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DUBLIN WASTE TO ENERGY PROJECT

WINTERING WATERFOWL AND CONSERVATION DESIGNATIONS IN DUBLIN BAY

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BRIEF OF EVIDENCE

25 April 2007

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1. QUALIFICATIONS AND EXPERIENCE.

My name is Eleanor Mayes. I graduated in 1978 with a B.A. (Mod.) in Natural Science from Trinity College Dublin, specialising in Zoology. I also hold an M.Sc. in Zoology from Trinity College Dublin.

I have carried out bird surveys and related ecological research for governmental and non-governmental conservation agencies, and have also been involved in policy work on the implementation of conservation legislation and the effectiveness of conservation designations in Ireland.

I have worked as an ecological consultant since 1989. I have carried out flora and fauna studies and Environmental Impact Assessments for a number of power stations, including the Synergen CCGT. I have also scoped and carried out winter waterfowl monitoring at power stations in compliance with IPCC license conditions. I have carried out a number of waterfowl studies in Dublin Bay, for projects including the Dublin Bay Project EIS and subsequent ecological monitoring, Bull Island Causeway studies, and studies of the Liffey Estuary for Dublin Port Co.

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2. REQUIREMENTS OF THE BIRDS AND HABITATS DIRECTIVES.

Article 6 of the Habitats Directive (92/43/EU) provides the legislative framework for the consideration of developments which could have an adverse impact on sites which are protected under the Habitats and the Birds Directives (i.e. Natura 2000 sites). Legal obligations under Article 4 of the Birds Directive (79/409/EU) are now superseded by Article 6 of the Habitats Directive.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.

If a Natura 2000 site concerned hosts priority listed 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 SAC designation of North Dublin Bay includes the Annex 1 priority listed habitat 'fixed coastal dunes with herbaceous vegetation' as a qualifying interest. The Birds Directive requires that important concentrations

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of migratory waterfowl and internationally important wetlands are treated in the same way as Annex 1 listed bird species (Article 4 (2)). Case law under the Birds Directive indicates that internationally important bird sites are given protection equivalent to priority listed habitats and species under the Habitats Directive.

The Habitats Directive does not prohibit development in, or affecting sites protected under the Directive. 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.

The proposed Dublin waste to energy facility site footprint does not physically impinge on areas subject to SAC and SPA designations in Dublin Bay. It will, however, generate licensed emissions to air and discharges to water. These emissions will include environmental contaminants which are already present within Dublin Bay. The question that arises under the Habitats Directive is whether the Dublin Waste to Energy Project emissions constitute an additional loading of environmental contaminants to the extent of causing deterioration of habitats, leading to adverse impacts on populations of migratory waterfowl species. In the event of a negative assessment, mitigation and compensatory measures would be required.

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3. BACKGROUND.

The purpose of this brief of evidence is to elaborate on Chapters 14 and 15 of the EIS with regard to wintering waterfowl, and the possible impact of the proposed Dublin Waste to Energy Project on the Natura 2000 sites in Dublin Bay. In doing so, I have drawn upon information contained in a number of different chapters of the EIS with regard to air, water, dioxins, construction and related issues. I have also referred to the baseline bird study of Dublin Bay which I undertook in 2003 on behalf of Dublin City Council, which drew on existing bird data for Dublin Bay, principally wintering waterfowl data from the Dublin Bay Project ecological monitoring programme database. The bird study is reproduced in Appendix D, Volume 2, of the Technical Appendices to the Dublin Waste to Energy Baseline Monitoring Report, which was prepared by COWI and RPS-MCOS in 2005. Material from the bird study was also incorporated into Chapter 3, Volume 1 of the Baseline Monitoring Report, entitled Estuarine Ecology. I understand that the baseline reports were made available on the project website from 2005, and were provided to An Bord Pleanála and re-notified to the public in advance of this hearing.

This brief of evidence contains an assessment of the potential impacts of the project on wintering waterfowl in Dublin Bay, recommends mitigation measures, and assesses residual impacts. Also, since the submission of the

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EIS to An Bord Pleanála, an extensive inter-tidal sediment monitoring programme has been commenced and is currently underway. The first data set to become available under this programme are included in this brief at Appendix 2[1] and further data will be available to inform the EPA licensing process.

Finally, the purpose of this brief of evidence is to respond to submissions made to An Bord Pleanála in relation to wintering waterfowl including Brent geese, and in relation to the existing SPA and SAC designations in Dublin Bay under the Birds and Habitats Directives respectively.

4. METHODS.

I identified activities during the construction and operational phases of the Dublin Waste to Energy Project with a potential to impact on wintering waterfowl and their habitats in Dublin Bay. I also reviewed the baseline environmental information given in the EIS, and in the Baseline Monitoring Report, to assess whether any additional information would assist in assessing potential impacts on wintering waterfowl in Dublin Bay, and their habitats. I determined that an additional sediment sampling programme would be helpful, and this was approved by Dublin City Council and was carried out by my colleagues in AWN Consulting and EcoServe. The results of this programme are discussed in Section 8 of this brief of evidence. I then reviewed the submissions made to An Bord Pleanála in relation to Brent geese and other wintering waterfowl, and to areas subject to conservation designations in Dublin Bay.

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The baseline bird study of Dublin Bay prepared in 2003 included wintering waterfowl data up to and including the 2002/03 wintering season. This Brief of Evidence includes more recent data, up to 2005/06, which is taken from the annual reports on the ecological monitoring programme for the Dublin Bay Project, and has been reproduced with the permission of Dublin City Council. These data, which refer to Brent geese and waders, cover a nine year period, from 1997/98 to 2005/06, during which counts were carried out in each month between August and April inclusive. It also includes some material from Chapter 3, Volume 1 of the Baseline Monitoring Report.

The assessment given in this evidence with regard to potential impacts on wintering waterfowl, and on areas subject to SAC and SPA conservation designations in Dublin Bay, has been prepared with regard to European

[1] The inter-tidal sediment sampling programme is being undertaken on behalf of Dublin City Council by me, Dr Ed Porter and Dr Fergal Callaghan of AWN Consulting, and EcoServe. The currently available data in relation to six initial sites in Appendix 2 has been prepared as a brief of evidence by Dr Fergal Callaghan for this Oral Hearing.

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Commission DG Environment guidance on the assessment of plans and projects significantly affecting Natura 2000 sites.

5. DUBLIN WASTE TO ENERGY PROJECT SITE CONTEXT.

5.1. SITE LOCATION.

The Dublin Waste to Energy Project is located on reclaimed land in the Dublin Port area, where there is a long history of human activities that can give rise to environmental contamination. These include land claim including some use of contaminated fill material, power generation, waste water treatment, re-cycling/disposal etc., involving a history of ground contamination, and discharges to air and water. These activities are now subject to planning and IPPC licence conditions, but were not subject to such controls in the past.

In coastal areas, important concentrations of wintering waterfowl generally occur in estuaries and bays which are naturally enriched by organic material carried in by rivers, by the growth and nutrient re-cycling of a variety of species of seaweeds including green algae, and by salt marsh habitats. Sheltered areas within bays and estuaries tend to accumulate organic material and fine sediments. These muddy habitats generally support high densities of macro-invertebrates which are not of conservation interest in themselves, but provide feeding for protected bird species. Muddy habitats also tend to accumulate pollutants arising from human activities, some of which are bio-accumulative and have the potential to impact adversely on protected bird species, and species of commercial interest (e.g. shell-fish, fish). Human activities and conservation importance are not mutually exclusive, however, and Dublin is a good example of the co-existence of a capital city with an internationally important coastal habitat complex and wintering waterfowl site.

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5.2. CONSERVATION DESIGNATIONS.

Special Areas of Conservation (SACs) under the Habitats Directive (92/43/EU).

There are two areas subject to SAC designations in Dublin Bay: North Dublin Bay, and South Dublin Bay (Figure 1). North Dublin Bay is designated for 9 habitat types, all of which are listed in Annex 1 of the Habitats Directive:

- Mudflats and sandflats not covered by seawater at low tide

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- Salicornia and other annuals colonising mud and sand
- Atlantic salt meadows
- Mediterranean salt meadows
- Annual vegetation of drift lines
- Embryonic shifting dunes
- Shifting dunes along the shoreline with Ammophila arenaria
- Fixed coastal dunes with herbaceous vegetation
- Humid dune slack

South Dublin Bay is designated for Mudflats and sandflats not covered by seawater at low tide.

Special Protection Areas (SPAs) under the Birds Directive (79/409/EU).

There are two areas subject to SPA designation is Dublin Bay: North Bull Island, and Sandymount Strand/Tolka Estuary (Figure 2). Both sites are designated because they support internationally important numbers of waterfowl.

Proposed Natural Heritage Areas, under the Wildlife (Amendment) Act, No. 38 of 2000.

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Proposed Natural Heritage Areas (pNHAs) are shown in Figure 3. These are largely co-incident with the SPA designations in the North and South of Dublin Bay, and additionally include two mooring Dolphins in Dublin Docks (Site Code 201) and Booterstown Marsh (Site Code 1205), as discussed in Chapter 14 of the EIS.

6. WINTERING WATERFOWL NUMBERS IN DUBLIN BAY.

Dublin Bay is internationally important for wintering waterfowl, because it supports more than 20,000 birds.

Threshold levels for international importance for individual species are set at 1% of the estimated species, sub-species or flyway population, and are subject to regular revision to take account of population change. They were last revised in 2002 by Wetlands International.

Threshold levels for national importance are 1% of the estimated all-Ireland population, and are taken from Crowe et al (in press).

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The data given in this Brief of Evidence covers the period up to the winter of 2005/06, the final winter season of the Dublin Bay Project ecological monitoring programme.

6.1. SPECIES OCCURRING IN INTERNATIONALLY IMPORTANT NUMBERS.

Five species occurred in internationally important numbers in Dublin Bay during the five-year period from 2001/02 to 2005/06: light-bellied Brent geese, knot, black-tailed godwit, bar-tailed godwit, and redshank. Three of these species have occurred consistently in internationally important numbers in Dublin Bay since the 1970s: Brent geese, bar-tailed godwit and redshank. Knot numbers have varied considerably through time; Dublin Bay held internationally important numbers of knot during the 1970s and 1980s, but counts were generally below the international threshold during the 1990s. Numbers of knot exceeded the international threshold level in 2001/02 and 2002/03, and again in 2004/05 and 2005/06. Black-tailed godwit numbers increased steadily during the late 1990s; peak counts in Dublin Bay have been above the international threshold in every year since 2000/01.

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6.2. SPECIES OCCURRING IN NATIONALLY IMPORTANT NUMBERS.

Dublin Bay is nationally important for the following five duck species which feed in salt meadow and intertidal habitats: shelduck, wigeon, teal, pintail, and shoveler. Eight wader species occur in nationally important numbers: oystercatcher, ringed plover, grey plover, sanderling, dunlin, curlew, greenshank, and turnstone. Another wader species, golden plover, reaches the national threshold in some years.

Nationally important diving species are great crested grebe and red-breasted merganser. These birds feed on fish, and are found on open water in Dublin Bay, and feed over intertidal habitats at high tide.

6.3. POPULATION TRENDS.

The numbers of migratory waterfowl recorded at any wetland site vary between years, in response to a variety of factors, including breeding success, mortality, food resources, and weather conditions. These factors can operate at some or all sites within the range of each individual species.

Peak counts in Dublin Bay for the last three years, mean peak counts since the mid 1990s, and population trends are given in Table 1. Nine species have

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increased in number within Dublin Bay and within Ireland (great crested grebe, cormorant, grey heron, little egret, Brent goose, oystercatcher, sanderling, redshank, and greenshank), with another two species increasing at a much greater rate in Dublin Bay than in the rest of Ireland (black-tailed godwit and bar-tailed godwit). Three species have increased in Dublin Bay and decreased within Ireland (knot, curlew, and turnstone). Five species have decreased both in Dublin Bay and within Ireland (wigeon, pintail, shoveler, goldeneye, and dunlin), while one species (grey plover) has declined at a greater rate in Dublin Bay than in the rest of the country. There is no definite trend for another six species in Dublin Bay, of which one has declined nationally (lapwing).

7. WINTERING WATERFOWL USE OF DUBLIN BAY.

Waterfowl distribution within Dublin Bay is determined by the distribution of the preferred feeding habitats of individual species, by tidal cycle and range, by the availability of roosting areas, and fresh water preening and loafing areas (which are important particularly for geese and duck). 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 (e.g. Yates et al, 1993). Bird distribution is also influenced by disturbance; a study carried out in South Dublin Bay indicated that uncontrolled dogs were the most significant source of disturbance to water birds (Nairn and Phalan in prep.).

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The habitats present in Dublin Bay are described in the Baseline Monitoring Report (Volume 1 Chapter 3), in Chapter 15 of the EIS, and in evidence presented by EcoServe. Figure 4 shows an overview of habitats and substrate types in the intertidal areas of Dublin Bay. In general, the central part of Dublin Bay and Dollymount Strand are sandy, with mud content increasing shore-wards and with shelter. Littoral muds occur in the Tolka Basin, where they are exposed below mid-tide level. Littoral muds in the North Bull Lagoons are covered progressively as the water rises between mid and high tide. Mixed substrates occur mainly in North Dublin Bay, and mussel beds are associated with them.

The salt meadow habitats on Bull Island are the main high tide roosting area for waterfowl in Dublin Bay. In the south bay, the main high tide roosts are on recently developing sand bars between Merrion Gates and Booterstown.

A summary of the distribution of the main habitat types and their use by wintering waterfowl is given in Table 2 of this Brief of Evidence. Further information is given in Appendix 1, including the findings of a literature review of the main food and prey items taken by individual species, which was carried out by me and was included in my baseline bird study in order to inform any future monitoring programmes. The distribution of the five species

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which occur in internationally important numbers in Dublin Bay is presented below, details on the distribution of nationally important species are given in Appendix 1.

7.1. Brent geese (see Figure 5).

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 North 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 different intertidal areas 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.

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Intensively managed grasslands, both amenity and agricultural, provide the main feeding habitat for Brent geese from December to February. Geese disperse from Dublin Bay soon after dawn to farmland near Kilcoole in Co. Wicklow and at Baldoyle Estuary, and to amenity grasslands around Dublin Bay, returning to roost in the bay 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, the 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 Waste Water Treatment Plant 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 was 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, as noted in a number of submissions made to An Bord Pleanala regarding the Dublin Waste to Energy Project. Geese started to feed on the replacement grassland as soon as it became available, although they have continued to use other grassland areas in Sean Moore Park, Irishtown Stadium, and Ringsend Park.

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Within Dublin Bay, 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). Use of grassland areas declines in spring as geese make more use of intertidal and salt meadow habitats, before they leave in April.

7.2. Knot (see Figure 6).

Knot feed on the sandier habitats in Dublin Bay, on littoral sands and muddy sands. On average, 47% of the low tide knot records are in the South Bull Lagoon and Bull Wall Sands, 29% in the North Bull Lagoon, and 24% in South Dublin Bay. There is considerable variation in use of these different areas between years. Flocks of knot and bar-tailed godwit are often found in association, feeding and roosting together.

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7.3. Black-tailed godwit (see Figure 7).

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.

On average, 59% of black-tailed godwit are recorded in the Tolka Basin and South Bull Lagoon, 39% in the North Bull Lagoon, and 2% in South Dublin Bay. There has been an increase in use of the South Bay in the last couple of years, and nationally important numbers were recorded in Booterstown Marsh and its outfall channel in 2005/06.

7.4. Bar-tailed godwit (see Figure 8).

Bar-tailed godwit, like knot, feed on littoral sands and muddy sands, and the two species often associate. On average, 55% of bar-tailed godwits use the

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South Bull Lagoon and Bull Wall Sands, 24% use South Dublin Bay, and 21% use the North Bull Lagoon.

7.5. Redshank (see Figure 9).

Redshank prefer feeding in muddy habitats, but also feed on muddy sands and mixed substrates. Overall, 55% of redshanks are recorded in the South Bull Lagoon and Tolka Basin, 31% in the North Bull Lagoon, and 14% in South Dublin Bay.

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8. POTENTIAL IMPACTS OF THE DUBLIN WASTE TO ENERGY PROJECT ON WINTERING WATERFOWL, AND MITIGATION MEASURES WHERE APPROPRIATE.

8.1. CONSTRUCTION PHASE.

8.1.1. Potential disturbance to Brent geese.

A 2 hectare area adjoining the proposed Dublin Waste to Energy site is identified as amenity grassland in Chapter 14 of the EIS, and use of this area by Brent geese has been noted by my colleague Dr Brian Madden in his evidence. This 2ha area was provided as a replacement feeding area for Brent geese, as a condition of the Certification of the Ringsend Waste Water Treatment Plant. A number of submissions refer to this area and the potential impacts on Brent geese. It is acknowledged that there is a potential for geese to be displaced from this area during construction, arising from disturbance due to human activity and noise. Pile-driving has a potential to cause disturbance to Brent geese in the immediate vicinity, depending on the type of equipment used and the timing of the work. These impacts are assessed as potentially significant during the construction phase.

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Appropriate mitigation measures for Brent geese during the construction phase are as follows. It is proposed that temporary construction area will be moved 20m west, so that it will not immediately adjoin the grassland area (see Figure 10). Given that the construction area will be fenced off, this set back is considered sufficient to allow geese to continue to use the replacement grassland, based on observations of their responses to disturbance arising from construction work on other projects in the Ringsend/Irishtown area over the last number of years, during the ecological monitoring for the Dublin Bay Project. However, it is recommended that the construction site lay-out is agreed with an ecologist prior to site set up.

It is also recommended that Brent goose use of grassland areas in the vicinity is monitored during construction (the 2ha replacement grassland area, Sean Moore Park, Irishtown Stadium, and Ringsend Park). The objective of the monitoring is to ensure that local factors, including scheduled construction activities on the Dublin Waste to Energy Project, can be taken into account on an on-going basis during construction, to inform any additional mitigation measures that can be taken from time to time, if appropriate, and the final landscaping layout along the southern boundary of the development site.

It is not envisaged that there will be any impacts on Brent goose use of the 2ha replacement grassland area arising from the proposed development during the operational phase. No mitigation measures are required.

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8.1.2. Potential release of contaminants during construction.

There is a potential for the release of existing contaminants on site into the wider environment, including Dublin Bay, during construction, as detailed in evidence being presented by Séan Mason of Arup Consulting Engineers, who has also identified appropriate mitigation measures. Any contaminated soil or water arising on site during construction will be identified, and either contained on site or disposed of to licensed facilities. With full implementation of these mitigation measures, it is not envisaged that there will be any impacts on inter-tidal habitats or waterfowl in Dublin Bay during the construction phase. Impacts are therefore assessed as neutral.

There is a potential for dust generation on site during the construction phase. Mitigation measures are detailed in Chapter 8 of the EIS, and also in evidence by Séan Mason, and by Dr Ed Porter of AWN Consulting. With implementation of these measures, it is not envisaged that there will be any adverse impacts on inter-tidal habitats or waterfowl in Dublin Bay, and dust impacts are therefore assessed as neutral.

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8.1.3. Lighting issues.

A number of submissions have referred to a potential for lighting to impact adversely on waterfowl in the general vicinity of the Poolbeg Peninsula during construction. Lighting will be provided on site and in the temporary construction compound during the construction phase. Since lighting will be directed to work areas, and as the site is separated from the inter-tidal habitats in South Dublin Bay by the mounded area along the southern edge of the Poolbeg peninsula, it is not envisaged that there will be any overspill of lighting onto inter-tidal habitats. However, I note that there are no indications that waterfowl in Dublin Bay are adversely affected by ambient lighting, as distinct from ambient lighting with associated human activity on and immediately adjoining inter-tidal habitats.

8.1.4. Potential impacts on waterfowl flight patterns due to building size and height.

Some submissions to An Bord Pleanala referred to a potential for the size of the Dublin Waste to Energy Project building to pose a hazard to migrating birds. In response to this concern, it is noted that most waterfowl flight movements between North and South Dublin Bay occur over the open water of Dublin Bay, and over the Great South Wall. Brent geese are the principal

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species which uses the Poolbeg Peninsula in significant numbers. It has been my observation that while Brent geese can and do fly between and over buildings on the peninsula, they generally follow an east-west flight-line when accessing and leaving the 2ha replacement grassland. Gull species can also use the Poolbeg area in number, but there is no indication that buildings present an obstacle to them. Ambient lighting on Pigeon House Road and on stacks is such that building bulk on the Poolbeg Pensinsula will be evident to any birds migrating at night. Impacts on waterfowl flight patterns are therefore assessed as neutral.

