46
20-Jan-04	16:45	49	63	45	50	47
20-Jan-04	17:00	48	56	45	49	46
20-Jan-04	17:15	47	58	44	48	46
20-Jan-04	17:30	47	55	44	48	45
20-Jan-04	17:45	47	55	44	48	45
20-Jan-04	18:00	47	59	43	48	45
20-Jan-04	18:15	47	54	44	48	45

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
20-Jan-04	18:30	46	55	44	48	45
20-Jan-04	18:45	46	55	43	47	44
20-Jan-04	19:00	46	63	43	47	44
20-Jan-04	19:15	46	57	43	47	44
20-Jan-04	19:30	45	54	43	46	44
20-Jan-04	19:45	45	57	43	46	44
20-Jan-04	20:00	45	51	42	46	44
20-Jan-04	20:15	46	56	42	47	44
20-Jan-04	20:30	46	59	42	47	44
20-Jan-04	20:45	46	57	42	47	43
20-Jan-04	21:00	45	54	42	46	43
20-Jan-04	21:15	45	69	42	47	43
20-Jan-04	21:30	45	61	41	46	43
20-Jan-04	21:45	43	52	40	45	42
20-Jan-04	22:00	43	50	40	44	42
20-Jan-04	22:15	44	62	40	45	42
20-Jan-04	22:30	43	59	40	44	41
20-Jan-04	22:45	43	70	40	43	41
20-Jan-04	23:00	42	55	40	44	41
20-Jan-04	23:15	44	68	40	43	41
20-Jan-04	23:30	42	50	39	44	41
20-Jan-04	23:45	42	48	38	43	40
21-Jan-04	00:00	40	55	37	41	39
21-Jan-04	00:15	40	51	36	41	38
21-Jan-04	00:30	40	47	37	41	38
21-Jan-04	00:45	40	48	37	41	38
21-Jan-04	01:00	40	56	37	41	38
21-Jan-04	01:15	39	48	36	40	37
21-Jan-04	01:30	39	53	36	40	37
21-Jan-04	01:45	39	46	36	40	37
21-Jan-04	02:00	38	47	35	40	37
21-Jan-04	02:15	40	66	35	40	36
21-Jan-04	02:30	38	52	35	39	36
21-Jan-04	02:45	39	57	36	41	37
21-Jan-04	03:00	39	54	35	40	37
21-Jan-04	03:15	38	46	36	40	37
21-Jan-04	03:30	39	54	35	40	37
21-Jan-04	03:45	39	56	36	41	37
21-Jan-04	04:00	40	48	36	42	37
21-Jan-04	04:15	40	59	35	43	37
21-Jan-04	04:30	40	48	36	42	37
21-Jan-04	04:45	41	53	36	43	38
21-Jan-04	05:00	42	55	38	44	39
21-Jan-04	05:15	44	60	38	45	41
21-Jan-04	05:30	45	69	39	45	41
21-Jan-04	05:45	44	59	39	46	42
21-Jan-04	06:00	44	53	40	46	42
21-Jan-04	06:15	45	54	41	47	43
21-Jan-04	06:30	46	58	42	48	44

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
21-Jan-04	06:45	48	64	42	49	45
21-Jan-04	07:00	49	61	45	50	46
21-Jan-04	07:15	48	58	45	49	46
21-Jan-04	07:30	48	61	45	49	46
21-Jan-04	07:45	48	58	45	49	46
21-Jan-04	08:00	50	64	45	50	47
21-Jan-04	08:15	53	70	45	56	47
21-Jan-04	08:30	56	79	46	52	48
21-Jan-04	08:45	49	65	46	50	47
21-Jan-04	09:00	60	81	46	57	48
21-Jan-04	09:15	63	83	47	59	49
21-Jan-04	09:30	64	81	47	67	50
21-Jan-04	09:45	62	81	46	57	48
21-Jan-04	10:00	55	73	45	54	48
21-Jan-04	10:15	51	65	48	53	49
21-Jan-04	10:30	51	70	46	53	48
21-Jan-04	10:45	50	60	45	52	48
21-Jan-04	11:00	51	68	47	52	48
21-Jan-04	11:15	51	64	47	53	49
21-Jan-04	11:30	53	73	46	51	47
21-Jan-04	11:45	56	77	46	53	47
21-Jan-04	12:00	53	69	45	53	48
21-Jan-04	12:15	53	70	46	54	49
21-Jan-04	12:30	53	71	47	54	49
21-Jan-04	12:45	58	76	46	59	48
21-Jan-04	13:00	54	79	45	54	47
21-Jan-04	13:15	50	67	44	51	47
21-Jan-04	13:30	52	70	44	52	47
21-Jan-04	13:45	51	68	45	53	47
21-Jan-04	14:00	50	63	45	52	48
21-Jan-04	14:15	50	58	46	51	47
21-Jan-04	14:30	53	74	46	53	47
21-Jan-04	14:45	56	79	45	56	47
21-Jan-04	15:00	53	71	46	53	48
21-Jan-04	15:15	51	63	46	53	48
21-Jan-04	15:30	60	80	45	56	49
21-Jan-04	15:45	62	82	46	55	49
21-Jan-04	16:00	52	71	46	53	48
21-Jan-04	16:15	52	66	47	54	48
21-Jan-04	16:30	51	68	46	53	48
21-Jan-04	16:45	52	65	46	53	48
21-Jan-04	17:00	52	70	46	53	48
21-Jan-04	17:15	50	64	45	52	47
21-Jan-04	17:30	49	71	44	50	46
21-Jan-04	17:45	49	61	45	51	47
21-Jan-04	18:00	48	53	45	50	47
21-Jan-04	18:15	49	62	44	50	47
21-Jan-04	18:30	49	63	44	50	46
21-Jan-04	18:45	50	61	45	53	47

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
21-Jan-04	19:00	50	63	45	51	47
21-Jan-04	19:15	49	64	45	50	47
21-Jan-04	19:30	49	56	44	50	47
21-Jan-04	19:45	48	60	45	50	46
21-Jan-04	20:00	51	66	44	54	46
21-Jan-04	20:15	47	61	43	49	45
21-Jan-04	20:30	49	65	43	50	46
21-Jan-04	20:45	47	54	42	49	45
21-Jan-04	21:00	53	74	43	52	45
21-Jan-04	21:15	48	62	42	50	45
21-Jan-04	21:30	49	65	43	50	45
21-Jan-04	21:45	47	54	42	48	45
21-Jan-04	22:00	46	54	42	48	44
21-Jan-04	22:15	50	62	44	53	46
21-Jan-04	22:30	46	52	42	48	43
21-Jan-04	22:45	48	62	42	51	44
21-Jan-04	23:00	46	55	41	48	43
21-Jan-04	23:15	45	51	40	47	42
21-Jan-04	23:30	46	52	42	47	44
21-Jan-04	23:45	45	58	40	47	42
22-Jan-04	00:00	43	54	39	46	41
22-Jan-04	00:15	46	57	40	49	42
22-Jan-04	00:30	47	61	41	49	44
22-Jan-04	00:45	49	61	42	52	44
22-Jan-04	01:00	45	57	39	48	41
22-Jan-04	01:15	43	54	38	45	40
22-Jan-04	01:30	42	52	37	45	39
22-Jan-04	01:45	40	47	36	42	38
22-Jan-04	02:00	41	50	37	44	38
22-Jan-04	02:15	40	50	36	42	38
22-Jan-04	02:30	42	52	37	45	39
22-Jan-04	02:45	41	49	37	44	39
22-Jan-04	03:00	41	49	37	43	38
22-Jan-04	03:15	41	51	37	44	38
22-Jan-04	03:30	42	52	37	45	39
22-Jan-04	03:45	41	52	37	44	38
22-Jan-04	04:00	41	54	37	44	38
22-Jan-04	04:15	43	56	37	47	38
22-Jan-04	04:30	42	53	37	45	39
22-Jan-04	04:45	43	58	38	45	40
22-Jan-04	05:00	44	53	38	46	41
22-Jan-04	05:15	46	55	38	49	42
22-Jan-04	05:30	48	58	42	50	45
22-Jan-04	05:45	47	58	43	48	44
22-Jan-04	06:00	47	54	43	49	44
22-Jan-04	06:15	48	58	44	50	46
22-Jan-04	06:30	50	64	45	52	47
22-Jan-04	06:45	51	64	45	53	47
22-Jan-04	07:00	51	74	45	51	48

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
22-Jan-04	07:15	51	75	47	52	48
22-Jan-04	07:30	51	68	46	54	47
22-Jan-04	07:45	53	67	47	56	48
22-Jan-04	08:00	53	66	48	56	50
22-Jan-04	08:15	61	81	49	57	51
22-Jan-04	08:30	55	66	50	57	53
22-Jan-04	08:45	54	64	50	56	52
22-Jan-04	09:00	54	67	50	56	52
22-Jan-04	09:15	61	81	50	61	52
22-Jan-04	09:30	53	64	48	55	50
22-Jan-04	09:45	52	68	46	53	48
22-Jan-04	10:00	53	68	46	55	48
22-Jan-04	10:15	51	62	46	52	48
22-Jan-04	10:30	54	78	47	54	49
22-Jan-04	10:45	66	90	49	68	51
22-Jan-04	11:00	59	76	47	60	49
22-Jan-04	11:15	74	98	49	72	51
22-Jan-04	11:30	57	77	49	57	50

Table A2 Phase 2 Continuous Noise Monitoring Results Location A

APPENDIX B
LOCATION B - CONTINUOUS MONITORING DATA

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)		
		L_{Aeq}	L_{A10}	L_{A90}
31 Jul 03	10:40	65	67	57
31 Jul 03	11:40	67	67	58
31 Jul 03	12:40	64	67	58
31 Jul 03	13:40	64	67	58
31 Jul 03	14:40	64	67	58
31 Jul 03	15:40	64	66	58
31 Jul 03	16:40	63	65	57
31 Jul 03	17:40	63	66	58
31 Jul 03	18:40	62	65	56
31 Jul 03	19:40	61	64	53
31 Jul 03	20:40	60	64	49
31 Jul 03	21:40	58	62	46
31 Jul 03	22:40	58	62	45
31 Jul 03	23:40	56	59	41
01 Aug 03	00:40	51	54	38
01 Aug 03	01:40	47	49	37
01 Aug 03	02:40	51	52	37
01 Aug 03	03:40	52	54	37
01 Aug 03	04:40	56	61	38
01 Aug 03	05:40	60	64	44
01 Aug 03	06:40	64	67	55
01 Aug 03	07:40	65	68	60
01 Aug 03	08:40	67	69	60
01 Aug 03	09:40	66	70	59
01 Aug 03	10:40	66	68	59
01 Aug 03	11:40	65	68	59
01 Aug 03	12:40	65	68	60
01 Aug 03	13:40	65	67	57
01 Aug 03	14:40	64	67	58
01 Aug 03	15:40	64	66	58
01 Aug 03	16:40	63	65	58
01 Aug 03	17:40	62	65	56
01 Aug 03	18:40	61	64	53
01 Aug 03	19:40	60	64	50
01 Aug 03	20:40	59	63	49
01 Aug 03	21:40	57	61	45
01 Aug 03	22:40	56	60	45
01 Aug 03	23:40	54	59	45
02 Aug 03	00:40	53	57	44
02 Aug 03	01:40	51	55	39
02 Aug 03	02:40	51	53	37
02 Aug 03	03:40	51	54	37
02 Aug 03	04:40	54	59	38
02 Aug 03	05:40	57	61	41
02 Aug 03	06:40	59	63	44
02 Aug 03	07:40	61	64	50
02 Aug 03	08:40	61	64	51
02 Aug 03	09:40	61	64	51
02 Aug 03	10:40	61	64	51

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)		
		L_{Aeq}	L_{A10}	L_{A90}
02 Aug 03	11:40	61	64	52
02 Aug 03	12:40	60	63	52
02 Aug 03	13:40	64	63	50
02 Aug 03	14:40	59	63	50
02 Aug 03	15:40	59	62	49
02 Aug 03	16:40	60	63	50
02 Aug 03	17:40	60	63	51
02 Aug 03	18:40	60	63	50
02 Aug 03	19:40	59	63	49
02 Aug 03	20:40	61	62	45
02 Aug 03	21:40	57	61	44
02 Aug 03	22:40	56	60	42
02 Aug 03	23:40	54	59	40
03 Aug 03	00:40	54	58	39
03 Aug 03	01:40	52	57	38
03 Aug 03	02:40	51	56	37
03 Aug 03	03:40	50	52	38
03 Aug 03	04:40	53	57	40
03 Aug 03	05:40	54	59	42
03 Aug 03	06:40	56	61	43
03 Aug 03	07:40	58	61	43
03 Aug 03	08:40	59	61	41
03 Aug 03	09:40	58	62	44
03 Aug 03	10:40	58	62	46
03 Aug 03	11:40	58	62	50
03 Aug 03	12:40	59	62	50
03 Aug 03	13:40	60	63	51
03 Aug 03	14:40	58	61	49
03 Aug 03	15:40	58	61	48
03 Aug 03	16:40	59	62	52
03 Aug 03	17:40	62	63	52
03 Aug 03	18:40	61	63	49
03 Aug 03	19:40	59	63	48
03 Aug 03	20:40	59	62	46
03 Aug 03	21:40	57	61	44
03 Aug 03	22:40	56	60	43
03 Aug 03	23:40	54	58	41
04 Aug 03	00:40	51	55	40
04 Aug 03	01:40	50	53	40
04 Aug 03	02:40	51	53	40
04 Aug 03	03:40	49	51	39
04 Aug 03	04:40	53	57	41
04 Aug 03	05:40	56	60	42
04 Aug 03	06:40	57	61	44
04 Aug 03	07:40	59	62	50
04 Aug 03	08:40	58	62	50
04 Aug 03	09:40	58	62	51
04 Aug 03	10:40	60	63	53
04 Aug 03	11:40	59	63	53
04 Aug 03	12:40	60	63	53
04 Aug 03	13:40	60	62	52
04 Aug 03	14:40	59	62	50

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)		
		L_{Aeq}	L_{A10}	L_{A90}
04 Aug 03	15:40	59	62	49
04 Aug 03	16:40	59	63	50
04 Aug 03	17:40	62	64	54
04 Aug 03	18:40	60	63	50
04 Aug 03	19:40	59	63	48
04 Aug 03	20:40	59	63	47
04 Aug 03	21:40	58	62	46
04 Aug 03	22:40	57	61	43
04 Aug 03	23:40	53	58	41
05 Aug 03	00:40	52	56	41
05 Aug 03	01:40	56	48	42
05 Aug 03	02:40	49	45	38
05 Aug 03	03:40	51	49	40
05 Aug 03	04:40	56	60	40
05 Aug 03	05:40	61	65	49
05 Aug 03	06:40	65	68	56
05 Aug 03	07:40	66	69	61
05 Aug 03	08:40	66	69	60
05 Aug 03	09:40	66	69	58
05 Aug 03	10:40	65	68	58
05 Aug 03	11:40	67	70	59
05 Aug 03	12:40	65	68	58
05 Aug 03	13:40	65	68	59
05 Aug 03	14:40	66	68	60
05 Aug 03	15:40	66	68	61
05 Aug 03	16:40	64	67	59
05 Aug 03	17:40	63	66	57
05 Aug 03	18:40	62	65	56
05 Aug 03	19:40	61	64	54
05 Aug 03	20:40	60	63	52
05 Aug 03	21:40	59	62	50
05 Aug 03	22:40	57	61	46
05 Aug 03	23:40	54	59	43
06 Aug 03	00:40	52	56	41
06 Aug 03	01:40	49	50	41
06 Aug 03	02:40	52	51	44
06 Aug 03	03:40	51	51	43
06 Aug 03	04:40	57	61	44
06 Aug 03	05:40	61	64	47
06 Aug 03	06:40	65	68	57
06 Aug 03	07:40	67	69	61
06 Aug 03	08:40	66	68	60

Table B1 Phase 1 Continuous Noise Monitoring Results Location B

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}
14 Jan 04	15:15	66	78	56	69	61
14 Jan 04	15:30	66	76	57	69	61
14 Jan 04	15:45	66	77	58	68	62
14 Jan 04	16:00	67	82	58	69	62
14 Jan 04	16:15	66	77	58	68	62
14 Jan 04	16:30	65	82	56	67	60
14 Jan 04	16:45	66	82	56	68	59
14 Jan 04	17:00	65	79	56	68	59
14 Jan 04	17:15	65	77	54	67	59
14 Jan 04	17:30	65	74	55	67	60
14 Jan 04	17:45	65	81	54	68	60
14 Jan 04	18:00	64	74	55	67	59
14 Jan 04	18:15	65	74	53	67	60
14 Jan 04	18:30	65	75	53	68	60
14 Jan 04	18:45	64	80	53	67	59
14 Jan 04	19:00	65	77	52	67	59
14 Jan 04	19:15	64	74	52	67	58
14 Jan 04	19:30	63	72	50	66	55
14 Jan 04	19:45	63	86	52	66	56
14 Jan 04	20:00	62	70	50	65	54
14 Jan 04	20:15	62	72	49	65	53
14 Jan 04	20:30	62	72	49	65	53
14 Jan 04	20:45	62	74	50	65	54
14 Jan 04	21:00	61	70	50	65	54
14 Jan 04	21:15	61	77	49	65	54
14 Jan 04	21:30	61	72	48	65	51
14 Jan 04	21:45	60	71	47	64	52
14 Jan 04	22:00	60	72	47	64	51
14 Jan 04	22:15	60	70	47	64	51
14 Jan 04	22:30	59	70	44	63	48
14 Jan 04	22:45	59	73	44	63	48
14 Jan 04	23:00	58	80	46	62	49
14 Jan 04	23:15	59	74	44	63	48
14 Jan 04	23:30	58	69	45	62	48
14 Jan 04	23:45	57	69	44	61	47
15 Jan 04	00:00	55	69	44	60	46
15 Jan 04	00:15	55	71	43	59	45
15 Jan 04	00:30	54	71	43	58	45
15 Jan 04	00:45	54	73	43	57	45
15 Jan 04	01:00	51	65	42	54	44
15 Jan 04	01:15	52	73	42	54	44
15 Jan 04	01:30	52	68	43	53	45
15 Jan 04	01:45	50	70	43	51	45
15 Jan 04	02:00	51	66	44	53	46
15 Jan 04	02:15	48	63	42	49	44
15 Jan 04	02:30	50	68	42	53	44
15 Jan 04	02:45	49	65	41	50	43
15 Jan 04	03:00	47	63	39	47	41

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}
15 Jan 04	03:15	47	67	40	46	42
15 Jan 04	03:30	48	67	39	48	41
15 Jan 04	03:45	59	85	40	55	41
15 Jan 04	04:00	52	72	40	53	42
15 Jan 04	04:15	52	72	42	53	45
15 Jan 04	04:30	52	72	41	52	45
15 Jan 04	04:45	51	66	42	55	44
15 Jan 04	05:00	55	68	43	59	45
15 Jan 04	05:15	58	76	43	63	47
15 Jan 04	05:30	59	78	42	62	46
15 Jan 04	05:45	59	75	42	63	45
15 Jan 04	06:00	60	74	43	64	46
15 Jan 04	06:15	61	77	44	64	49
15 Jan 04	06:30	63	75	44	66	52
15 Jan 04	06:45	64	78	46	67	55
15 Jan 04	07:00	65	78	52	68	58
15 Jan 04	07:15	69	91	50	70	60
15 Jan 04	07:30	66	78	54	69	61
15 Jan 04	07:45	66	76	56	68	62
15 Jan 04	08:00	66	77	56	68	62
15 Jan 04	08:15	66	76	57	69	62
15 Jan 04	08:30	64	78	55	67	60
15 Jan 04	08:45	66	78	54	68	61
15 Jan 04	09:00	66	78	56	69	61
15 Jan 04	09:15	66	79	56	68	61
15 Jan 04	09:30	66	83	55	69	61
15 Jan 04	09:45	66	78	57	69	62
15 Jan 04	10:00	67	79	54	69	62
15 Jan 04	10:15	67	79	56	70	63
15 Jan 04	10:30	68	77	60	70	64
15 Jan 04	10:45	67	80	58	69	62
15 Jan 04	11:00	68	85	58	70	62
15 Jan 04	11:15	67	78	54	69	62
15 Jan 04	11:30	66	76	56	69	60
15 Jan 04	11:45	67	76	57	69	62
15 Jan 04	12:00	66	79	56	69	61
15 Jan 04	12:15	66	76	55	68	61
15 Jan 04	12:30	66	77	55	69	61
15 Jan 04	12:45	65	79	56	68	61
15 Jan 04	13:00	67	90	54	69	59
15 Jan 04	13:15	65	78	53	68	59
15 Jan 04	13:30	66	78	53	68	60
15 Jan 04	13:45	65	76	54	68	60
15 Jan 04	14:00	66	83	54	68	60
15 Jan 04	14:15	65	80	54	68	59
15 Jan 04	14:30	65	75	54	68	59
15 Jan 04	14:45	66	78	54	68	61
15 Jan 04	15:00	66	77	52	68	59
15 Jan 04	15:15	66	78	53	69	60

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}
15 Jan 04	15:30	65	76	53	68	61
15 Jan 04	15:45	65	83	54	68	60
15 Jan 04	16:00	68	90	54	69	60
15 Jan 04	16:15	66	77	56	68	62
15 Jan 04	16:30	65	74	57	68	61
15 Jan 04	16:45	66	81	58	68	62
15 Jan 04	17:00	65	74	55	67	61
15 Jan 04	17:15	65	74	51	67	59
15 Jan 04	17:30	65	76	56	67	60
15 Jan 04	17:45	65	75	55	67	61
15 Jan 04	18:00	65	74	54	67	60
15 Jan 04	18:15	65	76	55	68	60
15 Jan 04	18:30	65	80	53	68	58
15 Jan 04	18:45	64	73	53	66	58
15 Jan 04	19:00	64	70	53	67	59
15 Jan 04	19:15	64	81	51	67	57
15 Jan 04	19:30	63	73	51	66	57
15 Jan 04	19:45	63	76	50	66	55
15 Jan 04	20:00	62	73	50	65	55
15 Jan 04	20:15	62	75	48	65	54
15 Jan 04	20:30	62	80	49	65	56
15 Jan 04	20:45	62	76	51	66	55
15 Jan 04	21:00	62	78	50	65	54
15 Jan 04	21:15	62	79	48	65	55
15 Jan 04	21:30	62	74	53	65	57
15 Jan 04	21:45	62	72	51	66	55
15 Jan 04	22:00	63	81	53	66	57
15 Jan 04	22:15	62	78	51	65	56
15 Jan 04	22:30	64	81	53	67	58
15 Jan 04	22:45	60	76	51	64	54
15 Jan 04	23:00	60	78	49	64	53
15 Jan 04	23:15	60	75	49	64	52
15 Jan 04	23:30	60	75	48	63	52
15 Jan 04	23:45	59	73	46	63	51
16 Jan 04	00:00	65	99	50	63	53
16 Jan 04	00:15	61	80	52	64	54
16 Jan 04	00:30	59	72	51	62	54
16 Jan 04	00:45	59	76	51	63	54
16 Jan 04	01:00	58	73	51	62	53
16 Jan 04	01:15	57	72	50	60	53
16 Jan 04	01:30	57	71	49	59	52
16 Jan 04	01:45	57	70	49	60	53
16 Jan 04	02:00	55	67	48	57	51
16 Jan 04	02:15	54	67	48	57	50
16 Jan 04	02:30	52	66	45	54	48
16 Jan 04	02:45	56	73	47	59	50
16 Jan 04	03:00	54	70	46	57	48
16 Jan 04	03:15	52	67	46	55	49
16 Jan 04	03:30	51	64	46	52	48

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}
16 Jan 04	03:45	52	64	46	54	49
16 Jan 04	04:00	54	71	45	57	48
16 Jan 04	04:15	56	75	45	57	47
16 Jan 04	04:30	54	67	46	58	48
16 Jan 04	04:45	56	70	46	60	49
16 Jan 04	05:00	55	71	46	59	47
16 Jan 04	05:15	58	74	46	62	48
16 Jan 04	05:30	60	74	46	64	50
16 Jan 04	05:45	61	74	48	65	51
16 Jan 04	06:00	61	86	48	64	51
16 Jan 04	06:15	64	79	50	68	53
16 Jan 04	06:30	65	79	52	68	56
16 Jan 04	06:45	66	83	54	69	59
16 Jan 04	07:00	67	80	55	69	61
16 Jan 04	07:15	68	82	61	70	64
16 Jan 04	07:30	68	87	60	70	64
16 Jan 04	07:45	68	84	60	70	64
16 Jan 04	08:00	68	81	60	71	64
16 Jan 04	08:15	68	78	59	70	64
16 Jan 04	08:30	67	77	60	69	63
16 Jan 04	08:45	68	83	59	71	63
16 Jan 04	09:00	67	80	57	69	62
16 Jan 04	09:15	67	79	59	70	63
16 Jan 04	09:30	66	76	59	69	63
16 Jan 04	09:45	67	84	57	69	63
16 Jan 04	10:00	67	82	58	69	62
16 Jan 04	10:15	67	78	58	70	63
16 Jan 04	10:30	67	79	56	70	61
16 Jan 04	10:45	69	89	57	71	62
16 Jan 04	11:00	66	82	56	68	61
16 Jan 04	11:15	67	83	52	70	60
16 Jan 04	11:30	67	80	55	70	61
16 Jan 04	11:45	67	80	55	69	62
16 Jan 04	12:00	67	85	56	70	61
16 Jan 04	12:15	67	81	56	69	61
16 Jan 04	12:30	68	80	59	71	63
16 Jan 04	12:45	66	77	57	69	62
16 Jan 04	13:00	67	87	55	70	62
16 Jan 04	13:15	67	80	56	69	63
16 Jan 04	13:30	68	89	56	70	63
16 Jan 04	13:45	68	84	56	70	63
16 Jan 04	14:00	67	79	58	70	63
16 Jan 04	14:15	68	85	58	71	63
16 Jan 04	14:30	68	81	58	70	63
16 Jan 04	14:45	68	83	56	70	62
16 Jan 04	15:00	67	82	59	70	63
16 Jan 04	15:15	69	86	61	71	64
16 Jan 04	15:30	67	75	61	69	63
16 Jan 04	15:45	67	80	59	69	63

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}
16 Jan 04	16:00	66	81	58	68	63
16 Jan 04	16:15	67	78	60	69	64
16 Jan 04	16:30	67	78	60	69	64
16 Jan 04	16:45	66	79	58	69	62
16 Jan 04	17:00	66	80	58	68	62
16 Jan 04	17:15	65	77	58	67	62
16 Jan 04	17:30	65	75	58	67	61
16 Jan 04	17:45	66	82	58	67	63
16 Jan 04	18:00	65	76	58	67	62
16 Jan 04	18:15	66	83	58	68	62
16 Jan 04	18:30	65	75	57	67	61
16 Jan 04	18:45	64	76	57	66	60
16 Jan 04	19:00	64	74	57	66	61
16 Jan 04	19:15	64	73	56	67	60
16 Jan 04	19:30	63	74	54	66	58
16 Jan 04	19:45	63	75	53	66	58
16 Jan 04	20:00	62	72	53	65	58
16 Jan 04	20:15	62	73	53	65	57
16 Jan 04	20:30	61	70	50	65	55
16 Jan 04	20:45	62	77	52	65	56
16 Jan 04	21:00	62	74	51	65	56
16 Jan 04	21:15	60	71	49	64	54
16 Jan 04	21:30	60	70	50	64	55
16 Jan 04	21:45	61	72	49	64	52
16 Jan 04	22:00	60	73	49	63	52
16 Jan 04	22:15	60	75	48	63	51
16 Jan 04	22:30	59	79	47	62	50
16 Jan 04	22:45	59	69	46	62	51
16 Jan 04	23:00	58	72	46	61	48
16 Jan 04	23:15	58	73	46	62	49
16 Jan 04	23:30	57	72	45	61	48
16 Jan 04	23:45	57	69	45	61	48
17 Jan 04	00:00	59	72	46	63	49
17 Jan 04	00:15	59	74	47	63	49
17 Jan 04	00:30	57	67	46	61	47
17 Jan 04	00:45	57	72	45	60	47
17 Jan 04	01:00	56	70	45	60	47
17 Jan 04	01:15	56	69	46	60	48
17 Jan 04	01:30	56	68	45	60	47
17 Jan 04	01:45	55	67	45	59	47
17 Jan 04	02:00	53	77	44	57	46
17 Jan 04	02:15	53	70	44	57	45
17 Jan 04	02:30	51	68	44	53	45
17 Jan 04	02:45	53	65	44	57	46
17 Jan 04	03:00	54	73	44	58	46
17 Jan 04	03:15	54	68	44	58	46
17 Jan 04	03:30	53	67	43	57	46
17 Jan 04	03:45	52	66	44	55	46
17 Jan 04	04:00	56	68	45	59	48

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}
17 Jan 04	04:15	57	66	53	59	55
17 Jan 04	04:30	57	66	51	58	55
17 Jan 04	04:45	55	82	49	58	51
17 Jan 04	05:00	55	66	49	58	51
17 Jan 04	05:15	57	71	50	60	51
17 Jan 04	05:30	55	70	49	59	51
17 Jan 04	05:45	57	73	49	60	51
17 Jan 04	06:00	58	77	49	62	51
17 Jan 04	06:15	57	75	49	61	51
17 Jan 04	06:30	60	74	50	63	52
17 Jan 04	06:45	60	82	50	63	52
17 Jan 04	07:00	59	79	51	63	53
17 Jan 04	07:15	61	74	52	64	55
17 Jan 04	07:30	62	78	53	64	55
17 Jan 04	07:45	63	79	54	66	57
17 Jan 04	08:00	65	86	56	68	59
17 Jan 04	08:15	63	75	55	66	57
17 Jan 04	08:30	65	78	54	68	58
17 Jan 04	08:45	65	75	57	68	60
17 Jan 04	09:00	65	77	58	67	61
17 Jan 04	09:15	65	78	59	68	61
17 Jan 04	09:30	65	76	57	68	61
17 Jan 04	09:45	66	79	56	68	61
17 Jan 04	10:00	66	82	57	68	61
17 Jan 04	10:15	66	79	57	68	61
17 Jan 04	10:30	66	78	58	69	62
17 Jan 04	10:45	66	78	58	69	61
17 Jan 04	11:00	66	80	57	69	62
17 Jan 04	11:15	67	77	58	69	62
17 Jan 04	11:30	67	79	59	69	63
17 Jan 04	11:45	67	79	58	69	62
17 Jan 04	12:00	67	80	59	69	63
17 Jan 04	12:15	67	84	58	69	63
17 Jan 04	12:30	66	75	59	68	63
17 Jan 04	12:45	67	78	54	69	61
17 Jan 04	13:00	66	81	57	69	61
17 Jan 04	13:15	66	79	57	69	61
17 Jan 04	13:30	66	77	57	68	62
17 Jan 04	13:45	66	76	58	68	62
17 Jan 04	14:00	66	76	58	68	63
17 Jan 04	14:15	66	83	58	68	63
17 Jan 04	14:30	66	78	57	69	62
17 Jan 04	14:45	65	76	57	68	61
17 Jan 04	15:00	65	75	57	67	61
17 Jan 04	15:15	65	77	56	68	60
17 Jan 04	15:30	65	74	57	68	61
17 Jan 04	15:45	65	74	57	67	61
17 Jan 04	16:00	65	77	57	68	61
17 Jan 04	16:15	65	75	55	68	61

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}
17 Jan 04	16:30	65	73	55	67	59
17 Jan 04	16:45	65	76	56	67	60
17 Jan 04	17:00	65	76	57	67	60
17 Jan 04	17:15	65	74	55	67	60
17 Jan 04	17:30	64	82	57	66	59
17 Jan 04	17:45	64	76	56	67	60
17 Jan 04	18:00	64	74	56	66	59
17 Jan 04	18:15	64	72	56	66	60
17 Jan 04	18:30	63	71	56	66	59
17 Jan 04	18:45	64	71	57	66	60
17 Jan 04	19:00	64	79	58	67	61
17 Jan 04	19:15	65	72	60	67	62
17 Jan 04	19:30	64	75	58	66	61
17 Jan 04	19:45	63	73	55	66	58
17 Jan 04	20:00	63	71	55	66	58
17 Jan 04	20:15	63	76	53	65	57
17 Jan 04	20:30	61	70	54	65	56
17 Jan 04	20:45	61	73	54	64	57
17 Jan 04	21:00	61	71	52	64	55
17 Jan 04	21:15	60	70	51	63	54
17 Jan 04	21:30	58	67	49	62	52
17 Jan 04	21:45	59	74	50	62	53
17 Jan 04	22:00	59	68	49	62	52
17 Jan 04	22:15	58	68	48	61	54
17 Jan 04	22:30	58	66	49	61	53
17 Jan 04	22:45	57	68	47	61	53
17 Jan 04	23:00	58	69	49	61	51
17 Jan 04	23:15	57	67	47	61	51
17 Jan 04	23:30	57	68	48	60	50
17 Jan 04	23:45	56	66	47	60	50
18 Jan 04	00:00	56	64	46	59	49
18 Jan 04	00:15	57	65	47	60	50
18 Jan 04	00:30	56	65	45	60	49
18 Jan 04	00:45	56	68	45	60	48
18 Jan 04	01:00	56	66	45	60	48
18 Jan 04	01:15	54	64	45	58	49
18 Jan 04	01:30	54	65	44	58	48
18 Jan 04	01:45	55	65	44	59	48
18 Jan 04	02:00	54	68	44	57	48
18 Jan 04	02:15	55	72	43	57	48
18 Jan 04	02:30	55	66	44	58	48
18 Jan 04	02:45	54	65	43	57	46
18 Jan 04	03:00	54	63	44	57	49
18 Jan 04	03:15	52	61	44	56	46
18 Jan 04	03:30	51	64	43	54	46
18 Jan 04	03:45	49	60	43	52	45
18 Jan 04	04:00	52	66	43	55	46
18 Jan 04	04:15	50	73	42	54	45
18 Jan 04	04:30	53	67	44	56	46

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}
18 Jan 04	04:45	54	69	45	57	47
18 Jan 04	05:00	52	66	45	56	47
18 Jan 04	05:15	54	68	45	57	47
18 Jan 04	05:30	56	69	47	59	49
18 Jan 04	05:45	54	66	48	58	49
18 Jan 04	06:00	55	70	47	58	49
18 Jan 04	06:15	53	66	46	57	48
18 Jan 04	06:30	53	69	45	57	47
18 Jan 04	06:45	55	66	47	59	49
18 Jan 04	07:00	56	70	47	60	49
18 Jan 04	07:15	57	70	47	60	49
18 Jan 04	07:30	57	70	49	60	53
18 Jan 04	07:45	58	68	49	61	52
18 Jan 04	08:00	57	67	47	61	50
18 Jan 04	08:15	59	79	46	62	49
18 Jan 04	08:30	58	74	45	62	49
18 Jan 04	08:45	59	77	45	62	49
18 Jan 04	09:00	59	70	46	63	49
18 Jan 04	09:15	62	81	46	64	51
18 Jan 04	09:30	60	71	48	63	52
18 Jan 04	09:45	61	69	46	64	54
18 Jan 04	10:00	61	72	46	64	52
18 Jan 04	10:15	62	75	50	65	54
18 Jan 04	10:30	61	77	48	64	54
18 Jan 04	10:45	62	73	49	65	55
18 Jan 04	11:00	61	69	48	64	54
18 Jan 04	11:15	61	74	48	64	55
18 Jan 04	11:30	65	85	50	65	54
18 Jan 04	11:45	61	74	49	64	56
18 Jan 04	12:00	61	73	48	64	55
18 Jan 04	12:15	62	70	49	65	55
18 Jan 04	12:30	62	69	48	64	56
18 Jan 04	12:45	63	75	53	65	58
18 Jan 04	13:00	62	69	51	65	57
18 Jan 04	13:15	62	71	48	65	56
18 Jan 04	13:30	63	78	51	65	59
18 Jan 04	13:45	62	70	50	65	57
18 Jan 04	14:00	63	80	52	65	57
18 Jan 04	14:15	63	75	51	65	57
18 Jan 04	14:30	62	72	49	65	57
18 Jan 04	14:45	63	72	53	65	58
18 Jan 04	15:00	63	73	55	65	59
18 Jan 04	15:15	62	77	49	65	57
18 Jan 04	15:30	62	75	53	65	58
18 Jan 04	15:45	62	71	54	65	58
18 Jan 04	16:00	62	69	53	65	58
18 Jan 04	16:15	63	79	51	65	57
18 Jan 04	16:30	63	84	51	65	57
18 Jan 04	16:45	61	71	51	64	56

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}
18 Jan 04	17:00	63	77	51	65	58
18 Jan 04	17:15	62	69	50	64	57
18 Jan 04	17:30	61	71	51	64	56
18 Jan 04	17:45	61	70	51	64	56
18 Jan 04	18:00	61	69	51	64	56
18 Jan 04	18:15	62	80	54	65	57
18 Jan 04	18:30	61	71	49	64	55
18 Jan 04	18:45	62	73	50	64	55
18 Jan 04	19:00	62	78	49	65	55
18 Jan 04	19:15	61	69	50	64	55
18 Jan 04	19:30	61	69	51	64	55
18 Jan 04	19:45	62	72	53	64	56
18 Jan 04	20:00	61	75	48	64	55
18 Jan 04	20:15	61	73	51	64	54
18 Jan 04	20:30	62	70	52	65	56
18 Jan 04	20:45	61	72	51	64	55
18 Jan 04	21:00	60	70	50	64	54
18 Jan 04	21:15	60	68	50	63	54
18 Jan 04	21:30	59	68	50	63	54
18 Jan 04	21:45	59	70	49	63	53
18 Jan 04	22:00	59	69	47	62	50
18 Jan 04	22:15	58	70	46	62	50
18 Jan 04	22:30	58	67	47	62	51
18 Jan 04	22:45	57	74	46	61	49
18 Jan 04	23:00	57	71	47	61	50
18 Jan 04	23:15	58	71	48	61	51
18 Jan 04	23:30	58	69	49	61	52
18 Jan 04	23:45	57	68	48	60	50
19 Jan 04	00:00	56	74	48	60	51
19 Jan 04	00:15	57	71	46	60	51
19 Jan 04	00:30	55	70	47	58	50
19 Jan 04	00:45	54	66	47	57	49
19 Jan 04	01:00	55	68	47	59	50
19 Jan 04	01:15	54	67	46	57	49
19 Jan 04	01:30	54	70	46	57	49
19 Jan 04	01:45	54	71	46	57	48
19 Jan 04	02:00	51	66	44	54	46
19 Jan 04	02:15	53	68	44	56	46
19 Jan 04	02:30	50	65	44	53	46
19 Jan 04	02:45	49	65	44	51	46
19 Jan 04	03:00	52	66	45	55	47
19 Jan 04	03:15	52	67	45	54	48
19 Jan 04	03:30	52	68	46	55	48
19 Jan 04	03:45	53	65	46	56	49
19 Jan 04	04:00	52	66	45	54	48
19 Jan 04	04:15	56	75	47	58	49
19 Jan 04	04:30	56	71	46	58	49
19 Jan 04	04:45	56	72	48	59	50
19 Jan 04	05:00	59	77	48	61	51

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}
19 Jan 04	05:15	59	77	50	63	53
19 Jan 04	05:30	60	73	50	63	53
19 Jan 04	05:45	60	77	51	64	53
19 Jan 04	06:00	60	76	50	63	52
19 Jan 04	06:15	62	76	50	65	53
19 Jan 04	06:30	63	74	52	65	55
19 Jan 04	06:45	65	81	53	67	58
19 Jan 04	07:00	66	81	54	70	60
19 Jan 04	07:15	67	81	60	70	63
19 Jan 04	07:30	68	87	58	70	63
19 Jan 04	07:45	66	75	58	69	61
19 Jan 04	08:00	66	80	60	69	63
19 Jan 04	08:15	67	83	59	70	63
19 Jan 04	08:30	67	76	61	69	64
19 Jan 04	08:45	66	80	57	68	63
19 Jan 04	09:00	66	77	59	69	63
19 Jan 04	09:15	66	83	58	68	62
19 Jan 04	09:30	66	78	58	68	63
19 Jan 04	09:45	67	84	59	69	63
19 Jan 04	10:00	66	78	58	69	62
19 Jan 04	10:15	67	79	56	70	62
19 Jan 04	10:30	67	79	58	70	62
19 Jan 04	10:45	67	90	58	70	62
19 Jan 04	11:00	67	78	57	70	62
19 Jan 04	11:15	67	81	56	70	62
19 Jan 04	11:30	65	79	56	68	60
19 Jan 04	11:45	67	81	57	70	62
19 Jan 04	12:00	68	86	56	70	61
19 Jan 04	12:15	66	81	56	69	61
19 Jan 04	12:30	67	84	58	70	62
19 Jan 04	12:45	66	81	58	69	62
19 Jan 04	13:00	67	82	58	70	63
19 Jan 04	13:15	67	77	59	70	63
19 Jan 04	13:30	67	83	56	69	62
19 Jan 04	13:45	67	78	56	70	62
19 Jan 04	14:00	67	79	59	70	62
19 Jan 04	14:15	67	82	58	70	62
19 Jan 04	14:30	67	82	56	70	62
19 Jan 04	14:45	68	85	57	70	62
19 Jan 04	15:00	66	82	58	69	62
19 Jan 04	15:15	67	82	57	69	62
19 Jan 04	15:30	67	80	58	70	62
19 Jan 04	15:45	66	79	57	69	62
19 Jan 04	16:00	67	78	59	69	63
19 Jan 04	16:15	67	84	57	70	61
19 Jan 04	16:30	65	81	54	67	61
19 Jan 04	16:45	66	79	58	68	62
19 Jan 04	17:00	66	78	59	69	62
19 Jan 04	17:15	66	76	57	68	61

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}
19 Jan 04	17:30	66	82	59	68	62
19 Jan 04	17:45	65	78	58	67	61
19 Jan 04	18:00	65	79	56	67	61
19 Jan 04	18:15	65	75	57	67	60
19 Jan 04	18:30	64	77	55	67	60
19 Jan 04	18:45	64	85	53	66	59
19 Jan 04	19:00	64	73	54	66	60
19 Jan 04	19:15	63	73	54	65	57
19 Jan 04	19:30	62	75	51	65	55
19 Jan 04	19:45	63	83	52	65	56
19 Jan 04	20:00	61	76	51	65	55
19 Jan 04	20:15	61	73	52	65	56
19 Jan 04	20:30	61	75	50	64	53
19 Jan 04	20:45	61	76	50	64	54
19 Jan 04	21:00	61	77	50	64	53
19 Jan 04	21:15	60	79	50	63	54
19 Jan 04	21:30	60	71	49	63	52
19 Jan 04	21:45	59	71	47	62	51
19 Jan 04	22:00	60	76	47	63	51
19 Jan 04	22:15	58	68	47	62	50
19 Jan 04	22:30	59	75	47	62	51
19 Jan 04	22:45	57	68	45	61	49
19 Jan 04	23:00	55	68	45	59	48
19 Jan 04	23:15	58	78	47	61	51
19 Jan 04	23:30	55	72	46	59	49
19 Jan 04	23:45	55	69	45	59	48
20 Jan 04	00:00	54	69	44	58	47
20 Jan 04	00:15	55	72	44	58	47
20 Jan 04	00:30	53	68	43	56	46
20 Jan 04	00:45	51	64	42	54	45
20 Jan 04	01:00	51	66	42	54	45
20 Jan 04	01:15	54	71	43	57	46
20 Jan 04	01:30	54	72	44	57	47
20 Jan 04	01:45	53	68	44	55	48
20 Jan 04	02:00	53	66	44	56	48
20 Jan 04	02:15	54	74	43	56	47
20 Jan 04	02:30	48	62	43	50	45
20 Jan 04	02:45	48	62	43	49	46
20 Jan 04	03:00	50	69	43	49	45
20 Jan 04	03:15	49	67	43	50	46
20 Jan 04	03:30	52	68	44	54	46
20 Jan 04	03:45	53	66	44	56	48
20 Jan 04	04:00	52	64	43	55	48
20 Jan 04	04:15	54	70	45	56	48
20 Jan 04	04:30	53	72	44	56	47
20 Jan 04	04:45	55	67	45	58	49
20 Jan 04	05:00	56	69	49	60	51
20 Jan 04	05:15	59	77	48	63	51
20 Jan 04	05:30	59	74	49	63	52

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}
20 Jan 04	05:45	61	75	50	64	53
20 Jan 04	06:00	62	76	50	66	53
20 Jan 04	06:15	63	82	50	67	54
20 Jan 04	06:30	64	80	52	67	56
20 Jan 04	06:45	65	77	54	68	58
20 Jan 04	07:00	66	78	53	70	60
20 Jan 04	07:15	67	82	57	70	62
20 Jan 04	07:30	67	81	58	70	63
20 Jan 04	07:45	67	78	59	70	63
20 Jan 04	08:00	67	81	58	70	62
20 Jan 04	08:15	66	77	57	69	62
20 Jan 04	08:30	66	78	55	68	62
20 Jan 04	08:45	66	79	58	68	63
20 Jan 04	09:00	66	78	57	69	62
20 Jan 04	09:15	66	78	56	69	62
20 Jan 04	09:30	67	92	59	69	62
20 Jan 04	09:45	66	86	53	68	61
20 Jan 04	10:00	65	80	54	68	60
20 Jan 04	10:15	66	86	56	69	62
20 Jan 04	10:30	67	85	56	69	61
20 Jan 04	10:45	67	82	57	70	62
20 Jan 04	11:00	67	88	58	70	62
20 Jan 04	11:15	69	98	56	70	61
20 Jan 04	11:30	68	80	54	70	61
20 Jan 04	11:45	69	72	67	71	67
20 Jan 04	11:50	67	69	61	85	56
20 Jan 04	12:05	67	69	62	81	56
20 Jan 04	12:20	67	70	62	78	57
20 Jan 04	12:35	67	69	62	80	57
20 Jan 04	12:50	67	69	62	82	55
20 Jan 04	13:05	66	68	60	89	54
20 Jan 04	13:20	67	69	60	81	54
20 Jan 04	13:35	66	69	60	77	56
20 Jan 04	13:50	64	67	60	75	55
20 Jan 04	14:05	66	69	62	80	58
20 Jan 04	14:20	65	68	60	77	55
20 Jan 04	14:35	64	67	60	76	54
20 Jan 04	14:50	65	68	60	81	56
20 Jan 04	15:05	66	68	61	80	55
20 Jan 04	15:20	66	68	61	76	55
20 Jan 04	15:35	65	68	61	76	56
20 Jan 04	15:50	65	67	61	80	56
20 Jan 04	16:05	65	68	61	78	53
20 Jan 04	16:20	64	67	59	78	53
20 Jan 04	16:35	64	67	59	75	56
20 Jan 04	16:50	64	67	59	76	53
20 Jan 04	17:05	65	67	61	76	57
20 Jan 04	17:20	64	66	59	77	54
20 Jan 04	17:35	64	67	61	79	56

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}
20 Jan 04	17:50	64	66	59	74	53
20 Jan 04	18:05	64	66	59	74	54
20 Jan 04	18:20	64	67	59	80	55
20 Jan 04	18:35	64	66	59	74	52
20 Jan 04	18:50	63	65	57	72	51
20 Jan 04	19:05	63	66	56	73	52
20 Jan 04	19:20	62	65	57	72	53
20 Jan 04	19:35	62	65	55	72	51
20 Jan 04	19:50	61	65	55	75	50
20 Jan 04	20:05	61	64	55	70	52
20 Jan 04	20:20	60	63	54	82	51
20 Jan 04	20:35	60	63	54	74	51
20 Jan 04	20:50	60	64	52	69	49
20 Jan 04	21:05	61	64	54	76	51
20 Jan 04	21:20	59	63	51	70	48
20 Jan 04	21:35	60	63	52	72	49
20 Jan 04	21:50	59	63	51	67	47
20 Jan 04	22:05	58	62	50	69	46
20 Jan 04	22:20	59	63	51	74	47
20 Jan 04	22:35	58	62	51	68	48
20 Jan 04	22:50	56	60	49	69	45
20 Jan 04	23:05	57	60	49	74	46
20 Jan 04	23:20	57	61	49	76	46
20 Jan 04	23:35	56	60	50	68	46
20 Jan 04	23:50	56	58	46	80	42
21 Jan 04	00:05	54	57	46	69	42
21 Jan 04	00:20	53	57	44	68	41
21 Jan 04	00:35	53	57	43	73	41
21 Jan 04	00:50	54	57	46	72	43
21 Jan 04	01:05	53	56	46	68	42
21 Jan 04	01:20	51	55	42	66	40
21 Jan 04	01:35	51	52	43	70	41
21 Jan 04	01:50	51	54	43	69	40
21 Jan 04	02:05	54	55	44	73	40
21 Jan 04	02:20	51	51	44	74	40
21 Jan 04	02:35	51	52	45	69	41
21 Jan 04	02:50	50	51	44	67	41
21 Jan 04	03:05	48	50	43	66	40
21 Jan 04	03:20	52	53	45	70	42
21 Jan 04	03:35	49	50	44	66	40
21 Jan 04	03:50	51	52	44	68	40
21 Jan 04	04:05	51	54	43	69	39
21 Jan 04	04:20	51	53	43	70	40
21 Jan 04	04:35	49	51	44	65	40
21 Jan 04	04:50	53	58	45	66	41
21 Jan 04	05:05	56	59	46	77	42
21 Jan 04	05:20	60	63	49	74	44
21 Jan 04	05:35	58	62	49	77	44
21 Jan 04	05:50	58	62	48	75	45

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}
21 Jan 04	06:05	59	62	48	80	45
21 Jan 04	06:20	62	66	50	77	46
21 Jan 04	06:35	63	66	52	77	46
21 Jan 04	06:50	64	67	56	82	48
21 Jan 04	07:05	66	68	58	85	53
21 Jan 04	07:20	65	67	58	80	53
21 Jan 04	07:35	65	68	61	77	55
21 Jan 04	07:50	65	68	60	82	55
21 Jan 04	08:05	68	72	62	76	58
21 Jan 04	08:20	67	71	61	79	53
21 Jan 04	08:35	65	67	61	75	54
21 Jan 04	08:50	66	70	61	79	57
21 Jan 04	09:05	65	67	60	85	54
21 Jan 04	09:20	65	68	59	84	53
21 Jan 04	09:35	65	68	60	79	52
21 Jan 04	09:50	64	67	58	77	51
21 Jan 04	10:05	65	67	60	78	52
21 Jan 04	10:20	65	68	60	81	54
21 Jan 04	10:35	66	68	59	84	52
21 Jan 04	10:50	65	68	59	80	52
21 Jan 04	11:05	65	67	59	85	53
21 Jan 04	11:20	67	70	61	83	56
21 Jan 04	11:35	68	71	63	77	56
21 Jan 04	11:50	65	69	58	78	52
21 Jan 04	12:05	65	68	59	78	53
21 Jan 04	12:20	67	69	60	88	54
21 Jan 04	12:35	67	70	59	80	52
21 Jan 04	12:50	64	67	58	82	51
21 Jan 04	13:05	64	67	57	76	53
21 Jan 04	13:20	64	67	58	77	50
21 Jan 04	13:35	65	68	59	79	51
21 Jan 04	13:50	64	67	58	77	51
21 Jan 04	14:05	65	67	59	77	50
21 Jan 04	14:20	65	68	59	77	55
21 Jan 04	14:35	64	67	59	78	52
21 Jan 04	14:50	65	68	59	82	54
21 Jan 04	15:05	65	68	59	84	51
21 Jan 04	15:20	65	67	60	77	56
21 Jan 04	15:35	66	69	60	79	53
21 Jan 04	15:50	68	69	60	88	55
21 Jan 04	16:05	65	67	60	78	54
21 Jan 04	16:20	64	67	59	75	53
21 Jan 04	16:35	65	67	60	81	53
21 Jan 04	16:50	64	66	59	78	52
21 Jan 04	17:05	64	66	59	75	52
21 Jan 04	17:20	64	66	58	78	52
21 Jan 04	17:35	63	65	58	77	53
21 Jan 04	17:50	63	66	58	75	53
21 Jan 04	18:05	63	66	58	75	53

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AMax}	L_{AMin}	L_{A10}	L_{A90}
21 Jan 04	18:20	63	65	58	72	49
21 Jan 04	18:35	62	65	56	71	48

Table B2 Phase 2 Continuous Noise Monitoring Results Location B

APPENDIX C
LOCATION C - CONTINUOUS MONITORING DATA

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)		
		L_{Aeq}	L_{A10}	L_{A90}
03 Jul 04	12:55	60	63	52
03 Jul 04	13:10	60	63	51
03 Jul 04	13:25	60	62	53
03 Jul 04	13:40	60	62	51
03 Jul 04	13:55	61	63	53
03 Jul 04	14:10	60	63	52
03 Jul 04	14:25	60	63	53
03 Jul 04	14:40	60	63	53
03 Jul 04	14:55	60	62	52
03 Jul 04	15:10	60	63	52
03 Jul 04	15:25	60	63	53
03 Jul 04	15:40	61	64	55
03 Jul 04	15:55	60	63	54
03 Jul 04	16:10	60	63	54
03 Jul 04	16:25	60	63	55
03 Jul 04	16:40	60	62	54
03 Jul 04	16:55	60	62	54
03 Jul 04	17:10	59	62	54
03 Jul 04	17:25	58	61	52
03 Jul 04	17:40	60	62	54
03 Jul 04	17:55	62	65	54
03 Jul 04	18:10	59	62	53
03 Jul 04	18:25	61	62	51
03 Jul 04	18:40	59	61	50
03 Jul 04	18:55	59	62	51
03 Jul 04	19:10	59	62	51
03 Jul 04	19:25	60	62	52
03 Jul 04	19:40	59	61	49
03 Jul 04	19:55	59	62	48
03 Jul 04	20:10	59	62	48
03 Jul 04	20:25	59	62	50
03 Jul 04	20:40	58	61	48
03 Jul 04	20:55	58	61	50
03 Jul 04	21:10	58	61	47
03 Jul 04	21:25	58	61	47
03 Jul 04	21:40	57	61	46
03 Jul 04	21:55	57	60	45
03 Jul 04	22:10	57	61	47
03 Jul 04	22:25	57	61	45
03 Jul 04	22:40	56	60	44
03 Jul 04	22:55	56	60	42
03 Jul 04	23:10	55	59	42
03 Jul 04	23:25	54	59	42
03 Jul 04	23:40	55	59	41
03 Jul 04	23:55	54	58	40
04 Jul 04	00:10	52	57	38
04 Jul 04	00:25	54	59	39
04 Jul 04	00:40	53	58	38
04 Jul 04	00:55	52	57	37

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)		
		L_{Aeq}	L_{A10}	L_{A90}
04 Jul 04	01:10	50	54	35
04 Jul 04	01:25	49	53	35
04 Jul 04	01:40	50	54	36
04 Jul 04	01:55	48	52	36
04 Jul 04	02:10	51	54	35
04 Jul 04	02:25	50	54	36
04 Jul 04	02:40	50	54	34
04 Jul 04	02:55	50	55	35
04 Jul 04	03:10	49	52	34
04 Jul 04	03:25	50	54	35
04 Jul 04	03:40	50	54	35
04 Jul 04	03:55	52	56	34
04 Jul 04	04:10	53	57	36
04 Jul 04	04:25	52	56	37
04 Jul 04	04:40	54	58	38
04 Jul 04	04:55	55	60	40
04 Jul 04	05:10	56	61	41
04 Jul 04	05:25	56	61	42
04 Jul 04	05:40	59	63	43
04 Jul 04	05:55	58	63	45
04 Jul 04	06:10	59	62	46
04 Jul 04	06:25	59	63	50
04 Jul 04	06:40	60	63	49
04 Jul 04	06:55	60	63	54
04 Jul 04	07:10	61	63	53
04 Jul 04	07:25	60	63	55
04 Jul 04	07:40	60	63	54
04 Jul 04	07:55	61	63	53
04 Jul 04	08:10	60	63	54
04 Jul 04	08:25	60	62	52
04 Jul 04	08:40	60	62	54
04 Jul 04	08:55	60	63	53
04 Jul 04	09:10	60	62	51
04 Jul 04	09:25	60	63	52
04 Jul 04	09:40	59	63	51
04 Jul 04	09:55	60	63	50
04 Jul 04	10:10	58	62	48
04 Jul 04	10:25	60	63	53
04 Jul 04	10:40	58	62	49
04 Jul 04	10:55	60	63	53
04 Jul 04	11:10	61	64	52
04 Jul 04	11:25	61	63	52
04 Jul 04	11:40	59	62	52
04 Jul 04	11:55	60	62	53
04 Jul 04	12:10	60	63	52
04 Jul 04	12:25	61	64	52
04 Jul 04	12:40	59	62	51
04 Jul 04	12:55	60	63	50
04 Jul 04	13:10	60	63	53
04 Jul 04	13:25	60	63	53
04 Jul 04	13:40	59	63	51
04 Jul 04	13:55	60	63	53

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)		
		L_{Aeq}	L_{A10}	L_{A90}
04 Jul 04	14:10	61	63	53
04 Jul 04	14:25	60	63	51
04 Jul 04	14:40	60	62	52
04 Jul 04	14:55	66	63	52
04 Jul 04	15:10	60	62	53
04 Jul 04	15:25	60	62	51
04 Jul 04	15:40	60	62	53
04 Jul 04	15:55	61	63	53
04 Jul 04	16:10	60	62	54
04 Jul 04	16:25	60	62	53
04 Jul 04	16:40	60	62	52
04 Jul 04	16:55	66	62	53
04 Jul 04	17:10	59	62	54
04 Jul 04	17:25	60	63	51
04 Jul 04	17:40	62	64	51
04 Jul 04	17:55	59	62	51
04 Jul 04	18:10	59	63	52
04 Jul 04	18:25	59	62	50
04 Jul 04	18:40	59	62	49
04 Jul 04	18:55	59	62	49
04 Jul 04	19:10	58	61	50
04 Jul 04	19:25	58	61	47
04 Jul 04	19:40	59	62	49
04 Jul 04	19:55	58	62	47
04 Jul 04	20:10	58	62	48
04 Jul 04	20:25	58	61	48
04 Jul 04	20:40	58	61	47
04 Jul 04	20:55	58	61	45
04 Jul 04	21:10	57	61	47
04 Jul 04	21:25	57	61	45
04 Jul 04	21:40	57	61	45
04 Jul 04	21:55	57	61	47
04 Jul 04	22:10	56	60	41
04 Jul 04	22:25	56	60	42
04 Jul 04	22:40	56	60	43
04 Jul 04	22:55	55	60	41
04 Jul 04	23:10	55	59	41
04 Jul 04	23:25	55	59	42
04 Jul 04	23:40	55	60	40
04 Jul 04	23:55	54	59	40
05 Jul 04	00:10	55	59	39
05 Jul 04	00:25	55	60	41
05 Jul 04	00:40	53	58	40
05 Jul 04	00:55	54	59	39
05 Jul 04	01:10	54	58	39
05 Jul 04	01:25	54	59	38
05 Jul 04	01:40	51	56	38
05 Jul 04	01:55	53	58	39
05 Jul 04	02:10	51	56	37
05 Jul 04	02:25	53	58	36
05 Jul 04	02:40	50	54	34
05 Jul 04	02:55	49	53	34

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)		
		L_{Aeq}	L_{A10}	L_{A90}
05 Jul 04	03:10	51	56	34
05 Jul 04	03:25	51	56	35
05 Jul 04	03:40	52	57	35
05 Jul 04	03:55	52	56	35
05 Jul 04	04:10	53	58	37
05 Jul 04	04:25	53	58	36
05 Jul 04	04:40	54	58	38
05 Jul 04	04:55	54	59	39
05 Jul 04	05:10	55	59	38
05 Jul 04	05:25	55	60	39
05 Jul 04	05:40	56	60	40
05 Jul 04	05:55	58	62	43
05 Jul 04	06:10	57	61	43
05 Jul 04	06:25	57	61	42
05 Jul 04	06:40	57	61	43
05 Jul 04	06:55	58	62	45
05 Jul 04	07:10	58	62	44
05 Jul 04	07:25	59	63	46
05 Jul 04	07:40	59	63	45
05 Jul 04	07:55	58	62	47
05 Jul 04	08:10	59	62	46
05 Jul 04	08:25	59	63	46
05 Jul 04	08:40	59	62	49
05 Jul 04	08:55	58	61	50
05 Jul 04	09:10	59	63	50
05 Jul 04	09:25	58	62	48
05 Jul 04	09:40	59	62	44
05 Jul 04	09:55	59	62	48
05 Jul 04	10:10	59	62	49
05 Jul 04	10:25	60	63	48
05 Jul 04	10:40	59	63	48
05 Jul 04	10:55	59	63	49
05 Jul 04	11:10	59	62	47
05 Jul 04	11:25	59	62	50
05 Jul 04	11:40	58	61	48
05 Jul 04	11:55	59	62	51
05 Jul 04	12:10	58	62	48
05 Jul 04	12:25	59	62	51
05 Jul 04	12:40	59	62	49
05 Jul 04	12:55	58	61	52
05 Jul 04	13:10	60	62	51
05 Jul 04	13:25	58	61	47
05 Jul 04	13:40	58	61	49
05 Jul 04	13:55	58	61	50
05 Jul 04	14:10	58	61	48
05 Jul 04	14:25	59	62	52
05 Jul 04	14:40	59	61	51
05 Jul 04	14:55	58	61	47
05 Jul 04	15:10	59	62	50
05 Jul 04	15:25	59	62	48
05 Jul 04	15:40	58	61	47
05 Jul 04	15:55	58	61	47

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)		
		L_{Aeq}	L_{A10}	L_{A90}
05 Jul 04	16:10	58	61	45
05 Jul 04	16:25	59	61	46
05 Jul 04	16:40	59	62	47
05 Jul 04	16:55	59	61	47
05 Jul 04	17:10	58	61	47
05 Jul 04	17:25	58	61	46
05 Jul 04	17:40	58	61	47
05 Jul 04	17:55	59	61	52
05 Jul 04	18:10	59	62	51
05 Jul 04	18:25	58	61	50
05 Jul 04	18:40	58	61	50
05 Jul 04	18:55	59	61	49
05 Jul 04	19:10	57	61	48
05 Jul 04	19:25	58	61	48
05 Jul 04	19:40	58	61	48
05 Jul 04	19:55	57	60	47
05 Jul 04	20:10	57	61	47
05 Jul 04	20:25	58	61	47
05 Jul 04	20:40	56	60	42
05 Jul 04	20:55	58	61	45
05 Jul 04	21:10	57	61	45
05 Jul 04	21:25	56	60	43
05 Jul 04	21:40	55	59	40
05 Jul 04	21:55	56	60	43
05 Jul 04	22:10	56	60	40
05 Jul 04	22:25	56	60	41
05 Jul 04	22:40	54	59	40
05 Jul 04	22:55	55	59	40
05 Jul 04	23:10	53	58	34
05 Jul 04	23:25	56	59	41
05 Jul 04	23:40	53	58	38
05 Jul 04	23:55	54	59	37
06 Jul 04	00:10	54	58	39
06 Jul 04	00:25	55	59	40
06 Jul 04	00:40	54	59	38
06 Jul 04	00:55	54	59	39
06 Jul 04	01:10	53	58	36
06 Jul 04	01:25	53	58	38
06 Jul 04	01:40	52	57	37
06 Jul 04	01:55	51	56	37
06 Jul 04	02:10	53	58	36
06 Jul 04	02:25	52	57	36
06 Jul 04	02:40	51	56	36
06 Jul 04	02:55	52	57	38
06 Jul 04	03:10	49	54	36
06 Jul 04	03:25	49	53	35
06 Jul 04	03:40	50	55	35
06 Jul 04	03:55	50	55	35
06 Jul 04	04:10	51	56	35
06 Jul 04	04:25	52	57	38
06 Jul 04	04:40	52	57	37
06 Jul 04	04:55	51	57	37

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)		
		L_{Aeq}	L_{A10}	L_{A90}
06 Jul 04	05:10	51	56	37
06 Jul 04	05:25	53	58	37
06 Jul 04	05:40	53	58	39
06 Jul 04	05:55	51	57	35
06 Jul 04	06:10	53	58	36
06 Jul 04	06:25	53	58	39
06 Jul 04	06:40	53	58	39
06 Jul 04	06:55	54	59	42
06 Jul 04	07:10	54	59	39
06 Jul 04	07:25	55	59	40
06 Jul 04	07:40	55	60	37
06 Jul 04	07:55	56	60	40
06 Jul 04	08:10	56	60	39
06 Jul 04	08:25	56	60	41
06 Jul 04	08:40	54	59	40
06 Jul 04	08:55	55	60	41
06 Jul 04	09:10	55	60	43
06 Jul 04	09:25	56	60	42
06 Jul 04	09:40	56	60	43
06 Jul 04	09:55	56	60	42
06 Jul 04	10:10	57	60	44
06 Jul 04	10:25	57	60	45
06 Jul 04	10:40	56	60	44
06 Jul 04	10:55	58	61	45
06 Jul 04	11:10	57	61	48
06 Jul 04	11:25	57	60	48
06 Jul 04	11:40	58	60	48
06 Jul 04	11:55	57	60	48
06 Jul 04	12:10	57	60	48
06 Jul 04	12:25	57	60	48
06 Jul 04	12:40	58	61	49
06 Jul 04	12:55	55	58	49
06 Jul 04	13:10	57	60	47
06 Jul 04	13:25	57	60	50
06 Jul 04	13:40	55	57	49
06 Jul 04	13:55	62	61	51
06 Jul 04	14:10	57	60	46
06 Jul 04	14:25	57	61	47
06 Jul 04	14:40	57	60	49
06 Jul 04	14:55	59	61	50
06 Jul 04	15:10	57	60	46
06 Jul 04	15:25	57	60	47
06 Jul 04	15:40	57	61	49
06 Jul 04	15:55	57	60	47
06 Jul 04	16:10	58	61	49
06 Jul 04	16:25	57	60	48
06 Jul 04	16:40	57	60	47
06 Jul 04	16:55	58	61	47
06 Jul 04	17:10	57	60	46
06 Jul 04	17:25	59	60	50
06 Jul 04	17:40	59	60	48
06 Jul 04	17:55	57	60	49

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)		
		L_{Aeq}	L_{A10}	L_{A90}
06 Jul 04	18:10	58	60	49
06 Jul 04	18:25	57	60	52
06 Jul 04	18:40	57	60	48
06 Jul 04	18:55	57	60	49
06 Jul 04	19:10	57	60	52
06 Jul 04	19:25	58	60	50
06 Jul 04	19:40	58	61	47
06 Jul 04	19:55	57	60	47
06 Jul 04	20:10	58	61	47
06 Jul 04	20:25	58	61	48
06 Jul 04	20:40	57	61	47
06 Jul 04	20:55	58	61	49
06 Jul 04	21:10	57	60	45
06 Jul 04	21:25	57	60	47
06 Jul 04	21:40	56	60	46
06 Jul 04	21:55	56	60	45
06 Jul 04	22:10	57	60	45
06 Jul 04	22:25	55	59	43
06 Jul 04	22:40	55	59	41
06 Jul 04	22:55	55	60	40
06 Jul 04	23:10	54	59	38
06 Jul 04	23:25	55	60	38
06 Jul 04	23:40	53	58	39
06 Jul 04	23:55	53	58	35
07 Jul 04	00:10	52	57	35
07 Jul 04	00:25	51	56	33
07 Jul 04	00:40	51	56	33
07 Jul 04	00:55	51	54	32
07 Jul 04	01:10	49	53	32
07 Jul 04	01:25	50	54	31
07 Jul 04	01:40	42	42	29
07 Jul 04	01:55	49	49	30
07 Jul 04	02:10	49	50	30
07 Jul 04	02:25	46	47	30
07 Jul 04	02:40	45	47	31
07 Jul 04	02:55	47	45	30
07 Jul 04	03:10	47	48	32
07 Jul 04	03:25	48	52	32
07 Jul 04	03:40	43	42	31
07 Jul 04	03:55	50	51	33
07 Jul 04	04:10	51	55	34
07 Jul 04	04:25	51	55	37
07 Jul 04	04:40	52	57	39
07 Jul 04	04:55	54	59	40
07 Jul 04	05:10	55	59	39
07 Jul 04	05:25	56	60	43
07 Jul 04	05:40	57	61	44
07 Jul 04	05:55	58	61	46
07 Jul 04	06:10	59	63	46
07 Jul 04	06:25	59	63	49
07 Jul 04	06:40	60	63	51
07 Jul 04	06:55	60	62	51

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)		
		L_{Aeq}	L_{A10}	L_{A90}
07 Jul 04	07:10	60	63	55
07 Jul 04	07:25	60	63	54
07 Jul 04	07:40	60	62	55
07 Jul 04	07:55	59	62	53
07 Jul 04	08:10	60	63	53
07 Jul 04	08:25	60	62	52
07 Jul 04	08:40	59	62	54
07 Jul 04	08:55	60	63	53
07 Jul 04	09:10	59	62	52
07 Jul 04	09:25	59	62	52
07 Jul 04	09:40	59	62	51
07 Jul 04	09:55	59	62	50
07 Jul 04	10:10	59	62	50
07 Jul 04	10:25	59	62	50
07 Jul 04	10:40	59	62	50
07 Jul 04	10:55	59	62	50
07 Jul 04	11:10	59	62	52
07 Jul 04	11:25	59	62	53
07 Jul 04	11:40	58	61	50
07 Jul 04	11:55	59	62	52
07 Jul 04	12:10	59	62	52
07 Jul 04	12:25	59	62	52
07 Jul 04	12:40	59	62	51
07 Jul 04	12:55	59	62	51
07 Jul 04	13:10	59	61	52
07 Jul 04	13:25	58	61	51
07 Jul 04	13:40	59	62	52
07 Jul 04	13:55	59	63	52
07 Jul 04	14:10	59	61	51
07 Jul 04	14:25	58	61	52
07 Jul 04	14:40	59	61	50
07 Jul 04	14:55	59	62	51
07 Jul 04	15:10	58	61	52
07 Jul 04	15:25	59	61	49
07 Jul 04	15:40	58	61	52
07 Jul 04	15:55	60	62	51
07 Jul 04	16:10	58	61	51
07 Jul 04	16:25	59	61	54
07 Jul 04	16:40	59	61	52
07 Jul 04	16:55	58	61	50
07 Jul 04	17:10	58	61	52
07 Jul 04	17:25	59	61	51
07 Jul 04	17:40	60	63	54
07 Jul 04	17:55	59	61	53
07 Jul 04	18:10	58	61	52
07 Jul 04	18:25	57	60	50
07 Jul 04	18:40	58	61	46
07 Jul 04	18:55	57	60	48
07 Jul 04	19:10	58	61	48
07 Jul 04	19:25	58	60	49
07 Jul 04	19:40	58	61	47
07 Jul 04	19:55	58	61	48

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)		
		L_{Aeq}	L_{A10}	L_{A90}
07 Jul 04	20:10	57	60	47
07 Jul 04	20:25	57	60	47
07 Jul 04	20:40	58	61	48
07 Jul 04	20:55	57	60	46
07 Jul 04	21:10	56	60	45
07 Jul 04	21:25	56	60	46
07 Jul 04	21:40	57	60	47
07 Jul 04	21:55	56	59	46
07 Jul 04	22:10	55	59	42
07 Jul 04	22:25	54	58	42
07 Jul 04	22:40	55	59	44
07 Jul 04	22:55	54	58	42
07 Jul 04	23:10	54	59	41
07 Jul 04	23:25	53	58	39
07 Jul 04	23:40	53	57	40
07 Jul 04	23:55	53	57	38
08 Jul 04	00:10	51	55	36
08 Jul 04	00:25	50	55	35
08 Jul 04	00:40	50	55	36
08 Jul 04	00:55	48	52	32
08 Jul 04	01:10	49	51	34
08 Jul 04	01:25	48	52	32
08 Jul 04	01:40	47	51	31
08 Jul 04	01:55	46	45	30
08 Jul 04	02:10	45	45	31
08 Jul 04	02:25	46	47	30
08 Jul 04	02:40	47	47	31
08 Jul 04	02:55	45	45	30
08 Jul 04	03:10	47	47	30
08 Jul 04	03:25	46	46	31
08 Jul 04	03:40	46	47	31
08 Jul 04	03:55	48	50	33
08 Jul 04	04:10	51	55	34
08 Jul 04	04:25	52	56	33
08 Jul 04	04:40	53	57	37
08 Jul 04	04:55	54	59	36
08 Jul 04	05:10	55	60	39
08 Jul 04	05:25	55	60	38
08 Jul 04	05:40	58	61	41
08 Jul 04	05:55	55	60	40
08 Jul 04	06:10	58	62	44
08 Jul 04	06:25	59	63	47
08 Jul 04	06:40	59	62	47
08 Jul 04	06:55	60	63	52
08 Jul 04	07:10	60	63	51
08 Jul 04	07:25	60	63	53
08 Jul 04	07:40	59	62	53
08 Jul 04	07:55	60	62	50
08 Jul 04	08:10	59	62	51
08 Jul 04	08:25	59	62	51
08 Jul 04	08:40	59	62	50
08 Jul 04	08:55	59	62	52

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)		
		L_{Aeq}	L_{A10}	L_{A90}
08 Jul 04	09:10	59	62	51
08 Jul 04	09:25	58	62	47
08 Jul 04	09:40	59	62	52
08 Jul 04	09:55	59	62	51
08 Jul 04	10:10	58	61	51
08 Jul 04	10:25	59	62	50
08 Jul 04	10:40	61	63	48
08 Jul 04	10:55	59	62	50
08 Jul 04	11:10	59	62	50
08 Jul 04	11:25	59	62	50
08 Jul 04	11:40	58	62	47
08 Jul 04	11:55	59	62	51
08 Jul 04	12:10	61	64	53
08 Jul 04	12:25	60	63	55
08 Jul 04	12:40	61	64	55
08 Jul 04	12:55	61	64	53
08 Jul 04	13:10	58	61	48
08 Jul 04	13:25	59	62	46
08 Jul 04	13:40	59	62	50
08 Jul 04	13:55	59	62	50
08 Jul 04	14:10	59	62	51
08 Jul 04	14:25	59	61	51
08 Jul 04	14:40	59	61	51
08 Jul 04	14:55	64	69	54
08 Jul 04	15:10	66	70	54
08 Jul 04	15:25	58	61	50
08 Jul 04	15:40	60	63	52
08 Jul 04	15:55	59	61	51
08 Jul 04	16:10	57	60	52
08 Jul 04	16:25	59	61	53
08 Jul 04	16:40	59	62	52
08 Jul 04	16:55	59	61	53
08 Jul 04	17:10	58	61	51
08 Jul 04	17:25	59	61	53
08 Jul 04	17:40	59	61	50
08 Jul 04	17:55	59	61	53
08 Jul 04	18:10	60	64	49
08 Jul 04	18:25	58	60	49
08 Jul 04	18:40	58	61	52
08 Jul 04	18:55	58	61	49
08 Jul 04	19:10	58	61	48
08 Jul 04	19:25	57	61	49
08 Jul 04	19:40	57	61	47
08 Jul 04	19:55	57	60	48
08 Jul 04	20:10	60	61	48
08 Jul 04	20:25	58	60	45
08 Jul 04	20:40	58	61	49
08 Jul 04	20:55	57	60	46
08 Jul 04	21:10	57	60	45
08 Jul 04	21:25	57	60	45
08 Jul 04	21:40	56	60	44
08 Jul 04	21:55	56	60	44

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)		
		L_{Aeq}	L_{A10}	L_{A90}
08 Jul 04	22:10	56	60	41
08 Jul 04	22:25	55	59	43
08 Jul 04	22:40	55	59	42
08 Jul 04	22:55	56	60	43
08 Jul 04	23:10	54	59	39
08 Jul 04	23:25	53	57	38
08 Jul 04	23:40	54	58	38
08 Jul 04	23:55	53	57	37
09 Jul 04	00:10	53	58	37
09 Jul 04	00:25	52	56	36
09 Jul 04	00:40	48	53	33
09 Jul 04	00:55	48	52	31
09 Jul 04	01:10	50	55	31
09 Jul 04	01:25	50	52	35
09 Jul 04	01:40	49	50	38
09 Jul 04	01:55	46	47	34
09 Jul 04	02:10	48	52	32
09 Jul 04	02:25	45	45	33
09 Jul 04	02:40	46	46	34
09 Jul 04	02:55	46	51	35
09 Jul 04	03:10	42	41	34
09 Jul 04	03:25	47	47	37
09 Jul 04	03:40	46	48	35
09 Jul 04	03:55	50	53	33
09 Jul 04	04:10	50	53	37
09 Jul 04	04:25	51	54	34
09 Jul 04	04:40	54	58	39
09 Jul 04	04:55	54	58	39
09 Jul 04	05:10	54	59	40
09 Jul 04	05:25	56	61	41
09 Jul 04	05:40	55	60	41
09 Jul 04	05:55	56	61	39
09 Jul 04	06:10	57	61	43
09 Jul 04	06:25	60	63	45
09 Jul 04	06:40	59	62	47
09 Jul 04	06:55	60	62	49
09 Jul 04	07:10	60	62	52
09 Jul 04	07:25	59	62	52
09 Jul 04	07:40	59	62	53
09 Jul 04	07:55	59	62	51
09 Jul 04	08:10	59	62	52
09 Jul 04	08:25	58	61	50
09 Jul 04	08:40	59	62	52
09 Jul 04	08:55	59	62	51
09 Jul 04	09:10	59	62	51
09 Jul 04	09:25	59	61	44
09 Jul 04	09:40	59	62	48
09 Jul 04	09:55	58	61	48
09 Jul 04	10:10	59	62	48
09 Jul 04	10:25	58	61	47
09 Jul 04	10:40	58	62	48
09 Jul 04	10:55	59	62	51

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)		
		L_{Aeq}	L_{A10}	L_{A90}
09 Jul 04	11:10	58	61	51
09 Jul 04	11:25	59	62	52
09 Jul 04	11:40	59	62	51
09 Jul 04	11:55	58	61	52
09 Jul 04	12:10	59	62	51
09 Jul 04	12:25	58	61	52
09 Jul 04	12:40	59	62	51
09 Jul 04	12:55	59	62	52
09 Jul 04	13:10	59	61	52
09 Jul 04	13:25	58	61	52
09 Jul 04	13:40	59	61	52
09 Jul 04	13:55	59	62	51
09 Jul 04	14:10	58	61	52
09 Jul 04	14:25	59	62	54
09 Jul 04	14:40	60	62	52
09 Jul 04	14:55	59	61	52
09 Jul 04	15:10	59	62	52
09 Jul 04	15:25	59	61	53
09 Jul 04	15:40	58	61	52
09 Jul 04	15:55	59	61	52
09 Jul 04	16:10	59	62	53
09 Jul 04	16:25	59	62	54
09 Jul 04	16:40	58	61	53
09 Jul 04	16:55	58	60	53
09 Jul 04	17:10	61	62	55
09 Jul 04	17:25	59	61	53
09 Jul 04	17:40	59	61	53
09 Jul 04	17:55	60	62	55
09 Jul 04	18:10	59	61	54
09 Jul 04	18:25	58	61	51
09 Jul 04	18:40	59	63	51
09 Jul 04	18:55	57	60	50
09 Jul 04	19:10	59	62	52
09 Jul 04	19:25	58	61	50
09 Jul 04	19:40	57	60	47
09 Jul 04	19:55	58	61	49
09 Jul 04	20:10	60	62	49
09 Jul 04	20:25	57	60	48
09 Jul 04	20:40	58	61	52
09 Jul 04	20:55	59	62	52
09 Jul 04	21:10	59	61	52
09 Jul 04	21:25	58	61	51
09 Jul 04	21:40	59	62	53
09 Jul 04	21:55	59	62	51
09 Jul 04	22:10	58	61	51
09 Jul 04	22:25	59	62	52
09 Jul 04	22:40	59	62	53
09 Jul 04	22:55	59	61	52
09 Jul 04	23:10	59	61	53
09 Jul 04	23:25	64	61	53
09 Jul 04	23:40	61	64	53

Table C1 Phase 1 Continuous Noise Monitoring Results Location C

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
03 Feb 04	19:45:00	60	73	47	63	52
03 Feb 04	20:00:00	61	68	50	64	53
03 Feb 04	20:15:00	60	69	47	63	52
03 Feb 04	20:30:00	60	74	48	63	53
03 Feb 04	20:45:00	60	72	45	63	52
03 Feb 04	21:00:00	59	66	45	62	50
03 Feb 04	21:15:00	59	70	45	63	50
03 Feb 04	21:30:00	59	68	45	62	49
03 Feb 04	21:45:00	60	75	46	63	50
03 Feb 04	22:00:00	59	72	43	62	47
03 Feb 04	22:15:00	60	78	45	62	49
03 Feb 04	22:30:00	58	70	44	62	48
03 Feb 04	22:45:00	58	69	41	62	46
03 Feb 04	23:00:00	59	75	41	62	46
03 Feb 04	23:15:00	56	67	40	61	43
03 Feb 04	23:30:00	58	69	38	62	47
03 Feb 04	23:45:00	56	73	38	60	44
04 Feb 04	00:00:00	55	74	38	60	42
04 Feb 04	00:15:00	53	67	38	58	41
04 Feb 04	00:30:00	53	66	36	58	39
04 Feb 04	00:45:00	53	72	35	58	38
04 Feb 04	01:00:00	53	67	33	58	36
04 Feb 04	01:15:00	51	68	33	55	35
04 Feb 04	01:30:00	55	79	33	54	35
04 Feb 04	01:45:00	49	73	32	48	34
04 Feb 04	02:00:00	49	65	33	53	35
04 Feb 04	02:15:00	43	64	32	42	34
04 Feb 04	02:30:00	53	73	33	55	36
04 Feb 04	02:45:00	47	65	33	48	35
04 Feb 04	03:00:00	51	70	33	52	35
04 Feb 04	03:15:00	48	66	33	49	35
04 Feb 04	03:30:00	46	65	35	45	37
04 Feb 04	03:45:00	50	65	38	51	40
04 Feb 04	04:00:00	52	75	37	49	39
04 Feb 04	04:15:00	50	69	35	51	36
04 Feb 04	04:30:00	52	71	35	55	37
04 Feb 04	04:45:00	55	71	37	58	40
04 Feb 04	05:00:00	56	72	39	60	40
04 Feb 04	05:15:00	57	73	39	61	44
04 Feb 04	05:30:00	57	70	40	62	43
04 Feb 04	05:45:00	58	71	43	62	47
04 Feb 04	06:00:00	59	72	43	63	46
04 Feb 04	06:15:00	60	73	43	64	49
04 Feb 04	06:30:00	62	74	48	66	53
04 Feb 04	06:45:00	62	76	47	65	52
04 Feb 04	07:00:00	63	72	48	66	56
04 Feb 04	07:15:00	63	73	50	66	57
04 Feb 04	07:30:00	64	79	49	66	59
04 Feb 04	07:45:00	63	71	52	65	59

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
04 Feb 04	08:00:00	63	74	54	65	59
04 Feb 04	08:15:00	63	72	55	65	59
04 Feb 04	08:30:00	63	72	55	66	59
04 Feb 04	08:45:00	63	72	51	65	58
04 Feb 04	09:00:00	63	76	54	66	59
04 Feb 04	09:15:00	63	72	52	66	58
04 Feb 04	09:30:00	62	75	51	65	55
04 Feb 04	09:45:00	63	74	49	65	58
04 Feb 04	10:00:00	62	75	50	65	56
04 Feb 04	10:15:00	62	75	51	65	55
04 Feb 04	10:30:00	63	76	50	65	55
04 Feb 04	10:45:00	62	75	52	65	55
04 Feb 04	11:00:00	63	73	51	65	57
04 Feb 04	11:15:00	62	73	51	65	56
04 Feb 04	11:30:00	62	73	51	65	55
04 Feb 04	11:45:00	62	76	51	65	56
04 Feb 04	12:00:00	62	82	51	65	55
04 Feb 04	12:15:00	62	73	51	64	55
04 Feb 04	12:30:00	62	72	49	65	55
04 Feb 04	12:45:00	61	71	49	64	54
04 Feb 04	13:00:00	62	77	50	64	55
04 Feb 04	13:15:00	62	79	51	65	57
04 Feb 04	13:30:00	63	77	50	65	56
04 Feb 04	13:45:00	62	75	50	64	55
04 Feb 04	14:00:00	63	80	52	66	56
04 Feb 04	14:15:00	62	72	51	65	56
04 Feb 04	14:30:00	63	76	51	65	57
04 Feb 04	14:45:00	62	72	51	65	56
04 Feb 04	15:00:00	62	74	50	65	56
04 Feb 04	15:15:00	63	86	51	64	55
04 Feb 04	15:30:00	63	74	52	66	58
04 Feb 04	15:45:00	63	74	51	65	57
04 Feb 04	16:00:00	62	76	52	65	57
04 Feb 04	16:15:00	62	76	50	64	57
04 Feb 04	16:30:00	63	77	50	64	57
04 Feb 04	16:45:00	64	86	51	65	58
04 Feb 04	17:00:00	62	72	52	64	57
04 Feb 04	17:15:00	62	78	50	65	56
04 Feb 04	17:30:00	62	75	51	64	58
04 Feb 04	17:45:00	62	74	49	64	57
04 Feb 04	18:00:00	61	76	49	64	56
04 Feb 04	18:15:00	61	71	52	64	57
04 Feb 04	18:30:00	61	75	49	64	55
04 Feb 04	18:45:00	62	80	50	64	55
04 Feb 04	19:00:00	61	71	48	64	55
04 Feb 04	19:15:00	64	87	49	64	55
04 Feb 04	19:30:00	61	77	50	64	55
04 Feb 04	19:45:00	62	72	49	64	55
04 Feb 04	20:00:00	61	70	50	64	55

