CODE OF PRACTICE

Environmental Risk Assessment for Unregulated Waste Disposal Sites

Environmental Protection Agency

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Abbreviations and Acronyms

C&D	Construction and Demolition Waste
CLM	Contaminated Land Management
CoP	Code of Practice
CSM	Conceptual Site Model
DoEHLG	Department of the Environment, Heritage and Local Government
ECJ	European Court of Justice
EPA	Environmental Protection Agency
GIS	Geographical Information System
GPS	Global Positioning System
GSI	Geological Survey of Ireland
GW	Groundwater
GWDTE	Groundwater Dependent Terrestrial Ecosystem
GWPS	Groundwater Protection Scheme
IR	Infra-Red
LA	Local Authority
NHA	Natural Heritage Area
NPWS	National Parks and Wildlife Service
OD	Ordnance Datum
OEE	Office of Environmental Enforcement
QRA	Quantitative Risk Assessment
RBD	River Basin District
RBDMP	River Basin District Management Project
SAC	Special Area of Conservation
SI	Site Investigation
SO	Outer Source Protection Area
SPA	Special Protection Area or Source Protection Area (GWPS)
S-P-R	Source - Pathway - Receptor linkage
SWDTE	Surface Water Dependent Ecosystem
WFD	Water Framework Directive

Preface

A Ministerial Direction (WIR 04/05) was issued on the 3rd May 2005 under Section 60 of the Waste Management Acts (WMA) 1996 to 2005. Inter alia, it reminds local authorities of their obligations, under Section 22 of the Waste Management Act, to carry out an inventory and risk assessment of all historic unregulated waste disposal sites. In addition, local authorities are required under Section 26(2) of the WMA to identify sites at which 'waste disposal activities, being activities that to a significant extent involved hazardous waste, have been carried on'. This Code of Practice, prepared by the Agency at the request of the Minister for the Environment, Heritage and Local Government, sets out a risk based assessment procedure, which is to be applied to these sites in order to evaluate the sites identified and placed on a Section 22 Register or in certain cases on a Section 26 register.

The Agency is empowered under Section 76 of the Environmental Protection Agency Act, 1992 (as amended) to prepare and publish codes of practice for the purpose of providing practical guidance with respect to compliance with any enactment or otherwise for the purposes of environmental protection. A document under the seal of the Agency purporting to be a code of practice published under Section 76 shall be received in evidence without further proof.

Following a period of public consultation this Code of Practice (CoP) is published under Section 76 of the EPA Act. It provides guidance on completing environmental risk assessment of unregulated waste disposal sites, which have been identified through the application of the Agency's Site Identification Methodology[1]. It sets out a framework, to allow the intrinsic risk posed by the activity to the environment to be assessed. The intrinsic risk relates to the risk posed without any mitigation measures having been put in place to reduce the risk.

The CoP follows international best practice and is primarily aimed at providing guidance for historic unregulated waste disposal sites but it shall also be used in relation to illegal landfills. It is not intended that the CoP be used directly for contaminated land however the general principles may be applied.

[1] Methodology for the Identification of Waste Disposal or Recovery Sites in Ireland (Appendix 1)

Acknowledgements

The principal author of this Code of Practice was Ms. Margaret Keegan of the OEE, EPA. Other personnel involved in the production and preparation of the Code were Professor Paul Nathanail - Head of Land Quality Management, University of Nottingham and Dr. Matt Crowe, Mr. Dara Lynott and Mr. Jim Moriarty.

A Steering Committee was set up to provide technical assistance in the development of this document. The EPA wishes to acknowledge the contribution of the members of the Steering Committee.

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Fehily Timoney & Co on behalf of the South East Local Authorities

Chapter 1 Introduction

1.1 Background

A Ministerial Direction (WIR 04/05) was issued on the 3rd May 2005 under Section 60 of the Waste Management Acts 1996 to 2005. It reminds local authorities of their responsibilities under Section 22 of the Waste Management Acts, 1996 to 2005 and it refers to an inventory and risk assessment of all non-licensed closed landfills (i.e. historic unregulated waste disposal sites).

This Code of Practice (CoP) has been developed to assist local authorities to comply with the requirements of Section 22 of the Waste Management Acts 1996 to 2005 (WMAs), the Ministerial Direction and any possible subsequent regulations. The Code of Practice pays particular attention to sites where waste disposal or recovery activities are suspected to have taken place without proper authorisation.

In relation to illegal waste activity, the Section 60 Direction states that

'the principal aim in dealing with illegal waste activity should be to secure the protection of the environment and human health. Therefore the primary obligation of a local authority or the Agency when illegal waste activity is discovered is to ensure that the waste is recovered or disposed of, in the shortest practicable time, without endangering the environment or human health and without using processes and methods which could harm the environment and in particular without:

- risk to human or animal health, water, air, soil or plant life;
- causing a nuisance through noise or odours;
- adversely affecting the countryside, or places of special interest.

The scale and seriousness of the situation should be assessed as quickly as possible and adequate management and monitoring put in place to take stock of immediate and longer-term impacts……. The aim in all cases, having regard to this direction, and the Agency's code, should be the making safe of the site, including the removal of waste where required as a consequence of a risk based assessment. In particular, all hazardous waste which is detected shall be removed and recyclable material shall be removed unless it can be shown that there are alternative environmentally sustainable options.'

A separate but associated guidance document outlining a Methodology for the Identification of Waste Disposal or Recovery Sites in Ireland (hereafter termed the Identification Methodology) has been produced (see Appendix 1) and the methodology outlined therein shall be adhered to in the development of an inventory of waste disposal and recovery sites. An online web based data management system has been developed by the Agency (WMA Section 22 Register) and shall be used by local authorities to record information in relation to the inventory of sites.

1.2 Objective

This Code of Practice has been produced to ensure a consistent approach to environmental risk assessment by local authorities of former waste disposal or recovery sites and in particular, to the assessment of the environmental impact and remediation options for historic unregulated waste disposal sites. These sites ceased operations before entry into force of a waste-licensing regime and therefore were not subject to a specific waste authorisation requirement and were not in breach of national legislation. The CoP provides guidance on how to deal with illegal

landfills that have come into being since the introduction of the waste licensing regime.

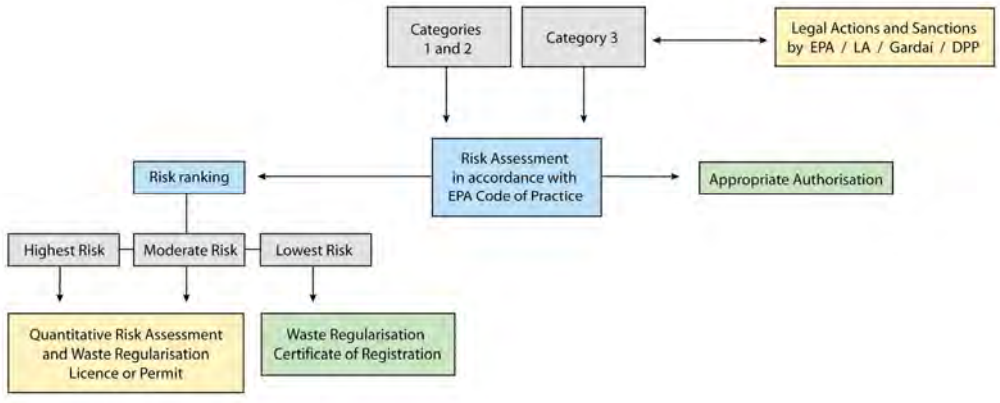
The intrinsic risk posed by the activity is what is assessed in this Code of Practice and this does not take into account remediation measures that may have been put in place, so it is a conservative approach. It enables the local authority to carry out a risk prioritisation of the historic unregulated closed landfills as identified by applying the Identification Methodology (Appendix 1). It will allow for a rapid response to the investigations of the highest risk sites by local authorities by setting out a clear methodology to conduct the risk assessment and the remediation required, and provide a transparent decision process. This document builds on the risk assessment work on landfills developed by the national WFD Groundwater Working Group as part of the requirements of the Water Framework Directive (2000/60/EC).

1.3 Application

This Code of Practice details the approach that should be taken in relation to unregulated sites. These include

- Historic unregulated waste disposal sites (closed landfills) that were operating between 1977 and 1997 i.e., Category 1[2] and Category 2[3] sites without being in breach of national legislation (Figure 1)
- Illegal landfills that were operating since 1997 i.e., Category 3[4] sites (Figure 1)

Figure 1: Application of Code of Practice in relation to Unregulated Waste Disposal Sites and Illegal Sites.



