



EPA Landfill Manuals

Manual on Site Selection

Draft for Consultation

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PREFACE

The Environmental Protection Agency was established in 1993 to licence, regulate and control activities for the purpose of protecting the environment. In the Environmental Protection Agency Act 1992 (as amended), it is stated in Section 62 that “*the Agency shall, as soon as practicable, specify and publish criteria and procedures for the selection, management, operation and termination of use of landfill sites for the purpose of environmental protection*”. These criteria and procedures are published in a number of manuals under the general heading of Landfill Manuals. This manual on Site Selection is being published to assist in meeting the statutory obligations of Section 62 of the above-mentioned Act. It is intended to be a nationally adopted manual for use by those involved in the selection of landfill sites.

This obligation to produce best practice guidance reflects a requirement in Article 7(1) of the Waste Framework Directive (2006/12/EC – formerly 75/442/EEC) in respect of Member States having to draw up plans outlining general technical requirements for waste facilities having regard to the BATNIEC (Best Available Technology Not Involving Excessive Cost) principles established in Article 5 of the Directive. In the more recent EU IPPC Directive (96/61/EC) on integrated permitting of large industrial operations (including waste facilities), the concept of best practice had evolved to become Best Available Techniques (BAT). BAT is equivalent in concept and purpose to the earlier EU BATNIEC, and could be considered an evolution or refinement of the earlier principle. The concept of BAT was formally introduced into Irish statute in 2003 (Protection of the Environment Act 2003, which was commenced in summer 2004).

The EPA BAT Guidance Note For The Waste Sector: Landfill Activities (Draft), 2003 forms part of an overall regulatory package for the waste sector. That guidance specifically refers to the EPA Landfill Manual series and other technical guidelines, with key references included in Annex 6 of the note – acknowledging them to be relevant to the concept of BAT.

This Manual on Site Selection should be read in conjunction with the other Manuals in the series, and is to be considered additional guidance informing the definition, and interpretation, of BAT for waste landfill in Ireland. In particular Investigations for Landfills (1995) describes the sequence and extent of investigations required to progress the selection, construction and operation of a landfill site. The requirement to select appropriate sites is also an element of the EIA process. Moreover, in Annex I of the Landfill Directive (1999/31/EC) there are specific requirements detailed in relation to the location of landfills. This guidance addresses both of these requirements.

The purpose of this manual is to provide guidance on the selection of a landfill site and assist those involved in assessing the impact of a landfill on the surrounding environment including those involved in the decision making in respect of such proposals. The site selection process proposed involves consideration of relevant criteria in an integrated, informed and transparent manner. The procedures proposed take account of the relevant statutory requirements at the time of going to print.

Future Irish landfills will be developed, managed, monitored and subjected to aftercare procedures in accordance with the Waste Management Act’s 1996 to 2005; the IPPC Directive, 1996; the Landfill Directive, 1999; and any BAT guidance as may be published for landfills.

An integral part of the proposals contained herein is that there should be a proactive approach to consultation regarding selection of a landfill site. The mechanisms suggested are an outline of those currently available and used by many private and public sector organisations. Communication of accurate and concise information in relation to proposals for a landfill should be one of the primary objectives of its proponents. These guidelines comply with the obligations of the Aarhus Convention (1998) on access to environmental information and participation in decision-making, by providing a publicly available framework for the selection and assessment of landfill proposals.

ACKNOWLEDGEMENTS

The Agency wishes to acknowledge those who contributed to and reviewed this manual.

LIST OF ABBREVIATIONS

Agency	Environmental Protection Agency
BAT	Best Available Techniques
DoEHLG	The Department of the Environment, Heritage & Local Government
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EU	European Union
GSi	Geological Survey of Ireland
GIS	Geographical Information System
ICAO	International Civil Aviation Authority
ICMSA	Irish Creamery Milk Supplier's Association
IFA	Irish Farmer's Association
IPPC	Integrated Pollution Prevention and Control
NHA	Natural Heritage Area
NHWMP	National Hazardous Waste Management Plan
NPWS	National Parks & Wildlife Service
OECD	Organisation for Economic Cooperation and Development
OPW	Office of Public Works
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SPA	Special Protection Area
WHO	World Health Organization

1. SCOPE OF GUIDANCE

1.1 Introduction

There are three broad classes of landfill, each of which represents a distinctively different environmental risk profile, viz,

- Hazardous Waste Landfill;
- Non-Hazardous Waste Landfill; and
- Inert Waste Landfill.

The following guidance is primarily aimed at municipal, industrial and commercial waste landfills falling into the non-hazardous waste landfill category. There is at present no merchant (independent commercial) Hazardous Waste Landfill in the State. In the event that one is proposed the guidance herein may offer some assistance, but for additional screening and selection criteria appropriate to such a facility, consultation with the statutory authorities is advised as is the use of any relevant international best practice (e.g. *Site Selection for New Hazardous Waste Management Facilities*, WHO European Region Publication #46).

The corollary of the above is that for inert waste landfills some of the advice contained herein would be considered too conservative (e.g., in relation to landfill gas risks, odour). There is also the case where certain industrial landfills though not inert, would be considered as mono-fills; where the waste placed in the landfill is of one type (e.g. peat ash from power stations, mining waste, etc.). In these circumstances the risks presented by the landfill do not fit into the norm and this must be factored into the use of this guidance.

Accordingly, the advice herein has certain limitations, and should be interpreted sensibly and proportionate to the environmental risk profile of the facility in question.

In addition it must be understood that the guidance herein is generic in nature; therefore facility proposers and decision makers may be faced with additional site-specific criteria that impact on the choice of facility location. Such criteria are generally identified in the preparation of an Environmental Impact Statement (EIS).

1.2 Best Available Techniques (BAT)

The concept of BAT was formally introduced into Irish statute in 2003 (Protection of the Environment Act 2003, which was commenced in summer 2004).

The EPA BAT Guidance Note For The Waste Sector: Landfill Activities (Draft, 2003) observes that it forms part of an overall regulatory package for the waste sector. The BAT Guidance specifically refers to the EPA Landfill Manual series and other technical guidelines acknowledging them to be relevant to the concept of BAT, with key references included in Appendix 6 of the note. This current Manual on Site Selection should be read in conjunction with the other Manuals in the series, and is to be considered additional guidance informing the definition, and interpretation, of BAT for waste landfill in Ireland.

1.3 European Requirements

The guidance herein is also to be read in conjunction with the site selection advice and requirements set out in a number of EU Directives.

The EU Directive on Assessment of the Effects of Certain Public and Private Projects on the Environment (the EIA Directive, 85/337/EEC as amended) specifies in Annex III part 2, and Annex IV part 2, certain obligations in relation to the location of projects and the consideration of alternatives.

The Landfill Directive (1999/31/EC) also sets out criteria that are relevant to the location of a landfill (Annex 1, part 1).

The EU Directive on Integrated Pollution Prevention and Control (96/61/EC) regulates industrial activities (including large landfills). The directive permits competent authorities when considering an application and the application of BAT, to take into account the technical characteristics of the proposed installation, its geographical location and the local environmental conditions.

Site selection is therefore an important aspect that feeds into EU obligations and the determination/application of BAT. The guidance herein has attempted to capture these EU obligations, however cross-reference to these directives should be undertaken by

landfill developers as part any site selection exercise.

The publication of these site selection guidelines complies with one of the main principles of the 1998 Aarhus Convention (introduced to EU law by the EU Aarhus Regulation 1367-2006), by articulating in a transparent way the framework for the selection and assessment of proposed landfill sites in Ireland.

1.4 Landfills attached to Industrial Facilities

There are certain industrial activities in the State that have associated landfill operations. Examples would include those attached to cement manufacturing plants (quarry waste and reject product); power stations (ash and gypsum landfills); and mining (tailings lagoons and rock dumps). Such industries are generally tied to a particular location (e.g. mines and cement manufactures at or close to source of mineral; power plants close to fuel source or point of import for fuel, or located at critical points in the national electricity distribution grid).

In these circumstances (i.e. ‘tied’ facilities) it may not be possible to select the optimum site for the associated landfill. The guidance herein should be interpreted in light of such constraints. However this is not to be taken as a *carte blanche* for such developments, as even in certain ‘tied’ development, the location of a landfill may be deemed inherently unsuitable under any circumstances.

Where an industry is not technically ‘tied’ to a specific location, then any proposal for an on-site landfill should be subjected to the equivalent locational tests falling to merchant landfills as set out herein.

1.5 Public and Private Landfill Proposals

Landfill developers have the responsibility of finding the optimum location for siting such waste infrastructure. Public Authorities developing a site within their jurisdiction are facilitated by powers to compulsory purchase lands. However private sector operators do not have powers of compulsory purchase and so must locate the best site in an area from those locations that are, or will be, made

available. This has a bearing on the interpretation of the guidance set out herein.