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
04 Feb 04	20:15:00	60	71	48	63	53
04 Feb 04	20:30:00	60	68	47	63	51
04 Feb 04	20:45:00	61	76	47	64	52
04 Feb 04	21:00:00	60	74	47	63	51
04 Feb 04	21:15:00	60	75	46	63	51
04 Feb 04	21:30:00	60	73	47	63	52
04 Feb 04	21:45:00	59	69	48	63	51
04 Feb 04	22:00:00	59	69	46	62	50
04 Feb 04	22:15:00	59	69	46	62	51
04 Feb 04	22:30:00	58	72	45	62	49
04 Feb 04	22:45:00	58	72	45	61	49
04 Feb 04	23:00:00	58	72	45	62	48
04 Feb 04	23:15:00	57	71	44	61	48
04 Feb 04	23:30:00	58	73	46	62	49
04 Feb 04	23:45:00	57	67	44	61	48
05 Feb 04	00:00:00	57	71	43	61	48
05 Feb 04	00:15:00	55	67	42	60	45
05 Feb 04	00:30:00	54	71	43	58	45
05 Feb 04	00:45:00	56	73	42	60	44
05 Feb 04	01:00:00	54	68	41	59	44
05 Feb 04	01:15:00	51	66	39	55	41
05 Feb 04	01:30:00	54	71	41	58	43
05 Feb 04	01:45:00	53	70	38	56	41
05 Feb 04	02:00:00	50	67	39	53	40
05 Feb 04	02:15:00	50	69	38	54	40
05 Feb 04	02:30:00	50	71	37	53	40
05 Feb 04	02:45:00	52	74	39	54	42
05 Feb 04	03:00:00	52	71	40	54	42
05 Feb 04	03:15:00	52	70	39	55	41
05 Feb 04	03:30:00	52	72	38	54	40
05 Feb 04	03:45:00	53	73	39	57	42
05 Feb 04	04:00:00	52	73	41	56	43
05 Feb 04	04:15:00	55	74	41	59	44
05 Feb 04	04:30:00	52	71	41	56	43
05 Feb 04	04:45:00	54	70	41	58	44
05 Feb 04	05:00:00	56	70	42	60	45
05 Feb 04	05:15:00	58	73	42	62	47
05 Feb 04	05:30:00	58	79	43	62	47
05 Feb 04	05:45:00	58	70	44	62	47
05 Feb 04	06:00:00	60	74	45	63	49
05 Feb 04	06:15:00	60	73	45	64	48
05 Feb 04	06:30:00	62	75	47	65	53
05 Feb 04	06:45:00	62	72	49	65	54
05 Feb 04	07:00:00	63	70	49	66	57
05 Feb 04	07:15:00	63	73	52	65	57
05 Feb 04	07:30:00	64	88	52	64	57
05 Feb 04	07:45:00	62	73	50	65	56
05 Feb 04	08:00:00	63	75	54	65	59
05 Feb 04	08:15:00	62	71	50	64	55

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
05 Feb 04	08:30:00	61	71	52	64	56
05 Feb 04	08:45:00	62	75	51	64	56
05 Feb 04	09:00:00	62	74	51	64	57
05 Feb 04	09:15:00	63	80	50	65	57
05 Feb 04	09:30:00	63	75	50	65	54
05 Feb 04	09:45:00	62	72	52	64	57
05 Feb 04	10:00:00	63	76	53	65	56
05 Feb 04	10:15:00	62	77	50	65	55
05 Feb 04	10:30:00	61	74	51	64	55
05 Feb 04	10:45:00	62	79	50	65	55
05 Feb 04	11:00:00	62	75	49	64	55
05 Feb 04	11:15:00	62	75	49	65	54
05 Feb 04	11:30:00	63	80	50	65	54
05 Feb 04	11:45:00	61	70	52	64	55
05 Feb 04	12:00:00	62	72	51	64	55
05 Feb 04	12:15:00	62	72	51	65	56
05 Feb 04	12:30:00	63	85	52	65	56
05 Feb 04	12:45:00	62	79	51	65	57
05 Feb 04	13:00:00	62	73	49	65	55
05 Feb 04	13:15:00	62	75	50	64	55
05 Feb 04	13:30:00	62	73	51	64	57
05 Feb 04	13:45:00	61	74	50	64	55
05 Feb 04	14:00:00	62	73	50	64	56
05 Feb 04	14:15:00	62	75	48	65	56
05 Feb 04	14:30:00	63	81	50	65	56
05 Feb 04	14:45:00	62	74	49	64	55
05 Feb 04	15:00:00	62	77	49	65	54
05 Feb 04	15:15:00	63	78	49	65	54
05 Feb 04	15:30:00	62	72	50	65	56
05 Feb 04	15:45:00	63	79	52	65	57
05 Feb 04	16:00:00	60	69	51	63	55
05 Feb 04	16:15:00	63	80	52	66	57
05 Feb 04	16:30:00	61	71	51	64	57
05 Feb 04	16:45:00	62	71	48	64	55
05 Feb 04	17:00:00	61	78	49	63	55
05 Feb 04	17:15:00	63	76	49	65	57
05 Feb 04	17:30:00	61	74	48	63	54
05 Feb 04	17:45:00	61	79	49	63	55
05 Feb 04	18:11:14	62	81	52	64	56
05 Feb 04	18:15:00	62	73	50	64	57
05 Feb 04	18:30:00	61	79	50	64	55
05 Feb 04	18:45:00	61	72	50	63	55
05 Feb 04	19:00:00	62	73	48	64	54
05 Feb 04	19:15:00	61	74	48	64	55
05 Feb 04	19:30:00	64	85	49	64	55
05 Feb 04	19:45:00	62	74	50	64	56
05 Feb 04	20:00:00	61	85	47	64	53
05 Feb 04	20:15:00	60	77	48	63	52
05 Feb 04	20:30:00	61	86	47	63	53

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
05 Feb 04	20:45:00	61	75	49	63	54
05 Feb 04	21:00:00	60	72	48	63	52
05 Feb 04	21:15:00	60	70	47	63	52
05 Feb 04	21:30:00	61	80	48	64	53
05 Feb 04	21:45:00	59	69	47	62	51
05 Feb 04	22:00:00	59	72	48	63	51
05 Feb 04	22:15:00	60	73	48	63	51
05 Feb 04	22:30:00	60	73	49	63	52
05 Feb 04	22:45:00	59	72	46	63	51
05 Feb 04	23:00:00	60	78	46	63	52
05 Feb 04	23:15:00	58	70	45	62	49
05 Feb 04	23:30:00	58	74	45	61	49
05 Feb 04	23:45:00	57	68	45	61	48
06 Feb 04	00:00:00	56	73	43	61	47
06 Feb 04	00:15:00	56	70	44	61	46
06 Feb 04	00:30:00	55	74	43	59	46
06 Feb 04	00:45:00	56	71	43	60	46
06 Feb 04	01:00:00	56	77	41	60	45
06 Feb 04	01:15:00	54	72	41	58	43
06 Feb 04	01:30:00	54	72	41	59	44
06 Feb 04	01:45:00	55	74	42	59	45
06 Feb 04	02:00:00	52	69	40	55	42
06 Feb 04	02:15:00	53	71	40	58	43
06 Feb 04	02:30:00	52	65	38	56	42
06 Feb 04	02:45:00	53	69	39	58	43
06 Feb 04	03:00:00	52	65	39	56	41
06 Feb 04	03:15:00	50	65	38	53	40
06 Feb 04	03:30:00	54	71	39	57	41
06 Feb 04	03:45:00	52	70	38	54	40
06 Feb 04	04:00:00	53	75	37	56	39
06 Feb 04	04:15:00	53	71	38	55	40
06 Feb 04	04:30:00	53	71	37	56	39
06 Feb 04	04:45:00	52	71	37	54	39
06 Feb 04	05:00:00	55	67	38	60	42
06 Feb 04	05:15:00	57	70	39	61	42
06 Feb 04	05:30:00	57	71	40	61	43
06 Feb 04	05:45:00	57	72	40	62	43
06 Feb 04	06:00:00	60	74	43	64	46
06 Feb 04	06:15:00	60	74	44	65	48
06 Feb 04	06:30:00	62	75	48	65	52
06 Feb 04	06:45:00	62	77	47	65	51
06 Feb 04	07:00:00	62	76	49	65	55
06 Feb 04	07:15:00	63	76	48	65	58
06 Feb 04	07:30:00	62	69	49	64	55
06 Feb 04	07:45:00	62	70	51	64	58
06 Feb 04	08:00:00	62	78	49	64	57
06 Feb 04	08:15:00	62	73	49	64	56
06 Feb 04	08:30:00	62	71	52	64	58
06 Feb 04	08:45:00	62	75	51	65	56

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
06 Feb 04	09:00:00	62	72	50	65	57
06 Feb 04	09:15:00	62	77	51	65	57
06 Feb 04	09:30:00	61	70	48	64	54
06 Feb 04	09:45:00	63	74	48	65	55
06 Feb 04	10:00:00	62	79	47	65	53
06 Feb 04	10:15:00	61	74	47	64	52
06 Feb 04	10:30:00	62	75	47	65	54
06 Feb 04	10:45:00	62	74	46	65	52
06 Feb 04	11:00:00	61	72	47	64	54
06 Feb 04	11:15:00	62	75	48	65	56
06 Feb 04	11:30:00	61	73	47	65	53
06 Feb 04	11:45:00	61	73	47	64	53
06 Feb 04	12:00:00	61	70	47	64	53
06 Feb 04	12:15:00	62	82	48	64	55
06 Feb 04	12:30:00	62	76	47	65	54
06 Feb 04	12:45:00	62	74	47	64	54
06 Feb 04	13:00:00	62	74	47	64	55
06 Feb 04	13:15:00	62	77	45	65	53
06 Feb 04	13:30:00	62	73	46	65	54
06 Feb 04	13:45:00	62	75	45	65	52
06 Feb 04	14:00:00	62	77	48	64	54
06 Feb 04	14:15:00	61	72	47	64	54
06 Feb 04	14:30:00	61	73	45	64	52
06 Feb 04	14:45:00	62	74	45	65	54
06 Feb 04	15:00:00	62	76	48	64	55
06 Feb 04	15:15:00	62	79	45	65	55
06 Feb 04	15:30:00	62	75	47	64	55
06 Feb 04	15:45:00	61	74	47	64	54
06 Feb 04	16:00:00	62	71	48	64	57
06 Feb 04	16:15:00	61	77	46	64	53
06 Feb 04	16:30:00	62	72	50	64	56
06 Feb 04	16:45:00	62	78	48	64	56
06 Feb 04	17:00:00	62	80	48	64	54
06 Feb 04	17:15:00	61	74	48	64	54
06 Feb 04	17:30:00	61	73	49	64	56
06 Feb 04	17:45:00	61	76	48	63	53
06 Feb 04	18:00:00	62	73	50	64	55
06 Feb 04	18:15:00	64	78	48	66	55
06 Feb 04	18:30:00	61	73	47	64	54
06 Feb 04	18:45:00	62	74	49	64	55
06 Feb 04	19:00:00	62	76	46	64	54
06 Feb 04	19:15:00	64	86	49	64	55
06 Feb 04	19:30:00	61	72	49	64	54
06 Feb 04	19:45:00	61	68	47	64	51
06 Feb 04	20:00:00	60	68	47	64	52
06 Feb 04	20:15:00	61	72	47	64	52
06 Feb 04	20:30:00	61	73	47	64	54
06 Feb 04	20:45:00	61	70	47	64	53
06 Feb 04	21:00:00	61	74	47	64	52

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
06 Feb 04	21:15:00	60	74	46	64	51
06 Feb 04	21:30:00	60	72	46	63	50
06 Feb 04	21:45:00	60	72	47	64	51
06 Feb 04	22:00:00	59	73	48	63	51
06 Feb 04	22:15:00	59	75	46	63	49
06 Feb 04	22:30:00	59	75	47	62	50
06 Feb 04	22:45:00	57	67	45	61	48
06 Feb 04	23:00:00	59	77	44	62	48
06 Feb 04	23:15:00	58	68	44	62	48
06 Feb 04	23:30:00	56	67	43	61	47
06 Feb 04	23:45:00	58	67	44	62	47
07 Feb 04	00:00:00	58	75	44	62	47
07 Feb 04	00:15:00	57	69	44	61	47
07 Feb 04	00:30:00	57	75	44	61	47
07 Feb 04	00:45:00	56	69	43	61	46
07 Feb 04	01:00:00	56	67	43	61	47
07 Feb 04	01:15:00	57	69	45	61	48
07 Feb 04	01:30:00	56	70	44	60	48
07 Feb 04	01:45:00	57	71	43	61	47
07 Feb 04	02:00:00	57	71	43	61	47
07 Feb 04	02:15:00	56	77	43	60	47
07 Feb 04	02:30:00	55	69	42	59	45
07 Feb 04	02:45:00	56	71	43	60	46
07 Feb 04	03:00:00	54	66	41	59	43
07 Feb 04	03:15:00	53	68	41	58	43
07 Feb 04	03:30:00	54	69	41	59	43
07 Feb 04	03:45:00	54	74	40	59	42
07 Feb 04	04:00:00	49	66	39	50	40
07 Feb 04	04:15:00	55	71	40	59	42
07 Feb 04	04:30:00	56	74	41	60	45
07 Feb 04	04:45:00	56	72	41	60	44
07 Feb 04	05:00:00	55	68	39	59	43
07 Feb 04	05:15:00	56	69	40	61	44
07 Feb 04	05:30:00	56	68	41	61	44
07 Feb 04	05:45:00	56	70	40	61	44
07 Feb 04	06:00:00	57	70	42	61	45
07 Feb 04	06:15:00	57	71	43	61	46
07 Feb 04	06:30:00	58	70	44	62	47
07 Feb 04	06:45:00	60	79	45	63	49
07 Feb 04	07:00:00	58	69	44	63	47
07 Feb 04	07:15:00	60	78	47	64	50
07 Feb 04	07:30:00	60	79	46	64	51
07 Feb 04	07:45:00	61	71	47	64	50
07 Feb 04	08:00:00	61	72	48	65	52
07 Feb 04	08:15:00	61	72	47	65	53
07 Feb 04	08:30:00	61	70	48	64	53
07 Feb 04	08:45:00	61	73	48	64	54
07 Feb 04	09:00:00	62	74	50	65	53
07 Feb 04	09:15:00	62	73	49	64	54

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
07 Feb 04	09:30:00	62	78	49	65	55
07 Feb 04	09:45:00	62	71	47	65	54
07 Feb 04	10:00:00	61	71	48	64	54
07 Feb 04	10:15:00	62	72	50	65	55
07 Feb 04	10:30:00	62	74	49	64	54
07 Feb 04	10:45:00	61	72	46	64	55
07 Feb 04	11:00:00	61	72	50	64	55
07 Feb 04	11:15:00	62	71	49	64	57
07 Feb 04	11:30:00	62	73	50	64	56
07 Feb 04	11:45:00	62	71	48	65	55
07 Feb 04	12:00:00	68	93	51	65	55
07 Feb 04	12:15:00	62	70	50	65	57
07 Feb 04	12:30:00	62	76	51	65	57
07 Feb 04	12:45:00	61	71	48	64	55
07 Feb 04	13:00:00	62	73	47	64	56
07 Feb 04	13:15:00	62	72	48	64	55
07 Feb 04	13:30:00	62	69	50	64	57
07 Feb 04	13:45:00	62	70	52	64	57
07 Feb 04	14:00:00	61	73	48	64	55
07 Feb 04	14:15:00	63	83	49	66	58
07 Feb 04	14:30:00	62	71	50	65	57
07 Feb 04	14:45:00	63	70	50	65	59
07 Feb 04	15:00:00	62	73	50	65	56
07 Feb 04	15:15:00	62	72	51	65	57
07 Feb 04	15:30:00	62	71	50	65	57
07 Feb 04	15:45:00	63	73	47	65	57
07 Feb 04	16:00:00	62	71	49	64	58
07 Feb 04	16:15:00	62	70	51	65	56
07 Feb 04	16:30:00	63	75	50	65	57
07 Feb 04	16:45:00	62	74	49	65	55
07 Feb 04	17:00:00	62	75	49	64	57
07 Feb 04	17:15:00	62	70	49	64	56
07 Feb 04	17:30:00	62	73	51	64	56
07 Feb 04	17:45:00	62	74	50	65	55
07 Feb 04	18:00:00	63	74	51	65	57
07 Feb 04	18:15:00	63	78	50	66	58
07 Feb 04	18:30:00	62	76	51	65	57
07 Feb 04	18:45:00	62	77	49	65	55
07 Feb 04	19:00:00	62	75	50	65	56
07 Feb 04	19:15:00	62	71	50	65	56
07 Feb 04	19:30:00	63	80	51	65	57
07 Feb 04	19:45:00	62	74	51	65	56
07 Feb 04	20:00:00	62	73	50	65	55
07 Feb 04	20:15:00	62	80	48	65	54
07 Feb 04	20:30:00	63	82	50	66	56
07 Feb 04	20:45:00	63	87	49	65	55
07 Feb 04	21:00:00	61	76	47	64	53
07 Feb 04	21:15:00	61	77	47	65	54
07 Feb 04	21:30:00	62	83	46	65	51

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
07 Feb 04	21:45:00	61	71	47	64	53
07 Feb 04	22:00:00	59	75	46	63	50
07 Feb 04	22:15:00	59	74	45	63	51
07 Feb 04	22:30:00	59	73	44	63	49
07 Feb 04	22:45:00	60	79	47	63	50
07 Feb 04	23:00:00	59	74	47	63	50
07 Feb 04	23:15:00	59	72	45	63	49
07 Feb 04	23:30:00	59	75	47	62	50
07 Feb 04	23:45:00	59	75	45	62	49
08 Feb 04	00:00:00	59	76	43	62	49
08 Feb 04	00:15:00	59	76	45	62	50
08 Feb 04	00:30:00	60	77	46	63	50
08 Feb 04	00:45:00	58	75	45	62	49
08 Feb 04	01:00:00	58	77	43	61	48
08 Feb 04	01:15:00	60	82	44	63	49
08 Feb 04	01:30:00	64	87	45	62	49
08 Feb 04	01:45:00	57	73	44	61	47
08 Feb 04	02:00:00	57	69	43	62	47
08 Feb 04	02:15:00	57	74	44	61	47
08 Feb 04	02:30:00	56	70	43	60	46
08 Feb 04	02:45:00	55	69	41	60	44
08 Feb 04	03:00:00	55	73	41	59	44
08 Feb 04	03:15:00	55	72	41	59	43
08 Feb 04	03:30:00	53	69	39	57	42
08 Feb 04	03:45:00	53	74	41	57	43
08 Feb 04	04:00:00	61	89	41	60	45
08 Feb 04	04:15:00	55	69	42	60	45
08 Feb 04	04:30:00	54	69	41	57	44
08 Feb 04	04:45:00	54	74	40	58	44
08 Feb 04	05:00:00	55	69	41	60	44
08 Feb 04	05:15:00	56	67	41	61	45
08 Feb 04	05:30:00	56	72	41	60	45
08 Feb 04	05:45:00	56	70	39	60	41
08 Feb 04	06:00:00	55	70	39	59	42
08 Feb 04	06:15:00	55	67	40	60	44
08 Feb 04	06:30:00	56	74	41	61	43
08 Feb 04	06:45:00	55	68	40	60	44
08 Feb 04	07:00:00	63	73	48	66	56
08 Feb 04	07:15:00	63	73	51	66	57
08 Feb 04	07:30:00	64	79	49	67	59
08 Feb 04	07:45:00	63	71	52	65	59
08 Feb 04	08:00:00	63	74	54	65	59
08 Feb 04	08:15:00	63	71	54	65	59
08 Feb 04	08:30:00	62	72	55	65	59
08 Feb 04	08:45:00	63	72	51	65	58
08 Feb 04	09:00:00	63	76	54	66	59
08 Feb 04	09:15:00	63	72	52	66	58
08 Feb 04	09:30:00	62	75	51	65	55
08 Feb 04	09:45:00	63	74	49	65	58

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
08 Feb 04	10:00:00	63	74	50	65	56
08 Feb 04	10:15:00	62	75	51	64	55
08 Feb 04	10:30:00	63	76	50	65	55
08 Feb 04	10:45:00	62	75	52	65	56
08 Feb 04	11:00:00	63	73	51	65	57
08 Feb 04	11:15:00	63	73	51	65	56
08 Feb 04	11:30:00	62	73	51	65	55
08 Feb 04	11:45:00	61	76	51	65	56
08 Feb 04	12:00:00	62	82	51	64	55
08 Feb 04	12:15:00	62	73	51	64	55
08 Feb 04	12:30:00	62	72	49	65	55
08 Feb 04	12:45:00	61	71	49	64	54
08 Feb 04	13:00:00	62	77	50	64	55
08 Feb 04	13:15:00	62	79	51	65	57
08 Feb 04	13:30:00	63	76	50	65	56
08 Feb 04	13:45:00	62	75	50	64	56
08 Feb 04	14:00:00	63	80	52	66	56
08 Feb 04	14:15:00	62	72	51	65	56
08 Feb 04	14:30:00	64	76	51	65	57
08 Feb 04	14:45:00	62	72	51	64	56
08 Feb 04	15:00:00	62	74	50	65	56
08 Feb 04	15:15:00	63	86	52	64	55
08 Feb 04	15:30:00	63	74	52	66	58
08 Feb 04	15:45:00	63	74	51	65	57
08 Feb 04	16:00:00	62	76	52	65	57
08 Feb 04	16:15:00	62	76	50	64	57
08 Feb 04	16:30:00	63	77	50	64	57
08 Feb 04	16:45:00	64	86	51	65	58
08 Feb 04	17:00:00	62	72	52	64	57
08 Feb 04	17:15:00	62	78	50	65	56
08 Feb 04	17:30:00	62	75	51	64	57
08 Feb 04	17:45:00	62	74	49	64	57
08 Feb 04	18:00:00	62	76	50	64	56
08 Feb 04	18:15:00	61	71	52	64	57
08 Feb 04	18:30:00	61	75	49	64	55
08 Feb 04	18:45:00	62	80	49	63	55
08 Feb 04	19:00:00	62	70	48	64	55
08 Feb 04	19:15:00	64	87	49	64	55
08 Feb 04	19:30:00	61	77	50	64	55
08 Feb 04	19:45:00	62	72	49	64	55
08 Feb 04	20:00:00	61	70	50	63	55
08 Feb 04	20:15:00	60	71	48	63	53
08 Feb 04	20:30:00	60	68	47	63	51
08 Feb 04	20:45:00	61	76	47	64	52
08 Feb 04	21:00:00	60	74	47	63	51
08 Feb 04	21:15:00	60	75	47	64	51
08 Feb 04	21:30:00	60	73	47	63	52
08 Feb 04	21:45:00	59	69	48	63	51
08 Feb 04	22:00:00	59	69	46	62	50

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
08 Feb 04	22:15:00	59	69	46	62	51
08 Feb 04	22:30:00	58	72	45	62	49
08 Feb 04	22:45:00	58	72	45	61	49
08 Feb 04	23:00:00	58	72	45	62	48
08 Feb 04	23:15:00	57	71	44	61	48
08 Feb 04	23:30:00	58	73	46	62	49
08 Feb 04	23:45:00	57	67	44	61	47
09 Feb 04	00:00:00	57	71	43	61	48
09 Feb 04	00:15:00	55	67	43	60	45
09 Feb 04	00:30:00	54	71	43	59	45
09 Feb 04	00:45:00	56	73	42	59	44
09 Feb 04	01:00:00	54	69	41	59	44
09 Feb 04	01:15:00	51	66	39	55	41
09 Feb 04	01:30:00	54	71	41	58	43
09 Feb 04	01:45:00	53	70	38	56	41
09 Feb 04	02:00:00	51	67	39	53	40
09 Feb 04	02:15:00	50	70	38	54	40
09 Feb 04	02:30:00	50	71	37	53	40
09 Feb 04	02:45:00	52	74	39	54	42
09 Feb 04	03:00:00	52	71	40	54	41
09 Feb 04	03:15:00	52	70	39	55	41
09 Feb 04	03:30:00	52	71	38	54	40
09 Feb 04	03:45:00	53	73	39	57	42
09 Feb 04	04:00:00	52	73	41	56	43
09 Feb 04	04:15:00	55	74	41	58	43
09 Feb 04	04:30:00	52	71	41	56	43
09 Feb 04	04:45:00	54	70	41	58	44
09 Feb 04	05:00:00	56	70	42	60	45
09 Feb 04	05:15:00	58	72	42	62	46
09 Feb 04	05:30:00	58	79	43	62	47
09 Feb 04	05:45:00	58	70	44	62	47
09 Feb 04	06:00:00	60	74	45	63	49
09 Feb 04	06:15:00	60	73	45	64	48
09 Feb 04	06:30:00	62	75	47	65	53
09 Feb 04	06:45:00	62	73	49	65	54
09 Feb 04	07:00:00	63	70	49	66	57
09 Feb 04	07:15:00	63	73	52	65	57
09 Feb 04	07:30:00	64	88	52	64	57
09 Feb 04	07:45:00	62	73	50	65	56
09 Feb 04	08:00:00	62	78	49	64	57
09 Feb 04	08:15:00	62	73	49	64	56
09 Feb 04	08:30:00	62	71	52	64	58
09 Feb 04	08:45:00	61	75	51	65	56
09 Feb 04	09:00:00	62	72	50	65	57
09 Feb 04	09:15:00	62	77	51	65	57
09 Feb 04	09:30:00	61	70	48	64	54
09 Feb 04	09:45:00	63	74	48	65	55
09 Feb 04	10:00:00	62	79	47	65	53
09 Feb 04	10:15:00	61	74	47	64	52

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
09 Feb 04	10:30:00	62	75	47	65	54
09 Feb 04	10:45:00	62	74	46	65	52
09 Feb 04	11:00:00	61	72	47	64	54
09 Feb 04	11:15:00	62	75	48	65	56
09 Feb 04	11:30:00	61	73	47	65	53
09 Feb 04	11:45:00	61	73	47	64	53
09 Feb 04	12:00:00	61	70	47	64	53
09 Feb 04	12:15:00	62	82	48	64	55
09 Feb 04	12:30:00	62	76	47	65	54
09 Feb 04	12:45:00	62	74	48	64	54
09 Feb 04	13:00:00	62	74	47	64	55
09 Feb 04	13:15:00	62	77	45	65	53
09 Feb 04	13:30:00	62	73	46	65	54
09 Feb 04	13:45:00	62	75	45	65	52
09 Feb 04	14:00:00	62	77	48	64	54
09 Feb 04	14:15:00	61	72	47	64	54
09 Feb 04	14:30:00	61	73	45	64	52
09 Feb 04	14:45:00	62	74	45	65	54
09 Feb 04	15:00:00	62	76	49	64	55
09 Feb 04	15:15:00	62	79	45	65	55
09 Feb 04	15:30:00	62	75	47	64	55
09 Feb 04	15:45:00	61	74	47	64	54
09 Feb 04	16:00:00	62	71	48	64	57
09 Feb 04	16:15:00	61	77	46	64	53
09 Feb 04	16:30:00	62	72	50	64	56
09 Feb 04	16:45:00	62	78	48	64	56
09 Feb 04	17:00:00	62	80	48	64	54
09 Feb 04	17:15:00	61	74	48	64	54
09 Feb 04	17:30:00	61	73	49	64	56
09 Feb 04	17:45:00	61	76	48	63	53
09 Feb 04	18:00:00	62	73	50	64	55
09 Feb 04	18:15:00	64	78	48	66	55
09 Feb 04	18:30:00	61	73	47	64	54
09 Feb 04	18:45:00	62	74	49	64	55
09 Feb 04	19:00:00	62	76	46	64	54
09 Feb 04	19:15:00	64	86	49	64	55
09 Feb 04	19:30:00	61	72	49	64	54
09 Feb 04	19:45:00	61	68	47	64	51
09 Feb 04	20:00:00	60	68	47	64	52
09 Feb 04	20:15:00	61	72	47	64	52
09 Feb 04	20:30:00	61	73	47	64	54
09 Feb 04	20:45:00	61	70	47	64	53
09 Feb 04	21:00:00	61	74	47	64	52
09 Feb 04	21:15:00	60	74	46	64	51
09 Feb 04	21:30:00	60	72	46	63	50
09 Feb 04	21:45:00	60	72	47	64	51
09 Feb 04	22:00:00	59	73	48	63	51
09 Feb 04	22:15:00	59	75	46	63	49
09 Feb 04	22:30:00	59	75	47	62	50

Date	Time	Measured Noise Levels (dB re. 2x10^{-5} Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
09 Feb 04	22:45:00	57	67	45	61	48
09 Feb 04	23:00:00	59	77	44	62	48
09 Feb 04	23:15:00	58	68	44	62	48
09 Feb 04	23:30:00	56	67	43	61	47
09 Feb 04	23:45:00	58	67	44	62	47
10 Feb 04	00:00:00	58	75	44	62	47
10 Feb 04	00:15:00	57	69	44	61	47
10 Feb 04	00:30:00	57	75	44	61	47
10 Feb 04	00:45:00	56	69	43	61	46
10 Feb 04	01:00:00	56	67	43	61	47
10 Feb 04	01:15:00	57	69	45	62	48
10 Feb 04	01:30:00	56	70	44	60	48
10 Feb 04	01:45:00	57	71	43	61	47
10 Feb 04	02:00:00	57	71	43	61	47
10 Feb 04	02:15:00	56	77	43	60	47
10 Feb 04	02:30:00	55	69	42	59	45
10 Feb 04	02:45:00	56	71	43	60	46
10 Feb 04	03:00:00	54	66	41	59	43
10 Feb 04	03:15:00	53	68	41	58	43
10 Feb 04	03:30:00	54	69	41	59	43
10 Feb 04	03:45:00	54	74	40	59	42
10 Feb 04	04:00:00	49	66	39	50	41
10 Feb 04	04:15:00	55	71	40	59	42
10 Feb 04	04:30:00	56	74	42	60	45
10 Feb 04	04:45:00	56	72	41	60	44
10 Feb 04	05:00:00	55	68	39	59	43
10 Feb 04	05:15:00	57	69	40	61	44
10 Feb 04	05:30:00	56	68	41	61	44
10 Feb 04	05:45:00	56	70	40	61	44
10 Feb 04	06:00:00	57	70	42	61	45
10 Feb 04	06:15:00	57	71	43	62	46
10 Feb 04	06:30:00	58	70	44	62	47
10 Feb 04	06:45:00	60	79	45	63	49
10 Feb 04	07:00:00	58	69	44	63	47
10 Feb 04	07:15:00	60	78	47	64	50
10 Feb 04	07:30:00	60	79	46	64	51
10 Feb 04	07:45:00	61	71	47	64	50
10 Feb 04	08:00:00	61	72	48	65	52
10 Feb 04	08:15:00	61	72	47	65	54
10 Feb 04	08:30:00	61	70	48	64	53
10 Feb 04	08:45:00	61	73	48	64	54
10 Feb 04	09:00:00	62	74	50	65	53
10 Feb 04	09:15:00	62	73	49	64	54
10 Feb 04	09:30:00	62	78	49	65	55
10 Feb 04	09:45:00	63	71	47	65	54
10 Feb 04	10:00:00	61	71	48	64	54
10 Feb 04	10:15:00	62	72	50	65	55
10 Feb 04	10:30:00	62	74	49	64	54
10 Feb 04	10:45:00	61	72	46	64	55

Date	Time	Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AMAx}	L_{AMin}	L_{A10}	L_{A90}
10 Feb 04	11:00:00	61	72	50	64	55
10 Feb 04	11:15:00	62	71	49	64	57
10 Feb 04	11:30:00	62	73	50	64	56
10 Feb 04	11:45:00	62	70	48	65	55
10 Feb 04	12:00:00	68	93	51	65	55
10 Feb 04	12:15:00	62	70	50	65	57
10 Feb 04	12:30:00	62	76	51	65	57
10 Feb 04	12:45:00	61	71	48	64	55
10 Feb 04	13:00:00	62	73	47	64	55
10 Feb 04	13:15:00	62	72	48	64	55
10 Feb 04	13:30:00	62	69	50	64	57
10 Feb 04	13:45:00	62	70	52	64	57
10 Feb 04	14:00:00	61	73	48	64	55
10 Feb 04	14:15:00	63	83	49	66	58
10 Feb 04	14:30:00	62	71	50	65	57
10 Feb 04	14:45:00	63	70	50	65	59
10 Feb 04	15:00:00	62	73	50	65	56
10 Feb 04	15:15:00	62	72	51	65	57
10 Feb 04	15:30:00	62	71	50	65	57
10 Feb 04	15:45:00	63	73	47	65	57
10 Feb 04	16:00:00	62	71	49	64	58
10 Feb 04	16:15:00	62	70	51	65	56
10 Feb 04	16:30:00	63	75	50	65	57
10 Feb 04	16:45:00	62	74	49	65	55
10 Feb 04	17:00:00	62	75	49	64	57
10 Feb 04	17:15:00	62	70	49	64	56
10 Feb 04	17:30:00	62	73	51	64	56
10 Feb 04	17:45:00	62	74	50	65	55
10 Feb 04	18:00:00	63	74	51	65	57
10 Feb 04	18:15:00	63	78	50	66	58
10 Feb 04	18:30:00	62	76	51	65	57
10 Feb 04	18:45:00	62	76	49	65	55
10 Feb 04	19:00:00	62	75	50	65	56
10 Feb 04	19:15:00	62	71	50	65	56
10 Feb 04	19:30:00	63	80	51	65	57
10 Feb 04	19:45:00	62	74	51	65	56
10 Feb 04	20:00:00	62	73	50	65	55
10 Feb 04	20:15:00	62	80	48	65	54
10 Feb 04	20:30:00	63	82	50	66	56
10 Feb 04	20:45:00	63	87	49	65	55
10 Feb 04	21:00:00	61	76	47	64	53
10 Feb 04	21:15:00	61	77	47	65	54
10 Feb 04	21:30:00	62	83	46	65	51
10 Feb 04	21:45:00	61	71	47	65	53
10 Feb 04	22:00:00	59	75	46	63	51

Table C2 Phase 2 Continuous Noise Monitoring Results Location C

APPENDIX D
VIBRATION MONITORING DATA[7]

Time	Tran PPV mm/s	Tran Freq Hz	Vert PPV mm/s	Vert Freq Hz	Long PPV mm/s	Long Freq Hz
13:56	0.08	37	0.05	>100	0.06	>100
13:57	0.08	>100	0.05	>100	0.06	>100
13:58	0.08	51	0.05	>100	0.06	>100
13:59	0.08	43	0.05	>100	0.06	>100
14:00	0.08	37	0.03	>100	0.06	73
14:01	0.08	39	0.05	73	0.06	>100
14:02	0.08	14	0.05	>100	0.06	23
14:03	0.08	34	0.05	>100	0.06	>100
14:04	0.08	43	0.03	>100	0.06	43
14:05	0.08	26	0.05	>100	0.06	73
14:06	0.08	43	0.08	13	0.06	73
14:07	0.11	34	0.27	43	0.11	64
14:08	0.08	6.2	0.05	>100	0.06	85
14:09	0.08	34	0.05	>100	0.06	27
14:10	0.08	43	0.05	85	0.06	21
14:11	0.08	8.5	0.05	>100	0.05	64
14:12	0.08	13	0.05	>100	0.06	37
14:13	0.08	8.1	0.05	73	0.06	30
14:14	0.08	8.8	0.05	>100	0.06	47
14:15	0.08	43	0.05	64	0.06	>100
14:16	0.08	11	0.05	>100	0.06	18
14:17	0.08	9	0.05	>100	0.06	73
14:18	0.08	14	0.05	>100	0.05	>100
14:19	0.08	57	0.05	>100	0.05	>100
14:20	0.08	4.8	0.05	>100	0.06	85
14:21	0.08	19	0.05	>100	0.06	64
14:22	0.08	8.1	0.05	>100	0.06	>100
14:23	0.11	51	0.27	13	0.11	7.9
14:24	0.10	9.1	0.24	11	0.08	8
14:25	0.08	13	0.05	85	0.06	28
14:26	0.08	12	0.05	>100	0.06	64
14:27	0.08	8.3	0.05	>100	0.06	57
14:28	0.06	64	0.05	>100	0.05	>100
14:29	0.08	43	0.05	>100	0.06	43
14:30	0.08	9	0.05	>100	0.06	>100
14:31	0.10	11	0.22	11	0.08	20
14:32	0.08	20	0.06	18	0.08	11
14:33	0.08	47	0.05	>100	0.08	16
14:34	0.08	7.8	0.05	73	0.06	>100
14:35	0.08	21	0.05	>100	0.06	85
14:36	0.08	14	0.05	>100	0.06	32
14:37	0.08	11	0.05	85	0.06	>100
14:38	0.06	85	0.05	>100	0.05	>100
14:39	0.08	34	0.05	>100	0.06	>100
14:40	0.08	47	0.03	>100	0.06	47

Table E1 Monitored Vibration Levels at Location A

7 All vibration monitoring was conducted on 22 January 2004.

Time	Tran	Tran	Vert	Vert	Long	Long
	PPV	Freq	PPV	Freq	PPV	Freq
	mm/s	Hz	mm/s	Hz	mm/s	Hz
14:45	0.10	8	0.06	14	0.06	>100
14:46	0.08	9.1	0.05	>100	0.06	>100
14:47	0.08	10	0.10	11	0.06	27
14:48	0.10	9	0.11	12	0.06	32
14:49	0.10	17	0.10	11	0.10	13
14:50	0.10	13	0.11	11	0.10	16
14:51	0.08	11	0.10	11	0.08	20
14:52	0.08	37	0.06	19	0.06	32
14:53	0.08	15	0.06	15	0.06	39
14:54	0.10	6.6	0.10	11	0.08	27
14:55	0.10	13	0.10	15	0.06	22
14:56	0.11	8.3	0.11	10	0.08	10
14:57	0.08	5.5	0.08	16	0.06	64
14:58	0.08	32	0.06	15	0.06	>100
14:59	0.10	9.5	0.10	12	0.08	18
15:00	0.08	20	0.06	43	0.06	34
15:01	0.08	85	0.06	12	0.06	37
15:02	0.10	9.7	0.10	14	0.11	13
15:03	0.08	23	0.11	11	0.08	34
15:04	0.08	10	0.11	10	0.08	12
15:05	0.08	30	0.10	10	0.06	85
15:06	0.10	9.3	0.11	12	0.08	51
15:07	0.08	14	0.08	17	0.06	34
15:08	0.08	8.4	0.11	12	0.10	18
15:09	0.08	6.9	0.10	16	0.06	28
15:10	0.08	57	0.10	11	0.08	51
15:11	0.10	10	0.10	11	0.08	20
15:12	0.08	39	0.10	11	0.08	73
15:13	0.10	8.8	0.08	13	0.06	85
15:14	0.10	9.1	0.10	11	0.06	51
15:15	0.08	10	0.08	13	0.08	30
15:16	0.08	10	0.18	9.5	0.14	11
15:17	0.10	12	0.10	12	0.08	17
15:18	0.08	39	0.11	12	0.08	11
15:19	0.10	10	0.08	13	0.06	51
15:20	0.10	11	0.08	12	0.08	27
15:21	0.10	10	0.08	16	0.08	15
15:22	0.10	9.5	0.10	12	0.08	26
15:23	0.08	14	0.06	14	0.06	85
15:24	0.10	11	0.06	37	0.06	47
15:25	0.08	27	0.05	57	0.06	>100
15:26	0.08	51	0.05	>100	0.06	43
15:27	0.08	57	0.10	12	0.06	51
15:28	0.10	9.3	0.08	15	0.08	16
15:29	0.08	51	0.08	13	0.06	>100

Table E2 Monitored Vibration Levels at Location B

Time	Tran PPV mm/s	Tran Freq Hz	Vert PPV mm/s	Vert Freq Hz	Long PPV mm/s	Long Freq Hz
11:47:16	0.08	24	0.06	34	0.0	>100
11:48:16	0.08	43	0.05	>100	0.1	>100
11:49:16	0.08	47	0.05	>100	0.1	>100
11:50:16	0.08	9.3	0.05	>100	0.0	>100
11:51:16	0.10	34	0.06	39	0.1	>100
11:52:16	0.08	34	0.05	>100	0.0	>100
11:53:16	0.08	>100	0.05	>100	0.0	>100
11:54:16	0.08	22	0.05	>100	0.0	51
11:55:16	0.08	13	0.05	64	0.0	73
11:56:16	0.08	9.8	0.05	>100	0.0	>100
11:57:16	0.08	14	0.05	>100	0.0	>100
11:58:16	0.19	>100	0.18	>100	0.1	>100
11:59:16	0.08	23	0.05	>100	0.0	>100
12:00:16	0.08	73	0.05	>100	0.0	>100
12:01:16	0.08	11	0.05	>100	0.0	>100
12:02:16	0.08	13	0.06	21	0.1	>100
12:03:16	0.08	51	0.05	>100	0.0	>100
12:04:16	0.08	9.8	0.05	73	0.0	>100
12:05:16	0.08	43	0.06	27	0.0	>100
12:06:16	0.06	39	0.06	20	0.0	>100
12:07:16	0.08	51	0.05	>100	0.1	>100
12:08:16	0.08	28	0.08	13	0.0	>100
12:09:16	0.08	12	0.06	57	0.1	>100
12:10:16	0.08	13	0.10	12	0.1	85
12:11:16	0.08	51	0.05	34	0.0	>100
12:12:16	0.08	12	0.06	18	0.1	>100
12:13:16	0.06	64	0.05	>100	0.0	>100
12:14:16	0.08	26	0.06	57	0.1	>100
12:15:16	0.08	26	0.06	19	0.1	73
12:16:16	0.08	10	0.05	>100	0.0	>100
12:17:16	0.08	17	0.06	26	0.0	>100
12:18:16	0.06	43	0.05	>100	0.0	>100
12:19:16	0.44	57	0.30	>100	0.3	>100
12:20:16	0.08	14	0.05	>100	0.0	>100
12:21:16	0.08	21	0.06	18	0.1	>100
12:22:16	0.08	85	0.06	19	0.1	>100
12:23:16	0.08	34	0.06	20	0.1	>100
12:24:16	0.08	47	0.08	16	0.0	>100
12:25:16	0.08	17	0.06	27	0.1	>100
12:26:16	0.08	14	0.08	16	0.0	>100

Table D3 Monitored Vibration Levels at Location C

Time	Tran PPV mm/s	Tran Freq Hz	Vert PPV mm/s	Vert Freq Hz	Long PPV mm/s	Long Freq Hz
10:50	0.10	>100	0.21	16	0.08	37
10:51	0.08	57	0.08	28	0.06	39
10:52	0.08	19	0.14	16	0.08	39
10:53	0.08	37	0.18	18	0.10	34
10:54	0.06	64	0.08	20	0.06	>100
10:55	0.06	>100	0.10	18	0.08	57
10:56	0.08	8.3	0.13	18	0.06	64
10:57	0.11	73	0.10	20	0.06	>100
10:58	0.08	18	0.13	17	0.06	85
10:59	0.08	15	0.19	17	0.08	32
11:00	0.08	20	0.10	17	0.06	>100
11:01	0.08	17	0.18	17	0.06	57
11:02	0.08	28	0.22	24	0.14	20
11:03	0.08	47	0.18	17	0.06	57
11:04	0.08	27	0.10	19	0.06	>100
11:05	0.08	47	0.13	37	0.06	64
11:06	0.08	18	0.18	15	0.10	21
11:07	0.08	73	0.14	19	0.11	37
11:08	0.08	>100	0.19	17	0.10	18
11:09	0.08	7.1	0.13	19	0.10	43
11:10	0.08	47	0.14	17	0.08	34
11:11	0.08	8.8	0.16	17	0.10	18
11:12	0.08	18	0.14	16	0.08	20
11:13	0.08	13	0.18	18	0.08	34
11:14	2.25	43	0.65	47	1.17	51
11:15	0.08	11	0.06	27	0.05	>100
11:16	0.10	73	0.18	16	0.10	23
11:17	0.11	>100	0.16	64	0.21	85
11:18	0.08	34	0.13	17	0.08	23
11:19	0.08	9.7	0.16	16	0.08	27
11:20	0.08	73	0.16	15	0.08	23
11:21	0.24	>100	0.13	20	0.13	>100
11:22	0.08	19	0.13	18	0.06	32
11:23	0.10	37	0.14	15	0.11	>100
11:24	0.21	>100	0.21	>100	0.22	>100
11:25	0.11	11	0.25	13	0.11	17
11:26	0.08	18	0.14	14	0.08	19
11:27	0.08	85	0.14	51	0.08	30
11:28	0.08	13	0.18	18	0.06	39
11:29	0.08	13	0.11	16	0.06	73
11:30	0.08	12	0.10	13	0.06	73
11:31	0.08	23	0.16	17	0.10	24
11:32	0.08	20	0.16	13	0.10	26
11:33	0.08	18	0.14	16	0.06	73
11:34	0.06	73	0.11	17	0.06	85
11:35	0.06	20	0.05	43	0.05	>100
11:36	0.10	64	0.22	16	0.11	28

Table D4 Monitored Vibration Levels at Location i

Time	Tran PPV mm/s	Tran Freq Hz	Vert PPV mm/s	Vert Freq Hz	Long PPV mm/s	Long Freq Hz
12:49	0.08	85	0.14	9.7	0.06	85
12:50	0.08	5.8	0.08	15	0.06	64
12:51	0.08	57	0.05	73	0.06	>100
12:52	0.08	11	0.05	73	0.05	>100
12:53	0.10	11	0.11	10	0.06	57
12:54	0.08	57	0.08	15	0.05	>100
12:55	0.08	11	0.11	12	0.06	30
12:56	0.08	26	0.10	14	0.05	>100
12:57	0.08	64	0.05	47	0.05	>100
12:58	0.10	7.3	0.10	14	0.06	73
12:59	0.08	16	0.06	15	0.06	73
13:00	0.08	>100	0.05	47	0.06	47
13:01	0.08	7.6	0.05	73	0.06	57
13:02	0.08	13	0.06	19	0.06	51
13:03	0.08	20	0.08	13	0.06	85
13:04	0.08	13	0.08	16	0.05	>100
13:05	0.08	37	0.11	12	0.06	47
13:06	0.10	9.3	0.14	9.3	0.06	>100
13:07	0.08	>100	0.05	>100	0.06	85
13:08	0.08	11	0.05	>100	0.05	>100
13:09	0.08	37	0.05	>100	0.06	43
13:10	0.08	26	0.11	15	0.06	23
13:11	0.08	6.7	0.11	12	0.05	>100
13:12	0.08	8.5	0.05	>100	0.05	>100
13:13	0.08	30	0.08	14	0.06	85
13:14	0.08	32	0.05	>100	0.06	>100
13:15	0.08	10	0.05	>100	0.05	>100
13:16	0.08	32	0.05	>100	0.05	39
13:17	0.08	24	0.05	>100	0.05	85
13:18	0.08	51	0.05	>100	0.05	>100
13:19	0.08	16	0.05	37	0.05	>100
13:20	0.08	28	0.11	11	0.06	51
13:21	0.13	7.5	0.25	8.8	0.06	85
13:22	0.08	10	0.08	16	0.05	>100
13:23	0.08	8.1	0.11	11	0.06	>100
13:24	0.08	5.6	0.18	11	0.06	21
13:25	0.10	11	0.10	12	0.06	51
13:26	0.08	14	0.14	12	0.05	>100
13:27	0.08	21	0.06	26	0.05	>100
13:28	0.08	8.8	0.08	12	0.06	64
13:29	0.08	8	0.10	9.8	0.06	>100
13:30	0.08	8.8	0.11	11	0.06	>100
13:31	0.08	20	0.06	47	0.05	64
13:32	0.75	>100	0.19	>100	0.22	>100
13:33	0.08	18	0.16	12	0.06	>100
13:34	0.08	9	0.05	43	0.06	47

Table D5 Monitored Vibration Levels at Location ii

Time	Tran PPV mm/s	Tran Freq Hz	Vert PPV mm/s	Vert Freq Hz	Long PPV mm/s	Long Freq Hz
15:34	0.43	85	0.27	11	0.11	28
15:35	0.10	12	0.16	9.1	0.08	16
15:36	0.08	7.6	0.11	12	0.06	32
15:37	0.16	11	0.24	11	0.10	26
15:38	0.08	11	0.10	14	0.06	43
15:39	0.11	9.8	0.18	11	0.10	17
15:40	0.10	5.6	0.16	9.7	0.08	18
15:41	0.10	12	0.27	11	0.08	17
15:42	0.16	12	0.18	10	0.08	28
15:43	0.11	43	0.21	11	0.08	20
15:44	0.11	11	0.19	14	0.06	27
15:45	0.11	9	0.22	13	0.08	73
15:46	0.08	20	0.14	11	0.06	47
15:47	0.10	12	0.13	11	0.06	>100
15:48	0.14	11	0.22	12	0.08	22
15:49	0.14	10	0.30	11	0.08	17
15:50	0.10	9.1	0.14	9.8	0.06	30
15:51	0.10	7.2	0.18	11	0.06	47
15:52	0.10	15	0.21	11	0.08	30
15:53	0.14	15	0.48	11	0.10	15
15:54	0.10	8.5	0.14	9	0.06	51
15:55	0.10	19	0.16	10	0.06	73
15:56	0.10	5.2	0.25	9.1	0.06	28
15:57	0.16	10	0.24	11	0.06	85
15:58	0.13	7.9	0.16	11	0.08	24
15:59	0.10	9.3	0.16	11	0.06	43
16:00	0.10	8.4	0.18	8.7	0.10	51
16:01	0.11	9.5	0.21	9.8	0.08	20
16:02	0.10	4.9	0.18	8.8	0.08	14
16:03	0.11	9.8	0.30	10	0.08	43
16:04	0.13	11	0.16	9	0.08	32
16:05	0.10	13	0.21	10	0.10	20
16:06	0.11	11	0.19	17	0.08	20
16:07	0.64	85	0.19	85	0.06	85
16:08	0.11	10	0.18	11	0.08	51
16:09	0.13	15	0.22	15	0.10	16
16:10	0.10	8.3	0.18	12	0.06	47
16:11	0.08	19	0.19	9.8	0.06	37
16:12	0.11	12	0.18	14	0.08	43
16:13	0.08	6.3	0.11	13	0.06	23
16:14	0.10	28	0.21	9.8	0.08	64
16:15	0.13	11	0.19	11	0.06	>100
16:16	0.08	19	0.10	11	0.06	>100
16:17	0.10	12	0.14	16	0.06	43
16:18	0.10	20	0.16	9.7	0.06	39
16:19	0.10	9.3	0.16	11	0.06	26
16:20	0.11	8.8	0.19	10	0.06	43
16:21	0.11	9	0.19	9.3	0.08	39
16:22	0.10	8.5	0.16	9.3	0.08	12

Table D6 Monitored Vibration Levels at Location iii

APPENDIX E
NOISE SURVEY DATABASE REVIEW

E.1 INTRODUCTION

The following is a review of the AWN database for noise surveys completed within the broad environs of the proposed development. Figure E1 to the end of this section of the document highlights the approximate locations of the survey work discussed in this section.

E.2 SURVEY 1 – TARA STREET

An environmental noise survey was conducted in the vicinity of Tara Street, Dublin 2 on 8 and 9 January 2001.

Noise levels were measured at the following locations:

Location 1A is on the pavement roughly half way along Poolbeg Street East.

During the daytime, the dominant sources of noise were road traffic along Tara Street, with occasional vehicles along Poolbeg Street. During the first two daytime periods there was also significant contribution of noise from the building site to the rear of the existing Coopers & Lybrand building. The main source of noise from the building site was the unloading of concrete from tankers and the concrete pumping machine. Noise levels were 71dB L_{Aeq} and 73 to 74dB L_{A10} with the construction noise and 68dB L_{Aeq} and 70dB L_{A10} without construction noise. This is considered typical for a city centre environment.

During the night-time, the dominant source of noise was road traffic on Tara Street; there were no vehicles on Poolbeg Street East. Also notable was an item of ventilation plant either associated with the Tara Street Station or the O'Reilly pub. There was generally no noise from the construction site, although for a period there was powerfloating of a concrete floor and this measurement location was excluded in that rotation of the positions. Noise levels were 58 to 60dB L_{Aeq} and 61 to 64dB L_{A10}. These noise levels are typical of a city centre location.

Location 1B is midway along the façade of the existing CIE building on Tara Street between Poolbeg Street and George's Quay.

During both the daytime and night-time periods, the dominant source of noise was road traffic on Tara Street. Daytime noise levels ranged from 75 to 76dB L_{Aeq} and 77 to 78dB L_{A10}, which is typical for the roadside of a busy city street. Night-time noise levels ranged from 62 to 68dB L_{Aeq} and 64 to 72dB L_{A10}, which is typical for the roadside of a busy city street with the fluctuating flows that occur during the night.

Location 1C is at the junction of George's Quay and Luke Street.

During both the daytime and night-time periods, the dominant source of noise was road traffic on George's Quay. Daytime noise levels ranged from 75 to 76dB L_{Aeq} and 76 to 78dB L_{A10}, which is typical for the roadside of a busy city street. Night-time noise levels ranged from 62 to 67dB L_{Aeq} and 64 to 71dB L_{A10}.

E.3 SURVEY 2 – IRISH FINANCIAL SERVICES CENTRE

An environmental noise survey was conducted on 1 May 2002 in the location of Exchange Place, IFSC, Dublin 1.

Noise measurements were carried out at four locations around Exchange Place in the IFSC.

Noise levels in the area where measured during periods when no construction work (on the site of interest) was taking place. Noise levels at the various locations were in the rage of 59 to 71dB L_{Aeq} and 56 to 68dB L_{A90}.

The dominant noise source was traffic movements on adjacent roads. It should be noted that other sources of construction noise (from sites not under consideration here) were audible at times.

An initial baseline noise survey conducted in the vicinity of this site showed that daytime monitoring results at this location were dominated by traffic movements in the local area. This was illustrated by the comparison of the L_{A10} to the L_{Aeq} values. L_{A10} levels are typically 3dB higher than then the L_{Aeq} values which is a strong indication of the presence of traffic noise. The average L_{Aeq} and L_{A90} levels measured during the continuous noise monitoring period were 62dB and 55dB respectively.

Again baseline survey work showed that night-time monitoring results at this location were dominated by traffic movements in the local area up to the early hours of the morning periods. This is illustrated by the comparison of the L_{A10} to the L_{Aeq} values. L_{A10} levels are typically 3dB higher than then the L_{Aeq} values which is a strong indication of the presence of traffic noise. The average L_{Aeq} and L_{A90} levels measured during the continuous noise monitoring period were 55dB and 52dB respectively.

E.4 SURVEY 3 – CHARLOTTE QUAY

An environmental noise survey was conducted on 27 May 2002, whilst construction site was active.

Noise levels were measured at the following locations:

Location 3A is in line with the façade of the apartment dwellings at Charlotte Quay and facing the main entrance to the construction site. This location provides a measure of the noise climate at the nearest dwelling to the site entrance.

During the survey, the dominant sources of noise were traffic entering and leaving the Charlotte Quay construction site, noise associated with a nearby construction site at Shelborne Park and traffic along the Ringsend Road. Noise levels ranged from 69dB L_{Aeq} to 72dB L_{Aeq} with background levels in the range 59dB L_{A90} to 67dB L_{A90}.

Location 3B is further north along the apartment complex from position 1 During the survey, the dominant sources of noise were traffic entering and leaving the construction site, traffic using the docks facility and traffic along the Ringsend Road. Noise levels ranged from 64dB L_{Aeq} to 76dB L_{Aeq} with background levels in the range 57dB L_{A90} to 62dB L_{A90}.

Location 3C is approximately 1m from the façade of a residential dwelling located along Ringsend Road. This location will provide a measure of the noise climate at the nearest noise-sensitive receptor to the south of the site.

During the survey, the dominant sources of noise were traffic along the Ringsend Road and noise associated with a construction activity at Shelbourne Park. Noise levels ranged from 64dB L_{Aeq} to 76dB L_{Aeq} with background levels in the range 57dB L_{A90} to 62dB L_{A90}.

E.5 SURVEY 4 – HANOVER QUAY

An environmental noise survey was conducted on 6th June 2002, in the vicinity of Units 1 and 5, Hanover Quay, Dublin 1.

Noise levels were measured at the following locations:

Location 4A North east of Unit 1. This position was chosen to be representative of the noise level experienced by the portion of Unit 2 nearest to the demolition at Unit 1. Noise levels were in the range of 67dB L_{Aeq} to 71dB L_{Aeq} with background levels in the range 56dB L_{A90} to 60dB L_{A90}.

Location 4B North west of Unit 5. This position is representative of the noise environment where Unit 5 joins Unit 4 and provides an indication of the noise environment currently experienced by the occupants of Unit 4. Noise levels were in the range of 69dB L_{Aeq} to 74dB L_{Aeq} with background levels in the range 56dB L_{A90} to 60dB L_{A90}.

The noise measurements at both locations show that the noise levels during demolition are relatively similar to the existing noise levels in the area. The existing noise environment is dominated by a continuous flow of concrete vehicles and regular traffic along the Quay. Furthermore there was a significant noise contribution from production plant within the Kilsaran Concrete compound. Mobile mechanical plant was also audible from the remediation works at the west of Hanover Quay.

E.6 SURVEY 5 – LOWER BAGGOT STREET

An environmental noise survey was conducted on 28th August 2002.

Noise levels were measured at the following locations:

Location 5A This location is at the façade of the office space located along Baggot Close. Baggot Close is an alleyway that leads to the existing entrance to the entertainment venue in the existing Baggot Street premises. The daytime noise environment at this location was dominated by traffic movements along Baggot Street Lower. Other sources of noise noted during the measurement period included the movement of cars in and out of the nearby car park and pedestrian activity on local streets. Noise levels were in the range of 62 to 64dB L_{Aeq} and 51 to 53dB L_{A95}.

Night-time noise levels at this location were again dominated by traffic movements along Baggot Street Lower. During lulls in traffic other sources of noise noted include noise from a public house on the opposite side of Baggot Street and further down the street. Noise levels were in the range of 56 to 61dB L_{Aeq} and 43 to 51dB L_{A95}.

Location 5B This location is on Baggot Street Lower adjacent to 'The Baggot Mews' newsagent. The location is directly opposite the existing Baggot Inn site. The daytime noise environment at this location was dominated by traffic movements along Baggot Street Lower. Other sources of noise noted during the measurement period during lulls in traffic noise included pedestrian activities and cars moving off from parking spaces on the near side of the street. Noise levels were in the range of 72 to 73dB L_{Aeq} and 58 to 62dB L_{A95}.

Night-time noise levels at this location were again dominated by traffic movements on Baggot Street Lower. Noise levels were in the range of 68 to 69dB L_{Aeq} and 48 to 57dB L_{A95}.

Location 5C Along Rogers Lane, opposite the proposed façade of the redeveloped Baggot Inn and in front of existing apartment façade. The daytime noise environment at this location was dominated by traffic movements along Baggot Street Lower. Other sources of noise noted during the measurement period included construction works, local traffic movements along the lane itself and pedestrian activity on local streets. Noise levels were in the range of 62 to 64dB L_{Aeq} and 51 to 53dB L_{A95}.

Night-time noise levels at this location were again dominated by traffic movements along Baggot Street Lower. During lulls in traffic other sources of noise noted included noise from a public house on the opposite side of Baggot Street and further down the street. Noise levels were in the range of 56 to 61dB L_{Aeq} and 44 to 49dB L_{A95}.

E.7 SURVEY 6 – LOWER ORMOND QUAY

An environmental noise survey was conducted on 19th December 2001.

Noise levels were measured at the following locations:

Location 6A At the eastern boundary of the site. The dominant noise source at this location during the survey period was player's voices and the sound of the ball hitting the timber panels around the perimeter of the pitches. The average noise level over each measurement period were in the range 58 to 65dB L_{Aeq}.

Location 6B At the western boundary of the site. Once again, player's voices and the ball hitting the perimeter hoarding were the dominant sources of noise. The average noise levels were in the range 63 to 67dB L_{Aeq}, however, when corrected to the rear of the adjacent houses, the range of levels become 59 to 63dB L_{Aeq}.

E.8 SURVEY 7 – PIGEON HOUSE ROAD

An environmental noise survey was conducted on 4th December 2001.

Noise levels were measured at the following locations:

Location 7A the front of No. 71 Pigeon House Road.

Noise build up in the area was dominated by local traffic movements and plant operating from the Marine Terminals Ltd. Noise levels were in the range of 57 to 68dB L_{Aeq} and 52 to 60dB L_{A90}

E.9 SURVEY 8 – BARROW ST

Environmental noise measurements were conducted over the course of two survey periods 12th February 2003 and 13th February 2003/2003.

Noise levels were measured at the following locations:

Location 8A is at the side of Barrow Street by the entrance to the Grand Canal Dock Station.

During the daytime, the dominant sources of noise were local road traffic, construction noise and trains on the DART rail line. Noise levels were in the range 64 to 68dB L_{Aeq} and 67 to 68dB L_{A10}.

During the night-time the amount of road traffic was less than during the day, there was no construction and there were no trains after midnight. Noise levels were in the range 54 to 58dB L_{Aeq}, with background noise levels as low as 37dB L_{A90}.

Both the daytime and night-time measurements are typical of the noise climate in an urban city environment.

Location 8B is at the side of the apartment block to the south side of the DART rail line. This is a similar from Barrow Street as the proposed residential units, but the south side of the DART rail line to be less affected by daytime construction noise.

During the daytime, the dominant sources of noise were local road traffic and trains on the DART rail line. Noise levels were in the range 59 to 63dB L_{Aeq} and 63 to 67dB L_{A10}.

During the night-time the amount of road traffic was less than during the day, there was no 59dB L_{Aeq}, with background noise levels as low as 40dB L_{A90}.

Both the daytime and night-time measurements are typical of the noise climate in an urban city environment.

Location 8C is at the corner of South Dock Street and Gerald Street. This provides a measure of the noise climate in this area of Dublin away from busier roads (including Barrow Street).

During the daytime, the dominant sources of noise were local road traffic, construction noise and trains on the DART rail line. Noise levels were in the range 53 to 54dB L_{Aeq} and 57dB L_{A10}.

During the night-time the amount of road traffic was less than during the day, there was no construction and there were no trains after midnight. Noise levels were in the range 41 to 49dB L_{Aeq}, with background noise levels as low as 37dB L_{A90}.

Both the daytime and night-time measurements are typical of the noise climate in an urban city environment.

E.10 SURVEY 9 – DUBLIN BAY WWTP

Environmental noise measurements were conducted on 26th March 2003.

Noise levels were measured at the following locations:

Position 9A This position was selected to provide a reference level adjacent to both the blowers and pumps.

With all plant items turned off, the dominate source of noise at this location was water noise. Daytime noise levels were of the order of 56dB L_{Aeq} and 53dB L_{A90}.

Position 9B This position is located at the designated monitoring point on the southern site boundary.

With all plant items turned off, the main sources of noise at this location was ESB noise, with some water noise. Daytime noise levels were of the order of 53B L_{Aeq} and 52dB L_{A90}

E.11 SURVEY 10 – SPENSER DOCK

Environmental noise measurements were conducted on 29th June 2003.

Noise levels were measured at the following locations:

Position 10A Located 1m from the boundary wall opposite No.1 Mayor Street Upper. This residence is the closest noise sensitive private property to the Spenser Dock site. Particular consideration will be given here to construction works associated with Sections M & N of the Spenser Dock site.

Noise levels during these periods were dominated by traffic movements on New Wapping Street and distant movements on North Wall Quay. Noise levels were in the range of 55 to 59dB L_{Aeq} and 39 to 42dB L_{A90}.

Noise measurements during the period of 08:00 to 11:00 hours at this location were dominated by industrial noise associated with a unit on a saw mill/timber yard site located on New Wapping Street. Ambient and background noise levels were dominated by this source. Noise levels were in the range of 64 to 66dB L_{Aeq} and 62 to 64dB L_{A90}.

Position 10B Located approximately 1m from the façade of an Apartment complex on Guild Street to the west of the Spenser Dock site. The complex is a six storey development with a significant frontage onto Guild Street overlooking the development site.

Noise levels during these periods were dominated by traffic movements along Guild Street. Noise associated with a party in one of the apartments was audible at times during these survey periods. Noise levels were in the range of 66 to 74dB L_{Aeq} and 43 to 52dB L_{A90}.

Position 10C Located approximately 1m from the façade of a private residence on New Wapping Street to the east of the development site. This location is indicative of noise levels experienced at No.1 to 14 New Wapping Street.

Noise levels during these periods were dominated by traffic movements along New Wapping Street. Noise associated with a plant item from the Wapping Street saw mill/timber yard influenced both ambient and background noise levels during these periods. Noise levels were in the range of 71 to 73dB L_{Aeq} and 60 to 61dB L_{A90}.

E.12 SURVEY 11 – EAST WALL ROAD

Environmental noise measurements were conducted on 25th & 26th February 2003.

Noise levels were measured at the following locations:

Location 11A This location is just inside the open fencing of The Point Depot close to the main gate on East Wall Road. The location is approximately 6 metres from the roadside.

The primary contributor to noise build-up at this location was road traffic on East Wall Road. Typical noise levels were of the order of 74dB L_{Aeq}, 66 to 67dB L_{A90} with an associated derived value of 76dB $L_{A10(18hour)}$.

Location 11B This location is at the eastern end of Sherrif Street about 4 metres from the traffic on Sherrif Street and approximately 34 metres from the traffic on East Wall Road.

The primary contributor to noise build-up at this location was road traffic on Sherrif Street and East Wall Road. Typical noise levels were in the range 69 to 71dB L_{Aeq}, 63 to 65dB L_{A90} with an associated derived value of 72dB $L_{A10(18hour)}$.

Location 11C This location is at the side of the East Wall Road at 1 metre from a building façade and around 3 metres from traffic on East Wall Road.

The primary contributor to noise build-up at this location was road traffic on East Wall Road. Typical noise levels were in the range 78 to 79dB L_{Aeq}, 70 to 71dB L_{A90} with an associated derived value of 81dB $L_{A10(18hour)}$.

Location 11D This location is on the north side of North Wall Quay at 1 metre from the façade of Maritime House (Dublin Maritime Limited) and approximately 5 metres from moving traffic on North Wall Quay.

The primary contributor to noise build-up at this location was road traffic on North Wall Quay. Typical noise levels were in the range 75 to 76dB L_{Aeq}, 62 to 64dB L_{A90} with an associated derived value of 78dB $L_{A10(18hour)}$.

Location 11E This location is on the south side of North Wall Quay at the quayside of the River Liffey. The flowing traffic on North Wall Quay is around 12 metres away. The location is just west of The Point Depot.

The primary contributor to noise build-up at this location was road traffic on North Wall Quay. Typical noise levels were in the range 68 to 70dB L_{Aeq}, 62 to 63dB L_{A90} with an associated derived value of 71dB $L_{A10(18hour)}$.

Location 11F This location is at the entrance to Fisherman's Wharf, a residential development on the south side of York Road, which is to the south side of the River Liffey close to the Eastlink Bridge access road.

The primary contributor to noise build-up at this location was road traffic on the East Link Bridge access road and York Road. Typical noise levels were in the range 60 to 62dB L_{Aeq}, 55 to 56dB L_{A90} with an associated derived value of 62dB $L_{A10(18hour)}$.

Location 11G This location is at the side of East Wall Road (outside No 188) and approximately 4 metres from the nearside flow of traffic.

The primary contributor to noise build-up at this location was road traffic on East Wall Road. During the first period the traffic was stationary for significant periods of time and this appears to have reduced the levels of noise slightly. Typical noise levels were in the range 75 to 77dB L_{Aeq}, 63 to 66dB L_{A90} with an associated derived value of 78dB $L_{A10(18hour)}$.

Location 11H This location is at the side of East Wall Road in front of a metal open gate to the vacant side at the junction of East Wall Road and Church Road (and approximately opposite an Esso Service Station). The location is approximately 5 metres from the nearside flow of traffic.

The primary contributor to noise build-up at this location was road traffic on East Wall Road. During the first period the traffic was stationary for significant periods of time and this appears to have increased the L_{A90} levels slightly. Typical noise levels were in the range 74 to 76dB L_{Aeq}, 64 to 69dB L_{A90} with an associated derived value of 77dB $L_{A10(18hour)}$.

Location 11I This location is on the west side pavement of Merchants Road and approximately 21 metres from the nearside flow of traffic on East Wall Road.

The primary contributor to noise build-up at this location was road traffic on East Wall Road. Typical noise levels were in the range 67 to 69dB L_{Aeq}, 56 to 57dB L_{A90} with an associated derived value of 70dB $L_{A10(18hour)}$. These noise levels are typical of what would be expected in the type of environment under consideration.

Location 11J This location is at the side of East Road (outside No 32) and near the junction of East Road and Ravensdale Road. The location is approximately 3 metres from the nearside flow of traffic.

The primary contributor to noise build-up at this location was road traffic on East Road. Typical noise levels were in the range 69 to 71dB L_{Aeq}, 57 to 60dB L_{A90} with an associated derived value of 71dB $L_{A10(18hour)}$.

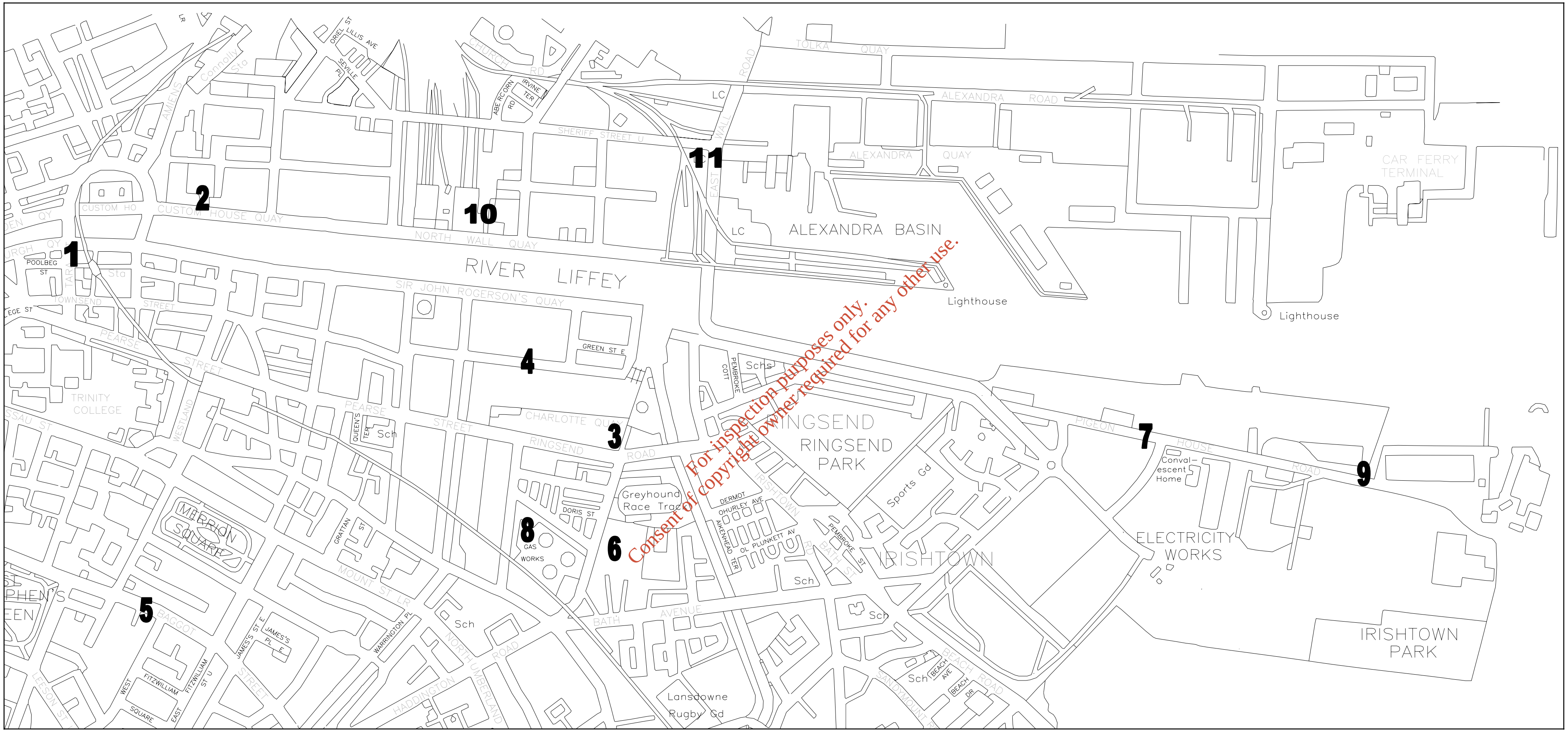
Location 11K This location is on the east side pavement at the northern end of Casteforbes Street (which has a cobbled surface). The location is approximately 30 metres from Sherrif Street.

The primary contributor to noise build-up at this location was road traffic on Sherrif Street along with occasional passing vehicles on Castleforbes Street. There was also some noise from the vehicle repair workshop across Castleforbes Road. Typical noise levels were in the range 65 to 66dB L_{Aeq}, 55 to 59dB L_{A90} with an associated derived value of 67dB $L_{A10(18hour)}$.

Location 11L This location is on the west side pavement at the southern end of Casteforbes Street (which has a cobbled surface). The location is approximately 72 metres from North Wall Quay.

The primary contributor to noise build-up at this location was road traffic on North Wall Quay along with occasional passing vehicles on Castleforbes Road. There was also some noise from fork lift trucks and unloading lorries associated with nearby tile store. Typical noise levels were in the range 68 to 70dB L_{Aeq}, 53 to 54dB L_{A90} with an associated derived value of 70dB $L_{A10(18hour)}$.

FIGURE E1
DATABASE SURVEY LOCATIONS



Appendix I

Soil Sampling & Risk Assessment

Soil Sampling

TECHNICAL REPORT

SAMPLING AND ANALYSIS OF SOIL SAMPLES IN THE DUBLIN BAY AREA FOR PCDD/F, PCB AND MERCURY

FOR

M.C. O'Sullivan & Co. Ltd
Carnegie House
Library Road
Dun Laoghaire
Co. Dublin

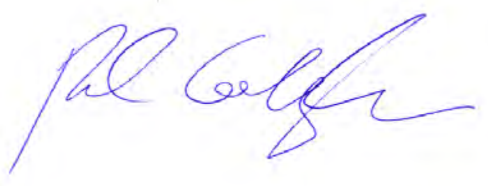
Report prepared by: **Dr Fergal Callaghan**
Our reference: FC/03/2008SR01
Date: 01 September 2004

EXECUTIVE SUMMARY

Soil sampling was conducted at 6 locations in the Dublin Bay area, with the aim of determining background soil PCDD/F, PCB and mercury concentrations. Soil samples were analysed for PCDD/F, PCBs and mercury. The conclusions of the sampling and analysis programme were as follows:

Background soil PCDD/F concentrations for the sites sampled in the Dublin Bay area were found to be generally low when compared with data for urban areas from other countries but two of the six samples analysed had PCDD/F concentrations which were similar to the medium and higher end of the concentration range noted in urban areas in other countries. These samples may have been influenced by localised combustion sources such as traffic emissions and bonfires.

PCB and mercury analysis data indicated that background soil concentrations for these analytes were generally low when compared with data for other urban centres, with the exception of two locations, where slightly elevated PCB concentrations were noted, and where it is recommended that further analysis be undertaken.



DR FERGAL CALLAGHAN
Senior Environmental Consultant

ELAINE NEARY
Environmental Consultant

CONTENTS

1.0 INTRODUCTION

AWN Consulting was requested by M.C. O'Sullivan & Co. Ltd. to undertake baseline surface soil sampling, dioxin, PCB and mercury analysis, reporting, interpretation and significance assessment for the Dublin Bay region.

The work was undertaken in support of an EIS for a proposed Waste to Energy Plant (WTE) in Ringsend, Dublin, which is to be located on the Poolbeg Peninsula, see Figure 1.1.

2.0 LOCATION OF SAMPLING SITES AND RATIONALE FOR CHOOSING INDIVIDUAL LOCATIONS

AWN Consulting undertook a soil dioxin sampling programme in the Dublin Bay area during October and November 2003, in order to determine background dioxin concentrations in soil in the area.

Sampling was carried out at 6 locations, in the Dublin Bay area. The sampling locations are shown in Figure 2.1.

The sampling programme carried out by AWN was designed to achieve the following goals:

- Establish a background concentration in the vicinity of the site
- Establish a background concentration at the nearest centres of population to the site

Soil sampling was carried out by AWN at the locations described in Table 2.1. The rationale for choosing these sampling locations is outlined in Table 2.2. The sampling locations are shown in Figure 2.1. The sampling programme was conducted during the months of October and November 2003 by Dr. Fergal Callaghan and Elaine Neary of AWN Consulting Ltd. It was noted from an inspection of the windrose data from Dublin Airport, for the period 1993 – 1997, that the predominant wind direction is south-westerly (see Attachment 1).

AWN Sampling Point	Sampling Point Location	Position	Sampling Date
A	Sean Moore Park	53^0 20.169' N 006^0 12.923' W	5th November 2003
B	Irishtown Nature Park	53^0 20.161' N 006^0 11.757' W	6th November 2003
C	Ringsend Park	53^0 20.520' N 006^0 13.258' W	3rd November 2003
D	Sandymount (grassed area along the sea front)	53^0 19.584' N 006^0 12.456' W	7th November 2003
E	Clontarf (grassed area along the sea front)	53^0 21.476' N 006^0 11.605' W	29th October 2003
F	Bull Island Nature Reserve	53^0 21.962' N 006^0 09.223' W	31st October 2003

Table 2.1 Location of AWN Sampling Points

Sampling Point	Sampling Point Location
A	SW of site, peak area from dispersion model
B	Adjacent and to the SW of site, peak area from dispersion model
C	West of site, closest residential community
D	SW of site, residential community (downwind of NE winds)
E	North of site, residential community
F	NE of site (downwind of SW winds)

Table 2.2 Rationale for choosing AWN sampling locations

3.0 SAMPLING METHODOLOGY

The aim of the sampling programme at each site was to establish a background topsoil concentration for each particular sampling location.

US EPA guidance, as presented in the US EPA EISOPQAM, was followed in the selection and design of the sampling methodology [1]. The EISOPQAM Areal Composite Methodology was selected as the method most applicable for determining background soil concentrations for an area [2]. This method ensures the sample collected is representative of an area. Briefly, the methodology consists of taking a number of samples in an identical manner and of an identical size and then combining these samples to form a composite sample, which is then thoroughly mixed. A sample of this composite material is then sent for analysis.

3.1 Sampling Depth

The investigation was designed to measure background contaminant concentrations in surface soils, which has been defined by EISOPQAM as soils between the ground surface and up to 6 to 12 inches (15 – 30cm) below the ground surface [3]. Other authors, such as Hendriks et al [4] have taken samples of cores which are 0 – 5cm thick, whereas the team which has been working for many years on assessing the impact of the Seveso accident near Milan in Italy, has used samples of 7cm thickness [5].

As the aim of this study was to assess the impact of surface deposition of contaminants, it was felt that the depth used by the Seveso study team (who were studying airborne deposition and were among the first teams to actively study the impact of dioxin deposition on soil concentrations) was the most appropriate and soil samples of 7cm thickness (from the surface to 7cm below the surface) were taken.

3.2 Sampling Pattern

The sampling on each site was carried out in a “W” Pattern. Following the EPA sampling methodology, samples were taken at 10m centres, or where this was not possible due to constraints of space on the site, at 4m centres.

The layout of the sampling grid at each sampling location is shown in Figures 3.1 – 3.6. The Field Record for each sampling site is presented as Attachment 2. A pictorial record of each sampling grid is shown in Figures 3.7 – 3.12.

3.3 Sample Acquisition and Handling

As can be seen from the Field Records, 100 soil samples were taken at 10m intervals, or where this was not possible due to constraints of space on the site, at 4m intervals, using a 2cm diameter corer, at the sampling sites, with the sample number and sampling interval being limited by area available for sampling.

Each composite sample weighed between 5 and 6kg. Samples were thoroughly mixed in a clean plastic basin and then a 0.5kg aliquot extracted from the mixed sample. The 0.5kg sample was placed in a glass jar (supplied by Scientific Analysis Laboratories Ltd, the analytical laboratory chosen for the analysis). All samples were labelled Sample Point A, Sample Point B, etc. and the analysis required for each sample was listed on a Geotrace Sampling and Chain of Custody Record, which is provided as Attachment 3.

The samples were couriered overnight in one batch to Scientific Analysis Laboratories Ltd, on 10th November 2003, for analysis.

3.4 Analysis suite

Scientific Analysis Laboratories Ltd are a UKAS accredited laboratory and were instructed to undertake the following analysis by AWN Consulting.

I. PCDD/F (NATO/CCMS I-TEQ)
II. PCB (4 non-ortho and 8 mono-ortho)
III. PCB (7 EC Congeners)
IV. Mercury

Scientific Analysis Laboratories Ltd hold UKAS accreditation for PCDD/F analysis, for items I, II, III and IV.

4.0 RESULTS OF LABORATORY ANALYSIS

The analysis results are presented as Attachment 4 of this report and have been summarised in Table 4.1 and Table 4.2.

Sample	Site Location	PCDD/F (ng/kg) [1]	Mercury (mg/kg)
A	Sean Moore Park	10	<1
B	Irishtown Nature Park	5.7	<1
C	Ringsend Park	3.2	2
D	Sandymount Promenade	23	<1
E	Clontarf Promenade	3.9	<1
F	Bull Island Nature Reserve	0.54	<1

Table 4.1 Analysis results

1 NATO/CCMS I TEQ (2,3,7,8 – tetrachloro dibenzo-p-dioxin)

Sample	Site Location	PCB Sum 8 Mono – Ortho µg/kg	PCB Sum 4 Non-Ortho µg/kg	PCB Sum EC 7 µg/kg
A	Sean Moore Park	7.45	0.14	22.45
B	Irishtown Nature Park	0.56	0.07	3.02
C	Ringsend Park	0.55	<0.05	2.58
D	Sandymount Promenade	0.72	<0.05	3.26
E	Clontarf Promenade	0.86	<0.05	14.49
F	Bull Island Nature Reserve	0.09	<0.05	0.79

Table 4.2 Analysis results

4 non-ortho (PCB 77, 81, 126 and 169),

8 mono-ortho (PCB 105, 114,118, 123, 156, 157, 167 and 189)

EC7 PCB Congeners (PCB no. 28, 52, 101, 118, 138, 153 and 180)

5.0 DISCUSSION OF RESULTS

The format for this Chapter of the report is as follows:

5.1 Issues associated with historical comparison of PCDD/F values

5.2 Analysis of measured PCDD/F values

5.3 Comparison of measured PCDD/F values with data for locations around Ireland

5.4 Comparison of measured PCDD/F values with published data for other countries

5.5 Comparison of PCB and mercury values with published data and relevant standards

5.1 Issues associated with historical comparison of PCDD/F values

Polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzo-p-furans (PCDF) are a group of tricyclic aromatic compounds, with similar chemical and physical properties and are ubiquitous in the modern environment [6]. Mixtures of the two groups are normally referred to as PCDD/F.

The ability of chlorine atoms to substitute at various positions on the benzene ring structures of these compounds allows numerous positional isomers to be formed. In total, there are 210 positional isomers of both groups, 75 for PCDD and 135 for PCDF. The majority of these compounds are of no concern with respect to ecological and human toxicity, with the exception of 17 (7 PCDD and 10 PCDF) which have chlorine substitution in the 2,3,7,8 positions [7].

2,3,7,8 TCDD is the most studied dioxin and is considered to be the most toxic by far of the 17 congeners. As data began to accumulate in the 1970's and early 1980's of the toxic effects of 2,3,7,8 TCDD, a number of systems for assessing the toxicity of other PCDD/F were developed, all using the concept of Toxic Equivalence Factors (TEQ) [7]. This concept assess the toxicity of other PCDD/F congeners and assigns a weighting compared to the known toxicity of 2,3,7,8 TCDD.

Examples of the systems which have been developed include the Swiss (published in 1982), German (published in 1985), Danish (published in 1984) and Canadian (published in 1983) systems [8,9,10,11].

These systems applied slightly different weighting factors for calculating TEQ expressed as units of 2,3,7,8 TCDD. For instance, 1,2,3,4,6,7,8 HeptaCDD (non

2,3,7,8) was assigned a Toxic Equivalency Factor (TEF) of 0.1 by the Swiss system, but was given a TEF of 0.001 by the German system, a one hundred fold difference.

Similar differences in weightings were noted for a number of the other congeners. These differences meant that it was not possible in many instances to compare TEQ data from different countries. The NATO/CCMS system began to be more widely used through the early 1990's and the WHO also introduced a similar [12,13].

The US EPA, NATO/CCMS and the EC systems now use the same TEF Factors and the World Health Organisation has also adopted a similar system, allowing direct comparability of TEQ values system (although there are still a number of minor differences between TEF factors used by the WHO and NATO/CCMS Systems) [14].

The NATO/CCMS TEFs (giving a result which is defined as I-TEQ), which correspond exactly with the EC and US EPA TEFs, have been used to calculate TEQs for the PCDD/Fs measured during this study.

It is also important to examine, when comparing PCDD/F measurements acquired by different laboratories, the approach taken when adding the Toxic Equivalents. It is current best practice by UKAS laboratories to exclude values which are below the limit of detection from the calculation of toxic equivalents, however, other laboratories have assumed that any value recorded as being below the limit of detection should be assigned a value for the relevant congener of 50% of the limit of detection. This can lead to slight discrepancies between laboratories.

Discrepancies can also arise when comparing soil samples taken with a hand corer or similar instrument, as the greater the depth of the core, the greater the potential for dilution of the sample by "cleaner soil". As dioxin concentrations in soil are influenced by airborne deposition rates, a concentration gradient will exist in the soil, with the greatest concentrations in the upper layer and decreasing concentrations being measured as depth increases and the influence of surface deposition decreases.

5.2 Analysis of measured PCDD/F values

The laboratory analysis results are presented as Attachment 4 of this report. For comparative purposes, the absolute amounts of each of the 17 PCDD/F congeners measured for soil are presented in Table 5.1 (in ng/kg). The I-TEQ values for the congeners are presented in Table 5.2. The PCDD/F profile for each sample is also presented in pictorial fashion as Attachment 5. All concentrations are expressed in ng/kg air-dried soil, unless otherwise stated.