[2] Category 1 sites are those operated by a local authority without a waste licence under the Act in the period between 15th July 1977 and prior to coming into operation of the Waste Management Licensing Regulations, 1997.
[3] Category 2 sites are those private waste disposal facilities that were in operation in the period 15th July 1977 to 31st March 1980.
[4] Category 3 sites are those on which the unregulated disposal of waste took place without a waste licence in the period after the coming into operation of the Waste Management Licensing Regulations, 1997 and private sites in operation after the coming into operation of The European Communities (Waste) Regulations 1979 (SI No. 390 of 1979).

Landfill sites operated and closed prior to 1977 are outside the general scope of this document as the Waste Framework Directive only came into force in July 1977. However, if landfill sites operated prior to 1977 are identified during the application of the Identification Methodology and it is considered that they may pose a risk to the environment or human health then the risk screening process should be applied in line with the precautionary principle and in the interest of environmental protection.

This methodology shall be used in conjunction with other guidance documents published by the Agency on various aspects of landfilling, including those listed in Chapter 9. The EPA landfill manual series includes guidance on site investigations, monitoring, and restoration and after care as well as providing details on specific risks from landfill gas and leachate.

Additional advice and guidance may be published by the Agency in the future in relation to other waste disposal activities, waste recovery activities and contaminated land sites.

1.4 Use of this Guidance by Local Authorities

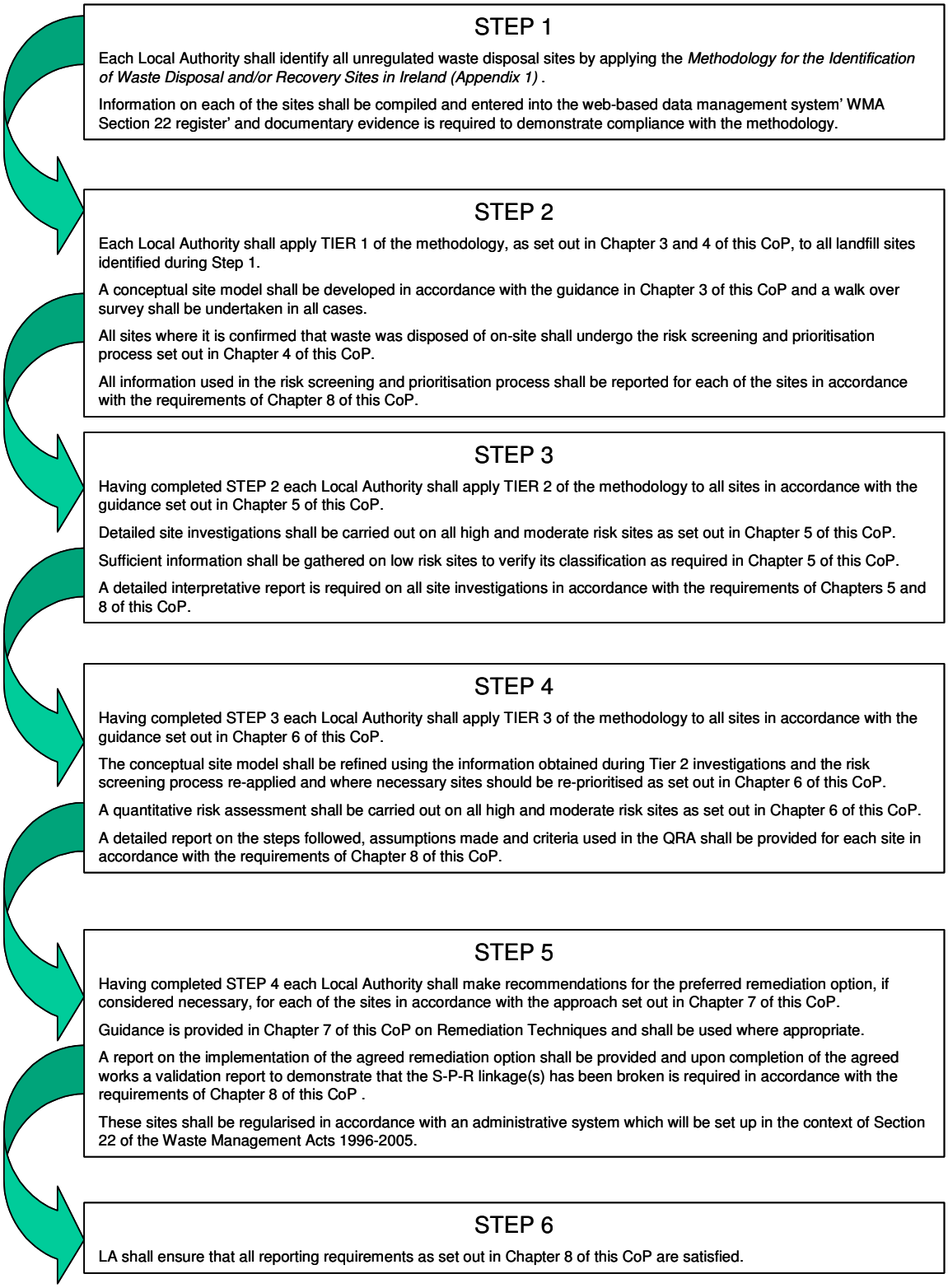
All local authorities are required to follow the methodologies set out in this Code of Practice. As described above there are two main applications of this methodology - Historic Unregulated Landfills and Illegal Landfill sites. The basic risk assessment methodology is the same but the application of the CoP for each type of site is different due to the different circumstances of the two types of sites.

1.4.1 Historic Unregulated Landfills

Historic unregulated waste disposal sites (closed landfills) (Category 1 and 2), which were in operation prior to 1997 and were not in breach of national legislation, do not fall under the Waste Management Licensing Regulations (1997) as amended. An administrative system, in the context of Section 22 of the Waste Management Acts 1996 to 2005, will be established to regularise the position of these sites arising from the European Court of Justice (ECJ) C-494/01 decision against Ireland in relation to the Waste Framework Directive (which entered into force in July 1977). Historic unregulated waste disposal sites, together with sites predating the Waste Framework Directive and which may be considered to pose a risk to the environment and human health, shall be identified by application of the Identification Methodology and shall be subject to this Code of Practice for the Environmental Risk Assessment of Unregulated Waste Disposal Sites.

Figure 2 sets out a Road Map that shall be followed by all local authorities responsible for embarking on this exercise of Site Identification and Risk Assessment for historic unregulated landfills.

Figure 2: Application of the Code of Practice for Historic Unregulated Landfills



1.4.2 Illegal Sites

In accordance with the Ministerial Direction (DoEHLG Circular WIR 04/05) local authorities and the Agency are directed to pursue sanctions against illegal waste activities. In this regard the Code of Practice is a tool to be used, without prejudice to any notices issued under the Waste Management Acts 1996 to 2005 and in conjunction with the taking of any legal actions, to assess the risk illegal sites pose to the environment and human health. The information provided through the application of the Code of Practice will inform any subsequent permit or licence assessment process to remediate the site.

In relation to Category 3 sites, the following steps shall be taken.

The local authority shall seek to have the cost of the risk assessment borne by the person(s) responsible for the illegal activity including, where appropriate, pursuit of the amount concerned as a simple contract debt in a court of competent jurisdiction.

The following sites shall at all times be remediated:

- 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;
- Places of special interest such as high amenity areas.

In all of these cases, prior to embarking on the risk assessment process, it is to be assumed that the waste shall be removed from the site except only where it can be shown that an alternative solution provides greater protection to the environment and the health of the local population. The remediation plan for these sites should therefore centre on the removal of waste from the site and the manner in which this is to be done. In almost all such cases, the majority of waste is likely to be required to be removed and the only circumstance where waste can remain on the site is where it can be clearly demonstrated that this will lead to greater protection of the environment or enhancement of the environment and greater protection of the health of the local population.

The local authority shall ensure that the holder[5] of the waste undertakes the following actions:

- Carry out, or arrange for the carrying out, of a risk assessment to determine the environmental impact, if any, of the waste illegally deposited;
- Where appropriate 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;

[5] The holder is the owner, person in charge, or any other person, having for the time being, possession or control, of the waste (in accordance with section 5 of the Waste Management Act and it shall be presumed, until the contrary is shown, that the recovery or disposal was carried on with that owner's consent.

- Subject to the application being approved, 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 remediation and closure.

This Code of Practice does not preclude local authorities from taking other enforcement actions to deal with short-term or local impacts such as surface water drainage, drinking water impacts or nuisance.