8.2. OPERATIONAL PHASE.

8.2.1. Potential impacts arising from aquatic discharges.

Cooling water will be the only direct discharge from the Waste to Energy Project to the aquatic environment during the operational phase. Hypochlorite will be used as a biocide to prevent and control fouling of pipes within the facility. Modelling of the thermal plume and of biocide degradation products is being presented in evidence by DHI. The potential impacts of this discharge and appropriate mitigation measures are considered in detail in evidence being presented by EcoServe, and are confined to the outfall channel shared with Synergen, and to the River Liffey in the Dublin Port area. No impacts arising from aquatic discharges are anticipated within the designated Natura 2000 SAC and SPA sites in Dublin Bay.

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8.2.2. Potential impacts arising from air emissions.

During the operational phase, air emissions from the Waste to Energy Project will be subject to IPPC licensing, under the terms of the EU Directive 2000/76/EU, as discussed in Chapter 8 of the EIS and in evidence presented to this hearing by Drs Ed Porter and Fergal Callaghan of AWN Consulting. The following parameters have been subject to air dispersion and deposition modelling for the EIS:

17 dioxin and furan congeners
4 non ortho and 8 mono ortho PCBs
7 EC PCB congeners
ICRCL Heavy Metal Suite

The potential of these emissions to impact adversely on inter-tidal habitats and wintering waterfowl in Dublin Bay has been assessed initially in respect of

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Dioxins and Furans, the parameters raised as being the issue of principal concern in submissions made to An Bord Pleanála.

At present, there are no internationally recognised standards for ambient air quality concentrations, or deposition rates, for Dioxins and Furans. The approach taken for Human health has been to assess risk arising from all sources of exposure, including foodstuffs which constitute the main source of intake.

There are no internationally recognised standards for Dioxin and Furan concentrations in inter-tidal sediments, including those which are listed among the qualifying interests for the SAC designations in Dublin Bay, and which are used as feeding habitat by internationally important numbers of waterfowl which are the qualifying interest for the SPA designations in the Bay. As far as the project team are aware, no determinations have been made of Dioxin and Furan concentrations in inter-tidal sediments, or indeed in marine or fresh-water sediments, anywhere in Ireland.

The UK Environment Agency has recently proposed a guideline limit value of 2000 ng kg^{-1} OC for Dioxins/Furans in freshwater sediments, and in sediments covered by the sea at all times (Grimwood et al, 2000 and © Environment Agency 2004), with the objective of the protection of freshwater and saltwater life. This limit value is equivalent to 20 ng-TEQ kg^{-1} for sediments with an organic carbon content of 1%. The guidelines are based on the most sensitive species and life-stage currently known; the early life stages of fish, particularly sac-fry. The species referred to as being the most sensitive is the freshwater lake trout *Salvelinus naymacush*, which is in the same genus as the arctic charr *Salvelinus alpinus* which occurs in lakes in Ireland, and is regarded as our most sensitive salmonid species with regard to water quality. The most important route of exposure to sac-fry in the wild is considered to be through redistribution from maternal tissues to developing oocytes. The guideline value is based on extensive laboratory research, and on dioxin/furan body burden data from laboratory and wild animals. The guideline level represents a combined No Observed Effect Level (NOEL) and No Observed Adverse Effect Level (NOAEL), and is interpreted as a threshold level above which adverse effects start to occur for the most sensitive species and life stages known.

There is good agreement between the proposed UK EA Guidelines, and the Canadian Interim Sediment Quality Guideline Probable Effect Level (PEL) threshold of 21.5 ng TEQ/kg, for the Protection of Aquatic Life, which is based on the WHO 1998 TEF values for fish.

The UK and Canadian Guidelines differ somewhat in their application, in that the UK Guidelines take the behaviour of dioxins and furans (referred to collectively as dioxins) in the aquatic environment into account. Dioxins are strongly adsorbed to suspended solids and sediments, and are rapidly removed from the water column through binding to suspended solids and

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dissolved organic carbon, followed by settling and accumulation in sediments. While there can be direct uptake of dissolved dioxins by aquatic organisms, the most important route of exposure is directly through sediments, or indirectly through sediments via the food chain. The UK Guidelines are based on Biota Sediment Accumulation Factors (BSAFs), which take account of all routes of dioxin uptake. The Guidelines are also linked directly to the organic carbon content of sediments, so that the Guideline value varies in relation to organic carbon. This approach is ecologically robust, since the Guideline value becomes lower in low organic carbon sediments, which are generally regarded as clean environments capable of supporting the most sensitive life forms.

8.2.2.1. Rationale for the sediment sampling programme in Dublin Bay.

An inter-tidal sediment monitoring programme has been initiated by Dublin City Council, with the aim of determining the current baseline conditions in Dublin Bay, in terms of existing cumulative concentrations of Dioxins/Furans, PCBs and PCB congeners, and heavy metals. I can inform this Oral Hearing of the initial results in respect of Dioxins/Furans, and I will have further information available for the EPA to inform the licensing process. The programme will also provide a means of assessing any changes which may potentially arise due to the construction and operational phases of the proposal, or due to alterations in cumulative loadings to sediments in Dublin Bay from all sources.

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Sediment sampling has been carried out in a total of 17 intertidal areas. Sampling areas were selected to represent the following:

- The maximum deposition area of air emissions from the Dublin Waste to Energy Project, as modelled in Chapter 8 of the EIS
- Known and potential areas of contaminant accumulation in Dublin Bay
- Preferred feeding areas used by wildfowl and waders in Dublin Bay
- Different substrate types, including soft muds, mixed substrates, muddy sands and sands.

The sampling areas are described in Table 3, and are mapped in Figure 11.

Six areas were sampled in mid-March 2007 (Nos. 4, 5, 6, 7, 12 and 13), representing areas within the maximum deposition area (Nos. 5 and 6, see EIS Chapter 8, and evidence presented by Dr Fergal Callaghan in Appendix 2 to this brief of evidence), areas of soft mud known to have accumulated contaminants to at least some extent (Nos. 7, 12 and 13, of which number 7, in the Tolka Basin was expected to represent a worst-case for existing cumulative contaminant levels), and finally an area in South Dublin Bay which

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had been found to contain slightly elevated levels of heavy metal contaminants by EcoServe in their baseline study (EIS Chapter 15).

The remaining 11 areas have been sampled, and are being analysed currently. These additional results will be available to inform the EPA licensing process.

The US EPA has used depths of 7cm and 14cm on recent sediment sampling programmes in the aftermath of Hurricane Katrina, to determine the impact of recently deposited sediment. A 14cm sampling depths was selected for the Dublin Bay study, to reflect the range of feeding depth for waders, which varies substantially between species. The longest wader bill lengths for the species occurring in Dublin Bay are as follows (Snow and Perrins 1998):

Oystercatcher 8-9cm
Black-tailed godwit 7.5-12cm
Bar-tailed godwit 8.5-10cm
Curlew 10-15cm
Redshank 3.7-5cm

A sampling depth of 14 cm represents the full feeding depth, given that curlew bills are strongly de-curved. Twenty 3" diameter cores were taken within a 100 x 100m sampling area at each site, as described in Fergal Callaghan in his brief of evidence. A GPS record was made of each core location.

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8.2.2.2. Baseline assessment.

The dioxin results for the six sampling locations for which data are now available are given in Table 4. These results are given in Toxic Equivalents (TEQs) for ecotoxicological assessment, as presented by the UK Environment Agency in 2004, to allow comparison with UK EA standards, and as NATO CCMS TEQ to allow comparison with the recorded concentrations at other sites internationally. The highest PCDD/F value recorded (TEQ OF 4.9 ng/kg) was for the sample from the Tolka Estuary, and is consistent with the general finding[2] that the soft muds in the Tolka Estuary are the most contaminated part of Dublin Bay, with the exception of the sediments in parts of the Liffey navigation channel. Samples taken in soft muds on either side of Bull Island Causeway were also slightly elevated at 0.7 and 2.4 ng/kg TEQ. The other three samples (4, 5 and 6) showed PCDD/F concentrations below the limit of detection of 0.5 ng/kg TEQ. (These samples had recorded concentrations of 0.019, 0.089 and 0.332 ng/kg respectively, but the laboratory's accreditation

[2] See Jeffrey et al (1992), Dublin Bay Water Quality Management Plan, Technical Report No. 7, and RPS/COWI (2005) Volume 1 Chapter 3.

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requires that they record a TEQ below 0.5 ng/kg as a "less than the limit of detection" value).

The sample results are compared with the UK Environment Agency Guideline limit values in Table 5. All six sample sites show that the measured concentrations are well below the relevant limit values for PCDD/F in sediment.

Dr Callaghan has reviewed the Dublin Bay data with recorded data from other countries, and his evidence is repeated here. Rose et al, in their study of UK river sediments in 1994 noted that concentrations varied between 1.99 and 122 ng/kg TEQ in a study of 36 different rivers, with only 10 out of 36 samples having a concentration less than 10 ng/kg TEQ (from Rose, McKay and Ambridge, NRA R&D Note 242, UK NRA 1994).

The OSPAR Commission (the Convention for the Protection of the Marine Environment of the North East Atlantic) published a comprehensive review of dioxins in the marine environment in 2005 (ref. Hazardous Substances Series "Dioxins", OSPAR, 2005). The review notes that recorded marine sediment levels in unpolluted fjords in Norway were up to 12 ng/kg TEQ, with harbour sediments having concentrations of 20 – 40 ng/kg TEQ and heavily polluted fjords had sediment concentrations of up to 60,000 ng/kg TEQ.

Background levels of 1 ng/kg or less were recorded for samples taken in the Barents Sea, and this was taken by the review as being the background concentration in natural sediment. The report also notes that storm water sediment from a study in Germany had concentrations of between 10 and 29 ng/kg TEQ and that harbour sediments in Hamburg had concentrations of up to 1500 ng/kg TEQ.

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Conclusion.
In summary, it can be concluded that, based on the samples analysed, the recorded concentrations of dioxins/furans in Dublin Bay are low and are close to what is termed natural background and are well below any proposed or interim limit values.

8.2.2.3. Potential additional dioxin loading arising from the Dublin Waste to Energy Project.

Sampling site 5, located on the southern side of the Great South Wall, is located in the vicinity of the maximum predicted deposition rate from the proposed Waste to Energy Project, and was therefore chosen as the site for modelling impacts. Modelling was carried out by Dr Callaghan of AWN Consulting, and is reported in detail in his evidence attached as Appendix 2 to my brief of evidence.

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The modelled results show a predicted increase in sediment PCDD/F concentration from 0.0848 ng/kg as a baseline TEQ, to 0.1071 ng/kg, over a 30 year period operating life of the facility. This theoretical increase is likely to be overly conservative as it does not take into account the impact of sediment transport and removal from the area by tides, with associated dioxin removal. When the existing baseline congener profile of site 5 is taken into account, the likely predicted increase is therefore likely to be from a background of 0.0848 ng/kg TEQ to 0.0898 ng/kg TEQ, an *insignificant* increase. It should also be noted that even the greater increase to 0.1071 is well below the limit value of 2 ng/kg TEQ for this site, and is also well below the natural baseline value of 1 ng/kg as noted by OSPAR.

Conclusion.

On the basis of these results, it is concluded that waterfowl populations, and the ecological integrity and conservation status of the areas subject to Natura 2000 SAC and SPA designations in Dublin Bay, will not be adversely affected by air emissions from the Dublin Waste to Energy Project. With regard to the assessment of impacts, it is considered inappropriate to give an assessment of imperceptible impact[3] because both the baseline dioxin levels and the predicted cumulative concentration after a projected 30 year operating life of the facility are below the accredited limit of detection of the analytical laboratory. The potential impacts are therefore assessed as neutral. Mitigation and compensatory measures are therefore not required, under the terms of Article 6 of the Habitats Directive.

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8.2.2.4. Response to submissions relating to dioxin levels in the environment.

A number of the submissions made to An Bord Pleanála state that 'there are no safe levels of dioxins'. Invertebrates are largely unaffected by dioxins since they lack the aryl hydrocarbon (Ah)-receptor which is essential to the expression of dioxin related toxic effects. Vertebrate animals do exhibit toxic responses to elevated levels of dioxins mediated through the Ah receptor, and the expression of toxic responses is best understood with regard to human health. Studies of the biochemistry and metabolism of the different dioxin and furan congeners indicate that there are indeed body burden threshold levels or limit values, above which toxic responses begin to be expressed. The World Health Organisation has developed Toxic Equivalency Factors for humans, mammals, fish and birds, and there internationally recognised risk assessment methodologies for assessing human health risk, as discussed by Drs Fergal Callaghan and Dieter Schrenk in their evidence.

[3] Imperceptible impact is defined as an impact capable of measurement but without noticeable consequences (EPA Guidelines on the information to be contained in Environmental Impact Statements, 2002).

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As noted at the beginning of this assessment, there are no internationally recognised standards for Dioxin and Furan concentrations in fresh-water, inter-tidal or marine sediments. Canada has proposed an Interim Sediment Quality Guideline (ISQG) of 0.85 ng-TEQ/kg dw, with a Probable Effect Level (PEL) of 21.5 ng-TEQ/KG dw for both freshwater and marine sediments. The UK Guideline Value is a limit value No Observed Effect Concentration (NOEC) and No Observed Adverse Effect Level (NOAEL), of 2000 ng kg-1 OC, equivalent to 20 ng-TEQ/kg at an organic carbon level of 1%. Grimwood et al note that it is difficult to determine what constitutes a "safe" long-term level in the environment.

It is probable that internationally recognised standards for dioxins in sediments will be adopted in the future. The main focus in recent years has been the development of reductive measures for the environment generally, through the introduction of air emission and water discharge limits for point sources of dioxins including incineration, and for industrial processes including wood pulp and paper milling, iron and steel making processes, and herbicide and pesticide manufacture. Diffuse sources of dioxins arising from general combustion processes are likely to be subject to emission limits in the future.

Internationally, dioxin levels are falling, in response to recent changes in processes and the application of emission and discharge limits. The sediment analyses carried out for this project in Dublin Bay will contribute to our knowledge of current baseline conditions in Ireland. When the remaining 11 sample results are available, a report incorporating the baseline results from all 17 sites will be prepared and made available to the competent authorities and to the public, and will assist in future environmental management of Dublin Bay. The data will also contribute to EPA and other databases on environmental contaminants in Ireland.

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8.3. 'DO – NOTHING' SCENARIO

Changes in Annex 1 listed habitats and habitat quality, and in the numbers of different waterfowl species 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 (and not listed in any particular order of importance) would seem to be as follows:

1. Morphological change.

While morphological change can arise in different parts of Dublin Bay, there has been notable sediment accumulation in South Dublin Bay during the last ten years. This has led to the development of sand bars, and also to the early

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development stages of embryonic dune and marram dune[4] habitats, which is occurring particularly in the area between Merrion Gates and Booterstown. There is a potential for further habitat change associated with sediment accumulation; for example salt meadow vegetation, or *Salicornia* and other annuals colonising mud and sand, could develop in conditions of increasing shelter in the western part of the South Bay. These sorts of changes result in the replacement of areas of one Annex 1 listed habitat with other coastal habitats which are also listed in Annex 1 of the Habitats Directive.

Morphological changes are likely to be on-going, and have the potential to alter tidal flows, mixing, and re-circulation patterns within the South Bay. The modelling of aquatic discharges carried out for the Dublin Waste to Energy Project indicates a current capacity of the westernmost part of the bay at Irishtown/Ringsend to accumulate pollutants, which could increase in the future.

2. Climate change.

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Climate change has the potential to alter the numbers of waterfowl wintering in Dublin Bay. One of the reasons this is anticipated is because milder winter weather within the existing ranges of individual species and populations, means that birds that breed in northern and eastern Europe and Russia no longer need to travel as far west as Ireland to reach favourable wintering conditions. There is evidence that this is already happening in Britain, with changes in the distribution of wading birds towards the east and north, so that individual populations winter closer to their breeding grounds (Rehfisch et al, 2004).

Comparable analysis of waterfowl data in Ireland is on-going and does not provide a clear trend across a range of species yet. However, the recent expansion from the south of the little egret, which first established a wintering population in 1990 and was first recorded as breeding in 1997, is taken as an indication of climate warming. Bewick's swans, which breed in the Russian tundra, have declined as a wintering species in Ireland as their wintering range has shifted further east, apparently also in association with climate change (Crowe, 2005). Changes in duck numbers at Lough Neagh have been partly attributed to an easterly shift in wintering range (Allen et al, 2004).

Other potential climate change impacts on waterfowl, which could impact on numbers in Dublin Bay in the future, include alterations in breeding success, changes in winter feeding habitat through sea level rise, and changes in food availability, all of which could result in changes in total population size for some species.

[4] Embryonic shifting dune, and shifting dune with *Ammophila arenaria*, are Annex 1 listed habitats

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3. Changes in licensed emissions and diffuse emissions to air and water, under environmental legislation and standards, and under climate change impact reduction measures, would in general be expected to reduce cumulative pollutant loadings on Dublin Bay in the future.

4. Other approved developments and infrastructure projects could potentially impact directly or indirectly on habitats and on the waterfowl using them.

5. Increased recreational uses causing disturbance on inter-tidal habitats in Dublin Bay have the potential to impact on waterfowl populations, or on the way they use Dublin Bay.

8.4. 'WORST-CASE' SCENARIO

In the context of the proposal a worst-case scenario could arise from loss of containment of hazardous materials within the facility arising from bund or bunker failure.

The surface water drainage and monitoring system within the facility is capable of detecting and containing any accidental spillages or bund failures. Mr Claus Nørgaard is giving evidence to An Bord Pleanála on the design and construction of the waste bunker in accordance with EU BREF Document on the best available techniques for waste incineration (August 2006) which provides that the waste bunkers shall be constructed with sealed fully waterproof and corrosion resistant surfaces. The structure is of reinforced concrete with a thickness in the order of 1.5 – 2 metres. Professional experience is that this type of bunker structure has never failed. Any EPA monitoring requirements, however, will be implemented.

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9. MITIGATION MEASURES

The proposed Dublin Waste to Energy Project has been designed to operate within the emission limits set by the EU Directive on Waste Incineration. Waste Licence Conditions will set by the EPA. It is envisaged that the Licence Conditions will include a requirement for environmental monitoring of any impacts arising from the project, with regard to normal operation, abnormal operation, or any 'worst case' scenarios which have a potential to affect sensitive receptors. These include human health and environment, and the areas subject to SAC and SPA conservation designations in Dublin Bay, with regard to habitats and species.

In this context, it is important that waterfowl and ecological monitoring is able to distinguish between the 'do nothing' scenario impacts, and the impacts of

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licensed or accidental discharges from the Dublin Waste to Energy Project. 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 inter-tidal 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.

It is recommended that the scope of the monitoring programme includes morphological and habitat distribution change, in addition to sediment, biota, and waterfowl numbers and distribution monitoring. It is further recommended that the National Parks and Wildlife Service of the Department of Environment, Heritage and Local Government is consulted as part of the scoping for the monitoring programme.

10. PREDICTED IMPACTS.

10.1. CONSTRUCTION PHASE.

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Mitigation measures are recommended for Brent geese, to ensure that they can continue to use the 2ha replacement grassland adjoining the site during construction. With full implementation of these measures, residual impacts on Brent geese arising from the construction phase of the Dublin Waste to Energy Project are assessed as neutral.

10.2. OPERATIONAL PHASE.

The assessment of potential impacts of air emissions arising from the proposed Dublin Waste to Energy Project resulted in a neutral assessment, in respect of waterfowl populations in Dublin Bay, and in respect of the ecological integrity and conservation status of the Natura 2000 SAC and SPA sites in Dublin Bay.