High PCDD/F I-TEQ concentrations (relative to the other sampling areas) were recorded at the Sean Moore Park (Site A) and Sandymount promenade (Site D).

In general all of the sites sampled showed similar I-TEQ congener profiles (Attachment 5). Sample sites A, B, C, D and E showed traces of the dioxins 2,3,7,8-TCDD, 1,2,3,7,8-PeCDD, 1,2,3,6,7,8-HxCDD, 1,2,3,4,7,8-HxCDD, 1,2,3,7,8,9-HxCDD, 1,2,3,4,6,7,8 HpCDD and OCDD. The furans present were 2,3,7,8 TCDF, 1,2,3,7,8 PeCDF, 2,3,4,7,8 PeCDF, 1,2,3,4,7,8 HxCDF, 1,2,3,6,7,8 HxCDF, 2,3,4,6,7,8 HxCDF, 1,2,3,7,8,9-HxCDF, 1,2,3,4,6,7,8-HpCDF, 1,2,3,4,7,8,9 HpCDF and OCDF. 2,3,4,7,8 PeCDF was the most predominant dioxin/furan for all of these sites.

Sample site F (Bull Island) showed only traces of the dioxins 1,2,3,6,7,8-HxCDD, 1,2,3,4,6,7,8 HpCDD and OCDD. The furans present were 2,3,7,8 TCDF, 2,3,4,7,8 PeCDF, 1,2,3,4,7,8 HxCDF, 1,2,3,6,7,8 HxCDF, 2,3,4,6,7,8 HxCDF, 1,2,3,4,6,7,8-HpCDF and OCDF. Sample site F showed considerably lower concentrations of dioxins and furans than the other sites.

Sample site A and D showed markedly higher concentrations of dioxins and furans than the other sites. Both sites showed similar congener patterns when compared with the other sampling sites in terms of furans (Attachment 5), but contained higher concentrations of each congener.

The congener profiles are similar to the emissions from the combustion of unleaded petrol [15 16]. Both areas are landscaped, which means that a manual lawnmower might well be used to cut the grass. A manual lawnmower may lead to high petrol combustion emissions, as the exhaust is very close to the ground. This may have contributed to the relatively high PCDD/F concentrations for sites A and D.

The values measured at sample site B may have been due to the bonfires which have occurred there. During the site visit, the remains of two recent bonfires were evident. The congener profile for the site was very similar to a typical congener profile produced from wood combusters [16].

	Sample Locations					
	A	B	C	D	E	F
Congener	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg
2,3,7,8-TCDD	0.69	0.49	0.30	0.78	0.51	N.D.
1,2,3,7,8-PeCDD	0.98	0.9	0.06	3.4	0.42	N.D.
1,2,3,6,7,8-HxCDD	4.2	2.3	1.1	4.6	1.5	0.34
1,2,3,4,7,8-HxCDD	1.1	0.92	0.62	2.7	0.79	N.D.
1,2,3,7,8,9-HxCDD	2.4	1.3	0.79	3.7	0.98	N.D.
1,2,3,4,6,7,8-HpCDD	88	33	13	33	18	3.0
OCDD	930	260	74	130	83	16
2,3,7,8-TCDF	7.5	3.2	3.0	18	2.9	0.67
1,2,3,7,8-PeCDF	5	3.2	1.6	17	2.0	N.D.
2,3,4,7,8-PeCDF	5.4	3.3	1.8	21	2.2	0.34
1,2,3,4,7,8-HxCDF	8.7	6.8	3.9	26	2.9	0.46
1,2,3,6,7,8-HxCDF	4.5	3.0	1.6	11	1.5	0.24
2,3,4,6,7,8-HxCDF	3.2	2.1	1.6	7.4	1.7	0.32
1,2,3,7,8,9-HxCDF	1.7	1.7	0.56	3.1	0.45	N.D.
1,2,3,4,6,7,8-HpCDF	58	18	13	93	44	11
1,2,3,4,7,8,9-HpCDF	3.9	2.3	1.1	8.9	1.2	N.D.
OCDF	87	16	10	63	32	12
Total	1212.27	358.51	127.13	446.58	196.05	44.37

Table 5.1 Mass of PCDD/F congeners measured in each Soil sample (ng/kg)

	Sample Locations					
	A	B	C	D	E	F
Congener						
2,3,7,8-TCDD	0.69	0.49	0.30	0.78	0.51	0.0
1,2,3,7,8-PeCDD	0.49	0.45	0.30	1.7	0.21	0.0
1,2,3,6,7,8-HxCDD	0.42	0.23	0.11	0.46	0.15	0.034
1,2,3,4,7,8-HxCDD	0.11	0.092	0.062	9.27	0.079	0.0
1,2,3,7,8,9-HxCDD	0.24	0.13	0.079	0.37	0.098	0.0
1,2,3,4,6,7,8-HpCDD	0.88	0.33	0.13	0.33	0.18	0.030
OCDD	0.93	0.26	0.074	0.13	0.083	0.016
2,3,7,8-TCDF	0.75	0.32	0.30	1.8	0.29	0.067
1,2,3,7,8-PeCDF	0.25	0.16	0.082	0.84	0.10	0.0
2,3,4,7,8-PeCDF	2.7	1.6	0.89	10	1.1	0.17
1,2,3,4,7,8-HxCDF	0.87	0.68	0.30	2.6	0.29	0.046
1,2,3,6,7,8-HxCDF	0.45	0.30	0.16	1.1	0.15	0.024
2,3,4,6,7,8-HxCDF	0.32	0.21	0.16	0.74	0.17	0.032
1,2,3,7,8,9-HxCDF	0.17	0.17	0.056	0.31	0.045	0.0
1,2,3,4,6,7,8-HpCDF	0.58	0.18	0.13	0.93	0.44	0.11
1,2,3,4,7,8,9-HpCDF	0.039	0.023	0.011	0.089	0.012	0.0
OCDF	0.087	0.016	0.010	0.063	0.032	0.012
Total I-TEQ	**10**	**5.7**	**3.2**	**23**	**3.9**	**0.54**

Table 5.2 Mass of PCDD/F congeners measured (converted to toxic equivalents) in each Soil sample and I-TEQ values

5.3 Comparison with EPA soil testing during December 2000 and AWN soil testing during December 2002

A number of surveys have been carried out by AWN Consulting at rural and industrial sites in Ireland over the past number of years. Soil dioxin surveys have been carried out in rural Co. Meath, and rural Co. Dublin in 2001 and 2002. Two more studies were undertaken in the Ringaskiddy area in Cork, one by the EPA, and a second by AWN Consulting.

The EPA data for the Cork Harbour area, which was collected during soil testing carried out in December 2000 is presented in Table 5.3. This is one of the more recent baseline surveys carried out in this part of Ireland and uses the NATO/CCMS I-TEQ TEFs. The AWN data from the same area carried out in 2001 is also presented.

EPA Sampling Location	EPA Sample No.	EPA I-TEQ (ng/kg)	AWN I-TEQ (ng/kg)	AWN Sample Label	AWN Sampling Location
W. of Martello Tower	6	0.8	3.4	A	At base of Mart. Tower
Pfizer/ADM (to s. of site)	7	0.7	0.55	B	IDA land south of Pfizer
Ballymore (SW face field)	8	1	1.8	C	Cushkinny Nature Res.
Carrignafoy GAA Ground	9	1	1	D	Cobh Water Tower
Iniscarra WTW	10	0.6	<0.5	H	EPA Inishcarra

Table 5.3 EPA and AWN (2001) Analysis Data and Sampling Locations

A similar study, carried out in the Cork Harbour area by AWN in 2001, shows similar low levels of dioxins in the area. The AWN data for July 2001 shows five sites sampled in the Ringaskiddy area. These sites corresponded to five of the EPA sites. The Total I-TEQ results ranged from <0.5 – 3.4 ng/kg. These results were found to be very similar to the results from the five corresponding EPA sites (0.6 – 1ng/kg I-TEQ).

The study in north County Dublin, which was carried out in December 2001, showed dioxin levels in the soil to range between <0.5 and 1.2 I-TEQ ng/kg. The study carried out in Co. Meath found the results from all 8 sample locations to range between <1.0 and 1.5 I-TEQ ng/kg.

A review of the sampling and analysis methodologies used for the Dublin Bay survey in November 2003 indicates that this data can be compared with the EPA data, and the AWN data, for the following reasons;

Firstly, all of the AWN samples at the various locations were taken using a 2 cm core diameter, to a depth of 7-8 cm, which was identical to the EPA sampling which was also conducted to a depth of 7-8 cm using a 2 cm corer.

Secondly, the analyses was carried out using the NATO/CCMS I-TEQ system and the results are expressed as I-TEQ values. TEQs are given for the AWN sampling at Dublin Bay and are identical to those used for the EPA Cork Harbour and AWN analyses.

The maximum Total I-TEQ for a site measured in Dublin Bay was I-TEQ 23 ng/kg, whereas the maximum concentration measured at any of the sites around the periphery of Cork Harbour was I-TEQ 3.4 ng/kg. (It should be noted that this excludes a number of samples from the EPA Cork Harbour Study – which were taken in and around the Naval Base at Haulbowline – and which were found to have PCDD/F concentrations of up to I-TEQ 28 ng/kg, these samples were influenced by a local source of PCDD/F and were not representative of soil background concentrations in the Cork Harbour area and therefore it was not considered appropriate to compare the measured values from the Dublin study with these samples).

The highest I-TEQ value for a site in rural Co. Meath was found to be 1.5 ng/kg, and for a site in rural County Dublin was found to be I-TEQ 1.2 ng/kg. However, it must be noted that concentrations in urban soils would be expected to be higher than those in rural soils, due to the much larger concentration of potential PCDD/F emitters such as traffic and domestic and industrial combustion of fuel in an urban area.

5.4 Comparison with PCDD/F data for other countries

There have been numerous studies of PCDD/F soil concentrations undertaken by many countries over the last 25 years. Comparing different studies can sometimes difficult, especially as many studies have given total PCDD/F values rather than expressing results as I-TEQ values. Nevertheless, there is sufficient data available for comparisons to be made.

A comprehensive US study, published in 1986, found 2,3,7,8 TCDD (*note* not 2,3,7,8 TCDD I-TEQ) concentrations in urban soils to range from 1 – 10 ng/kg [17]. The values measured by this survey (which includes the other 16 congeners) found 2,3,7,8 TCDD values to be at the lower end of this range (see Table 5.1).

A study of 19 urban locations in England and Wales found soil 2,3,7,8 TCDD concentrations ranging from <0.5 ng/kg to 11 ng/kg [18]. Again, results were not expressed as 2,3,7,8 TCDD I-TEQ values, but a comparison between this data and the data obtained during the AWN survey work shows that the background soil 2,3,7,8 TCDD concentrations for sites sampled in the Dublin Bay area are at the lower end of this scale (see Table 5.1).

Dioxin levels in soil were also measured in another major survey carried out in the UK by HMIP in 1995 [19]. The mean background level for urban soils was found to be 28.4 ng/kg I-TEQ (Mean rural background was found to be 5.17 ng/kg I-TEQ and agricultural soil with no record of application of artificial fertilisers or chemicals was found to have a concentration of 1.4 ng/kg I-TEQ).

It can be seen that the soil sample take from Bull Island had similar PCDD/F concentrations to rural soil samples analysed in Ireland and in the UK.

3 of the other samples (from Irishtown Nature Reserve, Ringsend Park and Clontarf Promenade) had PCDD/F concentrations which were in the range of 3 – 5 ng/kg I-TEQ and which is at the lower end of the concentration range for samples taken in urban areas in the UK.

The sample taken at Sean Moore Park, which had a PCDD/F concentration of 10 ng/kg I-TEQ and the sample taken at Sandymount, which had a concentration of 23 ng/kg I-TEQ, were still within the range of urban PCDD/F concentrations recorded in the UK , but were elevated when compared with the other samples analysed in this study, indicating possible localised contamination from combustion related activities.

Decreasing trends in environmental PCDD/F concentrations have been noted in many developed countries throughout the 1980's and 1990's. It has been proposed that this is due to a combination of the phasing out of leaded petrol, reduction in emissions from manufacturing industries and the introduction of emission controls on incinerator emissions [20]. This trend is likely to continue as controls on environmental emissions and on releases of PCDD/F continue to be implemented.

Some countries have set limits for maximum soil concentrations of PCDD/Fs. The German Government have set a limit of 40 ng/kg 2,3,7,8 TCDD I-TEQ. The growing of crops on land which has soil PCDD/F values greater than this limit value is restricted. A second limit has also been set by the German Government, of 100 ng/kg 2,3,7,8 TCDD I-TEQ for playgrounds. If this limit is breached the playground has to be remediated.

None of the PCDD/F values measured in the AWN survey approach the lower limit value.

5.5 Comparison of PCB and mercury concentrations with relevant standards

Mercury and PCB concentrations (7 EC congeners and 4 non-ortho and 8 mono-ortho congeners) were also analysed for the soil samples taken and these results are also presented in Attachment 4.

5.5.1 PCB

Table 5.4 summarises the dioxin like PCBs measured during the survey and Table 4.2 summarises all PCBs measured during the survey.

8 mono	**A**	**B**	**C**	**D**	**E**	**F**
105	1.9	0.16	0.16	0.2	0.27	<0.05
114	0.09	<0.05	<0.05	<0.05	<0.05	<0.05
118	4.4	0.35	0.39	0.46	0.51	0.09
123	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
156	0.62	0.05	<0.05	0.06	0.08	<0.05
157	0.17	<0.05	<0.05	<0.05	<0.05	<0.05
167	0.27	<0.05	<0.05	<0.05	<0.05	<0.05
189	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	7.45	**0.56**	**0.55**	**0.72**	**0.86**	**0.09**
4 non-ortho	**A**	**B**	**C**	**D**	**E**	**F**
81	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
77	0.14	0.07	<0.05	<0.05	<0.05	<0.05
126	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
169	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	0.14	**0.07**	**0**	**0**	**0**	**0**

Table 5.4 Summary of PCB non-ortho and mono congeners (all conc. in ug/kg)

It can be seen that Samples B – F recorded a value of < 1 μg/kg for the 8 mono-ortho PCBs and 0.07 μg/kg or less for the 4 non-ortho PCBs, whereas the Sample taken at Sampling Point A had PCB concentrations of 7.45 μg/kg (8 mono –ortho), 0.14 μg/kg (4 non-ortho) and 22.45 μg/kg (EC 7). The sample taken at Sampling Point E had concentrations of non-ortho and mono-ortho which were similar to Samples B – F, but the EC 7 congener concentration was substantially greater than that recorded for the other samples in the B – F sample group.

This pattern suggests that the elevated PCB EC 7 congener concentration recorded for Sample A may have been associated with the source of the mono and ortho-PCBs, whereas the concentration recorded for Sample E does not seem to be associated with the source of mono and ortho-PCBs.

There are a number of sources of these PCBs in the environment. Combustion sources (this is combustion of non-PCB materials – that is it is the *de novo* synthesis of PCB) are believed to be the main source of PCB-169 and 189 [21] and it has been shown that PCB-126 forms the dominant component of PCB emissions from combustion sources[22].

Aroclor, the trade name under which Monsanto Corp. sold commercial PCB formulations (specifically formulations 1221, 1232 and 1242) is likely to be the major source of PCBs 156, 105, 118 and 77 in the environment [21]. It will be seen that the majority of the PCBs recorded in the current study are in this group (156, 105, 118 and 77), whereas the combustion derived PCBs are generally not represented. Therefore, it can be concluded that the source of the mono-ortho and non-ortho PCBs measured was most likely to be Aroclor related sources.

Research work in the UK and USA has found that PCB-156, 126 and 118 account for 70 – 90% of the PCB TEQ burden in human breast milk [23]. This pattern is reflected in the PCB profile of the samples with PCB-156 and 118 being the dominant congeners recorded for the soil samples.

There is a relative shortage of published data on dioxin like PCBs in the soil environment. A study conducted in 1994 measured urban mono-ortho and non-ortho PCB concentrations at a number of locations in the US and Japan and found that concentrations ranged from 0.8 – 9.9 ng/kg I-TEQ [24].

Using the WHO I-TEQ values for PCB TEFs, the measured concentrations determined by the current study were converted to I-TEQ values, as shown in the following Tables. Following convention, the calculation was performed assuming that if a value of below the limit of detection was recorded then Table 5.4 (the value recorded was deemed equal to the limit of detection), Table 5.5 (the value recorded was = 0) or Table 5.6, the value recorded was deemed equal to half the limit of detection.

	TEF	TEF
	ug/kg	ng/kg
	Conc. = LOD	
Sample A	0.0066577	6.6577
Sample B	0.0056765	5.6765
Sample C	0.0056705	5.6705
Sample D	0.0056865	5.6865
Sample E	0.0057085	5.7085
Sample F	0.0056401	5.6401

Table 5.5 PCB mono and ortho TEQ Concentrations

	TEF	TEF
	ug/kg	ng/kg
	LOD = 0	
Sample A	0.0011427	1.1427
Sample B	0.000111	0.111
Sample C	0.000055	0.055
Sample D	0.000096	0.096
Sample E	0.000118	0.118
Sample F	0.0000396	0.0396

Table 5.6 PCB mono and ortho TEQ Concentrations

	TEF	TEF
	ug/kg	ng/kg
	Conc. = 0.5 LOD	
Sample A	0.0039002	3.9002
Sample B	0.002865	2.865
Sample C	0.0028515	2.8515
Sample D	0.0029038	2.90375
Sample E	0.0029258	2.92575
Sample F	0.0028411	2.8411

Table 5.7 PCB mono and ortho TEQ Concentrations

It can be seen that the recorded values were within the range recorded by the above mentioned study, even for the unrealistic scenario where the concentration of PCB congener was assumed to equal the limit of detection, when a value of below the limit of detection was recorded. The TEF calculation also shows that the, for the scenario where a value below LOD = 0, the I-TEQ contribution of dioxin like PCBs to overall PCDD/F I-TEQ concentrations is relatively low.

No Irish guidance is currently available for PCB contamination and in the absence of Irish Guidance, the Dutch Target and Intervention values are currently applied by the

EPA, for the EC 7 PCB Congeners, in Ireland to determine if soil is classed as contaminated [25].

The Dutch Government have set a national target value of 20 µg/kg PCB (7 EC Congeners) in soil and a threshold value (the concentration above which remedial action should be considered) of 1000 µg/kg. Apart from the sample analysed from Sean Moore Park, the measured concentrations (for the 7 EC Congeners) for the Dublin Bay area were well below the threshold value and can therefore be regarded as not significant with respect to human health(see Attachment 4). The sample taken at Sean Moore Park was above the Dutch Target Value but below the threshold value for remedial action and it would appear that the elevated concentration of the PCB EC 7 congeners was related to the mono and non-ortho PCB concentrations. However, it would be prudent to carry out additional soil sampling at Sean Moore Park to determine if a source of PCB contamination is present on the surface, or if the measured value is representative of the maximum concentrations present. Similarly, the PCB concentration recorded on Clontarf was also elevated when compared with the other samples measured and it would be prudent to conduct further sampling at this location also.

5.5.2 Mercury

Mercury concentrations were below the limit of detection of the analytical method (1mg/kg) with the exception of sample site C (Ringsend Park) which recorded a mercury concentration of 2 mg/kg. All values were well below the Dutch threshold Value of 10 mg/kg [25].

6.0 CONCLUSIONS

Background soil PCDD/F concentrations for the sites sampled in the Dublin Bay area were found to be generally low when compared with data for urban areas from other countries but two of the six samples analysed had PCDD/F concentrations which were similar to the medium and higher end of the concentration range noted in urban areas in other countries. These samples may have been influenced by localised combustion sources such as traffic emissions and bonfires.

PCB and mercury analysis data indicated that background soil concentrations for these analytes were generally low when compared with data for other urban centres, with the exception of two locations, where slightly elevated PCB concentrations were noted, and where it is recommended that further analysis be undertaken.

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FIGURES

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Location of proposed waste to energy facility

Project

Ringsend Waste to Energy Plant

Reference

03_2008SR01

Figure 1.1

Location of proposed waste to energy facility

awn consulting

The Tecpro Building, Clonshaugh Industrial Estate, Dublin 17. Tel: +353 (0)1 847 4220 Fax: +353 (0)1 847 4257

Location A : Sean Moore Park
Location B: Irishtown Nature Park
Location C: Ringsend Park
Location D: Sandymount (grassed area along the sea front)
Location E: Clontarf (grassed area along the sea front)
Location F: Bull Island Nature Reserve

Location F
Location E
Location C
Location B
Location A
Location D

Project
Ringsend Waste to Energy Plant

Reference
03_2008SR01

Figure 2.1
Soil sampling locations in vicinity of proposed WTE Plant

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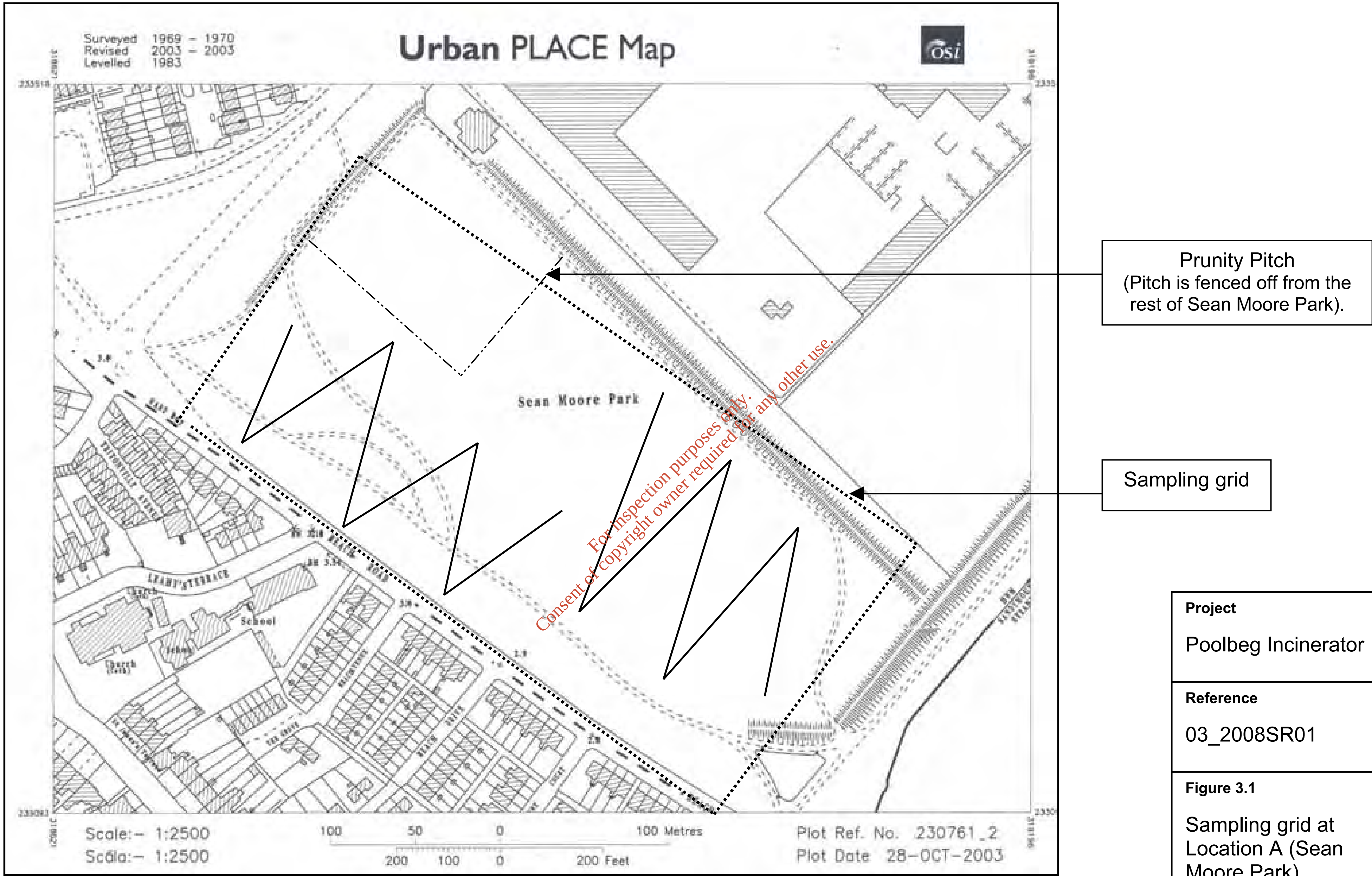

Project

Poolbeg Incinerator

Reference

03_2008SR01

Figure 3.1

Sampling grid at Location A (Sean Moore Park)

Scale 1:2500

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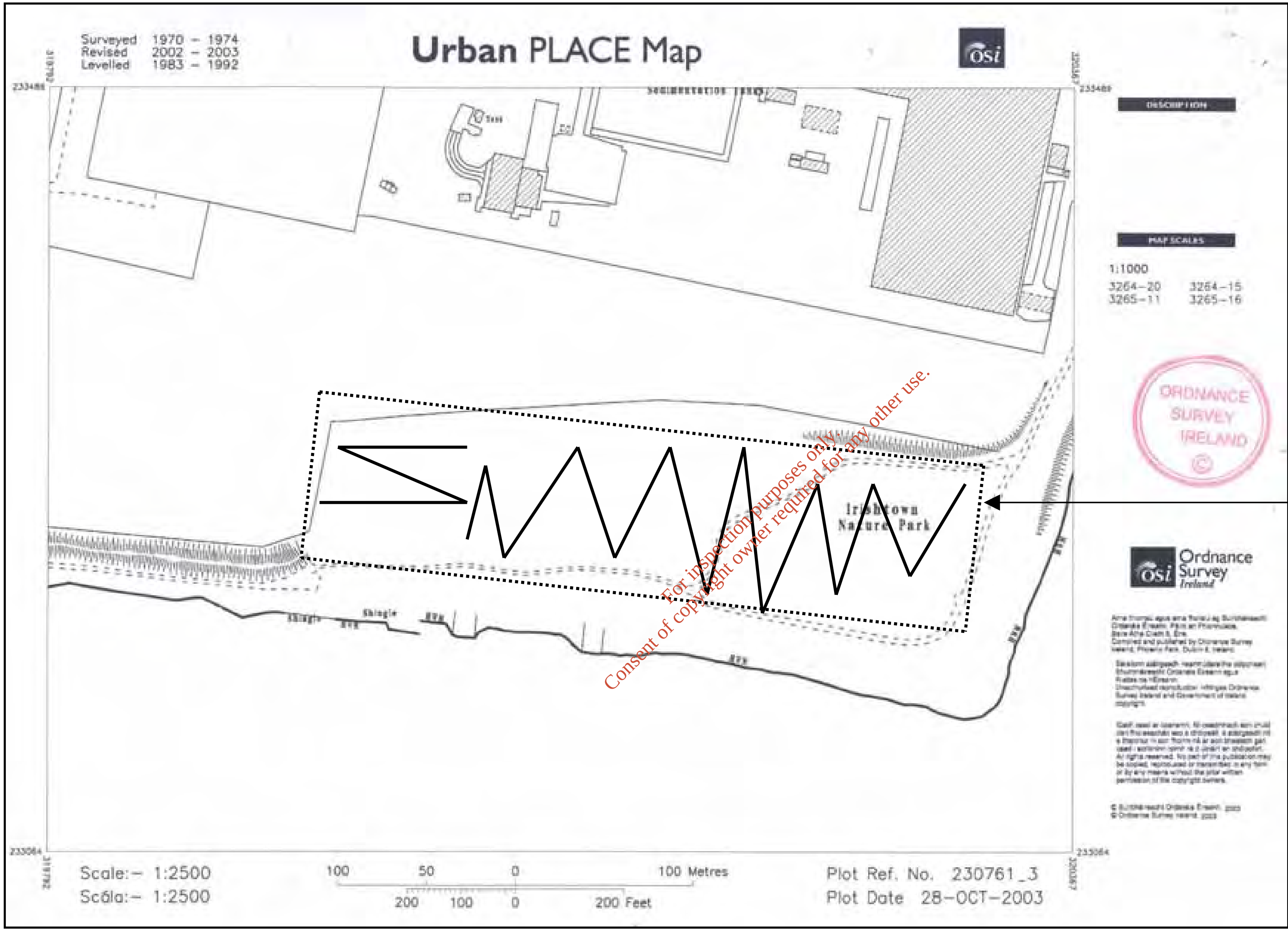

Sampling grid

Project

Poolbeg Incinerator

Reference

03_2008SR01

Figure 3.2

Sampling grid at Location B (Irishtown Nature Park)
Scale 1:2500

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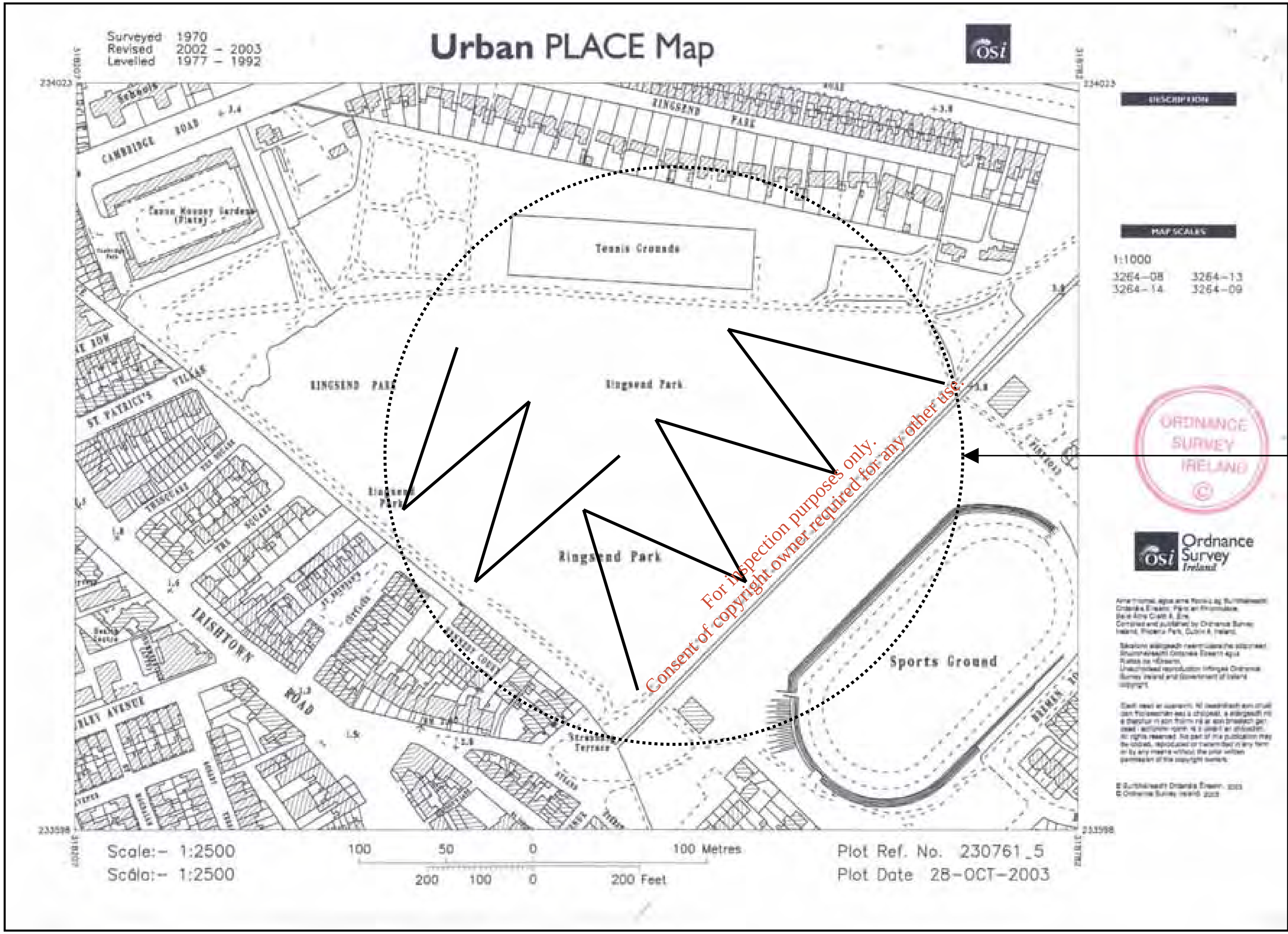

Project

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Reference

03_2008SR01

Figure 3.3

Sampling grid at Location C (Ringsend Park)

Scale 1:2500

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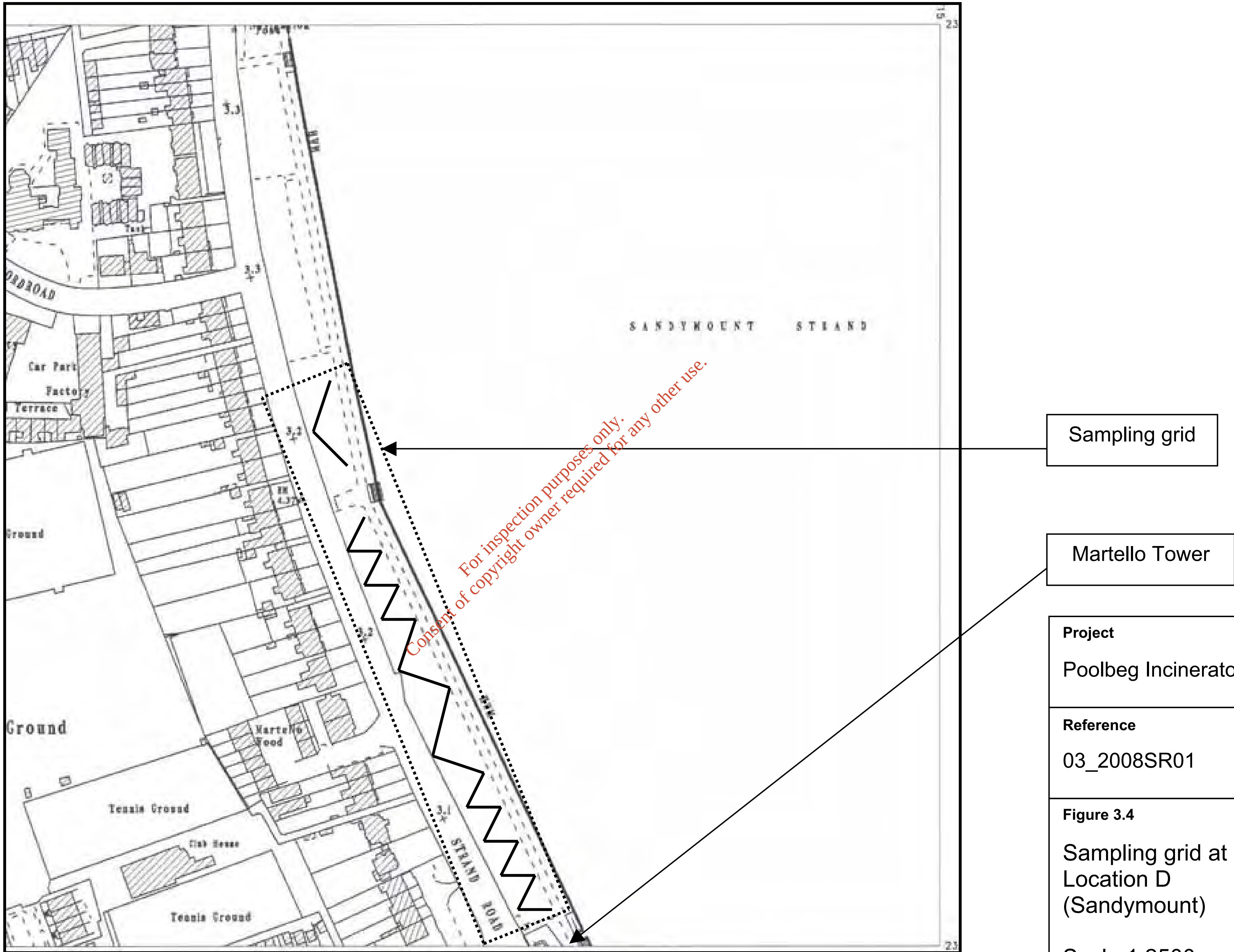


Project

Poolbeg Incinerator

Reference

03_2008SR01

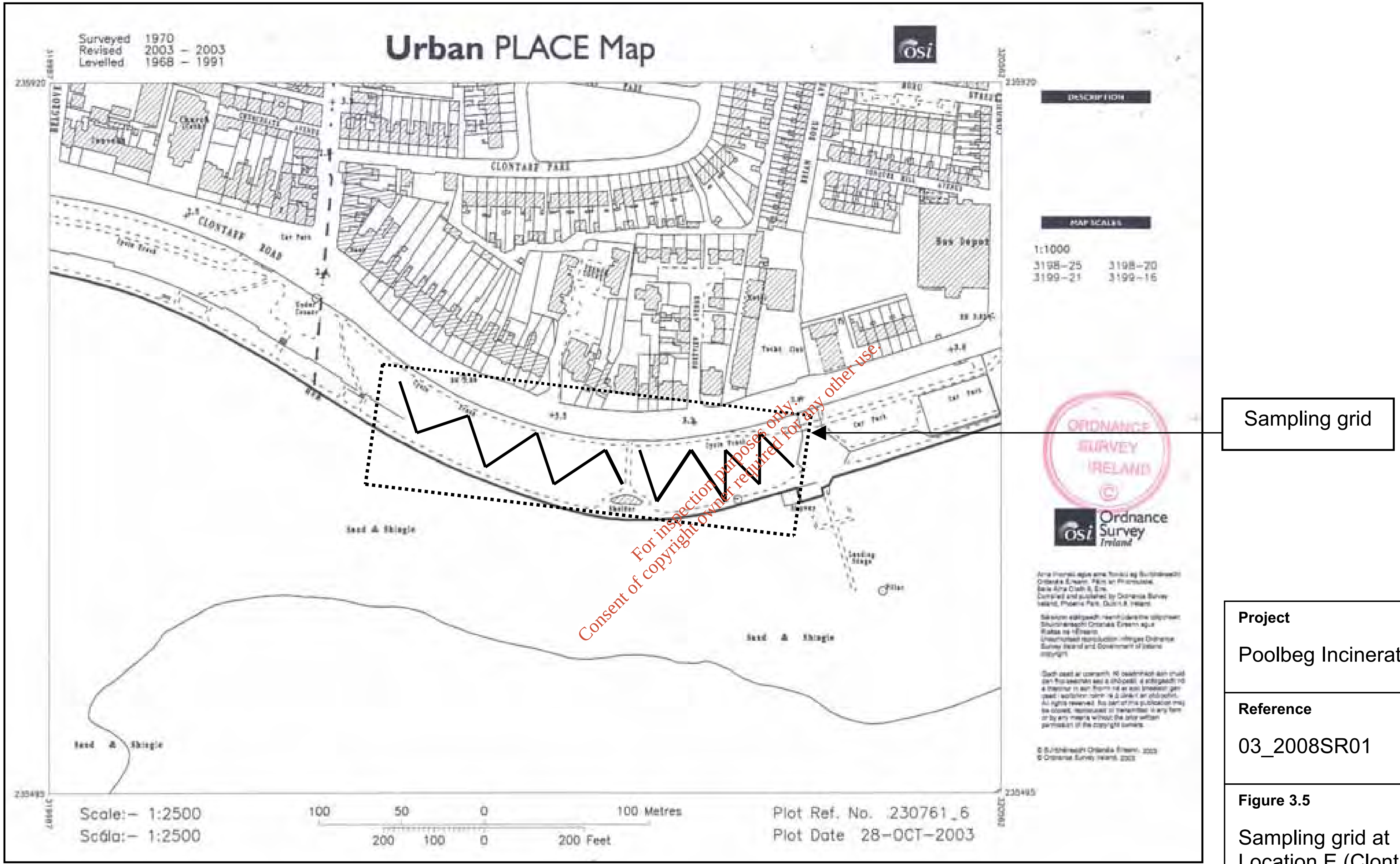
Figure 3.4

Sampling grid at Location D (Sandymount)

Scale 1:2500

awn consulting

The Tecpro Building, Clonshaugh Industrial Estate, Dublin 17. Tel: +353 (0)1 847 4220 Fax: +353 (0)1 847 4257



Project

Poolbeg Incinerator

Reference

03_2008SR01

Figure 3.5

Sampling grid at Location E (Clontarf Promenade)

Scale 1:2500

awn consulting

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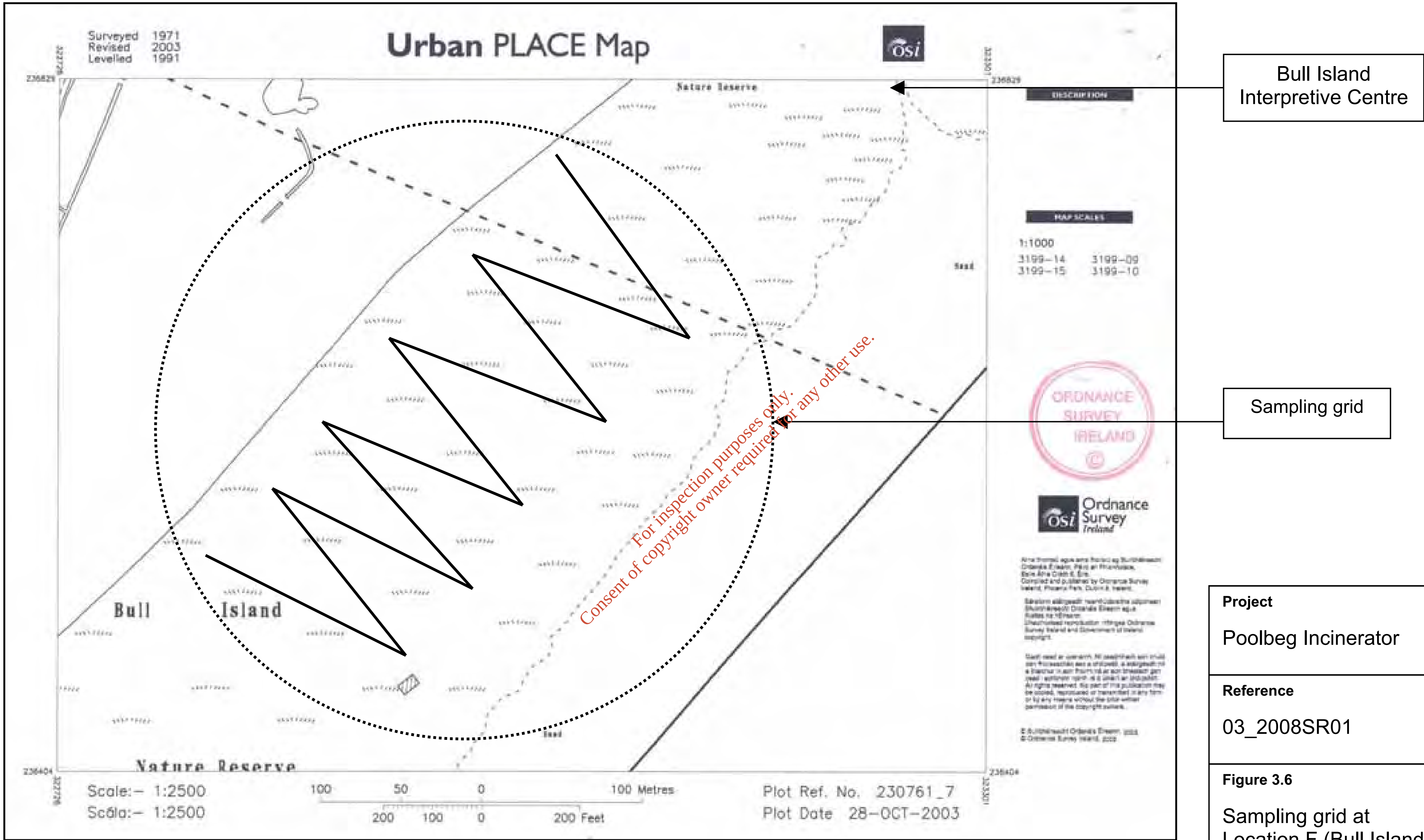


Project

Poolbeg Incinerator

Reference

03_2008SR01

Figure 3.6

Sampling grid at Location F (Bull Island Nature Reserve) Scale 1:2500

awn consulting

The Tecpro Building, Clonshaugh Industrial Estate, Dublin 17. Tel: +353 (0)1 847 4220 Fax: +353 (0)1 847 4257

Figure 3.7 Sample Point A – Sean Moore Park

Figure 3.8 Sample Point B – Irishtown Nature Park

Figure 3.9 Sample Point C – Ringsend Park

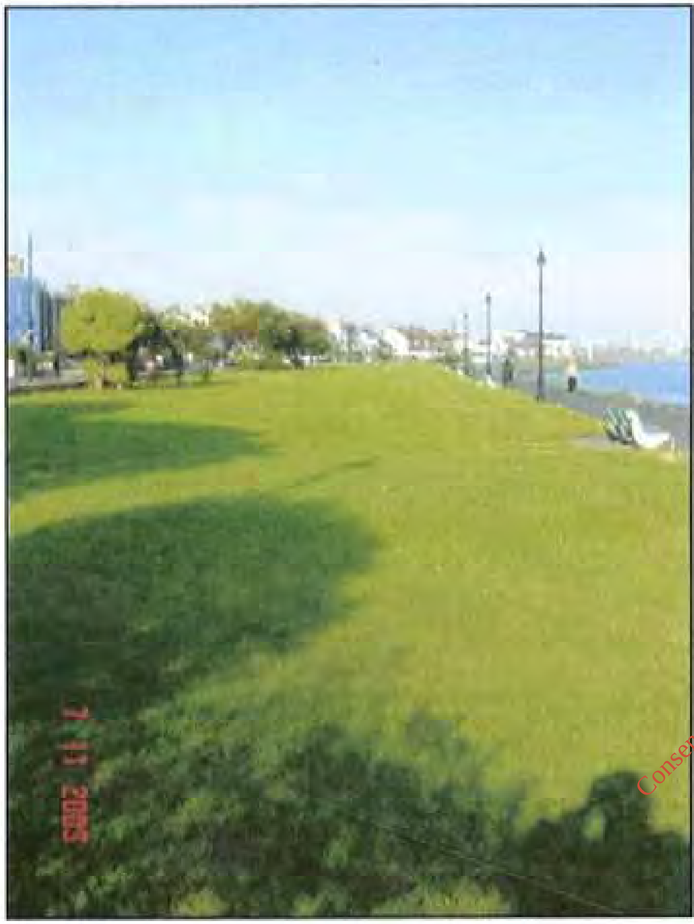


Figure 3.10 Sample Point D – Sandymount Promenade

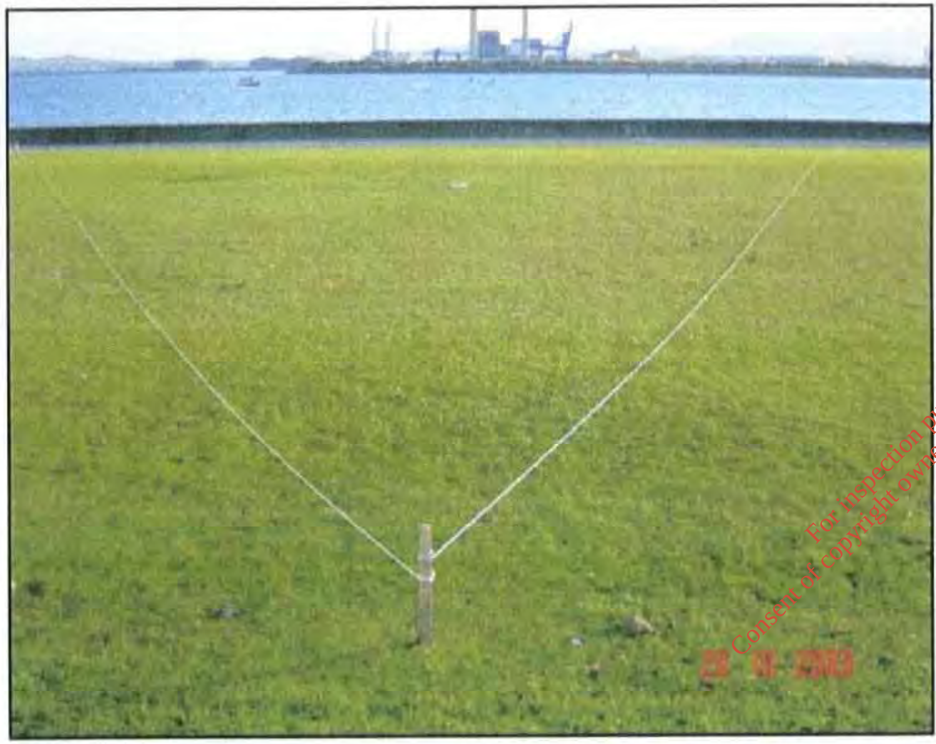


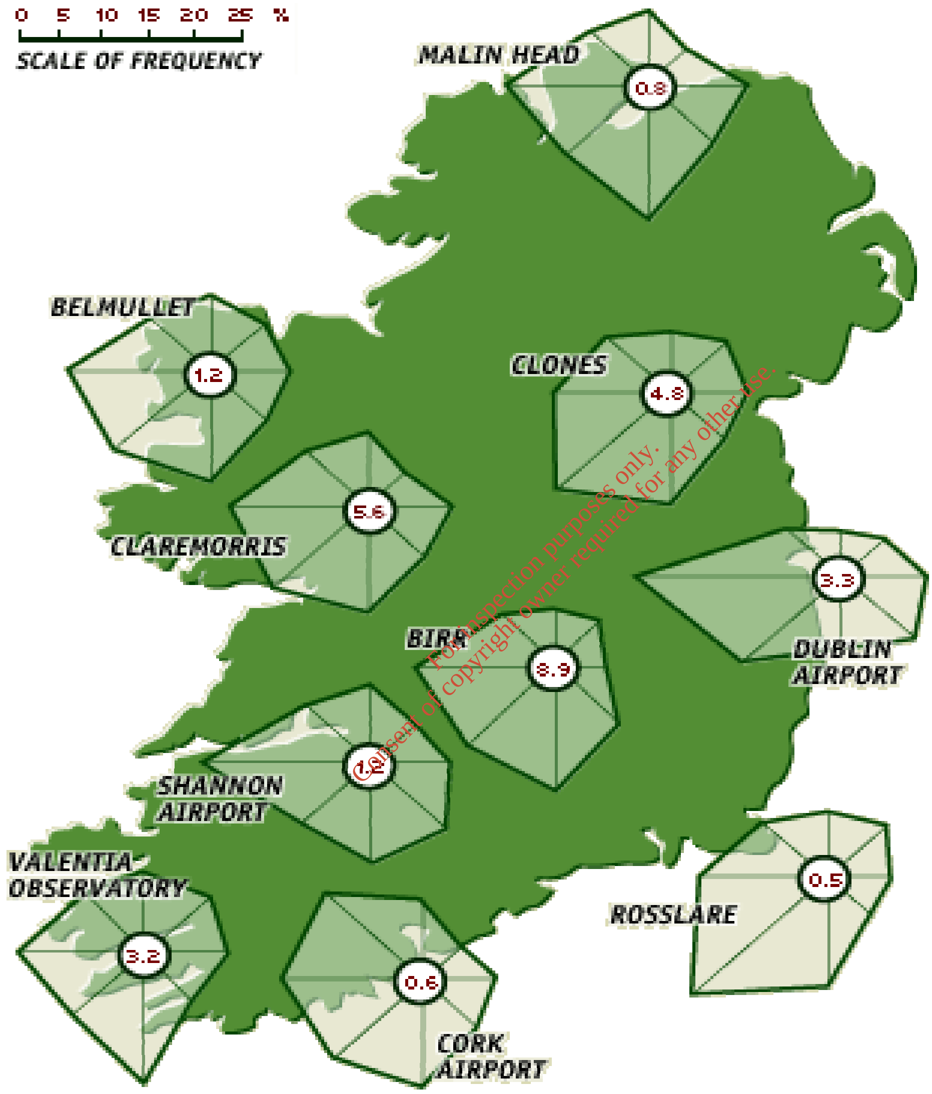
Figure 3.11 Sample Point E – Clontarf Promenade

Figure 3.12 Sample Point F – Bull Island Nature Reserve

ATTACHMENT 1 - WIND DIRECTION

WIND DIRECTION (percentage frequency of wind direction)

○- Circled number=%CALM



ATTACHMENT 2 - FIELD NOTES

Sample Location A - Sean Moore Park

Field Record
Location A Sean Moore Park
Date: 5/11/03
Conducted by: Elaine Neary

100 samples were taken at 10m intervals

A continuous "W" pattern was followed on the grassed area of the park

The "W" pattern was followed East to West.

The dimensions of the "W" legs starting from the east are as follows:

1: 110m
2: 115m
3: 136m
4: 140m
5: 130m
6: 70m
7: 64m
8: 70m
9: 90m
10: 105
11: 70

Position: 53°20.178' N
006°12.842' W

Field Record

Location A Sean Moore Park
Date: 5/11/03
Conducted by: Elaine Neary (AWN Consulting)

100 samples taken at 10 m intervals.

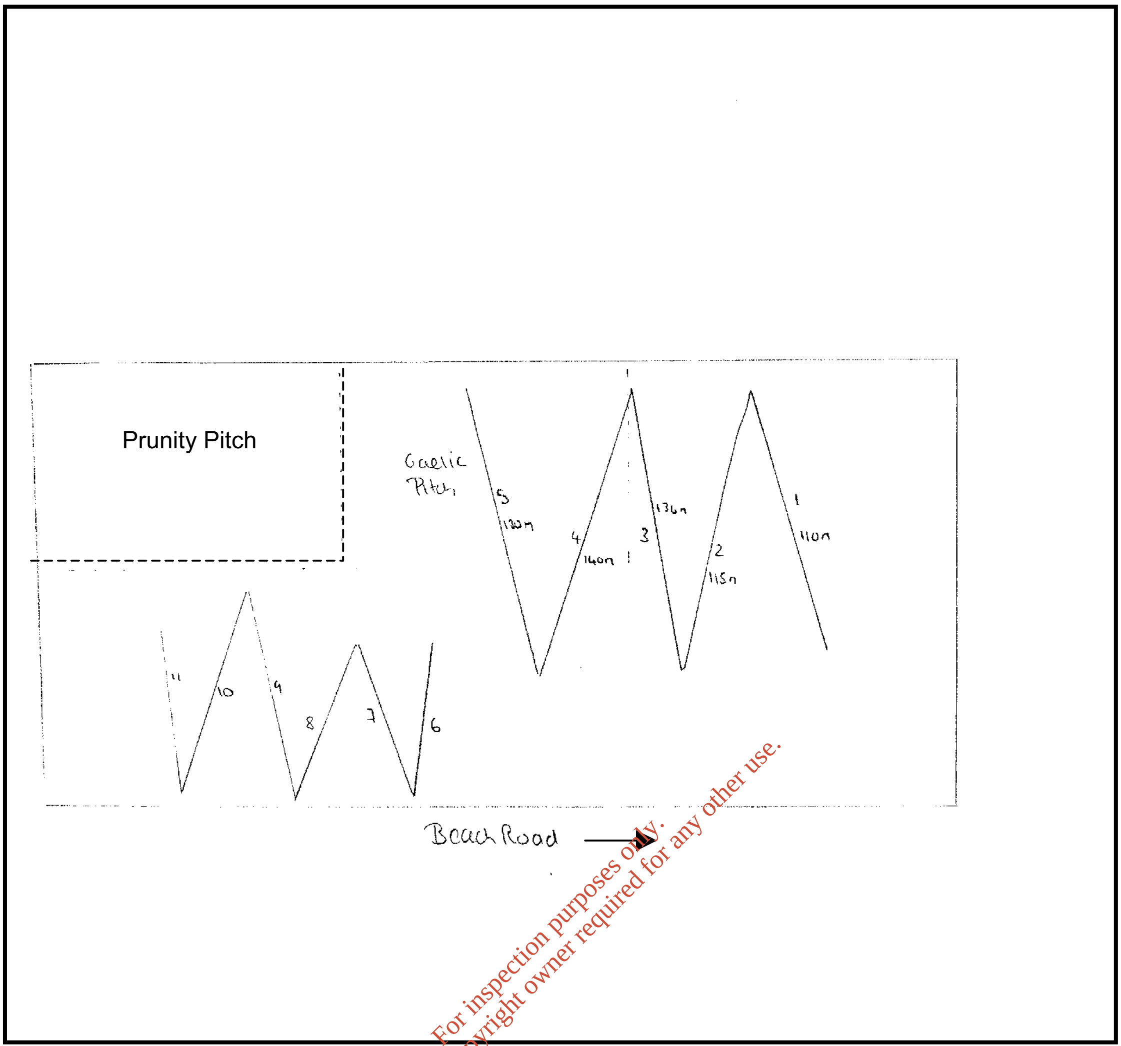
A “W” pattern was followed on the grassed area of the park.

The “W” pattern was followed East to West.

The dimensions of the “W” legs starting from the East are as follows:

1: 110 m
2: 115 m
3: 136 m
4: 140 m
5: 130 m
6: 70 m
7: 64 m
8: 70 m
9: 90 m
10: 105 m
11: 70 m

Position:
53^{o}20.169’N
006^{o}12.923’W


Prunity Pitch
Gaelic Pitch
5
120m
4
140m
3
136m
2
115m
1
110m
11
10
9
8
7
6
Beach Road

Sample Location B – Irishtown Nature Park

Field Record
Location B Irishtown Nature Park
Date: 6/11/03

Conducted by: Elaine Neary

100 samples taken at 10m intervals

A "W" pattern was followed from East to West

The dimensions of the "W" legs are as follows:

1: 30m
2: 30m
3: 58m
4: 60m
5: 73m
6: 73m
7: 71m
8: 70m
9: 60m
10: 52m
11: 70m
12: 60m
13: 50m
14: 80m
15: 85m
16: 80m

Position: N 53° 20.161'
W 006° 11.757'

Field Record

Location B Irishtown Nature Park
Date: 6/11/03
Conducted by: Elaine Neary (AWN Consulting)

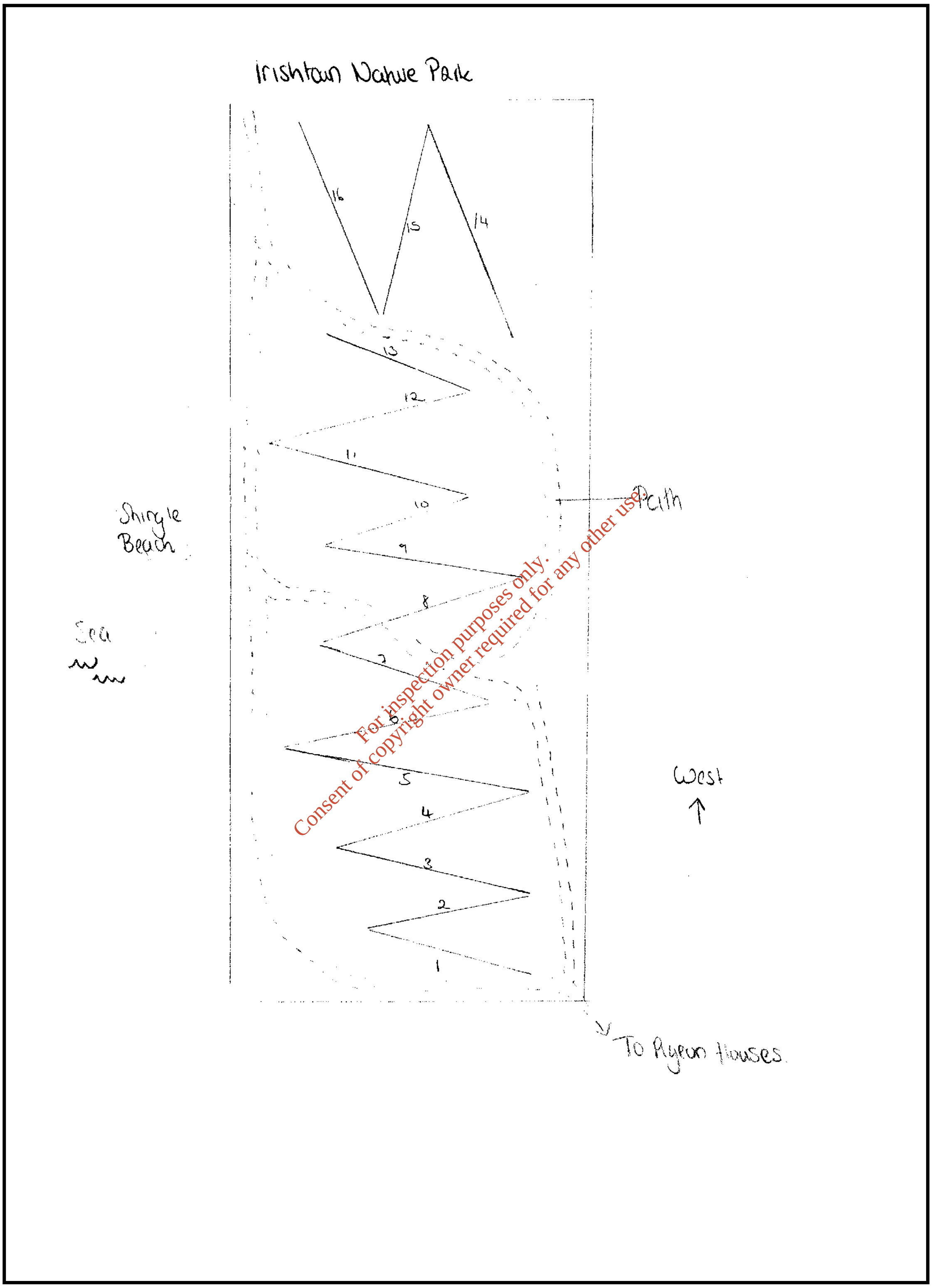
100 samples taken at 10 m intervals.

A "W" pattern was followed from east to west.

The dimensions of the "W" legs are as follows:

1: 30 m
2: 30 m
3: 58 m
4: 60 m
5: 73 m
6: 73 m
7: 71 m
8: 70 m
9: 60 m
10: 52 m
11: 70 m
12: 60 m
13: 50 m
14: 80 m
15: 85 m
16: 80 m

Position:
53^0 20.161' N
006^0 11.757' W


Irishtown Nature Park
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Path
Shingle Beach
Sea
West
To Pigeon Houses

Sample Location C – Ringsend Park

Field Record
Location C Ringsend Park
Date: 3/11/03
Conducted by: Elaine Neary

100 samples taken 10m intervals

A "W" pattern was followed in the park

The dimensions of the "W" legs are as follows:

1: 80m
2: 90m
3: 100m
4: ~~100~~ 80m
5: 90m
6: 100m
7: 105m
8: 120m
9: 117m
10: 120m

Position:
N 53°20.520'
W006°13.258'

Field Record

Location C Ringsend Park
Date: 3/11/03
Conducted by: Elaine Neary (AWN Consulting)

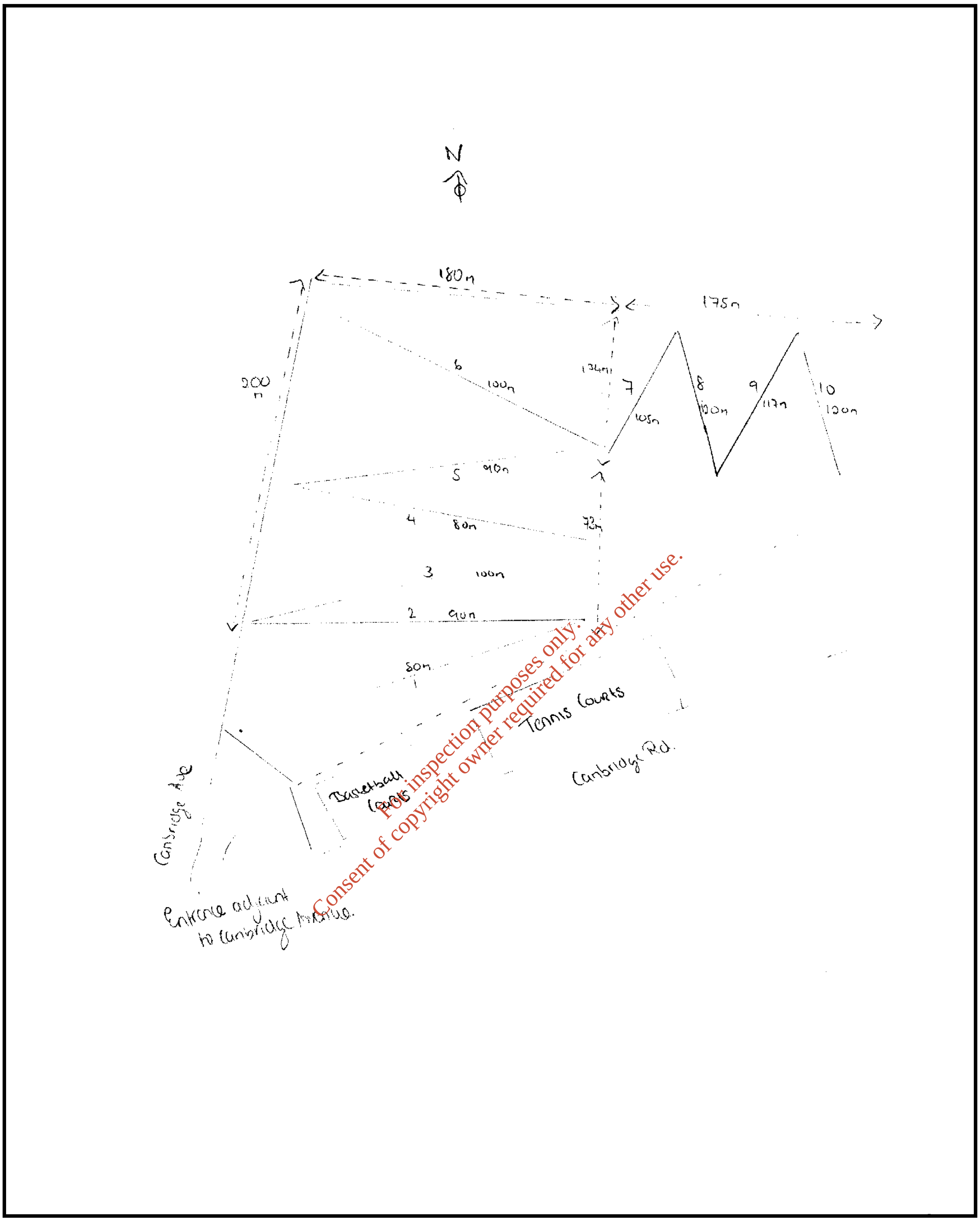
100 samples taken at 10 m intervals.

A “W” pattern was followed in the park.

The dimensions of the “W” legs are as follows:

1: 80 m
2: 90 m
3: 100 m
4: 80 m
5: 90 m
6: 100 m
7: 105 m
8: 120 m
9: 117 m
10: 120 m

Position:
53^0 20.520’ N
006^0 13.258’ W


N
180m
175m
200 m
6
100m
134m
7
105m
8
120m
9
117m
10
120m
5
90m
4
80m
73m
3
100m
2
90m
50m
Tennis Courts
Basketball Courts
Cambridge Rd.
Cambridge Ave
Entrance adjacent to Cambridge Avenue.

Sample Location D – Sandymount (grassed area along the sea front)

Field Record

Location D: Sandymount Green

Date: 7/11/03

Conducted by Elaine Neary (AWN Consulting)

A "W" pattern was followed on the grassed area along the sea front parallel to the strand road

The "W" pattern was followed East to West.

The dimensions of the "W" legs starting from the east are as follows:

1: 21.5m	11: 21.4m
2: 17.5m	12: 19m
3: 19.5m	13: 20.5m
4: 19.4m	14: 19.5m
5: 21.5m	15: 19.5m
6: 21m	16: 17.7m
7: 20.1m	17: 22.3m
8: 20.8m	18: 22m
9: 23m	19: 22m
10: 22.4m	20: 22.5m

100 samples taken at 4m intervals.

Position:

N53°19.584'

W006°12.456'

Field Record

Location D Sandymount Green
Date: 7/11/03
Conducted by: Elaine Neary (AWN Consulting)

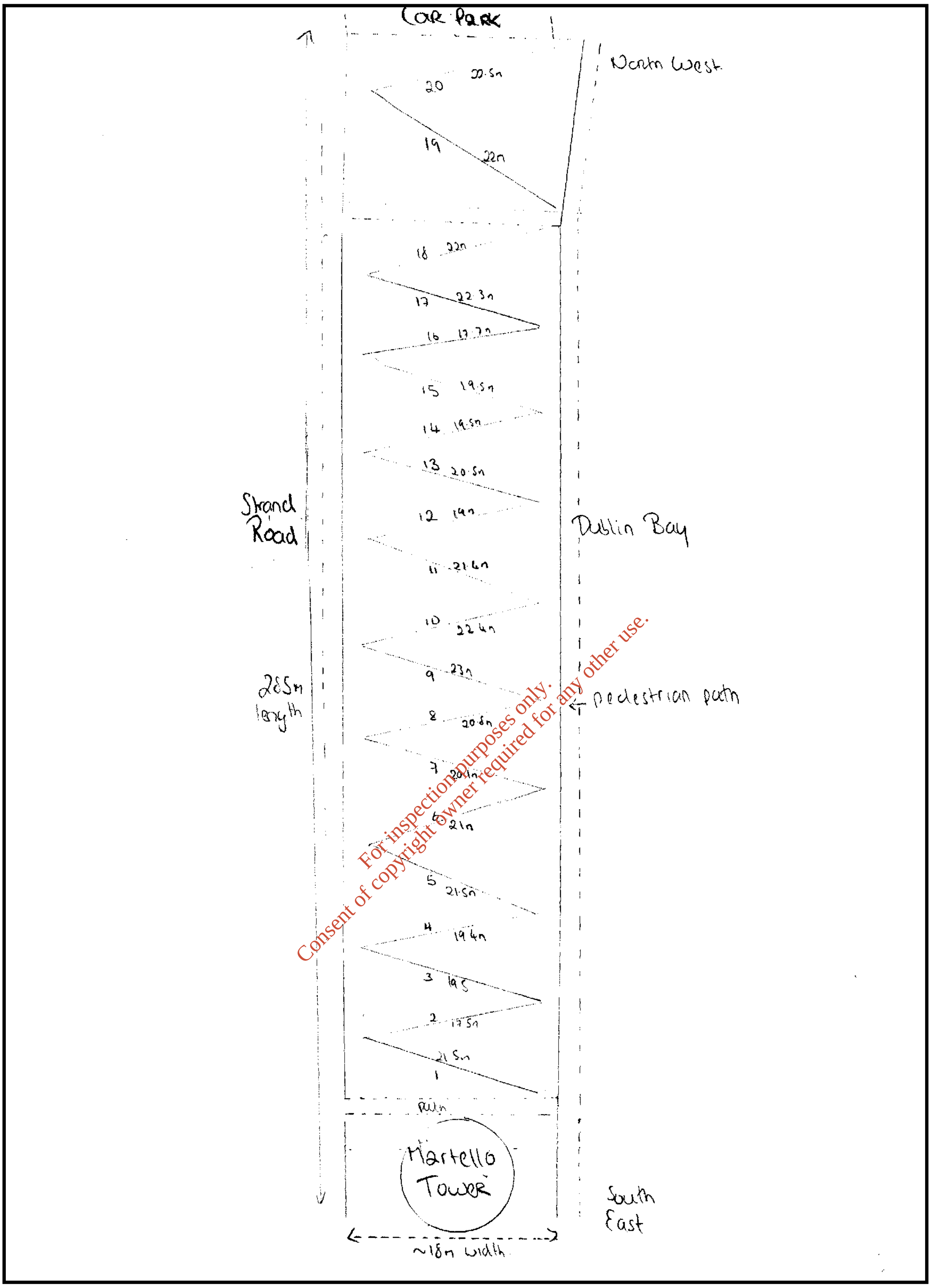
100 samples taken at 4 m intervals.

A “W” pattern was followed on the grassed area along the sea front parallel to the strand road. The pattern was followed from east to west.

The dimensions of the “W” legs starting from the east are as follows:

1: 21.5 m
2: 17.5 m
3: 19.5 m
4: 19.4 m
5: 21.5 m
6: 21 m
7: 20.1 m
8: 20.8 m
9: 23 m
10: 22.4 m
11: 21.4 m
12: 19 m
13: 20.5 m
14: 19.5 m
15: 17.7 m
16: 22.3 m
17: 22.3 m
18: 22 m
19: 22 m
20: 22.5 m

Position:
53^0 19.584’ N
006^0 12.456’ W



Car Park
North West
Strand Road
Dublin Bay
285m length
pedestrian path
Martello Tower
South East
~18m width

Sample Location E – Clontarf Promenade

Field Record

Location E Clontarf Promenade
Date: 29/10/03
Conducted by: Elaine Neary & DR. Fergal Callaghan

100 samples were taken @ 4m intervals.

A continuous "W" pattern was followed on the grassed area along the sea front parallel to the Clontarf Road.

The "W" pattern was followed East to West.

The dimensions of the "W" legs starting from the east are as follows:

1: 22m
2: 32m
3: 35m
4: 35m
5: 37m
6: 35m
7: 20m
8: 28m
9: 30·6m
10: 47m
11: 34m
12: 27m
13: 24m
14: 21m

Position: 53° 21.476' N
006°11.605' W

Field Record

Location E Clontarf Promenade
Date: 29/10/03
Conducted by: Dr. Fergal Callaghan and Elaine Neary (AWN Consulting)

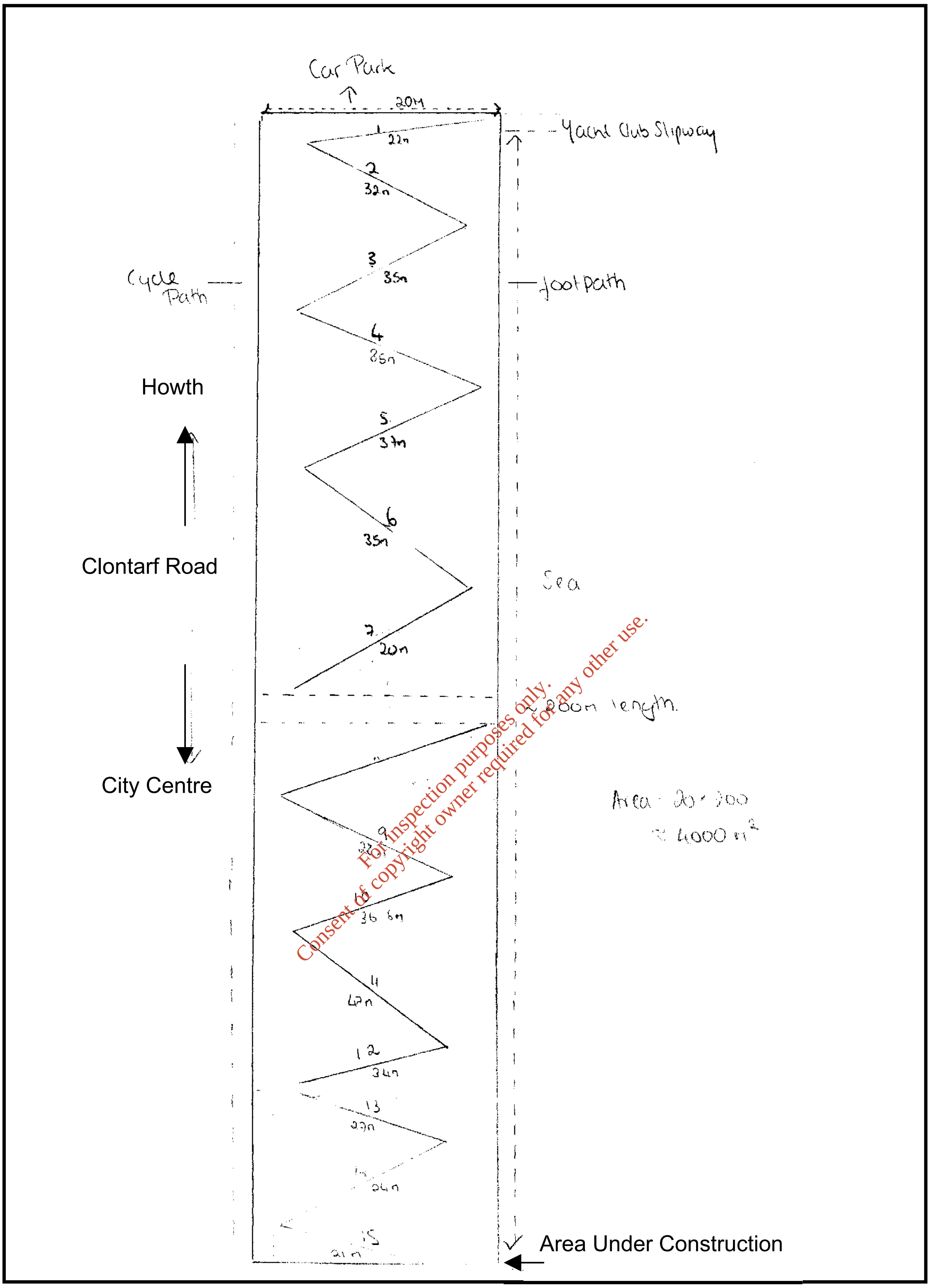
100 samples taken at 4 m intervals.

A "W" pattern was followed on the grassed area along the sea front parallel to the Clontarf Road. The "W" pattern was followed East to West.

The dimensions of the "W" legs starting from the East are as follows:

1: 22 m
2: 32 m
3: 35 m
4: 35 m
5: 37 m
6: 35 m
7: 20 m
8: 28 m
9: 30.6 m
10: 47 m
11: 34 m
12: 27 m
13: 24 m
14: 21 m

Position:
53°21.476'N
006°11.605'W


Car Park
20M
Yacht Club Slipway
Cycle Path
Foot Path
Howth
Clontarf Road
City Centre
Sea
~200m length
Area: 20×200
≈ 4000 m²
Area Under Construction

Sample Location F – Bull Island Nature Reserve

Field Record
Location F Bull Island Nature Reserve
Date: 31/10/03

Conducted by Elaine Neary

100 samples taken at 10m intervals

A "W" pattern was followed in the grassed area between the beach and the Royal Dublin Golf Course.

The dimensions of the "W" legs are as follows:

1: 95m
2: 98m
3: 93m
4: 100m
5: 100m
6: 105m
7: 105m
8: 100
9: 108
10: 110

Position:

N 53°21.962'
W 006°09.223'

Field Record

Location F Bull Island Nature Reserve
Date: 31/10/03
Conducted by: Elaine Neary (AWN Consulting)

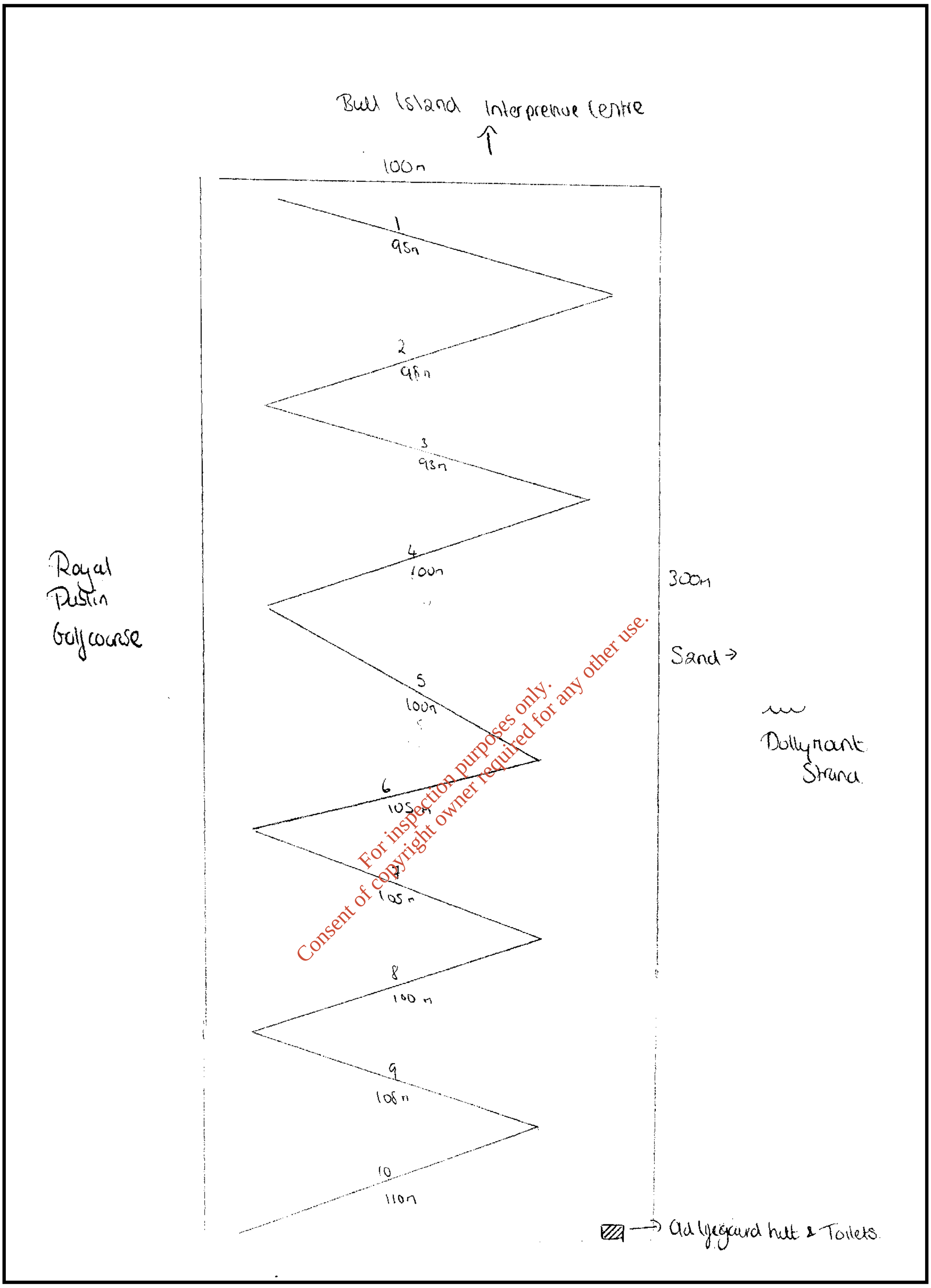
100 samples taken at 10 m intervals.

A “W” pattern was followed on the grassed area between the beach and the Royal Dublin Golf Course.

The dimensions of the “W” legs are as follows:

1: 95 m
2: 98 m
3: 93 m
4: 100 m
5: 100 m
6: 105 m
7: 105 m
8: 100 m
9: 108 m
10: 110 m

Position:
53^0 21.962’ N
006^0 09.223’ W


Bull Island Interprenue Centre
100m
1
95m
2
98m
3
93m
4
100m
300m
Royal Dublin Golfcourse
Sand
5
100m
Dollymount Strand
6
105m
7
105m
8
100m
9
108m
10
110m
Old lifeguard hut & Toilets

ATTACHMENT 4 – ANALYSIS RESULTS

SAL

SCIENTIFIC ANALYSIS LABORATORIES LTD.
Medlock House,
New Elm Road
Manchester M3 4JH
Telephone: 0161-827 1400
Fax: 0161-827 1414

Job 39572E/Dioxins

Dioxin and Furan Analysis

For

Attention: Elaine Neary

AWN Consulting

The Tecpro Building,
Clonshaugh Industrial Estate,
Dublin, 17.

Date of Sample Receipt: 12/11/03

Date(s) of Sample Testing: 18/11/03 - 20/11/03

Date of Issue of Report: 20/11/03

Scientific Analysis Laboratories Ltd.

Certificate of Analysis

All analytical results contained within have been obtained in accordance with the Laboratory's standard operating procedures contained in SAL SOP #1

Any deviations from these standard operating procedures are described in the following text.

Report written by P.Harrington Signature/date 20/11/2003
Dioxin Analyst

Report checked by D. Wood Signature/date 20/11/03
Laboratory Director

Job 39572E/Dioxins

Scientific Analysis Laboratories Ltd.

Report Checking Form

CHECK	SIGNED/DATE
CLIENT ID vs LAB ID CHECKED	20/11/03
DETECTION LIMITS CHECKED	20/11/03
QUALITY CONTROL DATA CHECKED	20/11/03
SAMPLE TEQs TRANSPOSED TO SUMMARY CORRECTLY	20/11/03
SAMPLE NARRATIVES CHECKED	20/11/03
ID OF TARGET COMPOUNDS	20/11/03
SELECTED ANALYTE CONCNS. CHECKED FROM RAW DATA	20/11/03
TRACKING FORMS CHECKED	20/11/03

Sample Data Pack, JOB # 39572E

Table of Contents

Chapter.page number

1.5 Summary of Objectives

A number of soil samples were analysed for the seventeen 2,3,7,8 containing chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans. The concentrations of total tetra- through heptachlorinated dioxin and furan homologues were also determined.

Please note that the data reported here are based on the sample 'dried and ground'. Analysis and quantitation was performed at SAL via isotope dilution high resolution gas chromatography/ high resolution mass spectrometry according to SAL SOP #1. Tests covered by this report are within the scope of our UKAS accreditation.

The detection limits were between 0.2 and 0.4 ng/kg per congener for the soil samples, depending upon the specific congeners involved.

Raw data from calibration and sample analyses are archived indefinitely on magnetic tape.

2.5 Sample data and results presentation

This is a brief explanation of the way in which the results are presented for this sample. The sample data pack commences with a sample narrative, this contains any comments upon the data, or any peculiarities observed in the sample's pathway through the laboratory.

Following this is a data summary sheet, this contains the results obtained for the targeted 2378 containing congeners and the "totals" for other chlorinated dioxin and furan isomers present in the sample.

The next page consists of the recovery information for the isotope labelled standards relative to the $^{13}C_6$-1,2,3,4-TCDD standard added prior to injection. Any comments thought appropriate will appear in the sample narrative.

Finally the sample tracking sheet is included.

"Totals" Determinations

In the case of quantitation of isomers other than the 2378 containing ones the RRFs of the first eluting 2378 isomer of the same degree of chlorination (or homologue group) are used.