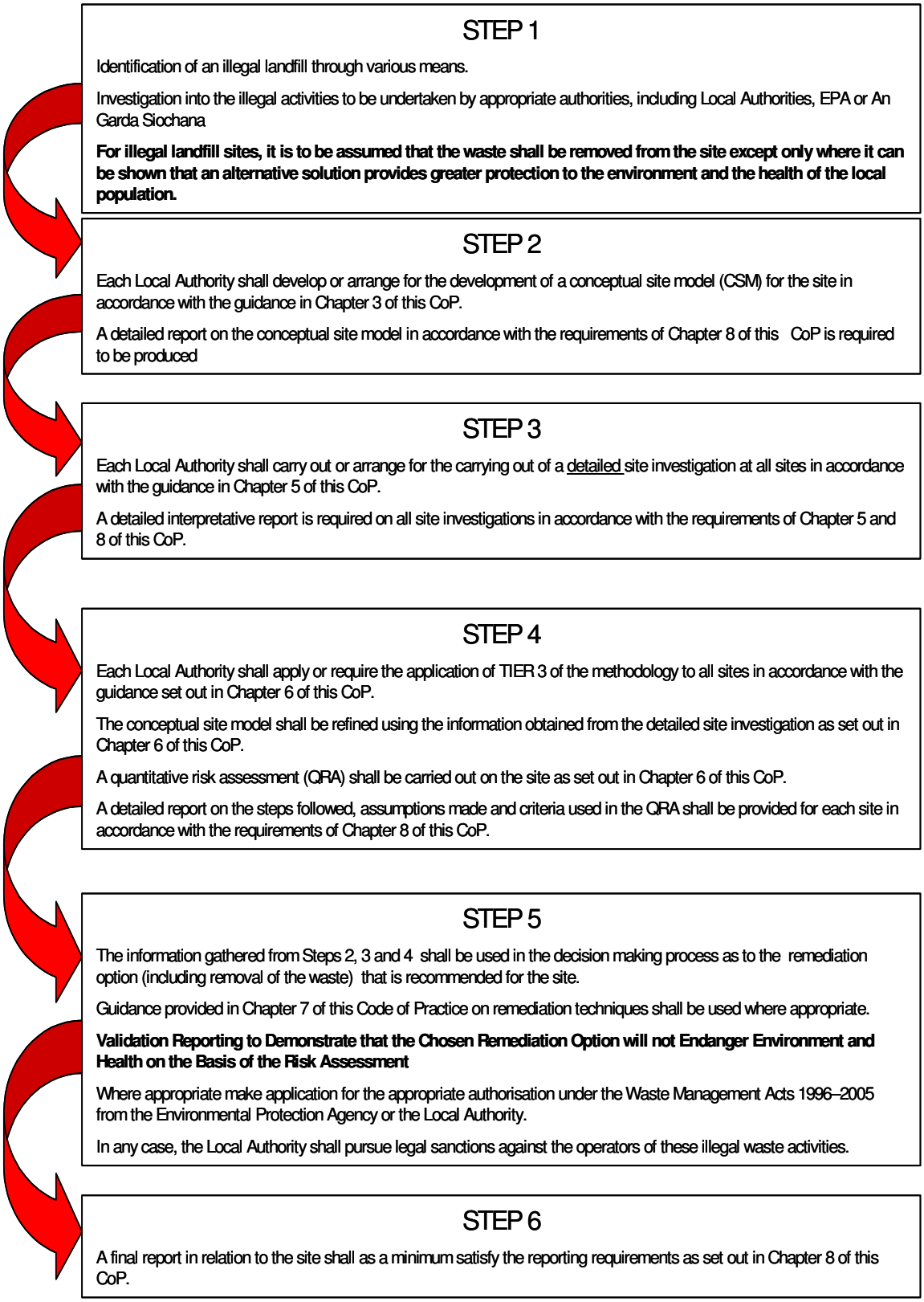
In addition, the local authority shall in any case conduct the risk assessment itself where responsibility for the illegal activity cannot be imputed or clearly determined, including those activities situated on commonages.

In overseeing or vetting risk assessments, the local authority shall ensure that the risk assessments are completed to a satisfactory standard and by appropriately qualified person as set out in Section 2.3 of this Code.

The local authority should consult with the National Parks and Wildlife Service of the Department of the Environment, Heritage and Local Government (NPWS) to ensure that lands close to wetlands, Natural Heritage Area, Candidate Special Areas of Conservation or Special Protection Areas or places of special interest such as high amenity areas are properly assessed.

Figure 3 sets out a Road Map that shall be followed by all competent authorities embarking on this exercise for illegal landfills.

Figure 3: Application of the Code of Practice for Illegal Landfills



1.5 Definitions

"Environmental Pollution" as defined in the Waste Management Acts, 1996 to 2005 means, in relation to waste, the holding, transport, recovery or disposal of waste in a manner which would, to a significant extent, endanger human health or harm the environment, and in particular -

- Create a risk to waters, the atmosphere, land soil, plants or animals,
- Cause a nuisance through noise or odours or litter, or
- Adversely affect the countryside or places of special interest"

"Non-licensed Closed Landfill" means a site operated by a local authority for the recovery or disposal of waste, without a waste licence under the Waste Management Acts 1996 to 2005 in the period between 15th July 1977 and prior to the entry into force of the Waste Management Licensing Regulations 1997 (27th March 1997) (i.e. prior to the relevant prescribed date) and a site operated by private operator for the recovery or disposal of waste in operation in the period 15th July 1977 to 31st March 1980, prior to the European Communities (Waste) Regulations, 1979 coming into force.

"Illegal Waste Facility" means a site operated by a local authority or private operator for the recovery or disposal of waste, without

- An appropriate waste permit issued under the European Communities (Waste) Regulations, 1979 (SI No. 390 of 1979) from the 1st April 1980 to the date of commencement of the Waste Management (Licensing) Regulations 1997, or
- An appropriate waste licence under the Waste Management Acts 1996 to 2005 since the entry into force of the Waste Management (Licensing) Regulations 1997 (27th March 1997)

"Hazardous waste" means any waste, which is covered by Article 1 (4) of Council Directive 91/689/EEC of 12 December 1991 on hazardous waste[6].

"Non hazardous waste" means waste, which is not covered by hazardous waste definition above[6].

"Inert waste" means waste that does not undergo any significant physical, chemical and biological transformations. Inert waste will not dissolve, burn or otherwise physically or chemically react, biodegrade or adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm human health[6].

"Industrial Waste" includes waste produced or arising from manufacturing or industrial activities or processes[6].

"Municipal waste" means waste from households, as well as other waste, which because of its nature or composition, is similar to waste from households[7].

"Construction and Demolition waste" means all wastes which arise from construction, renovation and demolition activities and all wastes mentioned in Chapter 17 of the European Waste Catalogue List. It includes surplus and damaged products and

[6] Landfill Directive 1999/31/EC
[7] Waste Management Act, 1996 (No. 10 of 1996)

materials arising at construction work or used temporarily during on-site activities and dredge spoil.[8]

1.6 Limitations

This methodology is intended to provide general guidance in terms of risk assessment of unregulated sites. The guidance assumes a certain level of technical expertise, judgement and experience. Further reference material is listed in each section and in Chapter 9 as an aide to suitably qualified persons carrying out each phase of the methodology; however, more specialist expertise may be required for carrying out Tiers 2 and 3 of the risk assessment.

[8] National Waste Database Report, (EPA, 1998).

Chapter 2 Risk Assessment Concepts

2.1 Introduction

Risk assessment considers the likelihood of occurrence and the consequences of the occurrence of an event. It represents a systematic means of determining and evaluating the nature, effect and extent of exposure a vulnerable receptor may experience in relation to a particular hazard. It informs the management and communication of risk. An environmental hazard is an event, or continuing process, which if realised will lead to circumstances having the potential to degrade, directly or indirectly, the quality of the environment (Royal Society, 1992).

A pathway[9] is a route by which a particle of water, substance or contaminant moves though the environment and comes into contact with, or otherwise, affects a receptor (EA, 2001). For a risk to exist there must be a source (or hazard or pressure), a pathway and a receptor (or target) (Daly, 2004). This is the basis for the Source-Pathway-Receptor (S-P-R) conceptual model for environmental management.

In addition, a conceptual model also provides information useful to the scoping of any investigation as it identifies the sites that pose the greatest risk to the environment and human beings and also identifies the S-P-R linkages that have the highest risk associated with them.

The risk assessment methodology facilitates a clear decision-making process in devising a strategy to control any potential risks evident in the conceptual model. The detailed information obtained through the investigative programme will inform the decision on the extent of measures which are required to manage the risk, which may involve breaking the pathway or removal of the source or in some cases monitoring of the receptor.