1.6 Historical Landfills

Arising from a European Court of Justice ruling against Ireland in 2005, landfills that were operational after the coming into effect of the Waste Framework Directive (75/442/EEC) (July 1977) and before the commencement of waste licensing under the Waste Management Act 1996 (commenced March 1997) will have to be retrospectively regularised.

In the regularisation of historical landfills regard must be had to the risk posed and the best practicable environmental option for a site. Most if not all of these sites are not engineered to modern standards, which influences the risk profile for the site. However, this increased risk is offset by the age of the waste in many of these facilities (20 years old and more), where degradation processes will be well advanced if not complete. This guidance is only of limited value in the case of historical landfills.

1.7 Illegal Landfills

Illegal landfills include those operational after the relevant commencement date following the introduction of waste licensing in May 1997 and which did not have the benefit of a waste licence.

Resolutions to illegal landfills which involve in the solution some on-site residual disposal component, should at the very least follow the standard regulatory norms and procedures as would apply to a legitimate operator proposing such a facility. To apply any lesser a burden would be disproportionate, and would undermine the value of pursuing legitimate regulatory protocols, and would also undermine the legitimate waste industry (i.e. by promoting the pursuit of retrospective legitimatising). For example, and in the case of illegal sites, site selection protocols have not been followed as would be required of a legitimate facility were it to be proposed for the same area of the illegal facility. These governance short-circuits prevent the community and other social partners from engaging in the conventional manner in the full (and normal) regulatory determination process for a domestic, commercial and industrial waste facility.

Having regard to the general risk profile for illegal landfills, the EPA does not believe that such 'short-circuiting' protects the interests of society, nor does it represent good governance. Thus, such practices cannot be said to adhere to the principle of sustainability.

On the 3 May 2005 the Minister for the Environment, Heritage & Local Government in Circular WIR: 04/05 gave a Policy Direction in relation to illegal waste activity. This specifies that the aim in all cases of illegal waste activity should be addressing the making safe of the site, including the removal of waste where required as a consequence of a risk based assessment, the removal of hazardous waste where it is detected, and the removal of recyclable material if environmentally sustainable.

A key guiding principle is that certain sites should at all times be remediated such as:

- lands proximate to existing or planned residential development or educational facilities, in which case remediation shall require the removal, in the shortest practicable time, of all waste except only where it is shown that an alternative solution provides greater protection to the environment and the health of the local population;
- wetlands;
- Natural Heritage Areas, Candidate Special Areas of Conservation or Special Protection Areas; and
- places of special interest such as high amenity areas.

The Minister's Direction goes further and states that where it is deemed appropriate to leave waste in situ, the holder of the waste shall:

- carry out, or arrange for the carrying out, of a risk assessment to determine the environmental impact, if any, of the waste illegally deposited;
- make application for a permit or licence to the relevant local authority or the Agency which will determine the actions required by the holder to remediate and manage the site into the future;
- comply with any permit or licence so given to ensure that all remediation and management measures determined by that permit or licence are complied with and

that the site poses no identifiable future threat to the environment or human health;

- not be permitted to import greater quantities of material for deposition other than such inert material/soil as may be necessary for site conditioning.

The application of this site selection guidance to illegal landfill (post 1997) is legitimate, reasonable and appropriate. If the site fails one of the site suitability criteria articulated herein, that cannot be mitigated by normal engineering measures, then appropriate enforcement action leading to the removal of the illegal waste is the most sustainable outcome. The application of excessive engineering solutions to offset inappropriate site location is not considered BAT.

1.8 Contaminated Land

There is widespread regeneration and development of former dockland areas and similar brownfield lands within the State. Some of these lands are contaminated and current technological limitations are such that removal of all the contaminated material is not possible or achievable in all circumstances. In such situations the development project usually seeks to encapsulate any residual contamination under or within the development. Some of these solutions are classed as landfill.

The strict application of these site selection guidelines for such projects is not in all cases appropriate or reasonable as the contamination is generally historic and is tied to that location. Judicious application of these guidelines is recommended in such circumstances.

1.9 Key Environmental Principles

There are a number of key principles on which current legislation is based. These are summarised below.

Proximity Principle

Article 5 of the Waste Framework Directive establishes the obligation on Member States to establish a network of disposal operations, for the purposes of becoming self-sufficient. This obligation was articulated as the proximity principle in the 1989 EU Commission Community Waste Strategy and in the revision of that strategy in 1996. In its simplest form,

the principle requires that waste for disposal should be dealt with in one of the nearest appropriate installations. This principle is also reflected in the Basel Convention.

It is accepted that for some waste producing regions/centres, export from that region or centre will remain a necessary option, due perhaps to the non-availability of land because of urbanisation or special designation; or because of the economics of scale will act against the environmentally and economically efficient operation of a dedicated disposal facility close to production; or because of the non-availability of technological alternatives to landfill in a given location.

For instance consider the case for a national hazardous waste landfill. Being such a small country and being modest hazardous waste producers the proximity principle is not best served by examination on a county by county, or necessarily a regional level for such a significant facility: a national perspective is perhaps appropriate.

Therefore the application of the proximity principle in relation to site selection must be reasonable, pragmatic and have regard to factors not necessarily specified herein (e.g., economies of scale). Proximity should be considered a broad aim rather than a defining point.

Precautionary Principle

This principle was enshrined at the 1992 Rio Conference on the Environment and Development. The Rio Declaration states *“in order to protect the environment, the precautionary approach shall be widely applied by States according to their capability. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation”*.

Polluter Pays Principle

This principle has been established since 1975 by the OECD and seeks to allocate the costs of pollution and resource consumption to the polluter and consumer rather than to society at large. Examples of this concept have been incorporated under the EPA Act, 1992 and the Waste Management Act, 1996. Article 10 of the Landfill Directive relates to cost recovery and requires Member States to take measures to ensure that all of the costs involved in the setting up, operation, closure and after-care of

a landfill site shall be covered by the price to be charged by the operator for the disposal of any type of waste in that site.

2. WASTE MANAGEMENT, POLICY AND PLANNING

2.1 Waste Policy

National policy in relation to waste management is based on a hierarchy of principles agreed by the European Union (The EU waste hierarchy). The EU approach is based on a number of key principles:

- waste prevention and reduction at source;
- waste recycling/ recovery;
- energy recovery;
- improving final disposal, monitoring and aftercare;
- provision of an effective waste infrastructure, which is, where possible, close to source.

Significant volumes of waste will continue to arise for disposal notwithstanding the implementation of effective waste prevention, reduction, recycling and recovery strategies. This applies particularly in relation to household and municipal wastes. The EU Commission¹ states that where possible, waste that cannot be recycled or reused should be safely incinerated, with landfill only used as a last resort.

Thermal treatment of non-recoverable waste streams with energy recovery is, where available, a preferred waste management solution over direct landfill. This technology will not eliminate the need for landfill but will, amongst other benefits, reduce the capacity required and the long-term pollution potential of the facility.

¹See: <http://ec.europa.eu/environment/waste/index.htm>

In April 2004 the Government produced their latest policy statement on waste management: *Waste Management – Taking Stock and Moving Forward*. It outlines policy objectives in relation to waste management, and suggests some key issues and considerations that must be addressed in order to achieve these objectives. In particular, it identifies:-

- that inter-regional waste movement needs to be catered for in waste planning;
- the need for a national waste prevention programme, and more awareness and communication programmes;
- that integrated waste management solutions are key to delivering national waste management objectives;
- the need to monitor for anti-competitive practices;
- the need for better regulation, and more enforcement particularly in relation to unauthorised activities;
- the need to keep waste plans updated and in line with national waste statistics;
- the need to implement a national biodegradable waste strategy;
- the need for seed capital for recovery initiatives;
- the need for more producer responsibility initiatives;
- that sufficient capacity for landfill of residual waste is a necessary element in the national waste management infrastructure; and
- that thermal treatment of waste with energy recovery has a role to play in the integrated approach to waste management in Ireland.

A number of these objectives (e.g. inter-regional movement of waste, capacity, currency of waste plans, etc.,) have particular relevance for matters of site selection.

Recent Government policies and initiatives (Reduce-Reuse-Recycle, Plastic Bag Levy, Biowaste Strategy, etc.), Local Government actions (recycling infrastructure, pay-by-weight, enforcement, etc.), and EU requirements (e.g., Packaging Directive, WEEE Directive, Landfill Directive) have dramatically impacted, and will continue to do so, on the volumes and ranges of waste going to landfill. Cleaner technology initiatives advanced through the IPPC licensing system are also contributing to a reduction in waste going to landfill.

The above initiatives are also impacting on the character of the waste going to landfill, in that the percentage of biodegradable (landfill gas and leachate producing) waste is reducing, thereby reducing risk profile of such facilities. The Landfill Directive requires that only waste, which has been subject to treatment be landfilled. This provision may not apply to inert waste for which treatment is not technically feasible, nor to waste where such treatment does not reduce the quantity of the waste or the hazards to human health or the environment.