Note that the current Toxic Equivalent Factors (TEFs) for the European Community/NATO (also known as i-TEF) are listed on the next page and are used to produce a total Dioxin and Furan equivalent amount for all congeners. The recently amended World Health Organisation TEF's are also included.

3.6 Toxic Equivalent Factors

Dioxin 2,3,7,8-Isomer	TEF	
	EC	WHO
2,3,7,8-TCDD	1.0	1.0
1,2,3,7,8-PeCDD	0.5	1.0
1,2,3,4,7,8-HxCDD	0.1	0.1
1,2,3,6,7,8-HxCDD	0.1	0.1
1,2,3,7,8,9-HxCDD	0.1	0.1
1,2,3,4,6,7,8-HpCDD	0.01	0.01
OCDD	0.001	0.0001
Furan 2,3,7,8-Isomer		
2,3,7,8-TCDF	0.1	0.1
1,2,3,7,8-PeCDF	0.05	0.05
2,3,4,7,8-PeCDF	0.5	0.5
1,2,3,4,7,8-HxCDF	0.1	0.1
1,2,3,6,7,8-HxCDF	0.1	0.1
1,2,3,7,8,9-HxCDF	0.1	0.1
2,3,4,6,7,8-HxCDF	0.1	0.1
1,2,3,4,6,7,8-HpCDF	0.01	0.01
1,2,3,4,7,8,9-HpCDF	0.01	0.01
OCDF	0.001	0.0001

Please note that the USEPA TEFs now employed correspond exactly with those promulgated by NATO/CCMS and the EC.

4.7 Data Summary

The WHO/EC/NATO/CCMS/I-TE total toxic equivalent amounts for each of the samples are given in the table below. Note that the results are reported in units of ng/kg on the 'dried and ground' sample . The results reported in brackets are the maximum possible limits.

SAL Reference	Your Reference	Amount ng/kg WHO	(Max)	I-TEQ	(Max)
39572E001	Sample Point A Soil	9.5	(9.5)	10.0	(10.0)
39572E002	Sample Point B Soil	5.9	(5.9)	5.7	(5.7)
39572E003	Sample Point C Soil	3.4	(3.4)	3.2	(3.2)
39572E004	Sample Point D Soil	25	(25)	23	(23)
39572E005	Sample Point E Soil	4.0	(4.0)	3.9	(3.9)
39572E006	Sample Point F Soil	0.52	(1.1)	0.54	(0.96)
39572EBL	Method Blank	0.0	(0.62)	0.0	(0.53)

5.8 Sample Narrative, Sample Number 39572E001

Extraction/ Clean up :- No Comments.

Data Acquisition :- No Comments.

Data Analysis :- All of the toxic PCDD/Fs were detected in this sample together with a good number of non-toxic ones.

The internal standard recoveries are good.

RESULTS SUMMARY REPORT (Sally Version 6.7)

Job Number : 39572E   Sample Number : 39572E001   Client Id :-
Date Acquired : 19-Nov-03   Acquired File : A:D1911
Operator : P. Harrington   Instrument : Ultima   Column :DB5-ms
PC File : R:\DIOXINV\D1911\sample.008\D1911.DAT
File Text : Sample Point A Soil
Sample Employed : 10.0 g, Volume Extracted: 30.0000 ul, Volume Injected : 1.0000 ul

Compound Name	Quantity		Toxic Equivalents			
	ng/kg	LOD	WHO	Max.	I-TEQ	Max.
Dioxins						
2,3,7,8-TCDD	0.69	0.22	0.69	0.69	0.69	0.69
1,2,3,7,8-PeCDD	0.98	0.20	0.98	0.98	0.49	0.49
1,2,3,6,7,8-HxCDD	4.2	0.18	0.42	0.42	0.42	0.42
1,2,3,4,7,8-HxCDD	1.1	0.18	0.11	0.11	0.11	0.11
1,2,3,7,8,9-HxCDD	2.4	0.18	0.24	0.24	0.24	0.24
1,2,3,4,6,7,8-HpCDD	88	0.26	0.88	0.88	0.88	0.88
OCDD	930	0.39	0.093	0.093	0.93	0.93
Total Dioxins TEQ			3.4	3.4	3.8	3.8
Furans						
2,3,7,8-TCDF	7.5	0.19	0.75	0.75	0.75	0.75
1,2,3,7,8-PeCDF	5.0	0.20	0.25	0.25	0.25	0.25
2,3,4,7,8-PeCDF	5.4	0.20	2.7	2.7	2.7	2.7
1,2,3,4,7,8-HxCDF	8.7	0.19	0.87	0.87	0.87	0.87
1,2,3,6,7,8-HxCDF	4.5	0.19	0.45	0.45	0.45	0.45
2,3,4,6,7,8-HxCDF	3.2	0.19	0.32	0.32	0.32	0.32
1,2,3,7,8,9-HxCDF	1.7	0.39	0.17	0.17	0.17	0.17
1,2,3,4,6,7,8-HpCDF	58	0.19	0.58	0.58	0.58	0.58
1,2,3,4,7,8,9-HpCDF	3.9	0.38	0.039	0.039	0.039	0.039
OCDF	87	0.39	0.0087	0.0087	0.087	0.087
Total Furans TEQ			6.1	6.1	6.2	6.2
Grand Total TEQ			9.5	9.5	10.0	10.0

TARGETING REPORT (Sally Version 6.7)

Job Number : 39572E
Date Acquired : 19-Nov-03
Operator : P. Harrington
PC File : R:\DIOXINV\D1911\sample.008\D1911.DAT
File Text : Sample Point A Soil
Sample Employed : 10.0 g

Sample Number : 39572E001
Acquired File : A:D1911
Instrument : Ultima

Client Id :-
Column :DB5-ms

Compound Name	M1	M2	M1/M2 thry	M1/M2 actl	Ok	Retention Time theory	Retention Time found	Area	RRF	Amount
Dioxins										
13C 1,2,3,4-TCDD	326	328	0.78	0.75	Y	00:29:43	00:29:44	40170	1.00	300.0
13C 2,3,7,8-TCDD	332	334	0.78	0.75	Y	00:30:15	00:30:16	5873	0.64	68.1
2,3,7,8-TCDD	320	322	0.78	0.84	Y	00:30:16	00:30:16	51	1.27	0.7
13C 1,2,3,7,8-PeCDD	368	370	1.55	1.59	Y	00:35:32	00:35:35	14825	1.45	76.4
1,2,3,7,8-PeCDD	356	358	1.55	1.46	Y	00:35:33	00:35:36	144	0.99	1.0
13C 1,2,3,6,7,8-HxCDD	402	404	1.24	1.30	Y	00:40:03	00:40:11	9949	0.89	83.1
1,2,3,6,7,8-HxCDD	390	392	1.24	1.10	Y	00:40:04	00:40:12	565	1.35	4.2
1,2,3,4,7,8-HxCDD	390	392	1.24	1.27	Y	00:39:57	00:40:03	111	1.06	1.1
1,2,3,7,8,9-HxCDD	390	392	1.24	1.16	Y	00:40:26	00:40:36	298	1.25	2.4
13C 1,2,3,4,6,7,8-HpCDD	436	438	1.05	1.20	Y	00:44:19	00:44:24	10416	0.84	92.2
1,2,3,4,6,7,8-HpCDD	424	426	1.05	0.99	Y	00:44:20	00:44:25	9526	1.03	88.4
13C OCDD	470	472	0.89	0.95	Y	00:48:57	00:49:07	4401	0.43	76.8
OCDD	458	460	0.89	0.92	Y	00:48:58	00:49:10	57458	1.40	932.7
Furans										
13C 1,2,3,4-TCDD	326	328	0.78	0.75	Y	00:29:43	00:29:44	40170	1.00	300.0
13C 2,3,7,8-TCDF	316	318	0.78	0.82	Y	00:29:32	00:29:33	16882	1.62	78.0
2,3,7,8-TCDF	304	306	0.78	0.82	Y	00:29:33	00:29:34	1624	1.29	7.5
13C 1,2,3,7,8-PeCDF	352	354	1.55	1.47	Y	00:34:04	00:34:06	23099	2.32	74.3
1,2,3,7,8-PeCDF	340	342	1.55	1.55	Y	00:34:05	00:34:07	938	0.82	5.0
2,3,4,7,8-PeCDF	340	342	1.55	1.69	Y	00:35:13	00:35:15	1062	0.85	5.4
13C 1,2,3,4,7,8-HxCDF	384	386	0.51	0.48	Y	00:38:52	00:38:56	16751	1.62	77.2
1,2,3,4,7,8-HxCDF	374	376	1.24	1.26	Y	00:38:53	00:38:57	1427	0.98	8.7
1,2,3,6,7,8-HxCDF	374	376	1.24	1.19	Y	00:39:02	00:39:07	976	1.29	4.5
2,3,4,6,7,8-HxCDF	374	376	1.24	1.24	Y	00:39:44	00:39:52	505	0.95	3.2
1,2,3,7,8,9-HxCDF	374	376	1.24	1.24	Y	00:40:55	00:41:06	234	0.81	1.7
13C 1,2,3,4,6,7,8-HpCDF	418	420	0.46	0.41	Y	00:42:49	00:42:55	9882	0.93	79.6
1,2,3,4,6,7,8-HpCDF	408	410	1.05	1.02	Y	00:42:50	00:42:55	7089	1.25	57.5
1,2,3,4,7,8,9-HpCDF	408	410	1.05	1.09	Y	00:45:08	00:45:13	336	0.86	3.9
13C OCDD	470	472	0.89	0.95	Y	00:48:57	00:49:07	4401	0.43	76.8
OCDF	442	444	0.89	0.83	Y	00:49:20	00:49:29	5849	1.52	87.2

RECOVERY REPORT (Sally Version 6.7)

Job Number	: 39572E	Sample Number	: 39572E001	Client Id	:-
Date Acquired	: 19-Nov-03	Acquired File	: A:D1911		
Operator	: P. Harrington	Instrument	: Ultima	Column	:DB5-ms
PC File	: R:\DIOXINV\D1911\sample.008\D1911.DAT				
File Text	: Sample Point A Soil				
Sample Employed	: 10.0 g				

Compound Name	Recovery %	Standard Addition / ng
Dioxins		
13C 1,2,3,4-TCDD		
13C 2,3,7,8-TCDD	68	1.00
13C 1,2,3,7,8-PeCDD	76	1.00
13C 1,2,3,6,7,8-HxCDD	83	1.00
13C 1,2,3,4,6,7,8-HpCDD	92	1.00
13C OCDD	77	1.00
Furans		
13C 1,2,3,4-TCDD		
13C 2,3,7,8-TCDF	78	1.00
13C 1,2,3,7,8-PeCDF	74	1.00
13C 1,2,3,4,7,8-HxCDF	77	1.00
13C 1,2,3,4,6,7,8-HpCDF	80	1.00
13C OCDD	77	1.00

SAL Sample Tracking Form : Issue 6

PLEASE INITIAL AND DATE ALL ENTRIES

Job Number 39572 Sample Number 001 Analysis PCDD/F, PCB WHO12/EC7

Sample Extraction

Weight/Volume Extracted 10g [18.11.03 S.D.]

PCCD/F Internal Standard id/Lot #/Volume EDF957/32461-83/48 3µl [18.11.03 S.D.]

PCB Internal Standard id/Lot #/Volume 20µl PCB WHO12 [18.11.03 S.D.]

Extraction Method/Solvent/Volume SOXHLET, 300ml TOLUENE [18.11.03 S.D.]

Extraction Start 17:00 [18.11.03 S.D.] End 09:00 [19.11.03 S.D.]

Additional Comments

Extract Clean-up

Clean-up 1 ACID SILICA [19.11.03 S.D.]

Clean-up 2 COMBINATION COLUMN [19.11.03 S.D.]

Clean-up 3 FLORACIL COLUMN [19.11.03 S.D.]

Additional Comments SAMPLE SPIKED WITH 10µl PCB 52/153 [20.11.03 S.D.]

GC/MS Analysis

Instrument ULTIMA Analyte PCDD/F Injection 48491 [19.11.03 PSH]

Instrument Analyte Injection

Instrument Analyte Injection

Quantitation

Method SALLY (DIOXIN) [20.11.03 PSH]

Additional Comments

6.13 Sample Narrative, Sample Number 39572E002

Extraction/ Clean up :- No Comments.

Data Acquisition :- No Comments.

Data Analysis :- All of the toxic PCDD/Fs were detected in this sample together with some non-toxic ones.

The internal standard recoveries are good.

RESULTS SUMMARY REPORT (Sally Version 6.7)

Job Number : 39572E   Sample Number : 39572E002   Client Id :-
Date Acquired : 19-Nov-03   Acquired File : A:D1911
Operator : P. Harrington   Instrument : Ultima   Column :DB5-ms
PC File : R:\DIOXINV\D1911\sample.009\D1911.DAT
File Text : Sample Point B Soil
Sample Employed : 10.0 g, Volume Extracted: 30.0000 ul, Volume Injected : 1.0000 ul

Compound Name	Quantity		Toxic Equivalents			
	ng/kg	LOD	WHO	Max.	I-TEQ	Max.
Dioxins						
2,3,7,8-TCDD	0.49	0.17	0.49	0.49	0.49	0.49
1,2,3,7,8-PeCDD	0.90	0.22	0.90	0.90	0.45	0.45
1,2,3,6,7,8-HxCDD	2.3	0.19	0.23	0.23	0.23	0.23
1,2,3,4,7,8-HxCDD	0.92	0.19	0.092	0.092	0.092	0.092
1,2,3,7,8,9-HxCDD	1.3	0.19	0.13	0.13	0.13	0.13
1,2,3,4,6,7,8-HpCDD	33	0.26	0.33	0.33	0.33	0.33
OCDD	260	0.37	0.026	0.026	0.26	0.26
Total Dioxins TEQ			2.2	2.2	2.0	2.0
Furans						
2,3,7,8-TCDF	3.2	0.22	0.32	0.32	0.32	0.32
1,2,3,7,8-PeCDF	3.2	0.23	0.16	0.16	0.16	0.16
2,3,4,7,8-PeCDF	3.3	0.23	1.6	1.6	1.6	1.6
1,2,3,4,7,8-HxCDF	6.8	0.21	0.68	0.68	0.68	0.68
1,2,3,6,7,8-HxCDF	3.0	0.21	0.30	0.30	0.30	0.30
2,3,4,6,7,8-HxCDF	2.1	0.21	0.21	0.21	0.21	0.21
1,2,3,7,8,9-HxCDF	1.7	0.41	0.17	0.17	0.17	0.17
1,2,3,4,6,7,8-HpCDF	18	0.19	0.18	0.18	0.18	0.18
1,2,3,4,7,8,9-HpCDF	2.3	0.39	0.023	0.023	0.023	0.023
OCDF	16	0.37	0.0016	0.0016	0.016	0.016
Total Furans TEQ			3.7	3.7	3.7	3.7
Grand Total TEQ			5.9	5.9	5.7	5.7

TARGETING REPORT (Sally Version 6.7)

Job Number	: 39572E	Sample Number : 39572E002	Client Id :-		
Date Acquired	: 19-Nov-03	Acquired File : A:D1911			
Operator	: P. Harrington	Instrument : Ultima	Column :DB5-ms		
PC File	: R:\DIOXINV\D1911\sample.009\D1911.DAT				
File Text	: Sample Point B Soil				
Sample Employed	: 10.0 g				

Compound Name	M1	M2	M1/M2 thry	M1/M2 actl	Ok	Retention Time theory	Retention Time found	Area	RRF	Amount
Dioxins										
13C 1,2,3,4-TCDD	326	328	0.78	0.70	Y	00:29:43	00:29:43	43785	1.00	300.0
13C 2,3,7,8-TCDD	332	334	0.78	0.80	Y	00:30:15	00:30:16	8227	0.64	87.5
2,3,7,8-TCDD	320	322	0.78	0.84	Y	00:30:16	00:30:16	51	1.27	0.5
13C 1,2,3,7,8-PeCDD	368	370	1.55	1.50	Y	00:35:32	00:35:33	14214	1.45	67.2
1,2,3,7,8-PeCDD	356	358	1.55	1.65	Y	00:35:33	00:35:35	127	0.99	0.9
13C 1,2,3,6,7,8-HxCDD	402	404	1.24	1.32	Y	00:40:03	00:40:10	10403	0.89	79.7
1,2,3,6,7,8-HxCDD	390	392	1.24	1.24	Y	00:40:04	00:40:10	319	1.35	2.3
1,2,3,4,7,8-HxCDD	390	392	1.24	1.27	Y	00:39:57	00:40:01	102	1.06	0.9
1,2,3,7,8,9-HxCDD	390	392	1.24	1.42	Y	00:40:26	00:40:35	163	1.25	1.3
13C 1,2,3,4,6,7,8-HpCDD	436	438	1.05	1.14	Y	00:44:19	00:44:20	11316	0.84	91.9
1,2,3,4,6,7,8-HpCDD	424	426	1.05	0.96	Y	00:44:20	00:44:21	3892	1.03	33.3
13C OCDD	470	472	0.89	0.88	Y	00:48:57	00:49:01	5095	0.43	81.6
OCDD	458	460	0.89	0.93	Y	00:48:58	00:49:02	18627	1.40	261.1
Furans										
13C 1,2,3,4-TCDD	326	328	0.78	0.70	Y	00:29:43	00:29:43	43785	1.00	300.0
13C 2,3,7,8-TCDF	316	318	0.78	0.72	Y	00:29:32	00:29:32	15892	1.62	67.3
2,3,7,8-TCDF	304	306	0.78	0.71	Y	00:29:33	00:29:33	654	1.29	3.2
13C 1,2,3,7,8-PeCDF	352	354	1.55	1.49	Y	00:34:04	00:34:05	22591	2.32	66.7
1,2,3,7,8-PeCDF	340	342	1.55	1.69	Y	00:34:05	00:34:06	592	0.82	3.2
2,3,4,7,8-PeCDF	340	342	1.55	1.65	Y	00:35:13	00:35:14	629	0.85	3.3
13C 1,2,3,4,7,8-HxCDF	384	386	0.51	0.46	Y	00:38:52	00:38:54	17283	1.62	73.1
1,2,3,4,7,8-HxCDF	374	376	1.24	1.22	Y	00:38:53	00:38:55	1153	0.98	6.8
1,2,3,6,7,8-HxCDF	374	376	1.24	1.30	Y	00:39:02	00:39:05	670	1.29	3.0
2,3,4,6,7,8-HxCDF	374	376	1.24	1.18	Y	00:39:44	00:39:51	340	0.95	2.1
1,2,3,7,8,9-HxCDF	374	376	1.24	1.22	Y	00:40:55	00:41:05	240	0.81	1.7
13C 1,2,3,4,6,7,8-HpCDF	418	420	0.46	0.43	Y	00:42:49	00:42:51	10502	0.93	77.6
1,2,3,4,6,7,8-HpCDF	408	410	1.05	1.06	Y	00:42:50	00:42:52	2355	1.25	18.0
1,2,3,4,7,8,9-HpCDF	408	410	1.05	1.03	Y	00:45:08	00:45:09	212	0.86	2.3
13C OCDD	470	472	0.89	0.88	Y	00:48:57	00:49:01	5095	0.43	81.6
OCDF	442	444	0.89	0.90	Y	00:49:20	00:49:23	1252	1.52	16.1

RECOVERY REPORT (Sally Version 6.7)

Job Number	: 39572E	Sample Number	: 39572E002	Client Id :-	
Date Acquired	: 19-Nov-03	Acquired File	: A:D1911		
Operator	: P. Harrington	Instrument	: Ultima	Column	:DB5-ms
PC File	: R:\DIOXINV\D1911\sample.009\D1911.DAT				
File Text	: Sample Point B Soil				
Sample Employed	: 10.0 g				

Compound Name	Recovery %	Standard Addition / ng
Dioxins		
13C 1,2,3,4-TCDD		
13C 2,3,7,8-TCDD	88	1.00
13C 1,2,3,7,8-PeCDD	67	1.00
13C 1,2,3,6,7,8-HxCDD	80	1.00
13C 1,2,3,4,6,7,8-HpCDD	92	1.00
13C OCDD	82	1.00
Furans		
13C 1,2,3,4-TCDD		
13C 2,3,7,8-TCDF	67	1.00
13C 1,2,3,7,8-PeCDF	67	1.00
13C 1,2,3,4,7,8-HxCDF	73	1.00
13C 1,2,3,4,6,7,8-HpCDF	78	1.00
13C OCDD	82	1.00

SAL Sample Tracking Form : Issue 6

PLEASE INITIAL AND DATE ALL ENTRIES

Job Number 39572 Sample Number 002 Analysis PCDD/F, PCB WHO12/EC7

Sample Extraction

Weight/Volume Extracted 10g | 18.11.03 S.D.

PCCD/F Internal Standard id/Lot #/Volume EDF957/32461-83/48 3μl | 18.11.03 S.D.

PCB Internal Standard id/Lot #/Volume 20μl PCB WHO12 | 18.11.03 S.D.

Extraction Method/Solvent/Volume SOXHLET, 300ml TOLUENE | 18.11.03 S.D.

Extraction Start 17.00 | 18.11.03 S.D. | End 09.00 | 19.11.03 S.D.

Additional Comments

Extract Clean-up

Clean-up 1 ACID SILICA | 19.11.03 S.D.

Clean-up 2 COMBINATION COLUMN | 19.11.03 S.D.

Clean-up 3 FLORACIL COLUMN | 19.11.03 S.D.

Additional Comments SAMPLE SPIKED WITH 10μl PCB 52/153 | 20.11.03 S.D.

GC/MS Analysis

Instrument ULTIMA Analyte PCDD/F Injection 48492 | 19.11.03 PSH

Instrument Analyte Injection

Instrument Analyte Injection

Quantitation

Method SALLY (DIOXIN) | 20.11.03 PSH

Additional Comments

7.18 Sample Narrative, Sample Number 39572E003

Extraction/ Clean up :- No Comments.

Data Acquisition :- No Comments.

Data Analysis :- All of the toxic PCDD/Fs were detected in this sample together with some non-toxic ones.

The internal standard recoveries are good.

RESULTS SUMMARY REPORT (Sally Version 6.7)

Job Number : 39572E Sample Number : 39572E003 Client Id :-
Date Acquired : 19-Nov-03 Acquired File : A:D1911
Operator : P. Harrington Instrument : Ultima Column :DB5-ms
PC File : R:\DIOXINV\D1911\sample.010\D1911.DAT
File Text : Sample Point C Soil
Sample Employed : 10.0 g, Volume Extracted: 30.0000 ul, Volume Injected : 1.0000 ul

Compound Name	Quantity		Toxic Equivalents			
	ng/kg	LOD	WHO	Max.	I-TEQ	Max.
Dioxins						
2,3,7,8-TCDD	0.30	0.22	0.30	0.30	0.30	0.30
1,2,3,7,8-PeCDD	0.60	0.25	0.60	0.60	0.30	0.30
1,2,3,6,7,8-HxCDD	1.1	0.19	0.11	0.11	0.11	0.11
1,2,3,4,7,8-HxCDD	0.62	0.19	0.062	0.062	0.062	0.062
1,2,3,7,8,9-HxCDD	0.79	0.19	0.079	0.079	0.079	0.079
1,2,3,4,6,7,8-HpCDD	13	0.29	0.13	0.13	0.13	0.13
OCDD	74	0.36	0.0074	0.0074	0.074	0.074
Total Dioxins TEQ			1.3	1.3	1.1	1.1
Furans						
2,3,7,8-TCDF	3.0	0.25	0.30	0.30	0.30	0.30
1,2,3,7,8-PeCDF	1.6	0.25	0.082	0.082	0.082	0.082
2,3,4,7,8-PeCDF	1.8	0.25	0.89	0.89	0.89	0.89
1,2,3,4,7,8-HxCDF	3.0	0.22	0.30	0.30	0.30	0.30
1,2,3,6,7,8-HxCDF	1.6	0.22	0.16	0.16	0.16	0.16
2,3,4,6,7,8-HxCDF	1.6	0.22	0.16	0.16	0.16	0.16
1,2,3,7,8,9-HxCDF	0.56	0.44	0.056	0.056	0.056	0.056
1,2,3,4,6,7,8-HpCDF	13	0.21	0.13	0.13	0.13	0.13
1,2,3,4,7,8,9-HpCDF	1.1	0.42	0.011	0.011	0.011	0.011
OCDF	10	0.36	0.0010	0.0010	0.010	0.010
Total Furans TEQ			2.1	2.1	2.1	2.1
Grand Total TEQ			3.4	3.4	3.2	3.2

TARGETING REPORT (Sally Version 6.7)

Job Number : 39572E Sample Number : 39572E003 Client Id :-
Date Acquired : 19-Nov-03 Acquired File : A:D1911
Operator : P. Harrington Instrument : Ultima Column :DB5-ms
PC File : R:\DIOXINV\D1911\sample.010\D1911.DAT
File Text : Sample Point C Soil
Sample Employed : 10.0 g

Compound Name	M1	M2	M1/M2 thry	M1/M2 actl	Ok	Retention Time theory	Retention Time found	Area	RRF	Amount
Dioxins										
13C 1,2,3,4-TCDD	326	328	0.78	0.79	Y	00:29:43	00:29:43	66685	1.00	300.0
13C 2,3,7,8-TCDD	332	334	0.78	0.81	Y	00:30:15	00:30:15	9553	0.64	66.7
2,3,7,8-TCDD	320	322	0.78	0.80	Y	00:30:16	00:30:16	36	1.27	0.3
13C 1,2,3,7,8-PeCDD	368	370	1.55	1.48	Y	00:35:32	00:35:34	19713	1.45	61.2
1,2,3,7,8-PeCDD	356	358	1.55	1.58	Y	00:35:33	00:35:35	116	0.99	0.6
13C 1,2,3,6,7,8-HxCDD	402	404	1.24	1.27	Y	00:40:03	00:40:09	15386	0.89	77.4
1,2,3,6,7,8-HxCDD	390	392	1.24	1.36	Y	00:40:04	00:40:10	224	1.35	1.1
1,2,3,4,7,8-HxCDD	390	392	1.24	1.25	Y	00:39:57	00:40:02	101	1.06	0.6
1,2,3,7,8,9-HxCDD	390	392	1.24	1.26	Y	00:40:26	00:40:35	152	1.25	0.8
13C 1,2,3,4,6,7,8-HpCDD	436	438	1.05	1.18	Y	00:44:19	00:44:21	15549	0.84	82.9
1,2,3,4,6,7,8-HpCDD	424	426	1.05	0.98	Y	00:44:20	00:44:22	2159	1.03	13.4
13C OCDD	470	472	0.89	0.84	Y	00:48:57	00:49:02	7906	0.43	83.1
OCDD	458	460	0.89	0.84	Y	00:48:58	00:49:03	8200	1.40	74.1
Furans										
13C 1,2,3,4-TCDD	326	328	0.78	0.79	Y	00:29:43	00:29:43	66685	1.00	300.0
13C 2,3,7,8-TCDF	316	318	0.78	0.75	Y	00:29:32	00:29:32	21273	1.62	59.2
2,3,7,8-TCDF	304	306	0.78	0.82	Y	00:29:33	00:29:33	832	1.29	3.0
13C 1,2,3,7,8-PeCDF	352	354	1.55	1.51	Y	00:34:04	00:34:05	30872	2.32	59.8
1,2,3,7,8-PeCDF	340	342	1.55	1.50	Y	00:34:05	00:34:06	413	0.82	1.6
2,3,4,7,8-PeCDF	340	342	1.55	1.61	Y	00:35:13	00:35:14	468	0.85	1.8
13C 1,2,3,4,7,8-HxCDF	384	386	0.51	0.47	Y	00:38:52	00:38:54	24361	1.62	67.7
1,2,3,4,7,8-HxCDF	374	376	1.24	1.20	Y	00:38:53	00:38:56	706	0.98	3.0
1,2,3,6,7,8-HxCDF	374	376	1.24	1.24	Y	00:39:02	00:39:05	512	1.29	1.6
2,3,4,6,7,8-HxCDF	374	376	1.24	1.27	Y	00:39:44	00:39:50	368	0.95	1.6
1,2,3,7,8,9-HxCDF	374	376	1.24	1.14	Y	00:40:55	00:41:05	110	0.81	0.6
13C 1,2,3,4,6,7,8-HpCDF	418	420	0.46	0.44	Y	00:42:49	00:42:52	14842	0.93	72.0
1,2,3,4,6,7,8-HpCDF	408	410	1.05	1.02	Y	00:42:50	00:42:53	2463	1.25	13.3
1,2,3,4,7,8,9-HpCDF	408	410	1.05	1.06	Y	00:45:08	00:45:10	147	0.86	1.1
13C OCDD	470	472	0.89	0.84	Y	00:48:57	00:49:02	7906	0.43	83.1
OCDF	442	444	0.89	0.90	Y	00:49:20	00:49:24	1257	1.52	10.4

RECOVERY REPORT (Sally Version 6.7)

Job Number	: 39572E	Sample Number	: 39572E003	Client Id	:-
Date Acquired	: 19-Nov-03	Acquired File	: A:D1911		
Operator	: P. Harrington	Instrument	: Ultima	Column	:DB5-ms
PC File	: R:\DIOXINV\D1911\sample.010\D1911.DAT				
File Text	: Sample Point C Soil				
Sample Employed	: 10.0 g				

Compound Name	Recovery %	Standard Addition / ng
Dioxins		
13C 1,2,3,4-TCDD		
13C 2,3,7,8-TCDD	67	1.00
13C 1,2,3,7,8-PeCDD	61	1.00
13C 1,2,3,6,7,8-HxCDD	77	1.00
13C 1,2,3,4,6,7,8-HpCDD	83	1.00
13C OCDD	83	1.00
Furans		
13C 1,2,3,4-TCDD		
13C 2,3,7,8-TCDF	59	1.00
13C 1,2,3,7,8-PeCDF	60	1.00
13C 1,2,3,4,7,8-HxCDF	68	1.00
13C 1,2,3,4,6,7,8-HpCDF	72	1.00
13C OCDD	83	1.00

SAL Sample Tracking Form : Issue 6

PLEASE INITIAL AND DATE ALL ENTRIES

Job Number 39572 **Sample Number** 003 **Analysis** PCDD/F, PCB WHO12/EC7

Sample Extraction

Weight/Volume Extracted	10g	18.11.03 S.D.
PCCD/F Internal Standard id/Lot #/Volume	EDF957/32461-83/48 3µl	18.11.03 S.D.
PCB Internal Standard id/Lot #/Volume	20µl PCB WHO12	18.11.03 S.D.
Extraction Method/Solvent/Volume	SOXHLET, 300ml TOLUENE	18.11.03 S.D.
Extraction Start	17.00 18.11.03 S.D. **End** 09.00	19.11.03 S.D.
Additional Comments		

Extract Clean-up

Clean-up 1	ACID SILICA	19.11.03 S.D.
Clean-up 2	COMBINATION COLUMN	19.11.03 S.D.
Clean-up 3	FLORACIL COLUMN	19.11.03 S.D.
Additional Comments	SAMPLE SPIKED WITH 10µl PCB 52/153	20.11.03 S.D.

GC/MS Analysis

Instrument	ULTIMA	**Analyte**	PCDD/F	**Injection**	48492	19.11.03 PSM
Instrument		**Analyte**		**Injection**		
Instrument		**Analyte**		**Injection**		

Quantitation

Method	SALLY (DIOXIN)	20.11.03 PSM
Additional Comments		

8.23 Sample Narrative, Sample Number 39572E004

Extraction/ Clean up :- No Comments.

Data Acquisition :- No Comments.

Data Analysis :- All of the toxic PCDD/Fs were detected in this sample together with a good number of non-toxic ones.

The internal standard recoveries are good.

RESULTS SUMMARY REPORT (Sally Version 6.7)

Job Number : 39572E Sample Number : 39572E004 Client Id :-
Date Acquired : 19-Nov-03 Acquired File : A:D1911
Operator : P. Harrington Instrument : Ultima Column :DB5-ms
PC File : R:\DIOXINV\D1911\sample.011\D1911.DAT
File Text : Sample Point D Soil
Sample Employed : 10.0 g, Volume Extracted: 30.0000 ul, Volume Injected : 1.0000 ul

Compound Name	Quantity		Toxic Equivalents			
	ng/kg	LOD	WHO	Max.	I-TEQ	Max.
Dioxins						
2,3,7,8-TCDD	0.78	0.21	0.78	0.78	0.78	0.78
1,2,3,7,8-PeCDD	3.4	0.21	3.4	3.4	1.7	1.7
1,2,3,6,7,8-HxCDD	4.6	0.18	0.46	0.46	0.46	0.46
1,2,3,4,7,8-HxCDD	2.7	0.18	0.27	0.27	0.27	0.27
1,2,3,7,8,9-HxCDD	3.7	0.18	0.37	0.37	0.37	0.37
1,2,3,4,6,7,8-HpCDD	33	0.31	0.33	0.33	0.33	0.33
OCDD	130	0.51	0.013	0.013	0.13	0.13
Total Dioxins TEQ			5.6	5.6	4.1	4.1
Furans						
2,3,7,8-TCDF	18	0.26	1.8	1.8	1.8	1.8
1,2,3,7,8-PeCDF	17	0.20	0.84	0.84	0.84	0.84
2,3,4,7,8-PeCDF	21	0.20	10	10	10	10
1,2,3,4,7,8-HxCDF	26	0.20	2.6	2.6	2.6	2.6
1,2,3,6,7,8-HxCDF	11	0.20	1.1	1.1	1.1	1.1
2,3,4,6,7,8-HxCDF	7.4	0.20	0.74	0.74	0.74	0.74
1,2,3,7,8,9-HxCDF	3.1	0.40	0.31	0.31	0.31	0.31
1,2,3,4,6,7,8-HpCDF	93	0.22	0.93	0.93	0.93	0.93
1,2,3,4,7,8,9-HpCDF	8.9	0.44	0.089	0.089	0.089	0.089
OCDF	63	0.51	0.0063	0.0063	0.063	0.063
Total Furans TEQ			19	19	19	19
Grand Total TEQ			25	25	23	23

TARGETING REPORT (Sally Version 6.7)

Job Number : 39572E Sample Number : 39572E004 Client Id :-
Date Acquired : 19-Nov-03 Acquired File : A:D1911
Operator : P. Harrington Instrument : Ultima Column :DB5-ms
PC File : R:\DIOXINV\D1911\sample.011\D1911.DAT
File Text : Sample Point D Soil
Sample Employed : 10.0 g

Compound Name	M1	M2	M1/M2 thry	M1/M2 actl	Ok	Retention Time theory	Retention Time found	Area	RRF	Amount
Dioxins										
13C 1,2,3,4-TCDD	326	328	0.78	0.74	Y	00:29:43	00:29:47	40656	1.00	300.0
13C 2,3,7,8-TCDD	332	334	0.78	0.73	Y	00:30:15	00:30:21	6157	0.64	70.5
2,3,7,8-TCDD	320	322	0.78	0.81	Y	00:30:16	00:30:22	61	1.27	0.8
13C 1,2,3,7,8-PeCDD	368	370	1.55	1.59	Y	00:35:32	00:35:42	14261	1.45	72.6
1,2,3,7,8-PeCDD	356	358	1.55	1.76	Y	00:35:33	00:35:43	481	0.99	3.4
13C 1,2,3,6,7,8-HxCDD	402	404	1.24	1.39	Y	00:40:03	00:40:28	9829	0.89	81.1
1,2,3,6,7,8-HxCDD	390	392	1.24	1.36	Y	00:40:04	00:40:29	610	1.35	4.6
1,2,3,4,7,8-HxCDD	390	392	1.24	1.15	Y	00:39:57	00:40:20	286	1.06	2.7
1,2,3,7,8,9-HxCDD	390	392	1.24	1.17	Y	00:40:26	00:40:53	454	1.25	3.7
13C 1,2,3,4,6,7,8-HpCDD	436	438	1.05	1.12	Y	00:44:19	00:44:41	8862	0.84	77.5
1,2,3,4,6,7,8-HpCDD	424	426	1.05	1.00	Y	00:44:20	00:44:42	3023	1.03	33.0
13C OCDD	470	472	0.89	0.96	Y	00:48:57	00:49:31	3388	0.43	58.4
OCDD	458	460	0.89	0.91	Y	00:48:58	00:49:33	6280	1.40	132.4
Furans										
13C 1,2,3,4-TCDD	326	328	0.78	0.74	Y	00:29:43	00:29:47	40656	1.00	300.0
13C 2,3,7,8-TCDF	316	318	0.78	0.81	Y	00:29:32	00:29:36	12659	1.62	57.8
2,3,7,8-TCDF	304	306	0.78	0.84	Y	00:29:33	00:29:38	2913	1.29	17.9
13C 1,2,3,7,8-PeCDF	352	354	1.55	1.54	Y	00:34:04	00:34:12	24028	2.32	76.4
1,2,3,7,8-PeCDF	340	342	1.55	1.50	Y	00:34:05	00:34:14	3308	0.82	16.9
2,3,4,7,8-PeCDF	340	342	1.55	1.59	Y	00:35:13	00:35:23	4295	0.85	20.9
13C 1,2,3,4,7,8-HxCDF	384	386	0.51	0.48	Y	00:38:52	00:39:16	16287	1.62	74.2
1,2,3,4,7,8-HxCDF	374	376	1.24	1.20	Y	00:38:53	00:39:17	4213	0.98	26.5
1,2,3,6,7,8-HxCDF	374	376	1.24	1.20	Y	00:39:02	00:39:28	2248	1.29	10.7
2,3,4,6,7,8-HxCDF	374	376	1.24	1.20	Y	00:39:44	00:40:10	1142	0.95	7.4
1,2,3,7,8,9-HxCDF	374	376	1.24	1.24	Y	00:40:55	00:41:26	405	0.81	3.1
13C 1,2,3,4,6,7,8-HpCDF	418	420	0.46	0.43	Y	00:42:49	00:43:13	8590	0.93	68.4
1,2,3,4,6,7,8-HpCDF	408	410	1.05	1.07	Y	00:42:50	00:43:14	10015	1.25	93.5
1,2,3,4,7,8,9-HpCDF	408	410	1.05	0.98	Y	00:45:08	00:45:27	662	0.86	8.9
13C OCDD	470	472	0.89	0.96	Y	00:48:57	00:49:31	3388	0.43	58.4
OCDF	442	444	0.89	0.88	Y	00:49:20	00:49:52	3274	1.52	63.4

RECOVERY REPORT (Sally Version 6.7)

Job Number	: 39572E	Sample Number	: 39572E004	Client Id	:-
Date Acquired	: 19-Nov-03	Acquired File	: A:D1911		
Operator	: P. Harrington	Instrument	: Ultima	Column	:DB5-ms
PC File	: R:\DIOXINV\D1911\sample.011\D1911.DAT				
File Text	: Sample Point D Soil				
Sample Employed	: 10.0 g				

Compound Name	Recovery %	Standard Addition / ng
Dioxins		
13C 1,2,3,4-TCDD		
13C 2,3,7,8-TCDD	71	1.00
13C 1,2,3,7,8-PeCDD	73	1.00
13C 1,2,3,6,7,8-HxCDD	81	1.00
13C 1,2,3,4,6,7,8-HpCDD	77	1.00
13C OCDD	58	1.00
Furans		
13C 1,2,3,4-TCDD		
13C 2,3,7,8-TCDF	58	1.00
13C 1,2,3,7,8-PeCDF	76	1.00
13C 1,2,3,4,7,8-HxCDF	74	1.00
13C 1,2,3,4,6,7,8-HpCDF	68	1.00
13C OCDD	58	1.00

SAL Sample Tracking Form : Issue 6

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Job Number 39572 **Sample Number** 004 **Analysis** PCDD/F, PCB WHO12/EC7

Sample Extraction

Weight/Volume Extracted	10g	18.11.03 S.D.
PCCD/F Internal Standard id/Lot #/Volume	EDF957/32461-83/48 3µl	18.11.03 S.D.
PCB Internal Standard id/Lot #/Volume	20µl PCB WHO12	18.11.03 S.D.
Extraction Method/Solvent/Volume	SOXHLET, 300ml TOLUENE	18.11.03 S.D.
Extraction Start	17.00 18.11.03 S.D. **End** 09.00	19.11.03 S.D.
Additional Comments		

Extract Clean-up

Clean-up 1	ACID SILICA	19.11.03 S.D.
Clean-up 2	COMBINATION COLUMN	19.11.03 S.D.
Clean-up 3	FLORACIL COLUMN	19.11.03 S.D.
Additional Comments	SAMPLE SPIKED WITH 10µl PCB 52/153	20.11.03 S.D.

GC/MS Analysis

Instrument	ULTIMA	**Analyte**	PCDD/F	**Injection**	48493	19.11.03 PBM
Instrument		**Analyte**		**Injection**		
Instrument		**Analyte**		**Injection**		

Quantitation

Method	SALLY (DIOXIN)	20.11.03 PBM
Additional Comments		

9.28 Sample Narrative, Sample Number 39572E005

Extraction/ Clean up :- No Comments.

Data Acquisition :- No Comments.

Data Analysis :- A good number of the toxic PCDD/Fs were detected in this sample together with a good number of non-toxic ones.

The internal standard recoveries are good.

RESULTS SUMMARY REPORT (Sally Version 6.7)

Job Number : 39572E Sample Number : 39572E005 Client Id :-
Date Acquired : 19-Nov-03 Acquired File : A:D1911
Operator : P. Harrington Instrument : Ultima Column :DB5-ms
PC File : R:\DIOXINV\D1911\sample.012\D1911.DAT
File Text : Sample Point E Soil
Sample Employed : 10.0 g, Volume Extracted: 30.0000 ul, Volume Injected : 1.0000 ul

Compound Name	Quantity		Toxic Equivalents			
	ng/kg	LOD	WHO	Max.	I-TEQ	Max.
Dioxins						
2,3,7,8-TCDD	0.51	0.14	0.51	0.51	0.51	0.51
1,2,3,7,8-PeCDD	0.42	0.19	0.42	0.42	0.21	0.21
1,2,3,6,7,8-HxCDD	1.5	0.17	0.15	0.15	0.15	0.15
1,2,3,4,7,8-HxCDD	0.79	0.17	0.079	0.079	0.079	0.079
1,2,3,7,8,9-HxCDD	0.98	0.17	0.098	0.098	0.098	0.098
1,2,3,4,6,7,8-HpCDD	18	0.28	0.18	0.18	0.18	0.18
OCDD	83	0.37	0.0083	0.0083	0.083	0.083
Total Dioxins TEQ			1.4	1.4	1.3	1.3
Furans						
2,3,7,8-TCDF	2.9	0.19	0.29	0.29	0.29	0.29
1,2,3,7,8-PeCDF	2.0	0.19	0.10	0.10	0.10	0.10
2,3,4,7,8-PeCDF	2.2	0.19	1.1	1.1	1.1	1.1
1,2,3,4,7,8-HxCDF	2.9	0.18	0.29	0.29	0.29	0.29
1,2,3,6,7,8-HxCDF	1.5	0.18	0.15	0.15	0.15	0.15
2,3,4,6,7,8-HxCDF	1.7	0.18	0.17	0.17	0.17	0.17
1,2,3,7,8,9-HxCDF	0.45	0.36	0.045	0.045	0.045	0.045
1,2,3,4,6,7,8-HpCDF	44	0.19	0.44	0.44	0.44	0.44
1,2,3,4,7,8,9-HpCDF	1.2	0.38	0.012	0.012	0.012	0.012
OCDF	32	0.37	0.0032	0.0032	0.032	0.032
Total Furans TEQ			2.6	2.6	2.6	2.6
Grand Total TEQ			4.0	4.0	3.9	3.9

TARGETING REPORT (Sally Version 6.7)

Job Number : 39572E Sample Number : 39572E005 Client Id :-
Date Acquired : 19-Nov-03 Acquired File : A:D1911
Operator : P. Harrington Instrument : Ultima Column :DB5-ms
PC File : R:\DIOXINV\D1911\sample.012\D1911.DAT
File Text : Sample Point E Soil
Sample Employed : 10.0 g

Compound Name	M1	M2	M1/M2 thry	M1/M2 actl	Ok	Retention Time theory	Retention Time found	Area	RRF	Amount
Dioxins										
13C 1,2,3,4-TCDD	326	328	0.78	0.79	Y	00:29:43	00:29:45	59370	1.00	300.0
13C 2,3,7,8-TCDD	332	334	0.78	0.86	Y	00:30:15	00:30:17	14048	0.64	110.2
2,3,7,8-TCDD	320	322	0.78	0.81	Y	00:30:16	00:30:18	90	1.27	0.5
13C 1,2,3,7,8-PeCDD	368	370	1.55	1.51	Y	00:35:32	00:35:36	23206	1.45	80.9
1,2,3,7,8-PeCDD	356	358	1.55	1.50	Y	00:35:33	00:35:38	98	0.99	0.4
13C 1,2,3,6,7,8-HxCDD	402	404	1.24	1.29	Y	00:40:03	00:40:14	15752	0.89	89.0
1,2,3,6,7,8-HxCDD	390	392	1.24	1.18	Y	00:40:04	00:40:15	324	1.35	1.5
1,2,3,4,7,8-HxCDD	390	392	1.24	1.24	Y	00:39:57	00:40:06	132	1.06	0.8
1,2,3,7,8,9-HxCDD	390	392	1.24	1.26	Y	00:40:26	00:40:41	192	1.25	1.0
13C 1,2,3,4,6,7,8-HpCDD	436	438	1.05	1.15	Y	00:44:19	00:44:24	14312	0.84	85.7
1,2,3,4,6,7,8-HpCDD	424	426	1.05	0.96	Y	00:44:20	00:44:25	2610	1.03	17.6
13C OCDD	470	472	0.89	0.88	Y	00:48:57	00:49:05	6806	0.43	80.4
OCDD	458	460	0.89	0.97	Y	00:48:58	00:49:06	7880	1.40	82.7
Furans										
13C 1,2,3,4-TCDD	326	328	0.78	0.79	Y	00:29:43	00:29:45	59370	1.00	300.0
13C 2,3,7,8-TCDF	316	318	0.78	0.76	Y	00:29:32	00:29:34	25861	1.62	80.8
2,3,7,8-TCDF	304	306	0.78	0.82	Y	00:29:33	00:29:35	964	1.29	2.9
13C 1,2,3,7,8-PeCDF	352	354	1.55	1.52	Y	00:34:04	00:34:08	36107	2.32	78.6
1,2,3,7,8-PeCDF	340	342	1.55	1.44	Y	00:34:05	00:34:08	589	0.82	2.0
2,3,4,7,8-PeCDF	340	342	1.55	1.59	Y	00:35:13	00:35:17	673	0.85	2.2
13C 1,2,3,4,7,8-HxCDF	384	386	0.51	0.48	Y	00:38:52	00:38:59	26463	1.62	82.5
1,2,3,4,7,8-HxCDF	374	376	1.24	1.30	Y	00:38:53	00:38:59	756	0.98	2.9
1,2,3,6,7,8-HxCDF	374	376	1.24	1.34	Y	00:39:02	00:39:09	515	1.29	1.5
2,3,4,6,7,8-HxCDF	374	376	1.24	1.19	Y	00:39:44	00:39:55	426	0.95	1.7
1,2,3,7,8,9-HxCDF	374	376	1.24	1.25	Y	00:40:55	00:41:08	97	0.81	0.5
13C 1,2,3,4,6,7,8-HpCDF	418	420	0.46	0.44	Y	00:42:49	00:42:55	14469	0.93	78.9
1,2,3,4,6,7,8-HpCDF	408	410	1.05	1.06	Y	00:42:50	00:42:55	7987	1.25	44.3
1,2,3,4,7,8,9-HpCDF	408	410	1.05	1.07	Y	00:45:08	00:45:12	153	0.86	1.2
13C OCDD	470	472	0.89	0.88	Y	00:48:57	00:49:05	6806	0.43	80.4
OCDF	442	444	0.89	0.87	Y	00:49:20	00:49:28	3301	1.52	31.8

RECOVERY REPORT (Sally Version 6.7)

Job Number : 39572E Sample Number : 39572E005 Client Id :-
Date Acquired : 19-Nov-03 Acquired File : A:D1911
Operator : P. Harrington Instrument : Ultima Column :DB5-ms
PC File : R:\DIOXINV\D1911\sample.012\D1911.DAT
File Text : Sample Point E Soil
Sample Employed : 10.0 g

Compound Name	Recovery %	Standard Addition / ng
Dioxins		
13C 1,2,3,4-TCDD		
13C 2,3,7,8-TCDD	110	1.00
13C 1,2,3,7,8-PeCDD	81	1.00
13C 1,2,3,6,7,8-HxCDD	89	1.00
13C 1,2,3,4,6,7,8-HpCDD	86	1.00
13C OCDD	80	1.00
Furans		
13C 1,2,3,4-TCDD		
13C 2,3,7,8-TCDF	81	1.00
13C 1,2,3,7,8-PeCDF	79	1.00
13C 1,2,3,4,7,8-HxCDF	83	1.00
13C 1,2,3,4,6,7,8-HpCDF	79	1.00
13C OCDD	80	1.00

SAL Sample Tracking Form : Issue 6

PLEASE INITIAL AND DATE ALL ENTRIES

Job Number 39572 **Sample Number** 005 **Analysis** PCDD/F, PCB WHO12/EC7

Sample Extraction

Weight/Volume Extracted	10g	18.11.03 S.D.
PCCD/F Internal Standard id/Lot #/Volume	EDF957/32461-83/48 3μl	18.11.03 S.D.
PCB Internal Standard id/Lot #/Volume	2091 PCB WHO12	18.11.03 S.D.
Extraction Method/Solvent/Volume	SOXHLET, 300ml TOLUENE	18.11.03 S.D.
Extraction Start	17.00 18.11.03 S.D. **End** 09.00	19.11.03 S.D.
Additional Comments		

Extract Clean-up

Clean-up 1	ACID SILICA	19.11.03 S.D.
Clean-up 2	COMBINATION COLUMN	19.11.03 S.D.
Clean-up 3	FLORACIL COLUMN	19.11.03 S.D.
Additional Comments	SAMPLE SPIKED WITH 1097 PCB 52/153	20.11.03 S.D.

GC/MS Analysis

Instrument	ULTIMA	**Analyte**	PCDD/F	**Injection**	46494	19.11.03 RSH
Instrument		**Analyte**		**Injection**		
Instrument		**Analyte**		**Injection**		

Quantitation

Method	SALLY (DIOXIN)	20.11.03 RSH
Additional Comments		

10.33 Sample Narrative, Sample Number 39572E006

Extraction/ Clean up :- No Comments.

Data Acquisition :- No Comments.

Data Analysis :- A number of the toxic PCDD/Fs were detected in this sample together with a good number of non-toxic ones.

The internal standard recoveries are good.

RESULTS SUMMARY REPORT (Sally Version 6.7)

Job Number : 39572E Sample Number : 39572E006 Client Id :-
Date Acquired : 19-Nov-03 Acquired File : A:D1911
Operator : P. Harrington Instrument : Ultima Column :DB5-ms
PC File : R:\DIOXINV\D1911\sample.013\D1911.DAT
File Text : Sample Point F Soil
Sample Employed : 10.0 g, Volume Extracted: 30.0000 ul, Volume Injected : 1.0000 ul

Compound Name	Quantity		Toxic Equivalents			
	ng/kg	LOD	WHO	Max.	I-TEQ	Max.
Dioxins						
2,3,7,8-TCDD	N.D.	0.16	0.0	0.16	0.0	0.16
1,2,3,7,8-PeCDD	N.D.	0.28	0.0	0.28	0.0	0.14
1,2,3,6,7,8-HxCDD	0.34	0.23	0.034	0.034	0.034	0.034
1,2,3,4,7,8-HxCDD	N.D.	0.23	0.0	0.023	0.0	0.023
1,2,3,7,8,9-HxCDD	N.D.	0.23	0.0	0.023	0.0	0.023
1,2,3,4,6,7,8-HpCDD	3.0	0.39	0.030	0.030	0.030	0.030
OCDD	16	0.56	0.0016	0.0016	0.016	0.016
Total Dioxins TEQ			0.066	0.55	0.081	0.43
Furans						
2,3,7,8-TCDF	0.67	0.18	0.067	0.067	0.067	0.067
1,2,3,7,8-PeCDF	N.D.	0.26	0.0	0.013	0.0	0.013
2,3,4,7,8-PeCDF	0.34	0.26	0.17	0.17	0.17	0.17
1,2,3,4,7,8-HxCDF	0.46	0.27	0.046	0.046	0.046	0.046
1,2,3,6,7,8-HxCDF	0.24	0.27	0.024	0.024	0.024	0.024
2,3,4,6,7,8-HxCDF	0.32	0.27	0.032	0.032	0.032	0.032
1,2,3,7,8,9-HxCDF	N.D.	0.53	0.0	0.053	0.0	0.053
1,2,3,4,6,7,8-HpCDF	11	0.27	0.11	0.11	0.11	0.11
1,2,3,4,7,8,9-HpCDF	N.D.	0.54	0.0	0.0054	0.0	0.0054
OCDF	12	0.56	0.0012	0.0012	0.012	0.012
Total Furans TEQ			0.45	0.52	0.46	0.53
Grand Total TEQ			0.52	1.1	0.54	0.96

TARGETING REPORT (Sally Version 6.7)

Job Number	: 39572E	Sample Number : 39572E006	Client Id :-
Date Acquired	: 19-Nov-03	Acquired File : A:D1911	
Operator	: P. Harrington	Instrument : Ultima	Column :DB5-ms
PC File	: R:\DIOXINV\D1911\sample.013\D1911.DAT		
File Text	: Sample Point F Soil		
Sample Employed	: 10.0 g		

Compound Name	M1	M2	M1/M2 thry	M1/M2 actl	Ok	Retention Time theory	Retention Time found	Area	RRF	Amount
Dioxins										
13C 1,2,3,4-TCDD	326	328	0.78	0.74	Y	00:29:43	00:29:44	30629	1.00	300.0
13C 2,3,7,8-TCDD	332	334	0.78	0.79	Y	00:30:15	00:30:16	6136	0.64	93.3
13C 1,2,3,7,8-PeCDD	368	370	1.55	1.47	Y	00:35:32	00:35:33	7973	1.45	53.9
13C 1,2,3,6,7,8-HxCDD	402	404	1.24	1.24	Y	00:40:03	00:40:04	6010	0.89	65.8
1,2,3,6,7,8-HxCDD	390	392	1.24	1.20	Y	00:40:04	00:40:05	28	1.35	0.3
13C 1,2,3,4,6,7,8-HpCDD	436	438	1.05	1.16	Y	00:44:19	00:44:19	5258	0.84	61.0
1,2,3,4,6,7,8-HpCDD	424	426	1.05	0.94	Y	00:44:20	00:44:20	165	1.03	3.0
13C OCDD	470	472	0.89	0.79	Y	00:48:57	00:48:58	2336	0.43	53.4
OCDD	458	460	0.89	0.79	Y	00:48:58	00:48:59	519	1.40	15.9
Furans										
13C 1,2,3,4-TCDD	326	328	0.78	0.74	Y	00:29:43	00:29:44	30629	1.00	300.0
13C 2,3,7,8-TCDF	316	318	0.78	0.72	Y	00:29:32	00:29:33	13724	1.62	83.1
2,3,7,8-TCDF	304	306	0.78	0.72	Y	00:29:33	00:29:34	119	1.29	0.7
13C 1,2,3,7,8-PeCDF	352	354	1.55	1.58	Y	00:34:04	00:34:05	13586	2.32	57.3
2,3,4,7,8-PeCDF	340	342	1.55	1.49	Y	00:35:13	00:35:12	40	0.85	0.3
13C 1,2,3,4,7,8-HxCDF	384	386	0.51	0.48	Y	00:38:52	00:38:52	9349	1.62	56.5
1,2,3,4,7,8-HxCDF	374	376	1.24	1.22	Y	00:38:53	00:38:54	42	0.98	0.5
1,2,3,6,7,8-HxCDF	374	376	1.24	1.25	Y	00:39:02	00:39:03	29	1.29	0.2
2,3,4,6,7,8-HxCDF	374	376	1.24	1.32	Y	00:39:44	00:39:46	28	0.95	0.3
13C 1,2,3,4,6,7,8-HpCDF	418	420	0.46	0.45	Y	00:42:49	00:42:49	5255	0.93	55.5
1,2,3,4,6,7,8-HpCDF	408	410	1.05	1.03	Y	00:42:50	00:42:51	704	1.25	10.7
13C OCDD	470	472	0.89	0.79	Y	00:48:57	00:48:58	2336	0.43	53.4
OCDF	442	444	0.89	0.97	Y	00:49:20	00:49:20	432	1.52	12.1

RECOVERY REPORT (Sally Version 6.7)

Job Number : 39572E Sample Number : 39572E006 Client Id :-
Date Acquired : 19-Nov-03 Acquired File : A:D1911
Operator : P. Harrington Instrument : Ultima Column :DB5-ms
PC File : R:\DIOXINV\D1911\sample.013\D1911.DAT
File Text : Sample Point F Soil
Sample Employed : 10.0 g

Compound Name	Recovery %	Standard Addition / ng
Dioxins		
13C 1,2,3,4-TCDD		
13C 2,3,7,8-TCDD	93	1.00
13C 1,2,3,7,8-PeCDD	54	1.00
13C 1,2,3,6,7,8-HxCDD	66	1.00
13C 1,2,3,4,6,7,8-HpCDD	61	1.00
13C OCDD	53	1.00
Furans		
13C 1,2,3,4-TCDD		
13C 2,3,7,8-TCDF	83	1.00
13C 1,2,3,7,8-PeCDF	57	1.00
13C 1,2,3,4,7,8-HxCDF	57	1.00
13C 1,2,3,4,6,7,8-HpCDF	56	1.00
13C OCDD	53	1.00

SAL Sample Tracking Form : Issue 6

PLEASE INITIAL AND DATE ALL ENTRIES

Job Number 39572 **Sample Number** 006 **Analysis** PCDD/F, PCB WHO12/EC7

Sample Extraction

Weight/Volume Extracted	10g	18.11.03 S.D.
PCCD/F Internal Standard id/Lot #/Volume	EDF957/32461-83/48 3µl	18.11.03 S.D.
PCB Internal Standard id/Lot #/Volume	20µl PCB WHO12	18.11.03 S.D.
Extraction Method/Solvent/Volume	SOXHLET, 300ml TOLUENE	18.11.03 S.D.
Extraction Start	17.00 18.11.03 S.D. **End** 09.00	19.11.03 S.D.
Additional Comments		

Extract Clean-up

Clean-up 1	ACID SILICA	19.11.03 S.D.
Clean-up 2	COMBINATION COLUMN	19.11.03 S.D.
Clean-up 3	FLORACIL COLUMN	19.11.03 S.D.
Additional Comments	SAMPLE SPIKED WITH 10µl PCB 52/153	20.11.03 S.D.

GC/MS Analysis

Instrument	ULTIMA	**Analyte**	PCDD/F	**Injection**	48445	19.11.03 ASM
Instrument		**Analyte**		**Injection**		
Instrument		**Analyte**		**Injection**		

Quantitation

Method	SALLY (DIOXIN)	20.11.03 ASM
Additional Comments		

11.38 Reagent Blank Narrative

Extraction/ Clean up :- No Comments.

Data Acquisition :- No Comments.

Data Analysis :- This reagent blank contains none of the target congeners. Data is reported based upon 10g of sample being taken.

The internal standard recoveries are acceptable.

RESULTS SUMMARY REPORT (Sally Version 6.7)

Job Number : 39572E Sample Number : 39572EBL Client Id :-
Date Acquired : 19-Nov-03 Acquired File : A:D1911
Operator : P. Harrington Instrument : Ultima Column :DB5-ms
PC File : R:\DIOXINV\D1911\sample.007\D1911.DAT
File Text : Method Blank
Sample Employed : 10.0 g, Volume Extracted: 30.0000 ul, Volume Injected : 1.0000 ul

Compound Name	Quantity		Toxic Equivalents			
	ng/kg	LOD	WHO	Max.	I-TEQ	Max.
Dioxins						
2,3,7,8-TCDD	N.D.	0.16	0.0	0.16	0.0	0.16
1,2,3,7,8-PeCDD	N.D.	0.18	0.0	0.18	0.0	0.090
1,2,3,6,7,8-HxCDD	N.D.	0.18	0.0	0.018	0.0	0.018
1,2,3,4,7,8-HxCDD	N.D.	0.18	0.0	0.018	0.0	0.018
1,2,3,7,8,9-HxCDD	N.D.	0.18	0.0	0.018	0.0	0.018
1,2,3,4,6,7,8-HpCDD	N.D.	0.27	0.0	0.0027	0.0	0.0027
OCDD	N.D.	0.39	0.0	0.0000	0.0	0.0004
Total Dioxins TEQ			0.0	0.40	0.0	0.31
Furans						
2,3,7,8-TCDF	N.D.	0.15	0.0	0.015	0.0	0.015
1,2,3,7,8-PeCDF	N.D.	0.19	0.0	0.0096	0.0	0.0096
2,3,4,7,8-PeCDF	N.D.	0.19	0.0	0.096	0.0	0.096
1,2,3,4,7,8-HxCDF	N.D.	0.18	0.0	0.018	0.0	0.018
1,2,3,6,7,8-HxCDF	N.D.	0.18	0.0	0.018	0.0	0.018
2,3,4,6,7,8-HxCDF	N.D.	0.18	0.0	0.018	0.0	0.018
1,2,3,7,8,9-HxCDF	N.D.	0.37	0.0	0.037	0.0	0.037
1,2,3,4,6,7,8-HpCDF	N.D.	0.18	0.0	0.0018	0.0	0.0018
1,2,3,4,7,8,9-HpCDF	N.D.	0.35	0.0	0.0035	0.0	0.0035
OCDF	N.D.	0.39	0.0	0.0000	0.0	0.0004
Total Furans TEQ			0.0	0.22	0.0	0.22
Grand Total TEQ			0.0	0.62	0.0	0.53

TARGETING REPORT (Sally Version 6.7)

Job Number : 39572E
Date Acquired : 19-Nov-03
Operator : P. Harrington
PC File : R:\DIOXINV\D1911\sample.007\D1911.DAT
File Text : Method Blank
Sample Employed : 10.0 g

Sample Number : 39572EBL
Acquired File : A:D1911
Instrument : Ultima

Client Id :-
Column :DB5-ms

Compound Name	M1	M2	M1/M2 thry	M1/M2 actl	Ok	Retention Time theory	Retention Time found	Area	RRF	Amount
Dioxins										
13C 1,2,3,4-TCDD	326	328	0.78	0.75	Y	00:29:43	00:29:42	26276	1.00	300.0
13C 2,3,7,8-TCDD	332	334	0.78	0.78	Y	00:30:15	00:30:14	5171	0.64	91.7
13C 1,2,3,7,8-PeCDD	368	370	1.55	1.50	Y	00:35:32	00:35:32	10573	1.45	83.3
13C 1,2,3,6,7,8-HxCDD	402	404	1.24	1.29	Y	00:40:03	00:40:02	6367	0.89	81.3
13C 1,2,3,4,6,7,8-HpCDD	436	438	1.05	1.12	Y	00:44:19	00:44:18	6566	0.84	88.8
13C OCDD	470	472	0.89	0.86	Y	00:48:57	00:48:56	2889	0.43	77.1
Furans										
13C 1,2,3,4-TCDD	326	328	0.78	0.75	Y	00:29:43	00:29:42	26276	1.00	300.0
13C 2,3,7,8-TCDF	316	318	0.78	0.76	Y	00:29:32	00:29:31	13716	1.62	96.8
13C 1,2,3,7,8-PeCDF	352	354	1.55	1.58	Y	00:34:04	00:34:04	15943	2.32	78.4
13C 1,2,3,4,7,8-HxCDF	384	386	0.51	0.45	Y	00:38:52	00:38:50	11533	1.62	81.3
13C 1,2,3,4,6,7,8-HpCDF	418	420	0.46	0.41	Y	00:42:49	00:42:48	6868	0.93	84.6
13C OCDD	470	472	0.89	0.86	Y	00:48:57	00:48:56	2889	0.43	77.1

RECOVERY REPORT (Sally Version 6.7)

Job Number : 39572E   Sample Number : 39572EBL   Client Id :-
Date Acquired : 19-Nov-03   Acquired File : A:D1911
Operator : P. Harrington   Instrument : Ultima   Column :DB5-ms
PC File : R:\DIOXINV\D1911\sample.007\D1911.DAT
File Text : Method Blank
Sample Employed : 10.0 g

Compound Name	Recovery %	Standard Addition / ng
Dioxins		
13C 1,2,3,4-TCDD		
13C 2,3,7,8-TCDD	92	1.00
13C 1,2,3,7,8-PeCDD	83	1.00
13C 1,2,3,6,7,8-HxCDD	81	1.00
13C 1,2,3,4,6,7,8-HpCDD	89	1.00
13C OCDD	77	1.00
Furans		
13C 1,2,3,4-TCDD		
13C 2,3,7,8-TCDF	97	1.00
13C 1,2,3,7,8-PeCDF	78	1.00
13C 1,2,3,4,7,8-HxCDF	81	1.00
13C 1,2,3,4,6,7,8-HpCDF	85	1.00
13C OCDD	77	1.00

SAL Sample Tracking Form : Issue 6

PLEASE INITIAL AND DATE ALL ENTRIES

Job Number 39572 **Sample Number** BLANK **Analysis** PCDD/F, PCB WHO12/GC7

Sample Extraction

Weight/Volume Extracted 10g | 18.11.03 S.D.

PCCD/F Internal Standard id/Lot #/Volume EDF957/32461-83/48 3μl | 18.11.03 S.D.

PCB Internal Standard id/Lot #/Volume 2091 PCB WHO12 | 18.11.03 S.D.

Extraction Method/Solvent/Volume SOXHLET, 300ml TOLUENE | 18.11.03 S.D.

Extraction Start 17.00 | 18.11.03 S.D. **End** 09.00 | 19.11.03 S.D.

Additional Comments

Extract Clean-up

Clean-up 1 ACID SILICA | 19.11.03 S.D.

Clean-up 2 COMBINATION COLUMN | 19.11.03 S.D.

Clean-up 3 FLORACIL COLUMN | 19.11.03 S.D.

Additional Comments SAMPLE SPIKED WITH 1091 PCB 52/153 | 20.11.03 S.D.

GC/MS Analysis

Instrument ULTIMA **Analyte** PCDD/F **Injection** 46490 | 19.11.03 PSM

Instrument **Analyte** **Injection**

Instrument **Analyte** **Injection**

Quantitation

Method SAL-7 (DIOXIN) | 20.11.03 PSM

Additional Comments

12.43 Extraction and Clean Up Procedures

Each sample was processed in accordance with the procedures defined in SAL SOP #1. In summary a 10 g aliquot of each 'dried and ground' sample was placed into a pre-extracted Soxhlet thimble that was then spiked with labelled internal standards. The samples were extracted with 300 mls of toluene for in excess of sixteen hours.

A reagent blank thimble was processed at the same time.

Following extraction, the toluene was reduced to incipient dryness *in vacuo*, prior to reconstitution in *ca* 5 ml hexane and purification by elution through a column combining sulphuric acid impregnated silica, potassium hydroxide impregnated silica and anhydrous sodium sulphate. The entire eluate from this column was further purified via activated Florisil column chromatography and then concentrated to near-dryness prior to GC/MS analysis.

Immediately prior to analysis by GC/MS nonane spiked with recovery standard $^{13}C_6$-1,2,3,4-TCDD and nonane were added to the samples and the blank (see the sample tracking form for the respective amounts). An aliquot of this solution was then injected onto the GC/MS system.

13.43 Analytical Procedures

The analytical methods may be summarised as follows,

Stable isotopically labelled internal standards are added at known concentration to the samples prior to extraction and clean up.

A standard solution containing the known first and last eluting isomers of the tetra, penta, hexa and hepta furans is injected onto the GC/MS system with ions monitored for all the homologues. This allows the setting up of appropriate acquisition windows for the more specific multi-group data acquisition for the sample analysis. The resulting elution windows are incorporated into the multi group acquisition tables.

Following this, another standard solution containing the 2378 TCDD native compound and the known close eluting isomers is injected. This permits the ability of the column to identify 2378-TCDD to be evaluated.

Two masses each are monitored for each native and isotopically labelled congener, this allows the isotope ratio to be checked with the theoretical value as additional confirmation of the compound's identity. Note that although the mass spectrometer is operated at 10,000 resolving power there are still other compounds which may survive the clean up and may be close enough in mass to yield a response in the dioxin or furan channels. To aid in identification of these interferences two other QA masses are monitored, firstly the molecular ion species for polychlorinated diphenyl ethers which yield fragments in their mass spectra of exactly the same mass as the furans, if a response is observed in this channel coincident with the furan masses then the peaks are discarded if appropriate. Secondly, as part of the system's performance checks, a "lock mass" from perfluorokerosene (present in the batch inlet throughout the entire GC run) is monitored and scanned to compensate for any mass drift during the run. Use is made of this feature to monitor the lock mass before it has been used to correct for drift. This trace would, if no large components were present, appear as a continuous line, however, if a large (many nanograms/micrograms) peak elutes from the GC column the ion source sensitivity is suppressed and a negative going "peak" will be seen. If such a peak coelutes with possible interferences they may also be discarded, (see each sample's narrative).

Standards of both the isotopically labelled and native 2378 containing congeners of interest are injected sequentially, starting with the least concentrated. The composition of these are given later. The resulting target results and relative response factors are given.

All 2378 containing native congeners are quantitated by isotope dilution methods relative to their carbon-13 labelled internal standards. For quantitation of the "totals" of all non-2378 containing congeners, the relative response factor is assumed to be the same as for the first eluting native 2378 congener of the same homologue group. For example, non-2,3,7,8-chlorinated PeCDFs are quantified using the RRF derived for 1,2,3,7,8-PeCDF.

As a check upon the efficiency of the extraction/clean up, $^{13}C_6$-1,2,3,4-TCDD was added to the samples immediately prior to injection onto the GC/MS system. This is also used to help evaluate the method detection limit in the case where no peak is detected for one of the targeted analytes. A recovery table is printed in each sample's report.

A nonane blank is injected prior to sample analysis. This blank must contain no target isomers above noise before the analysis of samples can continue.

The sample log sheet for the job is given at the end of the report.

14.44 (a) GC Conditions for the Analysis, Acquisition System Used for Window Standard.

Column 60m J&W DB5-ms, 0.25u film thickness, 0.25mm i.d., head pressure 30 p.s.i.

Program 140° C for 4 minutes, then 15 C°/min to 220 °C, then 1.5 C°/min to 240 °C, hold for 2 minutes, then 4 C°/min to 310 °C, which is held for 10 minutes.

Injection Conditions Temperature 300 °C, Splitless mode, valve time 2 minutes.

(b) GC/MS Acquisition System, Window Standard

Group Time, 0:01:0 to 0:50:0

Masses Monitored

Component	Mass	Sample Time(ms)	Delay Time(ms)
TCDF	305.8987	40	10
PeCDF	339.8597	40	10
HxCDF	373.8208	40	10
HpCDF	407.7818	40	10

This test is performed at 1000 resolving power (10% valley definition).

15.45 Mass Spectrometer Conditions and Instrumentation Used

The operating parameters for the mass spectrometer used during sample analysis are listed below.

Resolving Power	10,000 (10% valley definition).
Source Conditions	Electron Energy 30 eV. Trap Current 700 μA. Source Temperature 250 °C.
Interface Temperatures	280 °C.
Detector Conditions	Amplifier Range 10^{-6} Amps Full Scale. Amplifier Response Time 0.01 ms. Multiplier Voltage 320 volts.

GC/MS system VG Autospec Ultima Mass Spectrometer equipped with HP 5890A Gas Chromatograph. Data system is a VG OPUS. Samples were injected with an HP7673B autosampler.

16.45 Compounds Present in the Window Determination Standard.

	First eluting isomer	Last eluting isomer
Tetra Furan	1368	1289
Penta Furan	13468	12389
Hexa Furan	123468	123489
Hepta Furan	1234678	1234789

Only one isomer exists for the octachlorinated furan and so no standard is necessary to define the acquisition window.

Please note that 1,2,8,9-TCDF elutes after 1,3,4,6,8-PeCDF on the DB-5ms column. On the basis of operator experience, it has been decided that the acquisition windows be set to permit measurement of 1,3,4,6,8-PeCDF, which is far more prevalent in samples than 1,2,8,9-TCDF. The data reported here for "total non-targeted TCDFs" therefore, omits 1,2,8,9-TCDF.

Compounds in Column Performance Standard

The following TCDD isomers:

1478, 1234, 1237/1238, 2378, 1278, 1267

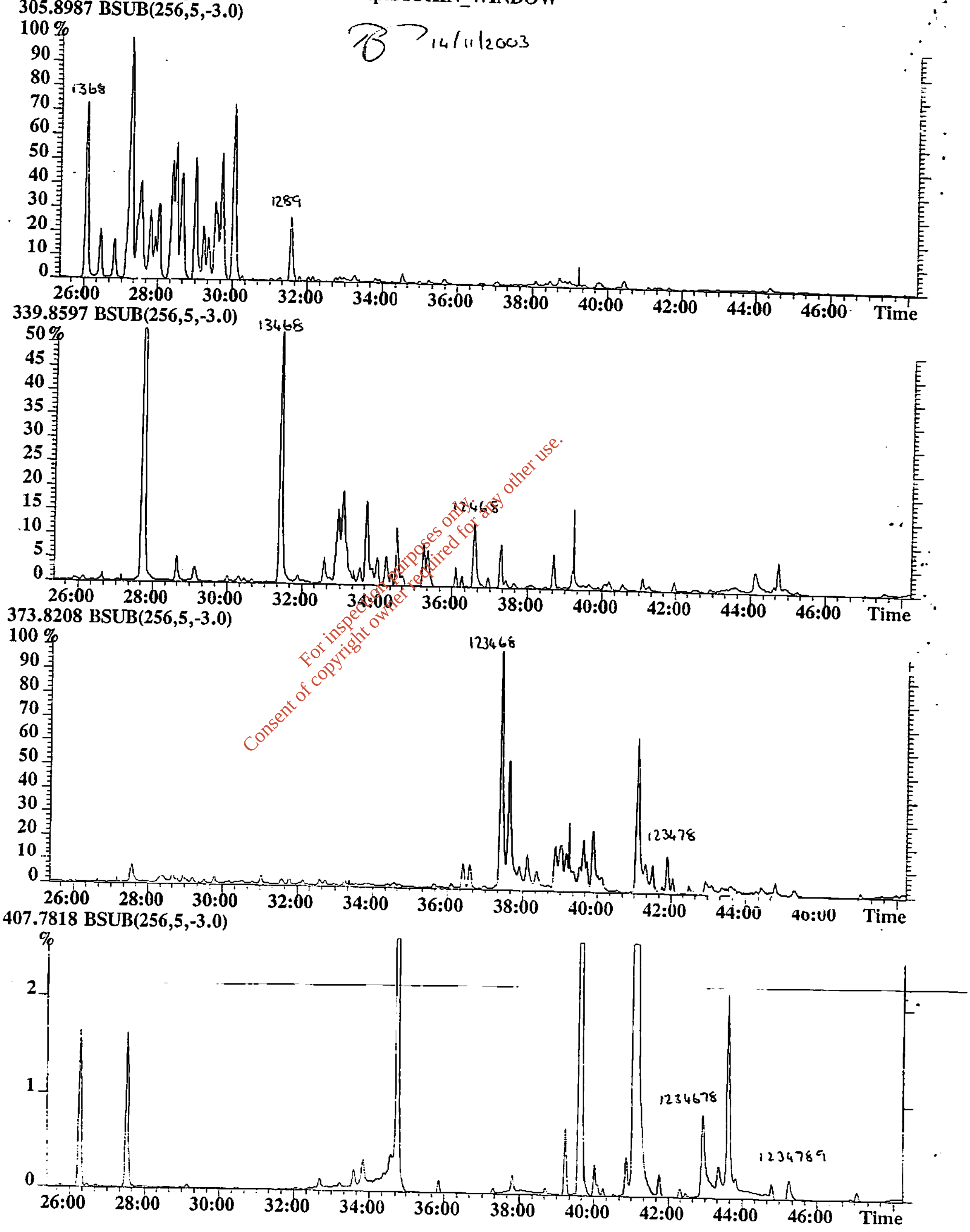
Note :- The DB5-ms column chosen achieves satisfactory resolution of 2378 TCDF from its close eluting isomers.

EPA protocols require that the separation between 1237/1238 and 2378 TCDD be better than 25% valley, clearly easily achieved on the DB5-ms column used.

Please note that the DB5-ms column employed does not effect satisfactory resolution of 2,3,4,7,8-PeCDF and 1,2,3,7,8,9-HxCDF from their close-eluting isomers. The amount reported for these isomers are therefore the *maximum possible*. The amount of the 2,3,4,7,8-PeCDF may be over reported by as much as 25%, based upon the analysis of five extracts chosen at random that were then confirmed on a polar column.

17.46 Raw Data from the Window Determination Standard, Including Peak Identifications.

File:WI1411 #1-2999 Acq:14-NOV-2003 15:52:44 GC EI+ Voltage SIR Autospec-Ulti£
Sample#1 Text:GC perf.., PSH Exp:DIOXIN_WINDOW



18.47 Acquisition Systems Used for Sample Analysis.

Group 1

Component	Mass	Sample Time(ms)	Delay Time(ms)	
PFK	292.9825	10	5	Lock Mass Check
PFK	292.9825	50	10	Lock Mass
TCDF	303.9015	100	10	
TCDF	305.8987	100	10	
^{13}C TCDF	315.9419	30	10	
^{13}C TCDF	317.9389	30	10	
TCDD	319.8965	100	10	
TCDD	321.8936	100	10	
^{13}C6 1234 TCDD	325.9166	30	10	Recovery Std.
^{13}C6 1234 TCDD	327.9137	30	10	Recovery Std.
^{13}C 2378 TCDD	331.9368	30	10	
^{13}C 2378 TCDD	333.9339	30	10	
CDPE	375.8364	30	50	Furan Interference

Group 2

Component	Mass	Sample Time(ms)	Delay Time(ms)	
PeCDF	339.8597	100	10	
PeCDF	341.8567	100	10	
^{13}C PeCDF	351.9000	30	10	
^{13}C PeCDF	353.8970	30	10	
PeCDD	355.8546	100	10	
PeCDD	357.8516	100	10	
PFK	366.9792	10	5	Lock Mass Check
PFK	366.9792	50	10	Lock Mass
^{13}C PeCDD	367.8949	30	10	
^{13}C PeCDD	369.8919	30	10	
CDPE	409.7974	30	50	Furan Interference

Group 3

Component	Mass	Sample Time(ms)	Delay Time(ms)	
HxCDF	373.8208	100	10	
HxCDF	375.8358	100	10	
^{13}C HxCDF	383.8639	30	10	
^{13}C HxCDF	385.8610	30	10	
HxCDD	389.8157	100	10	
HxCDD	391.8127	100	10	
PFK	392.9760	10	5	Lock Mass Check
PFK	392.9760	50	10	Lock Mass
^{13}C HxCDD	401.8559	30	10	
^{13}C HxCDD	403.8529	30	10	
CDPE	445.7555	30	50	Furan Interference

Group 4

Component	Mass	Sample Time(ms)	Delay Time(ms)	
HpCDF	407.7818	100	10	
HpCDF	409.7789	100	10	
^{13}C HpCDF	417.8253	30	10	
^{13}C HpCDF	419.8220	30	10	
HpCDD	423.7766	100	10	
HpCDD	425.7737	100	10	
PFK	430.9729	10	5	Lock Mass Check
PFK	430.9729	50	10	Lock Mass
^{13}C HpCDD	435.8169	30	10	
^{13}C HpCDD	437.8140	30	10	
CDPE	479.7165	30	50	Furan Interference

Group 5

Component	Mass	Sample Time(ms)	Delay Time(ms)	
OCDF	441.7428	100	10	
PFK	442.9728	10	5	Lock Mass Check
PFK	442.9728	50	10	Lock Mass
OCDF	443.7399	100	10	
^{13}C OCDF	453.7830	30	10	
^{13}C OCDF	455.7800	30	10	
OCDD	457.7377	100	10	
OCDD	459.7348	100	10	
^{13}C OCDD	469.7835	30	10	
^{13}C OCDD	471.7750	30	10	
CDPE	513.6775	30	50	Furan Interference

19.49 Dioxin and Furan Calibration Standards Preparation Certificate.

Dioxin/Furan Calibration Standards Preparation Certificate

This certifies that a set of five dioxin/furan calibration standards were prepared in accordance with SAL SOP 2, issue 3.

The batch numbers of the stock dioxin and furan reference standards used in the preparation of the calibrations standards were:

$^{13}C_6$-1,2,3,4-TCDD (080299)

Mixed labelled/native standards CS1-CS5 (EDF-4947), batch numbers 34752-77A, 33384-42B, 35005-04, 3384-42D and 34752-77E respectively.

All the above standards are traceable to certified reference standards purchased from Cambridge Isotope Laboratories.

	Signature	Name	Position
Standards prepared by	[signature]	**P.Harrington**	**Dioxin Analyst**

Date of Preparation :- CS2: 26/11/01, CS3: 28/06/02, CS1,4,5: 14/08/02 .

Standard Codes :- CS1/140802, CS2/261101, CS3/280602, CS4/140802, CS5/140802

Please note that these standards contain $^{13}C_{12}$-OCDF and are suitable for use in method EN1948 analysis (SAL SOP1c).

The continuing calibration solution, CS3, is in constant use and is exhausted regularly. This standard is prepared on an as needed basis, the current standard being CS3/~~280602.~~

~~041003~~ PSH
~~031003~~ PS
170503 PSH

20.50 Initial Calibration Results Table (IC1711)

CALIBRATION RESULTS (Sally Version 6.7)

File Number	Date (d:m:year)	File Name
1	17-Nov-03	R:\DIOXINV\IC1711\SAMPLE.001\IC1711.DAT
2	17-Nov-03	R:\DIOXINV\IC1711\SAMPLE.003\IC1711.DAT
3	17-Nov-03	R:\DIOXINV\IC1711\SAMPLE.002\IC1711.DAT
4	17-Nov-03	R:\DIOXINV\IC1711\SAMPLE.004\IC1711.DAT
5	17-Nov-03	R:\DIOXINV\IC1711\SAMPLE.005\IC1711.DAT

File	1	2	3	4	5	Average	%s.d.
13C 1,2,3,4-TCDD-R					Retention Time Standard		
13C 1,2,3,4-TCDD							
Recovery Standard							
Amount	91.0	91.0	91.0	91.0	91.0		
RF	1.00	1.00	1.00	1.00	1.00	1.00	
RRF	1.00	1.00	1.00	1.00	1.00	1.00	0
13C 2,3,7,8-TCDD							
Internal Standard							
Amount	91.0	91.0	91.0	91.0	91.0		
RF	0.913	0.818	0.835	1.09	1.16	0.00	
RRF	0.913	0.818	0.835	1.09	1.16	0.644	0.00
2,3,7,8-TCDD							
Analyte							
Amount	0.5	9.1	1.8	36.0	182.0		
RF	0.006	0.124	0.027	0.487	2.50	0.628	
RRF	1.31	1.24	1.34	1.23	1.25	1.27	4
13C 1,2,3,7,8-PeCDD							
Internal Standard							
Amount	91.0	91.0	91.0	91.0	91.0		
RF	0.957	0.973	1.13	1.16	1.31	0.00	
RRF	0.957	0.973	1.13	1.16	1.31	1.45	0.00
1,2,3,7,8-PeCDD							
Analyte							
Amount	2.3	45.4	9.1	182.0	910.0		
RF	0.022	0.490	0.102	2.13	9.80	2.51	
RRF	0.899	0.982	1.02	1.07	0.980	0.989	6
13C 1,2,3,4,7,8-HxCDF-T					Retention Time Standard		
13C 1,2,3,6,7,8-HxCDD							
Internal Standard							
Amount	91.0	91.0	91.0	91.0	91.0		
RF	0.727	0.723	0.864	0.912	0.993	0.00	
RRF	0.727	0.723	0.864	0.912	0.993	0.894	0.00

1,2,3,6,7,8-HxCDD
Analyte

Amount	2.3	45.4	9.1	182.0	910.0		
RF	0.034	0.696	0.133	2.57	14.0	3.48	
RRF	1.37	1.40	1.33	1.28	1.40	1.35	4

1,2,3,4,7,8-HxCDD
Analyte

Amount	2.3	45.4	9.1	182.0	910.0		
RF	0.023	0.542	0.104	2.27	11.2	2.83	
RRF	0.936	1.09	1.04	1.13	1.12	1.06	8

1,2,3,7,8,9-HxCDD
Analyte

Amount	2.3	45.4	9.1	182.0	910.0		
RF	0.029	0.668	0.125	2.48	12.9	3.23	
RRF	1.15	1.34	1.25	1.24	1.29	1.25	6

13C 1,2,3,4,6,7,8-HpCDD-R Retention Time Standard
13C 1,2,3,4,6,7,8-HpCDD
Internal Standard

Amount	91.0	91.0	91.0	91.0	91.0		
RF	0.526	0.603	0.647	0.736	0.799	0.00	
RRF	0.526	0.603	0.647	0.736	0.799	0.844	0.00

1,2,3,4,6,7,8-HpCDD
Analyte

Amount	2.3	45.4	9.1	182.0	910.0		
RF	0.023	0.525	0.106	2.16	10.7	2.69	
RRF	0.912	1.05	1.06	1.08	1.07	1.03	7

13C OCDD
Internal Standard

Amount	182.0	182.0	182.0	182.0	182.0		
RF	0.497	0.622	0.631	0.734	0.906	0.00	
RRF	0.249	0.311	0.315	0.367	0.453	0.428	0.00

OCDD
Analyte

Amount	4.5	91.0	18.0	360.0	1820.0		
RF	0.030	0.720	0.130	3.07	14.7	3.73	
RRF	1.22	1.44	1.32	1.55	1.47	1.40	9

13C 1,2,3,4-TCDD-R Retention Time Standard
13C 1,2,3,4-TCDD
Recovery Standard

Amount	91.0	91.0	91.0	91.0	91.0		
RF	1.00	1.00	1.00	1.00	1.00	1.00	
RRF	1.00	1.00	1.00	1.00	1.00	1.00	0

13C 2,3,7,8-TCDF
Internal Standard

Amount	91.0	91.0	91.0	91.0	91.0		
RF	1.56	1.75	1.75	2.02	1.99	0.00	
RRF	1.56	1.75	1.75	2.02	1.99	1.62	0.00

2,3,7,8-TCDF
Analyte

Amount	0.5	9.1	1.8	36.0	182.0		
RF	0.006	0.129	0.027	0.521	2.42	0.621	
RRF	1.27	1.29	1.35	1.32	1.21	1.29	4

13C 1,2,3,7,8-PeCDF
Internal Standard

Amount	91.0	91.0	91.0	91.0	91.0		
RF	1.49	1.49	1.75	1.76	1.83	0.00	
RRF	1.49	1.49	1.75	1.76	1.83	2.32	0.00

1,2,3,7,8-PeCDF
Analyte

Amount	2.3	45.4	9.1	182.0	910.0		
RF	0.021	0.399	0.079	1.60	8.54	2.13	
RRF	0.838	0.799	0.791	0.798	0.854	0.816	3

2,3,4,7,8-PeCDF
Analyte

Amount	2.3	45.4	9.1	182.0	910.0		
RF	0.020	0.414	0.076	1.88	9.33	2.34	
RRF	0.804	0.829	0.761	0.941	0.933	0.854	9

13C 1,2,3,4,7,8-HxCDF-T Retention Time Standard
13C 1,2,3,4,7,8-HxCDF
Internal Standard

Amount	91.0	91.0	91.0	91.0	91.0		
RF	1.00	1.07	1.13	1.24	1.45	0.00	
RRF	1.00	1.07	1.13	1.24	1.45	1.62	0.00

1,2,3,4,7,8-HxCDF
Analyte

Amount	2.3	45.4	9.1	182.0	910.0		
RF	0.023	0.477	0.098	2.01	10.1	2.53	
RRF	0.934	0.957	0.984	1.00	1.01	0.977	3

1,2,3,6,7,8-HxCDF
Analyte

Amount	2.3	45.4	9.1	182.0	910.0		
RF	0.031	0.654	0.124	2.77	12.7	3.25	
RRF	1.23	1.31	1.24	1.39	1.27	1.29	5

2,3,4,6,7,8-HxCDF
Analyte

Amount	2.3	45.4	9.1	182.0	910.0		
RF	0.021	0.478	0.095	2.10	9.59	2.46	
RRF	0.853	0.957	0.947	1.05	0.959	0.953	7

1,2,3,7,8,9-HxCDF
Analyte

Amount	2.3	45.4	9.1	182.0	910.0		
RF	0.018	0.390	0.079	1.77	8.43	2.14	
RRF	0.733	0.781	0.792	0.886	0.843	0.807	7

13C 1,2,3,4,6,7,8-HpCDD-R Retention Time Standard

13C 1,2,3,4,6,7,8-HpCDF

Internal Standard

Amount	91.0	91.0	91.0	91.0	91.0		
RF	0.628	0.715	0.754	0.830	0.933	0.00	
RRF	0.628	0.715	0.754	0.830	0.933	0.927	0.00

1,2,3,4,6,7,8-HpCDF

Analyte

Amount	2.3	45.4	9.1	182.0	910.0		
RF	0.028	0.604	0.129	2.65	12.7	3.23	
RRF	1.14	1.21	1.29	1.33	1.27	1.25	6

1,2,3,4,7,8,9-HpCDF

Analyte

Amount	2.3	45.4	9.1	182.0	910.0		
RF	0.021	0.406	0.077	1.90	9.47	2.37	
RRF	0.836	0.814	0.768	0.951	0.947	0.863	10

13C OCDD

Internal Standard

Amount	182.0	182.0	182.0	182.0	182.0		
RF	0.497	0.622	0.631	0.734	0.906	0.00	
RRF	0.249	0.311	0.315	0.367	0.453	0.428	0.00

OCDF

Analyte

Amount	4.5	91.0	18.0	360.0	1820.0		
RF	0.034	0.740	0.154	3.27	15.6	3.96	
RRF	1.37	1.48	1.56	1.65	1.56	1.52	7

21.54 Continuing Calibration Check, 19th November 2003

Standard 'CS3/061003' is injected onto the 60m DB5-ms column prior to sample analysis. The relative response factors are determined for all analytes and must not have changed by more than 25% from the initial values for analysis to proceed.