2.2 Risk Assessment Methodology Approach

The risk assessment methodology is a structured, transparent and practical process that will aid decision-making. A phased approach is being used for this risk assessment methodology (Figure 4). This will ensure that the greatest amount of effort and resources may be targeted where the most vulnerable and sensitive receptors are located or where there is significant uncertainty combined with potential for significant environmental damage to occur.

2.2.1 Risk Assessment Methodology Tier 1: Conceptual Site Model, Risk Screening and Prioritisation (Qualitative Risk Assessment)

Risk screening is a process that will determine whether a development or site represents or potentially represents a risk to receptors (Environment Agency, 2003). It also identifies possible Source-Pathway-Receptor (S-P-R) linkages through the development of a conceptual site model (CSM). It provides a preliminary or qualitative risk assessment of the site. It includes an assessment of the likelihood and magnitude of any effects of each linkage. The screening process also categorises the site into different waste categories such as the following:

- Historical construction and demolition waste landfill
- Historical LA operated municipal landfill
- Historical Privately operated municipal landfill

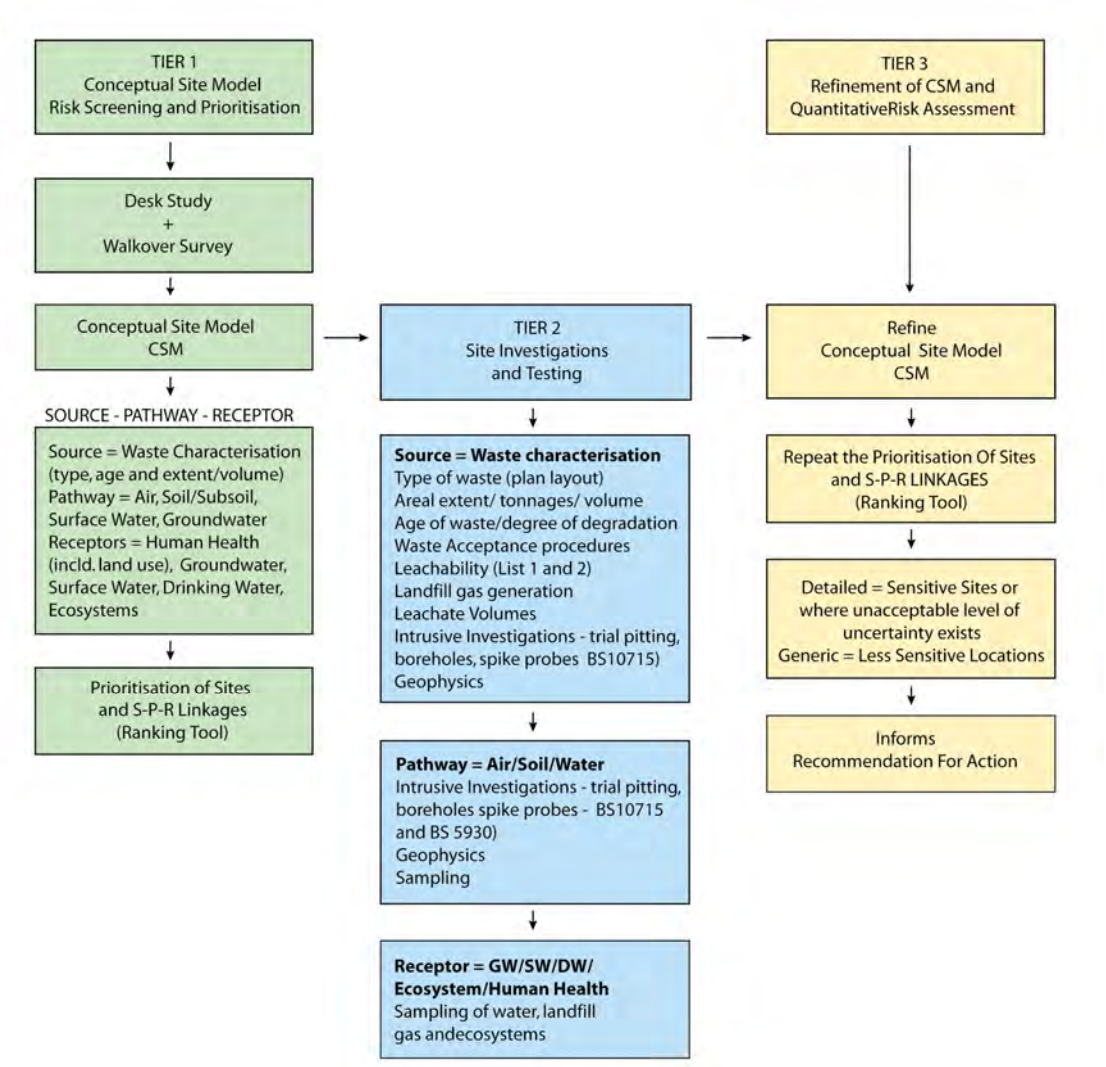
[9] A pathway is one or more routes or means by, or through, which a receptor: is being exposed to, or affected by, a contaminant, or could be so exposed or affected (DETR Circular 2/2000)

- Hazardous Waste landfill
- Illegal Waste Facility (disposal)

The initial screening process allows for the prioritisation of sites into high, moderate and low risk so that resources can be allocated to the investigation of the higher risk sites and also focus upon the examination of the associated S-P-R linkages at each of the sites. The Risk Screening and Prioritisation process to be applied in Tier 1 includes a Preliminary investigation comprising a Site Inspection (including walkover survey) in all cases.

The approach, which should be adopted under Tier 1, is elaborated upon in Chapter 3 of this Code of Practice.

Figure 4: Risk Assessment Methodology - Phased Approach



2.2.2 Risk Assessment Methodology Tier 2: Site Investigations and Testing

Tier 1 will inform the scoping of Tier 2: Site Investigations and Testing. The site investigations should focus on providing sufficient information to determine whether a linkage exists and the significance of the linkage and the risk posed by the hazard (waste type).

For example when investigating the hazard/source (waste body), it may be appropriate to use the investigative techniques of trial pitting, geophysics, probing or boreholes in a phased approach. The degree of uncertainty that exists within each site and the cost of the investigations should be balanced against the level of the perceived risk. The site investigations will have to determine whether or not the waste body has the potential to generate landfill gas and leachate, which may contain List 1 and/or List 2[10] substances and the depth to the water table so that compliance with the Groundwater Directive (80/68/EEC) and other relevant legislation may be assessed.

More detailed guidance will be provided in Chapter 5 of this Code of Practice and reference should also be made to the EPA Landfill Manuals: Investigations for Landfills, 1995.

2.2.3 Risk Assessment Methodology Tier 3: Refinement of CSM and Quantitative Risk Assessment

On the basis of information gathered during the Tier 2 investigations, the conceptual site model (CSM) developed in Tier 1 should be refined using all the information gathered during the Tier 2 investigations. Where appropriate, the risk screening methodology should be re-applied to validate the risk classification of the site prior to proceeding to the quantitative risk assessment. This approach enables the sensitivity and/or degree of uncertainty for each S-P-R linkage to be identified. This allows a decision as to the nature and extent of the risk assessment to be completed (and to determine whether a Generic Risk Assessment or a Detailed Risk Assessment needs to be carried out).

A Generic Risk Assessment[11] may be used at less sensitive locations and/or where the information is available to suggest that the level of risk is low. It is generally a deterministic (i.e. resulting in a pre-determined outcome given particular conditions) and conservative approach, which uses generic guideline values (i.e. values which are generally applicable to an entire group e.g. based on the proposed future land use of the site).

On the other hand in the case of a sensitive site or where there is poor information and potential for high level of risk to the environment, a Detailed Risk Assessment[12] approach will be required. This type of risk assessment is probabilistic (i.e. is based on the probability or likelihood) and requires a lot of site-specific data, which will have to be gathered if it has not already been obtained during Tier 2.

More detailed guidance on procedures for Quantitative Risk Assessment is provided in Chapter 6 of this Code of Practice.

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[10] Substances as stated in the Groundwater Directive (80/68/EEC)

[11] Generic Risk Assessments should consist of simple quantitative calculations, typical analytical solutions solved in a deterministic fashion using conservative input parameters, assumptions and methods (Environment Agency, 2003a).

[12] Detailed Risk Assessments should be carried out in a quantitative manner using stochastic techniques to analytical solutions, or numeric solutions using site-specific data (Environment Agency, 2003a).

2.2.4 Remediation Techniques

The Code of Practice is not intended to be prescriptive in relation to remediation options. However, for the purposes of an introduction to the subject, Chapter 7 directs the reader to other sources of information on the various techniques. The selection of a remediation technique or action will be based on site-specific criteria and cost benefit analysis, which is outside the scope of this document. Ultimately, the approval of any remediation option including removal of waste is likely to be subject to an authorisation procedure.