2.2 Sustainable Development

Sustainable development in landfill requires that we do not allow the landfilling practices of this generation to adversely affect the quality of life of the next generation. This can be achieved by, inter alia:-

- avoidance of areas of significant natural resource quality in terms of usable groundwater, national monuments and significant ecological areas;
- use of landfilling practices which accelerate rather than restrict waste degradation (e.g. use of containment, treatment of leachate, gas collection and reuse, leachate recirculation);
- diversion of biodegradable and other recoverable wastes from landfill; and
- proper and secured financing of facilities for closure and aftercare.

2.3 Waste Management Planning

Local Authorities are responsible for preparing Waste Management Plans in respect of their functional areas under Section 22 of the Waste Management Acts 1996-2005. The Waste Management (Planning) Regulations 1997 (SI No. 137 of 1997) detail the statutory requirements for the preparation of waste plans, which must have regard to national and EU policy in relation to waste management.

The majority of Local Authorities have prepared plans on a regional basis to address waste infrastructural needs. Local authorities and/or other developers of landfill facilities must take into account the needs identified in these plans when considering proposals for new facilities and it must be clearly demonstrated that such a facility is required. Planning on a regional level has improved the strategic approach to delivery of an appropriate range of waste infrastructure.

The Plans quantify the amounts and types of waste, which will require recovery or disposal. These estimates together with the proposed life of the facilities (existing and proposed) are used to calculate the size of landfill required.

If landfill is to continue to be one of the principal methods of waste disposal, the selection and ultimate use of a site is of primary importance. Existing sites must be evaluated and new landfill sites identified to provide sufficient capacity for long term needs and to replace depleted or unsatisfactory sites.

Where waste to energy is available in any given region, plans should provide for the pre-treatment of all residual waste in such plants prior to disposal at landfill. Such an obligation is in keeping with the requirements of the EU Waste Hierarchy.

With respect to hazardous waste the EPA is responsible for making the National Hazardous Waste Management Plan (NHWMP) under the 1996 Waste Management Act.

2.4 Planning Control

A local authority wishing to develop a new landfill in its functional area must obtain the approval of An Bord Pleanála. An Environmental Impact Statement (EIS) is required as part of the process under Part 10 of the Planning & Development Act, 2000 and

the Planning and Development Regulations 2001 (SI No. 600 of 2001)).

An EIS contains an assessment of the likely environmental impacts of a development. Reference should be made to EPA 'Guidelines on the Information to be Contained in Environmental Impact Statements' (2002). Landfill developments also require an EPA waste licence under the Waste Management Act's 1996 - 2005.

2.5 Strategic Environmental Assessment (SEA)

The Directive on the Assessment of the Effects of Certain Plans and Programmes on the Environment (SEA Directive, 2001/42/EC) was transposed into Irish law by Regulations SI No. 435 and SI No. 436 of 2004. The objective is to provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation of specified plans and programmes before they are adopted.

The SEA process includes preparation of an environmental report, consultations and the taking into account of these consultations in decision-making that must then be reported on publicly.

Local and Regional Waste Management Plans and the NHWMP are subject to environmental assessment under the Planning and Development (Strategic Environmental Assessment) Regulations 2004 (SI No. 436 of 2004).

3. LOCAL DEVELOPMENT POLICY

Under the Planning and Development Act 2000 each Local Authority is required to make a development plan every six years. The Plan is the main instrument for regulation and control of development in the county and includes objectives for:

- Provision of infrastructure including water and sewerage services, waste recovery and disposal facilities;
- Zoning of areas for residential, commercial, industrial, agricultural etc. purposes.

- Preserving, improving and extending amenities;
- Development and renewal of obsolete areas;

Development plans will also usually include development objectives relating to the control of use of buildings, community planning, reservation of land, preservation, conservation etc. The plan may list for preservation, particular natural amenities (views, trees, landscape etc.) and particular buildings, features or sites of artistic, architectural or historic interest.

The siting of landfills must have regard to local development policy as outlined in the County Development Plan. Also the Regional Waste Management Plan once made becomes a subset of the County Development Plan and the policies set out are by definition policy in the County Development Plan.

4. CONSULTATIVE FRAMEWORK

4.1 Introduction

The selection of a landfill site is a detailed and involved process. Adoption of a consultative framework early in the process is essential to achieve a successful outcome to site selection. In order to address concerns of the general public, innovative approaches are required in relation to public participation. At the earliest possible stage the public must be given the opportunity to:-

- participate in/contribute to, the selection process;
- understand the issues and the possible solutions;
- understand the approach being suggested;
- participate in scoping of the EIS; and
- comment on potential impacts, both positive and negative.

4.2 Consultation on Landfill Siting

In relation to selection of a landfill site the following forms of public consultation are available for use. Landfill developers are advised to use a combination of these methods to inform and collect public opinion. There is no requirement to use all of these methods and neither is this list intended to be exhaustive.

- public notices concerning waste strategy or project planning in local/national press circulating in area;
- briefings to elected members & local representative groups;
- information leaflets / newsletters;
- meetings with interested groups;
- meetings with landowners, either separately or in groups;
- public meetings;
- local seminars / conferences / workshops / exhibitions;
- public information videos and other audiovisual aids;
- site visits to other landfills operating to a high standard;
- public information centres;
- correspondence with interested parties;
- public information programmes directed at schools, resident associations and other community groups;
- panel discussions and interviews on local or national media;
- private house visits;
- setting up of public liaison group / committee; and
- establishment of a local authority committee (for local authority applications) to hear concerns.

Where a public liaison group / committee is proposed its membership could include:-

- the community, its representatives and local politicians;
- representatives of the local authority;
- representatives of waste collection, recovery companies;
- representatives of local industry;
- representatives of recycling organisations operating in the area;
- representatives of non governmental environmental organisations;
- representatives of the farming community (IFA, ICMSA); and,
- representatives of the relevant chambers of commerce;

Developers should consider how local community involvement in site selection can be facilitated and how liaison might be maintained during subsequent landfill operation. Where there are downstream advantages these should be identified and communicated to the local community.

The development of facilities should only take place having regard to existing statutory procedures (EIS, Planning Permission, Licence application, etc.) on the one hand and progress on public consultation on the other.

Public health risk is a perceived issue for many communities in cases of proposed landfill development / operation. The communications process must endeavour to collect these concerns and address them in consultation and in the EIS for the application.

4.3 Public Information Centres

Where public information centres are set up, they should be open at defined times and staffed with personnel who have an understanding of the proposal and the necessary communication skills. In addition, personnel with the requisite technical knowledge should also be in attendance as the need arises.

5. IDENTIFICATION OF EXCLUSIONARY AREAS

5.1 Introduction

When the need for a landfill has been established there are a number of steps to be undertaken before selection of a landfill site. See **Figure 1**.

At an early stage in the site selection process exclusionary areas, i.e. areas considered to be generally unsuitable for landfill should be identified. This step should be carried out at a regional or catchment level, as a desk exercise and using GIS where appropriate.

A site's natural characteristics will greatly determine its acceptability or otherwise for landfill in terms of environmental impact. Engineering measures can be used to alleviate or minimise risks to the environment – having regard to the principles of BAT, however, not all sites can be engineered to a satisfactory standard and hence exclusionary areas should apply. This approach also allows unsuitable areas to be identified at an early stage in the siting process.

The factors detailed in Sections 5.2 to 5.9 are to be taken into account in order to determine areas generally unsuitable for landfill.

5.2 Landfill Directive

When examining locations for a landfill the requirements below must be taken into consideration (as detailed in Annex I of the Landfill Directive, 1999/31/EC).

- the distances from the boundary of the site to residential and recreation areas, waterways, waterbodies and other agricultural or urban sites;
- the existence of groundwater, coastal water or nature protection zones in the area;
- the geological and hydrogeological conditions in the area;
- the risk of flooding, subsidence, or landslides; and
- the protection of the nature or cultural patrimony in the area.

5.3 Regionally Important Aquifers

The DoELG, EPA and GSI in 1999 jointly issued guidelines on the preparation of Groundwater Protection Schemes. A specific set of groundwater protection responses developed under this scheme for landfill is included in **Appendix A**. The responses outline the likely acceptability of landfills with respect to aquifer category or source protection area and groundwater vulnerability.

It is recommended that landfills should, where possible, not be placed on 'regionally important aquifers' of high vulnerability rating as defined by category R4 under the GSI guidelines in **Appendix A**. In some very site specific and exceptional technical circumstances this restriction can be overcome.

5.4 Geologically Unstable Areas

Geologically unstable areas are defined as locations where natural or manmade features pose a substantial risk to the integrity of the landfill structure. Landfills should generally not be sited within these areas.

Typical unstable areas would comprise;

- areas directly underlain by karstified limestone;
- areas prone to subsidence caused by previous mining activity;
- areas underlain by weak or unstable sub-soils not capable of remediation; and
- areas prone to landslip or slope failure.