The differences are reported in the tables below and are acceptable.

Compound Name	Mean RRF	%SD	RRFcc	%Delta
2,3,7,8-TCDD	1.27	4	1.34	-5
1,2,3,7,8-PeCDD	0.989	6	1.09	-10
1,2,3,6,7,8-HxCDD	1.35	4	1.40	-3
1,2,3,4,7,8-HxCDD	1.06	8	1.02	4
1,2,3,7,8,9-HxCDD	1.25	6	1.32	-5
1,2,3,4,6,7,8-HpCDD	1.03	7	1.01	2
OCDD	1.40	9	1.42	-2
2,3,7,8-TCDF	1.29	4	1.35	-5
1,2,3,7,8-PeCDF	0.816	3	0.836	-3
2,3,4,7,8-PeCDF	0.854	9	0.874	-2
1,2,3,4,7,8-HxCDF	0.977	3	1.02	-4
1,2,3,6,7,8-HxCDF	1.29	5	1.41	-10
2,3,4,6,7,8-HxCDF	0.953	7	0.997	-5
1,2,3,7,8,9-HxCDF	0.807	7	0.818	-1
1,2,3,4,6,7,8-HpCDF	1.25	6	1.35	-8
1,2,3,4,7,8,9-HpCDF	0.863	10	0.930	-8
OCDF	1.52	7	1.49	2

TARGETING REPORT (Sally Version 6.7)

Date Acquired : 19-Nov-03 Acquired File : A:D1911
Operator : P. Harrington Instrument : Ultima Column :DB5-ms
PC File : R:\DIOXINV\D1911\sample.001\D1911.DAT

Compound Name	M1	M2	M1/M2 thry	M1/M2 actl	Ok	Retention Time theory	Retention Time found	Area
Dioxins								
13C 1,2,3,4-TCDD	326	328	0.78	0.82	Y	00:29:43	00:29:42	63611
13C 2,3,7,8-TCDD	332	334	0.78	0.81	Y	00:30:15	00:30:14	37983
2,3,7,8-TCDD	320	322	0.78	0.82	Y	00:30:16	00:30:15	5088
13C 1,2,3,7,8-PeCDD	368	370	1.55	1.56	Y	00:35:32	00:35:31	73444
1,2,3,7,8-PeCDD	356	358	1.55	1.62	Y	00:35:33	00:35:33	39868
13C 1,2,3,6,7,8-HxCDD	402	404	1.24	1.22	Y	00:40:03	00:40:02	58244
1,2,3,6,7,8-HxCDD	390	392	1.24	1.29	Y	00:40:04	00:40:03	40682
1,2,3,4,7,8-HxCDD	390	392	1.24	1.27	Y	00:39:57	00:39:55	29544
1,2,3,7,8,9-HxCDD	390	392	1.24	1.30	Y	00:40:26	00:40:25	38353
13C 1,2,3,4,6,7,8-HpCDD	436	438	1.05	1.15	Y	00:44:19	00:44:17	42966
1,2,3,4,6,7,8-HpCDD	424	426	1.05	0.98	Y	00:44:20	00:44:18	21725
13C OCDD	470	472	0.89	0.88	Y	00:48:57	00:48:55	47984
OCDD	458	460	0.89	0.90	Y	00:48:58	00:48:57	34117
Furans								
13C 1,2,3,4-TCDD	326	328	0.78	0.82	Y	00:29:43	00:29:42	63611
13C 2,3,7,8-TCDF	316	318	0.78	0.73	Y	00:29:32	00:29:31	91667
2,3,7,8-TCDF	304	306	0.78	0.69	Y	00:29:33	00:29:32	12378
13C 1,2,3,7,8-PeCDF	352	354	1.55	1.47	Y	00:34:04	00:34:04	119486
1,2,3,7,8-PeCDF	340	342	1.55	1.62	Y	00:34:05	00:34:04	49851
2,3,4,7,8-PeCDF	340	342	1.55	1.63	Y	00:35:13	00:35:12	52093
13C 1,2,3,4,7,8-HxCDF	384	386	0.51	0.48	Y	00:38:52	00:38:50	78344
1,2,3,4,7,8-HxCDF	374	376	1.24	1.22	Y	00:38:53	00:38:51	39704
1,2,3,6,7,8-HxCDF	374	376	1.24	1.21	Y	00:39:02	00:39:01	55218
2,3,4,6,7,8-HxCDF	374	376	1.24	1.16	Y	00:39:44	00:39:44	38972
1,2,3,7,8,9-HxCDF	374	376	1.24	1.22	Y	00:40:55	00:40:54	31969
13C 1,2,3,4,6,7,8-HpCDF	418	420	0.46	0.43	Y	00:42:49	00:42:47	53417
1,2,3,4,6,7,8-HpCDF	408	410	1.05	1.05	Y	00:42:50	00:42:49	35954
1,2,3,4,7,8,9-HpCDF	408	410	1.05	1.01	Y	00:45:08	00:45:07	24782
13C OCDD	470	472	0.89	0.88	Y	00:48:57	00:48:55	47984
OCDF	442	444	0.89	0.92	Y	00:49:20	00:49:17	35724

22.56 Estimation of Method Detection Limits

The 'CS3' continuing calibration standard responses for the day when this sample was run (using standard CS3/061003) were used to estimate the method detection limits for the targeted analytes. The criteria is a minimum S/N of 2.5:1 for both isotope peaks.

Analyte	Std Amount(pg)	S/N	Detection Limit(pg)
Dioxins			
2,3,7,8-TCDD	10	500:1	0.05
1,2,3,7,8-PeCDD	50	2000:1	0.05
1,2,3,4,7,8-HxCDD	50	2000:1	0.05
1,2,3,6,7,8-HxCDD	50	2000:1	0.05
1,2,3,7,8,9-HxCDD	50	2000:1	0.05
1,2,3,4,6,7,8-HpCDD	50	1500:1	0.08
OCDD	100	2000:1	0.1
Furans			
2,3,7,8-TCDF	10	500:1	0.05
1,2,3,7,8-PeCDF	50	2000:1	0.05
2,3,4,7,8-PeCDF	50	2000:1	0.05
1,2,3,4,7,8-HxCDF	50	2000:1	0.05
1,2,3,6,7,8-HxCDF	50	2000:1	0.05
2,3,4,6,7,8-HxCDF	50	2000:1	0.05
1,2,3,7,8,9-HxCDF	50	1000:1	0.1
1,2,3,4,6,7,8-HpCDF	50	2000:1	0.05
1,2,3,4,7,8,9-HpCDF	50	1000:1	0.1
OCDF	100	2000:1	0.1

Note that these detection limits are given in **pg injected** , so the sample detection limits are obtained by using the following equation. The proportion of the sample injected may be determined from the sample tracking form included with each sample report.

$$\text{Analyte detection limit} = \frac{\text{Injection detection limit (above)}}{\text{(portion of sample injected) x (amount sample)}}$$

In the case of poor recoveries of the internal standards this amount should be further increased by multiplying by 100/(recovery %).

The detection limits for these samples, where *ca* 1/30th was injected and recoveries were *ca* 70% were between 0.2 and 0.4 ng/kg per congener for the soil samples.

23.57 GC Performance Check

The ability of the GC column used to resolve the known close eluting isomers of the Tetra Dioxins was tested prior to analysis. A performance check standard containing the following isomers is injected. The TCDD traces are given on the following pages.

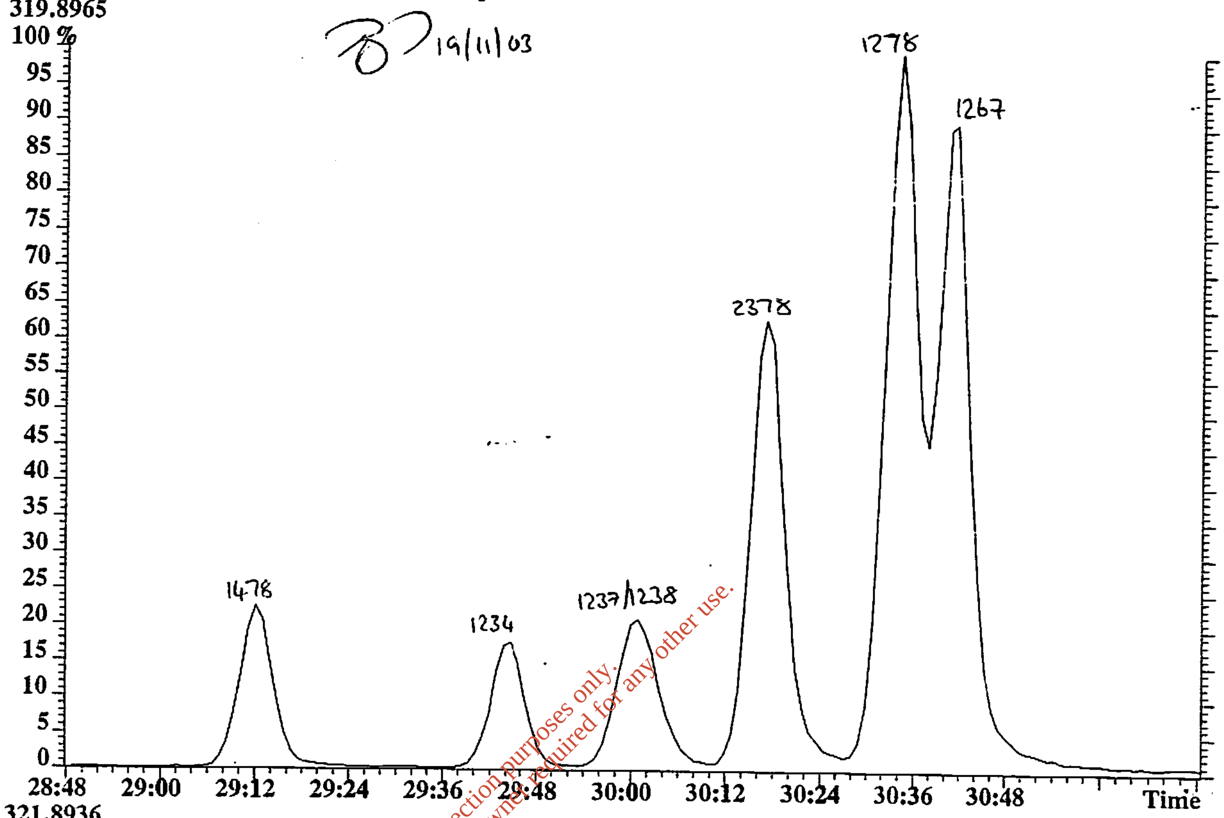
TCDD isomers contained in the GC Performance Check Standard in elution order.

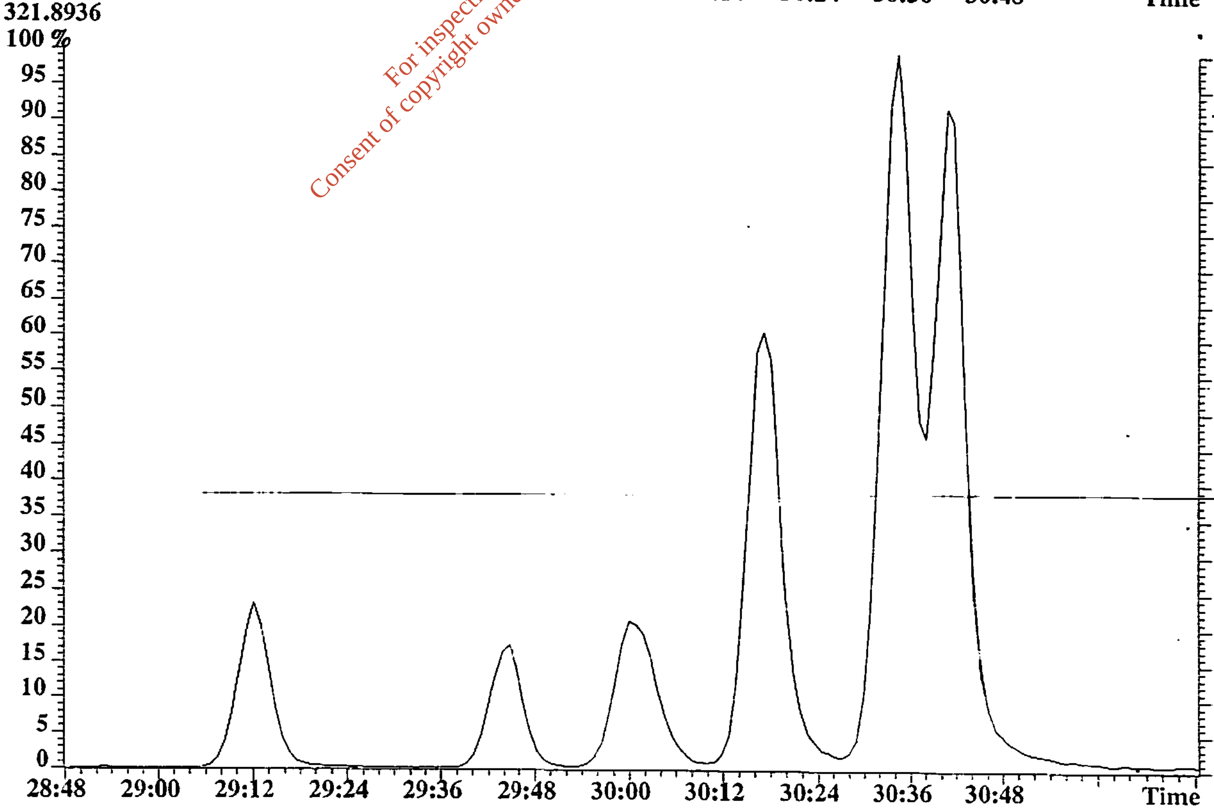
1,4,7,8
1,2,3,4
1,2,3,7/1,2,3,8
2,3,7,8
1,2,7,8
1,2,6,7

The criterion for acceptance of this test is that the 2,3,7,8 TCDD must be separated by a valley of at least 25% from its nearest neighbours.

24.58 GC Performance Check Data, DB5-ms Column, 19th November 2003

File:GC1911 #1-378 Acq:19-NOV-2003 17:13:50 GC EI+ Voltage SIR Autospec-Ultima
Sample#1 Text:GC perf.., PSH Exp:EPA1613





25.59 Sample Log Sheet Job 39572-1

for Quotation Ref Q13544-1
Customer M/S Mairead Morrissey at AWN Consultants, Tecpro Building, Clonshaugh Industrial Estate, Dublin 17
Tel: 00353 1 847 4220 Fax: 00353 1 847 4257

Logged in: 12-November-2003 **Report due:** 26-November-2003

Date	SAL Contact	Contact	Subject	Action
12-NOV-03	NSUMMERS		Reporting	Please address report top Elaine Neary
12-NOV-03	NSUMMERS		Failed sales review	Due date should be 26/11/03 (10 day turnaround)

Sample Information

Soil

SAL	Customer Reference	Condition	Logged In By	Location
001	SAMPLE POINT A	Ok	GQUIRK	Box
002	SAMPLE POINT B	Ok	GQUIRK	Box
003	SAMPLE POINT C	Ok	GQUIRK	Box
004	SAMPLE POINT D	Ok	GQUIRK	Box
005	SAMPLE POINT E	Ok	GQUIRK	Box
006	SAMPLE POINT F	Ok	GQUIRK	Box

Tests	Technique	Accreditation
Dioxins and Furans (Based on US EPA 1613)	GC/MS (HR)	UKAS
Mercury	ICP/OES	none
PCBs EC7 congeners(28,52,101,118,138,153,180)	GC/MS (HR)	UKAS
Poly Chlorinated Biphenyls (WHO 12)	Suite	none

Audit Trail

State	Set By	When	Why
Unfinished	GQUIRK	12-Nov-2003 14:38:42	
Sales Review Required	GQUIRK	12-Nov-2003 14:43:49	
Sales Review Underway	NSUMMERS	12-Nov-2003 17:12:31	
Failed Sales Review	NSUMMERS	12-Nov-2003 17:19:02	
Sales Review Required	NSUMMERS	12-Nov-2003 17:21:58	
Sales Review Underway	MILESW	13-Nov-2003 09:08:40	
Analyst Review Required	MILESW	13-Nov-2003 09:10:48	
Analyst Review Underway	PAULH	13-Nov-2003 09:42:34	
Analysis Underway	PAULH	13-Nov-2003 09:44:05	

26.60 SAL Authorised Signatories Register

SAL AUTHORISED SIGNATORIES SPECIMEN SIGNATURES
CURRENT AS OF 14-APR-2003. ISSUE: 32
MASTER COPY

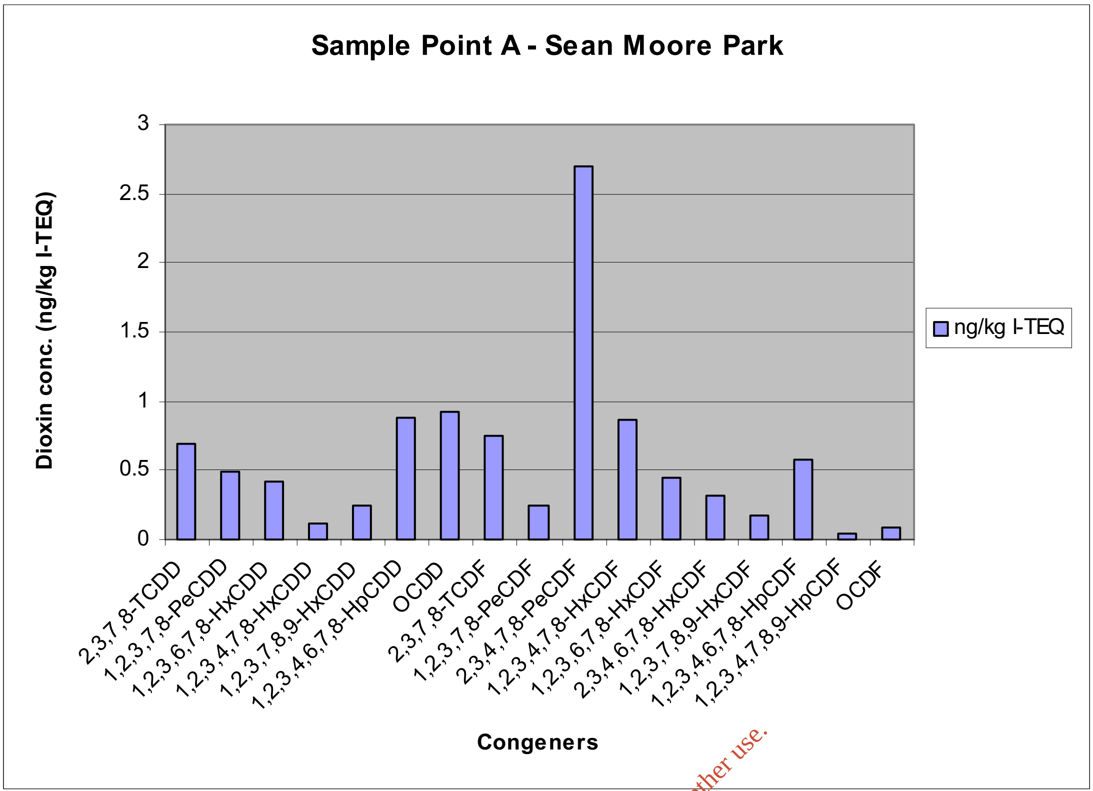
Name	Signature	Initials
Sarah Bannister		
Saber Chaudhry		
Bill Cohen		
Lindsay Collins		
Steve Conlan		
Will Crossley		
Sebastian Dahl		
Chris Field		
Jane Fletcher		
Jane Fox		
Subhash Gadher		
Philip George		
Paul Harrington		
Iain Haslock		
Ian Hayes		
Vanessa Higham		
Eifion Hollywell		
Pam Knott		

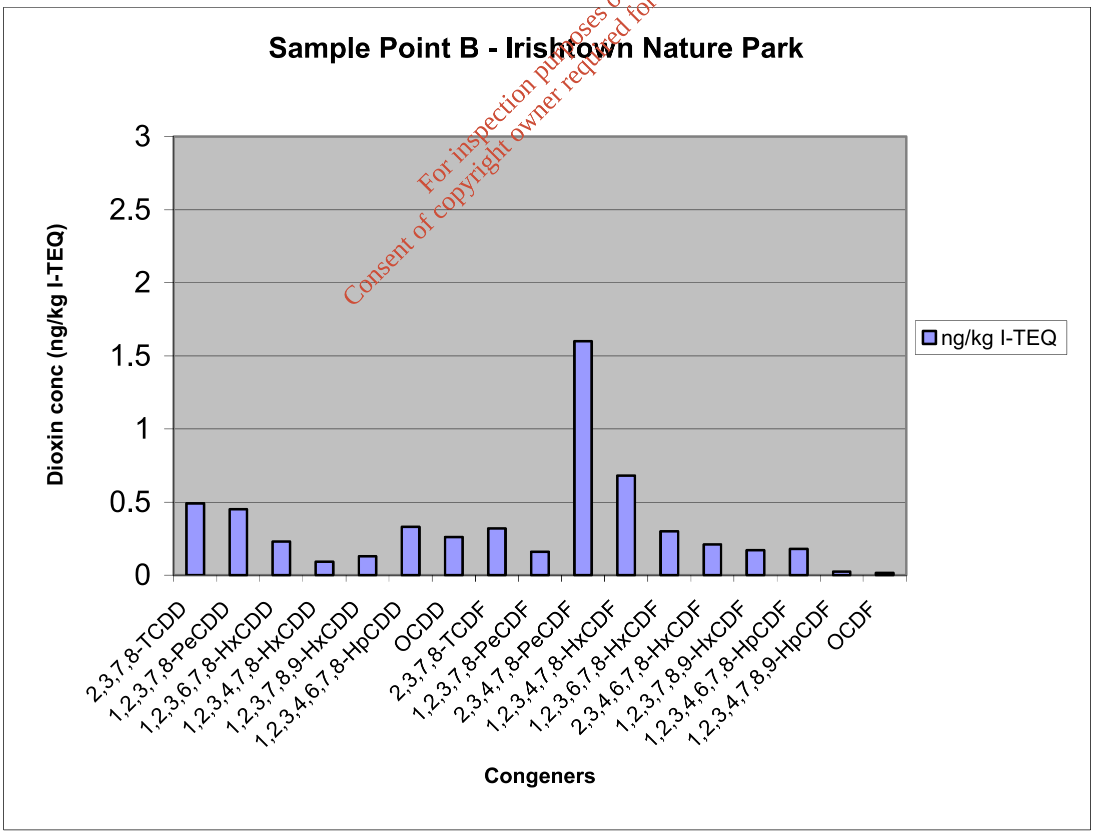
SAL Authorised Signatories Specimen Signatures (14/04/2003) Master Copy Page 1 of 2

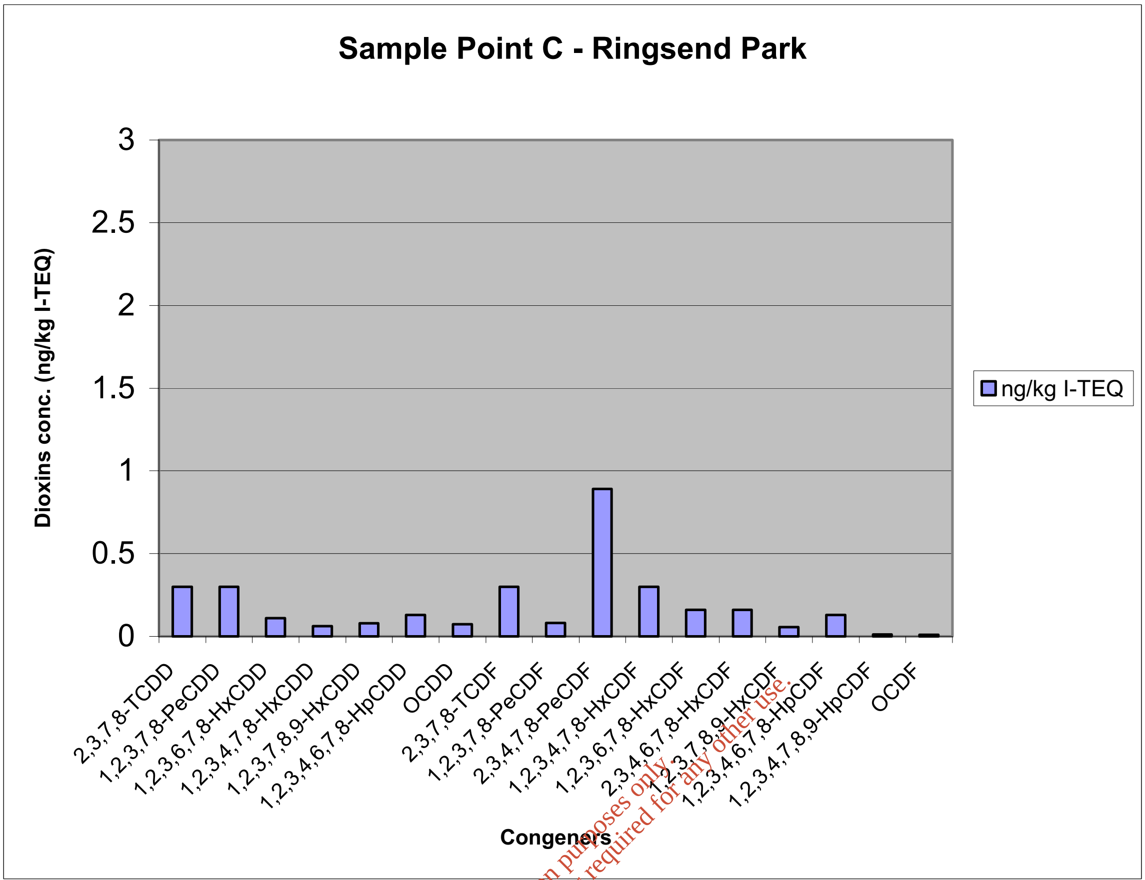
Name	Signature	Initials
Himanshu Lad		
Helen Mason		
Mike Maxwell		
Vic Parr		
Thi Pham		
Jane Pilot		
Metrey Prak		
Lee Quibell		
Suzanne Quick		
Gary Quirk		
Clifford Rodger		
Charlotte Riley		
Graham Small		
Robert Smith		
Nicola Summers		
Keith Thompson		
Leanne Taylor		
Peter Verrechia		
David Wood		

SAL Authorised Signatories Specimen Signatures (14/04/2003) Master Copy Page 2 of 2

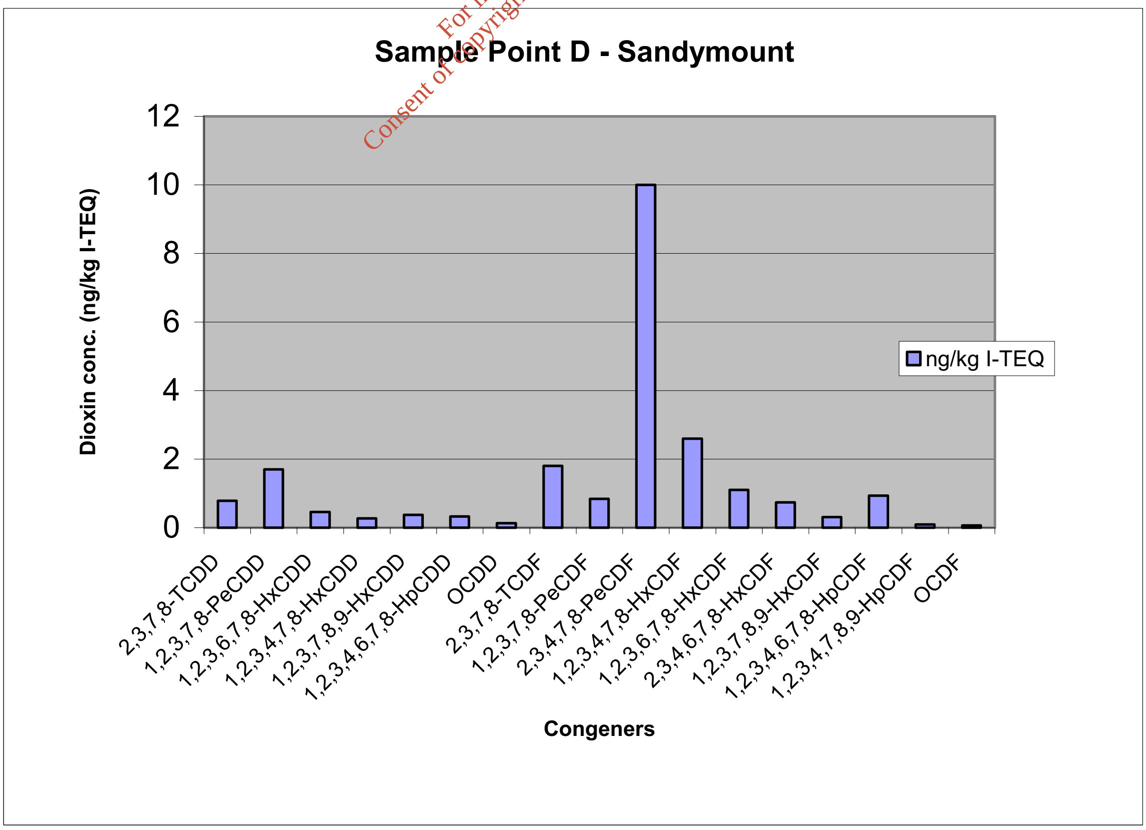
ATTACHMENT 5 – CONGENER PROFILES


Sample Point A - Sean Moore Park
Dioxin conc. (ng/kg I-TEQ)
3
2.5
2
1.5
1
0.5
0
ng/kg I-TEQ
2,3,7,8-TCDD
1,2,3,7,8-PeCDD
1,2,3,6,7,8-HxCDD
1,2,3,4,7,8-HxCDD
1,2,3,7,8,9-HxCDD
1,2,3,4,6,7,8-HpCDD
OCDD
2,3,7,8-TCDF
1,2,3,7,8-PeCDF
2,3,4,7,8-PeCDF
1,2,3,4,7,8-HxCDF
1,2,3,6,7,8-HxCDF
2,3,4,6,7,8-HxCDF
1,2,3,7,8,9-HxCDF
1,2,3,4,6,7,8-HpCDF
1,2,3,4,7,8,9-HpCDF
OCDF
Congeners

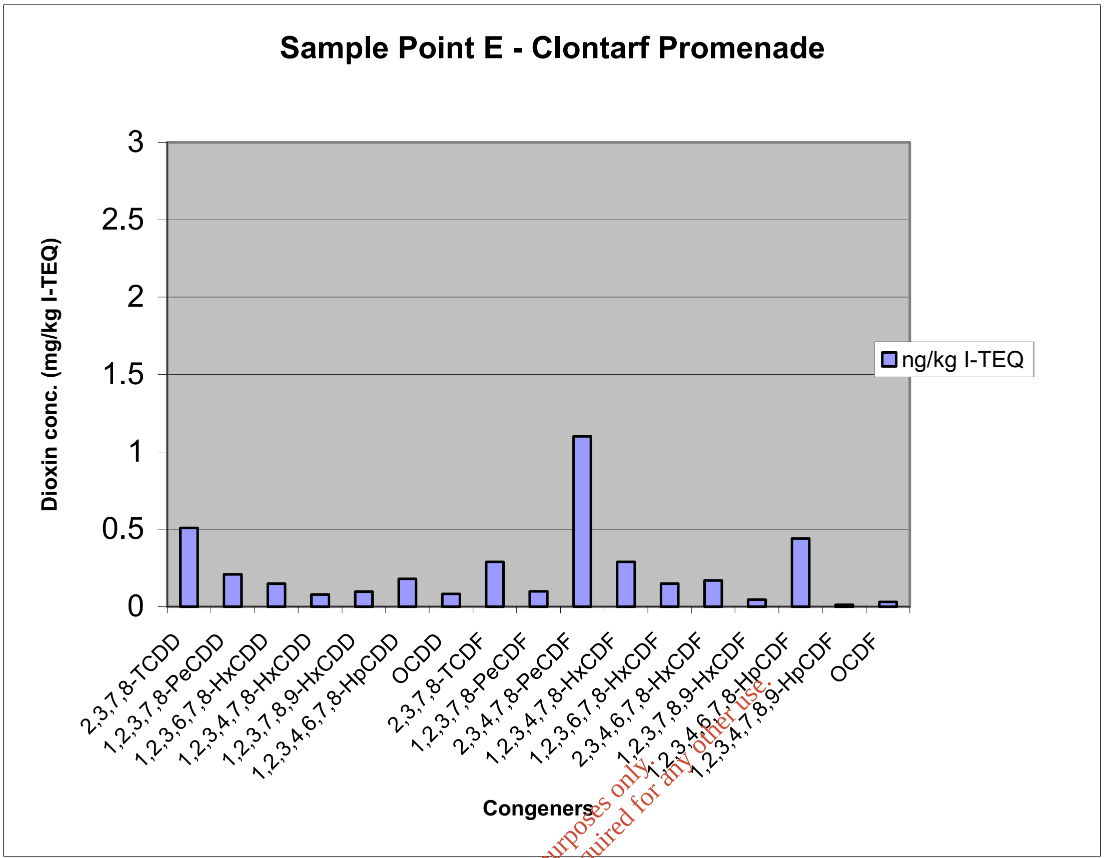

Sample Point B - Irishtown Nature Park
Dioxin conc (ng/kg I-TEQ)
3
2.5
2
1.5
1
0.5
0
ng/kg I-TEQ
2,3,7,8-TCDD
1,2,3,7,8-PeCDD
1,2,3,6,7,8-HxCDD
1,2,3,4,7,8-HxCDD
1,2,3,7,8,9-HxCDD
1,2,3,4,6,7,8-HpCDD
OCDD
2,3,7,8-TCDF
1,2,3,7,8-PeCDF
2,3,4,7,8-PeCDF
1,2,3,4,7,8-HxCDF
1,2,3,6,7,8-HxCDF
2,3,4,6,7,8-HxCDF
1,2,3,7,8,9-HxCDF
1,2,3,4,6,7,8-HpCDF
1,2,3,4,7,8,9-HpCDF
OCDF
Congeners

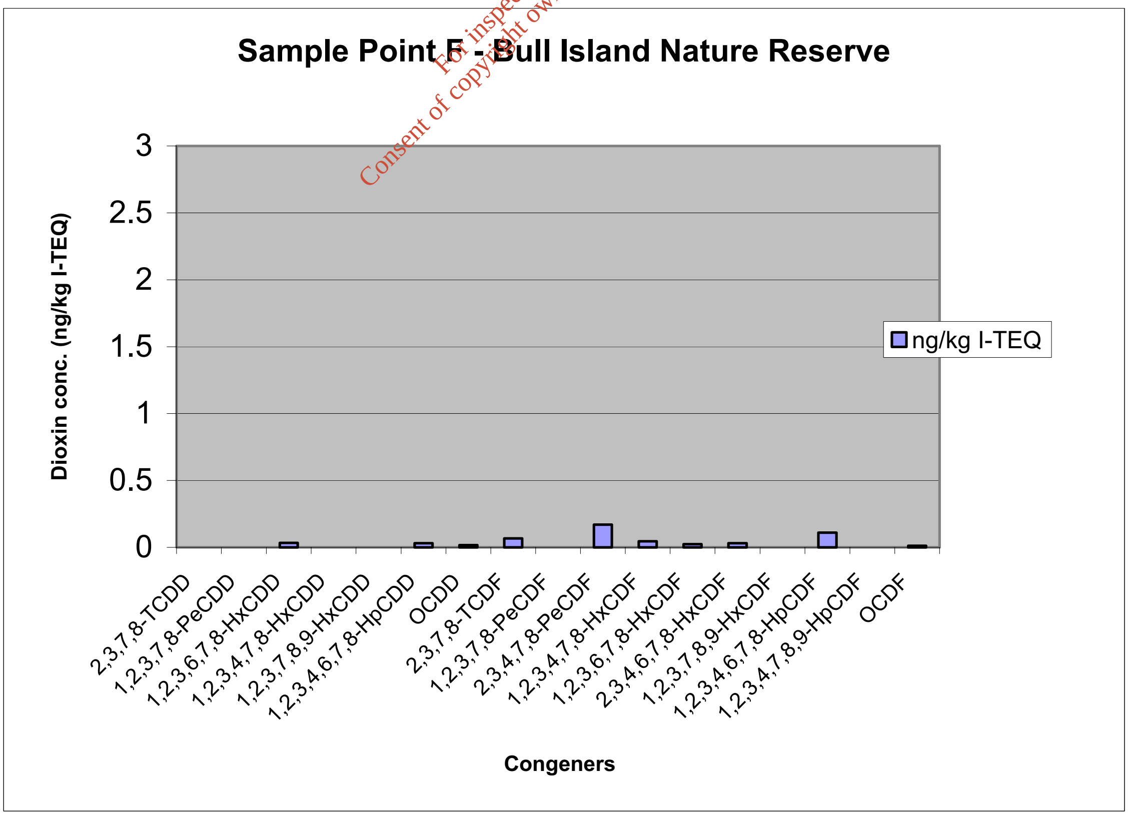


Sample Point C - Ringsend Park
Dioxins conc. (ng/kg I-TEQ)
3
2.5
2
1.5
1
0.5
0
ng/kg I-TEQ
2,3,7,8-TCDD
1,2,3,7,8-PeCDD
1,2,3,6,7,8-HxCDD
1,2,3,4,7,8-HxCDD
1,2,3,7,8,9-HxCDD
1,2,3,4,6,7,8-HpCDD
OCDD
2,3,7,8-TCDF
1,2,3,7,8-PeCDF
2,3,4,7,8-PeCDF
1,2,3,4,7,8-HxCDF
1,2,3,6,7,8-HxCDF
2,3,4,6,7,8-HxCDF
1,2,3,7,8,9-HxCDF
1,2,3,4,6,7,8-HpCDF
1,2,3,4,7,8,9-HpCDF
OCDF
Congeners



Sample Point D - Sandymount
Dioxin conc. (ng/kg I-TEQ)
12
10
8
6
4
2
0
ng/kg I-TEQ
2,3,7,8-TCDD
1,2,3,7,8-PeCDD
1,2,3,6,7,8-HxCDD
1,2,3,4,7,8-HxCDD
1,2,3,7,8,9-HxCDD
1,2,3,4,6,7,8-HpCDD
OCDD
2,3,7,8-TCDF
1,2,3,7,8-PeCDF
2,3,4,7,8-PeCDF
1,2,3,4,7,8-HxCDF
1,2,3,6,7,8-HxCDF
2,3,4,6,7,8-HxCDF
1,2,3,7,8,9-HxCDF
1,2,3,4,6,7,8-HpCDF
1,2,3,4,7,8,9-HpCDF
OCDF
Congeners


Sample Point E - Clontarf Promenade
Dioxin conc. (mg/kg I-TEQ)
3
2.5
2
1.5
1
0.5
0
ng/kg I-TEQ
2,3,7,8-TCDD
1,2,3,7,8-PeCDD
1,2,3,6,7,8-HxCDD
1,2,3,4,7,8-HxCDD
1,2,3,7,8,9-HxCDD
1,2,3,4,6,7,8-HpCDD
OCDD
2,3,7,8-TCDF
1,2,3,7,8-PeCDF
2,3,4,7,8-PeCDF
1,2,3,4,7,8-HxCDF
1,2,3,6,7,8-HxCDF
2,3,4,6,7,8-HxCDF
1,2,3,7,8,9-HxCDF
1,2,3,4,6,7,8-HpCDF
1,2,3,4,7,8,9-HpCDF
OCDF
Congeners


Sample Point F - Bull Island Nature Reserve
Dioxin conc. (ng/kg I-TEQ)
3
2.5
2
1.5
1
0.5
0
ng/kg I-TEQ
2,3,7,8-TCDD
1,2,3,7,8-PeCDD
1,2,3,6,7,8-HxCDD
1,2,3,4,7,8-HxCDD
1,2,3,7,8,9-HxCDD
1,2,3,4,6,7,8-HpCDD
OCDD
2,3,7,8-TCDF
1,2,3,7,8-PeCDF
2,3,4,7,8-PeCDF
1,2,3,4,7,8-HxCDF
1,2,3,6,7,8-HxCDF
2,3,4,6,7,8-HxCDF
1,2,3,7,8,9-HxCDF
1,2,3,4,6,7,8-HpCDF
1,2,3,4,7,8,9-HpCDF
OCDF
Congeners

Risk Assessment

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TECHNICAL REPORT

MODELLING OF BACKGROUND PCDD/F, PCDD/F-LIKE PCB AND MERCURY INTAKE AND PREDICTED IMPACT OF EMISSIONS FROM PROPOSED POOLBEG WASTE TO ENERGY PLANT ON PCDD/F, PCDD/F-LIKE PCB AND MERCURY INTAKE

FOR

RPS MCOS
Dun Laoghaire
Co. Dublin

Report prepared by: **Dr Fergal Callaghan**
Our reference: FC/03/2008SR02
Date: 1 September 2004

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AWN Consulting Limited Registered in Ireland. No. 319812 Registered Office: Evergreen House, Congress Road, Cork
Directors: F. Callaghan, C. Dilworth, T. Donnelly, E. Porter.

EXECUTIVE SUMMARY

Soil sampling and ambient air monitoring data, and published data for Irish food, was used to establish a baseline for PCDD/F(including PCDD/F-like PCB) and mercury intake for a theoretical Maximum At Risk Individual (MARI) in the Poolbeg area. The MARI was assumed to live at the point of maximum PCDD/F, PCDD/F-like PCB and mercury deposition from the proposed development and to be a subsistence farmer who obtained their vegetables from a 100m diameter site, upon which the maximum deposition flux impacted. It was also assumed that the MARI spent 24 hours per day, 7 days per week on the site, and spent 16 hours per day outside.

The baseline PCDD/F, PCDD/F-like PCB and mercury intake for the MARI was modelled following US EPA Methodology and using the Dutch Government Approved Model RISC Human 3.1. The baseline PCDD/F, PCDD/F-like PCB and mercury intake was predicted to be significantly below EU PCDD/F, PCDD/F-like PCB and mercury intake criteria.

The PCDD/F and mercury emissions under maximum operating conditions (assuming the WTE facility operated continuously at the process emission limits set by the Incineration Directive 2000/67/EC) were then used to model the increase in soil concentrations of PCDD/F and mercury over the operating life of the facility.

The modelled soil and air values were then added to the existing background values for PCDD/F, mercury and PCDD/F-like PCB and input to the RISC HUMAN Model.

The model predicted that the PCDD/F and PCDD/F like PCB and mercury intake for the MARI, even with the WTE operating at maximum licensed emission rates, was very low and was still significantly less than recommended Guideline values for PCDD/F and mercury intake.

It can therefore be concluded that the proposed WTE facility will have no significant impact on PCDD/F, PCDD/F-like PCB and mercury intake for even the theoretical MARI.

CONTENTS

1.0 INTRODUCTION

AWN Consulting was instructed by RPS-MCOS on behalf of Dublin City Council to undertake a mathematical modelling study to assess the potential impact of PCDD/F, PCDD/F-like PCB and mercury emissions from the proposed waste to energy (WTE) facility at Poolbeg.

2.0 MODELLING PHILOSOPHY

It was proposed to model the impact of the emissions following the methodology set out by the US EPA for hazardous waste facilities [1].

The modelling philosophy was as follows:

Develop a (Conceptual Site Model) CSM to assess the potential dietary intake of PCDD/F, PCDD/F-like PCB and mercury for the theoretical Maximum at Risk Individual (MARI);

Select most appropriate background soil PCDD/F, PCDD/F-like PCB and mercury concentration;

Model PCDD/F, PCDD/F-like PCB and mercury intake using background concentrations in soil;

Obtain data on deposition rates for PCDD/F and mercury from proposed WTE facility;

Model impact of deposition rates on soil concentrations of PCDD/F and mercury over 30 year operating life of facility;

Model increase in ambient air concentrations;

Model impact of WTE facility related PCDD/F and mercury deposition rates and increased ambient air concentrations on dietary intake of PCDD/F and mercury, for the MARI.

3.0 CONCEPTUAL SITE MODEL AND MAXIMUM AT RISK INDIVIDUAL

3.1 Conceptual Site Model

The Conceptual Site Model (CSM) was developed as follows, using the methodology presented in the relevant US EPA Modelling Guidance [1].

Background concentrations of PCDD/F are transferred to a human receptor by the following pathways;

- Inhalation indoor air
- Inhalation outdoor air
- Ingestion of soil
- Dermal contact with soil
- Inhalation of soil dust
- Ingestion of drinking water
- Dermal contact with shower water
- Inhalation of water vapour in the shower
- Ingestion of meat (this pathway was eliminated as the area of land in question is not agricultural and PCDD/F exposure from known levels in Irish produce was used to model this component of PCDD/F intake)
- Ingestion of milk (this pathway was eliminated as the area of land in question is not agricultural and PCDD/F exposure from known levels in Irish produce was used to model this component of PCDD/F intake)
- Ingestion of vegetables
- Ingestion of surface water

- Ingestion of suspended matter in water
- Dermal contact with surface water

The CSM assumes all PCDD/F and mercury is deposited on the ground and is available for uptake, apart from the fractions which are removed through volatilisation, surface water run off, erosion and degradation. These elements are calculated for each of the 17 PCDD/F congeners and for mercury.

The CSM then assumes the remainder of the PCDD/F deposited is available for uptake through the pathways listed above.

The group of 17 PCDD/F congeners vary widely in molecular weight and chemical characteristics and behave quite differently with respect to the fraction which absorbs to soil, dissolves in water, is present in the vapour phase or accumulates in meat or milk. It is therefore not valid to model the PCDD/F concentrations as a total I-TEQ as 2,3,7,8 PCDD/F value or to only model the chemical characteristics of PCDD/F intake as 2,3,7,8 PCDD/F and each congener must therefore be modelled separately.

3.2 Maximum At Risk Individual (MARI)

In order to conduct a conservative assessment of potential impact of PCDD/F emissions on a theoretical individual, the following assumptions were made for the MARI (these assumptions are based on the MARI as used by the US EPA for hazardous waste facility assessment) [1].

- The MARI lives at the point where the highest deposition rate, for emissions from the proposed WTE facility occurs.
- The MARI is a subsistence farmer, who spends 16 hours per day, 7 days per week, 50 weeks per year outside in the field where the deposition occurs;
- The MARI spends 6 years as a child and 60 years as an adult living on the site;
- The MARI only eats vegetables grown on this soil (milk and meat are obtained off site as the environment in question is an urban environment and cattle raising is not practised in this area);

4.0 SOIL BACKGROUND CONCENTRATIONS

AWN Consulting Ltd carried out a programme of background soil sampling and monitoring (ref FC/03/2008SR01).

The results of this survey and the location of the monitoring points are summarised in Tables 4.1 - 4.4.

AWN Sampling Point	Sampling Point Location	Position	Sampling Date
A	Sean Moore Park	53^0 20.169' N 006^0 12.923' W	5th November 2003
B	Irishtown Nature Park	53^0 20.161' N 006^0 11.757' W	6th November 2003
C	Ringsend Park	53^0 20.520' N 006^0 13.258' W	3rd November 2003
D	Sandymount (grassed area along the sea front)	53^0 19.584' N 006^0 12.456' W	7th November 2003
E	Clontarf (grassed area along the sea front)	53^0 21.476' N 006^0 11.605' W	29th October 2003
F	Bull Island Nature Reserve	53^0 21.962' N 006^0 09.223' W	31st October 2003

Table 4.1 Location of AWN Sampling Points

Sampling Point	Sampling Point Location
A	SW of site, peak area from dispersion model
B	Adjacent and to the SW of site, peak area from dispersion model
C	West of site, closest residential community
D	SW of site, residential community (downwind of NE winds)
E	North of site, residential community
F	NE of site (downwind of SW winds)

Table 4.2 Rationale for choosing AWN sampling locations

Sample	Site Location	PCDD/F (ng/kg) [1]	Mercury (mg/kg)
A	Sean Moore Park	10	<1
B	Irishtown Nature Park	5.7	<1
C	Ringsend Park	3.2	2
D	Sandymount Promenade	23	<1
E	Clontarf Promenade	3.9	<1
F	Bull Island Nature Reserve	0.54	<1

Table 4.3 Analysis results

1 NATO/CCMS I TEQ (Toxic Equivalent) (2,3,7,8 – tetrachloro dibenzo-p-dioxin)

Sample	Site Location	PCB Sum 8 Mono – Ortho µg/kg	PCB Sum 4 Non-Ortho µg/kg
A	Sean Moore Park	7.45	0.14
B	Irishtown Nature Park	0.56	0.07
C	Ringsend Park	0.55	<0.05
D	Sandymount Promenade	0.72	<0.05
E	Clontarf Promenade	0.86	<0.05
F	Bull Island Nature Reserve	0.09	<0.05

Table 4.4 Analysis results (LOD = 0)

4 non-ortho (PCB 77, 81, 126 and 169),

8 mono-ortho (PCB 105, 114,118, 123, 156, 157, 167 and 189)

The highest PCDD/F value recorded (NATO CCMS TEQ OF 23 ng/kg)was for the sample from the road side location at Sandymount, Sample D from the soil monitoring report. However, this is a road side location and is subject to localised PCDD/F emission sources such as traffic fumes and hence would not be a realistic background soil concentration for the MARI.

The next highest PCDD/F value, recorded for Sean Moore Park, which was also at the point of maximum ground level concentration as predicted using the US EPA approved ISC modelling software package (see Appendix 1). While this source may be influenced by localised emission sources such as bonfires, it is not close to significant traffic emissions and therefore is not likely to be significantly affected by the PCDD/F component of such emissions, unlike the Sandymouont sample.

The associated PCDD/F-like PCB value for this sample was 7.45 µg/kg (mono ortho) and 0.14 µg/kg non ortho, which is very high when compared with concentrations recorded for the other 5 samples, this elevated concentration may have been due to localised emission sources such as herbicide or pesticide application. The other 5 samples had PCB concentrations ranging from 0.56 – 0.86 µg/kg and <0.05 – 0.07 µg/kg (mono ortho and non ortho respectively), indicating that this is the likely background for the area sampled.

It is therefore proposed to use the 0.86 µg/kg value for PCDD/F like PCB to represent the likely contrubution of this element to the background PCDD/F exposure of the MARI.

The calculated WHO TEQ (Toxic Equivalent as 2,3,7,8 – tetrachloro dibenzo-p-dioxin) for this PCB concentration is 2.91 ng/kg, the calculation to derive this value is presented in Table 4.5. It should be noted that this is still quite a conservative assumption of PCDD/F contribution from PCB as most of the contribution is from Congener 126, the concentration of which was below the limit of detection of the analysis method and this congener only features as a measured value because the assumption has been made that the concentration is equal to half the limit of detection of the analysis suite.

It was therefore decided that the soil concentration for the background on the site inhabited by the MARI would consist of a PCDD/F contribution of 9.5 ng/kg WHO TEQ and a dioxin like PCB concentration of 2.91 ng/kg WHO TEQ. The ambient air concentrations used were those measured in Winter 2004 (see Appendix 1), which are considerably higher than those measured in Summer 2003 and hence it was felt that the use of these figures was suitably conservative.

8 mono-ortho	TEF	E	D (Conc. = 1/2 LOD)	WHO TEQ
PCBs	**WHO**	**ug/kg**	**ug/kg**	**ug/kg**
105	0.0001	0.27	0.27	0.000027
114	0.0005	<0.05	0.025	0.000025
118	0.0001	0.51	0.51	0.000051
123	0.0001	<0.05	0.025	0.0000025
156	0.0005	0.08	0.04	0.00004
157	0.0005	<0.05	0.025	0.0000125
167	0.00001	<0.05	0.025	2.5E-07
189	0.0001	<0.05	0.025	0.0000025
Sum		**0.86**	**0.945**	**0.0001608**
4 non-ortho				
81	0.0001	<0.05	0.025	0.0000025
77	0.0001	<0.05	0.025	0.0000025
126	0.1	<0.05	0.025	0.0025
169	0.01	<0.05	0.025	0.00025
Sum		**0**	**0.1**	**0.002755**
TEQ (ng/kg)				**2.91**

Table 4.5 Calculation of TEQ value for PCB Value Recorded for Sample A

5.0 BASELINE MODELLING OF INTAKE OF PCDD/F AND MERCURY

5.1 Model Selection and Set up

The RISC Human Model Version 3.1 package was chosen to model intake of PCDD/F. The model was developed by the Dutch National Institute of Public Health and Environmental Protection (RIVM)., on behalf of the Dutch Ministry for Spatial Planning, Housing and the Environment and has been used to model the Dutch Soil standards for protection of human health [2].

The model consists of series of equations which allow each of the pathways listed in Section 3.1 to be modelled mathematically. The principal model variables used to calculate total exposure are presented as Attachment A.

The equations used to calculate each variable are presented in Attachment B.

The values selected for the model variables and the justification for selecting these values is presented as Attachment C.

The model data base contains many of the necessary chemical parameters such as the octanol-water coefficient, Henry's coefficient and the water solubility, which are necessary to model the behaviour of substances in soil and water environments. Where these parameters were not available from the model database, The Handbook of Physical Chemistry [3] and Appendices A – J of the US EPA Human Health and Ecological Risk Assessment Report [1] were used.

5.2 Model Results

The Model Output Report, for each of the 17 PCDD/F congeners (including the contribution from PCDD/F like PCBs) and for mercury, for each intake pathway is presented as Attachment D. The modelled WHO TEQ intake value for the MARI, in pg/kg body weight/day, is presented in Table 5.1.

The model predicted a baseline PCDD/F intake of 0.072898 pg/kg body weight/week (0.0104014 pg/kg body weight/day), using the WHO TEF values. This is considerably less than the EC t-TWI (tolerable Total Weekly Intake) of 7 pg WHO-TEQ/kg body weight (from Opinion of the Scientific Committee on the Risk Assessment of Dioxins and Dioxin-like PCBs in Food 22/11/2000 (SCF/CS/CNTMDIOXIN/ 8 Final))

PCDD Congeners	mg/kg/d	WHO	mg/kg/d	pg/kg/d
	PCDD/F	TEQ	WHO TEQ	WHO TEQ
2,3,7,8-TCDD	4.90E-09	1	4.90E-09	4.90E-03
1,2,3,7,8-PeCDD	3.45E-09	1	3.45E-09	3.45E-03
1,2,3,4,7,8-HxCDD	1.51E-09	0.1	1.51E-10	1.51E-04
1,2,3,6,7,8-HxCDD	3.29E-09	0.1	3.29E-10	3.29E-04
1,2,3,7,8,9-HxCDD	5.74E-09	0.1	5.74E-10	5.74E-04
1,2,3,4,6,7,8-HpCDD	3.45E-08	0.01	3.45E-10	3.45E-04
OCDD	6.43E-10	0.0001	6.43E-14	6.43E-08
PCDF Congeners				
2,3,7,8-TCDF	3.70E-10	0.1	3.70E-11	3.70E-05
1,2,3,7,8-PeCDF	2.39E-10	0.05	1.20E-11	1.20E-05
2,3,4,7,8-PeCDF	4.64E-10	0.5	2.32E-10	2.32E-04
1,2,3,4,7,8-HxCDF	1.50E-09	0.1	1.50E-10	1.50E-04
1,2,3,6,7,8-HxCDF	7.87E-10	0.1	7.87E-11	7.87E-05
1,2,3,7,8,9-HxCDF	3.20E-10	0.1	3.20E-11	3.20E-05
2,3,4,6,7,8-HxCDF	3.64E-10	0.1	3.64E-11	3.64E-05
1,2,3,4,6,7,8-HpCDF	6.55E-09	0.01	6.55E-11	6.55E-05
1,2,3,4,7,8,9-HpCDF	2.50E-11	0.01	2.50E-13	2.50E-07
OCDF	8.50E-08	0.0001	8.50E-12	8.50E-06
			1.04E-08	**1.04014E-02**

Table 5.1 Modelled baseline PCDD/F intake for MARI – using WHO TEF

The model output data shows that, even with all of the conservative assumptions employed in constructing the model, the predicted baseline PCDD/F dose to the MARI is extremely low.

The model also predicted that the mercury dose for the MARI would be 0.0609 µg/kg body weight/day, compared with an acceptable dose of 0.61 µg/kg body weight/day.

However, in order to determine a PCDD/F total contribution for the MARI, it is necessary to include the meat and milk PCDD/F exposure, based on milk and milk products sourced in the Dublin area and meat sourced in Ireland. The input values for this calculation (for meat and milk) are given in Attachment C. The calculation procedure and calculated values are shown in Table 5.2.

ADULT		PCDD/F	PCDD/F	PCDD/F	Adult	PCDD/F
	kg/day	ng/kg	ng/day	pg/day	Body Wt	pg/kg/day
Meat	0.258	0.062	0.015996	15.996	60	0.2666
Milk	0.425	0.06	0.0255	25.5	60	0.425
Sum						**0.692**

Table 5.2 Calculated PCDD/F from Meat and Milk Intake

Combining the predicted PCDD/F intake values from Table 5.1, with those from Table 5.2, gives a total predicted intake of ((.0104014 x 7) + (0.692 x 7)) = 4.9168098 pg/kg body weight/week (0.7024014 pg/kg body weight/day), which is well below the EC t-TWI of 7 pg/kg body weight/week . It will also be seen that 98.5% of PCDD/F exposure is predicted to be from milk and meat products sourced outside the zone inhabited by the MARI.

The calculated mercury dose, for meat and milk sourced outside the subject site, but within Ireland, is shown in Table 5.3. The calculated dose is well below the relevant limit value (in fact less than 10% of the limit value), even though the calculation was run using mercury concentrations which were derived by assuming that the meat and milk in question had mercury concentrations equal to half the limit of detection.

		Hg	**Hg**	**Hg**	**Adult**	**Hg**
	kg/day	**mg/kg**	**mg/day**	**ug/day**	**Body Wt**	**ug/kg/day**
Meat	0.258	0.005	0.00129	1.29	60	0.0215
Milk	0.425	0.005	0.002125	2.125	60	0.035417
Sum						**0.057**

Table 5.3 Calculated mercury intake from Meat and Milk Intake

6.0 MAXIMUM DEPOSITION RATE OF PCDD/F FROM WTE EMISSIONS AND CALCULATION OF PREDICTED SOIL AND AIR CONCENTRATIONS

Air emissions from the proposed WTE facility were modelled by AWN Consulting (See Appendix 1), using a 40m stack height and a waste capacity of 400,000 tonnes/annum. Emissions were modelled using the ISCST3 dispersion model which is the USEPA's regulatory model used to assess pollutant concentrations associated with industrial sources. Emissions were assessed assuming the unrealistically worst case scenario that the plant operated continuously under the maximum emission limits of EU Directive 2000/76/EC.

The process characteristics were as follows:

Stack Reference	Stack Height (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temp (K)	Volume Flow (Nm^3/hr)	Exit Velocity (m/sec actual)
Stack	40	3.0	7.07	373	275,000	14.5

Table 6.1 Process Characteristics

The annual deposition rate under maximum operating conditions for each of the 17 PCDD/F congeners and for mercury is shown in Table 6.2.

Congener	Total flux
	g/m2/yr
2,3,7,8-TCDD	3.84E-11
1,2,3,7,8-PeCDD	1.80E-10
1,2,3,6,7,8-HxCDD	1.32E-10
1,2,3,4,7,8-HcCDD	6.53E-11
1,2,3,7,8,9-HxCDD	1.58E-10
1,2,3,4,6,7,8-HpCDD	1.16E-10
OCDD	1.80E-11
2,3,7,8-TCDF	1.31E-10
1,2,3,7,8-PeCDF	1.60E-11
2,3,4,7,8-PeCDF	4.37E-10
1,2,3,4,7,8-HxCDF	2.68E-10
1,2,3,6,7,8 HxCDF	8.90E-11
2,3,4,6,7,8-HpCDF	2.98E-10
1,2,3,7,8,9-HxCDF	1.80E-11
1,2,3,4,6,7,8-HpCDF	4.90E-11
1,2,3,4,7,8,9-HpCDF	1.50E-11
OCDF	7.00E-12
Mercury	1.7E-3

Table 6.2 Predicted annual average mercury and PCDD/F flux at WTE facility (facility assumed to be operating continuously at maximum operating conditions)

Congener Group	Modelled	Background	Background +
	ug/m3	ug/m3	modelled ug/m3
2,3,7,8-TCDD	2.315E-10	1.6923E-09	1.92E-09
1,2,3,7,8-PeCDD	8.975E-10	6.7691E-09	7.67E-09
1,2,3,4,7,8-HxCDD	3.075E-10	3.15892E-08	3.19E-08
1,2,3,6,7,8-HxCDD	6.2E-10	6.205E-09	6.83E-09
1,2,3,7,8,9-HxCDD	7.471E-10	2.87687E-08	2.95E-08
1,2,3,4,6,7,8-HpCDD	5.441E-10	2.4256E-07	2.43E-07
OCDD	8.304E-11	3.94865E-07	3.95E-07
2,3,7,8-TCDF	8.205E-10	2.482E-08	2.56E-08
1,2,3,7,8-PeCDF	8.19E-11	2.53841E-08	2.55E-08
2,3,4,7,8-PeCDF	2.153E-09	2.14355E-07	2.17E-07
1,2,3,4,7,8-HxCDF	1.2763E-09	8.46138E-08	8.59E-08
1,2,3,6,7,8-HxCDF	4.227E-10	7.3332E-08	7.38E-08
1,2,3,7,8,9-HxCDF	8.49E-11	1.01537E-07	1.02E-07
2,3,4,6,7,8-HxCDF	1.4108E-09	3.27173E-08	3.41E-08
1,2,3,4,6,7,8-HpCDF	2.312E-10	4.34351E-07	4.35E-07
1,2,3,4,7,8,9-HpCDF	7.02E-11	5.35888E-08	5.37E-08
OCDF	3.102E-11	2.4256E-07	2.43E-07

Table 6.3 Predicted airborne concentrations of PCDD/F (including background) – annual average under maximum operating conditions (and using winter 2004 measured background concentrations)

The deposition flux data from Table 6.2 was used to predict the average soil concentration over the exposure duration period, by applying the model used by the US EPA for Assessment of Hazardous Waste Facilities [1].

The model enables increases in soil concentrations due to aerial deposition of PCDD/F and mercury to be calculated, over a set time period and includes for natural processes such as volatilisation and sediment removal by surface water run-off, which reduce PCDD/F and mercury concentrations in soil.

The model equation to predict the increase in soil concentration of PCDD/F, resulting from aerial deposition is:

$$Sc_1 = \frac{Ds}{ks\ (Tc - T_1)} \left[\left(Tc + \frac{\exp(-ks\ Tc)}{ks} \right) - \left(T_1 + \frac{\exp(-ks\ T_1)}{ks} \right) \right] for\ 0 < T_1 < Tc$$

Equation terms are defined in Attachment E.

Ks, the soil loss constant due to all processes, is calculated using the following equation;

$$ks = ksl + kse + ksr + ksg + ksv$$

Equation terms and the equations used to calculate each of the "Ks" terms, are defined in Attachment F and definitions of terms used in equations to calculate KS are given in Attachment G.

Ds, the PCDD/F deposition term, expressed in terms of mg/kg/yr, is calculated as per Attachment H.

A radius of 50m was used to calculate the Ds values used in the modelling study. This assumes that the deposition occurs over a 100m diameter area, inside which the MARI spends all their time.

Tc, the time period over which the emissions occur, has been set at 30 years, as it has been assumed that the facility will have a 30 year operational lifetime.

T_1 = Tc – ED (where ED is the exposure duration).

The calculation of predicted soil concentration over the exposure period is presented as Attachment I.

7.0 MODELLING OF IMPACT OF WTE EMISSIONS ON PCDD/F INTAKE

The predicted ambient air concentrations and predicted soil concentrations were used to model the impact of WTE Emissions on PCDD/F and mercury intake for the MARI.

The predicted increase in soil and air concentrations is given in Table 7.1.

	Background	Sc	Sc	Background + Sc	Background + Sc	PreductedAir conc
	ng/kg	mg/kg	ng/kg	ng/kg	mg/kg	ug/m3
2,3,7,8-TCDD	3.6	9.342E-11	9.342E-05	3.600093423	3.60E-06	1.924E-09
1,2,3,7,8-PeCDD	0.98	2.623E-09	0.0026225	0.982622526	9.83E-07	7.667E-09
1,2,3,6,7,8-HxCDD	4.2	7.437E-12	7.437E-06	4.200007437	4.20E-06	3.19E-08
1,2,3,4,7,8-HcCDD	1.1	4.584E-09	0.0045836	1.104583569	1.10E-06	6.825E-09
1,2,3,7,8,9-HxCDD	2.4	2.148E-09	0.0021478	2.402147776	2.40E-06	2.952E-08
1,2,3,4,6,7,8-HpCDD	88	6.25E-11	6.25E-05	88.0000625	8.80E-05	2.431E-07
OCDD	930	2.512E-08	0.0251155	930.0251155	9.30E-04	3.949E-07
2,3,7,8-TCDF	7.5	4.681E-10	0.0004681	7.500468069	7.50E-06	2.564E-08
1,2,3,7,8-PeCDF	5	5.717E-11	5.717E-05	5.000057169	5.00E-06	2.547E-08
2,3,4,7,8-PeCDF	5.4	3.808E-09	0.0038083	5.403808282	5.40E-06	2.165E-07
1,2,3,4,7,8-HxCDF	8.7	3.135E-09	0.0031347	8.703134736	8.70E-06	8.589E-08
1,2,3,6,7,8 HxCDF	4.5	1.053E-09	0.001053	4.501053005	4.50E-06	7.375E-08
2,3,4,6,7,8-HpCDF	3.2	8.092E-09	0.0080918	3.208091805	3.21E-06	1.016E-07
1,2,3,7,8,9-HxCDF	1.7	2.982E-10	0.0002982	1.700298171	1.70E-06	3.413E-08
1,2,3,4,6,7,8-HpCDF	58	8.117E-10	0.0008117	58.00081169	5.80E-05	4.346E-07
1,2,3,4,7,8,9-HpCDF	3.9	1.856E-10	0.0001856	3.90018557	3.90E-06	5.366E-08
OCDF	87	8.66E-11	8.66E-05	87.0000866	8.70E-05	2.426E-07
Mercury (mg/kg)	1	9.46E-08	0.0945809		1.000000095	6.00E-03

Table 7.1 Predicted increase in soil concentrations over the lifetime of the facility and predicted increase in ambient air concentrations (facility assumed to be operating at maximum licensed emission rates over 30 year period)

The modelling methodology was as for the baseline intake modelling.

The Model output, for each of the 17 PCDD/F congeners and for mercury for each intake pathway is presented as Attachment J. The modelled PCDD/F WHO TEQ intake value for the impact of WTE Emissions on PCDD/F intake for the MARI, in pg/kg body weight/day, is presented in Table 7.2.

	mg/kg/d	WHO	mg/kg/d	pg/kg/d
PCDD Congeners	**PCDD/F**	**TEQ**	**WHO TEQ**	**WHO TEQ**
2,3,7,8-TCDD	4.90E-09	1	4.90E-09	4.90000E-03
1,2,3,7,8-PeCDD	3.46E-09	1	3.46E-09	3.46000E-03
1,2,3,4,7,8-HxCDD	1.52E-09	0.1	1.52E-10	1.52000E-04
1,2,3,7,8,9-HxCDD	3.29E-09	0.1	3.29E-10	3.29000E-04
1,2,3,6,7,8-HxCDD	5.74E-09	0.1	5.74E-10	5.74000E-04
1,2,3,4,6,7,8-HpCDD	3.45E-08	0.01	3.45E-10	3.45000E-04
OCDD	6.43E-10	0.0001	6.43E-14	6.43000E-08
PCDF Congeners				
2,3,7,8-TCDF	2.39E-10	0.1	2.39E-11	2.39000E-05
1,2,3,7,8-PeCDF	3.70E-10	0.05	1.85E-11	1.85000E-05
2,3,4,7,8-PeCDF	4.65E-10	0.5	2.33E-10	2.32500E-04
1,2,3,4,7,8-HxCDF	1.50E-09	0.1	1.50E-10	1.50000E-04
1,2,3,6,7,8-HxCDF	7.88E-10	0.1	7.88E-11	7.88000E-05
1,2,3,7,8,9-HxCDF	3.23E-10	0.1	3.23E-11	3.23000E-05
2,3,4,6,7,8-HxCDF	3.66E-10	0.1	3.66E-11	3.66000E-05
1,2,3,4,6,7,8-HpCDF	6.55E-09	0.01	6.55E-11	6.55000E-05
1,2,3,4,7,8,9-HpCDF	2.52E-11	0.01	2.52E-13	2.52000E-07
OCDF	8.51E-08	0.0001	8.51E-12	8.51000E-06
Sum				1.04069E-02

Table 7.2 Modelled WTE + baseline PCDD/F intake for MARI

It can be seen that the predicted PCDD/F intake increase is 0.053% of the baseline intake value of 1.04014E-02 pg/kg body weight/day.

Combining the predicted PCDD/F intake values from Table 5.2, gives a total predicted intake of (0.692 x 7) + (0.0104069 x 7) = 4.9168483 pg/kg body weight/week (0.7024069 pg/kg body weight/day), which is well below the EC t-TWI of 7 pg/kg body weight. This predicted increase in PCDD/F intake to 4.9168483 can be classed as insignificant when compared with the calculated baseline value 4.9168098 pg/kg body weight/week (0.7024014 pg/kg body weight/day).

It will also be seen that it is still the case that 98.5% of PCDD/F exposure is predicted to be from milk and meat products, which are sourced external to the MARI theoretical site. The emissions from the proposed WTE facility are therefore predicted to have an insignificant impact on PCDD/F intake and the modelling scenario shows that the most significant portion of PCDD/F exposure for the MARI, is from off-site sources.

The model also predicted that the mercury dose for the MARI would be at 0.0626µg/kg body weight/day, an increase of 2.7% over the baseline value. This predicted figure is still well below the acceptable dose of 0.61 µg/kg body weight/day.

8.0 CONCLUSIONS

It was concluded that the predicted impact of the emissions from the WTE facility, on the MARI, is not significant.

The predicted PCDD/F intake for the MARI was modelled to be well below the EC t-TWI of 7 pg/kg body weight. The predicted mercury intake for the MARI was also determined to be well below the recommended intake criteria.

9.0 REFERENCES

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APPENDIX 1

PRELIMINARY AIR DISPERSION MODELLING FOR DUBLIN WASTE TO ENERGY SCHEME

1.0 PRELIMINARY MODELLING FOR DUBLIN WASTE TO ENERGY SCHEME

1.1 Modelling Methodology

Preliminary modelling of emissions from the Dublin Waste to Energy Facility was carried out using the ISCST3 dispersion model, which has been developed by the U.S. Environmental Protection Agency (USEPA)[(1)]. The model is a steady-state Gaussian plume model used to assess pollutant concentrations associated with industrial sources. The model has been designated the regulatory model by the USEPA for modelling emissions from industrial sources in both flat and rolling terrain[(2)]. The Model is a steady state bi-Gaussian plume model used to assess pollutant concentrations from a wide variety of sources.

The ISCST3 model, in common with most dispersion models, deals separately with plume rise and diffusion. The treatment of diffusion is based on the Pasquill-Gifford system (updated by Turner) in which meteorological conditions are classified into a set of stability categories, defined by solar radiation, cloud cover and wind speed, with values of plume spread given for each category. The plume spread is based on a Gaussian distribution in both the horizontal and vertical.

Plume Rise and Behaviour

The core of the plume rise equations use algorithms developed by Briggs (1969, 1971 and 1975). The height of the final plume rise is dependant on the prevailing wind speed, atmospheric stability and momentum and buoyancy associated with the plume. The plume is also influenced by stack tip and building downwash, the equations of which used in this study have been calculated by Briggs (1974) and Schulman Scrire (1980) and subsequently refined by the USEPA. Downwash is a function of the structure dimensions, wind speed, wind-direction and emission height[(1)].

The plume is assumed to rise initially due to momentum and buoyancy and gradually rise to its maximum height above ground level once the heat and subsequent buoyancy of the plume has equilibrated with the surrounding air. Once the maximum plume height has been reached, the model assumes that the centre of the plume remains at this height while the plume is dispersed both horizontally and vertically.

Gaussian Dispersion

When the height of the plume has stabilised, the dispersion of pollutants is then based on Gaussian dispersion horizontally and vertically from the plume centreline. A number of dispersion coefficients are available to the model. In this study dispersion coefficients corresponding to densely populated areas have been used.

The plume is confined within a body of air defined by the mixing height, the height of which is dependant upon the atmospheric stability and extent of sun-radiation reaching the ground, wind speed and surface roughness. Mixing height measurements by radiosonde are only carried out by Met Eireann in Valentia and therefore the mixing heights used in this study have been inferred for each hour from the fore-mentioned parameters.

Due to the proximity to surrounding buildings, the Building Profile Input Program (BPIP) has been incorporated into the model to determine the influence (wake effects) of these buildings on dispersion in each direction considered.

The ISCST3 model incorporated the following features:

- Two nested receptor grids were identified at which concentrations would be modelled. Receptors were mapped with sufficient resolution to ensure all localised "hot-spots" were identified without adding unduly to processing time. Each grid was based on a Cartesian grid with the site at the centre. The first grid extended to 1500m from the site, with concentrations calculated at 200m intervals and the second grid extended to 10km with concentrations calculated at 1km intervals. In addition, boundary receptor locations were also placed along the boundary of the site, giving a total of 889 calculation points for each model case.

- All on-site buildings and significant process structures were mapped into the computer to create a three dimensional visualisation of the site and its emission points. Buildings and process structures can influence the passage of airflow over the emission stacks and draw plumes down towards the ground (termed building downwash). The stacks themselves can influence airflow in the same way as buildings by causing low pressure regions behind them (termed stack tip downwash). Both building and stack tip downwash were incorporated into the modelling.

- Hourly-sequenced meteorological information has been used in the model. Meteorological data over a five-year period was selected for use in the model.

- Detailed terrain has been mapped into the model. The site is located adjacent to several terrain features which have been mapped into the model out to a radius of 10 km with the site at the centre.

1.2 Meteorological Considerations

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

The selection of the appropriate meteorological data has followed the guidance issued by the USEPA[(2)]. A primary requirement is that the data used should have a data capture of greater than 90% for all parameters. The additional requirements of the selection process depend on the representativeness of the data. The representativeness can be defined as "the extent to which a set of measurements taken in a space-time domain reflects the actual conditions in the same or different space-time domain taken on a scale appropriate for a specific application"[(3)]. Thus, the meteorological data should be representative of conditions affecting the transport and dispersion of pollutants in the area of interest as determined by the location of the sources and receptors being modelled.

The representativeness of the data is dependent on[(2)]:

1) the proximity of the meteorological monitoring site to the area under consideration
2) the complexity of the terrain
3) the exposure of the meteorological monitoring site (surface characteristics around the meteorological site should be similar to the surface characteristics within the modelling domain)
4) the period of time during which data is collected.

The nearest meteorological stations to the site, which record data in the correct format for input into the model, are Casement Aerodrome and Dublin Airport. The surface characteristics around

Dublin Airport are more representative of those in Ringsend, and therefore real meteorological data collected at Dublin Airport from 1998-2002 has been used as input to the model. An on-site meteorological station has been in operation since late 2003 and data from this station will be used in the modelling assessment when a full year of data is available.

1.3 Air Dispersion Modelling

Emissions from the proposed site has been modelled using the ISCST3 dispersion model which is the USEPA's regulatory model used to assess pollutant concentrations associated with industrial sources(1). Emissions were assessed under the maximum emissions limits of the EU Directive 2000/76/EC.

Stack Emissions

The modelling will have one main process emission point which was initially assumed to have a stack height of 40m. The operating details of this emission point has been taken from information supplied by COWI, based on a 400,000 tonnes incinerator and are outlined in Table 1.1.

Table 1.1 Process Emission Design Details

Stack Reference	Stack Height (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temp (K)	Volume Flow (Nm^3/hr)	Exit Velocity (m/sec actual)
Stack	40	3.0	7.07	373	275,000	14.5

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

No detail designs are available for the building layout. The building layout may have a significant influence on dispersion due to building downwash. In the absence of this information, it was assumed that the building layout was similar to a proposed commercial incinerator recently granted planning permission in Carranstown, Co. Meath.

1.4 Modelling Strategy

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

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

Emission Rate

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

Congener-specific emission data are needed for the analyses of the ambient air impacts and deposition flux of dioxin-like compounds using air dispersion and deposition models. As each specific congener has different physico-chemical properties, the proportion of each congener will affect the final result. Thus, the congener profile expected from the current facility must be derived. The congener profile will be dependent on various factors including the type of waste being burnt, the temperature of combustion, the type of combustion chamber being operated and the air pollution control devices (APCDs) installed. In the present case, no site-specific stack testing for specific congeners is possible as the facility is not yet built. Shown in Table 1.4 are typical relative PCDD/PCDF congener emission factors for a municipal waste incinerator similar to that proposed in the current scheme, a mass burn refractometry system with wet scrubbing (MB-REF WS) taken from the Database of Sources of Environmental Releases of Dioxin-Like Compounds in the United States (USEPA, 1998 (CD-ROM))[4]. It would be expected that the relative congener profiles for this type of waste-to-energy plant would be somewhat similar to the current case.

Vapour / Particulate Partitioning

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

In relation to PCDD/PCDFs, V/P partitioning based on stack tests data is highly uncertain[5]. Research has indicated that higher temperatures favour the vaporous states for the lower chlorinated congeners and the particulate state for the higher chlorinated congeners[5]. However, measured data has indicated significant variability in the V/P partitioning. For these reasons, the USEPA has indicated that V/P distributions obtained from stack sampling should not be used.

Data can also be obtained from ambient air sampling using a glass fibre particulate filter and polyurethane foam (PUF) absorbent trap. As the sampler is not subjected to artificial heating or cooling, the method can be used to imply the vapour phase and particle bound partitioning of PCDD/Fs in ambient air. However, the results will be only approximate as mass transfer between the particulate matter on the filter and the vapour trap cannot be ruled out[5].

The recommended USEPA approach to obtaining the vapour/particulate partitioning at the current time is theoretical and based on the Junge-Pankow model for estimating the particle/gas distribution of PCDD/PCDFs[5]. This model is the one most commonly used for estimating the adsorption of semi-volatile compounds to aerosols:

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

where:

Φ = fraction of compound adsorbed to aerosol particles

c = constant (assumed 17.2 Pa-cm)

Θ = particle surface area per unit volume of air, cm^2 aerosol/cm^3 air

ρ^{o}_{L} = saturation liquid phase vapour pressure, Pa

The particulate fraction can also be expressed by:

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

where:

Φ = fraction of compound adsorbed to aerosol particles

C_p = concentration of semivolatile compounds associated with aerosols, ng/μg particles
C_g = gas-phase concentration, ng/m^3
TSP = total suspended particle concentration, μg/m^3

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

As the $\rho^o{}_L$ is referenced to 25ºC and an ambient temperature of 10ºC has been assumed which is appropriate for average annual temperatures in Ireland, the $\rho^o{}_L$ has been converted to the ambient temperature as indicated in Table 1.5. Other relevant data used in the calculations and the derived particle fraction at 10ºC is also shown in Table 1.5.

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

1.5 Modelling of Vapours and Particles Concentrations

PCDD/PCDFs have a range of vapour pressures and thus exist in both vapour and particle-bound states to various degrees. In order to adequately model dispersion and deposition of PCDD/PCDFs, modelling of both vapour and particle-bound states is thus necessary. For the vapour phase modelling, no dry deposition was assumed, as recommended by the USEPA[5,6]. Using the congener profile from Table 1.4 and the vapour – particle partitioning from Table 1.5, the vapour concentrations of the respective dioxin congeners was determined as outlined in Tables 1.6 for a default MWI (MS-Ref WS) profile. Results are shown under maximum operating conditions.

When modelling semi-volatile organics (such as PCDD/PCDFs) and mercury (Hg) the surface area weighting rather than mass weighting is used for deposition. The surface weighting reflects the mode of formation where volatiles condense on the surface of particulates in the post-combustion chamber (see Column 6 of Table 1.6). Thus, the apportionment of emissions by particle size becomes a function of the surface area of the particle which is available for chemical adsorption.

For the particle-phase concentration, the congener profile from Table 1.4 and the vapour – particle partitioning from Table 1.5 were used to give the particulate concentrations of the respective dioxin congeners as determined in Table 1.8. Results are shown under maximum operating conditions.

1.6 Deposition Modelling of Particulates

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

Dry Deposition

Dry deposition of particles refers to the transfer of airborne particles to the surface by means of the forces of gravity and turbulent diffusion followed by diffusion through the laminar sub-layer (thickness of 10^{-1} to 10^{-2} cm) to the surface (collectively know as the deposition flux)[5]. The meteorological factors which most influence deposition include the friction velocity and aerodynamic surface roughness. The ISCST3 model uses an algorithm which relates the deposition flux to functions of particle size, density, surface roughness and friction velocity.

In order to model dry deposition using ISCST3, the particle-size distribution from the stack must be derived. In the absence of a site-specific particle-size distribution, a generalised distribution recommended by the USEPA has been outlined in Table 1.4. This distribution is suitable as a default for some combustion facilities equipped with either electrostatic precipitators (ESPs) or fabric filters (such as the current case), because the distribution is relatively typical of particle size arrays that have been measured at the outlet to advanced equipment designs(6). As described above, the particles are apportioned based on the fraction of available surface area (see Column 6 of Table 1.6).

Dry gaseous deposition, although considered in the ISCST3 model, has not been calibrated for the estimation of the deposition flux of dioxin-like compounds into vegetation and thus the USEPA has recommended that this algorithm should not be used for site-specific applications(5,6).

Wet Deposition

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

Wet deposition flux depends on the fraction of the time precipitation occurs and the fraction of material removed by precipitation per unit of time by particle size. The ISCST3 model uses a scavenging ratio approach which is the product of the scavenging coefficient and precipitation rate. The scavenging coefficient depends on the size distribution for particles and the nature or form of the precipitation, i.e., liquid or frozen(5,6).