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Figure 1. Special Areas of Conservation (SACs) in Dublin Bay: North Dublin Bay, Site Code 206 South Dublin Bay , Site Code 210

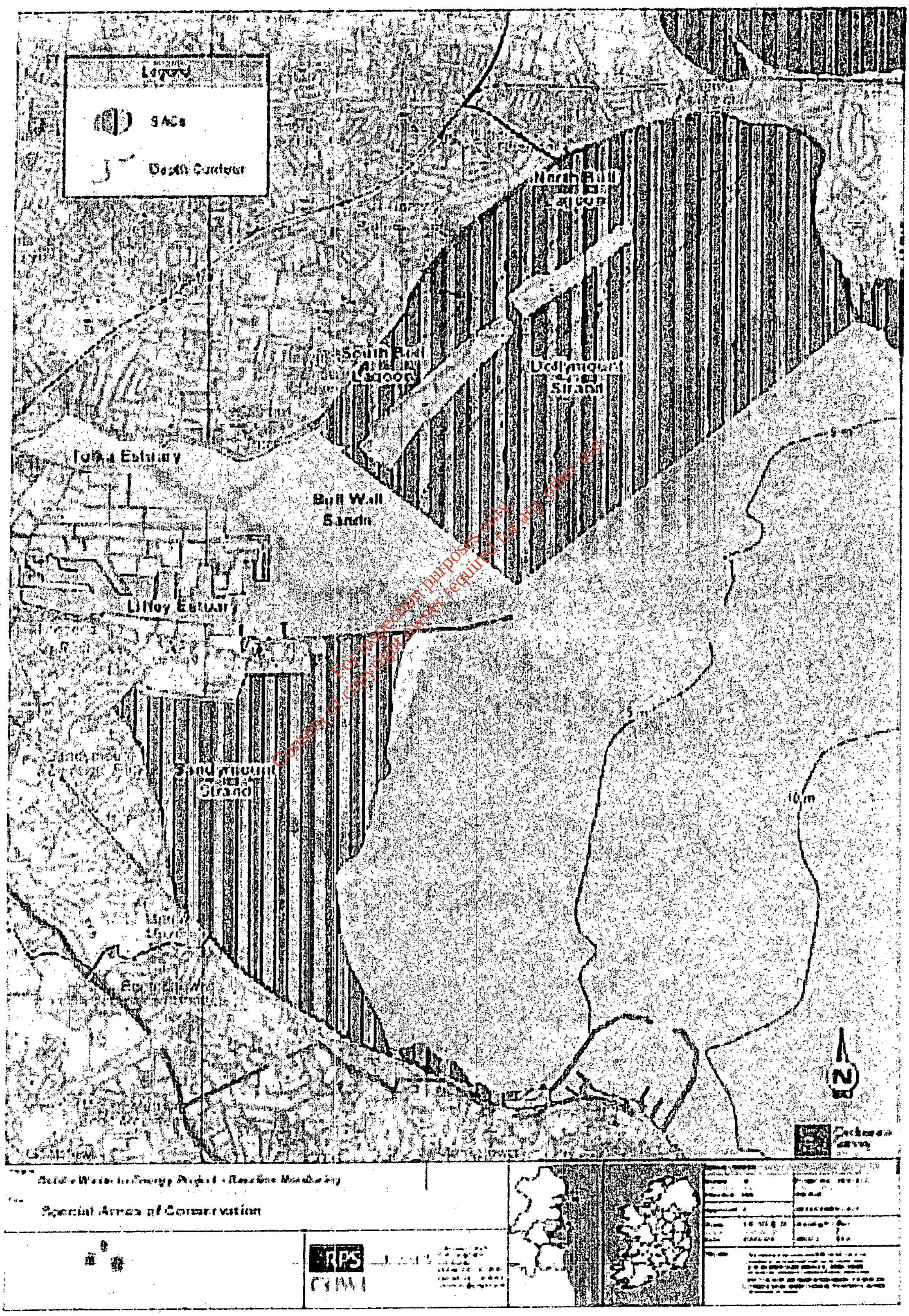

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Figure 2. Special Protection Areas (SPAs) in Dublin Bay:
Sandymount Strand/Tolka Estuary, Site Code 4024
North Bull Island, Site Code 4006

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Figure 3. Proposed Natural Heritage Areas in Dublin Bay.

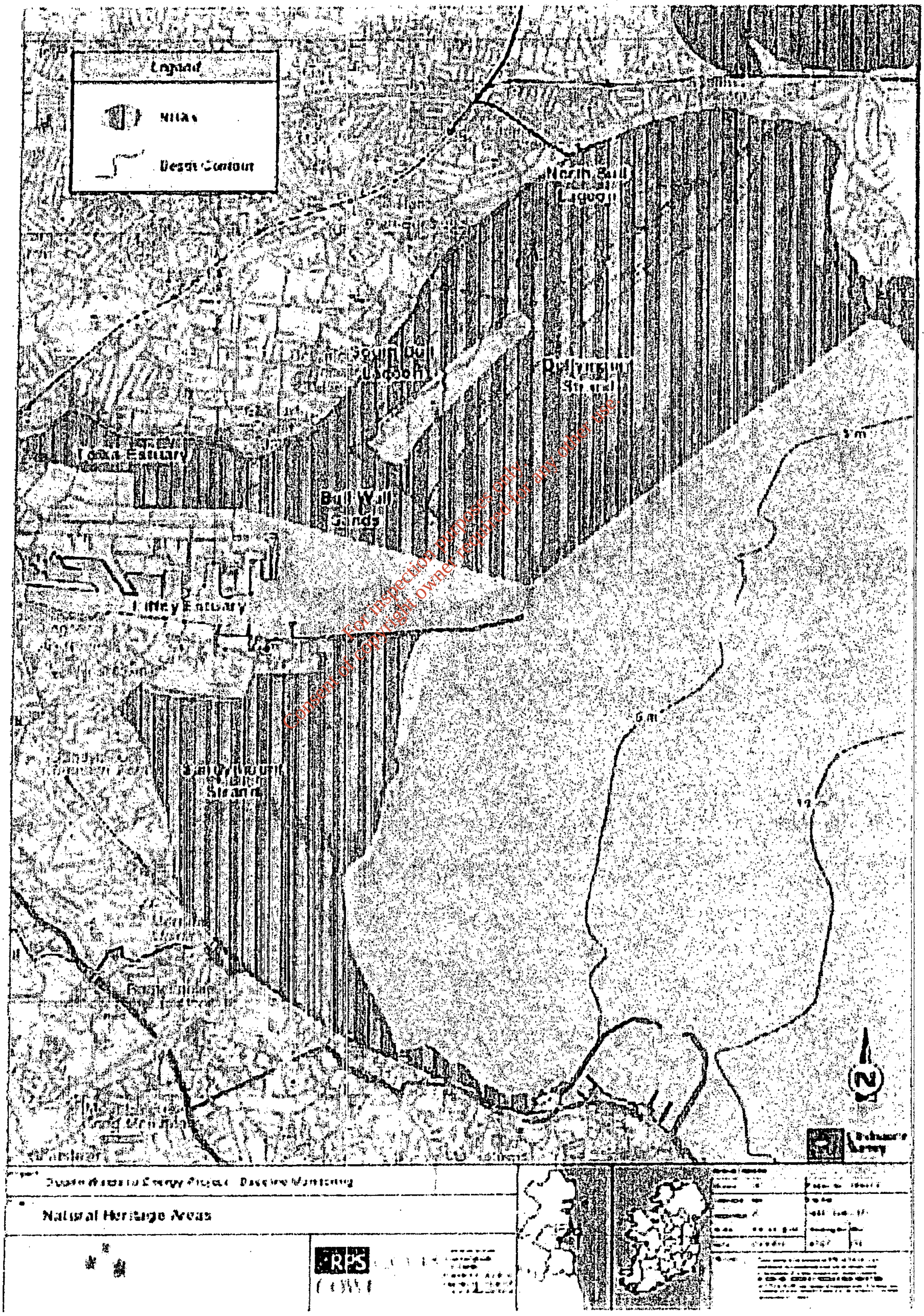

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Figure 4. Overview of sediment types and habitats in Dublin Bay.

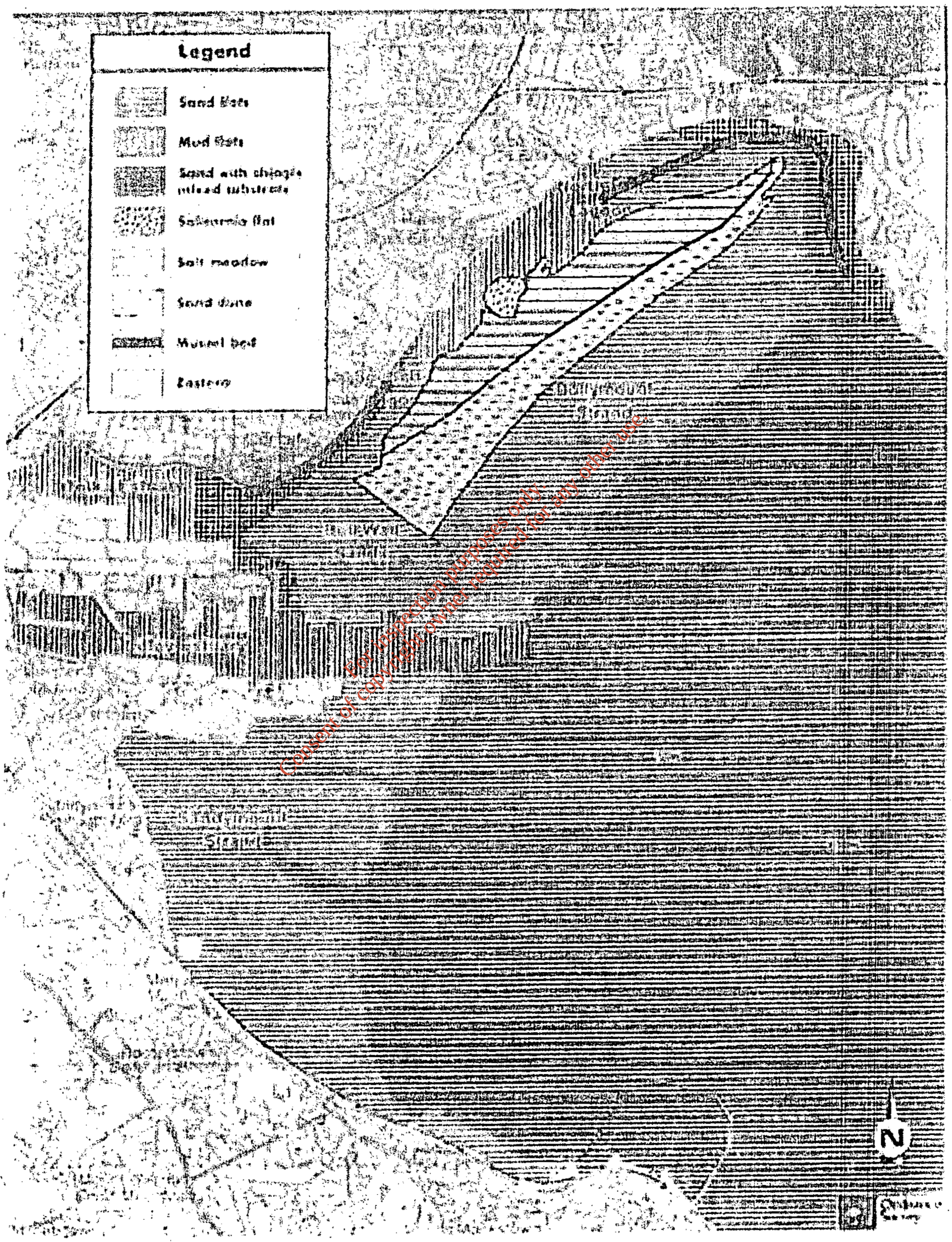

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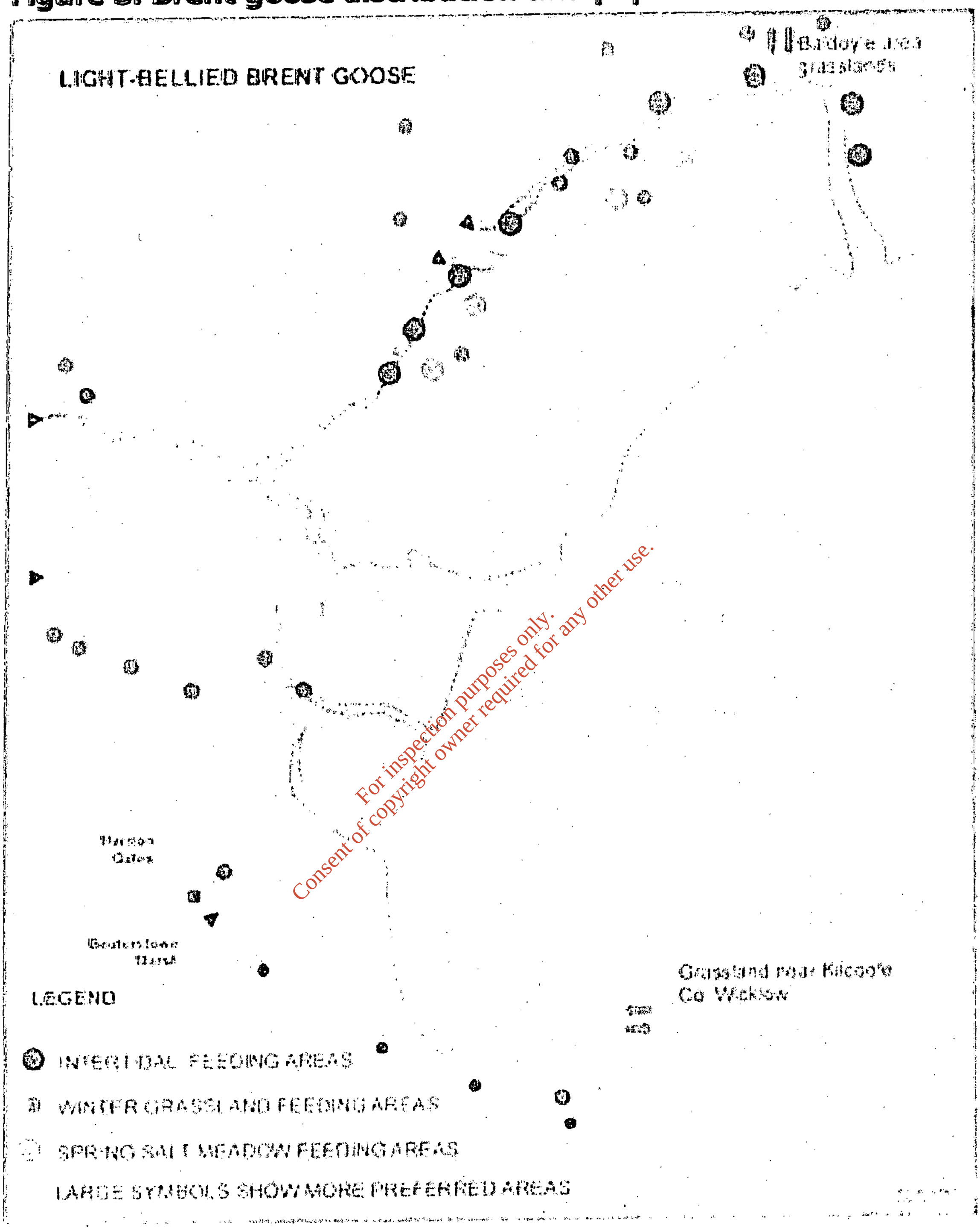
Figure 5. Brent goose distribution and population trend.



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Peak counts of Brent geese in Dublin Bay

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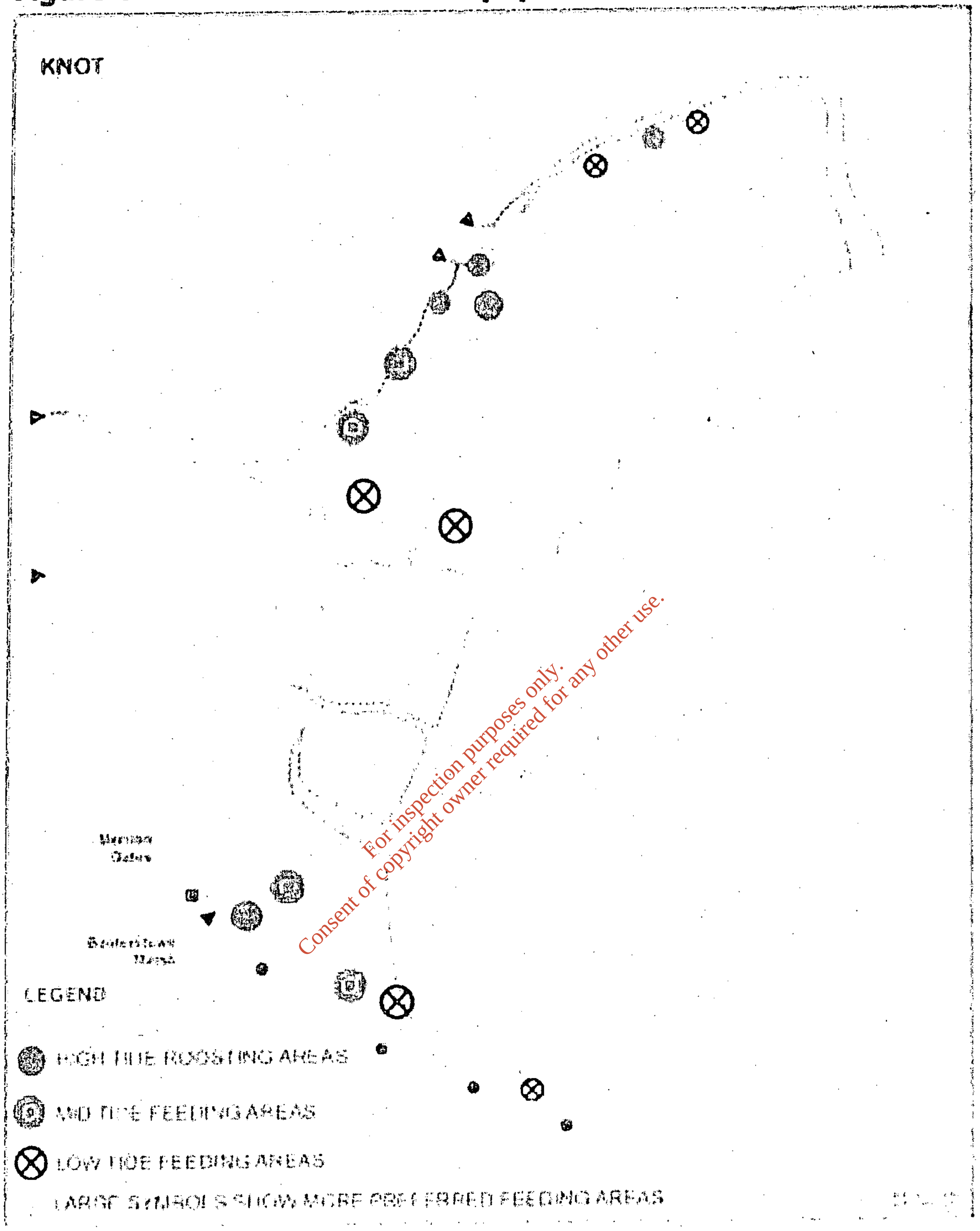
Figure 6. Knot distribution and population trend.