5.5 Flood Plains

Developers of landfills should ensure that the landfill is not located within the 50 year floodplain of rivers. The area is defined as the floodplain covered in water for return periods of less than 1 in 50 years. The only exception is where the containment levels and access roads are constructed above the anticipated flood levels.

In certain circumstances it may be necessary to carry out flood risk analyses using the procedures outlined in the Flood Studies Report (1975), National Environment

Research Council. Developers should contact the Office of Public Works (OPW) in this regard.

5.6 Airports

In siting landfills, developers shall, as may be relevant have regard to the recommendations of the International Civil Aviation Authority (ICAO).

Whether or not a landfill creates a potential hazard to aircraft depends on the location of the landfill in relation to airport flight paths, the nature of waste deposited, and the types of birds expected in the vicinity.

The opening of a landfill in the immediate vicinity of an airport can create a hazard even with strict controls in place. Therefore its location should be carefully considered and the advice of bird control specialists should be sought.

The type of landfill should also be taken into consideration. Landfills, which accept only one type of waste such as inert waste, should not attract birds and therefore would not constitute a hazard. In relation to biodegradable municipal waste the National Strategy on Biodegradable Waste, 2006 sets objectives for diversion of such waste from landfill, thereby reducing the potential for attraction of birds.

5.7 Designated Areas for Conservation

The National Parks & Wildlife Service (NPWS) (formerly Dúchas), of the Department of the Environment, Heritage & Local Government (DoEHLG) is responsible for the designation of conservation sites in Ireland.

The three main types of sites are:

Special Areas of Conservation (SACs):

These are prime wildlife conservation areas considered to be important on a European as well as Irish level. The legal basis on which sites are selected and designated is the Habitats Directive (92/43/EEC), transposed into national legislation by the European Communities (Natural Habitats) Regulations, 1997 as amended.

The Habitats Directive lists (in Annex I) certain habitats that must be protected. This

includes priority habitats, which require particular attention. Priority Irish habitats include raised bogs, active blanket bogs, turloughs and machair¹. Other Annex I habitats include heaths, lakes and woodlands among others. There is also a list of species which must be afforded protection (Annex II) and for Ireland this includes the Bottle-Nosed Dolphin, Otter, Freshwater Pearl Mussel and Killarney Fern.

Special Protection Areas (SPA's):

The EU Birds Directive (79/409/EEC) requires Member States to designate Special Protection Areas for birds. Annex I lists birds which require particular conservation measures. Species include Whooper Swan, Greenland White-fronted Goose, Peregrine Falcon, Corncrake and Terns. Member states are also required to protect sites which are important for migratory species such as ducks, geese and waders.

Natural Heritage Areas (NHA's):

The basic designation for wildlife in Ireland is the Natural Heritage Area. In 1995, proposals for NHAs (pNHA) were published and in 2000 powers were introduced for the statutory provisions for their designation and protection were put in place. Under the Wildlife (Amendment) Act, 2000, NHA's will be legally protected from damage from the date they are formally proposed.

When selecting a landfill site, the NPWS should be consulted as early as possible in the process in relation to the location and status of areas of ecological interest.

All developments likely to have a negative impact on these sites must be assessed to determine their likely impact on their conservation interest. If the assessment indicates significant negative impacts alternative solutions must be sought. Planning Authorities are required to assess the implications of granting planning permission, on the conservation interest of the sites.

Mixed waste landfills should not, as a general rule, be located within the boundaries of designated areas for conservation.

5.8 Archaeological Heritage

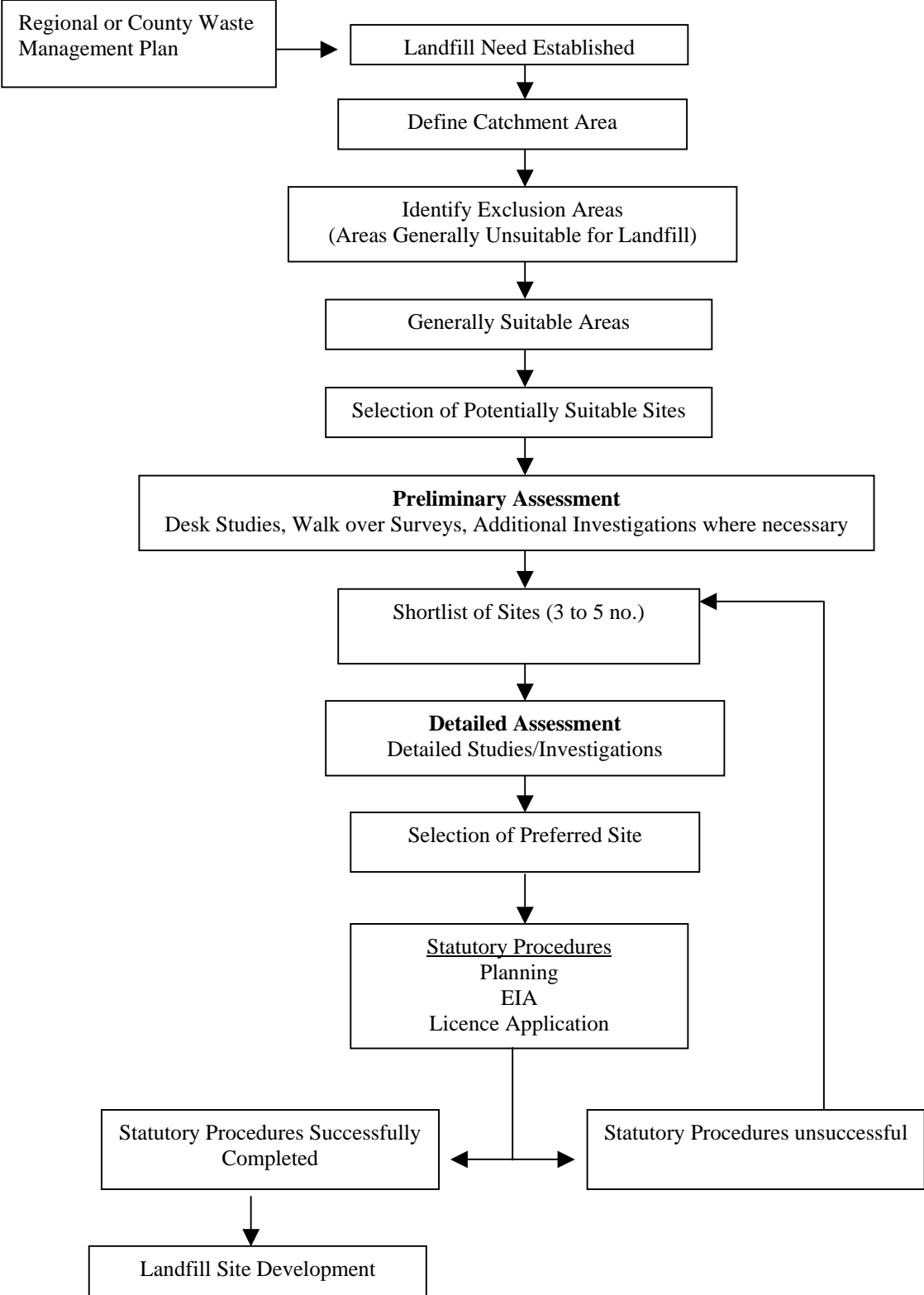
The Principal National Monument Act, 1930, and subsequent amendments provide the formal legal mechanisms to protect monuments in Ireland. The Department of the Environment, Heritage & Local Government manages the State's responsibilities for built heritage. As a desk exercise all recorded archaeological sites and monuments within the study area should be identified and mapped and their legal status recorded.

5.9 Areas of High Amenity

The Planning & Development Act 2000 made statutory provisions for designation of areas of special amenity (by way of the outstanding natural beauty or special recreational value) and landscape conservation areas. Where Development Plans identify such areas, landfills should not be placed within the boundaries so defined. Consideration should also be given to the need for a buffer zone around such areas.

¹ Fertile low-lying raised beach found along coastlines

Figure 1 – Landfill Site Selection Overview



6. CRITERIA FOR SITE ASSESSMENT AND SELECTION

6.1 Introduction

The principal aims of the overall site selection process from an environmental perspective are to find a landfill site, which will safeguard public health, have minimal impact on the environment, and provide for safe disposal of waste.

The site selected should be one, which satisfies the objectives of the Waste Management Plan (s), and be of a sufficient size to justify the expenditure necessary to develop, operate and maintain the site to the highest standards over an extended period.

Having taken account of the exclusion areas identified in Section 5, the areas, which may be suitable for landfill development, can be identified. In a phased approach the areas selected are then reduced to a list of potential sites and eventually to the preferred site using the siting criteria detailed herein.

6.2 Assessment Framework

The criteria to be considered in site assessment and site selection are outlined in the following sections. These criteria are generally the basis for overall comparison of sites and for selection of the preferred site, subject to statutory procedures. See also **Figure 1** which shows the step by step approach for site selection.