2.3 Experience and Qualifications Required

Risk assessment is not necessarily a new concept but it is only in recent years that the general approach has become a more systematic and formalised[13] process. It is very important to have a robust and transparent risk assessment for any site, as it will be the subject of close scrutiny and will determine the remediation measures to be applied and the resources required to undertake the work. To this end it is important to have experienced persons carrying out or supervising the application of this methodology.

Different levels of expertise and experience are required for the different phases of the methodology. The Tier 1: Conceptual Site Model, Risk Screening and Prioritisation requires the least amount of specialist input but it does require conscientious work and a good understanding of the basis and development of conceptual models and the source-pathway-receptor linkages. Furthermore, the importance of Tier 1 of the Risk Assessment Methodology must never be underestimated and it is a fundamental aspect of the overall risk assessment as the results of the risk prioritisation provide the initial risk classification and this assessment will influence subsequent actions or in-actions. Those applying the Tier 1 should have participated in EPA training or have gone through the appropriate training material.

The guidance provided on Tier 2 and Tier 3 of the Risk Assessment Methodology within this document will assist local authorities to carry out the work themselves, if they possess the relevant experience and expertise. In any case a suitably qualified, trained and experienced person, who is a registered professional with chartered status (or equivalent) awarded by a relevant professional body, and who has successfully conducted risk assessments at other sites should supervise the Site Investigations (and provide an Interpretive Report on the significance of factual information obtained) and be used to carry out the risk assessment. Alternatively, the guidance in the Code of Practice can be used to inform the specification for consultancy services. The information contained in the Code of Practice may be augmented by the provision of some risk assessment training through the Environmental Enforcement Network[14].

[13] Ferguson et al, 1998 Risk Assessment for contaminated sites in Europe. Vol 1. Scientific Basis. LQM Press, Nottingham.
[14] Environmental Enforcement Network was set up by the OEE to foster co-operation between the various public service bodies involved in the enforcement of environmental legislation, so that a higher and more consistent standard of enforcement is achieved throughout the country.

Chapter 3 Conceptual Model

3.1 Introduction

A conceptual model is a means of understanding the manner in which a system, which is used for a waste related activity is likely to behave. The Environment Agency of England and Wales has defined a conceptual model as follows,

'A textual or graphical representation of the relationship(s) and receptor(s) developed on the basis of hazard identification and refined during subsequent phases of assessment' (Environment Agency, 2000).

In simple terms, this means that a picture is built up progressively, on the basis of systematic investigations, through the application of a conceptual model of the relationship between the existence of a potential hazard and the linkage to the likely receptors. The programme of investigations is designed to establish the actual situation.

A well-defined conceptual site model (CSM) should be used as basis for all the subsequent risk assessments. It should be used to identify all possible sources (S), pathways (P) and receptors (R) as well as the processes that are likely to occur along each of the source-pathway-receptor (S-P-R) linkages and uncertainties.

CSM development should be an iterative process and the principles applied are closely aligned with the proposed approach to risk assessment methodology as illustrated in Figure 4. There are essentially three key stages of CSM development:

- Desk Study and Site Inspection (including walkover survey)(which provides information for the initial development of a CSM).
- Site Investigation (that may be required to test and refine the initial model).
- Environmental monitoring/modelling to validate the CSM.

CSM development should form an integral part of Tier 1 of the Risk Assessment Methodology and a CSM shall be developed for all sites irrespective of scale and extent. The CSM should be used to assist in the planning and design of Tier 2 investigations. It should also form an effective tool in clearly communicating the nature of the risk and in the understanding of the monitoring results. Finally, it provides support in the selection of remediation options. The detail required is dependent on the S-P-R specific for the site.

All uncertainties and assumptions made in the development of the CSM should be clearly identified and account should be taken of these in designing the programme of site investigations and in assessing potential remediation options.

3.2 Desk Study

The purpose of the desk study is to

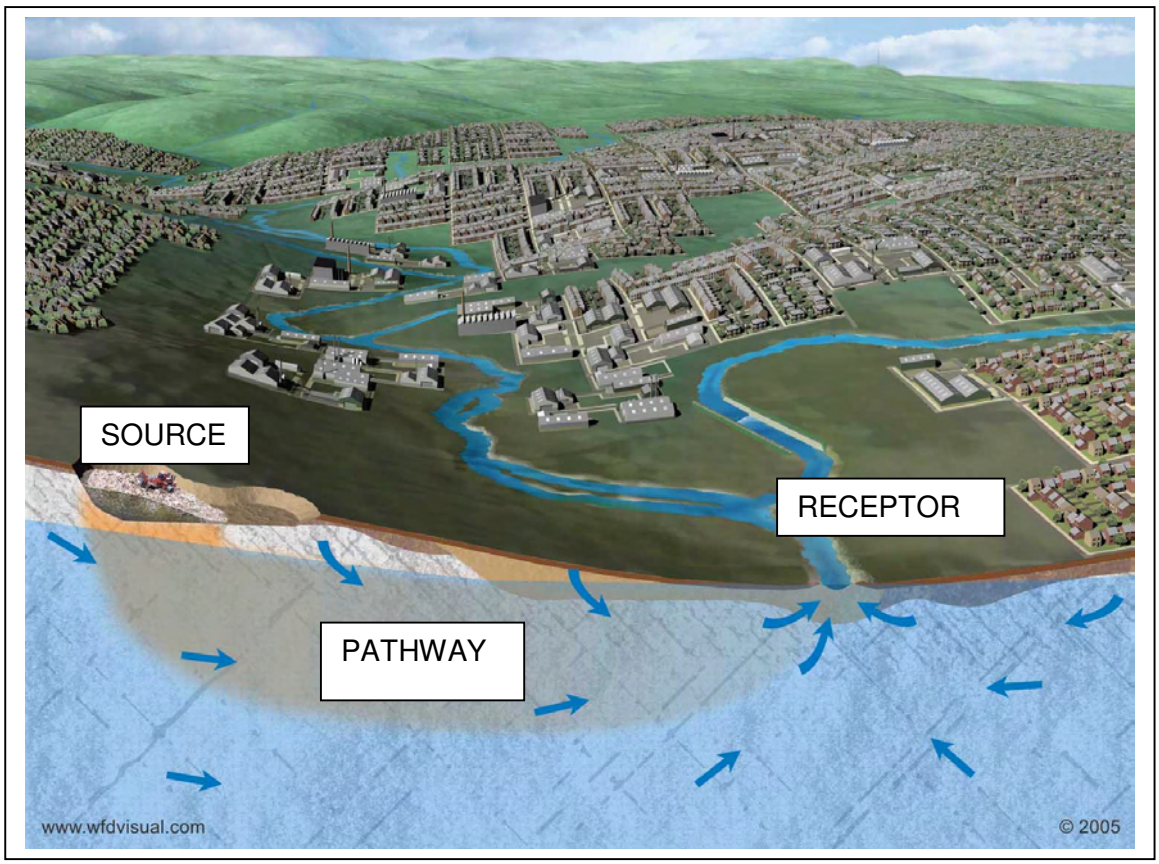
- Collect all information necessary to characterise the site and its surroundings.
- Develop an initial CSM and its hydrogeological setting.

In scoping the extent of a desk study, it should always be borne in mind that the building of a conceptual model requires a general understanding or working hypothesis of:

- The source (waste type, volumes and condition),
- The contaminant transport mechanisms,
- Potential migration pathways, and
- Receptors.

The relationship between these aspects is illustrated in Figure 5 and these considerations are explored in more detail below.

Figure 5: Source – Pathway- Receptor Conceptual Model – *Leachate Migration*



3.2.1 Source/Hazard

The principal sources of contamination/hazard in the case of a waste body may be considered to be leachate and landfill gas. It is of paramount importance that the waste type should either be known or assumptions made on its characterisation so that the potential for leachate generation can be identified. The type of waste determines the potential toxicity of the leachate and therefore the degree of hazard, which it can pose to surface water and groundwater.

In addition, an assessment of the potential for landfill gas generation should be carried out. Landfill gas, if present, then becomes a source and its potential for migration of fugitive gas emissions needs to be assessed.

Dust is not considered as a principal source as in general historical waste disposal sites generally have a vegetative cover, which minimises dust generation. However, if waste is exposed at the surface, dust can be generated and should be assessed.

The hazard associated with pre-1977 sites is considered to be significantly reduced as the proportion of biodegradable waste contained in municipal solid waste was relatively low in that period and therefore the amount of leachate and landfill gas currently being generated is expected to be low.