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Peak counts of knot in Dublin Bay

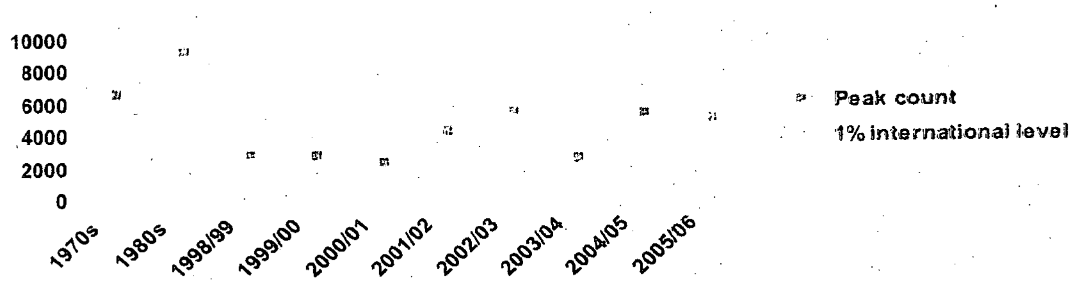

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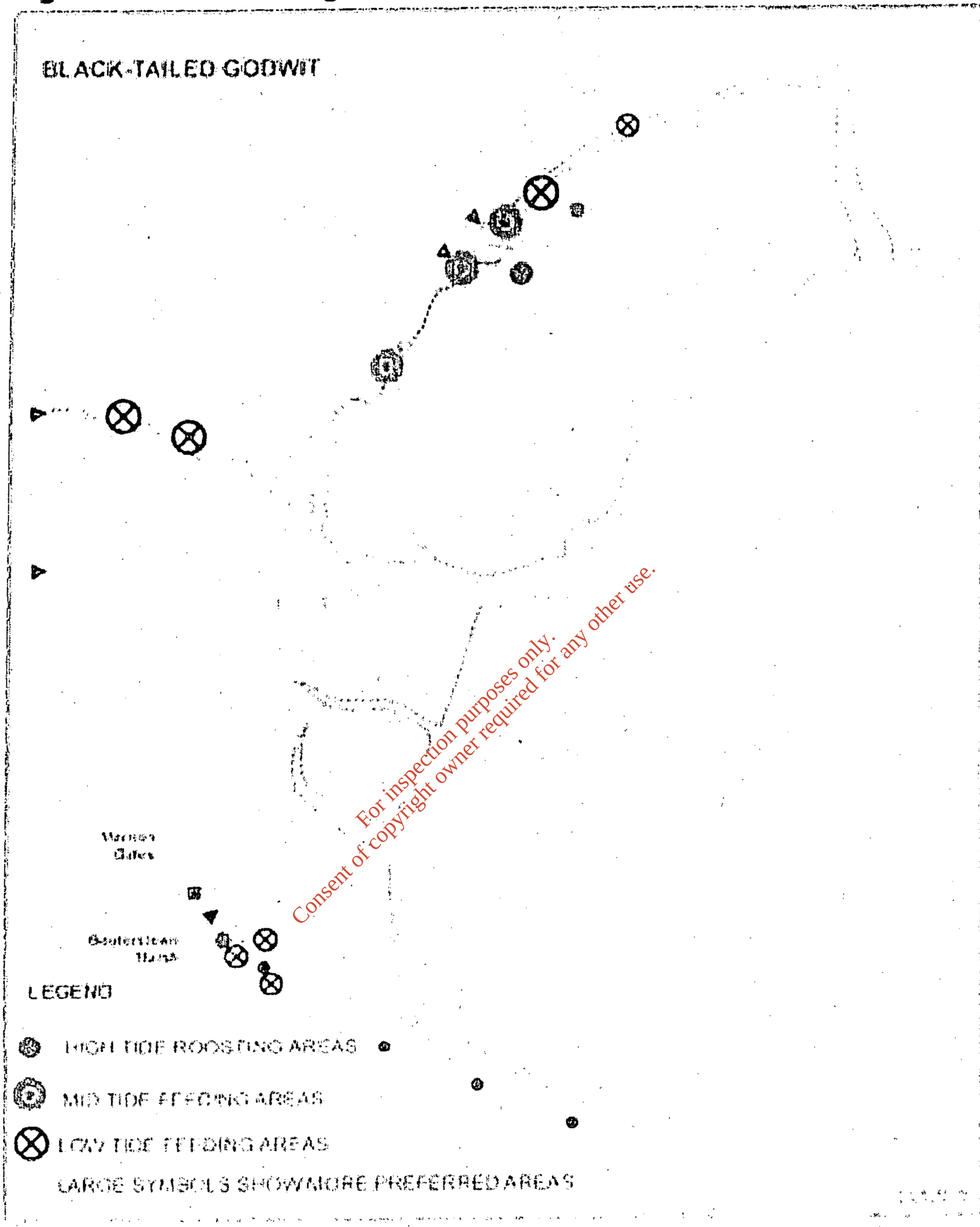
Figure 7. Black-tailed godwit distribution and population trend.



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Peak counts of black-tailed godwit in Dublin Bay

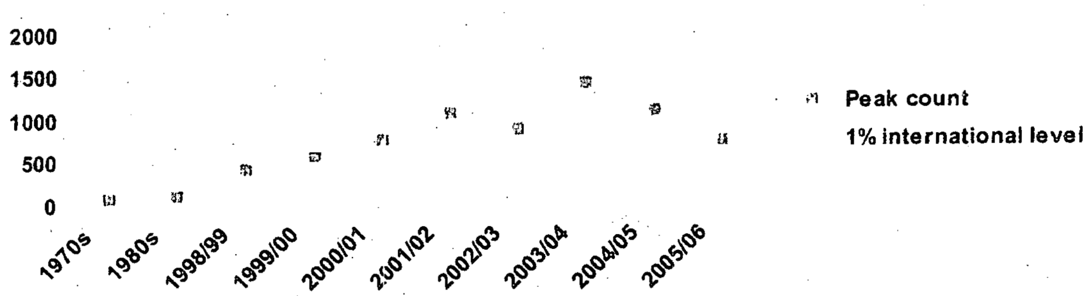

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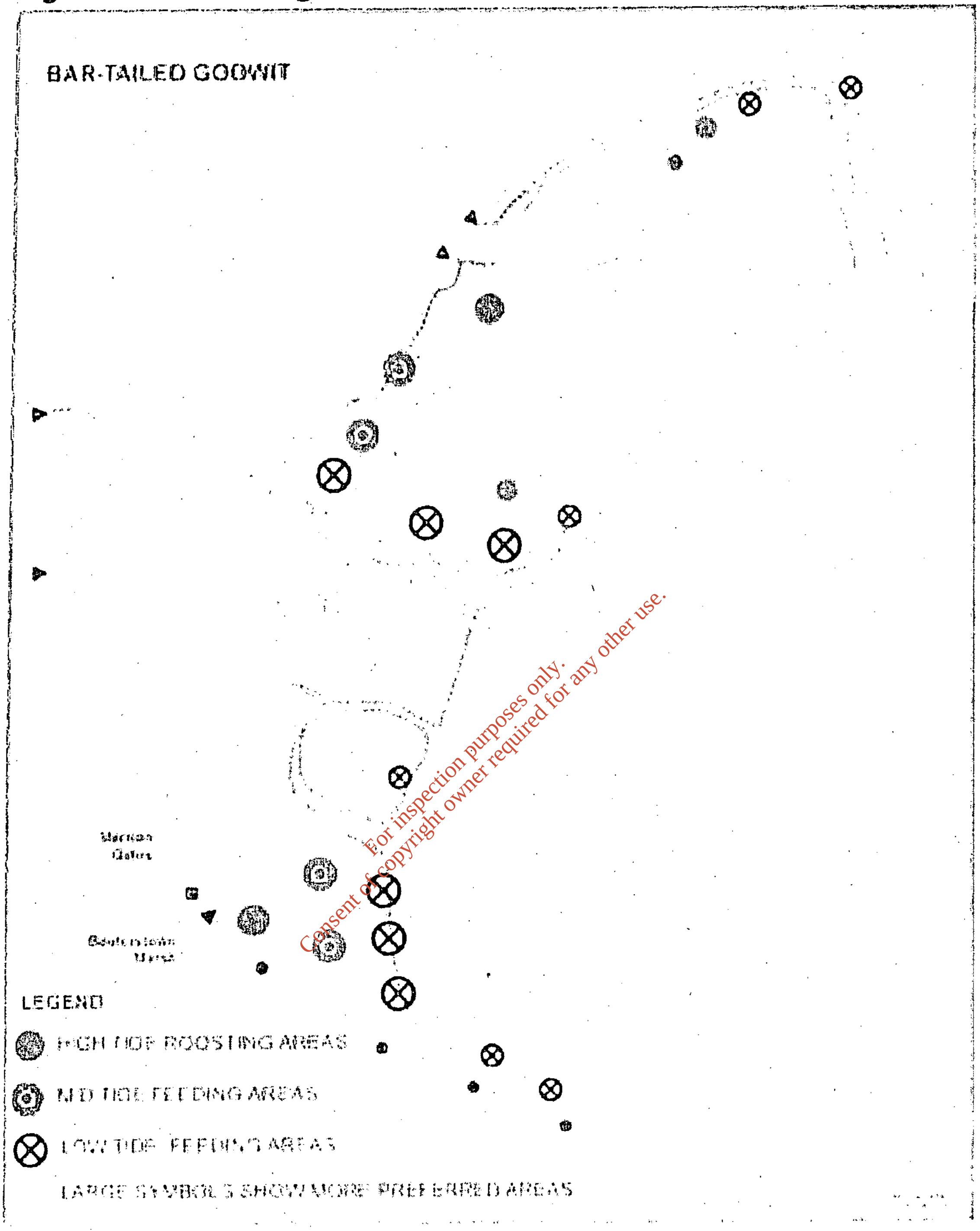
Figure 8. Bar-tailed godwit distribution and population trend.



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Peak counts of bar-tailed godwit in Dublin Bay

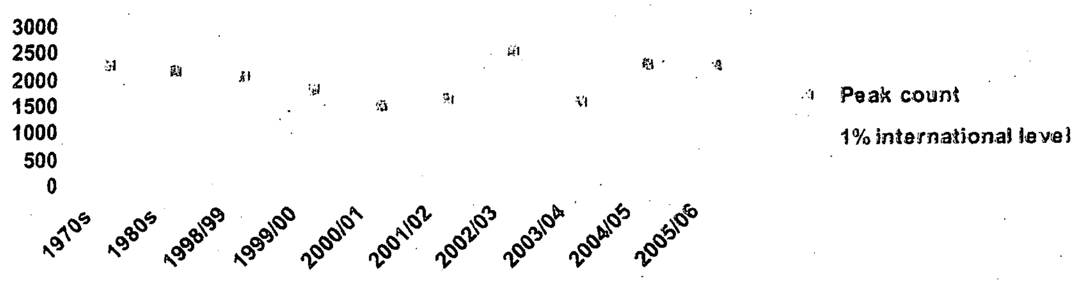

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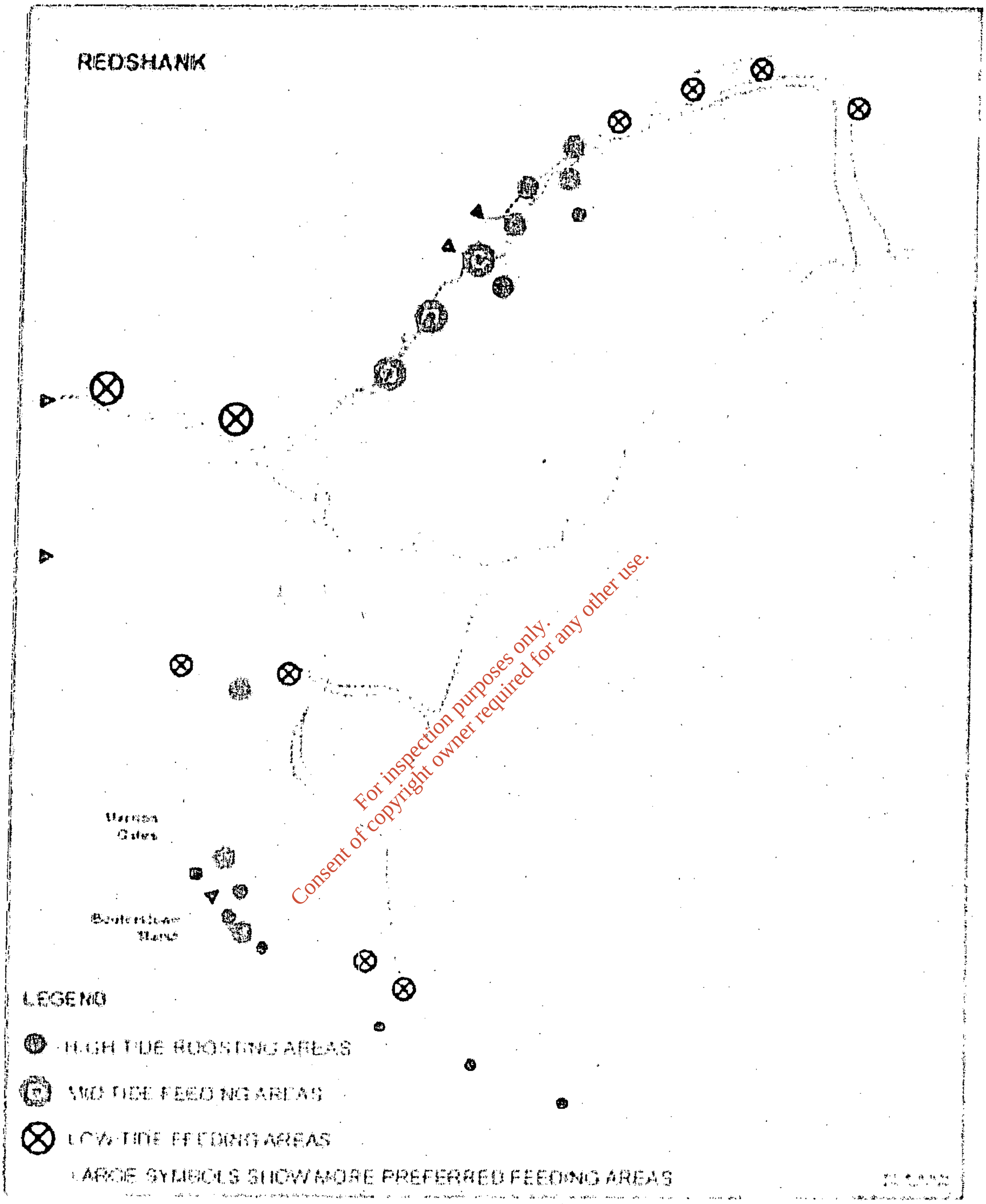
Figure 9. Redshank distribution and population trend.



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Mean and peak counts of redshank in Dublin Bay

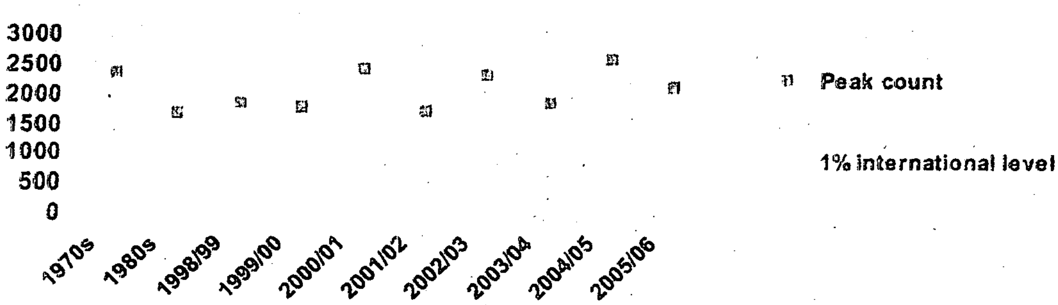

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Figure 10. Proposed revised layout of the temporary construction area, with 20m setback from the replacement grassland.

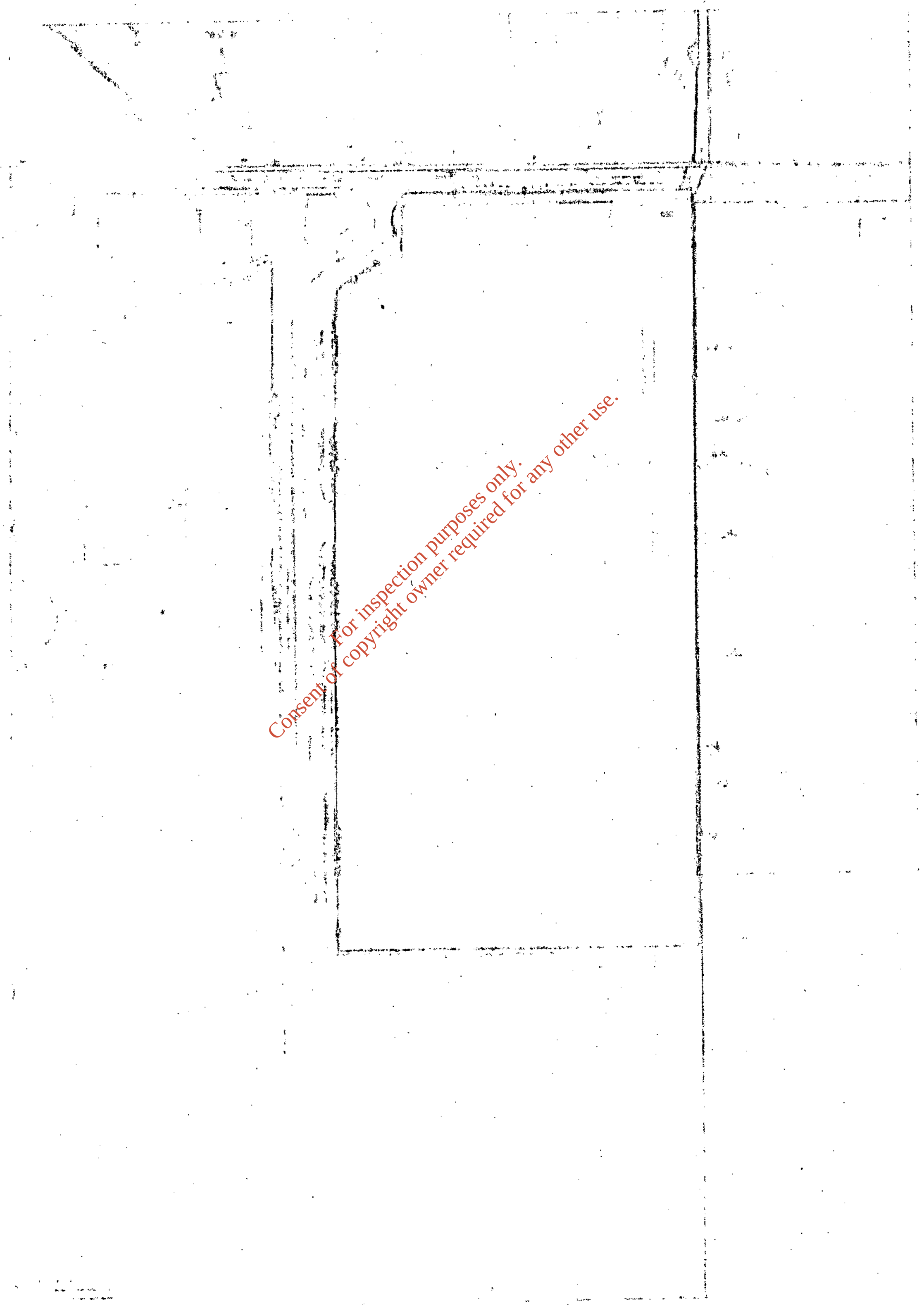

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Figure 11. Inter-tidal sediment monitoring programme sites, 2007.

Note that the red squares indicate the sample sites 4, 5, 6, 7, 12, and 13, for which Dioxin/Furan results are presented in this Brief of Evidence. Laboratory results are still awaited for the remaining 11 sites, indicated by white squares. The base map is taken from the Baseline Monitoring Report for the Dublin Waste to Energy Project, Volume 1, Chapter 3, which reports heavy metal results for the sites indicated by yellow circles.

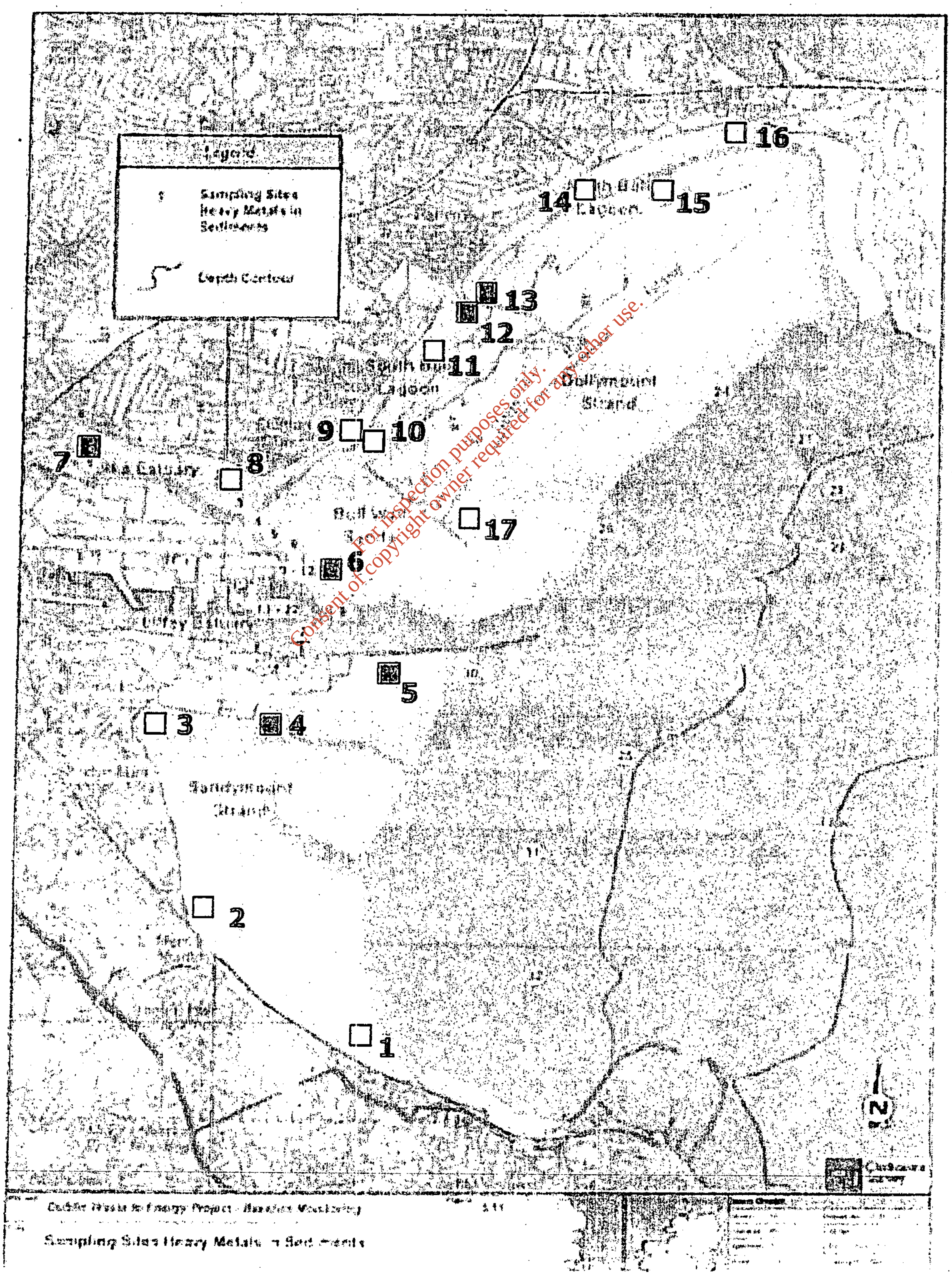

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Table 1. Peak counts of wildfowl and waders in Dublin Bay.