6.3 Land Use

The effect of siting a landfill on the existing land use together with the proposed after use of the site must be subject to detailed consideration and assessment. Ireland's land use is predominantly agricultural, and other landuse include forests and semi-natural areas, wetlands and artificial surfaces. Landuse information is available from the Corine Landcover database (2000) based on satellite imagery. Aerial photography may also be used.

Reference should be made to the County Development Plan in relation to landuse zoning and objectives. Zoning can include residential, agricultural, industrial or high amenity lands.

Population trends, and proposed changes in the transportation network also need to be taken into consideration. Sites in areas of lower population density are generally preferable but other factors including the extent of screening and the value of these areas in terms of amenity and tourism must also be taken into account.

6.4 Land Area Requirements/ Availability

A number of factors will influence the area of land needed for a landfill. Amongst the factors which can vary for different sites are:

- land to act as a buffer zone and to screen off residential or other developments;
- visual and aesthetic impact;
- availability of cover material;
- surface water, groundwater, geological and
- hydrogeological setting of the landfill;
- the availability of civic amenity and transfer/collection facilities.

6.5 Local Community

Landfill operations are a source of concern to the local community because of issues such as water pollution, litter, vermin, flies, dust, odour, fire, traffic and noise. Each of these can, however, be controlled and their effect minimised by modern engineering and design, good operating practices and effective management. Reservations about landfill operations tend to fall into the following categories:

- impacts on public health and on the environment;
- the competence and operating standards of the operator;
- reduction in property values and impact on the community in general;
- Impacts on future development near the landfill;

- Impacts on agriculture;
- Impacts on road safety.

Developers should consider how local community involvement in site selection can be facilitated and how liaison might be maintained during subsequent landfill operation. Where there are downstream advantages these should be identified and communicated to the local community.

6.6 Buffer Zones for Sensitive Receptors

The principle purpose of a buffer zone is to assist mitigation of environmental problems.

Buffers or ‘cordon sanitaires’ are intended to provide space or distance between an activity and a sensitive receptor for the purpose of mitigating an actual or potential environmental risk to that receptor in the knowledge that not all receptors are sensitive to the same impact. For example, in a landfill situation where potential impacts might include noise, dust, odour, visual, gas migration, etc., a receptor such as a commercial tree plantation will not be as sensitive to these potential impacts as may a local house. So the concept of a buffer will mean different things depending on the circumstance.

The distance provided between an identified receptor and a landfill footprint² will depend on, inter alia:

- The nature of the waste (inert, municipal, etc);
- The design of the landfill (containment, emissions control, etc);
- The landfilling sequence;
- The scale of operations;
- The environmental controls exercised during the operation of the landfill;
- Direction of prevailing wind, groundwater and surface water flow;
- The geology of the area;

- The topography of the area vis-a-vis the elevation of dwellings and the final profile of the landfill;
- The level of screening and landscaping provided; and
- The type of receptor.

The Irish development control documents (*‘Building Regulations 1997 - Part C’*, and the associated DoEHLG Guidance *‘Protection of New Buildings and Occupants from Landfill Gas’*, 1994) speak of a 250m **planning** control zone around landfills. The planning guidance notes that the 250m should be considered as a guideline; and in areas with particularly favourable gas migration paths, the gas may migrate further. Importantly the DoEHLG planning guidance notes that in cases where there are gas control measures (e.g. containment & extraction) then little or no gas migration may occur. The DoEHLG documents considered the 250m as a *zone around a proposed development site where the developer would check in particular for historical landfilling* (i.e. no gas control measures likely), and where a risk needed to be assessed. This is just a requirement to check for risk and not a requisite sterile zone. Indeed, in relation to separation distances, the DoEHLG 1994 planning guidance stated that no (private) houses should be permitted within 50m of an actively gassing landfill and no private garden within 10m.

The proximity of potential landfill sites to existing dwellings and similar sensitive receptors is a contentious issue, and, as noted, there are many site-specific aspects that can influence the final determination of an appropriate set-back distance between the landfill footprint and residential buildings and similar sensitive receptors. For many existing facilities (existing landfills or existing industrial developments) wishing to extend or develop landfilling there can be constraints posed in relation to proximity of housing and similar public use. In such cases a minimum distance of 100m should be provided between the area to be landfilled by mixed waste and any occupied dwelling (and other sensitive receptors); and any operation of such landfilling where technically feasible, be short-term. Though it is anticipated that developments of this nature in proximity to sensitive receptors would be the exception.

² The footprint is the area where waste is disposed of by deposition.

A distance of 250m between housing (and similar sensitive receptors) and a landfill footprint should be maintained for new 'greenfield' landfills that are handling potentially polluting/odorous wastes.

In the case of inert waste used in development or restoration related activities/landfills - these waste recovery activities being generally short-term in operation and non-odorous/gas forming - the selection of an appropriate buffer will be a site-specific determination.

6.7 Geology And Hydrogeology

It is essential to have an accurate understanding of the local geological setting of the sites involved in order to evaluate site suitability and the capability to provide protection from contamination. This will include aspects of the topography, details of the structure and characteristics of the solid strata, the composition and distribution of the subsoils, the distribution and characteristics of the hydrogeology.

Topographical data are used in the assessment of the likelihood of slope failure, failure over unstable ground and in the interpretation of the topographical expressions of the geology, hydrology and hydrogeology.

The factors of interest in the solid strata include the type of rock, the state of weathering, the extent and distribution of structural features such as faults, joints and bedding planes, the effects of karstification and the permeability of strata. For subsoils, it is necessary to know the composition, the lateral and vertical continuity of the strata, the permeability, resistance to erosion and the stress deformation behaviour.

Hydrogeological investigations should include assessment of the type and distribution of aquifers. The importance of the groundwater distribution, thickness and depth of the aquifers together with the permeability or transmissivity of the aquifers also need consideration. The importance of the groundwater resource should be established including protection zones, beneficial uses and the interaction between groundwater and surface water resources. Data on water levels and water quality should also be collected at this stage.

Landfill gas migration requires both a motive force and a pathway to facilitate movement towards the landfill boundary. The accessibility and permeability of any natural pathway beyond the site boundary will be governed by geological factors.

Further advice can be found in the 'Guide to Geology in Environmental Impact Statements' developed in 2002 by the Institute of Geologists of Ireland (www.igi.ie). This was to compliment the EPA guidance on information to be contained in EIS, 2002. Reference should be made to both these documents as part of the site selection process.

6.8 Geological Faults

In locating areas suitable for landfill, it is difficult to avoid being on, or close to geological 'faults'. Even though the majority of faults increase the permeability of the bedrock in the fault zone it would normally not be appropriate to rule out or downgrade a site because of the presence of faults. Equally the absence of faults should not be taken as an absolute assurance that a site is geologically suitable.

Fault zones in permeable rocks (generally regionally important aquifers) are usually more significant than in low permeability rocks (generally poor aquifers). The terms "major" and "minor" fault are relative and have no absolute significance and, in any case, have no particular hydrogeological significance.

It is recommended that there should be no general prohibition of landfill siting on areas with geological faults. Rather, attention should be drawn to them by noting firstly that they are ubiquitous in Irish bedrock, that they often increase the permeability somewhat, and that investigations should take account of their possible presence. Construction of potentially polluting landfills in direct contact with faults should be avoided in situations where investigations show that the fault zone is excessively permeable.

6.9 Hydrology and Surface Water Protection

Potential effects due to landfill siting can include effects on water quality, quantity and aquatic ecology (habitat loss, disturbance or

alteration). Impacts may be due to leachate contamination or increased surface runoff.

Under the EU Freshwater Fish Directive (78/659/EEC) rivers are designated as salmonid waters for the protection of fisheries. These and non-designated waters are important for salmonids (salmon and trout) and their water quality and fish habitat must be maintained. Also the EU Water Framework Directive (2000/60/EEC) requires that at least 'good status' is achieved for all waters by 2015.

Surface water bodies (streams, rivers, lakes, estuarine and coastal) within the impact zone of a possible landfill site should be recorded including any designations. Account should be taken of the ecological rating (Q rating) for rivers and the importance of water bodies in terms of ecological, amenity, fisheries or commercial value.

6.10 Topography

Topography refers to the physical features of the land surface, or the terrain. These features are represented on maps by means of contour lines.

A contoured map can be used to identify areas with steep slopes that may complicate construction or access to the site. The watershed that drains into or across a particular area can be determined from the contours. The watershed area determines the amount of runoff a site will receive from upstream areas. Existing natural depressions may also be identified which offer an advantage for landfill development with respect to visual screening and noise attenuation.

6.11 Site Visibility /Natural Screening

As part of the site selection process, areas with natural screening, isolated settings, or existing natural depressions would be preferable. Screening around landfill sites can also be accomplished through construction of berms, fences, planting, or enhancement of existing vegetation. Siting at remote locations must also take into consideration longer distances for transporting waste.

Consideration must be given to significant or designated views, natural features and the

assessment of potential impacts on sites in relation to their landscape character.