3.2.2 Pathways

A pathway is a mechanism or route by which a contaminant comes into contact with, or otherwise, affects a receptor[15]. A pathway must exist if a hazard is to pose a risk to a receptor. The pathway defines the likelihood of contact with, or transport to, a receptor (MFE, 2004). It should be assumed in all cases that historical landfill sites are unlined and that no synthetic containment barrier has been put in place.

3.2.2.1 Leachate Migration Pathways

There are three potential pathways for leachate migration:

- Vertically to the water table or top of an aquifer, where groundwater is the receptor being considered;
- Vertically to an aquifer and then horizontally in the aquifer to a receptor, such as a well, spring or stream;
- Horizontally at the ground surface or at shallow depth to a surface receptor.

The migration and attenuation of leachate from a landfill depend on the permeability and thickness of subsoil, and on both the bedrock permeability value and type. These elements are encompassed in the following factors:

- Groundwater Vulnerability
- Groundwater Flow Regime
- Surface Water Drainage

Groundwater vulnerability provides a measure of the ability of contaminants to migrate vertically to an aquifer and is a function of the subsoil permeability (usually dependent on subsoil type) and its thickness.

Groundwater flow regime provides a measure of the length of groundwater flow paths (or horizontal flow component) of the aquifer, the attenuation of pollutants in the aquifer and the likelihood of interaction with surface water. As part of the implementation of the Water Framework (WFD), the Geological Survey of Ireland (GSI) has categorised all aquifers on the basis of their flow regime.

Surface water drainage, in the context of this Code of Practice, is an assessment of the direct connection between surface water drainage associated with the waste body and nearby receptors. It provides an indication of the likelihood of rainfall or contaminants migrating horizontally at or close to the ground surface to a receptor, such as via overland flow or seepage to a stream.

[15] Investigation of potentially contaminated sites – Code of Practice, British Standards Institution, UK. BS 10175:2001

3.2.2.2 Landfill Gas Migration Pathway

The main pathway considered for landfill gas migration is through the subsoil and bedrock (in the case of rock quarries). Another relevant pathway is underground services, including pipelines and their way-leaves, drainage systems and manholes. In addition, landfill gas can migrate from the site when dissolved in groundwater. The subsoil and bedrock type gives an indication of the relative containment or ease of movement of landfill gas to a potential receptor.

3.2.3 Receptors

A receptor is a person, living organism (e.g. livestock, crops, pets or wildlife), ecological system, controlled waters, atmosphere, structures and utilities that could be adversely affected by the source.[16] The risk to receptors is dependent on the potential for exposure to the hazard, whether leachate or landfill gas, and is dependent on the pathway and the distance between the hazard/source and the receptor or the value of the resource in the case of an aquifer.

3.2.3.1 Leachate Migration Receptors

The following receptors are considered to be sensitive receptors in respect of leachate migration:

- Human Presence, which is an indicator of the potential for private water supplies and a risk to human health, is considered a sensitive receptor.
- Protected Areas (including wetlands/ecosystems), which are designated under the Water Framework Directive, Birds Directive, Habitats Directive, Wildlife Act (as well as some important undesignated sites), Freshwater Fish Directive, Bathing Waters Directive are potential sensitive receptors and their proximity to the facility has an influence of the risk score.
- Aquifer Category, which is an indicator of the groundwater resource and is an important receptor, is a likely target in the case of leachate migration.
- Public Water Supplies, which are an indicator of the risk to public health, are considered to be an important receptor. Proximity of the landfill to a water supply must be considered and its location relative to the groundwater and/or surface water flow direction has an impact on the risk score.
- Surface water bodies include river, lake, estuarine and coastal water bodies as defined under the Water Framework Directive and the proximity to these receptors is an important factor.

[16] BS 10175:2001

3.2.3.2 Landfill Gas Migration Receptors

Human Presence is considered to be the principal sensitive receptor in respect of landfill gas (and other related nuisance factors such as dust and odours) due to the potential for the build up of gas within confined areas such as schools, houses, etc. In general the flammability and explosion risk from outdoor exposure to landfill gas is not significant.

The geological conceptual models developed by the Geological Survey of Ireland in association with the River Basin District Management projects should be used for the development of a CSM for the waste body (GSI 2005). Additional pathways (services) and receptors (human presence, i.e., dwellings) should be identified at a local scale and added to the CSM. All potential pathways or transport mechanisms should be identified.

Minimum distances to all potential receptors should be identified and clearly marked on a map.

The information below should be presented in the Conceptual Site Model where available and appropriate:

Element	Description	Information Required
Source	Composition of Waste and its extent	Extent of waste body; General description of topography; Actual waste type and area deposited on site (delineated in plan and cross section); Age of waste /period of operation of landfill; Evidence (or potential) of leachate or landfill gas generation (use of Infra Red Detector (IR) following site inspection (including walkover); and History of site development including age of waste/phases.
Pathway	Leachate Migration	Groundwater Flow direction; Groundwater Vulnerability Rating (vertical pathway); Groundwater Flow Regime (horizontal pathway); and Surface water drainage (surface water pathway).
	Landfill Gas Migration	Subsoil and Bedrock Type Likely presence of Underground Services
Receptors	Leachate Migration	Aquifer category (groundwater resource); Drinking Water Supplies (other than private wells) within 1000m (both surface water and drinking water); Location of houses, schools, industrial development, including land use (zoned lands) within 1000m (protection of potential private wells); Protected Areas: Location and designation of any groundwater or surface water dependent ecosystems, flood plains, Special Protected Areas (SPAs), Natural Heritage Areas (NHAs), or Special Areas of Conservation (SACs), bathing waters within 1000m of the boundary of the site; Wetlands; and Location and designation of any surface water bodies within 1000m of boundary of the site.

	Landfill Gas Migration	Location of houses, schools, industrial developments[17], temporary accommodation, and land use (zoned lands) within 250m of the site; and Details and locations of underground services

3.3 Data sources

Each local authority is responsible for the identification of waste disposal and recovery facilities within its area under Section 22 of the Waste Management Acts 1996-2005 and steps should be taken to ensure that all information compiled is as accurate as possible. The list of facilities compiled for the purposes of the Section 22 register is the starting point for the identification of facilities for risk screening. The EPA has developed an Identification Methodology for use by local authorities (Appendix 1). The term 'facilities' is used to mean any site or premises that may have been used for waste disposal or recovery activities. If new facilities become known then these should be added to the register and the appropriate information about the facility compiled. As a minimum the area and thickness of the waste body should be delineated on a GIS and the age and type of waste should be identified.

The River Basin District Management Projects (RBDMPs) also have compiled data layers on the location of some of these known waste disposal facilities. The RBDMPs have GIS layers for the following, which are available to the local authorities through the individual management projects:

Aquifer type

Groundwater bodies

Vulnerability (full national coverage of extreme vulnerable areas)

Soil and Subsoil type

Bedrock type

Runoff Potential

Drinking Water Supplies (both Groundwater and Surface Water)

Surface water bodies (rivers, lakes, estuarine and coastal)

Protected Areas including National Heritage Areas (NHAs), Special Protected Areas (SPAs), and Bathing Waters etc.

Postal Geo-directory (location of residential development)

Other useful datasets, which the local authority may have, are:

Water mains system

County Development Plan

Planning register/ iPlan (location of dwellings)

Aerial Photographs

[17] Including preferential pathways such as significant geological fissures, gravel layers.

The Geological Survey of Ireland (GSI) has developed and has widely disseminated aquifer maps, vulnerability maps, groundwater protection schemes groundwater body maps, and runoff potential maps. In addition, the GSI has developed simple conceptual models for each groundwater body in Ireland and local authorities should use these as a starting point in this process.

RBDMPs have maps showing groundwater dependent terrestrial ecosystems (GWDTE). The National Parks and Wildlife Service (NPWS) of the DoEHLG have maps of all NHAs, SPAs, and SACs, which include non-water related sites.

3.4 Site Inspection (including Walk Over Survey)

A site inspection (including walk over survey)[18], which should be undertaken by a suitably qualified /trained person, should be completed as an integral part of the Tier 1 Risk Assessment Methodology and should allow for the information collated during the desk study to be confirmed or otherwise (see Example Walkover Survey Check List in Appendix 2).

In cases where the confidence level for the information being used in the risk assessment is poor, it is essential for the walkover survey to confirm basic data prior to application of the risk screening methodology. In any case a walkover survey is essential if a facility is to be eliminated from further consideration. If significant impacts are uncovered during the walkover, then the site should be treated as a potentially high-risk site and the appropriate site investigations carried out.

Prior to carrying out the walk over survey permission, if possible, should be sought from the landowner/tenant and all relevant health and safety precautions should be observed. Section 14 of the WMA allows authorised persons to enter lands and guidance on the use of these powers is included in Section 3.2 of the Environmental Enforcement Network Guidance Manual, OEE 2005.