	Peak count 2005/06	Peak count 2004/05	Peak count 2003/04	Mean peak 2001/02-2005/06	Mean peak 98/99-2002/03	Mean peak 1994/95-1998/99	Trend in Dublin Bay	National trend	Threshold 2005/06 National	Threshold 2005/06 International
Great-grested grebe	139	72	121	112	62	26	Increase	Increase	55	4,800
Cormorant	287	153	190	151	62	24	Increase	Increase	140	1,200
Grey heron	40	31	35	33	34	24	Increase	Increase	30	2,700
Little egret	23	8	3	7	-	-	Increase	Increase	20	1,300
Light-bellied Brent goose	2,909	3,759	2,698	3,181	2,907	1,930	Increase	Increase	220	220
Shelduck	755	949	987	1,140	1,287	1,261			150	3,000
Wigeon	584	402	1,469	855	785	924	Decrease*	Decrease	820	15,000
Teal	970	1,386	1,478	1,125	870	1,157			450	4,000
Mallard	55	95	60	90	135	90			380	20,000
Pintail	120	100	157	139	204	296	Decrease	Decrease	20	600
Shoveler	142	72	206	133	128	191	Decrease	Decrease	25	400
Goldeneye	21	15	18	17	13	34	Decrease	Decrease	95	4,000
Red-breasted merganser	47	41	49	40	40	35			35	1,700
Oystercatcher	3,923	3,958	3,633	4,349	4,177	2,526	Increase	Increase	680	10,200
Ringed plover	273	396	323	316	365	302			150	730
Golden plover	1,810	4,640	1,340	1,924	2,174	3,118	Decrease		1,700	9,300
Grey plover	536	698	524	573	629	705	Decrease		65	2,500
Lapwing	127	39	40	56	68	60		Decrease	2,100	20,000
Knot	4,894	5,330	2,506	4,475	3,503	3,575	Increase	Decrease	190	4,500
Sanderling	589	592	525	519	386	402	Increase	Increase	65	1,200
Dunlin	4,131	4,646	5,104	5,595	6,141	6,810	Decrease	Decrease	880	13,300
Black-tailed godwit	751	1,117	1,447	1,059	752	397	Increase		140	350
Bar-tailed godwit	2,210	2,259	1,548	2,026	1,901	1,669	Increase		160	1,200
Curlew	1,046	1,454	1,301	1,210	1,091	1,056	Increase	Decrease	550	3,200
Redshank	2,146	2,614	1,871	2,146	2,056	1,679	Increase	Increase	310	1,900
Greenshank	38	29	79	37	17	14	Increase	Increase	20	3,100
Turnstone	613	346	203	338	255	206	Increase	Decrease	120	1,000

Note: Internationally important numbers are shown bold-faced, nationally important numbers are in italics. Data for Brent geese and waders are combined Dublin Bay Project and I-WeBS data from 1998 on, other species and dates are I-WeBS data. National trends are indicated where these exceed 5% change between 1994/95-1998/99 and 1999/00-2003/04 (Crowe et al in press). Trends in Dublin Bay are indicated for changes of more that 10% between 1994/95-98/99 and 2001/02-05/06, because of the smaller database and difference in the time periods referred to. I-WeBS is a joint project of BirdWatch Ireland, the National Parks and Wildlife Service of DoEHLG, and the Wildfowl and Wetlands Trust. *Wigeon populations have declined by c. 7.7% nationally and in Dublin Bay.

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

Habitat	Main distribution	Use by waterfowl
Sand dune habitats	Bull Island Small areas of dune development in South Dublin Bay	Dune slack areas on Bull Island 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 oystercatcher and turnstone.
Mixed substrate shore (Cobble/gravel with finer sediments)	North Dublin Bay distribution, with small ephemeral patches in the western South Bay. Extends in varying width from the base of the sea wall in the Liffey Estuary and South Bull Lagoon - supports a 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, redshank and turnstone.

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Habitat	Main distribution	Use by waterfowl
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. Green algae (*Enteromorpha*) grow in sheltered areas.	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.

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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%)

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Table 3. Sediment sampling locations in Dublin Bay.

Site no.	Description and rationale
	South Dublin Bay.
1.	Sand. Main bar-tailed godwit and knot feeding area in South Dublin Bay
2.	Muddy sand. *Zostera* bed, Brent goose feeding area in autumn.
3.	Possible leachate from made ground, sheltered area potentially accumulating contaminants. Feeding area used mainly by black-headed gulls, oystercatcher and redshank, in relatively low densities.
4.	**Muddy sand, possible leachate from made ground, located in low tide channel area and used by several wader species (dunlin, ringed plover, redshank, curlew), and by Brent geese.**
5.	**Sand. Located in zone of maximum deposition from air emissions. Relatively little feeding use by waterfowl.**
	Liffey Estuary (Tolka Basin and Bull Wall Sands).
6.	**Mixed substrate/muddy sand. Located in zone of maximum deposition from air emissions, exposed only on low spring tides. Close to known accumulation of contaminants.Feeding use by oystercatcher, bar-tailed godwit, curlew, turnstone.**
7.	**Soft mud overlying mixed substrate. Known accumulation of contaminants. Preferred black-tailed godwit and redshank feeding area, also used by other species including Brent geese and dunlin.**
8.	Mixed substrate/mud. Potential accumulation of contaminants. Feeding area for Brent geese, oystercatcher, turnstone.
	South Bull Lagoon
9.	Mixed substrate in South Bull Lagoon. Brent goose and wigeon feeding area, with oystercatcher, black-tailed godwit, redshank and turnstone the main wader species
10.	Muddy sand. Brent goose and wader feeding area, main species bar-tailed godwit, knot, redshank.
11.	Sand/muddy sand. Wader feeding area, mainly knot, bar-tailed godwit, curlew, redshank.
12.	**Soft mud. Likely accumulation of contaminants. Brent goose and duck feeding area, main wader species black-tailed godwit and redshank.**
	North Bull Lagoon
13.	**Soft mud. Likely accumulation of contaminants. Brent goose and duck feeding area, main wader species black-tailed godwit and redshank.**
14.	Mud. Potential accumulation of contaminants. Brent goose feeding area, main wader species ringed plover, black-tailed godwit, redshank
15.	Sand/muddy sand. Wader feeding area, mainly oystercatcher, ringed plover, grey plover, knot, dunlin, bar-tailed godwit, curlew.
16.	Mixed substrate. Brent goose feeding area, main wader species oystercatcher, ringed plover, grey plover, redshank, turnstone
	Dollymount Strand
17.	Sand. Wader feeding and sub-roost, mainly bar-tailed godwit.

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Note: The 6 sampling sites for which results are presented at oral hearing (4,5,6,7,12 and 13) are bold-faced. The other 11 sites have been sampled and are being analysed currently. Results will be available for consideration by the EPA.

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Table 4. Dioxin baseline levels at six sampling location in Dublin Bay.

Sediment Sampling Point	Sampling Point Location	PCDD/F TEQ (ng/kg) [1]	PCDD/F I-TEQ (ng/kg) [2]
4	Sandymount Strand	< 0.5	<0.5
5	Along southern boundary of South Bull Wall	<0.5	<0.5
6	Area to the north of the Shipping Channel	<0.5	<0.5
7	Tolka Estuary near Alfie Byrne Rd	4.9	5.6
12	North of the Causeway onto Bull Island	0.7	0.9
13	South of the Causeway onto Bull Island	2.4	2.7

1 TEQ derived using Ecotoxicological TEFs as per UK EA 2004

2 TEQ derived using NATO/CCMS TEFs

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Table 5. UK Environment Agency Limit Values for the six sampling locations analysed.

Sample	% Organic Carbon	Dioxin Limit	Dioxin Conc.
		ng/kg TEQ	ng/kg TEQ
		(% Org C x 2000)	ecotox TEF
4	0.1	2	<0.5
5	0.2	4	<0.5
6	0.3	6	<0.5
7	1.9	38	4.9
12	0.4	8	0.7
13	0.6	12	2.4

Note that samples 4,5,6 had measured concentrations of 0.019, 0.089 and 0.332 ng/kg respectively but that the PCDD/F limit was calculated using an assumed concentration of 0.5 ng/kg, which is the limit of detection of the assay

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APPENDIX 1. WATERFOWL SPECIES DISTRIBUTION, AND FOOD SPECIES TAKEN.

Detailed information on feeding use of Dublin Bay by waterfowl has been collected during the last twelve years, mainly as part of environmental impact assessment studies for several different projects. Data on Brent goose and wader use of different areas of Dublin Bay have been collected for the Dublin Bay Project EIS and subsequent 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. Information on the distribution of duck is taken mainly from the Causeway Study prepared for Dublin City Council in 2002. 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 taken from the 1997 EIS for the proposed 21 Hectare Reclamation at Dublin Port, and from studies carried out for Dublin City Council in 2006 for flood defence work at Clontarf Promenade.

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1. 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

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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.

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2. Oystercatcher.

Nationally important species.

Oystercatcher are widely distributed in Dublin Bay, with 34% of the total recorded in the North Lagoon, 29% in the South Lagoon and Liffey Estuary, and 37% in South Dublin Bay. 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.

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.

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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 bars 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.

3. Ringed plover.

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Nationally important species.

Ringer plover occur mainly in the North Bull Lagoon (38%) and in South Dublin Bay (47%), with relatively little use of the South Bull Lagoon and Liffey Estuary at 15% overall. 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.

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4. Grey plover.

Nationally important species.

Grey plover occur mainly in the North Bull Lagoon (77%), with some use of the South Bull Lagoon and Liffey Estuary (22%), and very little use of South Dublin Bay (<1%). The preference indices for grey plover show strong selection of the North Bull Lagoon. 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.

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5. Sanderling.

Nationally important species.

In Dublin Bay, Sanderling feed on the littoral sands on Dollymount Strand and in South Dublin Bay, with 30% of the total number of birds recorded at low tide in South Dublin Bay. Generally, sanderlings are associated with open sandy coasts rather than 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. They occasionally feed in small numbers along the drift line, where they probably feed on dipteran flies (including adults, larvae and pupae), and on amphipod crustaceans like sand-hoppers *Talitris saltator*.

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.

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6. 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. On average, 44% of dunlin are recorded in the North Bull Lagoon at low tide, 23% in South Dublin Bay, and 33% in the Liffey Estuary.

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.

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7. Curlew.

Nationally important species.

Curlew are widely distributed in Dublin Bay, but occur in substantially higher densities in the North Bay. 52% of all low tide records are in the North Bull lagoon, 41% in the Liffey Estuary, and 7% in South Dublin Bay. 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).

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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.

8. Turnstone.

Nationally important species.

Turnstone show the highest preference for the South Bull Lagoon and Liffey Estuary, with 66% of low tide records here, followed by the North Bull Lagoon (23%). Small numbers occur in South Dublin Bay (11%), 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.

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9. Prey species taken by the internationally important wader species.

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).

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Black-tailed godwit

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.

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.*

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Redshank.

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).

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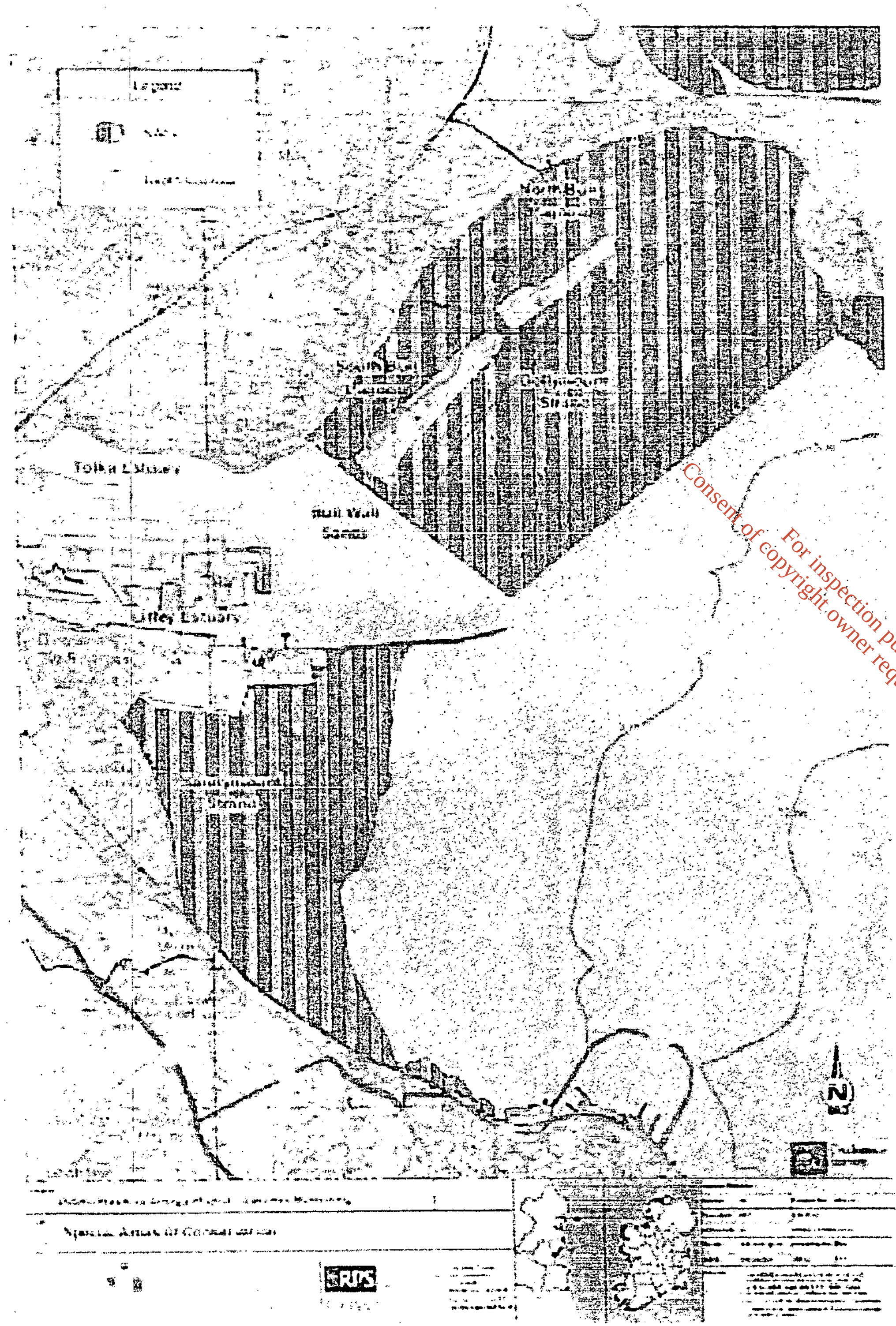

Figure 1. Special Areas of Conservation (SACs) in Dublin Bay: North Dublin Bay, Site Code 206 South Dublin Bay , Site Code 210

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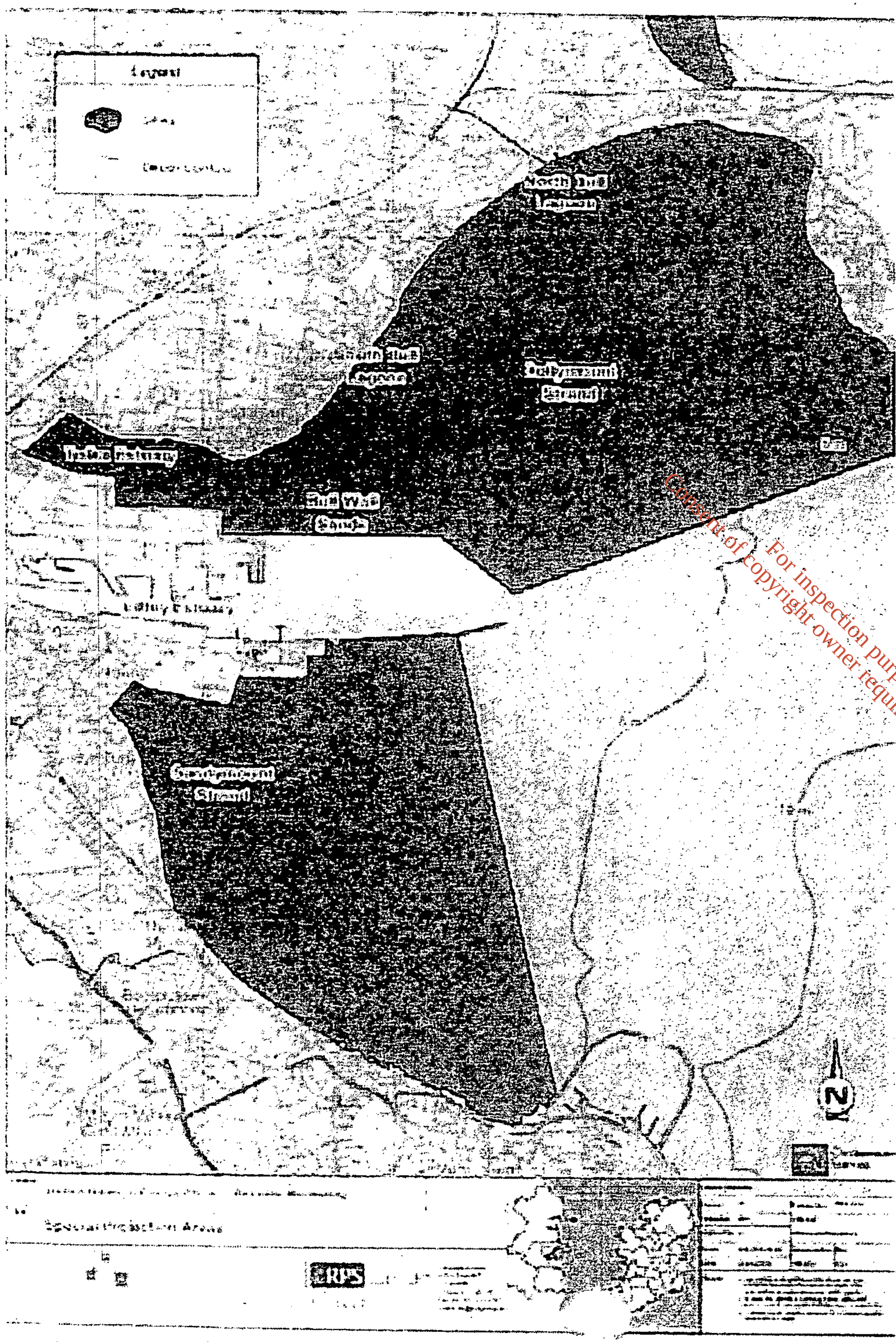

Figure 2. Special Protection Areas (SPAs) in Dublin Bay: Sandymount Strand/Tolka Estuary, Site Code 4024 North Bull Island, Site Code 4006