Modelling Approach

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

For the particle-phase deposition, the congener profile from Table 1.4 and the vapour – particle partitioning from Table 1.5 were used to give the particulate emission rate of the respective dioxin congeners as determined in Table 1.9. The deposition flux for each congener was calculated by multiplying the emission rate of each congener by the unitised deposition flux as shown in Table 1.9. Results are shown under maximum operating conditions.

1.7 Comparison with Standards And Guidelines

Currently, no internationally recognised ambient air quality concentration or deposition standards exist for PCDD/PCDFs. Both the USEPA and WHO recommended approach to assessing the risk to human health from PCDD/PCDFs entails a detailed risk assessment analysis involving the determination of the impact of PCDD/PCDFs in terms of the TDI (Tolerable Daily Intake) approach(5,7). A TDI has been defined by the WHO as “an estimate of the intake of a substance over a lifetime that is considered to be without appreciable health risk”(7). Occasional short term excursions above the TDI would have no health consequences provided the long-term average is not exceeded. The WHO currently proposes a maximum TDI of between 1-4 pgTEQ/kg of body weight per day. A TDI of 4 pgTEQ/kg of body weight per day should be considered a maximal tolerable intake on a provisional basis and that the ultimate goal is to reduce human intake levels of below 1 pgTEQ/kg of body weight per day. This reflects the concept that guidance values for the protection of human health should consider total exposure to the substance including air, water, soil, food and other media sources.

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

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

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

Table 1.3 The TEF scheme for TEQ_{DFP}-WHO_{98} and I-TEQ_{DF} [(1)].

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

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

(2) Values in parentheses are those given in Annex 1, Council Directive 2000/76/EC and equate to I-TEQ_{DF}.

Table 1.4 PCDD/PCDF Relative Emission Factors for Municipal Waste Incinerator (MB-Ref WS)(1)

	Emission Factor (relative to sum of toxic congeners)	Emission Concentration (ng/m^3 from stack)	Emission Factor (ng/sec from stack)
Congener Group	Nondetects set to zero	Nondetects set to zero	Nondetects set to zero
2,3,7,8-TCDD	0.0009	0.00231	0.09663
1,2,3,7,8-PeCDD	0.0068	0.00896	0.37559
1,2,3,4,7,8-HxCDD	0.0117	0.00307	0.12880
1,2,3,6,7,8-HxCDD	0.0235	0.00620	0.25975
1,2,3,7,8,9-HxCDD	0.0284	0.00747	0.31281
1,2,3,4,6,7,8-HpCDD	0.2063	0.00543	0.22757
OCDD	0.3152	0.00083	0.03477
2,3,7,8-TCDF	0.0310	0.00817	0.34222
1,2,3,7,8-PeCDF	0.0062	0.00082	0.03438
2,3,4,7,8-PeCDF	0.0163	0.02150	0.90081
1,2,3,4,7,8-HxCDF	0.0484	0.01275	0.53433
1,2,3,6,7,8-HxCDF	0.0161	0.00423	0.17705
1,2,3,7,8,9-HxCDF	0.0032	0.00085	0.03553
2,3,4,6,7,8-HxCDF	0.0535	0.01409	0.59045
1,2,3,4,6,7,8-HpCDF	0.0878	0.00231	0.09680
1,2,3,4,7,8,9-HpCDF	0.0267	0.00070	0.02950
OCDF	0.1178	0.00031	0.01300
Total PCDD/PCDF	**1.0**	**0.1 ng/m^3**	**4.19 ng/sec**

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

Table 1.5 PCDD/PCDF Particle Fraction, Φ, at 10ºC In Airshed (Background plus Local Sources)(1)

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

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

(2) Background plus local sources default values: $\Theta = 3.5 \times 10^{-6}$ cm^2 aerosol/cm^3 air, TSP =42 $\mu g/m^3$.

Table 1.6 Generalized Particle Size Distribution & Proportion of Available Surface Area[1]

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

(1) USEPA (1998) Chapter 3: Air Dispersion and Deposition Modelling, Human Health Risk Assessment Protocol, Region 6 Centre for Combustion Science and Engineering

(2) Used in the deposition modelling of metals (except Hg)

(3) Used in the deposition modelling of PCDD/PCDFs and Hg.

1.8 Modelling Results

Tables 1.7 – 1.9 details the predicted PCCD/PCDFs GLC and deposition flux for the maximum scenario.

Table 1.7 PCDD/PCDF Annual Vapour Concentrations & Wet Vapour Deposition (Based on a Default MWI Profile (MB-Ref WS)) Under Maximum Operating Conditions

Congener Group	Vapour Fraction	Vapour Emission Rate (ng/sec)	Annual Vapour Concentration (fg/m^3)
2,3,7,8-TCDD	0.237	0.0418	0.0555
1,2,3,7,8-PeCDD	0.039	0.0267	0.0355
1,2,3,4,7,8-HxCDD	0.008	0.0019	0.0025
1,2,3,6,7,8-HxCDD	0.008	0.0038	0.0050
1,2,3,7,8,9-HxCDD	0.008	0.0046	0.0061
1,2,3,4,6,7,8-HpCDD	0.002	0.0008	0.0011
OCDD	0.0005	0.00003	0.00004
2,3,7,8-TCDF	0.25	0.1560	0.2075
1,2,3,7,8-PeCDF	0.083	0.0052	0.0069
2,3,4,7,8-PeCDF	0.049	0.0805	0.1070
1,2,3,4,7,8-HxCDF	0.018	0.0175	0.0233
1,2,3,6,7,8-HxCDF	0.018	0.0058	0.0077
1,2,3,7,8,9-HxCDF	0.011	0.0007	0.0009
2,3,4,6,7,8-HxCDF	0.011	0.0118	0.0158
1,2,3,4,6,7,8-HpCDF	0.005	0.0009	0.0012
1,2,3,4,7,8,9-HpCDF	0.0026	0.0001	0.0002
OCDF	0.0005	0.00001	0.00002
Sum			**0.48 fg/m^3**

Table 1.8 PCDD/PCDF Annual Particulate Concentrations (Based on a Default MWI Profile (MB-Ref WS)) Under Maximum Operating Conditions

Congener Group	Particulate Fraction	Particulate Emission Rate (ng/sec)	Annual Particulate Concentration (fg/m^3)
2,3,7,8-TCDD	0.763	0.134	0.176
1,2,3,7,8-PeCDD	0.961	0.658	0.862
1,2,3,4,7,8-HxCDD	0.992	0.233	0.305
1,2,3,6,7,8-HxCDD	0.992	0.470	0.615
1,2,3,7,8,9-HxCDD	0.992	0.566	0.741
1,2,3,4,6,7,8-HpCDD	0.998	0.414	0.543
OCDD	0.9995	0.063	0.083
2,3,7,8-TCDF	0.75	0.468	0.613
1,2,3,7,8-PeCDF	0.917	0.057	0.075
2,3,4,7,8-PeCDF	0.951	1.562	2.046
1,2,3,4,7,8-HxCDF	0.982	0.957	1.253
1,2,3,6,7,8-HxCDF	0.982	0.317	0.415
1,2,3,7,8,9-HxCDF	0.989	0.064	0.084
2,3,4,6,7,8-HxCDF	0.989	1.065	1.395
1,2,3,4,6,7,8-HpCDF	0.995	0.176	0.230
1,2,3,4,7,8,9-HpCDF	0.9974	0.054	0.070
OCDF	0.9995	0.024	0.031
Sum			**9.53 fg/m^3**

Table 1.9 PCDD/PCDF Annual Particulate Deposition Fluxes (Based on a Default MWI Profile (MB-Ref WS)) Under Maximum Operating Conditions

Congener Group	Particulate Emission Rate (ng/sec)	Dry Particulate Deposition Flux (ng/m^2)	Wet Particulate Deposition Flux (ng/m^2)	Combined Particulate Deposition Flux (ng/m^2)
2,3,7,8-TCDD	0.134	0.032	0.025	0.038
1,2,3,7,8-PeCDD	0.658	0.155	0.124	0.184
1,2,3,4,7,8-HxCDD	0.233	0.055	0.044	0.065
1,2,3,6,7,8-HxCDD	0.470	0.110	0.088	0.132
1,2,3,7,8,9-HxCDD	0.566	0.133	0.106	0.158
1,2,3,4,6,7,8-HpCDD	0.414	0.097	0.078	0.116
OCDD	0.063	0.015	0.012	0.018
2,3,7,8-TCDF	0.468	0.110	0.088	0.131
1,2,3,7,8-PeCDF	0.057	0.014	0.011	0.016
2,3,4,7,8-PeCDF	1.562	0.367	0.294	0.437
1,2,3,4,7,8-HxCDF	0.957	0.225	0.180	0.268
1,2,3,6,7,8-HxCDF	0.317	0.075	0.060	0.089
1,2,3,7,8,9-HxCDF	0.064	0.015	0.012	0.018
2,3,4,6,7,8-HxCDF	1.065	0.250	0.200	0.298
1,2,3,4,6,7,8-HpCDF	0.176	0.041	0.033	0.049
1,2,3,4,7,8,9-HpCDF	0.054	0.013	0.010	0.015
OCDF	0.024	0.006	0.004	0.007
Sum		**1.71 ng/m^2**	**1.37 ng/m^2**	**2.04 ng/m^2**
Equivalent Daily Deposition Flux		**4.68 pg/m^2/day**	**3.75 pg/m^2/day**	**5.67 pg/m^2/day**

Table 1.10 Dispersion Model Summary of Combined Vapour and Particulate Concentrations – PCCD/PCDFs.

Pollutant / Scenario	Annual Mean Background (pg/m^3)	Averaging Period	Process Contribution (pg/m^3)	Predicted Emission Concentration (pg/Nm^3)
PCCD/PCDFs / Maximum	0.093	Annual Average	0.010	0.103

Table 1.11 Deposition Model Summary of Combined Particulate Deposition Flux – PCCD/PCDFs.

Pollutant / Scenario	Annual Mean Background (pg/m^2/day)	Averaging Period	Process Contribution (pg/m^2/day)	Predicted Total Particulate Deposition Flux (pg/m^2/day)
PCCD/PCDFs / Maximum	6 – 36[(1)]	Annual Average	4.68	10.7 – 40.7

(1) Based on the range of deposition levels recorded in Germany 1993-1997[(10)]

Table 1.12 I-TEQ values derived from measurements of airborne dioxins in various locations.

Location	Site Type	I-TEQ[1] (fg/m^3)
Kilcock , Co. Meath (1998)[2]	Rural	Range 2.8 – 7
Ireland[2]	Baseline	Mean – 26
	Potential Impact Areas	Mean – 49
Ringaskiddy (2001)[3]	Industrial	Lower Limit – 4.0[8] Upper Limit – 16.4[9]
Carranstown (2001)[4]	Rural	Lower Limit – 28[8] Upper Limit – 46[9]
Germany (1992)[4]	Rural	< 70
	Urban	71 – 350
	Close to Major Source	351 – 1600
Bavaria, Germany (1997)[10]	Rural Mean	Range 3.3 – 88.4
	Augsburg, Before MWI	Range 14 – 120
	Augsburg, After MWI	Range 7.6 – 206
Thuringia, Germany (1997)[10]	Urban 1993 - 1997	Range 9 – 231, Mean = 71
	Urban 1993 - 1997	Range 11 – 169, Mean = 52
	Urban 1993 - 1997	Range 18 – 210, Mean = 92
Austria[10]	Wien-14 (urban) 1992 - 1997	Range 9.3 – 129, Mean = 37
	Graz-Ost (urban) 1993 - 1997	Range 139 – 302, Mean = 198
	Linz-Ursulinenhof (urban) 1994 - 1997	Range 69 – 179, Mean = 120
	Leoben-BFI (urban) 1995 - 1998	Range 69 – 262, Mean = 150
Italy[10]	Florence (Urban)	Range 72 – 200
	Rome (Urban)	Range 48 – 277, Mean = 85
Manchester[6]	Urban 1997-2001	Annual Mean – 29 - 72
Middlesbrough[6]	Urban 1997-2001	Annual Mean – 20 - 43
Hazelrigg[6]	Semi-rural 1997 -2001	Annual Mean – 3.7 - 11
Stoke Ferry[6]	Rural 1997 - 2001	Annual Mean – 5.4 - 21
High Muffles[6]	Rural 1997 - 2001	Annual Mean – 2.8 – 6.3

(1) $I\text{-}TEQ_{DF}$ values based on NATO/CCMS (1988) and as used in Annex 1, Council Directive 2000/76/EC.
(2) Taken from Chapter 8 of Thermal Waste Treatment Plant, Kilcock EIS, Air Environment (1998)
(3) Taken from Chapter 9 of Waste Management Facility, Indaver Ireland Ringaskiddy EIS, Baseline Dioxin Survey (2001)
(4) Taken from Chapter 9 of Waste Management Facility, Indaver Ireland Carranstown EIS, Baseline Dioxin Survey (2001)
(5) Raffe, C (1996) Sources and environmental concentrations of dioxins and related compounds, *Pure & Appl. Chem* **Vol. 68**, No. 9, pp 1781-1789
(6) Duarte-Davidson et al (1994) Polychlorinated Dibenzo-*p*-Dioxins (PCDDs) and Furans (PCDFs) in Urban Air and Deposition, *Environ. Sci. & Pollut. Res.*, **1 (4)**, 262-270
(7) Taken from TOMPS Network website, WWW.aeat.co.uk/netcen/airqual.
(8) Lower Limit TEQ calculated assuming non-detects are equal to zero.
(9) Upper limit assuming non-detects are equal to limit of detection.
(10) European Commission (1999) Compilation of EU Dioxin Exposure & Health Data Task 2 Environmental Levels - Technical Annex.

Table 1.13 Mean I-TEQ Deposition Fluxes Of Dioxins In Various Locations

Location	Site Type	Mean I-TEQ[1] (pg/m^2/ day)
Germany (1992)[2]	Rural	5 -22
	Urban	10 – 100
	Close to Major Source	123 - 1293
Germany (1998)[4]	Hamburg 1995 (Urban Background)	6
	Rheinland-Palatinate 1994 (Urban)	9
	Thuringia 1993-97 (Urban)	29
	Brandenburg 1993 (Conurbation)	36
Belgium (1997)[4]	Eksel (Background)	3.1
	Mol (Background)	0.7
	Merksem (Urban)	12.0
	Antwerpen (Urban)	0.9
UK[3]	Stevenage	3.2
	London	5.3
	Cardiff	12
	Manchester	28

(1) I-TEQDF values based on NATO/CCMS (1988) and as used in Annex 1, Council Directive 2000/76/EC.
(2) Raffe, C (1996) Sources and environmental concentrations of dioxins and related compounds, *Pure & Appl. Chem* Vol. 68, No. 9, pp 1781-1789
(3) Duarte-Davidson et al (1994) Polychlorinated Dibenzo-*p*-Dioxins (PCDDs) and Furans (PCDFs) in Urban Air and Deposition, *Environ. Sci. & Pollut. Res.*, 1 (4), 262-270
(4) European Commission (1999) Compilation of EU Dioxin Exposure & Health Data Task 2 Environmental Levels - Technical Annex.

1.9 Result Findings

Background levels of PCDD/PCDFs occur everywhere and existing levels in the surrounding area have been monitored as part of this study. The 8-week mean, shown in Table A1.1, indicates that results are higher than measurements elsewhere in Ireland averaging 93 fg/m^3 compared to previous measurements ranging from 2.8 – 46 fg/m^3. However, previous measurements have been in rural or industrial zoned land whereas the current site is urban with vehicle, home heating & power stations in close proximity. Data from other urban locations through Europe is available (see Table A1.1). The mean ambient concentration over the eight-week period is similar to results obtained in Germany, Austria and Italy over the last decade.

The contribution from the site in this context is minor with levels under maximum operation averaging 11% of the background level based on this worst-case assessment (see Table 1.12).

Shown in Table 1.11 is the maximum dioxin deposition rate. Modelled total dioxin particulate deposition flux indicate that deposition levels would be expected to approximately 13 – 78% of typical background levels experienced in urban locations in Germany (6-36 pg/m^2/day) (see Table 1.13).

REFERENCES

(1) USEPA (1995) User's Guide for the Industrial Source Complex (ISC3) Dispersion Model Vol I & II
(2) USEPA (2003) Guidelines on Air Quality Models, Appendix W to Part 51, 40 CFR Ch.1
(5) USEPA (1998) Minimum Meteorological Data Requirements For AERMOD – Study & Recommendations", 1998, USEPA.
(6) Database of Sources of Environmental Releases of Dioxin-Like Compounds in the United States (1998, USEPA (CD-ROM)).

(7) USEPA (2000) Estimating Exposure to Dioxin-Like Compounds Volume IV, Chapter 3 Evaluating Atmospheric Releases of Dioxin-Like Compounds from Combustion Sources (Draft)
(8) USEPA (1998) Human Health Risk Assessment Protocol, Chapter 3: Air Dispersion and Deposition Modelling, Region Centre for Combustion Science and Engineering
(9) World Health Organisation (1999) Guidelines For Air Quality
(10) European Commission (1999) Compilation of EU Dioxin Exposure & Health Data Task 2 Environmental Levels - Technical Annex.

APPENDIX I

BASELINE MONITORING OF PCDDS & PCDFS

Sampling Methodology

Sampling for PCDDs and PCDFs was carried out over two one-month periods (August / September 2003 and January/February 2004) in accordance with the requirements of the United States Environmental Protection Agency (US EPA) methodology. Monitoring was carried out at the fixed monitoring station (see Figure 1.1). The sampling method was taken from the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. Method TO9 describes a method for the sampling of PCDDs and PCDFs in ambient air using high resolution gas chromatography/mass spectrometry.

Sampling of the ambient air was achieved using a high volume air sampler (General Metal Works Model PS-1). Air was drawn through a fine porosity quartz filter and adsorbent cartridge containing polyurethane foam (PUF) to trap the particulate and volatile fractions respectively. In order to obtain a detection limit in ambient air of approximately one femtogram (fg), a sample volume of at least $500m^3$ was required.

The calibrated sampler was assembled with a pre-cleaned quartz fibre filter and PUF trap. The filter used in the tests had a pore size of 0.45 microns, capable of attaining a > 99.5 percent efficiency of capture of 0.3 micron particles. The filter composite comprised a PUF plug retained in a glass sampling cartridge. The PUF foam trap was spiked with ^{13}C labelled isomers in order to allow a recovery experiment to be performed.

The flow through the system was monitored using a Venturi/Magnehelic assembly. From the calibration graph the gauge reading was then used to calculate an average flowrate in cubic metres per minute (m^3/min) over the sampling period. From the known sampling period a sampling volume in m^3 was then calculated.

Analysis for PCDDs and PCDFs was by high-resolution gas chromatography/mass spectrometry (GC/MS) and was carried out by Scientific Analysis Laboratories (SAL), Manchester. SAL Ltd are UKAS accredited for the analysis of PCDDs and PCDFs. Extraction, clean-up and analysis procedures followed USEPA protocols and the full quality assurance and quality control regime set out in EPA Method 1613 was followed.

Ambient Air Quality Compliance Criteria

Currently, no internationally recognised ambient air quality concentration or deposition standards exist for PCDD/PCDFs. Both the USEPA and World Health Organisation (WHO) recommended approach to assessing the risk to human health from PCDD/PCDFs entails a detailed risk assessment analysis involving the determination of the impact of PCDD/PCDFs in terms of the TDI (Tolerable Daily Intake) approach. The WHO currently proposes a maximum TDI of between 1-4 pgTEQ/kg of body weight per day(2).

Results

Background levels of PCDD/PCDFs occur everywhere and existing levels in the Poolbeg region have been extensively monitored over two one-month periods as part of this study. Monitoring was carried out over four 4-5 day periods spread over one month in summer and again, over the same time period in winter, the results of which are detailed in Tables A1.1 and A1.5.

Historically, measurements of PCDDs in Ireland have been limited. Table 1.12 shows the range of concentrations measured in ambient air in Ireland and elsewhere in recent years. Levels at Poolbeg show significant variations between monitoring periods with mean results a factor of ten - twenty higher in winter. A similar variation has been report in the literature for monitoring carried out in Germany in the 1990s[(8)]. The 8-week mean, shown in Table A1.1, indicates that results are higher than measurements elsewhere in Ireland averaging 93 fg/m^3 compared to previous measurements ranging from 2.8 – 46 fg/m^3. However, previous measurements have been in rural or industrial zoned land whereas the current site is urban with vehicle, home heating & power stations in close proximity. Data from other urban locations through Europe is available (see Table A1.1). The mean ambient concentration over the eight-week period is similar to results obtain in Germany, Austria and Italy over the last decade.

Data on deposition is limited. Shown in Table 1.13 are a range of deposition data from the UK, Belgium and Germany. No data is available in Ireland, but based on the measured ambient PCDD and PCDF concentrations, baseline deposition levels would be expected to be similar to urban areas of Germany (6-36 pg/m^2/day).

Table A1.1 Summary of Baseline PCCD/PCDFs Ambient Air Concentrations.

Pollutant	Averaging Period	Minimum PCDDs/PCDFs (TEQ) (Fg/m^3)	Maximum PCDDs/PCDFs (TEQ) (Fg/m^3)
PCCD/PCDFs	28/08/03 – 31/08/03	1.4	7.1
PCCD/PCDFs	03/09/03 – 08/09/03	3.3	3.3
PCCD/PCDFs	08/09/03 – 12/09/03	14.3	14.3
PCCD/PCDFs	15/09/03 – 19/09/03	12.1	12.1
PCCD/PCDFs	11/02/04 – 16/02/04	157.9	157.9
PCCD/PCDFs	16/02/04 – 20/02/04	75.3	75.3
PCCD/PCDFs	23/02/04 – 27/02/04	304.6	304.6
PCCD/PCDFs	03/03/04 – 08/03/04	175.6	175.6
PCCD/PCDFs	**8-Week Average**	**93.1**	**93.8**

Table A1.1 Levels of PCDDs and PCDFs measured at the fixed monitoring station, Poolbeg during the period 28/8/03 – 19/9/03 (1x10^3 fg/m^3 = 1 pg/m^3)

PCDD Congeners	TEF[(1)]	Sampling Period 1: 28/08/03 - 31/08/03			Sampling Period 2: 03/09/03 - 08/09/03		
		Concentration[(2)] (fg/m^3)	Lower Limit TEQ[(3)] (fg/m^3)	Upper Limit TEQ[(4)] (fg/m^3)	Concentration[(2)] (fg/m^3)	Lower Limit TEQ[(3)] (fg/m^3)	Upper Limit TEQ[(4)] (fg/m^3)
2,3,7,8-TCDD	1.0	<3.1133		3.1133	0.5533	0.5533	0.5533
1,2,3,7,8-PeCDD	0.5	<2.8827		1.4414	0.5533	0.2767	0.2767
1,2,3,4,7,8-HxCDD	0.1	0.8072	0.0807	0.0807	1.4524	0.1452	0.1452
1,2,3,6,7,8-HxCDD	0.1	<2.6521		0.2652	0.4150	0.0415	0.0415
1,2,3,7,8,9-HxCDD	0.1	<2.6521		0.2652	0.9683	0.0968	0.0968
1,2,3,4,6,7,8-HpCDD	0.01	5.7654	0.0577	0.0577	13.833	0.1383	0.1383
OCDD	0.001	16.143	0.0161	0.0161	30.432	0.0304	0.0304
PCDF Congeners	**TEF[(1)]**						
2,3,7,8-TCDF	0.1	0.6919	0.0692	0.0692	1.2450	0.1245	0.1245
1,2,3,7,8-PeCDF	0.05	0.9225	0.0461	0.0461	0.7608	0.0380	0.0380
2,3,4,7,8-PeCDF	0.5	0.9225	0.4612	0.4612	2.1441	1.0720	1.0720
1,2,3,4,7,8-HxCDF	0.1	1.8449	0.1845	0.1845	1.8674	0.1867	0.1867
1,2,3,6,7,8-HxCDF	0.1	1.3837	0.1384	0.1384	1.6599	0.1660	0.1660
1,2,3,7,8,9-HxCDF	0.1	<2.0756		0.6227	0.8300	0.0830	0.0830
2,3,4,6,7,8-HxCDF	0.1	6.2267	0.2076	0.2076	2.7666	0.2767	0.2767
1,2,3,4,6,7,8-HpCDF	0.01	6.2267	0.0623	0.0623	8.9913	0.0899	0.0899
1,2,3,4,7,8,9-HpCDF	0.01	<5.0736		0.0507	1.3141	0.0131	0.0131
OCDF	0.001	3.8052	0.0038	0.0038	9.6830	0.0097	0.0097
		Total TEQ	**1.4**	**7.1**	**Total TEQ**	**3.3**	**3.3**

(1) Annex 1, Council Directive 2000/76/EC.
(2) Ambient concentration of congener (values in italics indicate levels below the limit of detection).
(3) Lower Limit TEQ calculated assuming non-detects are equal to zero (i.e. congeners with ambient levels below the limit of detection not included in Total TEQ)
(4) Upper Limit TEQ calculated assuming non-detects are equal to the limit of detection (i.e. congeners with ambient levels below the limit of detection included in Total TEQ).

Table A1.2 Levels of PCDDs and PCDFs measured at the fixed monitoring station, Poolbeg during the period 28/8/03 – 19/9/03 ($1x10^3$ fg/m^3 = 1 pg/m^3)

PCDD Congeners	TEF(1)	Sampling Period 3: 08/09/03 - 12/09/03			Sampling Period 4: 15/09/03 - 19/09/03		
		Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)	Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)
2,3,7,8-TCDD	1.0	1.1757	1.1757	1.1757	0.9701	0.9701	0.9701
1,2,3,7,8-PeCDD	0.5	3.2751	1.6376	1.6376	2.4252	1.2126	1.2126
1,2,3,4,7,8-HxCDD	0.1	7.978	0.7978	0.7978	5.0120	0.5012	0.5012
1,2,3,6,7,8-HxCDD	0.1	3.1072	0.3107	0.3107	2.3443	0.2344	0.2344
1,2,3,7,8,9-HxCDD	0.1	5.0386	0.5039	0.5039	4.6078	0.4608	0.4608
1,2,3,4,6,7,8-HpCDD	0.01	18.475	0.1847	0.1847	17.785	0.1778	0.1778
OCDD	0.001	50.386	0.0504	0.0504	55.779	0.0558	0.0558
PCDF Congeners	**TEF(1)**						
2,3,7,8-TCDF	0.1	4.7867	0.4787	0.4787	2.9102	0.2910	0.2910
1,2,3,7,8-PeCDF	0.05	37.790	1.8895	1.8895	6.6288	0.3314	0.3314
2,3,4,7,8-PeCDF	0.5	10.917	5.4585	5.4585	8.8923	4.4462	4.4462
1,2,3,4,7,8-HxCDF	0.1	4.955	0.4955	0.4955	9.7007	0.9701	0.9701
1,2,3,6,7,8-HxCDF	0.1	4.955	0.4955	0.4955	9.7007	0.9701	0.9701
1,2,3,7,8,9-HxCDF	0.1	2.8552	0.2855	0.2855	2.1827	0.2183	0.2183
2,3,4,6,7,8-HxCDF	0.1	5.542	0.5542	0.5542	9.7007	0.9701	0.9701
1,2,3,4,6,7,8-HpCDF	0.01	10.917	0.1092	0.1092	16.168	0.1617	0.1617
1,2,3,4,7,8,9-HpCDF	0.01	1.3436	0.0134	0.0134	1.9401	0.0194	0.0194
OCDF	0.001	8.230	0.0082	0.0082	13.743	0.0137	0.0137
		Total TEQ	**14.3**	**14.3**	**Total TEQ**	**12.1**	**12.1**

(1) Annex 1, Council Directive 2000/76/EC.
(2) Ambient concentration of congener (values in italics indicate levels below the limit of detection).
(3) Lower Limit TEQ calculated assuming non-detects are equal to zero (i.e. congeners with ambient levels below the limit of detection not included in Total TEQ)
(4) Upper Limit TEQ calculated assuming non-detects are equal to the limit of detection (i.e. congeners with ambient levels below the limit of detection included in Total TEQ).

Table A1.3 Levels of PCDDs and PCDFs measured at the fixed monitoring station, Poolbeg during the period 11/02/04 – 08/03/04 ($1x10^3$ fg/m^3 = 1 pg/m^3)

PCDD Congeners	TEF(1)	Sampling Period 1: 11/02/04 - 16/02/04			Sampling Period 2: 16/02/04 - 20/02/04		
		Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)	Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)
2,3,7,8-TCDD	1.0	1.6923	1.6923	1.6923	1.0954	1.0954	1.0954
1,2,3,7,8-PeCDD	0.5	6.7691	3.3846	3.3846	7.5310	3.7655	3.7655
1,2,3,4,7,8-HxCDD	0.1	31.5892	3.1589	3.1589	9.5849	0.9585	0.9585
1,2,3,6,7,8-HxCDD	0.1	6.2050	0.6205	0.6205	3.6970	0.3697	0.3697
1,2,3,7,8,9-HxCDD	0.1	28.7687	2.8769	2.8769	8.9003	0.8900	0.8900
1,2,3,4,6,7,8-HpCDD	0.01	242.560	2.4256	2.4256	82.156	0.8216	0.8216
OCDD	0.001	394.865	0.3949	0.3949	198.544	0.1985	0.1985
PCDF Congeners	**TEF(1)**						
2,3,7,8-TCDF	0.1	24.820	2.4820	2.4820	75.310	7.5310	7.5310
1,2,3,7,8-PeCDF	0.05	25.3841	1.2692	1.2692	82.1563	4.1078	4.1078
2,3,4,7,8-PeCDF	0.5	214.355	107.1775	107.1775	82.156	41.0782	41.0782
1,2,3,4,7,8-HxCDF	0.1	84.6138	8.4614	8.4614	41.7628	4.1763	4.1763
1,2,3,6,7,8-HxCDF	0.1	73.3320	7.3332	7.3332	36.9703	3.6970	3.6970
1,2,3,7,8,9-HxCDF	0.1	101.5366	3.2717	3.2717	47.9245	1.3693	1.3693
2,3,4,6,7,8-HxCDF	0.1	32.7173	10.1537	10.1537	13.6927	4.7925	4.7925
1,2,3,4,6,7,8-HpCDF	0.01	434.351	4.3435	4.3435	130.081	1.3008	1.3008
1,2,3,4,7,8,9-HpCDF	0.01	53.5888	0.5359	0.5359	30.1240	0.3012	0.3012
OCDF	0.001	242.560	0.2426	0.2426	56.825	0.0568	0.0568
		Total TEQ	**159.8**	**159.8**	**Total TEQ**	**76.5**	**76.5**

(1) Annex 1, Council Directive 2000/76/EC.
(2) Ambient concentration of congener (values in italics indicate levels below the limit of detection).
(3) Lower Limit TEQ calculated assuming non-detects are equal to zero (i.e. congeners with ambient levels below the limit of detection not included in Total TEQ)
(4) Upper Limit TEQ calculated assuming non-detects are equal to the limit of detection (i.e. congeners with ambient levels below the limit of detection included in Total TEQ).

Table A1.4 Levels of PCDDs and PCDFs measured at the fixed monitoring station, Poolbeg during the period 11/02/04 – 08/03/04 ($1x10^3$ fg/m^3 = 1 pg/m^3)

PCDD Congeners	TEF(1)	Sampling Period 3: 23/02/04 - 27/02/04			Sampling Period 4: 03/03/04 - 08/03/04		
		Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)	Concentration(2) (fg/m^3)	Lower Limit TEQ(3) (fg/m^3)	Upper Limit TEQ(4) (fg/m^3)
2,3,7,8-TCDD	1.0	2.5386	2.5386	2.5386	1.5960	1.5960	1.5960
1,2,3,7,8-PeCDD	0.5	48.5958	24.2979	24.2979	6.3841	3.1920	3.1920
1,2,3,4,7,8-HxCDD	0.1	123.3028	12.3303	12.3303	29.7925	2.9792	2.9792
1,2,3,6,7,8-HxCDD	0.1	27.5618	2.7562	2.7562	5.8521	0.5852	0.5852
1,2,3,7,8,9-HxCDD	0.1	101.5435	10.1543	10.1543	27.1324	2.7132	2.7132
1,2,3,4,6,7,8-HpCDD	0.01	797.841	7.9784	7.9784	228.764	2.2876	2.2876
OCDD	0.001	1087.966	1.0880	1.0880	372.406	0.3724	0.3724
PCDF Congeners	**TEF(1)**						
2,3,7,8-TCDF	0.1	11.605	1.1605	1.1605	23.408	2.3408	2.3408
1,2,3,7,8-PeCDF	0.05	94.2904	4.7145	4.7145	23.9404	1.1970	1.1970
2,3,4,7,8-PeCDF	0.5	210.340	105.1700	105.1700	202.163	101.0816	101.0816
1,2,3,4,7,8-HxCDF	0.1	304.6304	30.4630	30.4630	79.8012	7.9801	7.9801
1,2,3,6,7,8-HxCDF	0.1	253.8587	25.3859	25.3859	69.1611	6.9161	6.9161
1,2,3,7,8,9-HxCDF	0.1	130.5559	43.5186	43.5186	95.7615	3.0856	3.0856
2,3,4,6,7,8-HxCDF	0.1	435.1863	13.0556	13.0556	30.8565	9.5761	9.5761
1,2,3,4,6,7,8-HpCDF	0.01	1595.683	15.9568	15.9568	409.646	4.0965	4.0965
1,2,3,4,7,8,9-HpCDF	0.01	224.8462	2.2485	2.2485	50.5408	0.5054	0.5054
OCDF	0.001	797.841	0.7978	0.7978	228.764	0.2288	0.2288
		Total TEQ	**303.6**	**303.6**	**Total TEQ**	**150.7**	**150.7**

(1) Annex 1, Council Directive 2000/76/EC.
(2) Ambient concentration of congener (values in italics indicate levels below the limit of detection).
(3) Lower Limit TEQ calculated assuming non-detects are equal to zero (i.e. congeners with ambient levels below the limit of detection not included in Total TEQ)
(4) Upper Limit TEQ calculated assuming non-detects are equal to the limit of detection (i.e. congeners with ambient levels below the limit of detection included in Total TEQ).

ATTACHMENT A

Principal Model Variables

Total exposure:	Total exposure via relevant routes
Distribution over (soil) phases	Fugacity Mass fraction in soil phases Concentration in soil water Concentration in soil air Concentration in surface water Concentration in suspended matter
Evaporation from soil:	Diffusion coefficient Fluxes Dilution in outdoor air Concentration in outdoor air Concentration in indoor air
Drinking water:	Permeation through service pipes Concentration in drinking water Concentration in bathroom air
Plants:	Bioconcentration factors Concentration in plants through uptake Concentration in plants due to deposition Total concentration in plant
Meat and milk:	Time division cattle Uptake by cattle Concentration in meat and milk
Fish:	Bioconcentration factor fish Concentration in Fish
Time division	Time division Daily amount of soil ingested Daily amount of ingested surface water

Ingestion:	Ingestion of soil and dust Ingestion of vegetables Ingestion of meat Ingestion of milk Ingestion of drinking water Ingestion of surface water Ingestion of suspended matter Ingestion of fish
Dermal contact:	Dermal contact with soil and dust Dermal contact with surface water Dermal contact with shower water
Inhalation:	Inhalation of soil and dust Inhalation of indoor air Inhalation of outdoor air Inhalation of vapours shower water

ATTACHMENT B
MODEL EQUATIONS

$$Dose.a = \sum_{i=1}^{n} \text{exposure via selected routes. If all routes are selected:}$$
$$= IVo.a + IVi.a + IP.a + IVw.a + DA.a + DAw.a + DI.a + DIw.a + MIme.a + MImi.a + VI.a + DAsw.a + DIsw.a + DIsm.a + FI.a$$

$$Dose.c = \sum_{i=1}^{n} \text{exposure via selected routes. If all routes are selected:}$$
$$= IVo.c + IVi.c + IP.c + IVw.c + DA.c + DAw.c + DI.c + DIw.c + MIme.c + MImi.c + VI.c + DAsw.c + DIsw.c + DIsm.c + FI.c$$

$$Dose = (Dose.a * Ifta + Dose.c * Iftc) / (Ifta + Iftc)$$

Element	Definition
Dose a	Dose adult
Dose c	Dose child
Dose	Intake mg/kg body weight/day
Ifta	Exposure period adult
Iftc	Exposure period child
IVi	Volume of air inhaled (indoor)
IVo	Volume of air inhaled (outdoor)
IP	Mass of inhaled particulates
IVw	Inhaled volume of water vapour shower
DAa	Dermal contact with soil and dust
DAw	Dermal contact shower water
DIw	Ingestion of soil and dust
MIme	Ingestion of meat
MImi	Ingestion of milk
VI	Ingestion of leafy vegetables
DAsw	Dermal content surface water
DIsw	Ingestion surface water
DIsm	Ingestion suspended matter
FI	Ingestion of fish

ATTACHMENT C

Justification for Selecting Model Variables

The highest **ambient air** value measured for in the vicinity of the site, for PCDD/F, was 16.03 WHO TEQ fg/m^3 (0.01603 pg/m^3) (ref. AWN Report 03_1744AR02_3) calculation as follows).

PCDD Congeners	TEF	TEF	Sampling Period 3: 08/09/03 - 12/09/03		
	NATO	WHO	Concentration(fg/m3)	I TEQ(fg/m3)	WHO TEQ (fg/m3)
2,3,7,8-TCDD	1	1	1.1757	1.1757	1.1757
1,2,3,7,8-PeCDD	0.5	1	3.2751	1.63755	3.2751
1,2,3,4,7,8-HxCDD	0.1	0.1	7.978	0.7978	0.7978
1,2,3,6,7,8-HxCDD	0.1	0.1	3.1072	0.31072	0.31072
1,2,3,7,8,9-HxCDD	0.1	0.1	5.0386	0.50386	0.50386
1,2,3,4,6,7,8-HpCDD	0.01	0.01	18.475	0.18475	0.18475
OCDD	0.001	0.0001	50.386	0.050386	0.0050386
PCDF Congeners					0
2,3,7,8-TCDF	0.1	0.1	4.7867	0.47867	0.47867
1,2,3,7,8-PeCDF	0.05	0.05	37.79	1.8895	1.8895
2,3,4,7,8-PeCDF	0.5	0.5	10.917	5.4585	5.4585
1,2,3,4,7,8-HxCDF	0.1	0.1	4.955	0.4955	0.4955
1,2,3,6,7,8-HxCDF	0.1	0.1	4.955	0.4955	0.4955
1,2,3,7,8,9-HxCDF	0.1	0.1	2.8552	0.28552	0.28552
2,3,4,6,7,8-HxCDF	0.1	0.1	5.542	0.5542	0.5542
1,2,3,4,6,7,8-HpCDF	0.01	0.01	10.917	0.10917	0.10917
1,2,3,4,7,8,9-HpCDF	0.01	0.01	1.3436	0.013436	0.013436
OCDF	0.001	0.0001	8.23	0.00823	0.000823
SUM				14.45	**16.03**

Mercury

The Highest Ambient Air Concentration measured for mercury was **0.001 µg/m^3** (PCDD/F WHO TEQ)

The **highest background soil PCDD/F** concentration measured was **25 ng WHO TEQ /kg**

PCDD Congeners	**TEF**	**TEF**	**Sample D**		
	NATO	**WHO**	**Concentration(ng/kg)**	**I TEQ(ng/kg)**	**WHO TEQ (ng/kg)**
2,3,7,8-TCDD	1	1	0.78	0.78	0.78
1,2,3,7,8-PeCDD	0.5	1	3.4	1.7	3.4
1,2,3,4,7,8-HxCDD	0.1	0.1	2.7	0.27	0.27
1,2,3,6,7,8-HxCDD	0.1	0.1	4.6	0.46	0.46
1,2,3,7,8,9-HxCDD	0.1	0.1	3.7	0.37	0.37
1,2,3,4,6,7,8-HpCDD	0.01	0.01	33	0.33	0.33
OCDD	0.001	0.0001	130	0.13	0.013
PCDF Congeners					0
2,3,7,8-TCDF	0.1	0.1	18	1.8	1.8
1,2,3,7,8-PeCDF	0.05	0.05	17	0.85	0.85
2,3,4,7,8-PeCDF	0.5	0.5	21	10.5	10.5
1,2,3,4,7,8-HxCDF	0.1	0.1	26	2.6	2.6
1,2,3,6,7,8-HxCDF	0.1	0.1	11	1.1	1.1
1,2,3,7,8,9-HxCDF	0.1	0.1	3.1	0.31	0.31
2,3,4,6,7,8-HxCDF	0.1	0.1	7.4	0.74	0.74
1,2,3,4,6,7,8-HpCDF	0.01	0.01	93	0.93	0.93
1,2,3,4,7,8,9-HpCDF	0.01	0.01	8.9	0.089	0.089
OCDF	0.001	0.0001	63	0.063	0.0063
SUM				23.02	**24.55**

The Contribution from PCDD/F like PCBs was calculated to be 2.88 ng/kg

Mercury

The soil concentration measured at Sampling Site D, where this sample was taken, was < 1 mg/kg. For the purposes of this assessment, the concentration was assumed to be equal to the LOD, that is **1 mg/kg**.

SOIL PARAMETERS

Soil temperature, soil water

Van den Berg, 1991

Berg, R. van den, 1991, *Blootstelling van de mens aan bodemverontreiniging. Een kwalitatieve en kwanitatieve analyse, leidend tot voorstellen voor humaan toxicologische C-toetsingswaarden*, RIVM reportnumber 725201006. In Dutch

Exposure of man to soil contamination. Proposals for human-toxicological soil standards as a result of an analysis on quantitative and qualitative aspects.

Capillary transition boundary

Explanation

The height of the capillary transition boundary above the groundwater table depends on soil properties. It can be calculated using the retention curve of the soil together with an average capillary rise of water, and the pressure head, corresponding to the air-entry value.

It can be calculated from pressure profiles, which are unique for each soil (De Laat, 1980). The pressure profiles give the relation between the height above the groundwater table (z) and the pressure-head (h) for different values of steady upward flow. According to this method heights above the groundwater table of the capillary transition boundary can be assessed for different soil types.

Soil type	Arithmetic mean of: (see table above)	Clay (%)	Org. Matter (%)	z (cm)
Sand	B1, B2, B3, B4	< 8	0 - 15	50
Loam	B7, B8, B9	8 - 25	0 - 15	60
Clay	B10, B11, B12	25 - 100	0 - 15	20
Peat	B16, B17, B18	0 - 100	16 - 100	40

Explanation:

Proposed (rounded off downward) height (z) of the capillary transition boundary above the groundwater table for a steady upward water flow of 0.1 cm.d-1 for different soil classes.

De Laat, 1980

Laat PJM de (1980): Model for unsaturated flow above a shallow water-table; applied to a regional sub-surface flow problem. PhD Thesis, Wageningen Agricultural University, The Netherlands.

However, if more detailed soil research is available the first table can be applied.

The height of the capillary transition boundary, the depth of the groundwater table and the depth of crawl space beneath soil surface it determines the length of soil column.

$$L_s = (d_g - z) - d_{c,volasoil}$$

Ls	length of soil column
dg	depth of groundwater table
z	height of the capillary transition boundary
dc,volasoil	depth of crawl space beneath soil surface

Note: If the calculated length of the soil column is smaller than 0.01 m, the value 0.01 m is used. A negative value or a value of zero gives inaccurate results.

Air permeability of soil

Definition: air permeability of soil
Symbol: kappa
Unit: m2
Default: 3.2E-11
Range: 1E-07 - 1E-30
Reference: Waitz et al., 1996for comparison purposesExposure route: Inhalation of indoor air

Used to calculate
Air conductivity of soil

Change at:
Edit Case: Site parameters; Soil parameters
Edit Case: Measurements; Soil parameters
Edit Landuse: Parameters; Soil parameters

Explanation
The air permeability and the dynamic viscosity of air [6.0 * E-9 Pa.h] are used to calculate the air conductivity of soil. Air permeabilties depend on the type of soil. Values for this parameter can be found in various references. The permeability in the table below are determined at field capacity moisture content

Soil type	Permeability kappa m2	Reference
Coarse sand	1 E-10	Nazaroff et al., 1988; Sextro et al., 1986; Put and Meijer, 1989
Medium sand	3.2 E -11	Johnson and Ettinger, 1991; Ferguson et al., 1995
Fine sand	3.2 E -12	Johnson and Ettinger, 1991; Ferguson et al., 1995
Silty sand	3.2 E -13	Johnson and Ettinger, 1991; Ferguson et al., 1995
Silt	3.2 E -14	Johnson and Ettinger, 1991; Ferguson et al., 1995
Clay	1 E-16	Nazaroff et al., 1988; Sextro et al., 1986; Put and Meijer, 1989

Nazaroff et al., 1988

Nazaroff WW, Moed BA, Sextro RG (1988): Soil as a source of indoor radon: generation, migration, and entry, Chapter 2. In: Radon and its decay products in indoor air. Wiley-Interscience, New York, NY.

PARTICLES IN AIR
suspended particles – indoors

Hawley, 1985

Hawley, 1985, *Assessment of Health Risk from Exposure to Contaminated Soil*, Risk Analysis, vol 5, No. 4, p. 289-302.

INHALATION INDOOR AIR

Thickness of concrete slab in basement minimum default value,

Veerkamp and ten Berge, 1994

Veerkamp, W. and W. ten Berge, 1994, *The concepts of HESP. Reference manual. Human exposure to soil pollutants*, versie 2.10a, Shell internationale Petroleum Maatschappij, The Hague.

Boundary layer – thickness of stagnant air layer between soil and air

Jury et al., 1983

Jury, W. A., W. F. Spencer and W. J. Farmer, 1983, *Behavior Assessment Model for Trace organics in Soil: I. Model description*, Journal of Environmental Quality, vol. 12, no. 4, p. 558-564.

INHALATION OF OUTDOOR AIR

Diameter of contaminated area

Van den Berg, 1991

Berg, R. van den, 1991, *Blootstelling van de mens aan bodemverontreiniging. Een kwalitatieve en kwanitatieve analyse, leidend tot voorstellen voor humaan toxicologische C-toetsingswaarden*, RIVM reportnumber 725201006. In Dutch

Exposure of man to soil contamination. Proposals for human-toxicological soil standards as a result of an analysis on quantitative and qualitative aspects.

Surface roughness

Definition:	A measure of roughness for the terrain. A high surface roughness means a large number of obstacles (for wind)
Symbol:	Zo
Unit:	m
Default:	1
Range:	0.03 -3
Reference:	Default, Van den Berg, 1991, Range: Wieringa and Rijkoort, 1983
Exposure route:	Inhalation of outdoor air

Used to calculate
Friction velocity
Wind velocity at respiration height

Change at:
Edit Case: Site parameters
Edit Landuse: Parameters

Explanation
The surface roughness length is used to convert the wind velocity at a height of 10 m (default value) to the wind velocity at respiration height. The surface roughness length is used in both steps of the calculation (calculation friction velocity and wind velocity at respiration height). The wind velocity at respiration height is used to calculate the dilution velocity and therefore the concentration in outdoor air at respiration height.
Factors which effect the surface roughness length:
- the height of the obstacles on the site
- the distance between obstacles on the site
- the amount of obstacles

Standard values for the surface roughness length for certain types of areas are stated below. Surface roughness lengths can be determined with the help of this list.

surface roughness length	description site
0.03	flat land with little vegetation (grass) and small obstacles, e.g.: runway, grass-land without hedges, fallow farm-land
0.1	farm-land with regular low crops, grass-land with ditches, scattered obstacles
0.25	farm-land with varying high and low crops. Large obstacles with distances between them of ± 15 times the obstacle height
0.5	groups of obstacles separated by open spaces, ± 10 times the obstacle height. For example scattered bushes, young (crowded) forest, orchards
1.0	ground regularly and completely covered with reasonably large obstacles, spaces between obstacles not larger than a couple of obstacle heights, e.g. forest, low-rise buildings in villages and cities.
2.0	city centres with varying low- and high-rise buildings.

A large surface roughness length implies many obstacles, which are higher than the respiration height. These obstacles influence the wind patterns to an extent of 20 times the surface roughness length above obstacle height and all wind velocities at respiration heights vary heavily. Only an indication of the wind velocity and concentration at respiration height can be given as a result of this.

Van den Berg, 1991

Berg, R. van den, 1991, *Blootstelling van de mens aan bodemverontreiniging. Een kwalitatieve en kwantitatieve analyse, leidend tot voorstellen voor humaan toxicologische C-toetsingswaarden*, RIVM reportnumber 725201006. In Dutch

Exposure of man to soil contamination. Proposals for human-toxicological soil standards as a result of an analysis on quantitative and qualitative aspects.

Wind velocity
Assumed neutral as per Van Den Bergh 1991

Wind velocity measured at height of 10m as per

Wieringa and Rijkoort, 1983

Wieringa, J. and P.J. Rijkoort, 1983, *Windklimaat van Nederland*, Koninklijk Nederlands Meteorologisch Instituut Klimaat van Nederland 2, Staatsuitgeverij, The Hague. In Dutch.

Wind characteristics of the Netherlands.

INGESTION OF VEGETABLES

Ratio dry weight fresh weight, stem

Definition: Ratio between the dry weight of leafy vegetables and the fresh weight (after harvest)
Symbol: kg dw. kg^{-1} fw
Unit: -
Default: 0.117
Range: 0 - 1
Reference: Bockting and van den Berg, 1992, calculated from data by Ng et al., 1982
Exposure route: Ingestion of vegetables, ingestion meat, ingestion milk

Used to calculate
Bioconcentration factors
Concentration in plant through uptake

Change at:
Edit Case: Site parameters
Edit Landuse: Parameters

Explanation
The ratio dry weight-fresh weight for stem is used to calculate the concentration in leafy vegetables (based on fresh weight). The concentration in leafy vegetables is the sum of the concentration (via deposition) and the concentration via uptake from the soil or the soil water. These concentrations are based on dry weight. The ratio dry weight-fresh weight is used to convert to fresh weight. The concentration in leafy vegetables has to be converted to fresh weight, because consumption data are based on fresh weight. For inorganic substances it is assumed that the concentration of contamination in the water in leafy vegetables equals the concentration in the soil water. This means that the concentration in leafy vegetables (based on fresh weight) equals the water content of the leafy vegetables times the soil water concentration, so:

(1- ratio dry weight-fresh weight) * soil water concentration.

For metals and organic substances a bioconcentration factor is used. Factors effecting the ratio dry weight-fresh weight stem:
- type of leafy vegetable
- the time between harvest and consumption

Bockting and van den Berg, 1992

Bockting, G. and R. van den Berg, 1992, *De accumulatie van sporenmetalen in groenten geteeld op verontreinigde bodems. Een literatuurstudie*, RIVM Reportnumber 725201009. In Dutch.

Accumulation of metals in vegetables cultivated on contaminated soils.

Yield

Nijs and Vermeire, 1990

Nijs, A.C.M de, and T.G.Vermeire, 1990, *Soil plant and plant-mammal transfer factors*, RIVM-reportnumber 670203001.

Grass Growth Period

Veerkamp and ten Berge, 1994

Veerkamp, W. and W. ten Berge, 1994, *The concepts of HESP. Reference manual. Human exposure to soil pollutants*, versie 2.10a, Shell internationale Petroleum Maatschappij, The Hague.

Weathering Constant

Nijs and Vermeire, 1990

Nijs, A.C.M de, and T.G.Vermeire, 1990, *Soil plant and plant-mammal transfer factors* RIVM-reportnumber 670203001.

Fraction Of Particles Absorbed By The Plant

Van Den Berg 1991

Deposition Velocity

Van Den Berg 1991

CATTLE

Milk production 30 litres/day:

Veerkamp and ten Berge, 1994

Veerkamp, W. and W. ten Berge, 1994, *The concepts of HESP. Reference manual. Human exposure to soil pollutants*, versie 2.10a, Shell internationale Petroleum Maatschappij, The Hague.

Milk fat average 4% as per Irish EPA 2000 milk report

Consumption Of Food

Irish Department of Agriculture Annual Report 2000/2001 (vegetables) and Irish Department of Agriculture Annual Report 2002/2003 (other parameters)

Vegetables 90.8 kg/yr = 0.248 kg/day

Tuberous vegetables 162.5 kg/yr = 0.445 kg/day

Meat 94.3 kg/yr = 0.258 kg/day

Milk 155 kg/yr = 0.425 kg/day

Assume child is 50% consumption of adult

As PCDD/F data for meat is given in terms of mass PCDD/F per unit mass of meat, it is necessary to calculate the average fat content of this meat intake, as follows:

	kg/yr	**% Fat**	**Mass Fat**	**Ave Fat%**
Beef	17.1	4.1	0.70	
Pork	38.8	3.4	1.32	
Sheep	5.5	11.2	0.62	
Poultry	30.7	4.1	1.26	
Other	2.3	11.2	0.26	
	94.3		**4.15**	**4.40**

Baseline PCDD/F and PCDD/F like PCB Concentration in Food expressed as WHO-TEQ and Mercury

Vegetables
Calculated by Model

Tuberous vegetables
Calculated by Model

Meat
The highest PCDD/F and PDCC/F like PCB concentration measured in fat (poultry, pork and beef) was 1 ng/kg fat and for sheep meat was 3 ng/kg fat (ref. Food Residue Database, Teagasc, 2001). The PCDD/F content of the meat was calculated to be **0.062 ng/kg** as follows, (from Chan W, Brown J, Lee SM, & Buss DH (1995) Meat Poultry & Game. MAFF & Royal Society of Chemistry. HMSO, London.(Supplement to McCance & Widdowson's The Composition of Foods)

	kg/yr	% Fat	Mass Fat kg	Ave Fat%	PCDD/F ng/kg	Mass PCDD/F ng	Ave PCDD/F ng/kg fat	Ave PCDD/F ng/kg meat
Beef	17.1	4.1	0.70		1	0.70		
Pork	38.8	3.4	1.32		1	1.32		
Sheep	5.5	11.2	0.62		3	1.85		
Poultry	30.7	4.1	1.26		1	1.26		
Other	2.3	11.2	0.26		3	0.77		
	94.4		**4.15**	**4.40**		**5.90**	**1.421**	**0.062**

The Food Residue Database, Teagasc, 2001 notes that no mercury was found in a selection of Irish meat or pork samples, with a LOD of 0.01 mg/kg, therefore as a conservative approach the mercury concentration was assumed to be half the LOD = **0.005 mg/kg**

Milk
The EPA Report Dioxin Levels in the Irish Environment, April 2001 states that dioxin concentrations in whole milk from the County Dublin Catchment were found to be 0.0356 ng/kg (using WHO-TEQ and ½ LOD). This equates to 0.96ng/kg milk fat (see above report).

As the RISC HUMAN Model does not break milk consumption down in butter, cheese and cream, a weighted milk concentration of 0.06 ng/kg milk for PCDD/F WHO-TEQ incl. half LOD was calculated as follows:

	kg	Fat %	Mass Fat	pg/kg Fat	pg PCDD/F	ng/kg PCDD/F	Average ng/kg
Drinking Milk	154.7	4	6.188	960	5940.48	5.94	*for 154.7 kg milk*
Cream	2.5	20	0.5	960	480	0.48	
Butter	2.9	80	2.32	960	2227.2	2.23	
Cheese	5.5	40	2.2	960	2112	2.11	
Total	**165.6**				**10759.68**	**10.76**	**0.06**

The Food Residue Database, Teagasc, 2001 notes that no mercury was found in a selection of Irish milk powder samples, with a LOD of 0.01 mg/kg, therefore as a conservative approach the mercury concentration was assumed to be = half the LOD or **0.005 mg/kg**

Exposure To Soil And Air

Assume farmer works 16 hours per day 7 days per week 50 weeks per year outside

ATTACHMENT D

MODEL OUTPUT FILE

= Site =

Data from file: NOMILME2.LOC
Name: Ringsend Baseline
Code:

Description:

Scenario Scenario 0
Characteristic Standard Scenario
CSoilModel / VolaSoil: CSoilModel
Landuse none

Selected exposure routes on site level:
- inhalation indoor air
- inhalation outdoor air
- ingestion soil
- dermal contact soil
- inhalation soil
- ingestion drinking water
- dermal contact shower
- inhalation vapour shower
- ingestion vegetables
- ingestion surface water
- ingestion suspended matter
- dermal contact surface water

Changed parameters on site level:
Organic matter content [OS]
  2.48E+00 %
Justification
  Measured value for site
Depth of ground water table [Dg]
  3.00E+00 m
Justification
  Assumed value for groundwater in Ireland
Depth of contaminant below surface level [Dp.o]
  1.00E-02 m
Justification
  Assume contaminant at surface
Acidity [pH]
  7.52E+00 -
Justification

Measured value for site
Height of capillary transition boundary above ground water table [z]
2.00E-01 m
Justification
De Laat et al
Surface roughness [Zo]
1.00E-01 m
Justification
Van Den Bergh 1991
Ratio dry weight fresh weigth (stem) [fdws]
2.48E-01 kg dw.kg-1 fw
Justification
Changed without justification
Milk production [Qmicat]
0.00E+00 l.d-1
Justification
Assume milk obtained off site
Fraction fat in meat [ffme]
4.40E-01 -
Justification
Calculated average value
Fraction fat in milk [ffmi]
4.00E-02 -
Justification
Average value from EPA 2000 Milk Dioxin Report
Fraction ground water in drinking water cattle [fgcat]
1.00E-02 -
Justification
Assume minimum
Fraction surface water in drinking water cattle [fscat]
9.90E-01 -
Justification
Assume maximum surface water consumption by cattle
Time outside (summer) [tsocat]
0.00E+00 h.d-1
Justification
Changed without justification
Weeks summer [wscat]
4.90E+01 w.y-1
Justification
Cattle outside for maximum amount of time
Daily consumption of leafy vegetables (adult) [Qvla]
2.48E-01 kg fw.d-1
Justification
Dept of Agriculture Annual Report 2002/2003
Daily consumption of tuberous vegetables (adult) [Qvra]
4.45E-01 kg fw.d-1
Justification
dept of agriculture 2002/2003
Daily consumption of meat (adult) [Qmea]
0.00E+00 kg.d-1
Justification
Assume all meat from off site
Daily consumption of milk (adult) [Qmia]
0.00E+00 l.d-1
Justification
Assume all milk from off site

Body weight (adult) [Wa]
  6.00E+01   kg
Justification
  Body weight from US EPA
Daily consumption of leafy vegetables (child) [Qvlc]
  1.24E-01   kg fw.d-1
Justification
  assume 50% of adult
Daily consumption of tuberous vegetables (child) [Qvrc]
  2.23E-01   kg fw.d-1
Justification
  Assume 50% of adult
Daily consumption of meat (child) [Qmec]
  0.00E+00   kg.d-1
Justification
  Assume all meat from off site
Daily consumption of milk (child) [Qmic]
  0.00E+00   l.d-1
Justification
  Assume all milk from off site

Subsite: Subsite 0

Selected exposure routes on subsite level:
  inhalation indoor air
  inhalation outdoor air
  ingestion soil
  dermal contact soil
  inhalation soil
  ingestion drinking water
  dermal contact shower
  inhalation vapour shower
  ingestion vegetables
  ingestion surface water
  ingestion suspended matter
  dermal contact surface water

Changed parameters on subsite level:
Fraction contaminated leafy vegetables (adult) [fla]
  1.00E+00   -

Justification
  Changed without justification

Fraction contaminated leafy vegetables (child) [flc]
  1.00E+00   -
Justification
  Changed without justification

Fraction contaminated tuberous vegetables (adult) [fta]
  1.00E+00   -
Justification
  Changed without justification

Fraction contaminated tuberous vegetables (child) [ftc]
  1.00E+00   -
Justification
  Changed without justification

Fraction contaminated meat (adult) [fmea]
  0.00E+00   -
Justification
  Changed without justification

Fraction contaminated milk (adult) [fmia]
  0.00E+00   -
Justification
  Changed without justification

Fraction contaminated milk (child) [fmic]
  0.00E+00   -
Justification
  Changed without justification

Fraction contaminated meat (child) [fmec]
  0.00E+00   -
Justification
  Changed without justification

Time division adult :

days off	winter	h/d	d/w	w/y	summer	h/d	d/w	w/y
inside dermal		0.0	0.0	0.0		0.0	0.0	0.0
outside inhalant		0.0	0.0	0.0		0.0	0.0	0.0
outside dermal		0.0	0.0	0.0		0.0	0.0	0.0
working days	winter	h/d	d/w	w/y	summer	h/d	d/w	w/y
inside dermal		0.0	0.0	0.0		0.0	0.0	0.0
outside inhalant		16.0	7.0	25.0		16.0	7.0	25.0
outside dermal		16.0	7.0	25.0		16.0	7.0	25.0

```
time inside          winter+
sleeping             summer   h/d     d/w     w/y
-------------------------------------------------------------------------------------
---
                               8.0     7.0    50.0
-------------------------------------------------------------------------------------
---
```

Justification
Assume farmer works 16 hours per day 7 days per week

Time division child:

```
-------------------------------------------------------------------------------------
---
days off             winter   h/d     d/w     w/y    summer  h/d     d/w   w/y
-------------------------------------------------------------------------------------
---
inside dermal                12.0     2.0    25.0            12.0     2.0  25.0
outside inhalant              0.0     0.0     0.0             0.0     0.0   0.0
outside dermal                0.0     0.0     0.0             0.0     0.0   0.0
working days         winter   h/d     d/w     w/y    summer   h/d     d/w   w/ y
-------------------------------------------------------------------------------------
---
inside dermal                12.0     5.0    25.0             4.0     5.0  25.0
outside inhalant              0.0     0.0     0.0             8.0     5.0  25.0
outside dermal                0.0     0.0     0.0             8.0     5.0  25.0

time inside          winter+
sleeping             summer   h/d     d/w     w/y
-------------------------------------------------------------------------------------
---
                              12.0     7.0    50.0
-------------------------------------------------------------------------------------
---
```

Measurements
Code of measurement: Measurement 1
Substance: dioxine 2378 TeCDD

Site

```
-------------------------------------------------------------------------------------
---
  Concentration in soil                   3.60E-06   mg.kg-1
```

Built on area:

```
-------------------------------------------------------------------------------------
---
  Concentration in soil                   3.60E-06   mg.kg-1
```

Open surface:

  Concentration in soil   3.60E-06   mg.kg-1

Cultivated area:

  Concentration in soil   3.60E-06   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   1.69E-09   µg.m-3
  Concentration in indoor air   1.69E-09   µg.m-3

Soil parameters: Current Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 2
Substance: dioxine 1,2,3,7,8-PeCDD

Site

  Concentration in soil   9.80E-07   mg.kg-1

Built on area:

  Concentration in soil   9.80E-07   mg.kg-1

Open surface:

Concentration in soil 9.80E-07 mg.kg-1

Cultivated area:

Concentration in soil 9.80E-07 mg.kg-1

Sediment:

Contactmedia:

Concentration in outdoor air 6.76E-09 µg.m-3
Concentration in indoor air 6.76E-09 µg.m-3

Soil parameters: Current
Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 3
Substance: dioxine 1,2,3,6,7,8

Site

Concentration in soil 4.20E-06 mg.kg-1

Built on area:

Concentration in soil 4.20E-06 mg.kg-1

Open surface:

  Concentration in soil   4.20E-06   mg.kg-1

Cultivated area:

  Concentration in soil   4.20E-06   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   6.20E-09   µg.m-3
  Concentration in indoor air   6.20E-09   µg.m-3

Soil parameters: Current Default

Soil parameters	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 4
Substance: dioxine 1,2,3,4,7,8

Site

  Concentration in soil   1.10E-06   mg.kg-1

Built on area:

  Concentration in soil   1.10E-06   mg.kg-1

Open surface:

  Concentration in soil   1.10E-06   mg.kg-1

Cultivated area:

  Concentration in soil   1.10E-06   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   3.15E-08   µg.m-3
  Concentration in indoor air   3.15E-08   µg.m-3

Soil parameters: Current
Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 5
Substance: dioxine 1,2,3,7,8,9

Site

  Concentration in soil   2.40E-06   mg.kg-1

Built on area:

  Concentration in soil   2.40E-06   mg.kg-1

Open surface:

  Concentration in soil   2.40E-06   mg.kg-1

Cultivated area:

  Concentration in soil   2.40E-06   mg.kg-1

Sediment:

  Concentration in sediment   0.00E+00   mg.kg-1

Contactmedia:

  Concentration in outdoor air   2.88E-08   µg.m-3
  Concentration in indoor air   2.88E-08   µg.m-3

Soil parameters: Current Default

Soil parameters	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 6
Substance: dioxine 1,2,3,4,6,7,8

Site

  Concentration in soil   8.80E-05   mg.kg-1

Built on area:

  Concentration in soil   8.80E-05   mg.kg-1

Open surface:

  Concentration in soil   8.80E-05   mg.kg-1

Cultivated area:

  Concentration in soil   8.80E-05   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   2.42E-07   µg.m-3
  Concentration in indoor air   2.42E-07   µg.m-3

Soil parameters: Current Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 7
Substance: dioxine OCDD

Site

  Concentration in soil   9.30E-07   mg.kg-1

Built on area:

  Concentration in soil   9.30E-07   mg.kg-1

Open surface:

  Concentration in soil   9.30E-07   mg.kg-1

Cultivated area:

  Concentration in soil   9.30E-07   mg.kg-1

Sediment:

  Concentration in sediment   0.00E+00   mg.kg-1

Contactmedia:

  Concentration in outdoor air   3.94E-07   µg.m-3
  Concentration in indoor air   3.94E-07   µg.m-3

Soil parameters: Current
Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 8
Substance: 2,3,7,8 TCDF

Site

  Concentration in soil   7.50E-06   mg.kg-1

Built on area:

  Concentration in soil   7.50E-06   mg.kg-1

Open surface:

  Concentration in soil   7.50E-06   mg.kg-1

Cultivated area:

  Concentration in soil   7.50E-06   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   2.48E-08   µg.m-3
  Concentration in indoor air   2.48E-08   µg.m-3

Soil parameters:	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 9
Substance: 1,2,3,7,8 PeCDF

Site

  Concentration in soil   5.00E-06   mg.kg-1

Built on area:

  Concentration in soil   5.00E-06   mg.kg-1

Open surface:

Concentration in soil 5.00E-06 mg.kg-1

Cultivated area:

Concentration in soil 5.00E-06 mg.kg-1

Sediment:

Contactmedia:

Concentration in outdoor air 2.50E-08 µg.m-3
Concentration in indoor air 2.50E-08 µg.m-3

Soil parameters:	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 10
Substance: 1,2,3,4,7,8 HxCDF

Site

Concentration in soil 8.70E-06 mg.kg-1

Built on area:

Concentration in soil 8.70E-06 mg.kg-1

Open surface:

  Concentration in soil   8.70E-06   mg.kg-1

Cultivated area:

  Concentration in soil   8.70E-06   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   8.40E-08   µg.m-3
  Concentration in indoor air   8.40E-08   µg.m-3

Soil parameters: Current
Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 11
Substance: 2,3,4,7,8 PeCDF

Site

  Concentration in soil   5.40E-06   mg.kg-1

Built on area:

  Concentration in soil   5.40E-06   mg.kg-1

Open surface:

  Concentration in soil   5.40E-06   mg.kg-1

Cultivated area:

  Concentration in soil   5.40E-06   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   2.14E-07   µg.m-3
  Concentration in indoor air   2.14E-07   µg.m-3

Soil parameters: Current
Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 12
Substance: 1,2,3,6,7,8 HxCDF

Site

  Concentration in soil   4.50E-06   mg.kg-1

Built on area:

  Concentration in soil   4.50E-06   mg.kg-1

Open surface:

  Concentration in soil   4.50E-06   mg.kg-1

Cultivated area:

  Concentration in soil   4.50E-06   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   7.33E-08   µg.m-3
  Concentration in indoor air   7.33E-08   µg.m-3

Soil parameters:	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 13
Substance: 1,2,3,7,8,9 HxCDF

Site

  Concentration in soil   1.70E-06   mg.kg-1

Built on area:

  Concentration in soil   1.70E-06   mg.kg-1

Open surface:

  Concentration in soil   1.70E-06   mg.kg-1

Cultivated area:

  Concentration in soil   1.70E-06   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   1.01E-07   µg.m-3
  Concentration in indoor air   1.01E-07   µg.m-3

Soil parameters:	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 14
Substance: 2,3,4,6,7,8 Hp CDF

Site

  Concentration in soil   3.20E-06   mg.kg-1

Built on area:

  Concentration in soil   3.20E-06   mg.kg-1

Open surface:

  Concentration in soil   3.20E-06   mg.kg-1

Cultivated area:

  Concentration in soil   3.20E-06   mg.kg-1

Sediment:

  Concentration in sediment   0.00E+00   mg.kg-1

Contactmedia:

  Concentration in outdoor air   3.27E-08   µg.m-3
  Concentration in indoor air   3.27E-08   µg.m-3

Soil parameters:	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 15
Substance: 1,2,3,4,6,7,8 HpCDF

Site

  Concentration in soil   5.80E-05   mg.kg-1

Built on area:

  Concentration in soil   5.80E-05   mg.kg-1

Open surface:

  Concentration in soil   5.80E-05   mg.kg-1

Cultivated area:

  Concentration in soil   5.80E-05   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   4.34E-07   µg.m-3
  Concentration in indoor air   4.34E-07   µg.m-3

Soil parameters:	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 16
Substance: 1,2,3,4,7,8,9 HpCDF

Site

  Concentration in soil   3.90E-09   mg.kg-1

Built on area:

  Concentration in soil   3.90E-09   mg.kg-1

Open surface:

  Concentration in soil   3.90E-09   mg.kg-1

Cultivated area:

  Concentration in soil   3.90E-09   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   5.30E-08   µg.m-3
  Concentration in indoor air   5.30E-08   µg.m-3

Soil parameters: Current Default

Soil parameters	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 17
Substance: OCDF

Site

  Concentration in soil   8.70E-05   mg.kg-1

Built on area:

  Concentration in soil   8.70E-05   mg.kg-1

Open surface:

  Concentration in soil   8.70E-05   mg.kg-1

Cultivated area:

  Concentration in soil   8.70E-05   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   2.42E-07   µg.m-3
  Concentration in indoor air   2.42E-07   µg.m-3

Soil parameters: Current Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 18
Substance: mercury

Site

  Concentration in soil   1.00E+00   mg.kg-1

Built on area:

  Concentration in soil   1.00E+00   mg.kg-1

Open surface:

  Concentration in soil   1.00E+00   mg.kg-1

Cultivated area:

  Concentration in soil   1.00E+00   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   1.00E-03   µg.m-3
  Concentration in indoor air   1.00E-03   µg.m-3

Soil parameters: Current
Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

==== Result ====

Scenario : Scenario 0
Subsite : Subsite 0

= Uptake Table =

Measurement   : Measurement 1
Substance   : dioxine 2378 TeCDD

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	7.62E-13	1.87E-13	2.36E-13

inhalation outdoor air	1.03E-13	3.74E-13	3.51E-13
ingestion soil	3.60E-11	3.00E-12	5.83E-12
dermal contact soil	1.54E-12	4.59E-12	4.33E-12
inhalation soil	5.69E-14	3.35E-14	3.55E-14
ingestion drinking water	2.96E-15	1.48E-15	1.61E-15
dermal contact shower	5.33E-15	2.53E-15	2.77E-15
inhalation vapour shower	2.97E-17	1.93E-17	2.02E-17
ingestion vegetables	7.54E-09	3.76E-09	4.08E-09
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	7.58E-09	3.77E-09	4.09E-09

= Uptake Table =

Measurement : Measurement 2
Substance : dioxine 1,2,3,7,8-PeCDD

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	3.05E-12	7.48E-13	9.45E-13
inhalation outdoor air	4.12E-13	1.50E-12	1.40E-12
ingestion soil	9.80E-12	8.17E-13	1.59E-12
dermal contact soil	4.20E-13	1.25E-12	1.18E-12
inhalation soil	1.55E-14	9.11E-15	9.66E-15
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	6.36E-09	3.17E-09	3.45E-09
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	6.38E-09	3.18E-09	3.45E-09

= Uptake Table =

Measurement : Measurement 3
Substance : dioxine 1,2,3,6,7,8

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong

inhalation indoor air	2.80E-12	6.86E-13	8.67E-13
inhalation outdoor air	3.78E-13	1.37E-12	1.29E-12
ingestion soil	4.20E-11	3.50E-12	6.80E-12
dermal contact soil	1.80E-12	5.36E-12	5.05E-12
inhalation soil	6.64E-14	3.90E-14	4.14E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	1.06E-08	5.27E-09	5.73E-09
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	1.06E-08	5.28E-09	5.74E-09

= Uptake Table =

Measurement : Measurement 4
Substance : dioxine 1,2,3,4,7,8

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.42E-11	3.49E-12	4.41E-12
inhalation outdoor air	1.92E-12	6.97E-12	6.54E-12
ingestion soil	1.10E-11	9.17E-13	1.78E-12
dermal contact soil	4.71E-13	1.40E-12	1.32E-12
inhalation soil	1.74E-14	1.02E-14	1.08E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	2.77E-09	1.38E-09	1.50E-09
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	2.80E-09	1.39E-09	1.51E-09

= Uptake Table =

Measurement : Measurement 5
Substance : dioxine 1,2,3,7,8,9

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.30E-11	3.18E-12	4.02E-12
inhalation outdoor air	1.75E-12	6.37E-12	5.97E-12
ingestion soil	2.40E-11	2.00E-12	3.89E-12
dermal contact soil	1.03E-12	3.06E-12	2.89E-12
inhalation soil	3.79E-14	2.23E-14	2.37E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	6.04E-09	3.01E-09	3.27E-09
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	6.08E-09	3.03E-09	3.29E-09

= Uptake Table =

Measurement : Measurement 6
Substance : dioxine 1,2,3,4,6,7,8

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.09E-10	2.68E-11	3.38E-11
inhalation outdoor air	1.48E-11	5.36E-11	5.02E-11
ingestion soil	8.80E-10	7.33E-11	1.42E-10
dermal contact soil	3.77E-11	1.12E-10	1.06E-10
inhalation soil	1.39E-12	8.18E-13	8.67E-13
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	6.31E-08	3.15E-08	3.42E-08
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	6.42E-08	3.18E-08	3.45E-08

= Uptake Table =

Measurement : Measurement 7

Substance : dioxine OCDD

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.78E-10	4.36E-11	5.51E-11
inhalation outdoor air	2.40E-11	8.72E-11	8.18E-11
ingestion soil	9.30E-12	7.75E-13	1.51E-12
dermal contact soil	3.98E-13	1.19E-12	1.12E-12
inhalation soil	1.47E-14	8.65E-15	9.16E-15
ingestion drinking water	3.04E-17	1.52E-17	1.65E-17
dermal contact shower	6.10E-18	2.89E-18	3.17E-18
inhalation vapour shower	1.23E-19	7.97E-20	8.34E-20
ingestion vegetables	9.29E-10	4.63E-10	5.03E-10
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	1.14E-09	5.96E-10	6.43E-10

= Uptake Table =

Measurement : Measurement 8
Substance : 2,3,7,8 TCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.12E-11	2.74E-12	3.47E-12
inhalation outdoor air	1.51E-12	5.49E-12	5.15E-12
ingestion soil	7.50E-11	6.25E-12	1.21E-11
dermal contact soil	3.21E-12	9.56E-12	9.02E-12
inhalation soil	1.19E-13	6.97E-14	7.39E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	3.86E-10	1.92E-10	2.09E-10
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	4.77E-10	2.17E-10	2.39E-10

= Uptake Table =

Measurement : Measurement 9
Substance : 1,2,3,7,8 PeCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.13E-11	2.77E-12	3.50E-12
inhalation outdoor air	1.52E-12	5.53E-12	5.19E-12
ingestion soil	5.00E-11	4.17E-12	8.10E-12
dermal contact soil	2.14E-12	6.38E-12	6.01E-12
inhalation soil	7.90E-14	4.65E-14	4.93E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	6.40E-10	3.19E-10	3.47E-10
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	7.05E-10	3.38E-10	3.70E-10

= Uptake Table =

Measurement : Measurement 10
Substance : 1,2,3,4,7,8 HxCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	3.79E-11	9.30E-12	1.17E-11
inhalation outdoor air	5.12E-12	1.86E-11	1.74E-11
ingestion soil	8.70E-11	7.25E-12	1.41E-11
dermal contact soil	3.73E-12	1.11E-11	1.05E-11
inhalation soil	1.38E-13	8.09E-14	8.57E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	2.67E-09	1.33E-09	1.45E-09
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	2.81E-09	1.38E-09	1.50E-09

= Uptake Table =

Measurement : Measurement 11
Substance : 2,3,4,7,8 PeCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	9.65E-11	2.37E-11	2.99E-11
inhalation outdoor air	1.30E-11	4.74E-11	4.44E-11
ingestion soil	5.40E-11	4.50E-12	8.74E-12
dermal contact soil	2.31E-12	6.89E-12	6.49E-12
inhalation soil	8.54E-14	5.02E-14	5.32E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	6.91E-10	3.45E-10	3.75E-10
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	8.57E-10	4.27E-10	4.64E-10

= Uptake Table =

Measurement : Measurement 12
Substance : 1,2,3,6,7,8 HxCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	3.31E-11	8.11E-12	1.03E-11
inhalation outdoor air	4.47E-12	1.62E-11	1.52E-11
ingestion soil	4.50E-11	3.75E-12	7.29E-12
dermal contact soil	1.93E-12	5.74E-12	5.41E-12
inhalation soil	7.11E-14	4.18E-14	4.43E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	1.38E-09	6.90E-10	7.49E-10
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00

Total exposure	1.47E-09	7.24E-10	7.87E-10

= Uptake Table =

Measurement : Measurement 13
Substance : 1,2,3,7,8,9 HxCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	4.56E-11	1.12E-11	1.41E-11
inhalation outdoor air	6.16E-12	2.24E-11	2.10E-11
ingestion soil	1.70E-11	1.42E-12	2.75E-12
dermal contact soil	7.28E-13	2.17E-12	2.04E-12
inhalation soil	2.69E-14	1.58E-14	1.68E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	5.22E-10	2.61E-10	2.83E-10
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	5.92E-10	2.98E-10	3.23E-10

= Uptake Table =

Measurement : Measurement 14
Substance : 2,3,4,6,7,8 Hp CDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.47E-11	3.62E-12	4.57E-12
inhalation outdoor air	1.99E-12	7.24E-12	6.79E-12
ingestion soil	3.20E-11	2.67E-12	5.18E-12
dermal contact soil	1.37E-12	4.08E-12	3.85E-12
inhalation soil	5.06E-14	2.97E-14	3.15E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	6.34E-10	3.17E-10	3.44E-10

ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	6.85E-10	3.34E-10	3.64E-10

= Uptake Table =

Measurement : Measurement 15
Substance : 1,2,3,4,6,7,8 HpCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.96E-10	4.80E-11	6.07E-11
inhalation outdoor air	2.65E-11	9.61E-11	9.01E-11
ingestion soil	5.80E-10	4.83E-11	9.39E-11
dermal contact soil	2.49E-11	7.40E-11	6.97E-11
inhalation soil	9.17E-13	5.39E-13	5.72E-13
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	1.15E-08	5.74E-09	6.23E-09
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	1.23E-08	6.00E-09	6.55E-09

= Uptake Table =

Measurement : Measurement 16
Substance : 1,2,3,4,7,8,9 HpCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	2.39E-11	5.87E-12	7.41E-12
inhalation outdoor air	3.23E-12	1.17E-11	1.10E-11
ingestion soil	3.90E-14	3.25E-15	6.31E-15
dermal contact soil	1.67E-15	4.97E-15	4.69E-15
inhalation soil	6.17E-17	3.63E-17	3.84E-17
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00

dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	1.21E-11	6.05E-12	6.57E-12
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	3.93E-11	2.37E-11	2.50E-11

= Uptake Table =

Measurement : Measurement 17
Substance : OCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.09E-10	2.68E-11	3.38E-11
inhalation outdoor air	1.48E-11	5.36E-11	5.02E-11
ingestion soil	8.70E-10	7.25E-11	1.41E-10
dermal contact soil	3.73E-11	1.11E-10	1.05E-10
inhalation soil	1.38E-12	8.09E-13	8.57E-13
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	1.56E-07	7.81E-08	8.48E-08
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	1.57E-07	7.83E-08	8.51E-08

= Uptake Table =

Measurement : Measurement 18
Substance : mercury

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	0.00E+00	0.00E+00	0.00E+00
inhalation outdoor air	0.00E+00	0.00E+00	0.00E+00
ingestion soil	1.00E-05	8.33E-07	1.62E-06

dermal contact soil	0.00E+00	0.00E+00	0.00E+00
inhalation soil	1.58E-08	9.30E-09	9.85E-09
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	1.09E-04	5.43E-05	5.90E-05
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	1.19E-04	5.52E-05	6.06E-05

= Risk Table =

Maximum Permissable Risk level

Measurement	Substance	Dose(mg/(kg.d))	RfD(mg/(kg.d))	Dose/RfD
Measurement 1	dioxine 2378 TeCDD	4.09E-09	1.00E-08	4.09E-01
Measurement 2	dioxine 1,2,3,7,8-PeCDD	3.45E-09	0.00E+00	-
Measurement 3	dioxine 1,2,3,6,7,8	5.74E-09	0.00E+00	-
Measurement 4	dioxine 1,2,3,4,7,8	1.51E-09	0.00E+00	-
Measurement 5	dioxine 1,2,3,7,8,9	3.29E-09	0.00E+00	-
Measurement 6	dioxine 1,2,3,4,6,7,8	3.45E-08	0.00E+00	-
Measurement 7	dioxine OCDD	6.43E-10	1.00E-08	6.43E-02
Measurement 8	2,3,7,8 TCDF	2.39E-10	0.00E+00	-
Measurement 9	1,2,3,7,8 PeCDF	3.70E-10	0.00E+00	-
Measurement 10	1,2,3,4,7,8 HxCDF	1.50E-09	0.00E+00	-
Measurement 11	2,3,4,7,8 PeCDF	4.64E-10	0.00E+00	-
Measurement 12	1,2,3,6,7,8 HxCDF	7.87E-10	0.00E+00	-
Measurement 13	1,2,3,7,8,9 HxCDF	3.23E-10	0.00E+00	-
Measurement 14	2,3,4,6,7,8 Hp CDF	3.64E-10	0.00E+00	-
Measurement 15	1,2,3,4,6,7,8 HpCDF	6.55E-09	0.00E+00	-
Measurement 16	1,2,3,4,7,8,9 HpCDF	2.50E-11	0.00E+00	-
Measurement 17	OCDF	8.51E-08	0.00E+00	-
Measurement 18	mercury	6.06E-05	6.10E-04	9.94E-02

RfD = Reference Dose

Indoor concentration in air

Measurement	Substance	Cia(µg/m3)	TCA(µg/m3)	Cia/TCA
Measurement 1	dioxine 2378 TeCDD	1.69E-09	0.00E+00	-
Measurement 2	dioxine 1,2,3,7,8-PeCDD	6.76E-09	0.00E+00	-
Measurement 3	dioxine 1,2,3,6,7,8	6.20E-09	0.00E+00	-

Measurement 4	dioxine 1,2,3,4,7,8	3.15E-08	0.00E+00	-
Measurement 5	dioxine 1,2,3,7,8,9	2.88E-08	0.00E+00	-
Measurement 6	dioxine 1,2,3,4,6,7,8	2.42E-07	0.00E+00	-
Measurement 7	dioxine OCDD	3.94E-07	0.00E+00	-
Measurement 8	2,3,7,8 TCDF	2.48E-08	0.00E+00	-
Measurement 9	1,2,3,7,8 PeCDF	2.50E-08	0.00E+00	-
Measurement 10	1,2,3,4,7,8 HxCDF	8.40E-08	0.00E+00	-
Measurement 11	2,3,4,7,8 PeCDF	2.14E-07	0.00E+00	-
Measurement 12	1,2,3,6,7,8 HxCDF	7.33E-08	0.00E+00	-
Measurement 13	1,2,3,7,8,9 HxCDF	1.01E-07	0.00E+00	-
Measurement 14	2,3,4,6,7,8 Hp CDF	3.27E-08	0.00E+00	-
Measurement 15	1,2,3,4,6,7,8 HpCDF	4.34E-07	0.00E+00	-
Measurement 16	1,2,3,4,7,8,9 HpCDF	5.30E-08	0.00E+00	-
Measurement 17	OCDF	2.42E-07	0.00E+00	-
Measurement 18	mercury	1.00E-03	0.00E+00	-

TCA = Tolerable Concentration in Air Cia = Concentration in indoor air

Outdoor concentration in air

Measurement	Substance	Coa(µg/m3)	TCA(µg/m3)	Coa/TCA
Measurement 1	dioxine 2378 TeCDD	1.69E-09	0.00E+00	-
Measurement 2	dioxine 1,2,3,7,8-PeCDD	6.76E-09	0.00E+00	-
Measurement 3	dioxine 1,2,3,6,7,8	6.20E-09	0.00E+00	-
Measurement 4	dioxine 1,2,3,4,7,8	3.15E-08	0.00E+00	-
Measurement 5	dioxine 1,2,3,7,8,9	2.88E-08	0.00E+00	-
Measurement 6	dioxine 1,2,3,4,6,7,8	2.42E-07	0.00E+00	-
Measurement 7	dioxine OCDD	3.94E-07	0.00E+00	-
Measurement 8	2,3,7,8 TCDF	2.48E-08	0.00E+00	-
Measurement 9	1,2,3,7,8 PeCDF	2.50E-08	0.00E+00	-
Measurement 10	1,2,3,4,7,8 HxCDF	8.40E-08	0.00E+00	-
Measurement 11	2,3,4,7,8 PeCDF	2.14E-07	0.00E+00	-
Measurement 12	1,2,3,6,7,8 HxCDF	7.33E-08	0.00E+00	-
Measurement 13	1,2,3,7,8,9 HxCDF	1.01E-07	0.00E+00	-
Measurement 14	2,3,4,6,7,8 Hp CDF	3.27E-08	0.00E+00	-
Measurement 15	1,2,3,4,6,7,8 HpCDF	4.34E-07	0.00E+00	-
Measurement 16	1,2,3,4,7,8,9 HpCDF	5.30E-08	0.00E+00	-
Measurement 17	OCDF	2.42E-07	0.00E+00	-
Measurement 18	mercury	1.00E-03	0.00E+00	-