The site inspection (including walk over survey) shall seek to examine each of the possible S-P-R linkages and to gather additional evidence in the form of photographs, sketches, mapping etc. It will help design any intrusive investigations. A walkover survey, undertaken by a suitably trained/qualified person, is required for all sites during the Tier 1 stage.

Delineation of waste body, assessment of waste type, assessment of leachate and/or landfill gas generation (e.g. by using a landfill gas analyser) should be undertaken during the walkover survey. It should also be used to assess the effectiveness of any capping materials and identify the presence of surface water swales. Evidence of discoloration of vegetation, landfill gas odours, leachate leakage should always be documented and photographic evidence obtained. The use of a searcher bar and landfill gas analyser (infra red, methane and CO_2) at this stage may assist in determining whether or not landfill gas is being generated on-site. Older sites may be problematic in terms of obtaining reliable information due to the fact that they may be covered with grass and may not easily be noticeable as a landfill, however, changes in slope and in vegetation cover can be strong indicators of the extent of the waste or at least placed material.

Detailed examination of any cuttings/excavations, waste exposures shall be documented and in some cases trial pitting may be necessary to define the types of waste present. A suitably qualified and experienced person shall supervise any trial pitting. Logs should be made according to BS5930: 1999 for soil and rock descriptions.

[18] Guidance provided in Contaminated Land Research (CLR) Report No.2 (1994); Contaminated Land Management Ready Reference (2002); Environmental Enforcement Manual (2005) and EPA Site Investigations Manual (1995).

If there is evidence of environmental pollution at this stage then action should be taken and landowners, residents, well owners etc should be informed of any known risks or impacts.

The location of all the potential receptors shall be clearly marked on a map and particular attention should be given to identifying any important wetland within 1 km of the site.

3.5 Site Investigations

The initial conceptual model and risk screening exercise should inform the Tier 2 Risk Assessment Methodology: Site Investigations and Testing. Any gaps in information should be identified at the Tier 1 stage and these gaps should be filled (in order of priority) during Tier 2. The level of site investigations should be adequate to provide sufficient information for the site risk assessment. Site investigations should be undertaken in accordance with British Standard 10175:2001, Investigations of potentially contaminated sites: Code of Practice, British Standard 5930:1999 Code of Practice for Site Investigations, EPA Landfill Manual: Investigations for Landfill, 1995 and any further guidance contained in Chapter 5. All site investigations should adhere to the recommendations set out in a relevant Health and Safety Plan and take particular account of the uncertainty related to the site conditions. The risk screening should be re-applied following the site investigation in circumstances where additional information, which has been obtained, may result in a change in risk priority.

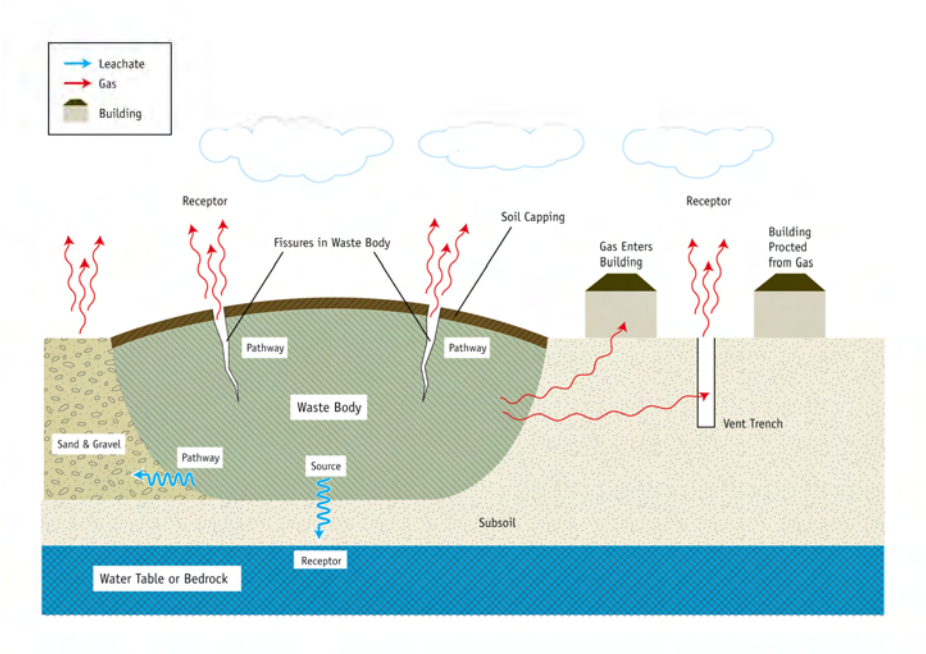
3.6 Verification of CSM

Site investigation and testing will allow for the initial conceptual site model to be refined and subsequent monitoring should verify the final conceptual model and the S-P-R linkages (Tiers 2 and 3).

3.7 Presentation of Information

The information required for a conceptual site model may be presented in a number of different formats. Most common is pictorial form, which includes cross sections showing S-P-R (Figure 6) and Site Plan (Figure 7) and the amount of details will vary with complexity of the site. It is important that the CSM information is clearly documented and accessible in the form of text, figures and tables.

Figure 6: Example of Conceptual Model Cross Section



Network diagrams (Figures 9 to 12 – refer to Section 4.4) and matrices are also commonly used. Written text is also a means of describing a CSM however, it is sometimes difficult to describe all the elements clearly and concisely. More detailed advice is available in Environment Agency publications (see reference list) and in Investigation of Potentially Contaminated Sites – Code of Practice, BS 10175:2001.

Figure 7: Site Plan showing source and receptors

Chapter 4 Risk Assessment Methodology Tier 1: Conceptual Site Model, Risk Screening and Prioritisation

4.1 Introduction

Tier 1 of the Risk Assessment Methodology: Conceptual Site Model, Risk Screening and Prioritisation includes a preliminary investigation of the site and also comprises the development of a Conceptual Site Model (CSM), using information obtained from the desk study and site inspection, and the preliminary risk assessment. The CSM outlines the different Source-Pathway-Receptor (S-P-R) linkages and thereby provides the information for the risk-screening element. A scoring system allows for risk prioritisation of sites.

4.2 Risk Screening

Risk screening represents an assessment of the source-pathway-receptor (S-P-R) linkages in the conceptual model. For an impact to occur there must be a source, pathway and receptor present. The CSM identifies each of the elements of the linkage present for the site and the associated uncertainty. The CSM will determine whether a site represents (or potentially represents) an unacceptable intrinsic risk to any receptor. Information on the development of a CSM has been presented in Chapter 3. The River Basin District Management Projects have developed GIS datasets for the purposes of the Water Framework Directive. These datasets include data layers for closed/illegal landfills (for some counties); aquifer type; vulnerability; location of public/group water supplies; surface water bodies; groundwater dependent terrestrial ecosystems and the An Post geo-directory (residential dwellings). The GIS layers/datasets will be the primary tool used to carry out the risk screening.

The risk that is being assessed is the 'intrinsic risk' that the activity poses without any mitigation measures having been put in place. The 'actual risk' posed to the environment will be reduced following remediation measures.

A separate risk screening shall be carried out for leachate migration and for landfill gas migration. The overall risk is the highest of both risk assessments.

4.3 Risk Prioritisation

Risk prioritisation will enable resources to be spent on the highest risk sites and also on the highest risk S-P-R linkage potential, in a clear and transparent manner that will be easily understood by the local authority and interested parties. The risk prioritisation process assigns a score to each linkage and, the overall site score is the maximum of the individual linkages for the site in question. This allows the potentially highest risk sites and associated significant linkages to be identified. It is likely that some S-P-R linkages will be more important than others thereby identifying the most sensitive receptors at each site.

The scoring system allocates higher numbers for the higher risk elements and thus it allows a meaningful comparison to be made between different sites and between individual linkages. Each of the S-P-R linkages will have a score, which can be assessed to identify the receptor most at risk. The sites can also be ranked in order of priority to allow for informed allocation of resources and attention. The higher the score a site/linkage receives the higher the risk. In cases where there is a high degree of uncertainty (or where information is not known) for a particular element of

risk, the highest score should be assumed, until evidence can be obtained through the site investigations, which more definitively characterises the classification of risk.

4.3.1 Source

The following information should be obtained through the application of the Methodology for the Identification of Waste Disposal or Recovery Sites (Appendix 1). The data sources, which should be systematically examined, are listed in the Identification Methodology.