6.12 Ecology

All potential landfill sites will differ in ecological value. A landfill operation can have an adverse effect on the ecology of the site and its immediate surroundings. It can also result in the destruction of existing vegetation and can disrupt aquatic and terrestrial life. A study of the ecology of potential sites must consider if there are:

- any relevant designations (e.g. Special Areas of Conservation, Special Protection Areas, Natural Heritage Area, or area of special interest having regard to Section 5.7);
- any rare species of plants and/or animals occurring;
- any particular features of habitats (terrestrial and aquatic) which should be protected; and
- any records of protected plants at the sites.

Any adverse impacts on ecology must be balanced against the advantages that will accrue once the site has been restored, or other compensatory measures.

Restoration should aim at integrating the landfill site into the existing landscape and establishing a viable ecology, possibly more valuable than the one it replaces. Landfill operations should be engineered to take account of effects on ecology.

6.13 Archaeological Heritage

Potential landfill sites should be assessed in relation to potential impacts on archaeological heritage. All recorded archaeological sites and monuments in the area should be identified (from Section 5.8). Sources to be consulted include: the Sites and Monuments Record (SMR), the Record of Monuments and Places (RMP), the Register of Historic Monuments, published County Surveys and Inventories, National Inventory of Architectural Heritage (NIAH), and County Development Plans.

Additional sources of information include early Ordnance Survey Mapping, National Museum of Ireland topographical files, aerial

photography and other relevant published sources. Investigations can also include field inspections, walkover and aerial surveys.

In addition to recorded sites and monuments, there is the potential for previously unknown features or monuments hidden beneath the soil surface. The archaeological potential of an area can be indicated by environmental characteristics or by archaeological testing.

Landfill siting should also have regard to County Development Plan objectives and policies for the protection of archaeological and architectural heritage.

6.14 Areas of High Amenity

The Planning & Development Act 2000 made statutory provisions for areas of special amenity and landscape conservation areas. Areas of special amenity can be by way of the outstanding natural beauty or its special recreational value.

County Development Plans must be consulted for the landscape and amenity objectives and designations. These may include for preservation of views and prospects, and the amenities of places and features of natural beauty or interest.

6.15 Airports

In siting landfills, developers shall, as may be relevant have regard to the recommendations of the International Civil Aviation Authority (ICAO).

When considering potential landfill sites the advice of bird control specialists should be sought and the potential hazard to aircraft due to bird strike assessed. Whether or not a landfill would create a potential hazard depends on the location of the landfill in relation to airport flight paths, the nature of waste deposited, and the types of birds expected in the vicinity.

There are many methods available to prevent birds from feeding at landfills. The method likely to be most acceptable near high risk areas such as airports is to enclose the tipping area by a net or enclosure to limit bird incursions. The proper siting of landfills and the type of landfill can reduce the risk of hazard near airports.

6.16 Meteorology

At site selection stage, consideration should be given to meteorological factors and information should be obtained from the Meteorological Office on precipitation and evapotranspiration for the areas in question. The annual rainfall is an important factor as all new sites must collect and contain any leachate generated. Wind strength and wind patterns must also be examined and windbreaks considered to avoid blowing or flying debris/litter.

6.17 Traffic/ Access

Landfill generated traffic (during construction and operation) can give rise to noise, vibration, exhaust emissions, dust, dirt and visual intrusion. Heavy vehicles on narrow roads may create traffic management issues including delays to other traffic, damage to roads and can be a source of complaint.

The following should be evaluated as part of the site selection process:

- Distance of potential sites from waste generation areas; regard should be taken to the Proximity Principle.
- Proximity to the existing national / regional road or rail network and expected vehicle movements; siting of landfills with good access to national or regional road routes is preferable.
- Any required upgrading or new road infrastructure to accommodate additional traffic.
- The residential nature of potential access routes.
- Objectives of County Development Plans and Local Area Plans.

6.18 Availability of Cover Material

The availability of suitable cover for the duration of the landfilling operation is essential. This includes daily cover material and cover for final restoration.

In considering an area for landfill, information must be obtained on the characteristics of the soils in the area. If suitable cover material were not available at the site, it would have to be imported and/or alternative cover systems employed.

Daily cover material should be permeable to aid rainfall penetration and assist waste degradation. It must also be suitable to reduce localised odour at the tipping face and reduce nuisance associated with insects and vermin.

6.19 Services and Security

Site selection should take account of the services that would be necessary to develop and operate a landfill to the required standards. For example water supply (including on-site storage), proximity to sewerage system and suitable wastewater treatment, power supply and telephone connections must be considered.

It may be necessary to transport leachate off-site for treatment and if this is the case, the location with respect to off-site treatment facilities should be taken into consideration.

Access to landfill sites must be controlled in order to prevent unauthorised vehicular traffic and illegal dumping of waste. When selecting a site, security should be considered and attention should be paid to natural barriers or suitability for artificial barriers.

7. SHORTLISTING OF SITES & SITE SELECTION

7.1 Introduction

Investigation or assessment of potential landfill sites is an essential part of the overall site selection process. The purpose is to determine the most suitable site or sites for landfill development. The step by step process, which is outlined below, is detailed in the EPA Landfill Manual series Investigations for Landfill, 1995, which should be read in conjunction with this manual. It describes the sequence and extent of preliminary and detailed assessments required to progress the selection, construction and operation of a landfill site.

7.2 Preliminary Assessment

Having taken account of the exclusionary areas identified in Section 5, the areas, which may be suitable for landfill development, can be identified. The selection should seek to avoid regionally important aquifers, flood plains of major rivers, designated conservation areas and areas of high amenity and archaeological interest. (See Section 5.)

The areas considered suitable for landfill are further reduced to a number of potential sites based on the criteria identified in Section 6. A preliminary assessment is undertaken to allow comparison between sites and to provide information on these. This will usually involve a desk study and walk-over surveys.

Through the process the number of sites being considered are reduced progressively as desk studies and preliminary investigations are completed. The siting criteria herein and those in the Waste Management Plan are used to form a shortlist of sites, which would then merit a more detailed assessment.

7.3 Detailed Assessment

At the conclusion of the Preliminary Assessment a maximum of three to five sites should remain. Detailed investigations and assessment are required to further characterise these sites and to either reject sites or confirm their suitability.

The detailed investigations should have regard to depth of overburden, bedrock type, groundwater protection, land use, likely impact on local population, quality of road access, quality of natural screening, and other factors of local importance. Aerial surveys and GIS systems may be of use at this stage. **Appendix B** includes a schedule of information sources available.

The assessment and site selection phases operate in parallel and overlap to some extent. The procedures adopted should follow those listed in the manual titled 'Investigations for Landfills' (EPA, 1995).

7.4 Shortlisting Process

It is important to emphasise that neither the short-listing process nor the final site selection lend themselves to precise mathematical determination. In addition, the preliminary investigations process of screening potential areas and sites needs to be a flexible one as the acquisition of site specific information may be slow. The process should therefore allow for consideration of shortlisted areas until there is sufficient relevant information to narrow down suitable sites within these areas.

Early investigations in shortlisted areas may also suggest adjacent areas of particular suitability, which were not obvious at desk study or preliminary stage. The purpose of the overall exercise is to find a suitable site. This should be the result of an informed judgement over the period of the investigations based on consideration of national and international standards on the one hand and local enabling factors on the other.

The principal factor likely to determine the degree of impact of a landfill on the local environment will be the natural qualities of the site itself and the mitigation measures adopted. It is also important to remember that with a decreasing number of sites, the level of investigative technique and the degree of intensification of study is greater and therefore flexibility must be maintained such that sites can be interchanged on the shortlist as a greater degree of information becomes available.

Also, a site should not be rejected too early because it does not appear to fully meet all criteria. Consideration should be given to design and operational techniques that could overcome initial reservations.

7.5 Private Landfills

As noted in Section 1.5, public authorities have the responsibility of finding the optimum location for a landfill within their jurisdiction, this being facilitated by powers to compulsory purchase lands for such waste infrastructure. Private sector operators (and Local Authorities searching for landfills in areas outside their functional area) do not have powers of compulsory purchase and so must locate the best site in an area from those locations that are, or will be, made available.

Where a site is offered to a local authority or a private developer, the site selection process outlined herein does not preclude its investigation but any assessment should use the selection criteria outlined in this manual.

7.6 Site Selection

Using information from the preliminary and detailed investigations and the siting criteria a comparative assessment should be carried out on the shortlisted sites.

The assessment should be in sufficient detail to allow decision making in technical, environmental and financial terms based on:

- the likely degree of impact due to each site;
- the site suitability in terms of technical and environmental factors; and,
- the estimated costs of the landfill development for each site.

With regard siting criteria it is necessary to consider each site in terms of positive and negative implications. Positive aspects can include good national or regional road access, location on a poor aquifer, good quality natural screening, and other considerations likely to assist the acceptable integration of a landfill site into a particular area. Typical negative aspects would include poor access to regional or national routes, proximity to ecologically sensitivity areas, high population density and other features, which would make landfill siting difficult to substantiate or defend.