TCA = Tolerable Concentration in Air Coa = Concentration in outdoor air

Concentration in drinking water

Measurement	Substance	Cdw(µg/l)	standard(µg/l)	Cdw/standard
Measurement 1	dioxine 2378 TeCDD	4.44E-11	0.00E+00	-

Measurement 2	dioxine 1,2,3,7,8-PeCDD	0.00E+00	0.00E+00	-
Measurement 3	dioxine 1,2,3,6,7,8	0.00E+00	0.00E+00	-
Measurement 4	dioxine 1,2,3,4,7,8	0.00E+00	0.00E+00	-
Measurement 5	dioxine 1,2,3,7,8,9	0.00E+00	0.00E+00	-
Measurement 6	dioxine 1,2,3,4,6,7,8	0.00E+00	0.00E+00	-
Measurement 7	dioxine OCDD	4.57E-13	0.00E+00	-
Measurement 8	2,3,7,8 TCDF	0.00E+00	0.00E+00	-
Measurement 9	1,2,3,7,8 PeCDF	0.00E+00	0.00E+00	-
Measurement 10	1,2,3,4,7,8 HxCDF	0.00E+00	0.00E+00	-
Measurement 11	2,3,4,7,8 PeCDF	0.00E+00	0.00E+00	-
Measurement 12	1,2,3,6,7,8 HxCDF	0.00E+00	0.00E+00	-
Measurement 13	1,2,3,7,8,9 HxCDF	0.00E+00	0.00E+00	-
Measurement 14	2,3,4,6,7,8 Hp CDF	0.00E+00	0.00E+00	-
Measurement 15	1,2,3,4,6,7,8 HpCDF	0.00E+00	0.00E+00	-
Measurement 16	1,2,3,4,7,8,9 HpCDF	0.00E+00	0.00E+00	-
Measurement 17	OCDF	0.00E+00	0.00E+00	-
Measurement 18	mercury	0.00E+00	1.00E+00	0.00E+00

Cdw = Concentration in drinking water

Background

Measurement	Substance	Dose(mg/(kg.d))	Background(mg/(kg.d))
Measurement 1	dioxine 2378 TeCDD	4.09E-09	0.00E+00
Measurement 2	dioxine 1,2,3,7,8-PeCDD	3.45E-09	0.00E+00
Measurement 3	dioxine 1,2,3,6,7,8	5.74E-09	0.00E+00
Measurement 4	dioxine 1,2,3,4,7,8	1.51E-09	0.00E+00
Measurement 5	dioxine 1,2,3,7,8,9	3.29E-09	0.00E+00
Measurement 6	dioxine 1,2,3,4,6,7,8	3.45E-08	0.00E+00
Measurement 7	dioxine OCDD	6.43E-10	0.00E+00
Measurement 8	2,3,7,8 TCDF	2.39E-10	0.00E+00
Measurement 9	1,2,3,7,8 PeCDF	3.70E-10	0.00E+00
Measurement 10	1,2,3,4,7,8 HxCDF	1.50E-09	0.00E+00
Measurement 11	2,3,4,7,8 PeCDF	4.64E-10	0.00E+00
Measurement 12	1,2,3,6,7,8 HxCDF	7.87E-10	0.00E+00
Measurement 13	1,2,3,7,8,9 HxCDF	3.23E-10	0.00E+00
Measurement 14	2,3,4,6,7,8 Hp CDF	3.64E-10	0.00E+00
Measurement 15	1,2,3,4,6,7,8 HpCDF	6.55E-09	0.00E+00
Measurement 16	1,2,3,4,7,8,9 HpCDF	2.50E-11	0.00E+00
Measurement 17	OCDF	8.51E-08	0.00E+00
Measurement 18	mercury	6.06E-05	1.40E-04

Substance : mercury

Physical-chemical parameters

Moleculair weight	2.01E+02	g.mol-1
Water solubility	3.00E+03	mg.l-1
Vapour pressure	-	Pa
Klw	-	-
Log Kow	-	-
Log Koc	-	dm3.kg-1
Kd	3.30E+03	dm3.kg-1
BCF(root)	1.50E-02	-
BCF(stem)	3.00E-02	-
D(pe)	-	m2.d-1
Diffusion coefficient (air)	-	m2.h-1
Diffusion coefficient(water)	-	m2.h-1
DAR(adult)	-	h-1
DAR(child)	-	h-1
fexcr	-	-
pKa	-	-

Standards

RfD	6.10E-04	mg.kg-1.d-1
TCA	-	µg.m-3
Drinking water standard	1.00E+00	µg.l-1

Background dose

Background concentration	0.00E+00	µg.m-3

Substance : dioxine 2378 TeCDD

Physical-chemical parameters

Moleculair weight	3.22E+02	g.mol-1
Water solubility	3.00E-04	mg.l-1
Vapour pressure	1.40E-06	Pa
Klw	6.39E-04	-
Log Kow	6.80E+00	-
Log Koc	6.41E+00	dm3.kg-1
Kd	-	dm3.kg-1
BCF(root)	-	-
BCF(stem)	-	-
D(pe)	1.00E-07	m2.d-1
Diffusion coefficient (air)	-	m2.h-1
Diffusion coefficient(water)	-	m2.h-1
DAR(adult)	5.00E-03	h-1
DAR(child)	1.00E-02	h-1
fexcr	-	-
pKa	-	-

Standards

RfD	1.00E-08	mg.kg-1.d-1
TCA	-	µg.m-3

Drinking water standard	-	µg.l-1
Background dose		
Background concentration	0.00E+00	µg.m-3

Substance : dioxine OCDD

Physical-chemical parameters

Moleculair weight	4.60E+02	g.mol-1
Water solubility	4.00E-07	mg.l-1
Vapour pressure	5.93E-10	Pa
Klw	2.90E-04	-
Log Kow	8.20E+00	-
Log Koc	7.81E+00	dm3.kg-1
Kd	-	dm3.kg-1
BCF(root)	-	-
BCF(stem)	-	-
D(pe)	1.00E-07	m2.d-1
Diffusion coefficient (air)	-	m2.h-1
Diffusion coefficient(water)	-	m2.h-1
DAR(adult)	5.00E-03	h-1
DAR(child)	1.00E-02	h-1
fexcr	-	-
pKa	-	-

Standards

RfD	1.00E-08	mg.kg-1.d-1
TCA	-	µg.m-3
Drinking water standard	-	µg.l-1
Background dose		
Background concentration	0.00E+00	µg.m-3

Substance : dioxine 1,2,3,7,8-PeCDD

Based on : none [organic - user defined]

Description

1,2,3,7,8-PeCDD

Physical-chemical parameters

Moleculair weight	3.56E+02	g.mol-1
Water solubility	1.18E-04	mg.l-1
Vapour pressure	8.80E-08	Pa
Klw	1.13E-04	-
Log Kow	7.40E+00	-
Log Koc	6.38E+00	dm3.kg-1
Kd	0.00E+00	dm3.kg-1

BCF(root)	-	-	calculated
BCF(stem)	0.00E+00	-	
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	0.00E+00	m2.h-1	
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
Parameters from Phys Chem Props of organic chemicals Vol 3 and US EPA vol 3

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : dioxine 1,2,3,6,7,8
Based on : none [organic - user defined]
Description
dioxin 1,2,3,6,7,8 HxCDD
Physical-chemical parameters

Moleculair weight	3.91E+02	g.mol-1	
Water solubility	4.40E-06	mg.l-1	
Vapour pressure	5.10E-09	Pa	
Klw	4.61E-04	-	
Log Kow	7.80E+00	-	
Log Koc	7.10E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
As above

Standards

RfD	0.00E+00	mg.kg-1.d-1	
TCA	0.00E+00	µg.m-3	
Drinking water standard	0.00E+00	µg.l-1	

Justification

Background dose			
Background concentration	0.00E+00	µg.m-3	

Justification

Substance : dioxine 1,2,3,4,7,8
Based on : none [organic - user defined]
Description
dioxin 1,2,3,4,7,8 HcDD
Physical-chemical parameters

Moleculair weight	3.91E+02	g.mol-1	
Water solubility	4.40E-06	mg.l-1	
Vapour pressure	5.10E-09	Pa	
Klw	4.61E-04	-	
Log Kow	7.80E+00	-	
Log Koc	7.10E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1	
TCA	0.00E+00	µg.m-3	
Drinking water standard	0.00E+00	µg.l-1	

Justification

Background dose			
Background concentration	0.00E+00	µg.m-3	

Justification

Substance : dioxine 1,2,3,7,8,9
Based on : none [organic - user defined]
Description
dioxin 1,2,3,7,8,9 HxCDD
Physical-chemical parameters

Moleculair weight	3.91E+02	g.mol-1	
Water solubility	4.60E-06	mg.l-1	
Vapour pressure	5.10E-09	Pa	
Klw	4.61E-04	-	
Log Kow	7.80E+00	-	
Log Koc	7.10E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : dioxine 1,2,3,4,6,7,8
Based on : none [organic - user defined]
Description
dioxin 1,2,3,4,6,7,8, HpCdd
Physical-chemical parameters

Moleculair weight	4.25E+02	g.mol-1
Water solubility	2.40E-06	mg.l-1
Vapour pressure	7.50E-10	Pa
Klw	5.41E-04	-
Log Kow	8.00E+00	-
Log Koc	7.80E+00	dm3.kg-1

Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : 2,3,7,8 TCDF
Based on : none [organic - user defined]
Description
2,3,7,8 TCDF
Physical-chemical parameters

Moleculair weight	1.68E+02	g.mol-1	
Water solubility	4.19E-03	mg.l-1	
Vapour pressure	2.00E-06	Pa	
Klw	6.21E-04	-	
Log Kow	6.10E+00	-	
Log Koc	7.50E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
As above

Standards			
RfD	0.00E+00	mg.kg-1.d-1	
TCA	0.00E+00	µg.m-3	
Drinking water standard	0.00E+00	µg.l-1	

Justification

Background dose			
Background concentration	0.00E+00	µg.m-3	

Justification

Substance : 1,2,3,7,8 PeCDF
Based on : none [organic - user defined]
Description
1,2,3,7,8 PeCDF

Physical-chemical parameters			
Moleculair weight	3.40E+02	g.mol-1	
Water solubility	2.36E-04	mg.l-1	
Vapour pressure	3.50E-07	Pa	
Klw	2.15E-04	-	
Log Kow	6.50E+00	-	
Log Koc	7.40E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
As above

Standards			
RfD	0.00E+00	mg.kg-1.d-1	
TCA	0.00E+00	µg.m-3	
Drinking water standard	0.00E+00	µg.l-1	

Justification

Background dose			
Background concentration	0.00E+00	µg.m-3	

Justification

Substance : 2,3,4,7,8 PeCDF
Based on : 1,2,3,7,8 PeCDF [organic - user defined]
Description
2,3,4,7,8 Pe CDF
Physical-chemical parameters

Moleculair weight	3.40E+02	g.mol-1	
Water solubility	2.36E-01	mg.l-1	
Vapour pressure	3.50E-07	Pa	
Klw	2.15E-04	-	
Log Kow	6.50E+00	-	
Log Koc	7.40E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
As above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : 1,2,3,4,7,8 HxCDF
Based on : none [organic - user defined]
Description
1,2,3,4,7,8 HxCDF
Physical-chemical parameters

Moleculair weight	3.75E+02	g.mol-1
Water solubility	1.77E-04	mg.l-1
Vapour pressure	3.50E-08	Pa
Klw	3.15E-04	-
Log Kow	7.00E+00	-

Log Koc	7.40E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : 1,2,3,6,7,8 HxCDF
Based on : 1,2,3,4,7,8 HxCDF [organic - user defined]
Description
1,2,3,6,7,8 Hx CDF
Physical-chemical parameters

Moleculair weight	3.75E+02	g.mol-1	
Water solubility	1.77E-04	mg.l-1	
Vapour pressure	3.50E-08	Pa	
Klw	3.15E-04	-	
Log Kow	7.00E+00	-	
Log Koc	7.40E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards			
RfD	0.00E+00	mg.kg-1.d-1	
TCA	0.00E+00	µg.m-3	
Drinking water standard	0.00E+00	µg.l-1	

Justification

Background dose		
Background concentration	0.00E+00	µg.m-3

Justification

Substance : 1,2,3,7,8,9 HxCDF
Based on : 1,2,3,6,7,8 HxCDF [organic - user defined]
Description
1,2,3,7,8,9 HxCDF

Physical-chemical parameters			
Moleculair weight	3.75E+02	g.mol-1	
Water solubility	1.77E-04	mg.l-1	
Vapour pressure	3.50E-08	Pa	
Klw	3.15E-04	-	
Log Kow	7.00E+00	-	
Log Koc	7.40E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards		
RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose		
Background concentration	0.00E+00	µg.m-3

Justification

Substance : 2,3,4,6,7,8 Hp CDF
Based on : none [organic - user defined]
Description
2,3,4,6,7,8 Hp CDF
Physical-chemical parameters

Moleculair weight	4.09E+02	g.mol-1	
Water solubility	1.30E-06	mg.l-1	
Vapour pressure	4.70E-09	Pa	
Klw	6.06E-04	-	
Log Kow	7.40E+00	-	
Log Koc	7.90E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : 1,2,3,4,6,7,8 HpCDF
Based on : 2,3,4,6,7,8 Hp CDF [organic - user defined]
Description
1,2,3,4,6,7,8 HpCDF
Physical-chemical parameters

Moleculair weight	4.09E+02	g.mol-1
Water solubility	1.30E-06	mg.l-1
Vapour pressure	4.70E-09	Pa
Klw	6.06E-04	-

Log Kow	7.40E+00	-	
Log Koc	7.90E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : 1,2,3,4,7,8,9 HpCDF
Based on : 1,2,3,4,6,7,8 HpCDF [organic - user defined]
Description
1,2,3,4,7,8,9 HpCDF
Physical-chemical parameters

Moleculair weight	4.09E+02	g.mol-1	
Water solubility	1.30E-06	mg.l-1	
Vapour pressure	4.62E-08	Pa	
Klw	6.06E-04	-	
Log Kow	7.40E+00	-	
Log Koc	6.70E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification

as above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : OCDF
Based on : none [organic - user defined]
Description
OCDF
Physical-chemical parameters

Moleculair weight	4.44E+02	g.mol-1	
Water solubility	1.16E-06	mg.l-1	
Vapour pressure	5.10E-10	Pa	
Klw	8.12E-05	-	
Log Kow	8.00E+00	-	
Log Koc	7.40E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	0.00E+00	m2.h-1	
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

ATTACHMENT E

TERMS FOR SOIL EQUATION (PREDICTION OF AVERAGE SOIL CONCENTRATION OVER EXPOSURE PERIOD)

Parameter	Definition
Sc	Average soil concentration over exposure duration (mg/kg)
Ds	Deposition term (mg/kg-yr)
ks	Soil loss constant (yr^{-1})
Tc	Time period over which deposition occurs (yr)
T_1	Time at beginning of exposure period (yr)

ATTACHMENT F

CALCULATION OF KS

	Ks	Ksl	Kse	Ksr	Ksv
2,3,7,8-TCDD	27.380571	0.0005	0	0.0016909	27.37838
1,2,3,7,8-PeCDD	4.5827058	0.0005	0	0.0016909	4.5805148
1,2,3,6,7,8-HxCDD	1180.0648	0.0001125	0	0.0003805	1180.0643
1,2,3,4,7,8-HcCDD	0.949219	2.177E-05	0	7.364E-05	0.9491236
1,2,3,7,8,9-HxCDD	4.9042984	0.0001125	0	0.0003805	4.9038054
1,2,3,4,6,7,8-HpCDD	123.73753	1.378E-05	0	4.659E-05	123.73747
OCDD	0.0017735	5.625E-05	0	0.0001902	0.001527
			0		
2,3,7,8-TCDF	18.658219	0.0006429	0	0.0021741	18.655402
1,2,3,7,8-PeCDF	7.6499933	0.0003553	0	0.0012015	7.647464
2,3,4,7,8-PeCDF	5.6995766	0.0002647	0	0.0008952	5.6981104
1,2,3,4,7,8-HxCDF	5.6346672	0.0001125	0	0.0003805	5.6336594
1,2,3,6,7,8 HxCDF	2.4551589	0.0001125	0	0.0003805	2.4546659
2,3,4,6,7,8-HpCDF	4.0245354	0.0001125	0	0.0003805	4.0240425
1,2,3,7,8,9-HxCDF	4.0245354	0.0001125	0	0.0003805	4.0240425
1,2,3,4,6,7,8-HpCDF	5.3888084	2.755E-05	0	9.317E-05	5.3884004
1,2,3,4,7,8,9-HpCDF	5.3885211	2.755E-05	0	9.317E-05	5.3884004
OCDF	0.0243666	3.462E-06	0	1.171E-05	0.02427
Mercury	1254657.6	0.0540707	0	0.1689556	1254657.6

ks = ksl+kse+ksr+ksg+Ksv

ks = soil loss constant
ksl = loss constant due to leaching (yr-1)
kse = loss ocnstant due to soil erosion
ksr = loss ocnstant due to surface run-off
ksg = loss constant due to degradation
ksv = loss constant due to volatilisation

	Kds	Koc	foc	Ksl	P cm/yr	I cm/yr	R cm/yr	Ev cm/yr	theta cm	Z cm	BD g/cm3
2,3,7,8-TCDD	16200	2.70E+06	0.006	0.0005	75	0	28.35	34.5	0.2	1	1.5
1,2,3,7,8-PeCDD	16200	2.70E+06	0.006	0.0005	75	0	28.35	34.5	0.2	1	1.5
1,2,3,6,7,8-HxCDD	72000	1.20E+07	0.006	0.0001125	75	0	28.35	34.5	0.2	1	1.5
1,2,3,4,7,8-HcCDD	372000	6.20E+07	0.006	2.177E-05	75	0	28.35	34.5	0.2	1	1.5
1,2,3,7,8,9-HxCDD	72000	1.20E+07	0.006	0.0001125	75	0	28.35	34.5	0.2	1	1.5
1,2,3,4,6,7,8-HpCDD	588000	9.80E+07	0.006	1.378E-05	75	0	28.35	34.5	0.2	1	1.5
OCDD	144000	2.40E+07	0.006	5.625E-05	75	0	28.35	34.5	0.2	1	1.5
					75						
					75						
2,3,7,8-TCDF	12600	2.10E+06	0.006	0.0006429	75	0	28.35	34.5	0.2	1	1.5
1,2,3,7,8-PeCDF	22800	3.80E+06	0.006	0.0003553	75	0	28.35	34.5	0.2	1	1.5
2,3,4,7,8-PeCDF	30600	5.10E+06	0.006	0.0002647	75	0	28.35	34.5	0.2	1	1.5
1,2,3,4,7,8-HxCDF	72000	1.20E+07	0.006	0.0001125	75	0	28.35	34.5	0.2	1	1.5
1,2,3,6,7,8 HxCDF	72000	1.20E+07	0.006	0.0001125	75	0	28.35	34.5	0.2	1	1.5
2,3,4,6,7,8-HpCDF	72000	1.20E+07	0.006	0.0001125	75	0	28.35	34.5	0.2	1	1.5
1,2,3,7,8,9-HxCDF	72000	1.20E+07	0.006	0.0001125	75	0	28.35	34.5	0.2	1	1.5
1,2,3,4,6,7,8-HpCDF	294000	4.90E+07	0.006	2.755E-05	75	0	28.35	34.5	0.2	1	1.5
1,2,3,4,7,8,9-HpCDF	294000	4.90E+07	0.006	2.755E-05	75	0	28.35	34.5	0.2	1	1.5
OCDF	2340000	3.90E+08	0.006	3.462E-06	75	0	28.35	34.5	0.2	1	1.5
Mercury	162	Kd from US EPA SSL		0.0540707	75	1	28.35	34.5	0.2	1	1.5

	Ksr	R	theta	Z	Kds	BD
2,3,7,8-TCDD	0.0016909	41.09	0.2	1	16200	1.5
1,2,3,7,8-PeCDD	0.0016909	41.09	0.2	1	16200	1.5
1,2,3,6,7,8-HxCDD	0.0003805	41.09	0.2	1	72000	1.5
1,2,3,4,7,8-HcCDD	7.364E-05	41.09	0.2	1	372000	1.5
1,2,3,7,8,9-HxCDD	0.0003805	41.09	0.2	1	72000	1.5
1,2,3,4,6,7,8-HpCDD	4.659E-05	41.09	0.2	1	588000	1.5
OCDD	0.0001902	41.09	0.2	1	144000	1.5
2,3,7,8-TCDF	0.0021741	41.09	0.2	1	12600	1.5
1,2,3,7,8-PeCDF	0.0012015	41.09	0.2	1	22800	1.5
2,3,4,7,8-PeCDF	0.0008952	41.09	0.2	1	30600	1.5
1,2,3,4,7,8-HxCDF	0.0003805	41.09	0.2	1	72000	1.5
1,2,3,6,7,8 HxCDF	0.0003805	41.09	0.2	1	72000	1.5
2,3,4,6,7,8-HpCDF	0.0003805	41.09	0.2	1	72000	1.5
1,2,3,7,8,9-HxCDF	0.0003805	41.09	0.2	1	72000	1.5
1,2,3,4,6,7,8-HpCDF	9.317E-05	41.09	0.2	1	294000	1.5
1,2,3,4,7,8,9-HpCDF	9.317E-05	41.09	0.2	1	294000	1.5
OCDF	1.171E-05	41.09	0.2	1	2340000	1.5
Mercury	0.1689556	41.09	0.2	1	162	1.5

	Kds	Koc	foc	Ksv	H	Z	R	T	BD	u	ua	roea	Da	A (m2)
2,3,7,8-TCDD	16200	2.70E+06	0.006	27.37838006	1.60E-05	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	4.70E-02	7.85E+03
1,2,3,7,8-PeCDD	16200	2.70E+06	0.006	4.580514834	2.60E-06	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	4.50E-02	7.85E+03
1,2,3,6,7,8-HxCDD	72000	1.20E+07	0.006	1180.064266	1.20E-05	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	1.20E-05	7854
1,2,3,4,7,8-HcCDD	372000	6.20E+07	0.006	0.949123629	1.20E-05	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	4.30E-02	7854
1,2,3,7,8,9-HxCDD	72000	1.20E+07	0.006	4.903805417	1.20E-05	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	4.30E-02	7854
1,2,3,4,6,7,8-HpCDD	588000	9.80E+07	0.006	123.737471	7.50E-06	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	7.50E-06	7854
OCDD	144000	2.40E+07	0.006	0.00152697	7.00E-09	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	3.90E-02	7854
2,3,7,8-TCDF	12600	2.10E+06	0.006	18.65540242	8.60E-06	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	4.80E-02	7854
1,2,3,7,8-PeCDF	22800	3.80E+06	0.006	7.647463978	6.20E-06	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	4.60E-02	7854
2,3,4,7,8-PeCDF	30600	5.10E+06	0.006	5.698110415	6.20E-06	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	4.60E-02	7854
1,2,3,4,7,8-HxCDF	72000	1.20E+07	0.006	5.63365945	1.40E-05	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	4.40E-02	7854
1,2,3,6,7,8 HxCDF	72000	1.20E+07	0.006	2.454665903	6.10E-06	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	4.40E-02	7854
2,3,4,6,7,8-HpCDF	72000	1.20E+07	0.006	4.024042464	1.00E-05	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	4.40E-02	7854
1,2,3,7,8,9-HxCDF	72000	1.20E+07	0.006	4.024042464	1.00E-05	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	4.40E-02	7854
1,2,3,4,6,7,8-HpCDF	294000	4.90E+07	0.006	5.388400395	5.30E-05	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	4.20E-02	7854
1,2,3,4,7,8,9-HpCDF	294000	4.90E+07	0.006	5.388400395	5.30E-05	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	4.20E-02	7854
OCDF	2340000	3.90E+08	0.006	0.02426996	1.90E-06	1	8.21E-05	288	1.5	5.713947	1.81E-04	1.20E-03	4.20E-02	7854

	Sc mg/kg	ks	Ds mg/kg/yr	Tc	T1	T1
2,3,7,8-TCDD	2.23175E-10	15.28846326	3.412E-09	30	12.7	12.7
1,2,3,7,8-PeCDD	3.52132E-09	2.559833837	9.014E-09	30	12.7	12.7
1,2,3,6,7,8-HxCDD	9.71475E-12	658.8605107	6.40067E-09	30	12.7	12.7
1,2,3,4,7,8-HcCDD	5.98887E-09	0.530025119	3.17467E-09	30	12.7	12.7
1,2,3,7,8,9-HxCDD	2.8152E-09	2.738463112	7.70933E-09	30	12.7	12.7
1,2,3,4,6,7,8-HpCDD	8.18875E-10	69.0858515	5.65727E-08	30	12.7	12.7
OCDD	1.81875E-08	0.001124305	8.627E-10	30	12.7	12.7
2,3,7,8-TCDF	7.19654E-10	10.41889261	7.498E-09	30	12.7	12.7
1,2,3,7,8-PeCDF	1.86726E-09	4.271490487	7.976E-09	30	12.7	12.7
2,3,4,7,8-PeCDF	6.98217E-09	3.182679188	2.2222E-08	30	12.7	12.7
1,2,3,4,7,8-HxCDF	4.22341E-09	3.145959227	1.32867E-08	30	12.7	12.7
1,2,3,6,7,8 HxCDF	3.22722E-09	1.371046077	4.42467E-09	30	12.7	12.7
2,3,4,6,7,8-HpCDF	3.904E-10	2.247269024	8.77333E-10	30	12.7	12.7
1,2,3,7,8,9-HxCDF	6.47126E-09	2.247269024	1.45427E-08	30	12.7	12.7
1,2,3,4,6,7,8-HpCDF	7.95272E-10	3.008614433	2.39267E-09	30	12.7	12.7
1,2,3,4,7,8,9-HpCDF	2.4308E-10	3.008614433	7.31333E-10	30	12.7	12.7
OCDF	5.94025E-09	0.013567261	3.22677E-10	30	12.7	12.7

	Background	Sc	Sc	Background + Sc
	ng/kg	mg/kg	ng/kg	ng/kg
2,3,7,8-TCDD	0.1	2.232E-10	0.0002232	0.100223175
1,2,3,7,8-PeCDD	0.085	3.521E-09	0.0035213	0.088521322
1,2,3,6,7,8-HxCDD	0.32	9.715E-12	9.715E-06	0.320009715
1,2,3,4,7,8-HcCDD	0.19	5.989E-09	0.0059889	0.195988874
1,2,3,7,8,9-HxCDD	0.38	2.815E-09	0.0028152	0.382815204
1,2,3,4,6,7,8-HpCDD	3.1	8.189E-10	0.0008189	3.100818875
OCDD	13	1.819E-08	0.0181875	13.01818753
2,3,7,8-TCDF	0.44	7.197E-10	0.0007197	0.440719654
1,2,3,7,8-PeCDF	0.38	1.867E-09	0.0018673	0.381867264
2,3,4,7,8-PeCDF	0.47	6.982E-09	0.0069822	0.476982168
1,2,3,4,7,8-HxCDF	0.56	4.223E-09	0.0042234	0.564223407
1,2,3,6,7,8 HxCDF	0.41	3.227E-09	0.0032272	0.41322722
2,3,4,6,7,8-HpCDF	0.4	3.904E-10	0.0003904	0.4003904
1,2,3,7,8,9-HxCDF	0.11	6.471E-09	0.0064713	0.116471262
1,2,3,4,6,7,8-HpCDF	2.4	7.953E-10	0.0007953	2.400795272
1,2,3,4,7,8,9-HpCDF	0.26	2.431E-10	0.0002431	0.26024308
OCDF	2.4	5.94E-09	0.0059403	2.405940255

ATTACHMENT G

DEFINITION OF KS TERMS

Parameter	Definition
ks	Soil loss constant due to all processes (yr^{-1})
ksl	Loss constant due to leaching (yr^{-1})
kse	Loss constant due to soil erosion (yr^{-1})
ksr	Loss constant due to surface runoff (yr^{-1})
ksg	Loss constant due to degradation (yr^{-1})
ksv	Loss constant due to volatilization (yr^{-1})

$$ksl = \frac{P + I - R - E_v}{\theta_s \bullet Z \bullet [1.0 + (BD \bullet Kd_s/\theta_s)]}$$

$$Kd_s = f_{oc} \bullet K_{oc}$$

Parameter	Definition
ksl	Loss constant due to leaching (yr^{-1})
P	Average annual precipitation (cm/yr)
I	Average annual irrigation (cm/yr)
R	Average annual runoff (cm/yr)
E_v	Average annual evapotranspiration (cm/yr)
θ_s	Soil volumetric water content (mL/cm^3)
Z	Soil depth from which leaching removal occurs (cm) (= soil mixing depth)
BD	Soil bulk density (g/cm^3)
Kd_s	Soil-water partition coefficient (cm^3/g)
f_{oc}	Fraction organic carbon in soil (unitless)
K_{oc}	Organic carbon partition coefficient (mL/g)

$$ksr = \frac{R}{\theta_s \bullet Z} \bullet \left(\frac{1}{1 + (Kd_s \bullet BD / \theta_s)} \right)$$

Parameter	Definition
ksr	Loss constant due to runoff (yr^{-1})
R	Average annual runoff (cm/yr)
θ_s	Soil volumetric water content (ml/cm^3)
Z	Soil mixing depth (cm)
Kd_s	Soil-water partition coefficient (cm^3/g)
BD	Soil bulk density (g/cm^3)

$$ksv = \left[\frac{3.1536x10^{7} \bullet H}{Z \bullet Kd_s \bullet R \bullet T \bullet BD}\right] \bullet \left[0.482 \bullet u^{0.78} \bullet \left(\frac{\mu_a}{\rho_a \bullet Da}\right)^{-0.67} \bullet \left(\sqrt{\frac{4 \bullet A}{\pi}}\right)^{-0.11}\right]$$

Parameter	Definition
ksv	Loss constant due to volatilization (yr^{-1})
$3.1536x10^7$	Conversion constant (s/yr)
H	Henry's law constant (atm-m^3/mol)
Z	Soil mixing depth (cm)
Kd_s	Soil-water partition coefficient (cm^3/g)
R	Universal gas constant (atm-m^3/mol-K)
T	Ambient air temperature (K)
BD	Soil bulk density (g/cm^3)
u	Average annual wind speed (m/s)
μ_a	Viscosity of air (g/cm-s)
ρa	Density of air (g/cm^3)
Da	Diffusivity of contaminant in air (cm^2/s)
A	Surface area of contaminated area (m^2)

APPENDIX H
CALCULATION OF DS FOR SOIL CONCENTRATION EQUATION

Diameter of area	Radius of area of concern	Area	Soil depth	Vol soil	BD	Mass soil
km	m	m2	m	m3	kg/m3	kg
0.1	50	7854	0.01	78.54	1500	117810

	Area of deposition	Total flux	mass PCDD/F	Mass of	Ds	Ds
	m2	g/m2/yr	over area g/yr	soil kg	g/kg/yr	mg/kg/yr
2,3,7,8-TCDD	7854	0.038	mass PCDD/F	117810	2.55798E-12	2.55798E-09
1,2,3,7,8-PeCDD	7854	0.184	over area g/yr	117810	1.20183E-11	1.20183E-08
1,2,3,6,7,8-HxCDD	7854	0.132	3.01356E-07	117810	8.77661E-12	8.77661E-09
1,2,3,4,7,8-HcCDD	7854	0.065	1.41587E-06	117810	4.35081E-12	4.35081E-09
1,2,3,7,8,9-HxCDD	7854	0.158	1.03397E-06	117810	1.05333E-11	1.05333E-08
1,2,3,4,6,7,8-HpCDD	7854	0.116	5.12569E-07	117810	7.73333E-12	7.73333E-09
OCDD	7854	0.018	1.24093E-06	117810	1.2E-12	1.2E-09
			9.11064E-07			0
			1.41372E-07			0
2,3,7,8-TCDF	7854	0.131		117810	8.73333E-12	8.73333E-09
1,2,3,7,8-PeCDF	7854	0.016		117810	1.06667E-12	1.06667E-09
2,3,4,7,8-PeCDF	7854	0.437	1.02887E-06	117810	2.91333E-11	2.91333E-08
1,2,3,4,7,8-HxCDF	7854	0.268	1.25664E-07	117810	1.78667E-11	1.78667E-08
1,2,3,6,7,8 HxCDF	7854	0.089	3.4322E-06	117810	5.93333E-12	5.93333E-09
2,3,4,6,7,8-HpCDF	7854	0.298	2.10487E-06	117810	1.98667E-11	1.98667E-08
1,2,3,7,8,9-HxCDF	7854	0.018	6.99006E-07	117810	1.2E-12	1.2E-09
1,2,3,4,6,7,8-HpCDF	7854	0.049	2.34049E-06	117810	3.26667E-12	3.26667E-09
1,2,3,4,7,8,9-HpCDF	7854	0.015	1.41372E-07	117810	1E-12	0.000000001
OCDF	7854	0.007	3.84846E-07	117810	4.66667E-13	4.66667E-10
Mercury	7854	0.038	1.1781E-07	117810	0.000118667	0.118666667

ATTACHMENT I

CALCULATION OF SOIL CONCENTRATION (Sc)

	Sc mg/kg	Ks	Ds mg/kg/yr	Tc	T1
2,3,7,8-TCDD	9.34233E-11	27.38057099	2.55798E-09	30	12.7
1,2,3,7,8-PeCDD	2.62253E-09	4.582705762	1.20183E-08	30	12.7
1,2,3,6,7,8-HxCDD	7.4374E-12	1180.064759	8.77661E-09	30	12.7
1,2,3,4,7,8-HcCDD	4.58357E-09	0.949219041	4.35081E-09	30	12.7
1,2,3,7,8,9-HxCDD	2.14778E-09	4.904298379	1.05333E-08	30	12.7
1,2,3,4,6,7,8-HpCDD	6.24979E-11	123.7375314	7.73333E-09	30	12.7
OCDD	2.51155E-08	0.001773452	1.2E-09	30	12.7
2,3,7,8-TCDF	4.68069E-10	18.65821932	8.73333E-09	30	12.7
1,2,3,7,8-PeCDF	5.71687E-11	7.64999329	1.06667E-09	30	12.7
2,3,4,7,8-PeCDF	3.80828E-09	5.699576574	2.91333E-08	30	12.7
1,2,3,4,7,8-HxCDF	3.13474E-09	5.634667153	1.78667E-08	30	12.7
1,2,3,6,7,8 HxCDF	1.05301E-09	2.455158865	5.93333E-09	30	12.7
2,3,4,6,7,8-HpCDF	8.0918E-09	4.024535426	1.98667E-08	30	12.7
1,2,3,7,8,9-HxCDF	2.98171E-10	4.024535426	1.2E-09	30	12.7
1,2,3,4,6,7,8-HpCDF	8.11688E-10	5.388808409	3.26667E-09	30	12.7
1,2,3,4,7,8,9-HpCDF	1.8557E-10	5.388521121	0.000000001	30	12.7
OCDF	8.66038E-11	0.024366596	4.66667E-10	30	12.7
Mercury	9.45809E-08	1254657.644	0.118666667	30	12.7

APPENDIX J

MODEL OUTPUT FILE – PREDICTED INCREASE IN PCDD/F DOSE

= Site =

Data from file: PREDREV1.LOC
Name: Ringsend Baseline
Code:

Description:

Scenario   Scenario 0
Characteristic   Standard Scenario
CSoilModel / VolaSoil: CSoilModel
Landuse   none

Selected exposure routes on site level:
  inhalation indoor air
  inhalation outdoor air
  ingestion soil
  dermal contact soil
  inhalation soil
  ingestion drinking water
  dermal contact shower
  inhalation vapour shower
  ingestion vegetables
  ingestion surface water
  ingestion suspended matter
  dermal contact surface water

Changed parameters on site level:
Organic matter content [OS]
  2.48E+00   %
Justification
  Measured value for site
Depth of ground water table [Dg]
  3.00E+00   m
Justification
  Assumed value for groundwater in Ireland
Depth of contaminant below surface level [Dp.o]
  1.00E-02   m
Justification
  Assume contaminant at surface
Acidity [pH]
  7.52E+00   -
Justification
  Measured value for site

Height of capillary transition boundary above ground water table [z]
  2.00E-01   m
Justification
  De Laat et al
Surface roughness [Zo]
  1.00E-01   m
Justification
  Van Den Bergh 1991
Ratio dry weight fresh weigth (stem) [fdws]
  2.48E-01   kg dw.kg-1 fw
Justification
  Changed without justification
Milk production [Qmicat]
  0.00E+00   l.d-1
Justification
  Assume milk obtained off site
Fraction fat in meat [ffme]
  4.40E-01   -
Justification
  Calculated average value
Fraction fat in milk [ffmi]
  4.00E-02   -
Justification
  Average value from EPA 2000 Milk Dioxin Report
Fraction ground water in drinking water cattle [fgcat]
  1.00E-02   -
Justification
  Assume minimum
Fraction surface water in drinking water cattle [fscat]
  9.90E-01   -
Justification
  Assume maximum surface water consumption by cattle
Time outside (summer) [tsocat]
  0.00E+00   h.d-1
Justification
  Changed without justification
Weeks summer [wscat]
  4.90E+01   w.y-1
Justification
  Cattle outside for maximum amount of time
Daily consumption of leafy vegetables (adult) [Qvla]
  2.48E-01   kg fw.d-1
Justification
  Dept of Agriculture Annual Report 2002/2003
Daily consumption of tuberous vegetables (adult) [Qvra]
  4.45E-01   kg fw.d-1
Justification
  dept of agriculture 2002/2003
Daily consumption of meat (adult) [Qmea]
  0.00E+00   kg.d-1
Justification
  Assume all meat from off site
Daily consumption of milk (adult) [Qmia]
  0.00E+00   l.d-1
Justification
  Assume all milk from off site
Body weight (adult) [Wa]

  6.00E+01   kg
Justification
  Body weight from US EPA
Daily consumption of leafy vegetables (child) [Qvlc]
  1.24E-01   kg fw.d-1
Justification
  assume 50% of adult
Daily consumption of tuberous vegetables (child) [Qvrc]
  2.23E-01   kg fw.d-1
Justification
  Assume 50% of adult
Daily consumption of meat (child) [Qmec]
  0.00E+00   kg.d-1
Justification
  Assume all meat from off site
Daily consumption of milk (child) [Qmic]
  0.00E+00   l.d-1
Justification
  Assume all milk from off site

Subsite: Subsite 0

Selected exposure routes on subsite level:
  inhalation indoor air
  inhalation outdoor air
  ingestion soil
  dermal contact soil
  inhalation soil
  ingestion drinking water
  dermal contact shower
  inhalation vapour shower
  ingestion vegetables
  ingestion surface water
  ingestion suspended matter
  dermal contact surface water

Changed parameters on subsite level:
Fraction contaminated leafy vegetables (adult) [fla]
  1.00E+00   -
Justification
  Changed without justification

Fraction contaminated leafy vegetables (child) [flc]
1.00E+00 -
Justification
Changed without justification

Fraction contaminated tuberous vegetables (adult) [fta]
1.00E+00 -
Justification
Changed without justification

Fraction contaminated tuberous vegetables (child) [ftc]
1.00E+00 -
Justification
Changed without justification

Fraction contaminated meat (adult) [fmea]
0.00E+00 -
Justification
Changed without justification

Fraction contaminated milk (adult) [fmia]
0.00E+00 -
Justification
Changed without justification

Fraction contaminated milk (child) [fmic]
0.00E+00 -
Justification
Changed without justification

Fraction contaminated meat (child) [fmec]
0.00E+00 -
Justification
Changed without justification

Time division adult :

days off	winter	h/d	d/w	w/y	summer	h/d	d/w	w/y
inside dermal		0.0	0.0	0.0		0.0	0.0	0.0
outside inhalant		0.0	0.0	0.0		0.0	0.0	0.0
outside dermal		0.0	0.0	0.0		0.0	0.0	0.0
working days	winter	h/d	d/w	w/y	summer	h/d	d/w	w/y
inside dermal		0.0	0.0	0.0		0.0	0.0	0.0
outside inhalant		16.0	7.0	25.0		16.0	7.0	25.0
outside dermal		16.0	7.0	25.0		16.0	7.0	25.0
time inside sleeping	winter+ summer	h/d	d/w	w/y				

```
-------------------------------------------------------------------------------
---
                             8.0     7.0    50.0
-------------------------------------------------------------------------------
---
```

Justification
Assume farmer works 16 hours per day 7 days per week

Time division child:

```
-------------------------------------------------------------------------------
---
days off            winter   h/d     d/w     w/y    summer  h/d     d/w   w/y
-------------------------------------------------------------------------------
---
inside dermal               12.0     2.0    25.0            12.0     2.0  25.0
outside inhalant             0.0     0.0     0.0             0.0     0.0   0.0
outside dermal               0.0     0.0     0.0             0.0     0.0   0.0
working days        winter   h/d     d/w     w/y    summer   h/d     d/w   w/ y
-------------------------------------------------------------------------------
---
inside dermal               12.0     5.0    25.0             4.0     5.0  25.0
outside inhalant             0.0     0.0     0.0             8.0     5.0  25.0
outside dermal               0.0     0.0     0.0             8.0     5.0  25.0

time inside         winter+
sleeping            summer   h/d     d/w     w/y
-------------------------------------------------------------------------------
---
                            12.0     7.0    50.0
-------------------------------------------------------------------------------
---
```


Measurements
Code of measurement: Measurement 1
Substance: dioxine 2378 TeCDD

Site

```
-------------------------------------------------------------------------------
---
  Concentration in soil                    3.60E-06   mg.kg-1
```

Built on area:

```
-------------------------------------------------------------------------------
---
  Concentration in soil                    3.60E-06   mg.kg-1
```

Open surface:

```
-------------------------------------------------------------------------------
---
```

Concentration in soil 3.60E-06 mg.kg-1

Cultivated area:

Concentration in soil 3.60E-06 mg.kg-1

Sediment:

Concentration in sediment 0.00E+00 mg.kg-1

Contactmedia:

Concentration in outdoor air 1.92E-09 µg.m-3
Concentration in indoor air 1.92E-09 µg.m-3

Soil parameters:	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 2
Substance: dioxine 1,2,3,7,8-PeCDD

Site

Concentration in soil 9.83E-07 mg.kg-1

Built on area:

Concentration in soil 9.83E-07 mg.kg-1

Open surface:

Concentration in soil 9.83E-07 mg.kg-1

Cultivated area:

Concentration in soil 9.83E-07 mg.kg-1

Sediment:

Concentration in sediment 0.00E+00 mg.kg-1

Contactmedia:

Concentration in outdoor air 7.66E-09 µg.m-3
Concentration in indoor air 7.66E-09 µg.m-3

Soil parameters:	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 3
Substance: dioxine 1,2,3,6,7,8

Site

Concentration in soil 4.20E-06 mg.kg-1

Built on area:

Concentration in soil 4.20E-06 mg.kg-1

Open surface:

Concentration in soil 4.20E-06 mg.kg-1

Cultivated area:

Concentration in soil 4.20E-06 mg.kg-1

Sediment:

Contactmedia:

Concentration in outdoor air	6.82E-09	µg.m-3
Concentration in indoor air	6.82E-09	µg.m-3

Soil parameters: Current
Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 4
Substance: dioxine 1,2,3,4,7,8

Site

Concentration in soil 1.10E-06 mg.kg-1

Built on area:

Concentration in soil 1.10E-06 mg.kg-1

Open surface:

Concentration in soil 1.10E-06 mg.kg-1

Cultivated area:

  Concentration in soil   1.10E-06   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   3.19E-08   µg.m-3
  Concentration in indoor air   3.19E-08   µg.m-3

Soil parameters: Current
Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 5
Substance: dioxine 1,2,3,7,8,9

Site

  Concentration in soil   2.40E-06   mg.kg-1

Built on area:

  Concentration in soil   2.40E-06   mg.kg-1

Open surface:

  Concentration in soil   2.40E-06   mg.kg-1

Cultivated area:

Concentration in soil	2.40E-06	mg.kg-1

Sediment:

Concentration in sediment	0.00E+00	mg.kg-1

Contactmedia:

Concentration in outdoor air	2.95E-08	µg.m-3
Concentration in indoor air	2.95E-08	µg.m-3

Soil parameters:	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 6
Substance: dioxine 1,2,3,4,6,7,8

Site

Concentration in soil	8.80E-05	mg.kg-1

Built on area:

Concentration in soil	8.80E-05	mg.kg-1

Open surface:

Concentration in soil	8.80E-05	mg.kg-1

Cultivated area:

Concentration in soil 8.80E-05 mg.kg-1

Sediment:

Concentration in sediment 0.00E+00 mg.kg-1

Contactmedia:

Concentration in outdoor air 2.43E-07 µg.m-3
Concentration in indoor air 2.43E-07 µg.m-3

Soil parameters:	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 7
Substance: dioxine OCDD

Site

Concentration in soil 9.30E-07 mg.kg-1

Built on area:

Concentration in soil 9.30E-07 mg.kg-1

Open surface:

Concentration in soil 9.30E-07 mg.kg-1

Cultivated area:

Concentration in soil 9.30E-07 mg.kg-1

Sediment:

Concentration in sediment 0.00E+00 mg.kg-1

Contactmedia:

Concentration in outdoor air 3.94E-07 µg.m-3
Concentration in indoor air 3.94E-07 µg.m-3

Soil parameters:	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 8
Substance: 2,3,7,8 TCDF

Site

Concentration in soil 7.50E-06 mg.kg-1

Built on area:

Concentration in soil 7.50E-06 mg.kg-1

Open surface:

Concentration in soil 7.50E-06 mg.kg-1

Cultivated area:

  Concentration in soil   7.50E-06   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   2.56E-08   µg.m-3
  Concentration in indoor air   2.56E-08   µg.m-3

Soil parameters:	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 9
Substance: 1,2,3,7,8 PeCDF

Site

  Concentration in soil   5.00E-06   mg.kg-1

Built on area:

  Concentration in soil   5.00E-06   mg.kg-1

Open surface:

  Concentration in soil   5.00E-06   mg.kg-1

Cultivated area:

  Concentration in soil   5.00E-06   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   2.55E-08   µg.m-3
  Concentration in indoor air   2.55E-08   µg.m-3

Soil parameters: Current Default

Parameter	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 10
Substance: 1,2,3,4,7,8 HxCDF

Site

  Concentration in soil   8.70E-06   mg.kg-1

Built on area:

  Concentration in soil   8.70E-06   mg.kg-1

Open surface:

  Concentration in soil   8.70E-06   mg.kg-1

Cultivated area:

  Concentration in soil   8.70E-06   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   8.58E-08   µg.m-3
  Concentration in indoor air   8.58E-08   µg.m-3

Soil parameters: Current
Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 11
Substance: 2,3,4,7,8 PeCDF

Site

  Concentration in soil   5.40E-06   mg.kg-1

Built on area:

  Concentration in soil   5.40E-06   mg.kg-1

Open surface:

  Concentration in soil   5.40E-06   mg.kg-1

Cultivated area:

```
--------------------------------------------------------------------------------
---
  Concentration in soil                   5.40E-06   mg.kg-1

Sediment:
--------------------------------------------------------------------------------
---

Contactmedia:
--------------------------------------------------------------------------------
---
  Concentration in outdoor air            2.17E-07   µg.m-3
  Concentration in indoor air             2.17E-07   µg.m-3

Soil parameters:                                            Current
Default
--------------------------------------------------------------------------------
---
 Depth of contaminant below surface level                    1.00E-02      1.25
 Organic matter content                                      2.48E+00      10
 Bulk density                                                1.50E+00      1.5
 Fraction water in soil                                      2.00E-01      0.2
 Fraction air in soil                                        2.00E-01      0.2
 Acidity                                                     7.52E+00      6
 Temperature of soil                                         2.83E+02      283
 Bulk density sediment                                       1.30E+00      1.3
 Organic matter content sediment                             1.00E+01      10
 Fraction water in sediment                                  4.00E-01      0.4
 Bulk density suspended matter                               1.30E+00      1.3
 Organic matter content suspended matter                     2.00E+01      20
 Fraction water in suspended matter                          4.00E-01      0.4



Measurements
Code of measurement:     Measurement 12
Substance:               1,2,3,6,7,8 HxCDF


Site
--------------------------------------------------------------------------------
---
  Concentration in soil                   4.50E-06   mg.kg-1

Built on area:
--------------------------------------------------------------------------------
---
  Concentration in soil                   4.50E-06   mg.kg-1

Open surface:
--------------------------------------------------------------------------------
---
  Concentration in soil                   4.50E-06   mg.kg-1

Cultivated area:
```


  Concentration in soil 4.50E-06 mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air 7.37E-08 µg.m-3
  Concentration in indoor air 7.37E-08 µg.m-3

Soil parameters:	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 13
Substance: 1,2,3,7,8,9 HxCDF

Site

  Concentration in soil 1.70E-06 mg.kg-1

Built on area:

  Concentration in soil 1.70E-06 mg.kg-1

Open surface:

  Concentration in soil 1.70E-06 mg.kg-1

Cultivated area:

  Concentration in soil   1.70E-06   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   1.02E-07   µg.m-3
  Concentration in indoor air   1.02E-07   µg.m-3

Soil parameters: Current Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 14
Substance: 2,3,4,6,7,8 Hp CDF

Site

  Concentration in soil   3.21E-06   mg.kg-1

Built on area:

  Concentration in soil   3.21E-06   mg.kg-1

Open surface:

  Concentration in soil   3.21E-06   mg.kg-1

Cultivated area:

  Concentration in soil   3.21E-06   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   3.41E-08   µg.m-3
  Concentration in indoor air   3.41E-08   µg.m-3

Soil parameters: Current
Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 15
Substance: 1,2,3,4,6,7,8 HpCDF

Site

  Concentration in soil   5.80E-05   mg.kg-1

Built on area:

  Concentration in soil   5.80E-05   mg.kg-1

Open surface:

  Concentration in soil   5.80E-05   mg.kg-1

Cultivated area:

  Concentration in soil   5.80E-05   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   4.35E-07   µg.m-3
  Concentration in indoor air   4.35E-07   µg.m-3

Soil parameters:	Current	Default
Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 16
Substance: 1,2,3,4,7,8,9 HpCDF

Site

  Concentration in soil   3.90E-09   mg.kg-1

Built on area:

  Concentration in soil   3.90E-09   mg.kg-1

Open surface:

  Concentration in soil   3.90E-09   mg.kg-1

Cultivated area:

  Concentration in soil   3.90E-09   mg.kg-1

Sediment:

Contactmedia:

  Concentration in outdoor air   5.37E-08   µg.m-3
  Concentration in indoor air   5.37E-08   µg.m-3

Soil parameters: Current
Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 17
Substance: OCDF

Site

  Concentration in soil   8.70E-05   mg.kg-1

Built on area:

  Concentration in soil   8.70E-05   mg.kg-1

Open surface:

  Concentration in soil   8.70E-05   mg.kg-1

Cultivated area:

  Concentration in soil   8.70E-05   mg.kg-1

Sediment:

  Concentration in sediment   0.00E+00   mg.kg-1

Contactmedia:

  Concentration in outdoor air   2.43E-07   µg.m-3
  Concentration in indoor air   2.43E-07   µg.m-3

Soil parameters: Current
Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

Measurements
Code of measurement: Measurement 18
Substance: mercury

Site

  Concentration in soil   1.00E+00   mg.kg-1

Built on area:

  Concentration in soil   1.00E+00   mg.kg-1

Open surface:

  Concentration in soil   1.00E+00   mg.kg-1

Cultivated area:

  Concentration in soil   1.00E+00   mg.kg-1

Sediment:

  Concentration in sediment   0.00E+00   mg.kg-1

Contactmedia:

  Concentration in outdoor air   6.00E-03   µg.m-3
  Concentration in indoor air   6.00E-03   µg.m-3

Soil parameters: Current
Default

Depth of contaminant below surface level	1.00E-02	1.25
Organic matter content	2.48E+00	10
Bulk density	1.50E+00	1.5
Fraction water in soil	2.00E-01	0.2
Fraction air in soil	2.00E-01	0.2
Acidity	7.52E+00	6
Temperature of soil	2.83E+02	283
Bulk density sediment	1.30E+00	1.3
Organic matter content sediment	1.00E+01	10
Fraction water in sediment	4.00E-01	0.4
Bulk density suspended matter	1.30E+00	1.3
Organic matter content suspended matter	2.00E+01	20
Fraction water in suspended matter	4.00E-01	0.4

==== Result ====

Scenario : Scenario 0
Subsite : Subsite 0

= Uptake Table =

Measurement   : Measurement 1
Substance   : dioxine 2378 TeCDD

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	8.66E-13	2.12E-13	2.68E-13
inhalation outdoor air	1.17E-13	4.25E-13	3.99E-13
ingestion soil	3.60E-11	3.00E-12	5.83E-12
dermal contact soil	1.54E-12	4.59E-12	4.33E-12
inhalation soil	5.69E-14	3.35E-14	3.55E-14

ingestion drinking water	2.96E-15	1.48E-15	1.61E-15
dermal contact shower	5.33E-15	2.53E-15	2.77E-15
inhalation vapour shower	2.97E-17	1.93E-17	2.02E-17
ingestion vegetables	7.54E-09	3.76E-09	4.08E-09
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	7.58E-09	3.77E-09	4.09E-09

= Uptake Table =

Measurement : Measurement 2
Substance : dioxine 1,2,3,7,8-PeCDD

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	3.46E-12	8.48E-13	1.07E-12
inhalation outdoor air	4.67E-13	1.70E-12	1.59E-12
ingestion soil	9.83E-12	8.19E-13	1.59E-12
dermal contact soil	4.21E-13	1.25E-12	1.18E-12
inhalation soil	1.55E-14	9.14E-15	9.69E-15
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	6.38E-09	3.18E-09	3.46E-09
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	6.40E-09	3.19E-09	3.46E-09

= Uptake Table =

Measurement : Measurement 3
Substance : dioxine 1,2,3,6,7,8

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	3.08E-12	7.55E-13	9.54E-13
inhalation outdoor air	4.16E-13	1.51E-12	1.42E-12

ingestion soil	4.20E-11	3.50E-12	6.80E-12
dermal contact soil	1.80E-12	5.36E-12	5.05E-12
inhalation soil	6.64E-14	3.90E-14	4.14E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	1.06E-08	5.27E-09	5.73E-09
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	1.06E-08	5.28E-09	5.74E-09

= Uptake Table =

Measurement : Measurement 4
Substance : dioxine 1,2,3,4,7,8

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.44E-11	3.53E-12	4.46E-12
inhalation outdoor air	1.94E-12	7.06E-12	6.62E-12
ingestion soil	1.10E-11	9.20E-13	1.79E-12
dermal contact soil	4.73E-13	1.41E-12	1.33E-12
inhalation soil	1.75E-14	1.03E-14	1.09E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	2.78E-09	1.39E-09	1.51E-09
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	2.81E-09	1.40E-09	1.52E-09

= Uptake Table =

Measurement : Measurement 5
Substance : dioxine 1,2,3,7,8,9

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong

inhalation indoor air	1.33E-11	3.26E-12	4.13E-12
inhalation outdoor air	1.80E-12	6.53E-12	6.12E-12
ingestion soil	2.40E-11	2.00E-12	3.89E-12
dermal contact soil	1.03E-12	3.06E-12	2.89E-12
inhalation soil	3.80E-14	2.23E-14	2.37E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	6.04E-09	3.02E-09	3.27E-09
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	6.08E-09	3.03E-09	3.29E-09

= Uptake Table =

Measurement : Measurement 6
Substance : dioxine 1,2,3,4,6,7,8

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.10E-10	2.69E-11	3.40E-11
inhalation outdoor air	1.48E-11	5.38E-11	5.04E-11
ingestion soil	8.80E-10	7.33E-11	1.42E-10
dermal contact soil	3.77E-11	1.12E-10	1.06E-10
inhalation soil	1.39E-12	8.18E-13	8.67E-13
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	6.31E-08	3.15E-08	3.42E-08
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	6.42E-08	3.18E-08	3.45E-08

= Uptake Table =

Measurement : Measurement 7
Substance : dioxine OCDD

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.78E-10	4.36E-11	5.51E-11
inhalation outdoor air	2.40E-11	8.72E-11	8.18E-11
ingestion soil	9.30E-12	7.75E-13	1.51E-12
dermal contact soil	3.99E-13	1.19E-12	1.12E-12
inhalation soil	1.47E-14	8.65E-15	9.17E-15
ingestion drinking water	3.05E-17	1.52E-17	1.65E-17
dermal contact shower	6.10E-18	2.89E-18	3.17E-18
inhalation vapour shower	1.23E-19	7.97E-20	8.35E-20
ingestion vegetables	9.29E-10	4.63E-10	5.03E-10
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	1.14E-09	5.96E-10	6.43E-10

= Uptake Table =

Measurement : Measurement 8
Substance : 2,3,7,8 TCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.15E-11	2.83E-12	3.58E-12
inhalation outdoor air	1.56E-12	5.67E-12	5.31E-12
ingestion soil	7.50E-11	6.25E-12	1.21E-11
dermal contact soil	3.21E-12	9.56E-12	9.02E-12
inhalation soil	1.19E-13	6.97E-14	7.39E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	3.86E-10	1.92E-10	2.09E-10
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	4.77E-10	2.17E-10	2.39E-10

= Uptake Table =

Measurement : Measurement 9

Substance : 1,2,3,7,8 PeCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.15E-11	2.82E-12	3.57E-12
inhalation outdoor air	1.55E-12	5.64E-12	5.29E-12
ingestion soil	5.00E-11	4.17E-12	8.10E-12
dermal contact soil	2.14E-12	6.38E-12	6.01E-12
inhalation soil	7.90E-14	4.65E-14	4.93E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	6.40E-10	3.19E-10	3.47E-10
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	7.05E-10	3.38E-10	3.70E-10

= Uptake Table =

Measurement : Measurement 10
Substance : 1,2,3,4,7,8 HxCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	3.87E-11	9.50E-12	1.20E-11
inhalation outdoor air	5.23E-12	1.90E-11	1.78E-11
ingestion soil	8.70E-11	7.25E-12	1.41E-11
dermal contact soil	3.73E-12	1.11E-11	1.05E-11
inhalation soil	1.38E-13	8.09E-14	8.58E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	2.67E-09	1.33E-09	1.45E-09
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	2.81E-09	1.38E-09	1.50E-09

= Uptake Table =

Measurement : Measurement 11
Substance : 2,3,4,7,8 PeCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	9.79E-11	2.40E-11	3.03E-11
inhalation outdoor air	1.32E-11	4.80E-11	4.50E-11
ingestion soil	5.40E-11	4.50E-12	8.75E-12
dermal contact soil	2.32E-12	6.89E-12	6.50E-12
inhalation soil	8.54E-14	5.02E-14	5.33E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	6.92E-10	3.45E-10	3.75E-10
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	8.59E-10	4.29E-10	4.65E-10

= Uptake Table =

Measurement : Measurement 12
Substance : 1,2,3,6,7,8 HxCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	3.32E-11	8.16E-12	1.03E-11
inhalation outdoor air	4.49E-12	1.63E-11	1.53E-11
ingestion soil	4.50E-11	3.75E-12	7.29E-12
dermal contact soil	1.93E-12	5.74E-12	5.41E-12
inhalation soil	7.12E-14	4.18E-14	4.44E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	1.38E-09	6.90E-10	7.49E-10
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	1.47E-09	7.24E-10	7.88E-10

= Uptake Table =

Measurement : Measurement 13
Substance : 1,2,3,7,8,9 HxCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	4.58E-11	1.12E-11	1.42E-11
inhalation outdoor air	6.19E-12	2.25E-11	2.11E-11
ingestion soil	1.70E-11	1.42E-12	2.75E-12
dermal contact soil	7.28E-13	2.17E-12	2.04E-12
inhalation soil	2.69E-14	1.58E-14	1.68E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	5.22E-10	2.61E-10	2.83E-10
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	5.92E-10	2.98E-10	3.23E-10

= Uptake Table =

Measurement : Measurement 14
Substance : 2,3,4,6,7,8 Hp CDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.54E-11	3.77E-12	4.77E-12
inhalation outdoor air	2.08E-12	7.55E-12	7.08E-12
ingestion soil	3.21E-11	2.67E-12	5.19E-12
dermal contact soil	1.37E-12	4.09E-12	3.86E-12
inhalation soil	5.07E-14	2.98E-14	3.16E-14
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	6.36E-10	3.17E-10	3.45E-10
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00

Total exposure 6.87E-10 3.35E-10 3.66E-10

= Uptake Table =

Measurement : Measurement 15
Substance : 1,2,3,4,6,7,8 HpCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.96E-10	4.81E-11	6.08E-11
inhalation outdoor air	2.65E-11	9.62E-11	9.02E-11
ingestion soil	5.80E-10	4.83E-11	9.39E-11
dermal contact soil	2.49E-11	7.40E-11	6.97E-11
inhalation soil	9.17E-13	5.39E-13	5.72E-13
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	1.15E-08	5.74E-09	6.23E-09
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	1.23E-08	6.00E-09	6.55E-09

= Uptake Table =

Measurement : Measurement 16
Substance : 1,2,3,4,7,8,9 HpCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	2.42E-11	5.94E-12	7.51E-12
inhalation outdoor air	3.27E-12	1.19E-11	1.11E-11
ingestion soil	3.90E-14	3.25E-15	6.31E-15
dermal contact soil	1.67E-15	4.97E-15	4.69E-15
inhalation soil	6.17E-17	3.63E-17	3.84E-17
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	1.21E-11	6.05E-12	6.57E-12

ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	3.97E-11	2.39E-11	2.52E-11

= Uptake Table =

Measurement : Measurement 17
Substance : OCDF

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	1.10E-10	2.69E-11	3.40E-11
inhalation outdoor air	1.48E-11	5.38E-11	5.04E-11
ingestion soil	8.70E-10	7.25E-11	1.41E-10
dermal contact soil	3.73E-11	1.11E-10	1.05E-10
inhalation soil	1.38E-12	8.09E-13	8.57E-13
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00
dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	1.56E-07	7.81E-08	8.48E-08
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	1.57E-07	7.83E-08	8.51E-08

= Uptake Table =

Measurement : Measurement 18
Substance : mercury

Exposure per route (mg/(kg.d))

Exposure route	Child	Adult	Lifelong
inhalation indoor air	0.00E+00	0.00E+00	0.00E+00
inhalation outdoor air	0.00E+00	0.00E+00	0.00E+00
ingestion soil	1.00E-05	8.33E-07	1.62E-06
dermal contact soil	0.00E+00	0.00E+00	0.00E+00
inhalation soil	1.58E-08	9.30E-09	9.85E-09
ingestion drinking water	0.00E+00	0.00E+00	0.00E+00

dermal contact shower	0.00E+00	0.00E+00	0.00E+00
inhalation vapour shower	0.00E+00	0.00E+00	0.00E+00
ingestion vegetables	1.09E-04	5.43E-05	5.90E-05
ingestion surface water	0.00E+00	0.00E+00	0.00E+00
ingestion suspended matter	0.00E+00	0.00E+00	0.00E+00
dermal contact surface water	0.00E+00	0.00E+00	0.00E+00
Total exposure	1.19E-04	5.52E-05	6.06E-05

= Risk Table =

Maximum Permissable Risk level

Measurement	Substance	Dose(mg/(kg.d))	RfD(mg/(kg.d))	Dose/RfD
Measurement 1	dioxine 2378 TeCDD	4.09E-09	1.00E-08	4.09E-01
Measurement 2	dioxine 1,2,3,7,8-PeCDD	3.46E-09	0.00E+00	-
Measurement 3	dioxine 1,2,3,6,7,8	5.74E-09	0.00E+00	-
Measurement 4	dioxine 1,2,3,4,7,8	1.52E-09	0.00E+00	-
Measurement 5	dioxine 1,2,3,7,8,9	3.29E-09	0.00E+00	-
Measurement 6	dioxine 1,2,3,4,6,7,8	3.45E-08	0.00E+00	-
Measurement 7	dioxine OCDD	6.43E-10	1.00E-08	6.43E-02
Measurement 8	2,3,7,8 TCDF	2.39E-10	0.00E+00	-
Measurement 9	1,2,3,7,8 PeCDF	3.70E-10	0.00E+00	-
Measurement 10	1,2,3,4,7,8 HxCDF	1.50E-09	0.00E+00	-
Measurement 11	2,3,4,7,8 PeCDF	4.65E-10	0.00E+00	-
Measurement 12	1,2,3,6,7,8 HxCDF	7.88E-10	0.00E+00	-
Measurement 13	1,2,3,7,8,9 HxCDF	3.23E-10	0.00E+00	-
Measurement 14	2,3,4,6,7,8 Hp CDF	3.66E-10	0.00E+00	-
Measurement 15	1,2,3,4,6,7,8 HpCDF	6.55E-09	0.00E+00	-
Measurement 16	1,2,3,4,7,8,9 HpCDF	2.52E-11	0.00E+00	-
Measurement 17	OCDF	8.51E-08	0.00E+00	-
Measurement 18	mercury	6.06E-05	6.10E-04	9.94E-02

RfD = Reference Dose

Indoor concentration in air

Measurement	Substance	Cia(µg/m3)	TCA(µg/m3)	Cia/TCA
Measurement 1	dioxine 2378 TeCDD	1.92E-09	0.00E+00	-
Measurement 2	dioxine 1,2,3,7,8-PeCDD	7.66E-09	0.00E+00	-
Measurement 3	dioxine 1,2,3,6,7,8	6.82E-09	0.00E+00	-
Measurement 4	dioxine 1,2,3,4,7,8	3.19E-08	0.00E+00	-
Measurement 5	dioxine 1,2,3,7,8,9	2.95E-08	0.00E+00	-
Measurement 6	dioxine 1,2,3,4,6,7,8	2.43E-07	0.00E+00	-

Measurement 7	dioxine OCDD	3.94E-07	0.00E+00	-
Measurement 8	2,3,7,8 TCDF	2.56E-08	0.00E+00	-
Measurement 9	1,2,3,7,8 PeCDF	2.55E-08	0.00E+00	-
Measurement 10	1,2,3,4,7,8 HxCDF	8.58E-08	0.00E+00	-
Measurement 11	2,3,4,7,8 PeCDF	2.17E-07	0.00E+00	-
Measurement 12	1,2,3,6,7,8 HxCDF	7.37E-08	0.00E+00	-
Measurement 13	1,2,3,7,8,9 HxCDF	1.02E-07	0.00E+00	-
Measurement 14	2,3,4,6,7,8 Hp CDF	3.41E-08	0.00E+00	-
Measurement 15	1,2,3,4,6,7,8 HpCDF	4.35E-07	0.00E+00	-
Measurement 16	1,2,3,4,7,8,9 HpCDF	5.37E-08	0.00E+00	-
Measurement 17	OCDF	2.43E-07	0.00E+00	-
Measurement 18	mercury	6.00E-03	0.00E+00	-

TCA = Tolerable Concentration in Air Cia = Concentration in indoor air

Outdoor concentration in air

Measurement	Substance	Coa(µg/m3)	TCA(µg/m3)	Coa/TCA
Measurement 1	dioxine 2378 TeCDD	1.92E-09	0.00E+00	-
Measurement 2	dioxine 1,2,3,7,8-PeCDD	7.66E-09	0.00E+00	-
Measurement 3	dioxine 1,2,3,6,7,8	6.82E-09	0.00E+00	-
Measurement 4	dioxine 1,2,3,4,7,8	3.19E-08	0.00E+00	-
Measurement 5	dioxine 1,2,3,7,8,9	2.95E-08	0.00E+00	-
Measurement 6	dioxine 1,2,3,4,6,7,8	2.43E-07	0.00E+00	-
Measurement 7	dioxine OCDD	3.94E-07	0.00E+00	-
Measurement 8	2,3,7,8 TCDF	2.56E-08	0.00E+00	-
Measurement 9	1,2,3,7,8 PeCDF	2.55E-08	0.00E+00	-
Measurement 10	1,2,3,4,7,8 HxCDF	8.58E-08	0.00E+00	-
Measurement 11	2,3,4,7,8 PeCDF	2.17E-07	0.00E+00	-
Measurement 12	1,2,3,6,7,8 HxCDF	7.37E-08	0.00E+00	-
Measurement 13	1,2,3,7,8,9 HxCDF	1.02E-07	0.00E+00	-
Measurement 14	2,3,4,6,7,8 Hp CDF	3.41E-08	0.00E+00	-
Measurement 15	1,2,3,4,6,7,8 HpCDF	4.35E-07	0.00E+00	-
Measurement 16	1,2,3,4,7,8,9 HpCDF	5.37E-08	0.00E+00	-
Measurement 17	OCDF	2.43E-07	0.00E+00	-
Measurement 18	mercury	6.00E-03	0.00E+00	-

TCA = Tolerable Concentration in Air Coa = Concentration in outdoor air

Concentration in drinking water

Measurement	Substance	Cdw(µg/l)	standard(µg/l)	Cdw/standard
Measurement 1	dioxine 2378 TeCDD	4.44E-11	0.00E+00	-
Measurement 2	dioxine 1,2,3,7,8-PeCDD	0.00E+00	0.00E+00	-
Measurement 3	dioxine 1,2,3,6,7,8	0.00E+00	0.00E+00	-
Measurement 4	dioxine 1,2,3,4,7,8	0.00E+00	0.00E+00	-

Measurement 5	dioxine 1,2,3,7,8,9	0.00E+00	0.00E+00	-
Measurement 6	dioxine 1,2,3,4,6,7,8	0.00E+00	0.00E+00	-
Measurement 7	dioxine OCDD	4.57E-13	0.00E+00	-
Measurement 8	2,3,7,8 TCDF	0.00E+00	0.00E+00	-
Measurement 9	1,2,3,7,8 PeCDF	0.00E+00	0.00E+00	-
Measurement 10	1,2,3,4,7,8 HxCDF	0.00E+00	0.00E+00	-
Measurement 11	2,3,4,7,8 PeCDF	0.00E+00	0.00E+00	-
Measurement 12	1,2,3,6,7,8 HxCDF	0.00E+00	0.00E+00	-
Measurement 13	1,2,3,7,8,9 HxCDF	0.00E+00	0.00E+00	-
Measurement 14	2,3,4,6,7,8 Hp CDF	0.00E+00	0.00E+00	-
Measurement 15	1,2,3,4,6,7,8 HpCDF	0.00E+00	0.00E+00	-
Measurement 16	1,2,3,4,7,8,9 HpCDF	0.00E+00	0.00E+00	-
Measurement 17	OCDF	0.00E+00	0.00E+00	-
Measurement 18	mercury	0.00E+00	1.00E+00	0.00E+00

Cdw = Concentration in drinking water

Background

Measurement	Substance	Dose(mg/(kg.d))	Background(mg/(kg.d))
Measurement 1	dioxine 2378 TeCDD	4.09E-09	0.00E+00
Measurement 2	dioxine 1,2,3,7,8-PeCDD	3.46E-09	0.00E+00
Measurement 3	dioxine 1,2,3,6,7,8	5.74E-09	0.00E+00
Measurement 4	dioxine 1,2,3,4,7,8	1.52E-09	0.00E+00
Measurement 5	dioxine 1,2,3,7,8,9	3.29E-09	0.00E+00
Measurement 6	dioxine 1,2,3,4,6,7,8	3.45E-08	0.00E+00
Measurement 7	dioxine OCDD	6.43E-10	0.00E+00
Measurement 8	2,3,7,8 TCDF	2.39E-10	0.00E+00
Measurement 9	1,2,3,7,8 PeCDF	3.70E-10	0.00E+00
Measurement 10	1,2,3,4,7,8 HxCDF	1.50E-09	0.00E+00
Measurement 11	2,3,4,7,8 PeCDF	4.65E-10	0.00E+00
Measurement 12	1,2,3,6,7,8 HxCDF	7.88E-10	0.00E+00
Measurement 13	1,2,3,7,8,9 HxCDF	3.23E-10	0.00E+00
Measurement 14	2,3,4,6,7,8 Hp CDF	3.66E-10	0.00E+00
Measurement 15	1,2,3,4,6,7,8 HpCDF	6.55E-09	0.00E+00
Measurement 16	1,2,3,4,7,8,9 HpCDF	2.52E-11	0.00E+00
Measurement 17	OCDF	8.51E-08	0.00E+00
Measurement 18	mercury	6.06E-05	1.40E-04

Substance : mercury
Physical-chemical parameters

Moleculair weight	2.01E+02	g.mol-1
Water solubility	3.00E+03	mg.l-1

Vapour pressure	-	Pa
Klw	-	-
Log Kow	-	-
Log Koc	-	dm3.kg-1
Kd	3.30E+03	dm3.kg-1
BCF(root)	1.50E-02	-
BCF(stem)	3.00E-02	-
D(pe)	-	m2.d-1
Diffusion coefficient (air)	-	m2.h-1
Diffusion coefficient(water)	-	m2.h-1
DAR(adult)	-	h-1
DAR(child)	-	h-1
fexcr	-	-
pKa	-	-

Standards

RfD	6.10E-04	mg.kg-1.d-1
TCA	-	µg.m-3
Drinking water standard	1.00E+00	µg.l-1

Background dose

Background concentration	0.00E+00	µg.m-3

Substance : dioxine 2378 TeCDD

Physical-chemical parameters

Moleculair weight	3.22E+02	g.mol-1
Water solubility	3.00E-04	mg.l-1
Vapour pressure	1.40E-06	Pa
Klw	6.39E-04	-
Log Kow	6.80E+00	-
Log Koc	6.41E+00	dm3.kg-1
Kd	-	dm3.kg-1
BCF(root)	-	-
BCF(stem)	-	-
D(pe)	1.00E-07	m2.d-1
Diffusion coefficient (air)	-	m2.h-1
Diffusion coefficient(water)	-	m2.h-1
DAR(adult)	5.00E-03	h-1
DAR(child)	1.00E-02	h-1
fexcr	-	-
pKa	-	-

Standards

RfD	1.00E-08	mg.kg-1.d-1
TCA	-	µg.m-3
Drinking water standard	-	µg.l-1

Background dose

Background concentration	0.00E+00	µg.m-3	

Substance : dioxine OCDD

Physical-chemical parameters

Moleculair weight	4.60E+02	g.mol-1	
Water solubility	4.00E-07	mg.l-1	
Vapour pressure	5.93E-10	Pa	
Klw	2.90E-04	-	
Log Kow	8.20E+00	-	
Log Koc	7.81E+00	dm3.kg-1	
Kd	-	dm3.kg-1	
BCF(root)	-	-	
BCF(stem)	-	-	
D(pe)	1.00E-07	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	
Diffusion coefficient(water)	-	m2.h-1	
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	-	-	
pKa	-	-	

Standards

RfD	1.00E-08	mg.kg-1.d-1	
TCA	-	µg.m-3	
Drinking water standard	-	µg.l-1	

Background dose

Background concentration	0.00E+00	µg.m-3	

Substance : dioxine 1,2,3,7,8-PeCDD

Based on : none [organic - user defined]

Description

1,2,3,7,8-PeCDD

Physical-chemical parameters

Moleculair weight	3.56E+02	g.mol-1	
Water solubility	1.18E-04	mg.l-1	
Vapour pressure	8.80E-08	Pa	
Klw	1.13E-04	-	
Log Kow	7.40E+00	-	
Log Koc	6.38E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	0.00E+00	-	
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated

Diffusion coefficient(water)	0.00E+00	m2.h-1	
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
Parameters from Phys Chem Props of organic chemicals Vol 3 and US EPA vol 3

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : dioxine 1,2,3,6,7,8
Based on : none [organic - user defined]
Description
dioxin 1,2,3,6,7,8 HxCDD
Physical-chemical parameters

Moleculair weight	3.91E+02	g.mol-1	
Water solubility	4.40E-06	mg.l-1	
Vapour pressure	5.10E-09	Pa	
Klw	4.61E-04	-	
Log Kow	7.80E+00	-	
Log Koc	7.10E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
As above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : dioxine 1,2,3,4,7,8
Based on : none [organic - user defined]
Description
dioxin 1,2,3,4,7,8 HcDD
Physical-chemical parameters

Moleculair weight	3.91E+02	g.mol-1	
Water solubility	4.40E-06	mg.l-1	
Vapour pressure	5.10E-09	Pa	
Klw	4.61E-04	-	
Log Kow	7.80E+00	-	
Log Koc	7.10E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : dioxine 1,2,3,7,8,9

Based on : none [organic - user defined]
Description
dioxin 1,2,3,7,8,9 HxCDD
Physical-chemical parameters

Moleculair weight	3.91E+02	g.mol-1	
Water solubility	4.60E-06	mg.l-1	
Vapour pressure	5.10E-09	Pa	
Klw	4.61E-04	-	
Log Kow	7.80E+00	-	
Log Koc	7.10E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : dioxine 1,2,3,4,6,7,8
Based on : none [organic - user defined]
Description
dioxin 1,2,3,4,6,7,8, HpCdd
Physical-chemical parameters

Moleculair weight	4.25E+02	g.mol-1	
Water solubility	2.40E-06	mg.l-1	
Vapour pressure	7.50E-10	Pa	
Klw	5.41E-04	-	
Log Kow	8.00E+00	-	
Log Koc	7.80E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	

Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : 2,3,7,8 TCDF
Based on : none [organic - user defined]
Description
2,3,7,8 TCDF
Physical-chemical parameters

Moleculair weight	1.68E+02	g.mol-1	
Water solubility	4.19E-03	mg.l-1	
Vapour pressure	2.00E-06	Pa	
Klw	6.21E-04	-	
Log Kow	6.10E+00	-	
Log Koc	7.50E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
As above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : 1,2,3,7,8 PeCDF
Based on : none [organic - user defined]
Description
1,2,3,7,8 PeCDF
Physical-chemical parameters

Moleculair weight	3.40E+02	g.mol-1	
Water solubility	2.36E-04	mg.l-1	
Vapour pressure	3.50E-07	Pa	
Klw	2.15E-04	-	
Log Kow	6.50E+00	-	
Log Koc	7.40E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
As above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : 2,3,4,7,8 PeCDF
Based on : 1,2,3,7,8 PeCDF [organic - user defined]
Description
2,3,4,7,8 Pe CDF
Physical-chemical parameters

Moleculair weight	3.40E+02	g.mol-1	
Water solubility	2.36E-01	mg.l-1	
Vapour pressure	3.50E-07	Pa	
Klw	2.15E-04	-	
Log Kow	6.50E+00	-	
Log Koc	7.40E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
As above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : 1,2,3,4,7,8 HxCDF
Based on : none [organic - user defined]
Description
1,2,3,4,7,8 HxCDF
Physical-chemical parameters

Moleculair weight	3.75E+02	g.mol-1	
Water solubility	1.77E-04	mg.l-1	
Vapour pressure	3.50E-08	Pa	
Klw	3.15E-04	-	
Log Kow	7.00E+00	-	
Log Koc	7.40E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated

D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : 1,2,3,6,7,8 HxCDF
Based on : 1,2,3,4,7,8 HxCDF [organic - user defined]
Description
1,2,3,6,7,8 Hx CDF
Physical-chemical parameters

Moleculair weight	3.75E+02	g.mol-1	
Water solubility	1.77E-04	mg.l-1	
Vapour pressure	3.50E-08	Pa	
Klw	3.15E-04	-	
Log Kow	7.00E+00	-	
Log Koc	7.40E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3

Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : 1,2,3,7,8,9 HxCDF
Based on : 1,2,3,6,7,8 HxCDF [organic - user defined]
Description
1,2,3,7,8,9 HxCDF
Physical-chemical parameters

Moleculair weight	3.75E+02	g.mol-1	
Water solubility	1.77E-04	mg.l-1	
Vapour pressure	3.50E-08	Pa	
Klw	3.15E-04	-	
Log Kow	7.00E+00	-	
Log Koc	7.40E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : 2,3,4,6,7,8 Hp CDF
Based on : none [organic - user defined]
Description
2,3,4,6,7,8 Hp CDF
Physical-chemical parameters

Moleculair weight	4.09E+02	g.mol-1	
Water solubility	1.30E-06	mg.l-1	
Vapour pressure	4.70E-09	Pa	
Klw	6.06E-04	-	
Log Kow	7.40E+00	-	
Log Koc	7.90E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : 1,2,3,4,6,7,8 HpCDF
Based on : 2,3,4,6,7,8 Hp CDF [organic - user defined]
Description
1,2,3,4,6,7,8 HpCDF
Physical-chemical parameters

Moleculair weight	4.09E+02	g.mol-1	
Water solubility	1.30E-06	mg.l-1	
Vapour pressure	4.70E-09	Pa	
Klw	6.06E-04	-	
Log Kow	7.40E+00	-	
Log Koc	7.90E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated

BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : 1,2,3,4,7,8,9 HpCDF
Based on : 1,2,3,4,6,7,8 HpCDF [organic - user defined]
Description
1,2,3,4,7,8,9 HpCDF
Physical-chemical parameters

Moleculair weight	4.09E+02	g.mol-1	
Water solubility	1.30E-06	mg.l-1	
Vapour pressure	4.62E-08	Pa	
Klw	6.06E-04	-	
Log Kow	7.40E+00	-	
Log Koc	6.70E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	-	m2.h-1	calculated
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1

TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Substance : OCDF
Based on : none [organic - user defined]
Description
OCDF
Physical-chemical parameters

Moleculair weight	4.44E+02	g.mol-1	
Water solubility	1.16E-06	mg.l-1	
Vapour pressure	5.10E-10	Pa	
Klw	8.12E-05	-	
Log Kow	8.00E+00	-	
Log Koc	7.40E+00	dm3.kg-1	
Kd	0.00E+00	dm3.kg-1	
BCF(root)	-	-	calculated
BCF(stem)	-	-	calculated
D(pe)	0.00E+00	m2.d-1	
Diffusion coefficient (air)	-	m2.h-1	calculated
Diffusion coefficient(water)	0.00E+00	m2.h-1	
DAR(adult)	5.00E-03	h-1	
DAR(child)	1.00E-02	h-1	
fexcr	0.00E+00	-	
pKa	-	-	calculated

Justification
as above

Standards

RfD	0.00E+00	mg.kg-1.d-1
TCA	0.00E+00	µg.m-3
Drinking water standard	0.00E+00	µg.l-1

Justification

Background dose

Background concentration	0.00E+00	µg.m-3

Justification

Appendix J

Data on Existing Health in the Community

Baseline health status assessment for Ringsend

- Dr. Anthony Staines, Department of Public Health Medicine and Epidemiology, UCD.
- Dr. Howard Johnson, Mr. Eugene Boyle, Dr. Bob McDonald and Dr. Deirdre Carey, Health information Unit, Eastern Regional Health Authority.

Executive summary

This is the report of a baseline health assessment of the Ringsend area, conducted as part of a wider baseline assessment before proposals for building a large municipal waste incinerator in the area are prepared.

Using routinely collected health data, gathered at the level of DEDs, we have tried to present a profile of the health of the people living in the affected area. We have compared their health, primarily, with the health of other people living in adjacent DEDs.

The DED containing most of the affected area, Pembroke East A, is significantly less affluent than most of the adjacent DEDs. The people living there also have much worse health. There is a striking excess of ill health and death related to respiratory causes in this DED. This is likely to be due to a combination of social, environmental and lifestyle factors.

When considering the impact of future developments on this population, their intrinsic vulnerability to adverse effects of development will need careful assessment.

Background

The Department of Public Health Medicine and Epidemiology, in University College Dublin was approached by Ms. Jean Clarke, of M.C.O'Sullivan Ltd. (MCOS) in 2003. MCOS were acting as agents for Dublin Corporation. We were asked to prepare a proposal for a full Health Impact Assessment on a proposed municipal waste incinerator in Ringsend in South Dublin City.

This proposal was not acted on at the time, and we were asked instead to contribute to a baseline study as a precursor to a planning application for the incinerator. Specifically we were asked to use available routinely collected data to examine the current health status of people living near the proposed site, to place this in the context of the health of people living in surrounding areas, and to comment on this.

After discussion with colleagues in the Health Information Unit (HIU) of the Eastern Regional Health Authority we drew up a preliminary proposal which was accepted by Ms. Clarke on behalf of MCOS.

In outline, we suggested the use of some combination of available mortality data, routinely collected prescribing data, cancer incidence data, hospital admissions data, and data on congenital anomalies, analysed at the level of DED's, to compare the baseline health of the population living near the proposed site to that of their neighbours, and that of the wider population.

Data sources

Five sources of routine data were evaluated for use in this project. These were routinely collected mortality data, derived from death certification; cancer incidence data , derived from active case ascertainment in hospitals by the cancer registry; routinely collected prescribing data collected by the GMS payments board, from prescriptions filled in pharmacies; hospital admissions data, recorded at hospital entry, and collated by the ESRI; records of the births of children affected by congenital anomalies, recorded by the Eurocat registry in Dublin.

Each of these sources of data is potentially useful, but each has substantial limitations. The main general problem is geocoding, which affects each one of these data sources in some way. For the kind of work proposed here it is essential to know where the people affected by a health event, a birth, death, hospital admission and so on actually lived at the time of the event. The process of linking a person to small area in which they live is called geocoding.

Most other EU countries have systems that permit the more or less simple linkage of a person to a specific place. The small area unit in Ireland is the District Electoral Division (DED). In England, which has some of the worst health information systems in the EU, it is possible to use postcodes to link someone's address to a small area. In Sweden there is full civil registration, so it is possible to link someone's personal number to a small area. In Ireland this has to be done by linking written address details to small areas. This is very expensive, hard to do in cities, and often impossible in rural areas.

The major problems with each data source will be discussed in turn.

Mortality data

Irish mortality data are collected at death registration. Registrars abstract death certificates, code the results, and send these centrally. The quality of death certification in Ireland is not known, but is probably very variable. By default, the area of residence written on the death certificates are only coded to county and city borough level. The HIU has carried out a series of special coding exercises, but despite a considerable effort, 5% of deaths cannot be linked to DED's. The data used here runs from 1994 to 1999. Data for 1999 to 2003 will be available later this year.