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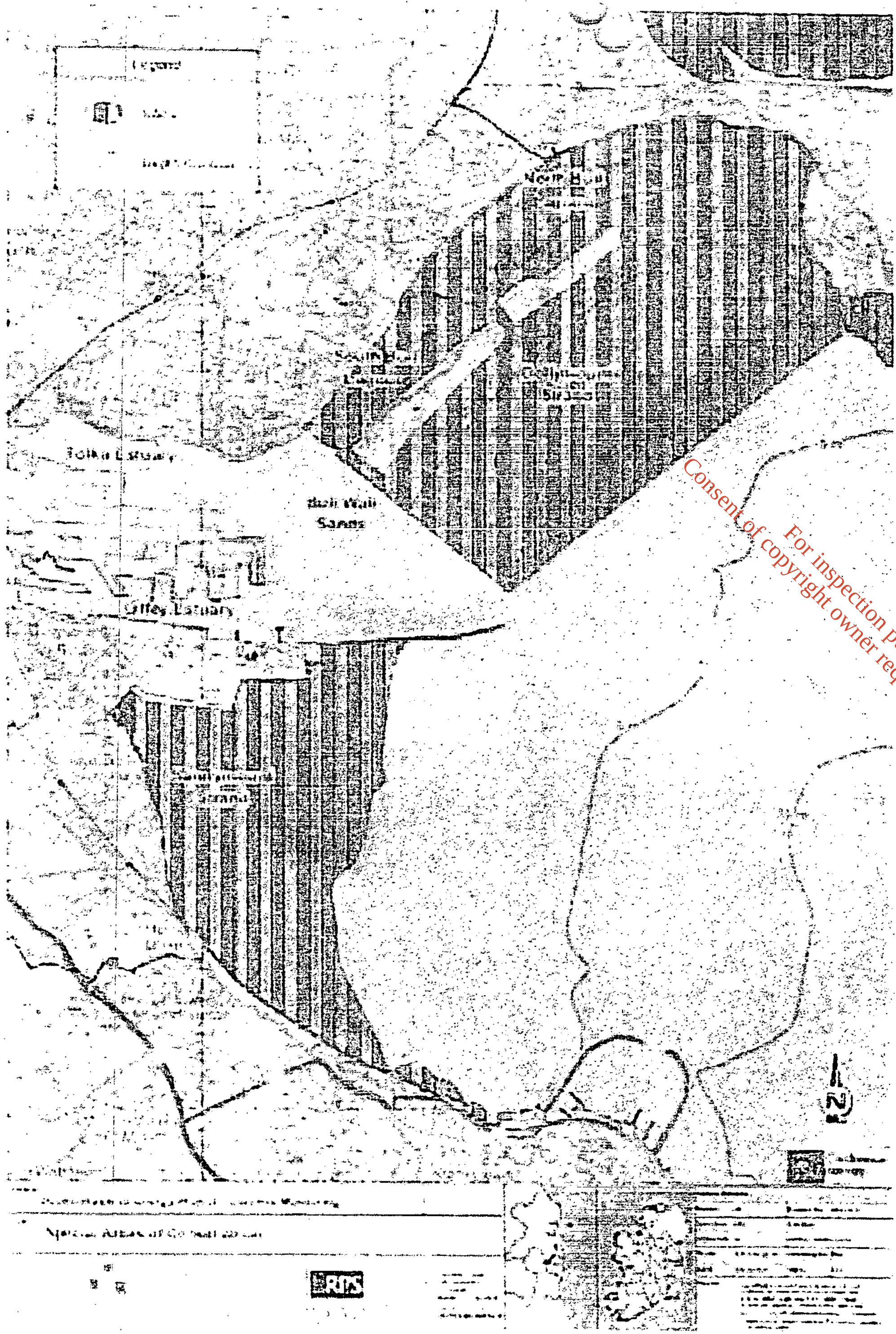

Figure 1. Special Areas of Conservation (SACs) in Dublin Bay: North Dublin Bay, Site Code 206 South Dublin Bay , Site Code 210

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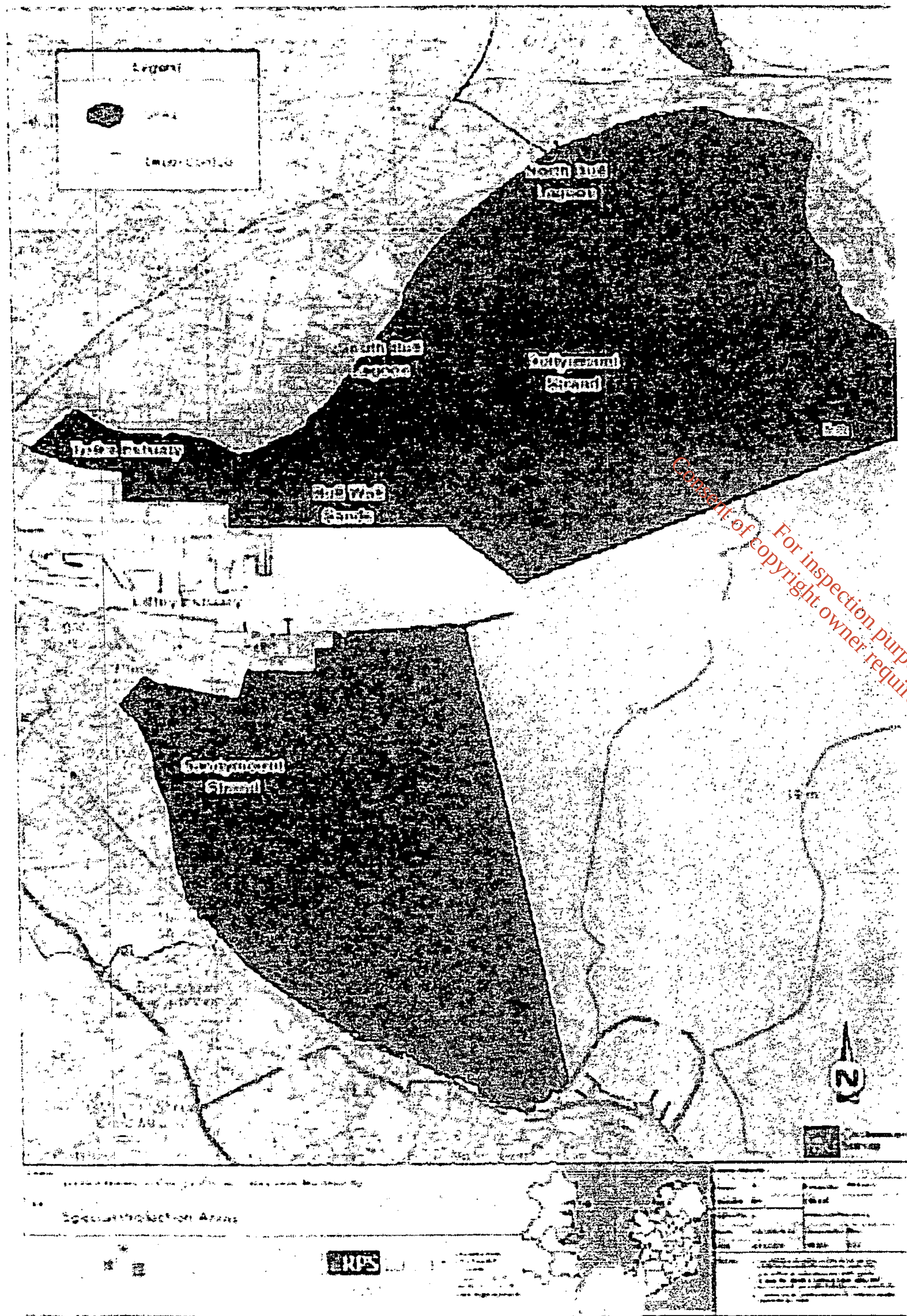

Figure 2. Special Protection Areas (SPAs) in Dublin Bay: Sandymount Strand/Tolka Estuary, Site Code 4024 North Bull Island, Site Code 4006

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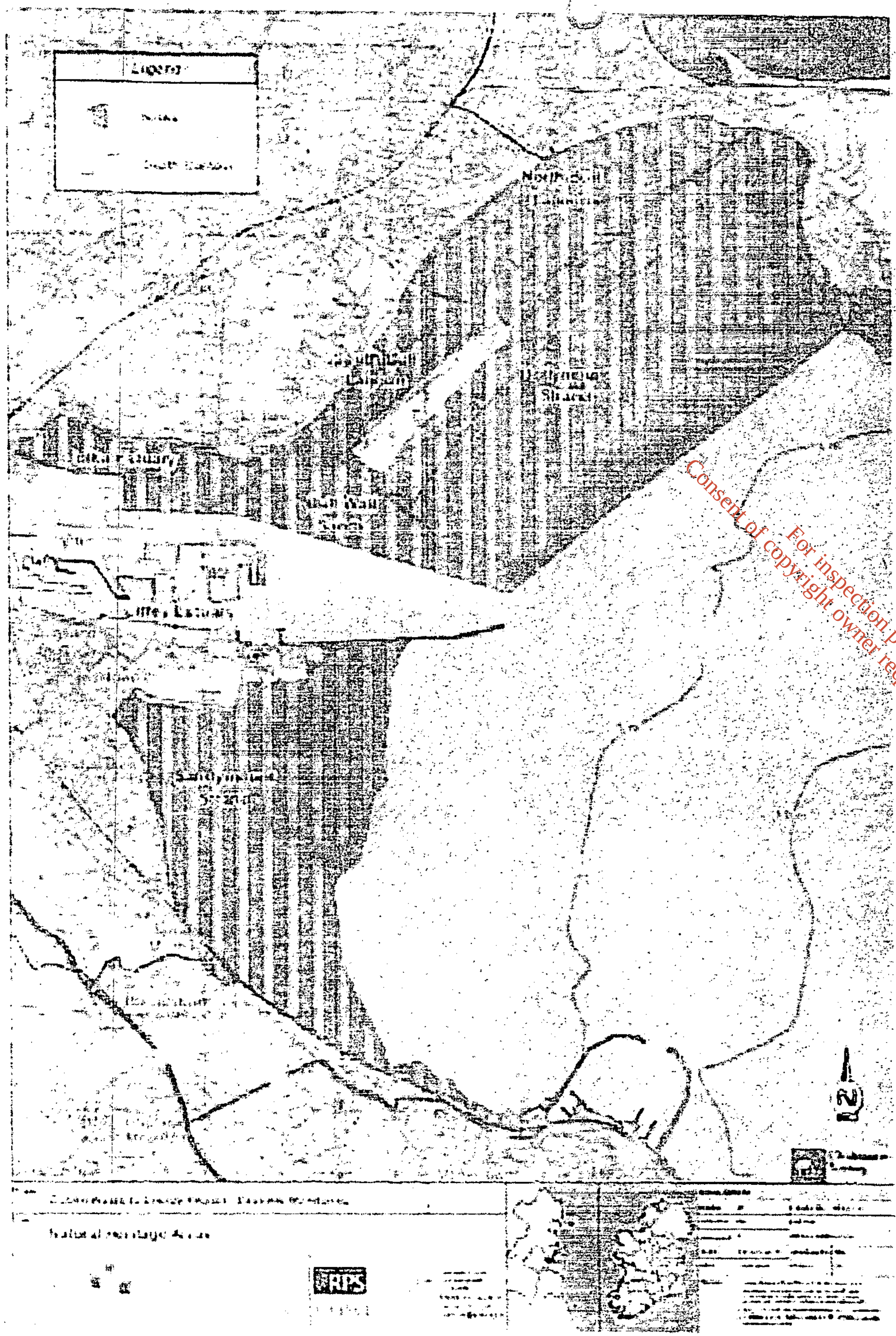

Figure 3. Proposed Natural Heritage Areas in Dublin Bay.

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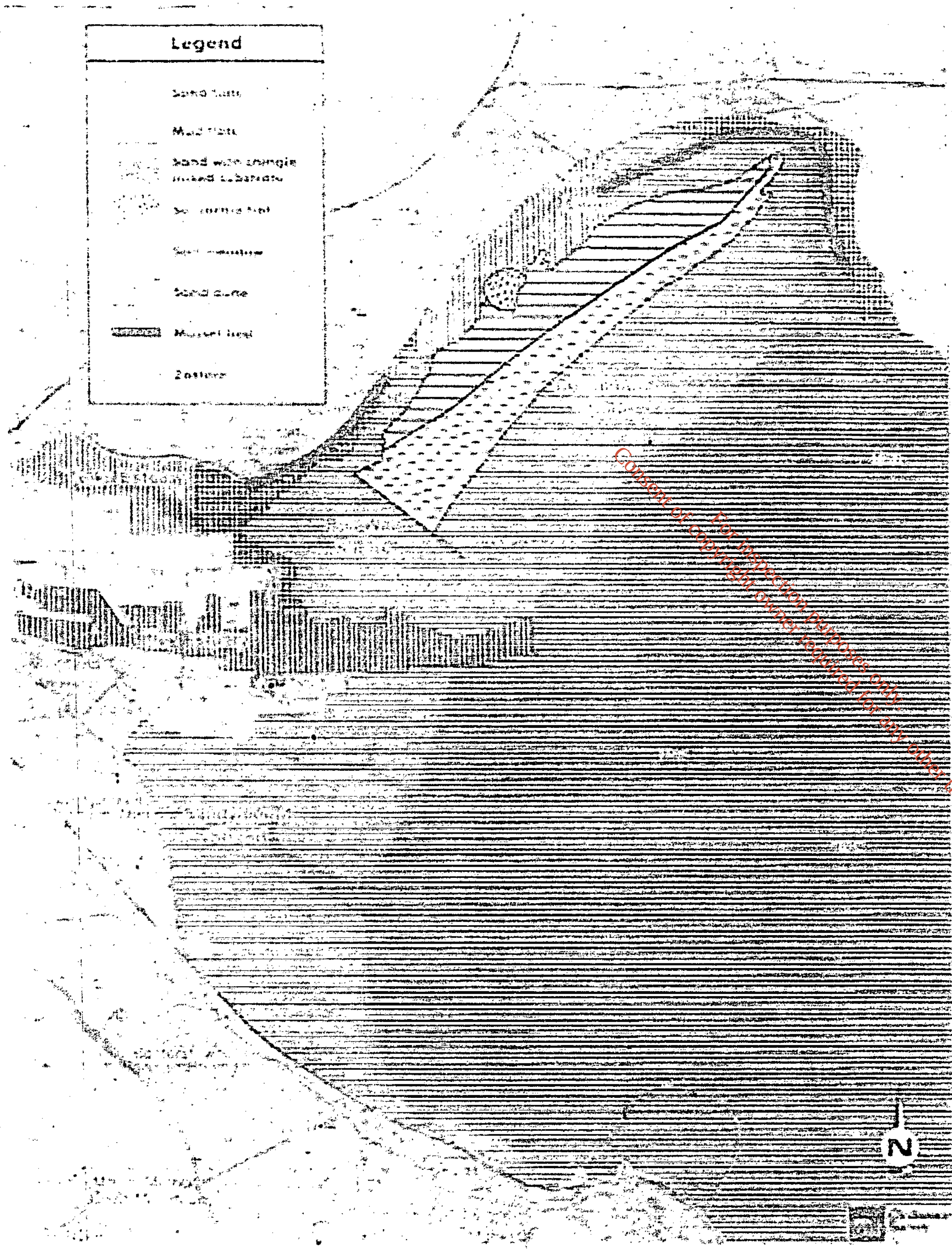

Figure 4. Overview of sediment types and habitats in Dublin Bay.

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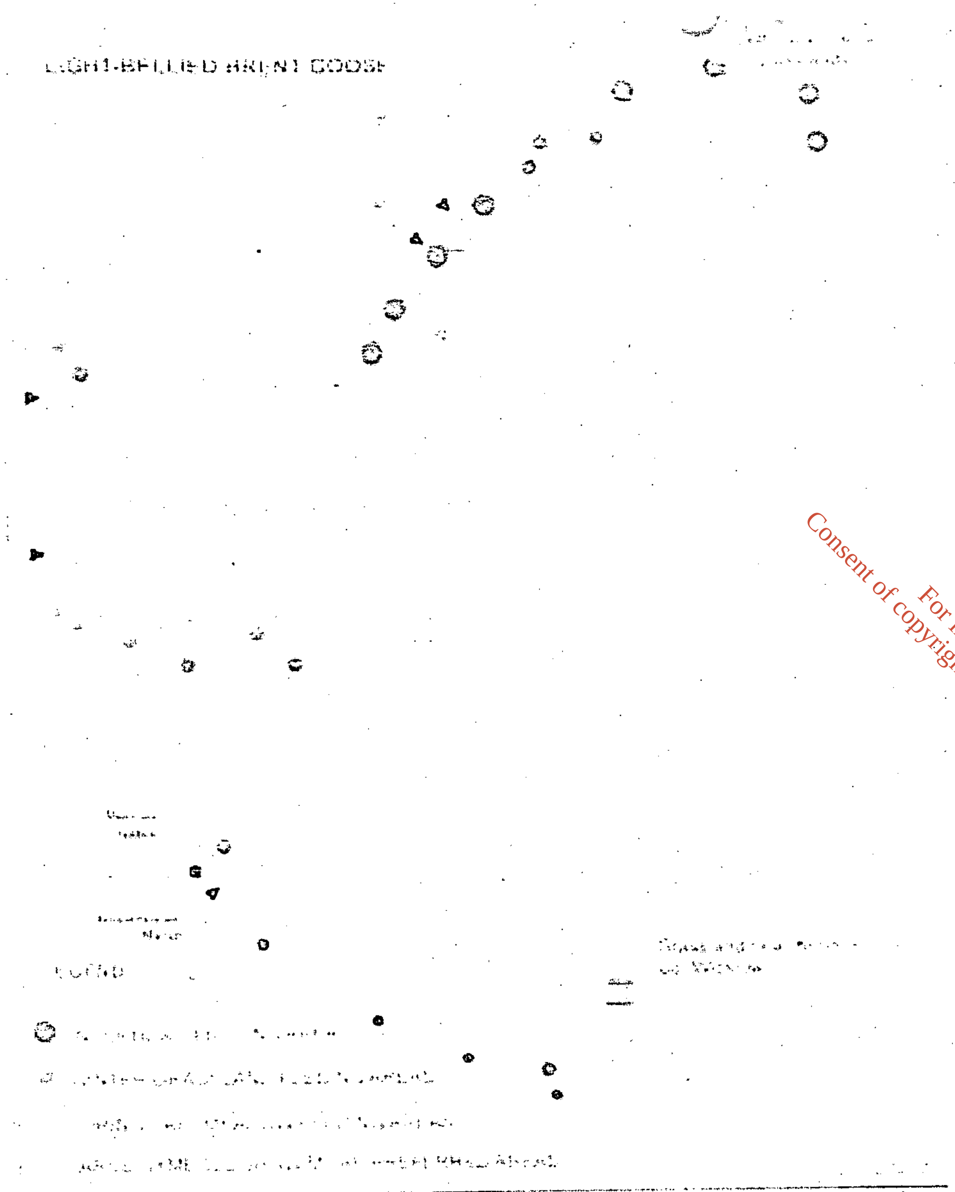

Figure 5. Brent goose distribution and population trend.