It is unlikely that any site will be favourable in relation to all siting criteria. Therefore the decision making process and the selection of the preferred site becomes a balance of trade-offs based on the judgement of those involved.

7.7 Preferred Site

A landfill site is deemed to be “selected” when statutory procedures have been successfully completed. The site must also meet the requirements of the EU Directive, on the landfill of waste (91/31/EC), which states that:

“Member states shall take measures in order that ... the Competent authority does not issue a landfill permit unless it is satisfied that ... the landfill project complies with all the relevant requirements of this Directive, including the annexes”

Annex 1 of the Directive also states that the landfill can be authorised only if the characteristics of the site and/or the corrective measures to be taken, indicate that the landfill does not pose a serious environmental risk.

The preferred site will be subject to an Environmental Impact Assessment (where required) before any landfill development can commence on that site. The EIS, which documents the assessment of the effects on the environment should also outline the alternatives considered. If the preferred site is rejected by the planning or licensing authority, the Developer may seek approval for another site on the shortlist, which would also be subject to an EIA.

It is emphasised that any landfill approval must, as far as protection of the environment is concerned, be based on sound scientific and engineering principles first and foremost. Many site factors can be improved by engineering design and potential impacts can be mitigated by appropriate methods of operation.

APPENDIX A

**GROUNDWATER PROTECTION RESPONSES FOR
LANDFILL**

Groundwater Protection Responses for Landfills

Background

Groundwater in Ireland is protected under European Community and national legislation. Local authorities and the Environmental Protection Agency (EPA) have responsibility for enforcing this legislation. The Geological Survey of Ireland (GSI) in conjunction with the Department of Environment and Local Government (DoELG) and the EPA have developed a methodology for the preparation of groundwater protection schemes to assist the statutory authorities and others to meet their responsibility to protect groundwater (DoELG/EPA/GSI, 1999). This methodology incorporates land surface zoning and groundwater protection responses.

These groundwater protection responses are concerned with the site selection process for landfills and the associated design, operation and monitoring of landfill sites. These responses outline the likely acceptability of landfills in each groundwater protection zone (as described in *Groundwater Protection Schemes* (DoELG/EPA/GSI, 1999)) and the recommended level of response/restriction, which depends on the groundwater vulnerability, the value of the groundwater and the contaminant loading.

In general terms this guidance is for the siting of landfills for non-hazardous wastes. The principles involved may also be applied to the selection process for landfill sites for hazardous and inert waste.

A significant factor in siting all landfills is the protection of groundwater, which is an important resource and source of water supply in Ireland, particularly in rural areas.

The geology and hydrogeology of any region have a major bearing on: (i) the availability of suitable areas for landfill sites; (ii) the level of natural protection for groundwater from contamination by landfill leachate; and (iii) the design, operation and monitoring of landfills.

Groundwater protection schemes, supported by detailed investigations, provide hydrogeological information for landfill site selection. They are used to identify areas where landfills should normally be excluded and areas where they are less likely to pose a risk to groundwater. The groundwater protection responses outlined here require that new landfills should not generally be developed on regionally important aquifers.

Developers of landfills should have regard to both the resource potential and the vulnerability of the underlying and adjacent aquifers. The groundwater protection responses combine both of these factors in a matrix which facilitates rational decisions on the acceptability or otherwise of a landfill from a hydrogeological point of view.

The risk to groundwater from the landfilling of waste is mainly influenced by:

- the nature of the waste;
- the leachate composition;
- the volume of leachate generated;
- the groundwater vulnerability;
- the proximity of a groundwater source;
- the value of the groundwater resource;
- the landfill design; and
- the landfill operation and management practices.

In general the pollution risk is greatest in source protection areas and on regionally important aquifers. The topsoil and subsoil, depending on their type, permeability and thickness, play a critical role in preventing groundwater contamination and mitigating the impact of many potential pollutants. They act as a protecting filtering layer over groundwater.

Guidance presented in these responses should be used to assist in the selection, design and management of landfill sites, and is based on the precautionary principle. The concept of risk management should be used in the decision making process for the selection of new landfill sites.

These groundwater protection responses should be read in conjunction with *Groundwater Protection Schemes* (EPA/DoELG/GSI, 1999).

Landfilling of Waste: a Hazard for Groundwater

The generation of leachate is one of the main hazards to groundwater from the disposal of waste by landfilling. Good site selection, design and operation assists in minimising the risk of pollution. Leachate from landfills for non hazardous waste is a highly polluting liquid and its composition is dependent on the nature of the waste within the landfill. The pollution potential can be evaluated by calculating the volume and predicting the composition of leachate that will be generated.

The volume of leachate depends principally on the area of the landfill, the meteorological and hydrogeological factors and the effectiveness of the capping. It is essential that the volume of leachate generated be kept to a minimum. The design and operation of the landfill should ensure that the ingress of groundwater and surface water is minimised and controlled.

Leachate composition varies due to a number of different factors such as the age and type of waste and operational practices at the site.

The conditions within a landfill vary over time from aerobic to anaerobic thus allowing different chemical reactions to take place. Most landfill leachates have high BOD, COD, ammonia, chloride, sodium, potassium, hardness and boron levels. Ammonia is a contaminant, which may be used as an indicator of contamination, particularly in terms of surface water, as it can be toxic to fish at low concentrations (1 mg/l). Chloride is a mobile constituent, which is often used as an indicator of contamination. The leachate from non-hazardous waste landfills may produce reducing conditions beneath the landfill, allowing the solution of iron and manganese from the underlying deposits.

Leachates from landfill sites for non-hazardous waste often contain complex organic compounds, chlorinated hydrocarbons and metals at concentrations which pose a threat to groundwater and surface waters. Solvents and other synthetic organic chemicals are a significant hazard, being of environmental significance at very low concentrations and resistant to degradation. Moreover, they may be transformed in some cases into more hazardous compounds.

Landfills have the potential to produce leachate for several hundred years.

Groundwater Protection Response Matrix for Landfills

The reader is referred to the full text in *Groundwater Protection Schemes* (DoELG/EPA/GSI, 1999) for an explanation of the role of groundwater protection responses in a groundwater protection scheme.

The siting, design, operation and monitoring of landfills must comply with the guidelines outlined in the EPA's Landfill manuals except where such facilities hold a waste licence issued by the EPA. A Waste Licence is required for all landfills.

From the point of view of reducing the risk to groundwater, it is recommended that all landfills be located in, or as near as possible to, the zone in the bottom right hand corner of the matrix.

The appropriate response to the risk of groundwater contamination is given by the assigned response category (**R**) appropriate to each protection zone (Table 1).

Table 1 Response Matrix for Landfills

VULNERABILITY RATING	SOURCE PROTECTION		RESOURCE PROTECTION						
	Inner	Outer	Regionally Imp		Locally Imp.		Poor Aquifers		
			Rk	Rf/Rg	Lm/Lg	Ll	Pl	Pu	
<i>Extreme (E)</i>	R4	R4	R4	R4	R3 ²	R2 ²	R2 ²	R2 ¹	↓ ↓ ↓ ↓
<i>High (H)</i>	R4	R4	R4	R4	R3 ¹	R2 ¹	R2 ¹	R1	
<i>Moderate (M)</i>	R4	R4	R4	R3 ¹	R2 ²	R2 ¹	R2 ¹	R1	
<i>Low (L)</i>	R4	R3 ¹	R3 ¹	R3 ¹	R1	R1	R1	R1	
→ → → → → →									

In all cases standards prescribed in the *EPA Landfill Site Design Manual (EPA, 1999)* or conditions of a waste licence will apply.

R1 Acceptable subject to guidance outlined in the EPA Landfill Design Manual or conditions of a waste licence.

R2¹ Acceptable subject to guidance outlined in the EPA Landfill Design Manual or conditions of a waste licence.

- Special attention should be given to checking for the presence of high permeability zones. If such zones are present then the landfill should only be allowed if it can be proven that the risk of leachate movement to these zones is insignificant and that special attention has been given to existing wells down-gradient of the site and to the projected future development of the aquifer.

R2² Acceptable subject to guidance outlined in the EPA Landfill Design Manual or conditions of a waste licence.

- Special attention should be given to checking for the presence of high permeability zones. If such zones are present then the landfill should only be allowed if it can be proven that the risk of leachate movement to these zones is insignificant and that special attention has been given to existing wells down-gradient of the site and to the projected future development of the aquifer.
- Groundwater control measures such as cut-off walls or interceptor drains may be necessary to control high water table or the head of leachate may be required to be maintained at a level lower than the water table depending on site conditions.

R3¹ Not generally acceptable, unless it can be shown that:

- the groundwater in the aquifer is confined; or
- it is proven that there will not be a significant impact on the groundwater; and
- it is not practicable to find a site in a lower risk area.