Cancer incidence data

Cancer incidence data are collected by the National Cancer Registry of Ireland (NCRI), which is based in Cork. They employ specially trained nurses, who search out cases of cancer in Irish hospitals. They also link death certificate diagnoses of cancer. The quality and completeness of the Cancer Registry data have to been shown to be very high.

The NCRI code addresses to DED level in house, using special software. In Dublin just over 5% of deaths could not be linked to DEDs. Cancer data is presently available for 1994 to 2000 inclusive. Data for 2001 will become available later this year.

Prescribing data

The GMS payments board record detailed data on prescriptions given to medical card holders. Very considerable detail is recorded, including the dose, duration and the name of the drug prescribed. These are presented for analysis in groups, derived by considering the main therapeutic indications for the particular drug.

A major limitation of this system is that it only covers medical card holders. Therefore the value of this system in comparing health states between areas with different proportions of medical card holders is limited. Against that, medical card holders are presumably some of the most vulnerable individuals in society, so measuring their usage of prescription drugs should give a useful indication of the health of an area.

Our analysis reports on drugs coded as being used to treat asthma. This includes much drug treatment of older people with chronic bronchitis, as well as specific treatment for asthma. The data presented here are for 2002.

HIPE data

Hospital discharges are recorded by the Hospital Inpatients Enquiry System (HIPE). Each state-funded acute hospital in Ireland participates in this system. Every hospital discharge is coded by specially trained staff based in the hospital. The main source of information is the discharge letter dictated by hospital medical staff.

HIPE records are coded to county level, to county borough level, to town, and, in Dublin only, to post code. Unfortunately Dublin has only 21 postcodes (Dublin 1,2,3 etc..). These are too coarse a geographical level to be useful for our purposes. While some hospital discharge records have been geocoded to DED level by the HIU in ERHA, the records are still incomplete for the hospital closest to our study area. For this reason, HIPE records are not usable for this exercise.

Eurocat data

Ireland is a member of the European system for recording the births of babies affected by congenital anomalies (Eurocat). Affected babies are identified, mostly, in maternity hospitals and registered. While the affected babies births are coded to DED level, there are no corresponding figures for unaffected babies.

For this reason, it is not possible to calculate rates of births of affected babies. The rate is the number of affected babies born in a DED in a year, divided by the total number of babies born in that DED in that year. This, however, is what is required for the analyses presented here, and so this data source cannot be used.

Statistical methods

There are several difficult and technical problems that arise in analysing this type of health data from small areas. These are discussed in the appendix. After carefully considering the issues, we selected two statistical methods, indirect standardisation and Empirical Bayes (EB) smoothing for use in this project. Further details of both are contained in the Appendix.

Both methods produce estimates of the risk of the event being considered (death from a particular cause, a new diagnosis of cancer, or being prescribed a specific drug), compared with the risk in the whole ERHA area. Indirect standardisation produces, a Standardised Mortality Ratio (SMR), Standardised Incidence Ratio (SIR), or a Standardised Prescribing Ratio (SPR), for deaths, new diagnoses of cancer, and being prescribed a particular group of drugs respectively.

The EB methods produce the corresponding smoothed figures. These are more reliable estimates of the actual risk in a small area compared with the risk in the Dublin City region.

Results

Following discussions with the HIU in ERHA it was decided to take 14 DEDs to make up the study area. The DEDs selected are those on the coast and just inland, lying north and south of the proposed site in Ringsend. The centre of interest is the Pembroke East A DED, which covers most of Ringsend, and where permission will be sought to erect a municipal waste incinerator. Table 1 lists basic features of the DEDs selected. They are also shown in Figure 1.

DED Code	DED Name	Population	Deprivation score(1)
42	Clontarf East B	6,458	1
43	Clontarf East C	3,029	1
44	Clontarf East D	2,772	1
48	Clontarf West C	3,372	2
49	Clontarf West D	2,140	2
108	North Dock B	3,628	4
110	Pembroke East A	4,304	4
111	Pembroke East B	3,595	1
112	Pembroke East C	3,900	1
114	Pembroke East E	3,337	1
115	Pembroke West A	3,241	2
116	Pembroke West B	3,140	1
117	Pembroke West C	4,188	1
143	South Dock	3,764	1

Table 1. Names, population sizes and deprivation scores for the DEDs making up the study area

[Map to be got please!]

Figure 1. Map of Dublin, showing the study area.

Populations

There are fourteen DEDs in the study area (Figure 1). They had a total population in 1996 of just over 49,000 people, ranging from just over 2000 to just under 6350 people. They are divided sharply by deprivation score (1), with the Ringsend area and the North Dock area both being quite deprived, and all of the other areas being in the most affluent fifth of Dublin areas, or the second most affluent fifth.

Mortality data

Five major groups of causes of death were examined. These were all-cause mortality, deaths due to ischaemic heart disease, deaths due to all types of cancer, deaths due to all types of respirator disease, deaths due to cerebrovascular disease (strokes) and deaths due to injury and poisoning.

Deaths were assigned to these groups using the ICD codes of the cause of death from the death certificates.

These groups were chosen because they fulfilled three criteria. They were available from existing data, they were important causes of death, and they were believed to be affected by poor external environments.

Results are presented in uniform format. Each cause of death is given as a singe table, listed in order of DED codes, with DED codes, DED names, the actual number of deaths observed, the SMR derived from indirect standardisation, the smoothed SMR smoothed using the Empirical Bayes method of Clayton and Kaldor, and 95% confidence limits for the SMR.

All deaths

DED Code	DED Name	Observed	SMR	Smoothed SMR	Lower CI	Upper CI
42	Clontarf East B	337	89	90	80	99
43	Clontarf East C	149	77	79	65	90
44	Clontarf East D	140	82	85	69	96
48	Clontarf West C	161	82	84	69	95
49	Clontarf West D	147	104	105	87	121
108	North Dock B	235	134	133	117	151
110	**Pembroke East A**	**245**	**143**	**141**	**125**	**161**
111	Pembroke East B	206	107	107	92	121
112	Pembroke East C	196	83	85	72	95
114	Pembroke East E	119	83	86	68	98
115	Pembroke West A	211	131	130	113	148
116	Pembroke West B	112	84	87	69	100
117	Pembroke West C	179	95	96	81	108
143	South Dock	176	134	132	114	154

The highest death rates are found in Pembroke East A, with raised mortality also in Pembroke West A and North Dock B. This pattern, which is closely related to the level of deprivation, is highly unlikely to be due to chance. However there are fifteen DEDs in Dublin City with higher all-cause smoothed SMRs than Pembroke East A.

Deaths from all cancers combined

DED Code	DED Name	Observed	SMR	Smoothed SMR	Lower CI	Upper CI
42	Clontarf East B	101	104	106	84	125
43	Clontarf East C	43	88	94	64	119
44	Clontarf East D	34	76	86	53	107
48	Clontarf West C	35	77	87	54	107
49	Clontarf West D	35	99	103	69	138
108	North Dock B	72	151	142	118	190
110	**Pembroke East A**	**65**	**136**	**130**	**105**	**174**
111	Pembroke East B	52	110	111	82	144
112	Pembroke East C	65	120	119	93	153
114	Pembroke East E	29	79	90	53	114
115	Pembroke West A	48	112	112	83	149
116	Pembroke West B	30	90	97	60	128
117	Pembroke West C	43	95	100	69	128
143	South Dock	40	120	118	86	164

This is similar to the previous table, showing higher death rates from cancer in North Dock and Pembroke East A. The latter is number 32 in order of decreasing cancer mortality. None of the other areas clearly shows a raised, or decreased cancer mortality.

Deaths from respiratory disease

DED Code	DED Name	Observed	SMR	Smoothed SMR	Lower CI	Upper CI
42	Clontarf East B	43	79	84	57	107
43	Clontarf East C	23	82	89	52	123
44	Clontarf East D	16	67	78	38	108
48	Clontarf West C	24	80	87	51	119
49	Clontarf West D	16	77	87	44	125
108	North Dock B	34	144	137	100	201
110	**Pembroke East A**	**44**	**197**	**177**	**143**	**265**
111	Pembroke East B	30	106	108	72	151
112	Pembroke East C	33	91	95	63	128
114	Pembroke East E	12	60	75	31	104
115	Pembroke West A	24	108	110	69	161
116	Pembroke West B	19	99	104	60	155
117	Pembroke West C	32	115	115	79	162
143	South Dock	28	153	142	102	221

Pembroke East A has the fifth highest respiratory disease mortality in Dublin City. South Dock also has modestly increased mortality from this group of diseases.

Deaths from Heart Disease

DED Code	DED Name	Observed	SMR	Smoothed SMR	Lower CI	Upper CI
42	Clontarf East B	81	92	94	73	114
43	Clontarf East C	37	82	88	58	113
44	Clontarf East D	35	88	93	61	122
48	Clontarf West C	46	103	105	75	137
49	Clontarf West D	32	97	101	66	137
108	North Dock B	55	134	130	101	175
110	**Pembroke East A**	**52**	**131**	**128**	**98**	**172**
111	Pembroke East B	47	106	107	78	141
112	Pembroke East C	45	84	89	61	112
114	Pembroke East E	27	83	90	54	120
115	Pembroke West A	55	147	140	111	191
116	Pembroke West B	25	82	90	53	120
117	Pembroke West C	47	110	111	81	146
143	South Dock	36	121	119	85	168

For heart disease, Pembroke West A, and North Dock have elevated mortality. Pembroke East A has non-significantly raised mortality, and is forty-second in order in Dublin City.

Deaths from Stroke

DED Code	DED Name	Observed	SMR	Smoothed SMR	Lower CI	Upper CI
42	Clontarf East B	33	89	94	61	125
43	Clontarf East C	12	63	83	33	110
44	Clontarf East D	18	111	107	66	176
48	Clontarf West C	5	25	62	8	57
49	Clontarf West D	15	107	105	60	177
108	North Dock B	22	138	119	86	209
110	**Pembroke East A**	**22**	**146**	**122**	**91**	**221**
111	Pembroke East B	17	89	96	52	143
112	Pembroke East C	12	49	72	25	86
114	Pembroke East E	12	88	97	46	154
115	Pembroke West A	17	113	107	66	181
116	Pembroke West B	14	109	105	59	182
117	Pembroke West C	15	80	92	45	132
143	South Dock	19	153	123	93	240

There is less variation between DEDs for stroke death rates than for the other causes of death described here. In particular there is no good evidence of increased mortality in Pembroke East A.

Deaths due to injury and poisoning

DED Code	DED Name	Observed	SMR	Smoothed SMR	Lower CI	Upper CI
42	Clontarf East B	6	54	73	20	118
43	Clontarf East C	3	55	84	11	161
44	Clontarf East D	5	102	110	33	240
48	Clontarf West C	7	117	117	47	239
49	Clontarf West D	7	175	143	71	365
108	North Dock B	5	86	100	28	201
110	**Pembroke East A**	**11**	**167**	**146**	**83**	**299**
111	Pembroke East B	5	78	95	25	183
112	Pembroke East C	10	135	128	65	248
114	Pembroke East E	5	96	106	31	223
115	Pembroke West A	4	70	92	19	180
116	Pembroke West B	1	23	73	1	127
117	Pembroke West C	2	27	64	3	100
143	South Dock	8	143	131	62	283

There is little real evidence of any substantial difference in death rates between the 14 DEDs. The pattern of SMRs, while not statistically significant, is similar to that noted previously.

Cancer incidence data

Five groups of people newly diagnosed with cancers (incident cancers) were considered. These were diagnoses of breast cancer in women, prostate cancer in men, lung cancer, colorectal cancer and all cancers considered as one group. Cancers were coded by the National Cancer Registry, and geographical coding was done by the HIU.

These groups of cancer diagnoses were chosen because they were all relatively common, and hence, major public health problems. Little is known about the relationships between specific environmental factors and cancer incidence at this level. Lung cancer is mainly caused by smoking, but radon gas and air pollution are probably significant causes too. Breast and prostate cancer are both known to be affected by hormones.

Results are presented as for the mortality data.

All cancers

DED CODE	DED NAME	OBSERVED	SIR	Smoothed SIR	LR_CI	UPR_CI
42	Clontarf East B	210	97	98	85	111
43	Clontarf East C	104	96	98	78	116
44	Clontarf East D	88	86	91	69	106
48	Clontarf West C	85	87	92	69	107
49	Clontarf West D	73	95	98	75	120
108	North Dock B	118	109	107	90	131
110	**Pembroke East A**	**124**	**110**	**108**	**91**	**131**
111	Pembroke East B	112	103	103	85	124
112	Pembroke East C	130	108	107	90	129
114	Pembroke East E	104	122	115	100	148
115	Pembroke West A	118	118	114	98	142
116	Pembroke West B	69	87	93	68	110
117	Pembroke West C	109	103	103	84	124
143	South Dock	95	124	116	100	151

There is little evidence for any differences in cancer incidence between the DEDs in the study area. There is only a very weak indication of an excess risk in Pembroke West A.

Lung cancer

DED CODE	DED NAME	OBSERVED	SIR	Smoothed SIR	LR_CI	UPR_CI
42	Clontarf East B	27	83	90	54	120
43	Clontarf East C	9	54	75	25	103
44	Clontarf East D	11	69	86	35	124
48	Clontarf West C	13	91	102	48	155
49	Clontarf West D	12	101	110	52	176
108	North Dock B	32	193	172	132	272
110	**Pembroke East A**	**26**	**154**	**145**	**101**	**225**
111	Pembroke East B	11	69	86	34	123
112	Pembroke East C	13	75	89	40	128
114	Pembroke East E	14	112	116	61	188
115	Pembroke West A	18	120	121	71	190
116	Pembroke West B	12	103	111	53	179
117	Pembroke West C	11	71	88	36	128
143	South Dock	17	152	141	88	243

In contrast to the results for other types of cancer the incidence of lung caner is elevated in Pembroke East A. It is in the top fifth of DEDs in Dublin for this disease. Lung cancer is known to be strongly related to deprivation, probably as a consequence of smoking.

Colorectal cancer

DED CODE	DED NAME	OBSERVED	SIR	Smoothed SIR	LR_CI	UPR_CI
42	Clontarf East B	36	116	107	81	161
43	Clontarf East C	15	96	97	53	158
44	Clontarf East D	15	101	99	57	167
48	Clontarf West C	11	79	92	40	142
49	Clontarf West D	17	153	113	89	245
108	North Dock B	10	65	87	31	120
110	**Pembroke East A**	**12**	**77**	**91**	**40**	**134**
111	Pembroke East B	18	118	105	70	186
112	Pembroke East C	17	100	99	58	160
114	Pembroke East E	13	110	101	59	188
115	Pembroke West A	15	106	101	60	175
116	Pembroke West B	7	63	88	25	130
117	Pembroke West C	19	129	108	78	202
143	South Dock	10	94	97	45	173

There is little evidence for any variation in colorectal cancer incidence between DEDs. Pembroke East A has a relatively low incidence but this is not significantly different from the Dublin average.

Prostate cancer

DED CODE	DED NAME	OBSERVED	SIR	Smoothed SIR	LR_CI	UPR_CI
42	Clontarf East B	14	70	79	38	117
43	Clontarf East C	10	98	91	47	180
44	Clontarf East D	5	46	73	15	108
48	Clontarf West C	11	128	100	64	229
49	Clontarf West D	7	97	90	39	200
108	North Dock B	7	69	81	28	141
110	**Pembroke East A**	**15**	**146**	**107**	**82**	**240**
111	Pembroke East B	9	87	87	40	166
112	Pembroke East C	13	131	102	70	225
114	Pembroke East E	18	231	128	137	365
115	Pembroke West A	6	68	81	25	148
116	Pembroke West B	4	63	81	17	160
117	Pembroke West C	12	141	104	73	247
143	South Dock	11	164	107	82	294

Again there is little evidence of any substantial difference between areas. Both Pembroke East A and Pembroke East E have a high SIR for of prostate cancer, but on smoothing this falls markedly, implying that this apparent excess is unlikely to be of any significance.

Breast cancer

DED CODE	DED NAME	OBSERVED	SIR	Smoothed SIR	LR_CI	UPR_CI
42	Clontarf East B	38	128	106	91	176
43	Clontarf East C	15	101	97	57	167
44	Clontarf East D	13	98	97	52	168
48	Clontarf West C	12	90	95	47	158
49	Clontarf West D	4	42	90	11	108
108	North Dock B	12	86	95	45	151
110	**Pembroke East A**	**9**	**57**	**89**	**26**	**107**
111	Pembroke East B	18	122	101	73	194
112	Pembroke East C	25	143	106	92	211
114	Pembroke East E	16	129	101	74	210
115	Pembroke West A	24	171	109	110	255
116	Pembroke West B	12	107	98	55	187
117	Pembroke West C	19	130	102	78	203
143	South Dock	10	99	97	47	182

There is little indication of any great variation between DEDs in this condition. Pembroke East A has a low incidence, but this rises substantially on smoothing, again suggesting that this is of no significance.

Prescribing data

The prescribing data analysed here is of drugs coded as prescriptions for asthma. This includes many drugs used to treat chronic bronchitis and emphysema in older people, as well as asthma.

DED	DED name	Observed	SPR	LR_CI	UPR_CI
42	Clontarf East B	135	84	69	100
43	Clontarf East C	62	84	63	110
44	Clontarf East D	64	86	65	112
48	Clontarf West C	63	82	62	108
49	Clontarf West D	70	94	73	120
108	North Dock B	147	111	95	129
110	**Pembroke East A**	**171**	**132**	**116**	**151**
111	Pembroke East B	71	77	57	100
112	Pembroke East C	71	86	66	110
114	Pembroke East E	38	63	40	93
115	Pembroke West A	87	91	72	113
116	Pembroke West B	48	74	52	103
117	Pembroke West C	51	78	56	106
143	South Dock	83	106	85	130

Interpretation of prescribing data, as discussed earlier, is difficult. While Pembroke East A has a high prevalence of recorded prescriptions for anti-asthmatic drugs, it also has a very high prevalence of medical card holders, far higher than the adjacent wards. As such, what is presented here is a comparison between a small proportion of the people resident in say, Clontarf East C, against the majority of the residents of Pembroke East A.

Nonetheless it seems likely that there is some increased prescribing for asthmas in this DED. This probably reflects a higher burden of respiratory disease, and is probably also a good marker of the extent of smoking in the study DEDs.

Conclusions

In general the results are consistent, and not unexpected. People living in Pembroke East A have worse health than residents of most of the adjoining DEDs, apart from North Dock B and (for some conditions) Pembroke West A. This is especially true for respiratory disease and lung cancer.

The remaining DEDs in Pembroke make up Sandymount and parts of Ballsbridge, while the Clontarf DEDs are mostly the seafront, and the parts of Clontarf just inland from there. North Dock B is another very deprived inner city area.

Given the high level of deprivation in the area, the poor levels of health are not especially surprising, although the excess of respiratory diseases is very striking. Poverty is the dominant factor influencing differences in health status between small areas in Ireland, as in the other countries where such analyses have been done. However, it is very possible that other factors are at work here. These could include smoking, occupation exposure to respiratory toxins, and air pollution affecting residents.

Ireland is a very unequal country, a fact reflected in poor levels of health overall, and in the concentration of ill health in deprived areas which this study has identified. The measurement of poverty chosen here is the SAHRU deprivation score (1, 2). This was developed by Alan Kelly and his colleagues in Trinity College Dublin, and has been widely used in the Irish health services.

The DED has experienced rapid social change over the last few years, partly due to gentrification of the existing housing stock, and partly due to extensive residential development in the DED. As a result the 2004 health of this population may be rather better than that presented here.

The implications of this for the proposed development are uncertain. There are many suggestions in the literature that poorer people may be more susceptible to environmental hazards than wealthier people. It is hard to come to any definitive conclusions about this, since poorer people are generally forced to live in more contaminated areas anyway. It is possible that on-going work in Britain on rural poverty, and in the United States on environmental equity might answer this question in the next few years.

This report, as such, merely documents the sad but not unexpected pattern of health inequalities in the study areas. What is not addressed in this report is differential exposure to environmental hazards (3). There is certainly an important issue of environmental equity to be addressed here, however this is work for another project.

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Appendix

Statistical issues

Comparison of health status between small areas poses several severe statistical problems, which current, and any likely future methods, can only partly overcome (2, 4).

MAUP

One source of these difficulties is the essentially arbitrary choice of boundaries. It has been known to geographers for many years that the choice of the boundaries into which an area is dissected has a major impact on the inferences that can be made from observations on that area (5). Put more bluntly, the choice of boundary can change the answers obtained from projects like this. The technical term for this in geography is the Modifiable Areal Unit Problem (MAUP).

There are no really satisfactory solutions to this problem. Integrity in analysis provides some defence, where the analyst chooses a set of boundaries, on either practical, or sound theoretical grounds, and sticks to them.

In our situation, there is really only one set of boundaries available, the DED's and we are using these.

Smoothing – yes or no?

A second issue, more technically statistical, is the problem of small numbers. Briefly, the number of events in small areas is likely to follow a Poisson distribution. Especially for less common events, small differences in the number of events observed, can lead to very large differences in the estimate of the risk for small areas (4, 6, 7).

For example, the expected number of cases of leukaemia in a small area, such as a DED, might be 0.2. Thus if no case happens to occur, the estimated risk will be zero, while if only one case occurs, the estimated risk is 5 times the average risk over the whole region. Neither is likely to be very credible as an estimate of the real risk of disease in a small area.

A response to this is to avoid the use of simple estimates of risk, and to report instead estimates which reflect the degree of credibility of the estimated risk. There are several ways to do this, and the method chosen here, empirical Bayes' smoothing, has the merits of simplicity. Fully Bayesian modelling is an alternative, but it remains difficult to report the results of such models to general audiences.

In summary, the risk identified for each small area, is weighted, so that risks derived from small areas, are given less weighting, and smoothed towards the overall average risk for the whole study area, while risks derived from larger areas are smoothed less. The degree of smoothing is related to the size of the population in each area.

Spatial autocorrelation

The final technical issue is known as spatial autocorrelation. The problem here is simple. There is a strong tendency for areas that are close together to be similar. Most of the statistical methods that we use assume that areas are (statistically) independent of each other. This means that each additional area studied adds as much information as any other area. However, this is seldom true. For example if you are already studying Ballygall A, B and D, adding Ballygall C tells you less about health in Dublin, than adding, say Drumfinn.

There are two approaches to this issue. The first is to say that this is a non-problem. Spatial autocorrelation measures the real effect of social factors that are common between areas, and that correcting for it, in effect, removes real differences and real similarities between areas.

The second is to try and model it. This modelling involves making an assumption about the degree and extent of the autocorrelation. These assumptions are not easy to test. The modelling is also difficult, and very hard to explain to non-specialists.

The truth probably lies between these two positions. For this report, particularly as we are only considering a restricted area of the city, we have decided not to address the issue.

Statistical methods

After consideration of these issues two methods were chosen to analyse the data for this project. These were Indirect standardisation, which compares the rate of ill health between area, after adjusting for differences in the age and sex of the people between areas. The second is Empirical Bayes smoothing of SMR's as described in the paper of Clayton and Kaldor.

Indirect standardisation.

This is a statistical method in common use in epidemiological studies. It is intended to solve the problem of comparing health outcomes between areas with different demographics. This is a major problem because the rates of most human diseases increase steeply with age. Also, for most diseases, women have lower rates than men of the same age. Thus a map of death rates for Dublin, would mainly identify the areas where older people live.

This is not useful for most purposes, so a procedure is adopted, where the actual number of deaths (or new cases of cancer, or hospital admissions …) occurring in an area is counted. This is referred to as the Observed number of deaths (O). This is then compared to the expected number (E), the number of deaths (etc ...) which would have occurred in that area had the death rates (etc …) for the whole city applied in that area. This is a simple calculation. The ratio of Observed to Expected (O/E) is then referred to as a standardised ratio, typically a Standardised Mortality Ratio (SMR) for deaths, a Standardised Incidence Ratio (SIR) for new cases of cancer, and so on. It is customary to multiply the ratio by 100 for presentation.

Empirical Bayes Smoothing

The method implemented here is the algorithm presented by Clayton and Kaldor in a classic 1987 paper (6). The rationale for this procedure is simple. SMRs from small area data typically cover a very wide range of values. Figure 2, which is a plot of the prostate cancer incidence data for Dublin City at DED level, is a typical example.

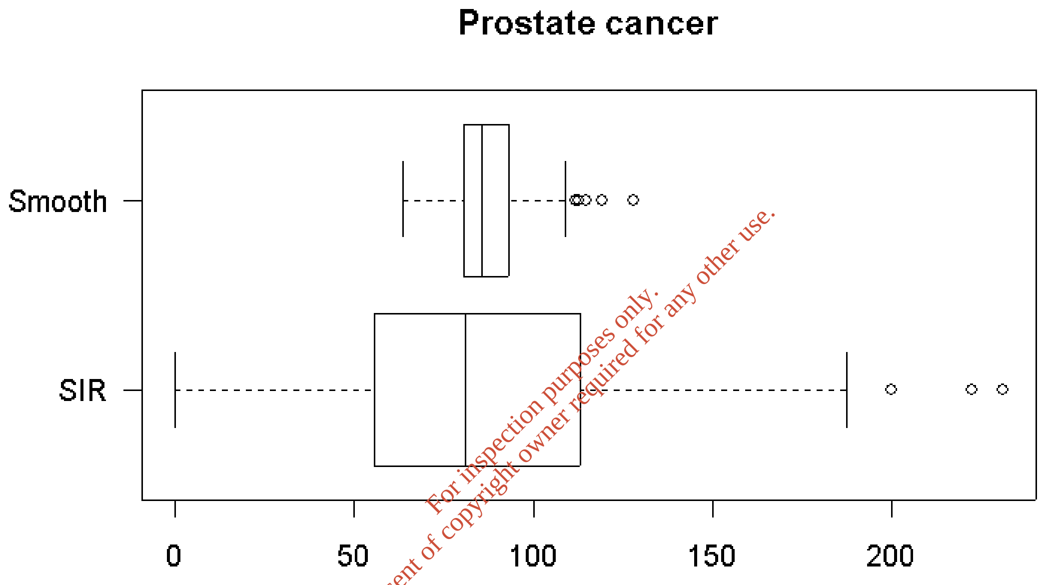

Figure 2. Comparison of unsmoothed, and empirical Bayes smoothed SIRs for Prostate cancer.

The very wide range of SIRs in the unsmoothed boxplot is simply not credible. It is most unlikely, that the real range of incidence of prostate cancer in Dublin runs from zero to more than twice the Dublin City average. The smoothed values are more believable.

The Clayton-Kaldor method provides a very simple implementation of a sophisticated statistical model for the true SIRs in this situation.

Appendix K

Landscape and Visual

RPS Planning & Environment

DUBLIN WASTE TO ENERGY PLANT
POOLBEG

LANDSCAPE AND VISUAL
BASELINE REPORT

Report Status: **Final** Date: 28 January 2004
Version 02

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TABLE OF CONTENTS

1.0 LANDSCAPE AND VISUAL BASELINE STUDY

1.1 Introduction

This section of the environmental baseline study establishes the landscape and visual baseline for the proposed site of the Dublin Waste to Energy Plant at Poolbeg. This section of the report seeks to:

- Identify current landscape designations and planning policies affecting the site and their surroundings;
- Assess the existing landscape character of the site and its surroundings;
- Assess the existing visual resource of the proposed site and its surroundings;
- Make recommendations if appropriate.

The purpose of this baseline study is to best inform the successful design team appointed to implement plans for the site with regards to the existing landscape and visual resources of the study area.

1.2 Methodology

The methods used in this baseline assessment have been drawn from the 'Guidelines for Landscape and Visual Impact Assessment' (GLVIA) by The Landscape Institute and Institute of Environmental Management and Assessment 2002. The guidelines recommend baseline studies to describe, classify and evaluate the existing landscape and visual resource focusing on its sensitivity and ability to accommodate change. The guidelines are not intended as a prescriptive set of rules but rather offer best practice methods and techniques of landscape and visual impact assessment. The GLVIA recommendations for landscape appraisal are consistent with the DOE & Local Government Draft Guidelines for Planning Authorities Landscape and Landscape Assessment (2000). The existing landscape and visual context of the study area is established through a process of desktop study, site survey work and photographic surveys. The proposal may then be applied to the baseline conditions by the successful design team to allow the identification of potential impacts, prediction of their magnitude and assessment of their significance. Mitigation can then be identified to reduce as far as possible potential landscape and visual impacts.

The assessment of impacts and proposal of mitigation measures has not formed part of this study. It will be necessary for such steps to be provided by the successful design team.

Assessment Terminology

Terminology for the measurement of landscape and visual change drawn from the GLVIA is based upon the sensitivity of the viewpoint or landscape and the extent to which the view/landscape characteristics are altered by the proposal.

Landscape sensitivity is defined as the extent to which a landscape can accept change of a particular type and scale proposed without unacceptable adverse effects on its character.

Landscape Resource is the combination of elements that contribute to landscape context, character and value.

Landscape Value is the relative value or importance attached to a landscape that expresses national or local consensus because of intrinsic characteristics.

Landscape Character is the distinct and homogenous pattern that occurs in the landscape reflecting geology, landform, soils, vegetation and mans impact.

Visual Resources of the landscape are the stimuli upon which actual visual experience is based. They are a combination of visual character and visual quality.

Visual Character When a viewer experiences the visual environment, it is not observed as one aspect at a time, but rather as an integrated whole. The viewer's visual understanding of an area is based on the visual character of elements and aspects and the relationships between them. The visual character is, therefore, descriptive and not evaluative.

Visual Quality Although the interpretation of viewers' experience can have preferential and subjective components, there is generally clear public agreement that the visual resources of certain landscapes have high visual quality. Some such areas have been officially designated Areas of Outstanding Natural Beauty and, therefore, it can be assumed that such areas were of high visual quality at the time of designation.

Due to the subjective value of the evaluation there is no comprehensive official process for identifying visual quality. The visual quality of this evaluation has been carried out by one landscape architect and verified by another.

Viewers Visual experience is a combination of visual resources and viewer responses. Given the nature and scale of this assessment, it is not possible to analyse individual viewer responses, thus views have been categorised based upon level of viewer exposure and level of viewer sensitivity.

Viewer Exposure Visual perception is the act of seeing and recognising. Accordingly, physical conditions will therefore affect perception. These include:

DISTANCE, which will affect the ability to see detail.
SPEED, which will affect the sharpness of lateral vision and the observer tends to focus vision along the line of travel.
DURATION, of view that will affect the degree of impact of the resulting image.

Viewer Sensitivity tends to vary according to the different viewer groups and is strongly related to visual preference. It can be gauged from information available in the form of formal designations of landscape quality, public hearings or published information, etc.

Landscape Baseline Assessment Methods

The capacity of a landscape to accept change of the type proposed has been assessed. The key landscape components are landform, vegetation, built and historical/ cultural components. Landform relates to topography, drainage problems and geology. Built and historical/ cultural components include human intervention, historic landscapes, listed buildings, conservation areas and historic designed landscapes. The landscape characters are mapped as shown in Figure 1.1. The sensitivity of the landscape can be assessed according to the GLVIA (LI/IEMA, 2002) from which the following categories have been identified for use in this appraisal:

Not sensitive: The landscape can absorb development of any scale without any negative change to the existing character.

Low sensitivity: The landscape would tolerate development of a small scale.

Medium sensitivity: The landscape would only tolerate small-scale development of very sensitive design.

High sensitivity The landscape would not tolerate development without changing the existing character.

As stated above a particular characteristic of the study area is its coastal location. It will be critically important to the future success of the prediction of Landscape and Visual impacts that consideration is giving to the Seascape. Seascape is defined as, " a picture or view to the sea". Careful consideration must be giving to the following points; Views from land to the sea; Views from the sea to the land; Views along the coastline; The effect on landscape of the conjunction of sea and land. The study approach has followed the recommendations of the *Irish Marine Institutes " Guide to Best Practice in Seascape Assessment".*

Figure 1.1: Landscape Character Areas

Urban Parkland Landscape

Urban Residential Landscape

Urban Industrial Landscape

Based on: 1:20,000 Series

Sheet no : Dublin Street Map

Proposed site location:

RPS mcos
Carnegie House
Dun Laoghaire
Co. Dublin
Phone: 01-2020870

Visual Baseline Assessment Methods

The procedure through which the visual baseline of the proposed site is realised is set out in Figure 1.2. The primary factors contained in this approach include the establishment of the visual environment surrounding the site in Dublin Harbour, a brief analysis of the visual resources of the area and the identification of viewer exposure and sensitivity. These combined factors define the existing, or baseline visual conditions. Once these are established, the predicted visual changes resulting from the proposed development can be assessed. The visual resource changes together with associated view response, forms the basis for the determination of the degree of visual impact. The assessment of magnitude of visual impact will form a separate stage of this project and it is not necessary that impacts be addressed here.

In predicting visual impact the main requirements are to show:

- The extent of potential/theoretical visibility
- The views and viewers affected
- The distance of view
- The resultant impacts upon the character and quality of views.

VISUAL EFFECTS

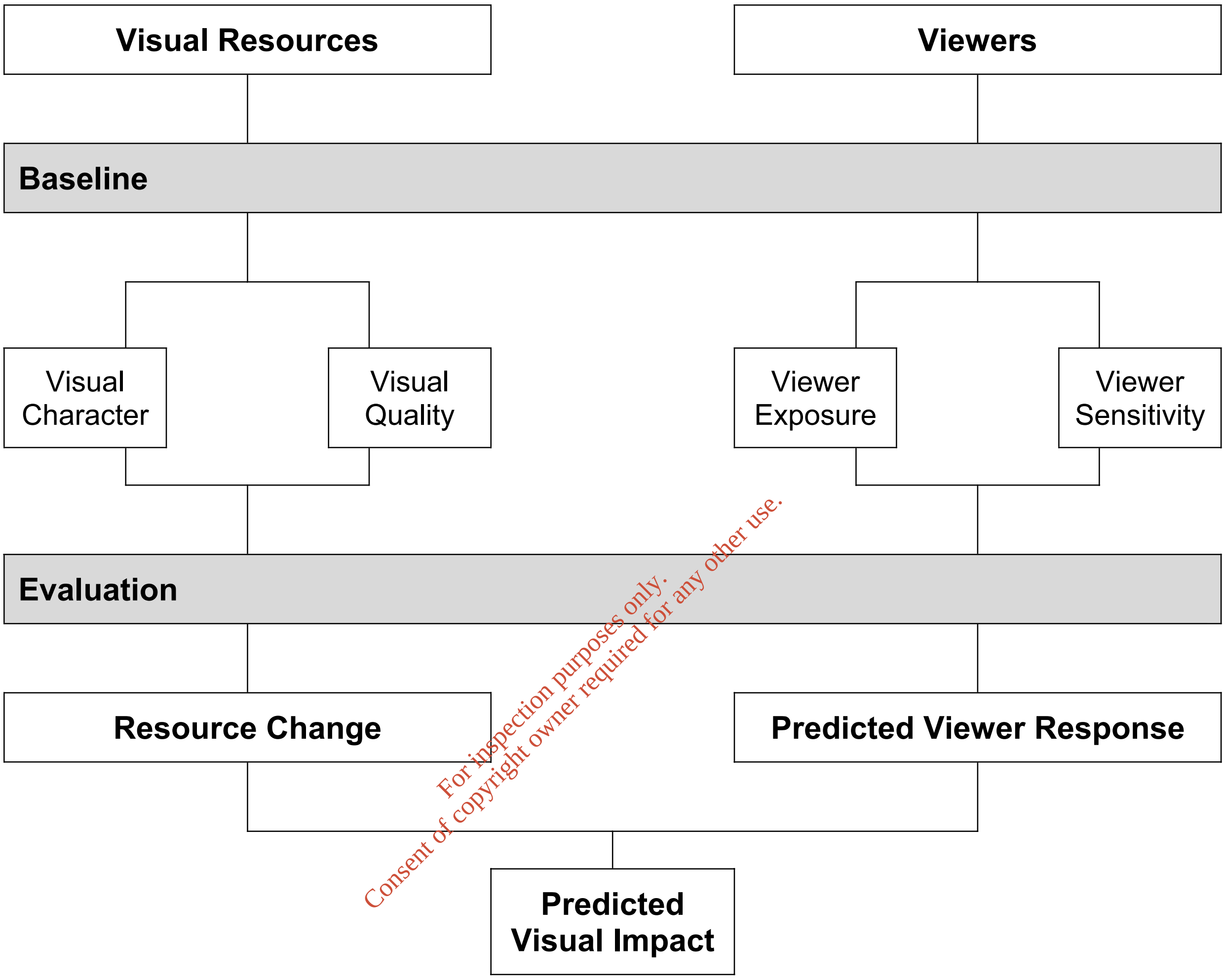

Figure 1.2 Visual Impact assessment procedure.

The evaluation of resource change, predicted viewer response and visual impacts will be the responsibility of the successful design team.

Zone of Visual Influence (ZVI)

The ZVI is the area within which views of the site and/or the development can, in theory, be obtained. The extent of the ZVI is determined primarily by the topography of the area. The ZVI is then refined by field studies to indicate where relevant forestry, woodlands, hedges and houses or other local features obscure visibility from the main roads, local viewpoints/landmarks and/or significant settlements. The theoretical ZVI is frequently more extensive than that found in the field.

Since the design of the proposed plant is not complete it is only possible to anticipate the likely ZVI at this stage. This ZVI will require to be revised once the final design is complete. The ZVI for the proposed development as described in the project description below is illustrated in Figure 1.3.

Computer terrain modelling software is the best method for establishing accurate ZVI. Buildings can be added to the terrain model once established to reduce the ZVI to more accurately reflect the visual influence of the proposal.

Photographs

A number of representative viewpoints have been selected around the site. Twenty-six viewpoints have been selected in total. The viewpoints have been selected following site survey to reflect typical views obtained of the site, using the parameters of distance and direction of view within the ZVI. The locations of the photographic viewpoints are provided in each viewpoint illustration. Summer and winter months views have been provided where vegetation is likely to provide seasonal variations in the extent or degree of visibility towards the proposed site.

Photographs from each viewpoint location have been taken covering an arc of view. The extent of the arc covered depends on what the photograph is intended to show. For instance, if the photograph is intended to show the context of the development in the landscape setting, an arc of view of 90-180º might be taken. A smaller arc of view of 40-60º, on the other hand, would be used to represent a single view rather than a panorama view, as this is approximately the viewing angle of the human eye. This viewing angle of the human eye is the angle without panning. A record is taken of the light conditions and visibility conditions, the camera height above ground, time of day and viewpoint coordinates are recorded.

Such photographs should be used to superimpose the development once finalised to generate photomontages. This method will allow clear illustration of the landscape and visual impacts of the proposal.

Figure **1.3**: Zone of Visual Influence

Visual Horizon

Intermediate Horizon

Based on:1:50,000 Series

Sheet no :50 (Dublin City and District)

Proposed site location:

RPS MCOS
Carnegie House
Dun Laoghaire
Co. Dublin
Phone: 01-2020870

1.3 *Project Description*

The proposed site is located in the southern part of Dublin Port, south of the River Liffey. The site lies between Pigeon House Road and Shellybanks Road within an existing industrial landscape. The site comprises of approximately 6 hectares. Several old industrial buildings currently occupy the site and these will be removed before development takes place. The appointed design team will determine the final design of the plant. It is expected that the building design will combine aesthetic values and functional composition. The plant design is expected to be a notable image that will be an example of high quality industrial architectural design. Typical heights of similar plants have been reviewed and it is possible that the stack may extend to 80m while the buildings may be 40-45m tall. These heights have only been used as a guide to inform the possible extent of study area. The study area will require to be revised once the detailed design is available. A grid connection will be necessary but no plans are available at present. Vehicular access to the site will be via the main Port entrance at South Bank Road.

1.4 *Existing Landscape and Visual Setting*

1.4.1 Scale and Character

The proposed site is located within an existing industrial landscape on the Poolbeg Peninsula and is surrounded by tall buildings and stacks. The most notable features nearby are the twin stacks of the Poolbeg Power Station, which are both 210m tall. The twin stacks are recognised landmarks in the Dublin City landscape and at the gateway to Dublin Port. The coastal location of the proposed site results in extensive potential views north and south due to the flat nature of the coastline in this part of Dublin Bay. It is only at Howth and Dalkey/Killiney that rocky coastline returns and extends to cliffs and hills. Residential landscape extends to the sea and boundary of the industrial harbour areas broken up by significant areas of public open space, which provide formal and informal recreation for the local community and visitors alike. The coastline is followed by an extensive footpath and cycle path system that is popular with the local community for informal recreation and links a number of open spaces along the eastern parts of Dublin City. The footpaths extend as far as Poolbeg Lighthouse on the Peninsula that afford extensive seascape views along the coast. Dublin City has a generally flat topography and medium and long distance views within the built fabric of the city are extremely limited.

1.4.2 Landscape Character Areas

The landscape character of the study area can be described by use of distinctive character areas as follows:

- Urban residential landscape

- Industrial landscape
- Urban parkland landscape

Urban residential landscape: Residential development consisting of two and single storey buildings are the predominant landscape features in the surrounding study area. Dollymount, Clontarf and Fairview lie to the north of the proposed site. To the west lie Ringsend and Irishtown. To the south are located Sandymount, Merrion and Booterstown. Occasionally larger buildings in the form of schools, office blocks and churches break the residential landscape. The visual quality of the landscape is low/medium. This landscape character area has a low sensitivity to change.

Industrial landscape: The Dublin Port has extended in recent years as the Irish economy continues to grow. Industrial and commercial activity within the Port area is extensive. Passenger ferries depart from Dublin to the Isle of Man and Holyhead on a daily basis. The Port area also acts as a major transport route between north and south Dublin via the East Link Bridge. Poolbeg Power Station twin stacks dominate the industrial landscape. Vertical elements are frequent and include stacks, cranes and associated lifting facilities. The visual quality of this landscape is low. This landscape character area has a low sensitivity to change.

Urban parkland landscape: A number of large public open spaces are located in the study area. Coastal promenades and walkways are located to the north at Clontarf and south at Sandymount. These coastal walkways are popular with visitors and the local community and provide panoramic views of Dublin Bay. Bull Island is located to the north east of the proposed site and consists of a flat duneland habitat. The island contains two golf courses (St. Anne's and Royal Dublin). The strand on the island is popular in summer months. Large formal gardens are also frequent such as Fairview Park and St. Annes Park. Both parks contain mature parkland landscapes and recreational facilities. Irishtown Nature Park is located immediately south of the proposed site. This Nature Park is zoned as a Natural Habitat Area in the Docklands Area Master Plan. Recreational facilities are also provided at Ringsend Park and Sean Moore Park. The visual quality of the urban parkland landscapes is high and they provide a valued resource to the local community. This landscape has a high sensitivity to change.

The locations of landscape character areas are provided in Figure 1.1.

1.4.3 Planning Context

Dublin City Council Development Plan 1999

A review of the above listed documentation with specific reference to the proposed site established that there are no current landscape designations relevant to the application site. The proposal lies within Objective Z7. This objective provides for the protection of industrial uses and facilitates opportunities for employment creation. A thermal treatment plant is listed as a permissible use under this zoning objective.

Dublin Docklands Area Master Plan 2003

A review of the docklands master plan produced by the Dublin Docklands Development Authority in 2003 has revealed that the zonings are broadly the same as described in the Dublin City Council Development Plan. The proposed site lies within Zone 7 that has the same objective as Z7 of the DCC Development Plan. All new developments will be assessed using a standard design guidelines checklist (Ref. Table 3 Section 6 DDAMP 2003). Landscape Design forms a heading in the design guideline checklist. The following questions will be asked of new development; does the project reinforce existing landscape character; does the project use landscape to enhance the building, site or neighbourhood; does the project use landscape to take advantage of site conditions. Section 6.3.6 of the Master Plan describes new facilities to be prompted during the life of the Plan. The DDA propose to create planted landscape strips between the utilities at Poolbeg Peninsula and the coastal parkland area to create an ECO Park. It is also proposed to link via a landscaped pedestrian route the nature park to the South Wall. This would result in three amenity areas being linked namely Sean Moore Park, the Irishtown Nature Park and the South Wall. The South Wall is a popular public walk that extends to the Poolbeg Lighthouse and offers views over Dublin Bay from Howth to the Dublin Mountains. The DDA offer a number of design guidelines to assist developers.

Dublin City Council Parks

Consultation with the Parks and Landscape Services Division of Dublin City Council revealed a number of planned developments of open spaces within the City. It is proposed to provide a new neighbourhood park at Father Collins Park at Baldoyle north of the proposed site at a cost of €12 million. Tolka Valley Parkway that lies east of the proposed site will be extended at Pelletstown/Ashtown in the next two years. Again to the north at Ballymun ongoing regeneration work will result in three public parks at a cost of €15 million. On the south side new development is centred around Irishtown Stadium where works are currently ongoing.

1.4.4 Visual Resource

The ZVI as illustrated in Figure 1.3 indicates that potentially extensive views of the proposed site are available. Views from the north-east extend to Howth and Sutton Strand. The existing twin stocks at Poolbeg are visible in long distance views from as far as the Balbriggan Junction on the New M1 motorway. The Poolbeg area is visible from the M50 between the M1 junction and the N2 junction. Intermittent views only are available from the M50 and it is difficult to discern detail from such distances (approximately 10 km). West of the proposed site the built components of Dublin City severely restrict views. Individual tall buildings within the City Centre will potentially have views of the proposed site. Broadly, the views are limited to Custom House Quay in the direction of the City Centre. The coastal road from Sutton to Ringsend and from Sandymount to Dun Laoghaire will have direct views of the proposed site (R105; R131; R118; N31). Long distance views from the south extend as far as Killiney and the Dublin Mountains. Views within the ZVI are described in detail in Viewpoints 1 – 26.

1.5 Recommendations

1.5.1 It is recommended that the Landscape and Visual impact assessment should complete a Seascape Assessment of the proposed development. The Seascape Assessment should use methods drawn from the Marine Institutes Guide to Best Practice in Seascape Assessment to establish the full extent of landscape and visual impacts of the proposal in its coastal location.

1.5.2 It is recommended that a selection of representative viewpoints are used to generate photomontages of the proposed development to best inform both the assessment process and local community of the visual impact of the development.

1.5.3 Dublin City Council proposes a number of open space development projects in the near future. It is recommended that the open spaces be revisited to establish if the visual context has been altered since the baseline study was completed. Follow up consultation will be necessary with DCC.

1.5.4 The Zone of Visual Influence (ZVI) is best illustrated for vertical elements such as stacks and buildings using computer generated models. Such topographical models can be refined to predict the impact that adjacent buildings and trees can have on the extent of visibility of the proposed development. A computer generated ZVI is an extremely accurate tool for predicting the visibility of the proposal in the adjacent landscape. It is suggested that consideration should be given to use of such a model. The ZVI will require to be accurately predicted once the final design parameters are known for the proposed plant.

1.6 References

DOELG (2000), Consultation Draft of Guidelines for Planning Authorities. Landscape Character Assessment.

Dublin City Council Development Plan 1999.

Dublin City Council Park Brochure (No Date).

Dublin Docklands Development Authority Draft Masterplan 2003.

Landscape Institute and Institute of Environmental Management and Assessment (LI/IEMA 2002) Guidelines for Landscape and Visual Impact Assessment.

Marine Institute (2001) Guide for Best Practice in Seascape Assessment.

Viewpoint 1 - Howth Golf Club Carpark

SUMMER

WINTER

Viewpoint Location: Howth Golf Club Carpark. 6.5km NE of proposed site.

Existing Visual Resource: The viewpoint is located at the main entrance to Howth Golf Club. The Howth Golf Club is located on elevated ground on the Howth peninsula which rises to the Ben of Howth. Glimpse views of Dublin Bay are available from the golf course. A partial view of the proposed site is available form the entrance / clubhouse through trees across the R105. The view is a long distance view. Existing stacks are discernible at Poolbeg through the trees.

Visual Receptors: Viewers at this vantage point include golf club members, visitors and tourists. Such viewers are likely to appreciate and focus on the views of the surrounding landscape.

Seasonal Variations: The winter time view indicates that greater visibility of Dublin Bay and the Poolbeg area are available when trees lose their leaves. It is however not possible to view individual building details.

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Sheet nos.: 50 (OS Discovery Series)
Viewpoint Location:
Photo Direction:
Proposed Site Location:

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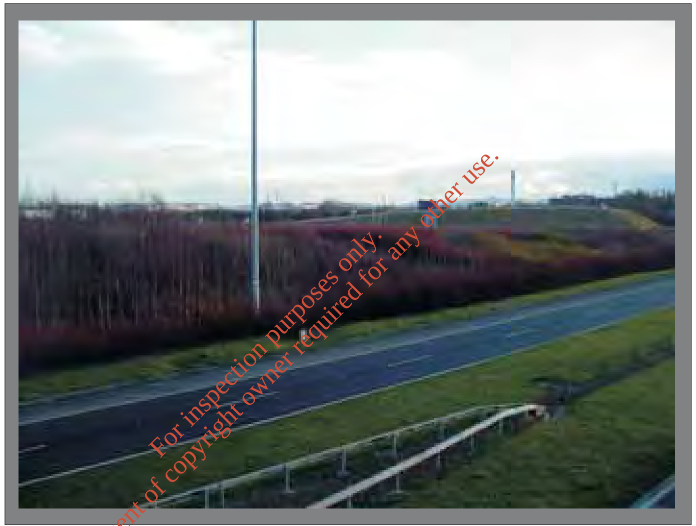
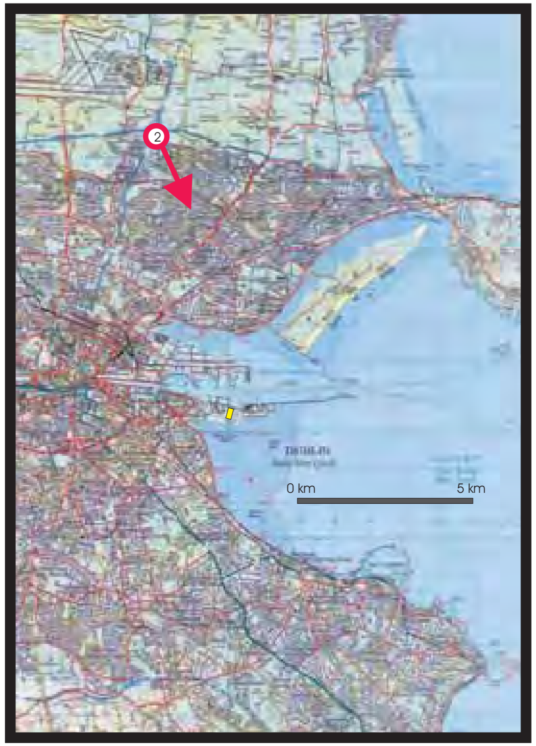
Viewpoint 2 - M50 / M1 Junction

SUMMER

WINTER





Viewpoint Location: M50 / M1 Junction. Approximately 8km North from the proposed site.

Existing Visual Resource: This view is typical of long distance views towards the proposed site from North and North West Dublin. Glimpse views such as the one illustrated, are available from the M50. The visual components include existing industrial buildings and stacks. The stacks at Poolbeg only are visible. Tree and shrub planting along the M50 and M1 has not reached maturity but still interrupts views towards the proposed site.

Visual Receptors: Views form this viewpoint will only be available to vehicle drivers / passengers. The view is brief in duration and at high speed.

Seasonal Variations: The winter time view indicates that there is no increase in visibility of the proposed site from this viewpoint. Maturity of roadside planting in future years will screen views to a much greater extent allowing only winter time views.

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Proposed Site Location:

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Viewpoint 3 - St. Fintan's Burial Ground, Howth

SUMMER

WINTER

Viewpoint Location: St. Fintan's Burial Ground, Howth. Approximately 6km NE from proposed site.

Existing Visual Resource: Open views of Dublin Bay are available from St. Fintan's Burial Ground. The elevated nature of the site allows broad views to the surrounding landscape. Views are potentially screened by trees within the site. Residential properties surround the burial ground and similar views will be available from these properties. Poolbeg and Dublin Harbour are visible. Visible components include sea, built elements and distant hills. The summer view consists of the stacks at Poolbeg only. The winter view allows views of both stacks and buildings at Poolbeg.

Visual Receptors: Viewers at the burial ground will include local community and tourists / visitors.

Seasonal Variations: Winter time views indicate that Dublin Bay is visible to a greater extent without tree cover. Views will however, remain broken by vegetation.

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Viewpoint 4 - Sutton Strand

SUMMER & WINTER

Viewpoint Location:	Sutton Strand. 8km NE from the proposed site.
Existing Visual Resource:	Open, direct and prolonged views are available from Sutton Strand and the R105 towards the proposed site. Existing industrial development at Poolbeg and Dublin Harbour are visible and appear to blend together with little detail discernible at this distance. Tall stacks are visible against the skyline. Existing buildings at Poolbeg are also visible. Visual components include seascape, distant hills, Bull Island and built elements at Dublin Harbour.
Visual Receptors:	Sutton Strand has areas of public open space and walkways. Seating areas are provided to allow the community to appreciate views of Dublin Bay. The viewpoint location will be used by the local community, visitors / tourists, joggers and cyclists.
Seasonal Variations:	No seasonal variations will occur.

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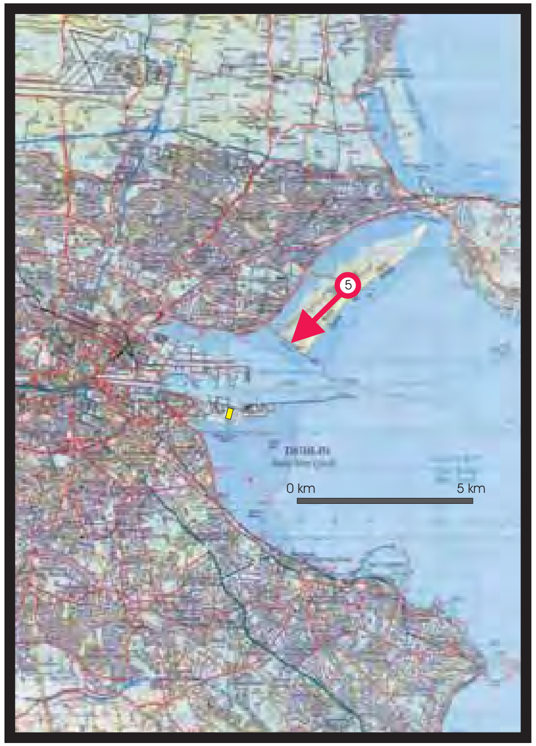
Viewpoint 5 - Bull Island Visitor Centre

SUMMER & WINTER



Viewpoint Location: North Bull Island Visitor Centre. 5km north east from the proposed site.

Existing Visual Resource: This viewpoint is located at North Bull Island Visitor Centre which is accessed from the R105 across a causeway to the island. Two golf courses are located at Bull Island. The Strand at Bull Island is popular during the summer months. Vehicle drivers are allowed on to the beach. Industrial buildings and stacks at Poolbeg (210 metres tall) are clearly visible. Visual components include sand dunes, distant hills and the built fabric of Dublin Harbour.

Visual Receptors: Viewers from this viewpoint will include the local community, birdwatchers, golfers, visitors / tourists, outdoor pursuits and recreationist (including cyclists, joggers).

Seasonal Variations: No seasonal variations will occur.

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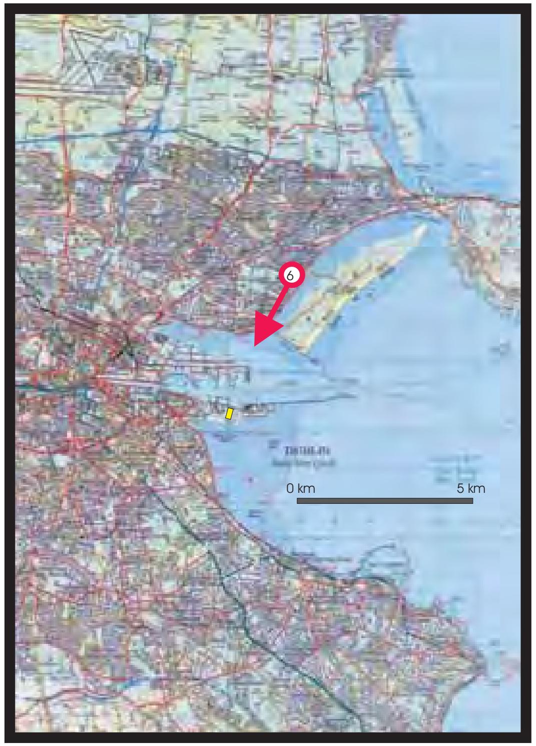
Viewpoint 6 - St. Anne's Park

SUMMER

WINTER



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Viewpoint Location: St. Anne's Park. 5km north of the proposed site.

Existing Visual Resource: St. Anne's Park is a public park maintained by Dublin City Council adjacent to the coastal road R105 at Dollymount. The Victorian park consists of open grassland and mature deciduous and evergreen trees. The viewpoint indicates how trees and buildings interrupt views of the proposed site resulting in the tall stacks (210 metres tall) at Poolbeg only being visible. The viewpoint is across Bull Island towards the harbour area. The park has 35 playing fields, 18 tennis courts and a par 3 golf course extending to 270 acres. Visual components include parkland, seascape, residential development and distant hills.

Visual Receptors: Viewers will include the local community, visitors and tourists.

Seasonal Variations: Due to the presence of evergreen trees, there is little variations in views during the winter months from this viewpoint.

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Viewpoint 7 - Bull Wall

SUMMER & WINTER

Viewpoint Location: Bull Wall. Approximately 3km north east of the proposed site.

Existing Visual Resource: A medium distance view is available from the Bull Wall. Extensive panoramic views of Dublin Harbour and the proposed site are available. Individual buildings and stacks are visible to the viewer. The view is direct and prolonged. No vegetation is available to interrupt the view. Residential properties on the R105 Clontarf Road share the view illustrated. Visual components include seascape, industrial harbour development and distant hills.

Visual Receptors: The Bull Wall is popular with the local community for walking and informal recreation. Fishing and birdwatching were observed during site surveys. Tourists / visitors do visit this location.

Seasonal Variations: No seasonal variations will occur.

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Viewpoint Location:
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Viewpoint 8 - Clontarf Golf Club Carpark

SUMMER

WINTER

Viewpoint Location: Clontarf Golf Club Carpark. 4km north of the proposed site.

Existing Visual Resource: Clontarf Golf Club consists of 18 holes located in mature parkland landscape. Glimpse views across Dublin Bay are available from some locations. The viewpoint indicates limited glimpse views of stacks in Dublin Harbour through the trees. No views of the broader harbour area or sea are available. Visual components include parkland and residential properties.

Visual Receptors: Viewers will be golf club members, tourists and visitors.

Seasonal Variations: Glimpse views of the stacks at Poolbeg are available through the deciduous trees in winter months. No buildings are visible at the harbour area.

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Viewpoint Location:
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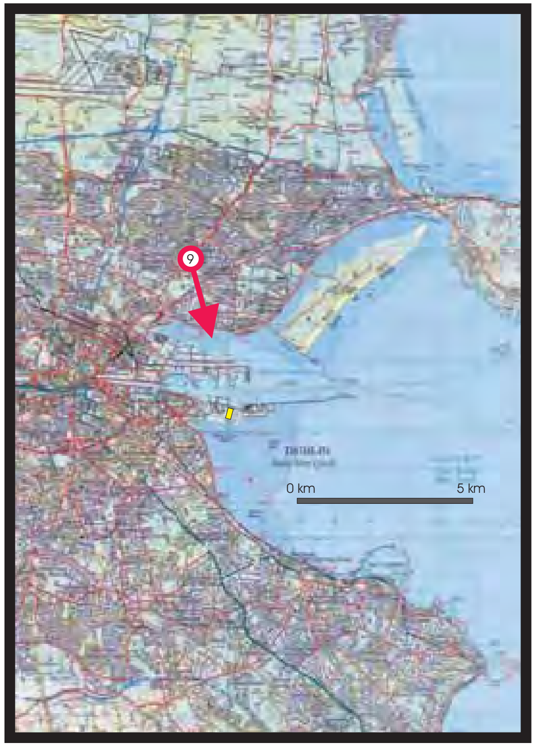
Viewpoint 9 - Maypark, Donnycarney

SUMMER & WINTER



Viewpoint Location: Maypark, Donnycarney. Approximately 4km north of the proposed site.

Existing Visual Resource: The landscape rises at Donnycarney and Artane. Where open spaces occur, medium distance views are available in the direction of Dublin Bay.The viewpoint indicates that stacks are only visible at Poolbeg. Residential houses dominate the view. The park is maintained by Dublin City Council,is used for football and extends for 3.25 hectares. Visual components include parkland, residential properties and distant hills.

Visual Receptors: The park is used by the local community. The R107 passes by the parks western boundary, and commuters will have a glimpse view.

Seasonal Variations: No seasonal variations will occur.

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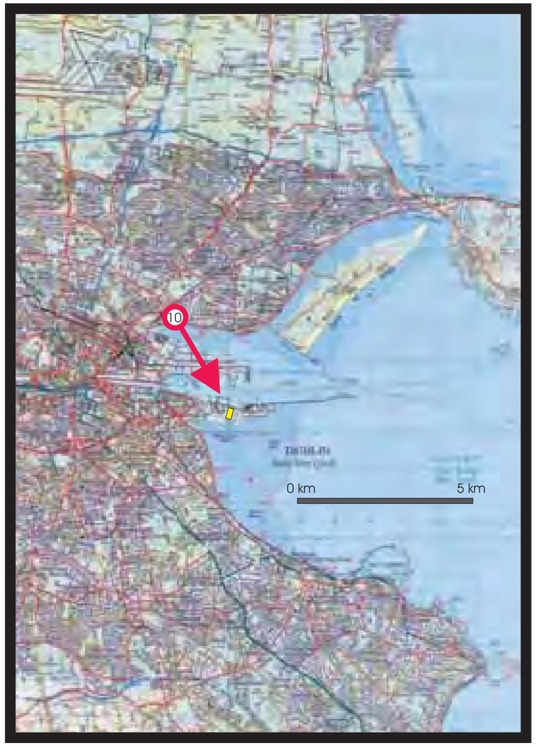
Viewpoint 10 - Clontarf Road Carpark, Clontarf

SUMMER

WINTER



Viewpoint Location: Car park at Clontarf Road, Clontarf. 3 km north east of the proposed site.

Existing Visual Resource: This view is typical of views attainable from the R105 and the promenade at Clontarf. Vertical elements at Dublin harbour and Poolbeg dominate the view. Existing stacks and buildings are visibleat Poolbeg.Little vegetation is located along the Clontarf seafront to interrupt the view. The Clontarf promenade extends for 3km from Fairview Park to Bull Wall at Dollymount. Visual components include seascape and built fabric of Dublin Harbour.

Visual Receptors: The carpark and seafront are used by the local community. The area is used for informal recreation by the community. Commuters use the carpark area.

Seasonal Variations: Planting has taken place along the western face of the Dublin harbour area. This planting has not realised maturity yet and does not, at present, provide any screening. No seasonal variation will occur.

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Viewpoint Location:
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Viewpoint 11 - Fairview Park

SUMMER

WINTER

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Viewpoint Location: Fairview Park, Fairview. 3.5km north west from the proposed site.

Existing Visual Resource: Fairview Park is a large urban park maintained by Dublin City Council and extends to 20 hectares. The park is broken into two separate parks by the DART railway line. The Tolka River passes along the parks southern boundary. The activities in the park include football, Gaelic games, athletics, tennis and a children's play area. Construction work is currently taking place through the park as part of the Dublin Port Tunnel scheme. Protective fencing and trees restrict views from the park at present. The railway line interrupts views to the proposed site, being located on an embankment. Visual components include parkland and trees. The existing stacks at Poolbeg only are visible.

Visual Receptors: Viewers at the park will include the local community using the park for informal and formal recreation. Occasional tourists are likely. The park is surrounded by busy roads.

Seasonal Variations: Due to the proximity of trees around the parks' boundary, winter months will allow views in the direction of the proposed site. In the upper park, the stacks at Poolbeg are visible in winter.

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Viewpoint 12 - Point Depot, North Wall Quay

SUMMER & WINTER

Viewpoint Location: Point Depot, North Wall Quay. 2km west of the proposed site.

Existing Visual Resource: The view is obtained from the public walkway along the North Wall Quay. The existing view is dominated by traffic and structures associated with the Dublin Port. Views along the River Liffey to the sea are available from the East Link bridge. Existing stacks and buildings at Poolbeg are clearly visible. Visual components include built harbour fabric, traffic and the river.

Visual Receptors: The walkway and Point Depot are used by the local community, tourists/visitors, commuters, cyclists and joggers.

Seasonal Variations: No seasonal variation will occur.

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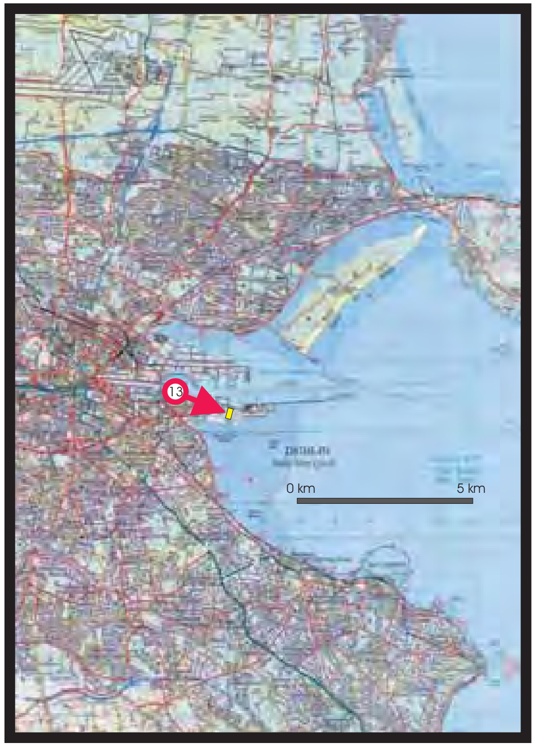
Viewpoint 13 - East Link Toll

SUMMER & WINTER



Viewpoint Location: East Link Toll, Ringsend. Approximately 1.5km west from the proposed site.

Existing Visual Resource: This viewpoint is typically of local views of the proposed site where the infrastructure associated with the Dublin Port dominates the view. The East Link Toll runs adjacent to Pigeon House Road which contains a row of small cottages. The East Link Toll is a heavily used road by commuters and Dublin port traffic. The stacks and buildings at Poolbeg are clearly visible. Visual components include built harbour fabric, traffic and the river.

Visual Receptors: Viewers from this viewpoint will include commuters, tourists/visitors and the local community.

Seasonal Variations: No seasonal variations will occur.

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Viewpoint Location:
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Viewpoint 14 - Leukos Road, Ringsend

SUMMER

WINTER

Viewpoint Location: Leukos Road, Ringsend. 1km west from the proposed site.

Existing Visual Resource: Partial views in the direction of the proposed site are available from residential areas of Ringsend. The view is across the busy Sean Moore Road. An entrance to the Dublin Port is visible from this vantage point. Buildings and storage area interrupt ground level views of the proposed site but the upper parts of nearby stacks are visible. Visual components include residential landscape, traffic and built fabric of the harbour.

Visual Receptors: Viewers at this vantage point will be the local community and commuters.

Seasonal Variations: Without deciduous tree cover, broader views of the Poolbeg area are available. The position of storage containers clearly fluctuates during the year which will alter the visibility of the buildings.

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Viewpoint 15 - Crawfords Garage, Sandymount

SUMMER

WINTER

Viewpoint Location: Crawfords Garage, Sandymount. Approximately 1km west from the proposed site.

Existing Visual Resource: This view is available from a public footpath beside Crawfords Garage. A landscaped roundabout and trees in Sean Moore Park interrupt views to the proposed site. The roads at this location are heavily used by commuters. Buildings at Poolbeg are not visible but the upper parts of the stacks can be observed through the trees. Visual components include trees, parkland, traffic and built elements.

Visual Receptors: Viewers at this vantage point will include the local community and commuters.

Seasonal Variations: The winter time assessment established that clear visibility of the upper sections of stacks at Poolbeg are available without tree cover.

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Viewpoint Location:
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Viewpoint 16 - Sean Moore Park, Beach Road.

SUMMER

WINTER

Based on: 1:50,000
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Viewpoint Location:
Photo Direction:
Proposed Site Location:

Viewpoint Location: Sean Moore Park, Beach Road, Sandymount. 1km south west of the proposed site.

Existing Visual Resource: The view is available from Sean Moore Park which is maintained by Dublin City Council. The park consists of relatively recent tree and shrub planting in grassland with footpaths. The planting has yet to reach maturity. Playing fields are provided for formal recreation and views across the Poolbeg area are available and detail of individual buildings is discernible during winter and summer. Trees partially obscure views. Residential properties overlook the park along Beach Road.

Visual Receptors: Viewers from this vantage point will include the local community, commuters, visitors and members of the public using the park for recreation purposes.

Seasonal Variations: The visibility of the Poolbeg area increases significantly during the winter months.

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Viewpoint 17 - Sandymount Strand Car Park

SUMMER

WINTER

Viewpoint Location: Carpark, Sandymount Strand. Approximately 1km south from the proposed site.

Existing Visual Resource: Panoramic views of Dublin Bay as far as Howth and Dun Laoghaire are available from the promenade at Sandymount. The promenade consists of footpaths and cycle paths, open grassland, trees and seating, and is maintained by Dublin City Council. The promenade is 1km long and contains a Martello Tower. Views of the proposed site are available, partially obscured, at ground level by the Irishtown Nature Reserve. Residential properties overlook the promenade along Beach Road. The existing buildings and stacks at Poolbeg are clearly visible.

Visual Receptors: This view is available to the local community, visitors/tourists, birdwatchers, cyclists, joggers and others using the area for informal recreation.

Seasonal Variations: No seasonal variation will occur.

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Viewpoint 18 - Bath Avenue, Irishtown

SUMMER *WINTER*

Viewpoint Location: Bath Avenue, Irishtown. 2km west from the proposed site.

Existing Visual Resource: Bath Avenue provides a long vista which terminates in a view of the Poolbeg area. Upper parts of the stacks are clearly visible. Street trees and garden vegetation partially screen views. The view is only obtained by pedestrians and vehicles travelling east. Visual components include traffic and built elements.

Visual Receptors: This view will be available to commuters and the local community.

Seasonal Variations: The winter time view illustrates that visibility of the Poolbeg area increases without tree cover, and buildings are more visible.

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Viewpoint Location:
Photo Direction:
Proposed Site Location:

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Viewpoint 19 - Booterstown DART Carpark

SUMMER

WINTER

Viewpoint Location: Booterstown DART station carpark. Approximately 3km south of the proposed site.

Existing Visual Resource: Glimpse views across Dublin Bay to Poolbeg are available from the Booterstown area. Upper parts of the stacks are visible only in summer months. The DART railway line runs along the coast at this location introducing vertical clutter to the view of the seascape. Vegetation associated with the Booterstown Nature Reserve partially screens views. Residential properties overlook the carpark and DART station.

Visual Receptors: Viewers at this vantage point will include the local community and commuters.

Seasonal Variations: In winter months the visibility of the proposed site increases and individual buildings and stacks are both visible.

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Viewpoint Location:
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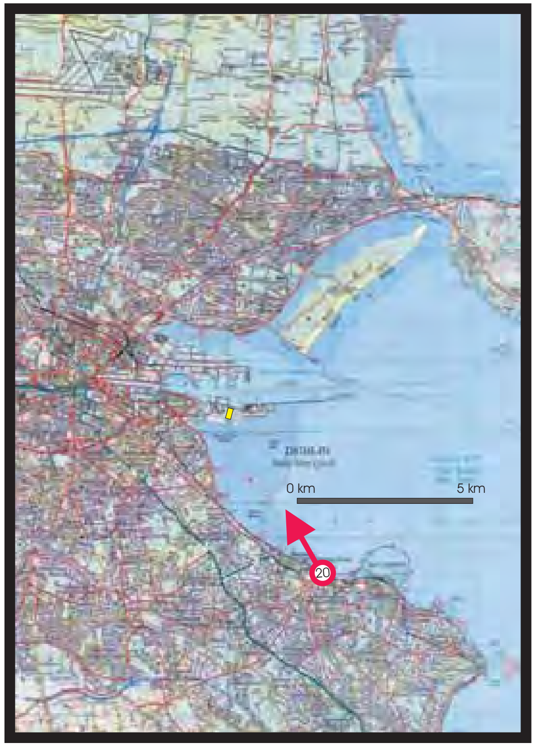
Viewpoint 20 - Idrone Terrace viewpoint, Blackrock

SUMMER & WINTER



Viewpoint Location: Idrone Terrace viewpoint, Blackrock. 5km south of the proposed site.

Existing Visual Resource: A promenade has been developed recently at Blackrock adjacent to a Martello Tower. This civic space includes seating, footpaths and grassland. Elevated meduim distance views of the Poolbeg area are available as part of a wider panoramic view from Sandymount to Howth. Both stacks and buildings are visible. The viewpoint is overlooked by residents at Idrone Terrace.

Visual Receptors: Viewers will include the local community and tourists/visitors.

Seasonal Variations: No seasonal variation will occur.

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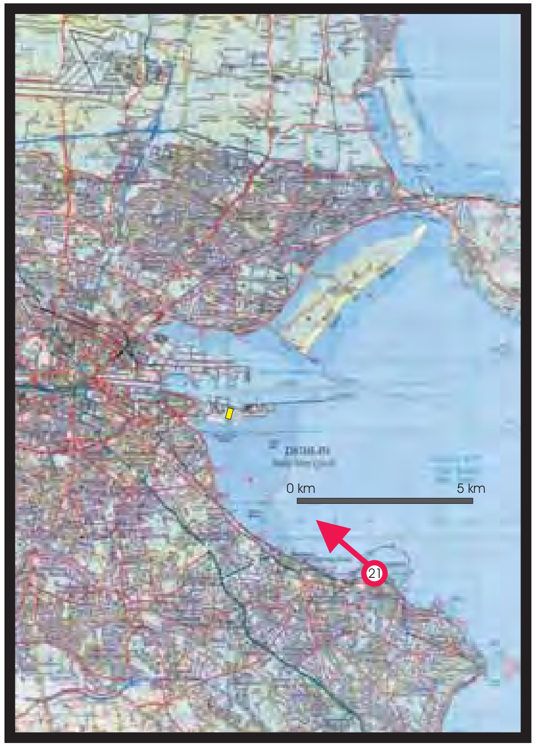
Viewpoint 21 - Royal Irish Yacht Club, Dun Laoghaire

SUMMER & WINTER



Viewpoint Location: Royal Irish Yacht Club, Dun Laoghaire. 6km south east of the proposed site.

Existing Visual Resource: Views of the proposed site are available from Dun Laoghaire Harbour area including the Royal Irish Yacht Club. The West Pier, boats and other infrastructure interrupt the view. The stacks at Poolbeg appear to blend with the vertical elements around the harbour. Taller buildings are visible.

Visual Receptors: This view will be available to the local community, harbour users, tourists and visitors.

Seasonal Variations: No seasonal variation will occur.

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Viewpoint Location:
Photo Direction:
Proposed Site Location:

RPS mcos
Carnegie House
Dun Laoghaire
Co. Dublin
Phone: 01-2020870

Viewpoint 22 - Dun Laoghaire Sea Front Car Park

SUMMER & WINTER

Viewpoint Location: Car Park at Dun Laoghaire Sea front. 7.5km south east from the proposed site.

Existing Visual Resource: A viewing point is located on the promenade at Dun Laoghaire which provides panoramic views from Poolbeg to Howth. The view to Poolbeg is partially observed by the East Pier and only upper parts of the buildings and stacks are visible. Other vertical elements are also components of the visual resource.

Visual Receptors: This view will be available to the local community, tourists and visitors.

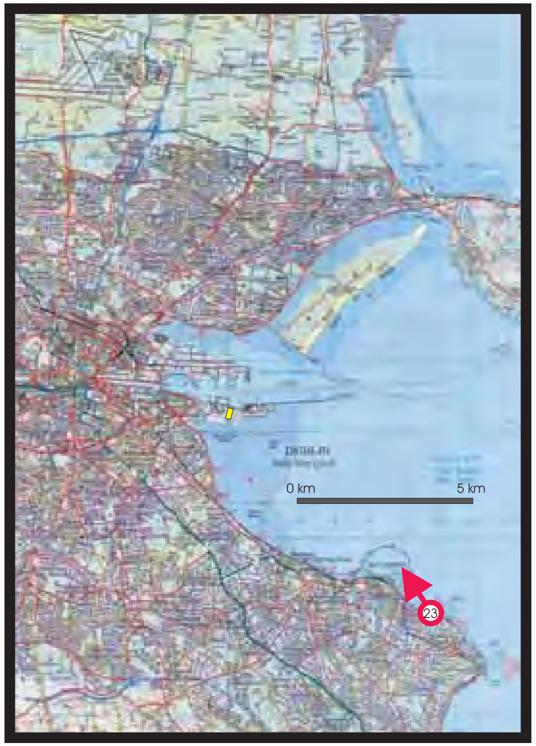
Seasonal Variations: No seasonal variations will occur.

Based on: 1:50,000
Sheet nos.: 50 (OS Discovery Series)
Viewpoint Location:
Photo Direction:
Proposed Site Location:

RPS mcos
Carnegie House
Dun Laoghaire
Co. Dublin
Phone: 01-2020870

Viewpoint 23 Sandycove

SUMMER & WINTER



Viewpoint Location: Sandycove Harbour. 8km south east from the proposed site

Existing Visual Resource: A small beach, popular in summer months, is located at Sandycove. The area is used for swimming in the sea throughout the year. The views are divided towards Dun Laoghaire and the proposed site is visible beyond the East Pier. Upper parts of buildings and stacks are visible. Panoramic views to the sea are not possible. Residential properties overlook the beach.

Visual Receptors: Viewers will include the local community, tourists and visitors.

Seasonal Variations: No seasonal variations will occur.

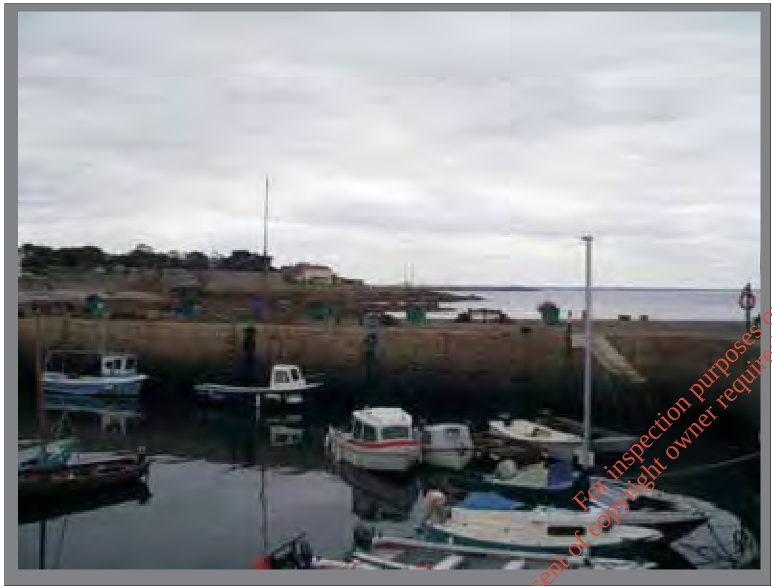
Based on: 1:50,000
Sheet nos.: 50 (OS Discovery Series)
Viewpoint Location:
Photo Direction:
Proposed Site Location:

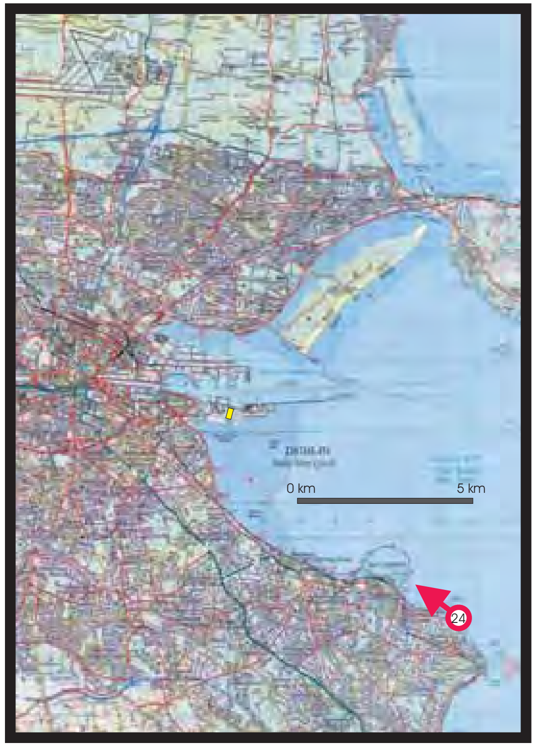
RPS mcos

Carnegie House
Dun Laoghaire
Co. Dublin
Phone: 01-2020870

Viewpoint 24 - Bullock Harbour, Dalkey

SUMMER & WINTER





Viewpoint Location: Bullock Harbour, Dalkey. 8.5km south east of the proposed site.

Existing Visual Resource: The rocky South Dublin Bay coastline provides viewpoints across the Bay seascape for long distances. Bullock Harbour illustrates how the visibility of the Poolbeg area decreases as one moves south along the coastline. Such views are enjoyed by tourists and the local community. Dun Laoghaire east pier and rocky inlets interrupt the view, but buildings and stacks are visible despite the distance.

Visual Receptors: This view is available to harbour users, fishermen, the local community, birdwatchers and tourists/visitors.

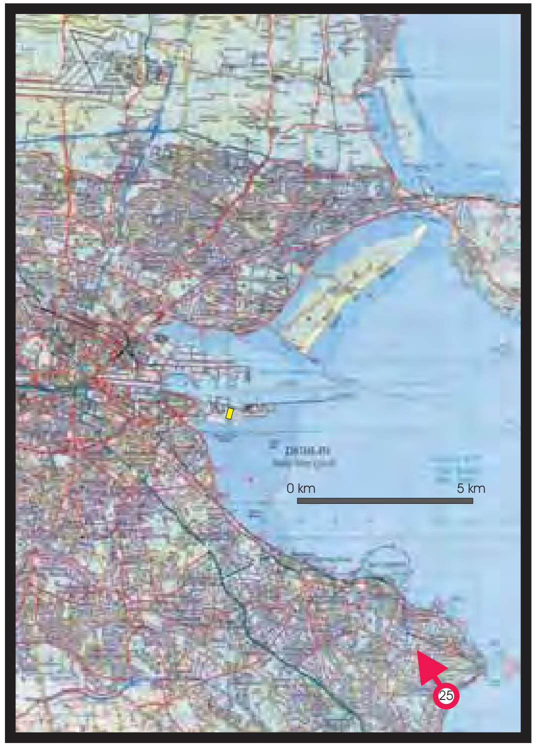
Seasonal Variations: No seasonal variations will occur.

Based on: 1:50,000
Sheet nos.: 50 (OS Discovery Series)
Viewpoint Location:
Photo Direction:
Proposed Site Location:

RPS mcos
Carnegie House
Dun Laoghaire
Co. Dublin
Phone: 01-2020870

Viewpoint 25 - Killiney Hill Obelisk

SUMMER & WINTER



Viewpoint Location: Killiney Hill Obelisk. 10km south east of the proposed site.

Existing Visual Resource: The distinctive rounded hill of Killiney allows uninterrupted panoramic views across Dublin City and Bay for long distances in clear weather. Long distance views such as this are available from the South Dublin area as the general level built urban landscape rises to join the hills and mountains which dominate this part of the city. It is difficult to discern detail of individual buildings at such distance.

Visual Receptors: Viewers at this location include the local community, tourists and visitors. The site is used for informal recreation.

Seasonal Variations: The trees and shrubs in the foreground have reached maturity and are affected by exposure which stunts their height. There will be no seasonal variation.

Based on: 1:50,000
Sheet nos.: 50 (OS Discovery Series)
Viewpoint Location:
Photo Direction:
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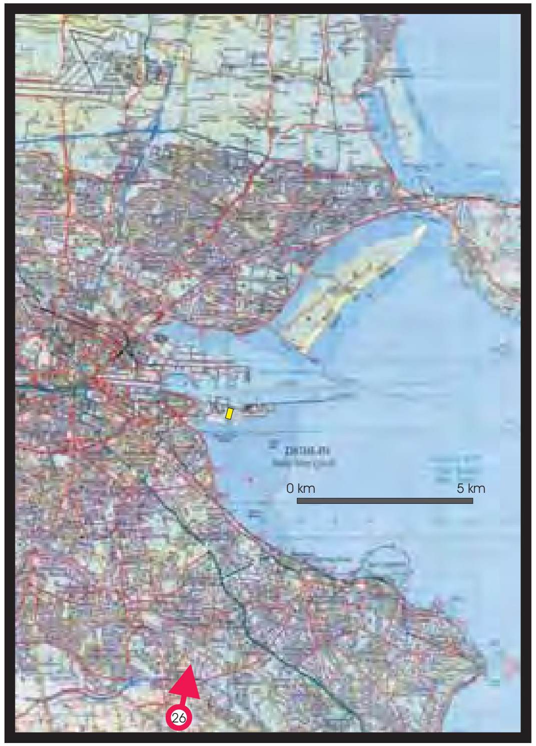
Co. Dublin
Phone: 01-2020870

Viewpoint 26 - Total Fitness Carpark, Sandyford

SUMMER & WINTER



Viewpoint Location:	Total Fitness carpark off the R117, Sandyford. Approximately 9km south of the proposed site.
Existing Visual Resource:	New development continues to expand up the north facing slopes of the Dublin mountains and hills providing direct prolonged views across Dublin City to the Harbour area. This viewpoint may change in future years as new development takes place but similar views are available from the R117 Enniskerry Road. Stacks and the upper parts of buildings in the Poolbeg/harbour area are visible in good weather conditions.
Visual Receptors:	This view is available to the local community and commuters.
Seasonal Variations:	No seasonal variations will occur.

Based on: 1:50,000
Sheet nos.: 50 (OS Discovery Series)
Viewpoint Location:
Photo Direction:
Proposed Site Location:

RPS mcos

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