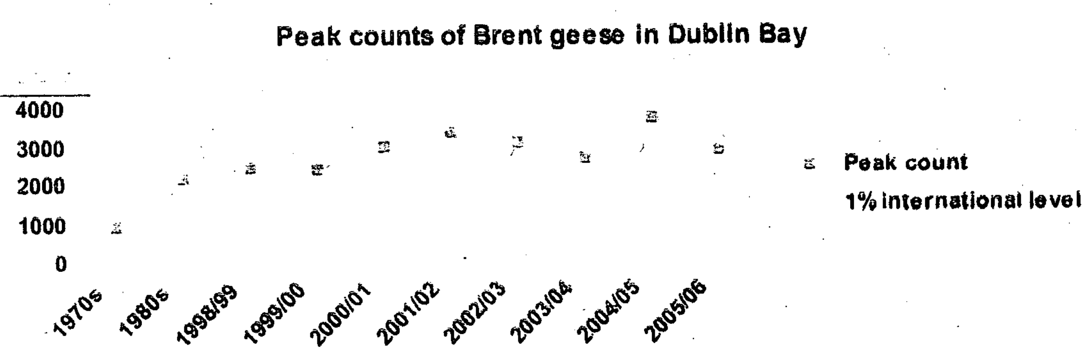

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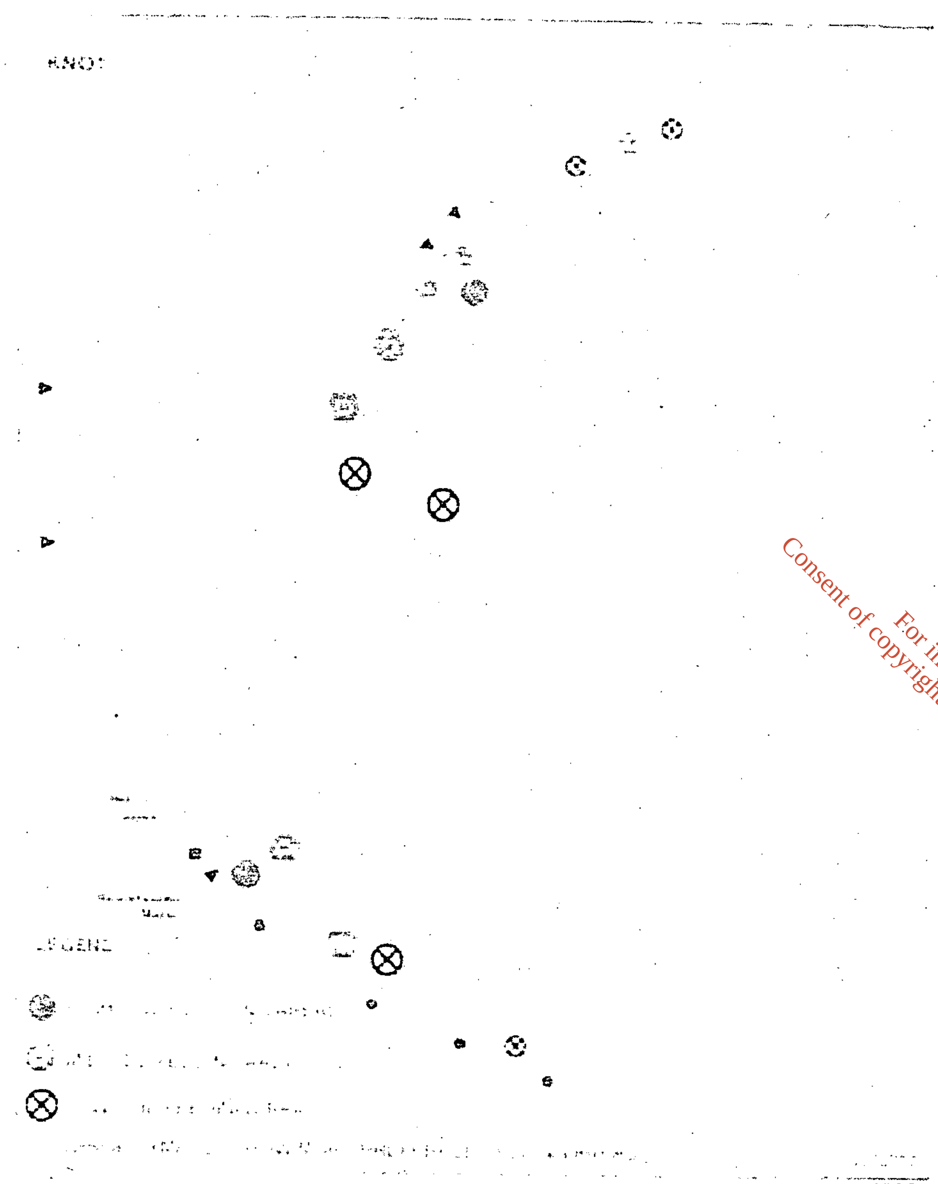
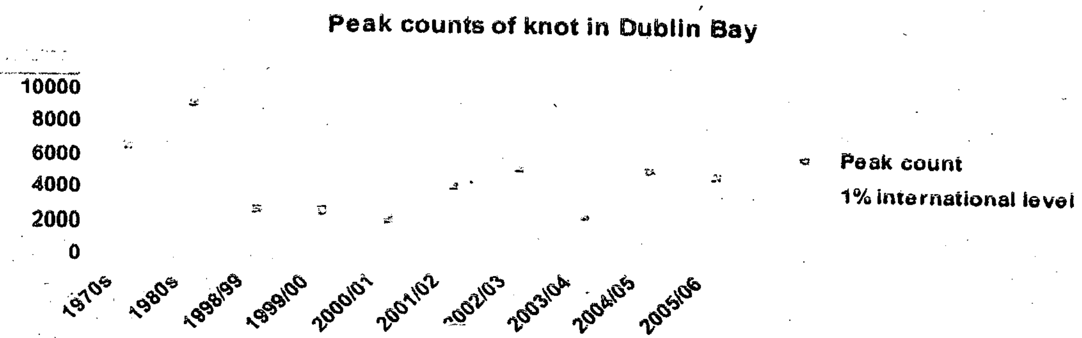
Figure 6. Knot distribution and population trend.





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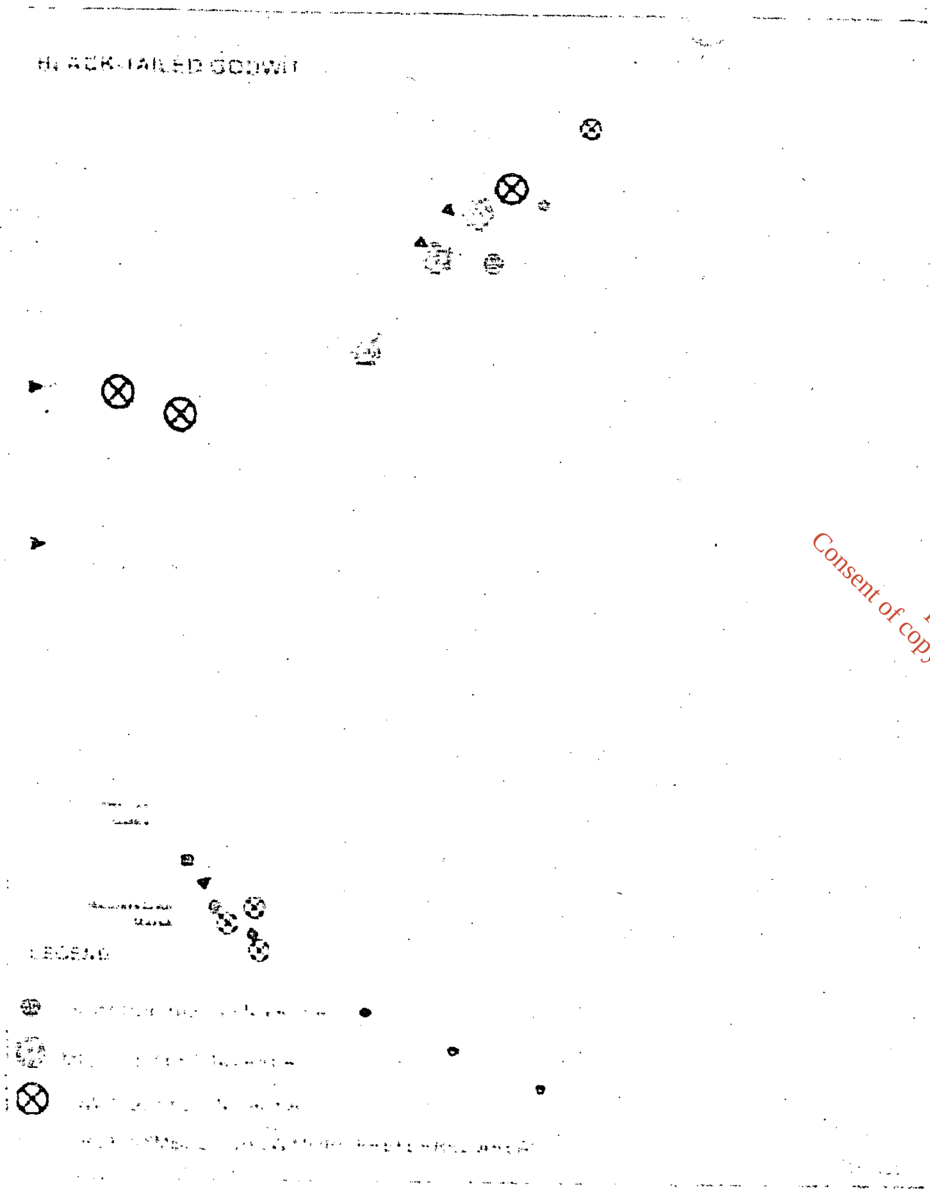

Figure 7. Black-tailed godwit distribution and population trend.

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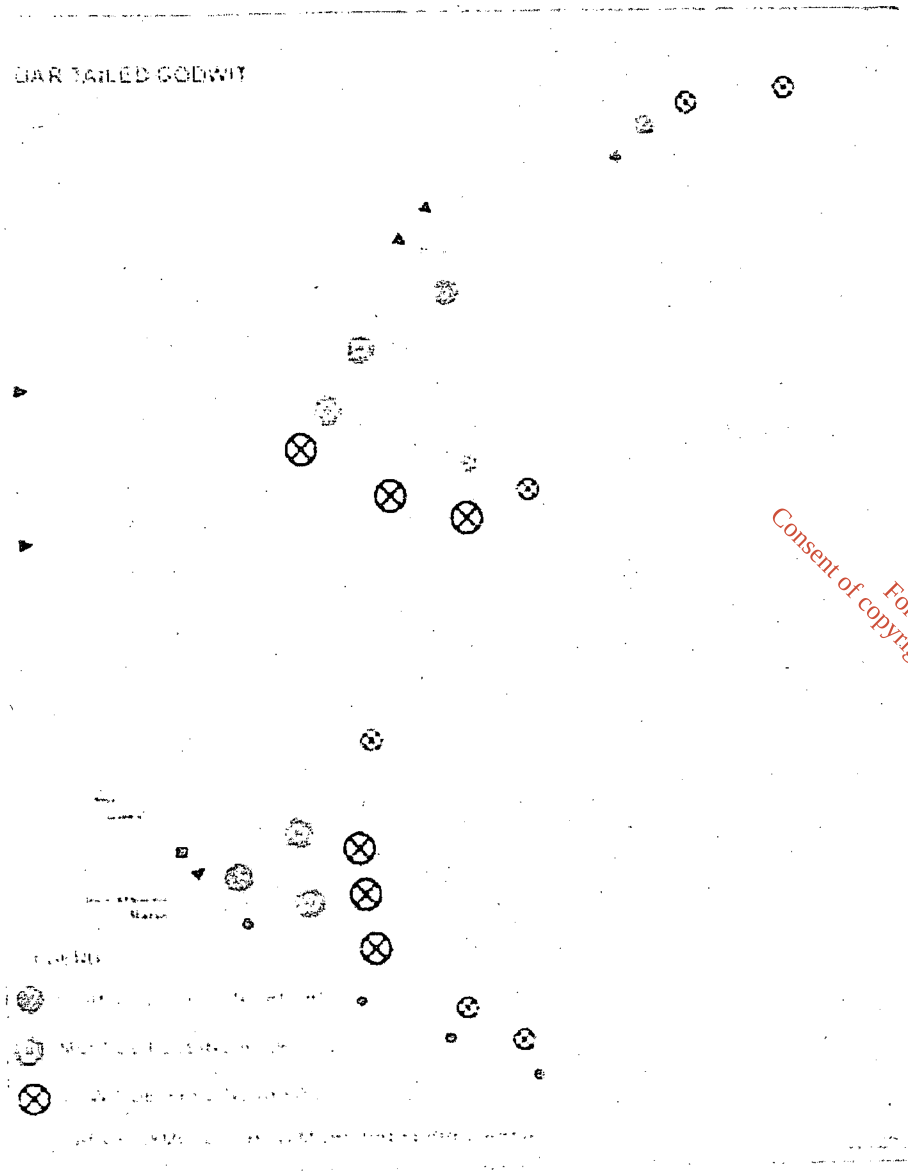

Figure 8. Bar-tailed godwit distribution and population trend.

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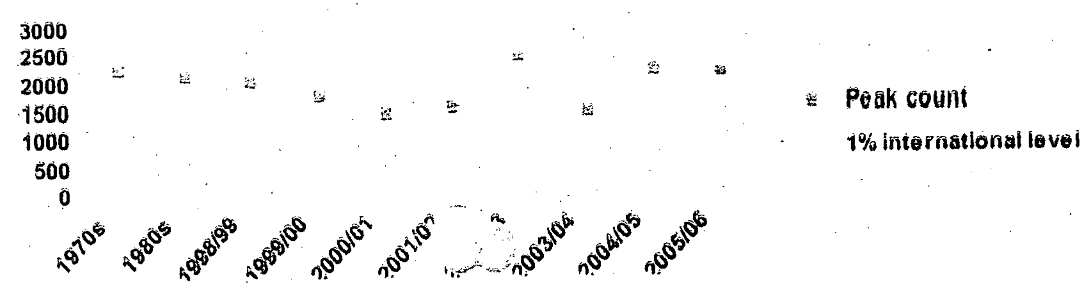
Peak counts of bar-tailed godwit in Dublin Bay



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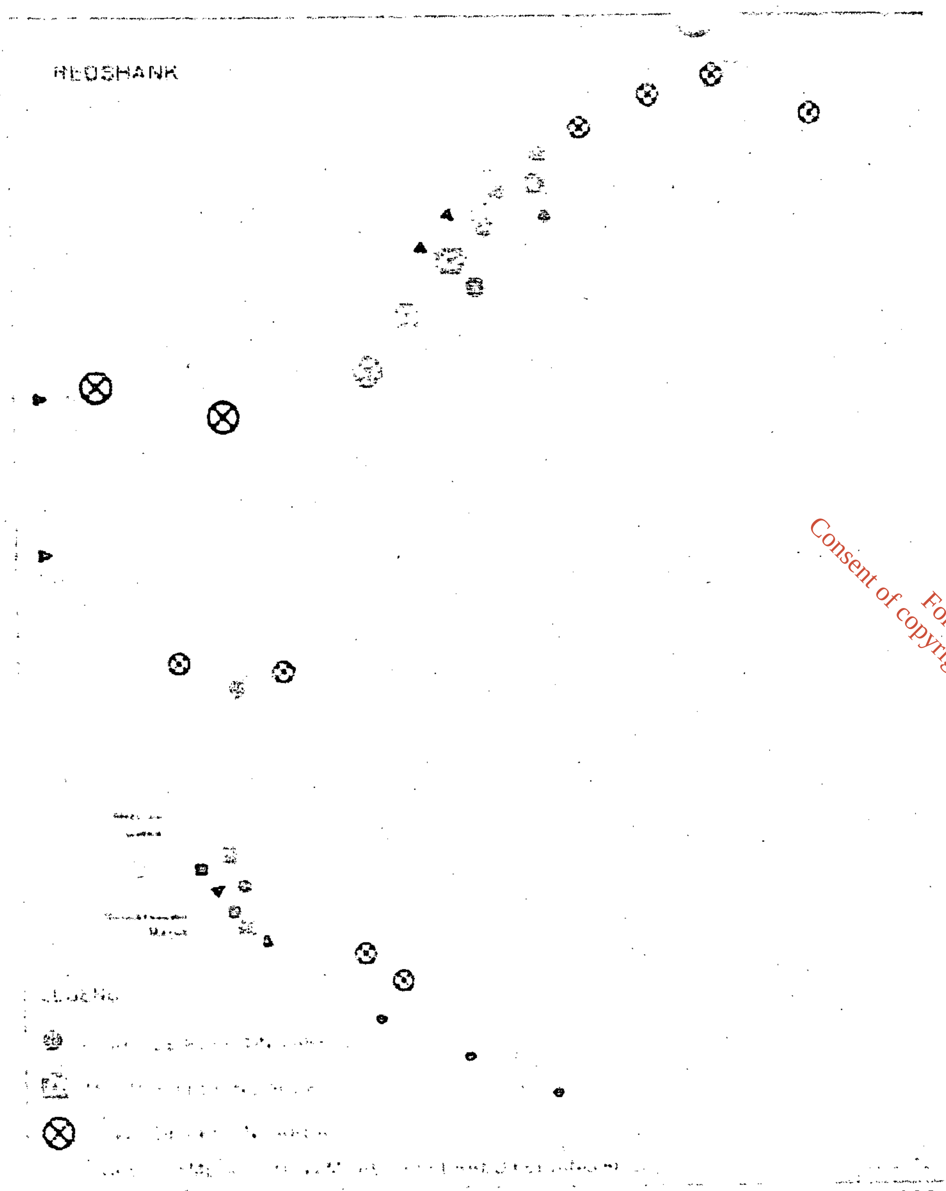

Figure 9. Redshank distribution and population trend.

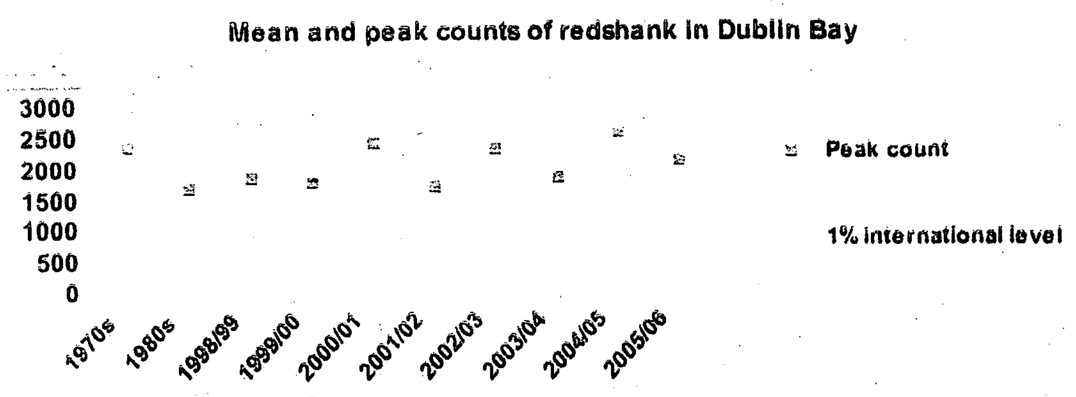

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**Figure 10.
Proposed revised layout of the temporary construction area, with 20m setback from the replacement grassland.**

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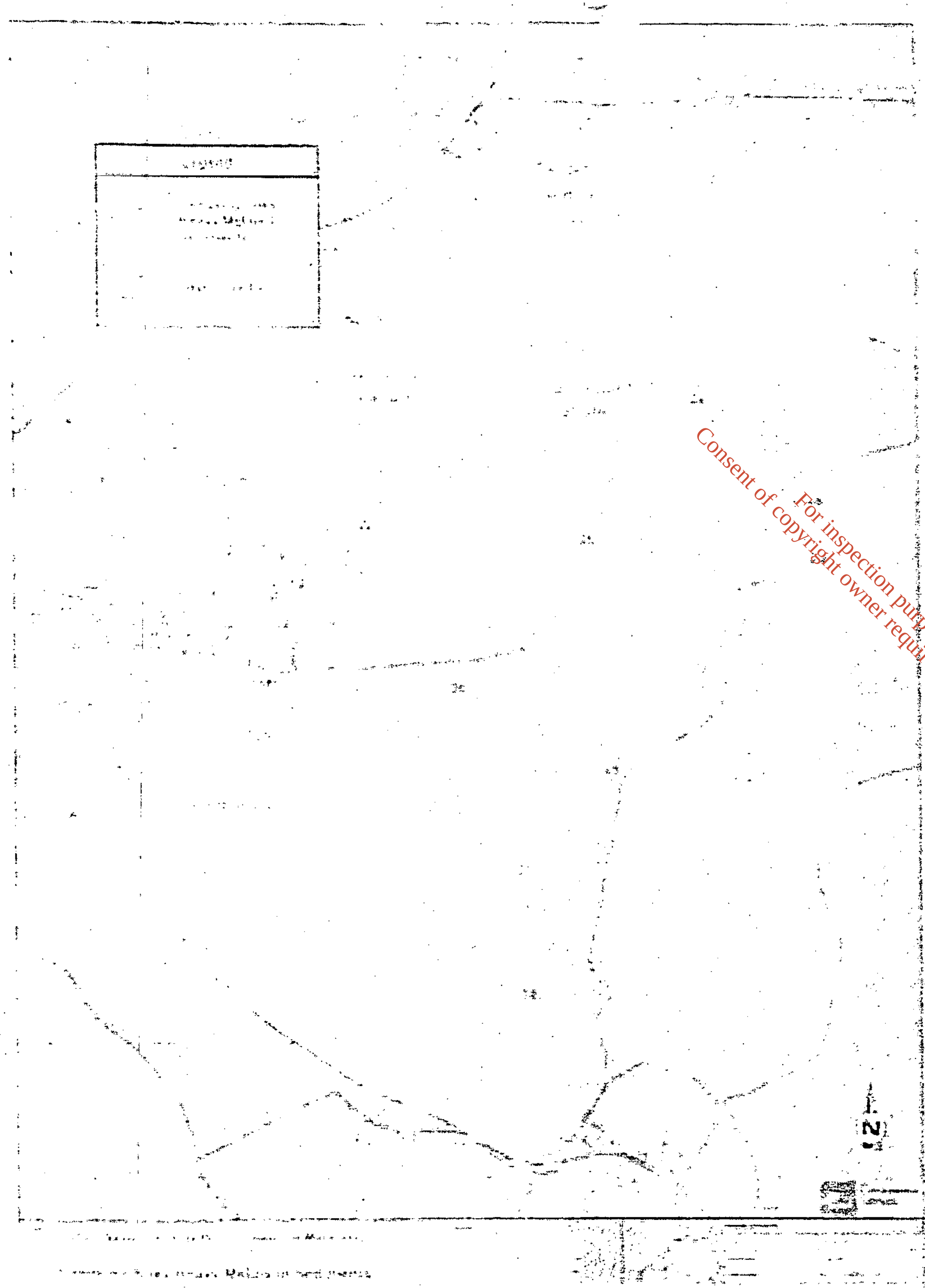

Figure 11. Inter-tidal sediment monitoring programme sites, 2007.