R3² Not generally acceptable, unless it can be shown that

- there is a minimum consistent thickness of 3 metres of low permeability subsoil present;
- it is proven that there will not be a significant impact on the groundwater; and
- it is not practicable to find a site in a lower risk area.

R4 Not acceptable.

Regionally Important Aquifers

The of landfills on or near regionally important aquifers should only be considered:

- Where the hydraulic gradient (relative to the leachate level at the base of the landfill) is upwards for a substantial proportion of each year (confined aquifer situation).
- Where the proposed landfill is located in the discharge area of an aquifer. In this case surface water may be more at risk.
- Where a map showing a regionally important aquifer includes low permeability zones or units which cannot be delineated using existing geological and hydrogeological information but which can be found by site investigations. Location of a landfill site on such a unit may be acceptable provided leakage to the permeable zones or units is insignificant.
- Where the wastes types are restricted and the waste acceptance procedures employed are in accordance with the criteria specified by the EPA.

Investigations

Special attention should be given to checking for the presence of more permeable zones, such as faults, particularly in fractured bedrock aquifers. Geophysical surveys may be used to identify zones which should be investigated further by drilling to determine their vertical and lateral extent. Hydrogeological tests should also be carried out to define the local and regional effects of the zones. Investigations should be carried out in accordance with the EPA's Landfill Manual *Investigations for Landfills, 1995*.

References

- DoELG/EPA/GSI, 1999. Groundwater Protection Schemes. Department of the Environment and Local Government, Environment Protection Agency and Geological Survey of Ireland.
- EPA, 1995 Landfill Manual Investigations for Landfills. Environmental Protection Agency.
- EPA, 1995 Landfill Manual Landfill Monitoring, Environmental Protection Agency.
- EPA, 1997 Landfill Manual Landfill Operational Practices, Environmental Protection Agency.

APPENDIX B

INFORMATION SOURCES

SUBJECT	SOURCE	INFORMATION
Topography	Ordnance Survey topographic maps and air photos, Air Corps air photography Digital Terrain Models Topographical surveys	Relief (approximate ground levels). Surface water drainage, Proximity of housing, Access
Geology	Geological Survey of Ireland (GSI) maps Other GSI publications Quarry Records Mining Records. Site investigation records	Geological Succession (bedrock and Superficial deposits), Thickness of strata and lateral extent Geological structure Mineral resources and utilisation
Aquifers, Aquifer Protection Zones	GSI Groundwater Division	Location and yield, vulnerability maps. protection zones
Soil Types and Drainage	Teagasc Field Surveys GSI	Agricultural land classification (limited to certain counties) Land use
Climate	Meteorological Office	Average rainfall and potential evapotranspiration (For calculation of effective rainfall and leachate generation)
Air Quality	EPA	
Water Resources, Quality Abstraction, Flow data	Local Authorities Environmental Protection Agency GSI Office of Public Works Field Surveys	Extent of water utilisation (river and reservoir catchment areas) Surface and groundwater quality Significance of on site surface/ groundwater
Planning and Development	Local Authority Development Plans National Development Plan Operational Programmes, Government Departments Regional Development Plans	Areas where landfill would be a permitted development and general considerations Industrial sites and developments Infrastructure Sectoral Development Proposals Population Data
Population	Central Statistics Office	
Human and Animal Health	Department of Health and Children Health and Safety Authority Health Research Board Department of Agriculture and Food	Human Health statistics and research studies. Animal Health
Archaeological and Architectural Heritage Ecology, Biodiversity, Flora and Fauna Landscape	Department of the Environment, Heritage and Local Government (DoEHLG), DoCMNR, Fisheries Boards Planning Authorities	National Monuments, Areas of Archaeological Importance Designated Areas for Conservation or Ecological Importance Landscape Designations

APPENDIX C

GLOSSARY OF TERMS

Aftercare:	Any measures necessary to be taken for the purposes of preventing environmental pollution following the cessation of the activity in question at a facility.
Aquifer:-	A permeable geological stratum or formation that is capable of both storing and transmitting water in significant amounts. Confined aquifer: an aquifer in which the water is confined under pressure by overlying and underlying impermeable strata. Unconfined aquifer: where the upper surface of a saturated zone forms a water table.
Attenuation:	The decrease in concentration of chemical species present in a liquid, caused by any of a variety of mechanisms, individually or in combination, including dilution, adsorption, precipitation, ion-exchange, biodegradation, oxidation, reduction, etc.
Bedrock:	The solid rock underlying soils.
Bund (Berm):	A dike or mound usually of clay or other inert material used to define limits of cells or phase or roadways; or to screen the operation of a landfill from adjacent properties; reducing noise, sight, dust, and litter impacts.
Civic Waste Facility (Civic Amenity):	A facility at which waste may be deposited by members of the public in accordance with conditions specified by the local authority
Clay:	One of four basic soil groups, along with silt, sand and gravel. Clay is composed of very small particles that make it plastic (mouldable) when wet. Clays are the preferred soils for landfill liner and cap applications, because they are resistant to flow (impermeable).
Closure:	The process of completing the landfill operation when it reaches final grade and stops receiving waste. Closure includes installation of the landfill cap. Following landfill closure is the aftercare period.
Collection:	Collection in relation to waste is the gathering, sorting, or mixing of waste for the purpose of its being transported and includes the transport of waste and the acceptance of control of waste.
Containment site:	Landfill site where the rate of release of leachate into the environment is extremely low. Polluting components in wastes are retained within such landfills for sufficient time to allow biodegradation and attenuation processes to have occurred; thus preventing the escape of polluting species at unacceptable concentration
Contour:	A line on a topographic map that connects points with the same elevation; or a line on a plan view that identifies common groundwater elevations or equal concentrations of pollutants in the groundwater (contamination plume).
Cover:	Material used to cover solid wastes deposited in landfills. Daily cover is used to cover each lift or layer at the end of each working day to prevent odours, windblown litter, insect or rodent infestation, and water ingress. Intermediate cover refers to cover material deposited over wastes at the end of a particular phase of landfilling. Final cover is the layer or layers of material placed on the surface of a landfill.
Effective Rainfall:	Total rainfall minus actual losses due to evaporation and transpiration. Effective rainfall includes both surface run-off and that which percolates into the ground below the soil zone.
Environmental Impact Statement:	Environmental Impact Statement (EIS) means a statement of the effects, if any, which a proposed development, if carried out would have on the environment

Evapotranspiration:	The total water transferred to the atmosphere by evaporation from the soil surface and transpiration by plants.
Groundwater:	Water below the earth's surface, either stored in aquifers, in "perched" conditions above layers of impermeable soils, or in the unsaturated (vadose) zone above the aquifer.
Impermeable: (impervious)	Used to describe materials, natural or synthetic, which have the ability to resist the passage of fluid through them. This property is not absolute, and a cut-off permeability of 10^{-9} to 10^{-10} m/s for water is often used to describe a landfill liner material as impervious.
Infiltration:	The flow of water, usually as rainfall into the soil. When stormwater percolates through the landfill cap, or cover, it can infiltrate into the waste to produce leachate.
Input:	Amount of waste imported into a landfill during a given period of time
Landfill Gas (LFG):	Landfill gas means all the gases generated from landfilled waste.
Leachate:	Leachate means any liquid percolating through the deposited waste and emitted from or contained within a landfill.
Leachate recirculation:	The practice of returning leachate to the upper layers of a landfill, from which it has been abstracted, usually by direct spraying on to its surface.
Mixed Waste	Waste comprising two or more of the following waste streams:- Inert Waste, Commercial Waste, Industrial Waste, Municipal Waste, and which has the potential to produce landfill gas, leachate and odour.
Permeability (k)	The rate at which a nominated fluid (usually water) is transmitted through a unit cross sectional area of a geological or synthetic medium under unit hydraulic gradient and at a specified temperature. Also referred to as Hydraulic Conductivity. Units usually quoted as meters per second (this is a reduced dimension from $m^3/m^2/s$). In certain circumstances it may be necessary to distinguish between vertical and horizontal permeability as there can be significant variations in many natural mediums (kv or kh).
Restoration	Completion of a landfill site to allow planned afteruse.
Sensitive Receptor	Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or area of high amenity which for its proper enjoyment requires the absence of environmental emissions leading to nuisance.
Subsidence (settlement)	The sinking of the landfill surface due to consolidation of waste as it decomposes and the filling of underground voids.
Subsoil	The less well structured and less biologically active layer below top soil which acts as a reserve of nutrients and water for plant growth in the top soil.
Suspended solids	Solid material suspended in liquids.
Transmissivity	The rate at which a nominated fluid (usually water) can pass through the thickness of a saturated medium of unit width under a unit hydraulic gradient.
Treatment	Treatment means the thermal, physical, chemical or biological processes that change the characteristics of the waste in order to reduce its volume or hazardous nature, or facilitate it's handling or enhance recovery.
Watershed	The upstream land area that contributes surface water drainage to a (<i>catchment</i>) particular point downstream