Note that the red squares indicate the sample sites 4, 5, 6, 7, 12, and 13, for which Dioxin/Furan results are presented in this Brief of Evidence. Laboratory results are still awaited for the remaining 11 sites, indicated by white squares. The base map is taken from the Baseline Monitoring Report for the Dublin Waste to Energy Project, Volume 1, Chapter 3, which reports heavy metal results for the sites indicated by yellow circles.

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AN BORD PLEANALA ORAL HEARING INTO THE

DUBLIN WASTE TO ENERGY FACILITY

REPORT

PCDD/F CONCENTRATION IN SEDIMENT

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DR FERGAL CALLAGHAN

AWN CONSULTING

24 April 2007

E-mail: awn.info@awnconsulting.com Website: www.awnconsulting.com

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1.0 QUALIFICATIONS AND EXPERIENCE

1.1 I hold a 2.1 honours degree of Bachelor of Science in Chemistry (1991) from the University of Limerick, where I majored in Environmental Chemistry and a Ph.D. in Chemical Engineering from the University of Birmingham (1998), where I specialised in the Chemistry and Degradation of waste materials. I am a Member of the UK Dioxin Network, an associate member of the Institute of Chemical Engineers (AMIChemE), a graduate member of the Chartered Institute of Water and Environmental Management, a member of the IChemE Environmental Protection Subject Group (EPSG), a member of the IChemE Loss Prevention and Safety Group and a Member of the Institute of Environmental Management and Assessment (IEMA) and have been appointed to the Irish Committee of this Organisation. It is a requirement of membership of these organisations that I am active in the field of professional chemistry and environmental assessment and satisfy their requirements with regard to level of qualifications and experience.

1.2 I have been active in the field of chemistry and environmental assessment for 16 years, the last 10 as an Environmental Consultant. I have considerable experience with respect to the analysis and behaviour of chemicals in the environment, and have monitored and modelled the behaviour of many man made chemicals on green field and brown field sites. I have conducted soil PCDD/F sampling studies in both urban and rural environments, in Ireland and the UK, for private developers and Local Authorities, and have modelled PCDD/F exposure for PCDD/F uptake and movement in the environment, in the UK and Ireland. I worked for many years in the UK where I designed and implemented soil contaminant monitoring programmes for the UK (Environment Agency) EA and private companies, and constructed mathematical models of contaminated sites to determine impacts on soil, water and human beings, through multiple exposure pathways. I have represented major brown field developers and Government Agencies developing brown field sites, in the UK and put together models and contaminant assessment strategies for PCDD/F, PAH, heavy metals and other contaminants, which have been accepted by the UK EA, as part of planning and licensing submissions. I have prepared soil quality assessments and modelled contaminant behaviour on development sites in Ireland and successfully presented these assessments to An Bord Pleanala and the EPA.

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1.3 I am currently Director with responsibility for Soil Quality with AWN Consulting.

Recent Soil PCDD/F Project Experience

- Carranstown Waste-to-Energy Plant An Bord Pleanala Oral Hearing (2007)
- Ringaskiddy Waste-to-Energy Plant Waste Licence & Oral Hearing (2005)
- Carranstown Waste-to-Energy Plant Waste Licence & Oral Hearing (2005)
- MBM Waste-to-Energy Plant EIS (2003)
- Liquid Waste Incinerator EIS, Cork (2003)

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- Courtlough Waste-to-Energy Plant EIS (2002)

Other Soil Chemistry Assessment Project Experience

- Dublin Port Tunnel (2006)
- Metro North (2007)
- Dublin North Fringe Project (2006)
- Wyeth Expansion (2004)
- Dublin S2S (2004/2005)
- Alza Pharmaceuticals EIS (2001)
- Analog Devices IPC Licence Review (2001).
- Clifden Airstrip EIS & Oral Hearing (2000))
- Heuston Office & Technology Park EIS & Oral Hearing (2002)

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2.0 INTRODUCTION

2.1 AWN Consulting Limited was commissioned by Dublin City Council to conduct a detailed appraisal of the potential impact on PCDD/F in sediment in Dublin Bay associated with the proposed Dublin Waste to Energy facility. PCDD/F will be used as the term to describe dioxins and furans, the 17 dioxin and furan congeners which are considered to be of toxicological significance are commonly referred to as dioxins, although these 17 congeners comprise 7 dioxin congeners and 10 furan congeners. Dioxins and furans are chemically very similar compounds, with furans having one less oxygen atom than dioxins, in their chemical structure.

2.2 Sediment PCDD/F quality data was assessed by means of a baseline sampling.

2.3 Available published guidance documents which are relevant to assessing PCDD/F in sediment were consulted.

2.4 The impact of the proposed Dublin Waste To Energy Facility on PCDD/F in sediment was assessed. The assessment was carried out using USEPA modelling methodology.

2.5 The impact of PCDD/F emissions on PCDD/F sediment concentrations was compared with relevant standards and guidance.

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3.0 ASSESSMENT APPROACH

3.1 The approach adopted for the PCDD/F intake assessment firstly involved a detailed consideration of the available published guidance documents and Directives which are relevant to assessing the PCDD/F intake impacts from an incineration facility. The key documents consulted in the assessment were:

- Council Directive 2000/76/EC (The Incineration Directive)
- Human Health And Ecological Risk Assessment Support To The Development Of Technical Standards For Emissions From Combustion Units Burning Hazardous Waste, EPA Contract No. 68 - W6 – 0053, US EPA, Washington, July 1999USEPA
- Proposed Environmental Quality Guidelines for Dioxins and Furans in Water and Sediments, UK EA 2004

3.2 The modelling approach, as per USEPA modelling techniques was:

3.2.1 Determine baseline concentrations;

3.2.2 Use US EPA Model for determining soil PCDD/F concentrations to predict impact of proposed facility and compare with limit values

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4.0 BASELINE ASSESSMENT

4.1 Information on current (baseline) sediment PCDD/F concentrations in the vicinity of the proposed WTE facility was obtained from a monitoring survey conducted in the region of the site of the proposed facility.

4.2 AWN Consulting Ltd, in co-operation with Ms Eleanor Mayes, Ecological Consultant and EcoServe, carried out a programme of background sediment sampling and monitoring. A total of 17 no. sampling locations were chosen by Ms Mayes and the rationale for selecting sampling sites is presented in her Brief of Evidence.

4.3 6 no. sample sites were chosen by Ms Mayes as being the priority for initial sampling and analysis and these were sampled first and the samples sent to the laboratory, the remaining 11 no. sites have since been sampled and are currently being analysed in the laboratory. The full suite of data will be available to the Environmental Protection Agency for the purpose of the waste licence application. The sampling locations are shown on Figure 4.1 and described in Table 4.1.

4.4 Sampling was conducted by marking out an area of 100m x 100m and taking 20 core samples using a 3" diameter core, operating to a depth of 14cm (the depth specified by Ms Mayes). Samples were combined in a clean container and thoroughly mixed and then transferred to a previously cleaned sample jar supplied by SAL Laboratories, the UKAS accredited laboratory which conducted the analysis of the samples.

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Sediment Sampling Point	Sampling Point Location	Sampling Date
4	Sandymount Strand	21st March 2007
5	Along southern boundary of South Bull Wall	21st March 2007
6	Mud bank to the north of the Shipping Channel	20th March 2007
7	Tolka Estuary near Alfie Byrne Rd	20th March 2007
12	South of the Causeway onto Bull Island	21st March 2007
13	North of the Causeway onto Bull Island	21st March 2007

Table 4.1 Location of Sampling Points

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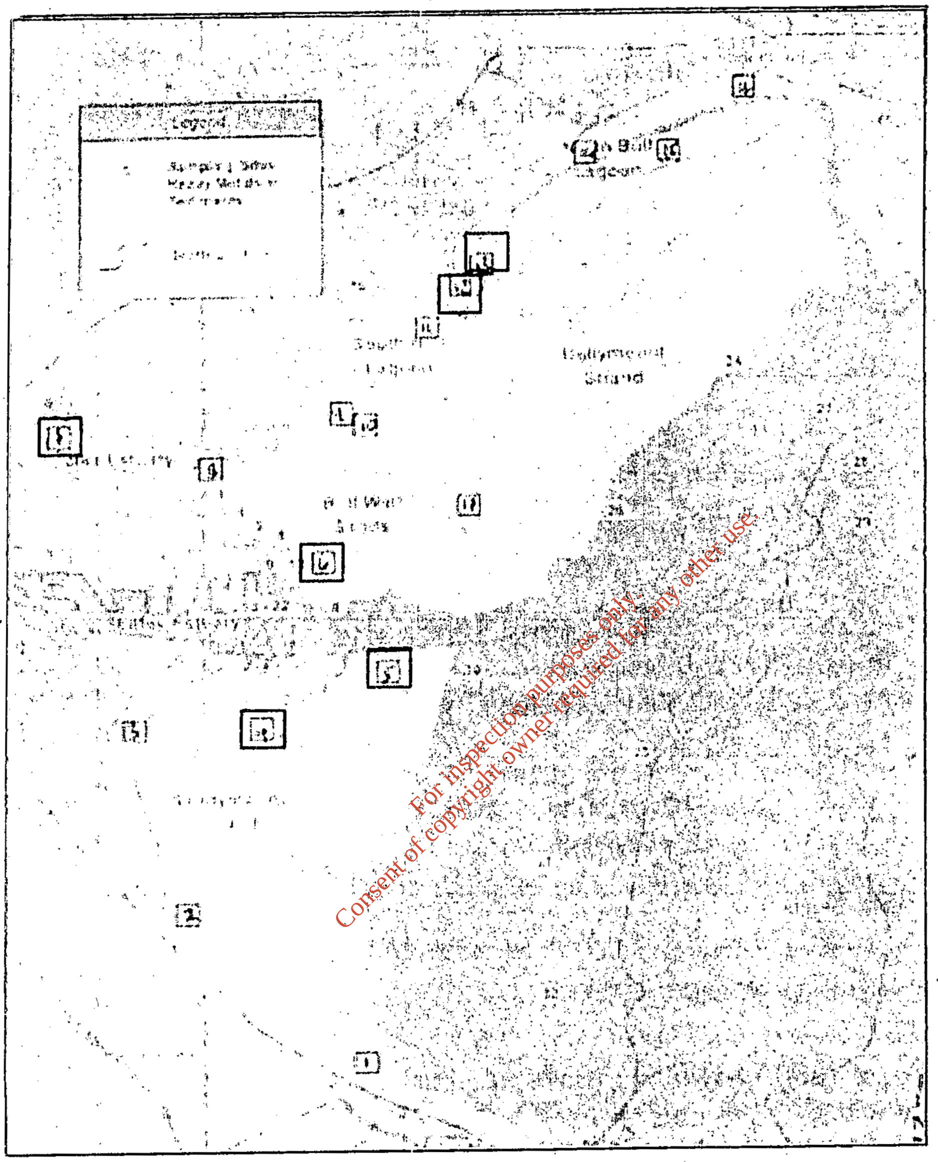

Figure 4.1 PCDD/F sampling locations in sediment

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Sediment Sampling Point	Sampling Point Location	PCDD/F TEQ (ng/kg) [1]	PCDD/F I-TEQ (ng/kg) [2]
4	Sandymount Strand	< 0.5	<0.5
5	Along southern boundary of South Bull Wall	<0.5	<0.5
6	Area to the north of the Shipping Channel	<0.5	<0.5
7	Tolka Estuary near Alfie Byrne Rd	4.9	5.6
12	North of the Causeway onto Bull Island	0.7	0.9
13	South of the Causeway onto Bull Island	2.4	2.7

Table 4.2 Analysis results

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1 TEQ derived using Ecotoxicological TEFs as per UK EA 2004

2 TEQ derived using NATO/CCMS TEFs

4.5 The dioxin results are shown in Table 4.2. Results are presented using TEFs for ecotoxicological assessment, as presented by the UK Environment Agency in 2004, to allow comparison with UK EA standards, and as NATO CCMS TEQ to allow comparison with the recorded concentrations at other sites, as listed in the sections on the following page. The highest PCDD/F value recorded (TEQ OF 4.9 ng/kg) was for the sample from the Tolka Estuary and 3 of the samples (4, 5 and 6) showed PCDD/F concentrations below the limit of detection of 0.5 ng/kg. (These samples had recorded concentrations of 0.019, 0.089 and 0.332 ng/kg respectively, but the laboratory's accreditation requires that they record a TEQ below 0.5 ng/kg as a "less than the limit of detection" value)

4.6 There are currently no standards for dioxin concentration in sediment and reference was therefore made to the UK Proposed Environmental Quality Guidelines for Dioxins and Furans in Water and Sediments, published by the UK EA in 2004. The Guidelines use the concept of using a 2000 ng/kg as a TEQ x fraction of organic carbon to determine the appropriate limit

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value. The PCDD/F limit values derived for the samples listed in Table 4.2 are presented in Table 4.3.

Sample	% Organic Carbon	Dioxin Limit	Dioxin Conc.
		ng/kg TEQ	ng/kg TEQ
		(% Org C x 2000)	ecotox TEF
4	0.1	2	<0.5
5	0.2	4	<0.5
6	0.3	6	<0.5
7	1.9	38	4.9
12	0.4	8	0.7
13	0.6	12	2.4

Table 4.3 Limit Values derived for Samples Analysed

Note that samples 4,5,6 had measured concentrations of 0.019, 0.089 and 0.332 ng/kg respectively but that the PCDD/F limit was calculated using an assumed concentration of 0.5 ng/kg, which is the limit of detection of the assay

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4.7 It can be seen from Table 4.3 that even using this very conservative calculation approach, and using TEFs published by the UK EA for ecotoxicological assessments, the measured concentrations are well below the relevant limit values for PCDD/F in sediment.

4.8 It is useful to compare the measured data with recorded data for other countries. Rose et al, in their study of UK river sediments in 1994 noted that concentrations varied between 1.99 and 122 ng/kg TEQ in a study of 36 different rivers, with only 10 out of 36 samples having a concentration less than 10 ng/kg TEQ (from Rose, McKay and Ambridge, NRA R&D Note 242, UK NRA 1994).

4.9 The OSPAR Commission (the Convention for the Protection of the Marine Environment of the North East Atlantic) published a comprehensive review of dioxins in the marine environment in 2005 (ref. Hazardous Substances Series "Dioxins", OSPAR, 2005). The review notes that recorded marine sediment levels in unpolluted fjords in Norway were up to 12 ng/kg TEQ, with harbour sediments having concentrations of 20 – 40 nk/kg TEQ and heavily polluted fjords had sediment concentrations of up to 60,000 ng/kg TEQ.

4.10 Background levels of 1 ng/kg or less were recorded for samples taken in the Barents Sea, and this was taken by the review as being the background concentration in natural sediment. The report also notes that storm water sediment from a study in Germany had concentrations of between 10 and 29 ng/kg TEQ and that harbour sediments in Hamburg had concentrations of up to 1500 ng/kg TEQ.

4.11 In summary, it can be concluded that, based on the samples analysed, the recorded concentrations in Dublin Bay are low and are close to what is termed natural background and are well below any limit values.

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5.0 MODELLING ASSESSMENT

5.1 Modelling Approach

In order to model the potential impact of the emission on sediment PCDD/f concentrations, reference was made to the model used in the US EPA document "Human Health And Ecological Risk Assessment Support To The Development Of Technical Standards For Emissions From Combustion Units Burning Hazardous Waste, EPA Contract No. 68 - W6 – 0053, US EPA, Washington, July 1999USEPA".

This model is used to predict the possible increase in soil PCDD/F concentrations due to the deposition of PCDD/F, and its use is conservative in this instance, as it does not have an algorithm for calculation the possible removal of PCDD/F from the effected area by tidal action and scouring. The model also assumes that the affected area is open to the atmosphere 24 hours per day, 7 days per week, whereas in actuality, the affected areas are covered by the tide for a portion of each day, the extent of that portion being determined by the tidal cycle at that particular time.

5.2 Maximum Deposition Rate of PCDD/F from WTE Emissions and Calculation of Predicted Soil and Air Concentrations

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PCDD/F deposition flux from the proposed facility was modelled by AWN Consulting and presented in the EIS and this data has been used in the following assessment.

5.3 Modelling of Impact of WTE Emissions on PCDD/F Intake

Sampling site 5, which was located along the southern boundary of the South Bull Wall, is in the vicinity of the maximum predicted deposition rate from the proposed facility and was therefore chosen as the site for modelling of the impacts. The current background, theoretical predicted increase in sediment concentrations and estimated likely increase in sediment concentrations are shown in Table 5.1.

5.4 Interpretation of Results

The modelled results shown in Table 5.1 show a predicted increase in sediment PCDD/F concentration from 0.0848 ng/kg as a baseline TEQ to 0.1071 ng/kg, over a 30 year period operating life of the facility. This theoretical increase is likely to be overly conservative as it does not take into account the impact of sediment transport and removal from the area by tides, with associated dioxin removal. Given that sources of all 17 PCDD/F congeners are present in soils in Dublin City coastal area (as baseline terrestrial soil samples showed the presence of all congeners of all 17 congeners) and yet only OCDD, 1,2,3,4,7,8-HxCDF, 2,3,4,6,7,8-HpCDF, 1,2,3,4,6,7,8-HpCDF were measured in the sediment sample taken from sampling location 5, it could be argued that only these congeners will remain bound to the sediment in that area and that other congeners will tend to be removed by transport of sediment fractions and the likely longer term increase is shown in the column titled "estimated" which shows the predicted increases in the congeners already noted as being present in the sediment.

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The likely predicted increase is therefore likely to be from a background of 0.0848 ng/kg TEQ to 0.0898 ng/kg TEQ, an insignificant increase. It should also be noted that even the greater increase to 0.1071 is well below the limit value of 2 ng/kg and the natural baseline value of 1 ng/kg as noted by OSPAR.

	Background ng/kg	Predicted ng/kg	TEF	Background TEQ ng/kg	Predicted TEQ ng/kg	Predicted TEQ ng/kg Estimated
2,3,7,8-TCDD	0.000	0.000	1	0	0.0003844	0
1,2,3,7,8-PeCDD	0.000	0.009	0.73	0	0.0065076	0
1,2,3,6,7,8-HxCDD	0.000	0.013	0.024	0	0.000317	0
1,2,3,4,7,8-HcCDD	0.000	0.006	0.319	0	0.0018187	0
1,2,3,7,8,9-HxCDD	0.000	0.008	0.1	0	0.0007937	0
1,2,3,4,6,7,8-HpCDD	0.000	0.012	0.002	0	2.369E-05	0
OCDD	6.600	6.602	0.001	0.0066	0.0066018	0.0066018
2,3,7,8-TCDF	0.000	0.002	0.028	0	5.274E-05	0
1,2,3,7,8-PeCDF	0.000	0.001	0.024	0	1.291E-05	0
2,3,4,7,8-PeCDF	0.000	0.018	0.359	0	0.00662	0
1,2,3,4,7,8-HxCDF	0.140	0.152	0.28	0.0392	0.0425458	0.0425458
1,2,3,6,7,8 HxCDF	0.000	0.006	0.1	0	0.0006052	0
2,3,4,6,7,8-HpCDF	0.300	0.316	0.1	0.03	0.0316382	0.0316382
1,2,3,7,8,9-HxCDF	0.000	0.001	0.1	0	9.857E-05	0
1,2,3,4,6,7,8-HpCDF	0.900	0.902	0.01	0.009	0.0090238	0.0090238
1,2,3,4,7,8,9-HpCDF	0.000	0.001	0.01	0	7.313E-06	0
OCDF	0.000	0.001	0.001	0	6.742E-07	0
Total as TEQ				0.0848	0.1071	0.0898

Table 5.1 Background, predicted and estimated predicted sediment PCDD/F concentrations

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