The age of the waste body should be determined (pre 1977, post 1977) and in many cases this will be based on anecdotal information from LA staff, including retired staff in some cases and from dates on materials such as newspapers found in the buried waste. The age and type of waste is an indicator of the potential hazard that the site poses in terms of leachate and landfill gas generation. The waste body will generally be unlined and therefore there is the potential that any leachate generated may migrate into groundwater and associated streams and also for landfill gas to migrate laterally off-site in certain conditions. If a landfill is older than 30 years (pre 1977) it is likely that in permeable aquifer situations any leachate generated may have already migrated off-site and that the risk to groundwater and water supplies arising from the presence of material in the landfill site has passed. Similarly landfill gas generation is likely to have significantly reduced or ceased and hence the hazard from the site should be reduced. However, on-site monitoring will be required to confirm this. This is reflected in the risk-scoring matrix (Table 1a and 1b).

In all cases, where acute risks[19] are seen or suspected (e.g. evidence of landfill gas migration or the presence of hazardous waste in the landfill), the waste body should be securely fenced-off to prevent access by unauthorised visitors, including members of the general public, and livestock, in order to protect both human and animal health and welfare. By assessing the potential impact on surface waters, the potential impact on livestock consuming the surface water is also assessed as well as the impact on any ecological receptors (e.g. fish).

At the desk study stage, the total volume or area of the waste body can be estimated from aerial photographs, historical mapping, visual evidence and other available information. The site inspection should be used to verify the types of wastes deposited on-site. In some cases some trial pitting will be required at this early stage or use of non-intrusive investigations such as infra-red (IR) or landfill gas analyser may be required to get an understanding of the waste type. In the case where it is known that the waste is in direct contact with the groundwater table as in a sand and gravel quarry then the Groundwater Directive (80/68/EEC) requirements come into force for sites operating post 1980. The groundwater directive prohibits the direct discharge of list 1 substances to groundwater and therefore remedial action will have to be taken on these sites if they contain List 1 substances.

If it is known that different areas of the waste body have different waste types then an estimate of the area of each waste type should be made and the appropriate score should be applied. In many cases there will be a mix of different waste types and expert judgement will be required to allocate the most appropriate score for the source. In the absence of any information to allow further resolution the worst case assumption about waste composition should be applied to the entire body of waste. The methodology for the calculation of weight of waste prescribed for use with the Landfill Levy (Appendix 3) may be used in circumstances where no records of the

[19] Acute risks arise from for example stockpiles of waste, ponded liquids, asbestos waste, unlabelled drums or other containers of waste under uncontrolled conditions.

quantities exists and may be applied if adequate information is available. In any case the most conservative of area/ volume criteria should be used.

In the unlikely event that a site is partially lined with a geo-synthetic membrane it should be assumed that the site is unlined unless a leachate collection system has been shown to be put in place. The lack of any quality assurance testing data or integrity testing for liner systems may also call their effectiveness into question.

Local Authorities are required under Section 22 (h) of the WMA to compile a register of closed waste disposal/recovery sites. The Section 26(2) register, relating to sites where waste disposal activities have been carried out involving hazardous waste to a significant extent, should be considered as a sub-set of the Section 22 register. Waste Management Plans should contain information on the age, tonnage and size of closed sites as well as the names of the operators be they local authority or privately operated sites. The list of facilities in each LA area has to contain accurate information in relation to the location, extent and age of the waste. It is acknowledged that in many cases and in particular for the old closed landfills there will not be sufficient information available on waste type and in these cases it is recommended that the waste type is assumed to be 'non-hazardous municipal waste'. The most important fact to determine in these cases is the time at which the landfill ceased accepting waste or was closed. Once this is known then a risk score may be awarded. In the absence of any information to the contrary, it should be assumed that the site is less than 30 years old.

Risk Assessment Methodology Tier 2: Site Investigations and Testing will allow for further verification of the waste types in accordance with the procedures set out in the Council Decision (2003/33/EC) 'establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to the landfill directive 1999/31/EC' and therefore provide verification, or otherwise, of the hazard posed by the waste body. Special attention should be given to the 'inert' category of waste through validation of anticipated results with findings of investigations.

The source/hazard (waste body) has a scoring matrix (Table 1a and 1b), which relates to the waste type and the area or volume of each of the individual waste types and age of the waste.

Table 1a: LEACHATE: SOURCE/HAZARD SCORING MATRIX

	WASTE FOOTPRINT (ha)		
WASTE TYPE	≤ 1 ha	> 1 ≤ 5 ha	> 5 ha
C&D[20]	0.5	1	1.5
Municipal[21]	5	7	10
Industrial[22]	5	7	10
Pre 1977 sites[23]	1	2	3
		MAX	10

[20] Predominantly inert waste with low biodegradable fraction and/or small industrial waste fraction.

[21] Typically non-hazardous domestic waste (highly biodegradable) with potentially small hazardous waste fraction and/or small industrial waste fraction, e.g. town dump.

[22] Generally industrial waste where hazardous waste was known to have been deposited or there is a strong likelihood that hazardous waste was deposited due to the close proximity of such industries.

[23] Pre 1977 wastes would have been substantially degraded within the landfill.

Table 1b: LANDFILL GAS: SOURCE/HAZARD SCORING MATRIX

	WASTE FOOTPRINT (ha)		
WASTE TYPE	≤ 1 ha	> 1 ≤ 5 ha	> 5 ha
C&D[20]	0.5	0.75	1
Municipal[21]	5	7	10
Industrial[22]	3	5	7
Pre 1977 sites[23]	0.5	0.75	1
		MAX	10

4.3.2 Pathways

The main drivers for the risk assessment are risks from leachate migration and the risks from landfill gas migration. These two factors are determined by the source of waste, the nature of any natural or artificial barrier and the rate of natural attenuation[24] processes. Therefore there is a need for two source-pathway-receptor assessments to be carried out. These two scenarios are dealt with separately.

4.3.2.1 Leachate Migration Pathway

The risk from leachate migration to a receptor is dependent on the groundwater vulnerability category, groundwater flow regime, surface water drainage and the distance to each receptor. There are a number of receptors potentially at risk from leachate.

Groundwater Vulnerability

Groundwater (resource) is a receptor in its own right. Therefore the vertical pathway from the ground surface to the groundwater body needs to be considered. The vulnerability mapping carried out by the Geological Survey of Ireland (GSI, 2005) represents this pathway. Vulnerability maps are available for 55% of the country and the Water Framework Directive River Basin District Management Projects (RBDMPs) have mapped the extremely vulnerable areas (< 3m thickness of subsoil) for the remaining 45%. The unmapped areas are defined as high to low vulnerability. This allows for a score to be allocated during the desk study stage (Table 2a). The classification of the vulnerability rating takes account of both subsoil type and permeability (e.g. sand and gravel, which is highly permeable will only, have an extreme or high vulnerability). Where a landfill is on peat, the vulnerability rating can be taken as low, as the peat has a low permeability and is usually underlain by clays, unless there is evidence that the depth to rock is shallow or the peat has been extracted prior to the landfilling having taken place. In the case of a site where the waste is placed directly on bedrock (e.g. quarry) then the vulnerability should always be defined as extreme, irrespective of the Groundwater Protection Scheme (GWPS) designation. This reflects the loss of any protective subsoil. Where it is known that the waste is in direct contact with the groundwater table then for the purpose of this screening exercise it should be considered to be equivalent to the extreme vulnerability rating. The site investigations will verify (or otherwise) the vulnerability rating. Where the site investigations indicate a different vulnerability rating then this takes precedence over the GSI classification and the GSI should be notified of such anomalies.

[24] Natural attenuation processes include physical, chemical and principally biological processes that slow down migration or degrade contaminants.

Table 2a: LEACHATE MIGRATION: *PATHWAYS*

Parameters	Points available
GROUNDWATER VULNERABILITY (Vertical pathway)	
Extreme Vulnerability	3
High Vulnerability	2
Moderate Vulnerability	1
Low Vulnerability	0.5
High – Low Vulnerability	2

Groundwater Flow Regime

The horizontal groundwater pathway (Figure 8) is represented by the groundwater flow regime parameter. This gives an indication of the relative length of flow path, time of travel and the interaction with surface water for different groundwater bodies. The flow regime associated with karstified groundwater bodies indicates a high groundwater velocity, high degree of inter connection between groundwater and surface water, variable baseflow to rivers, low drainage density and long groundwater flow paths. In contrast, the flow regime associated with poorly productive bedrock groundwater bodies indicates shallow fissure flow, low transmissivity, low baseflow contribution to streams, high surface water drainage density and generally short groundwater flow paths. The GSI have mapped the different groundwater bodies in the country and the flow regime can be determined from these national maps, which are available through the River Basin Districts Management Projects (RBDMPs). Table 2b allocates relative risk scores for leachate migration pathway to the different groundwater flow regimes.

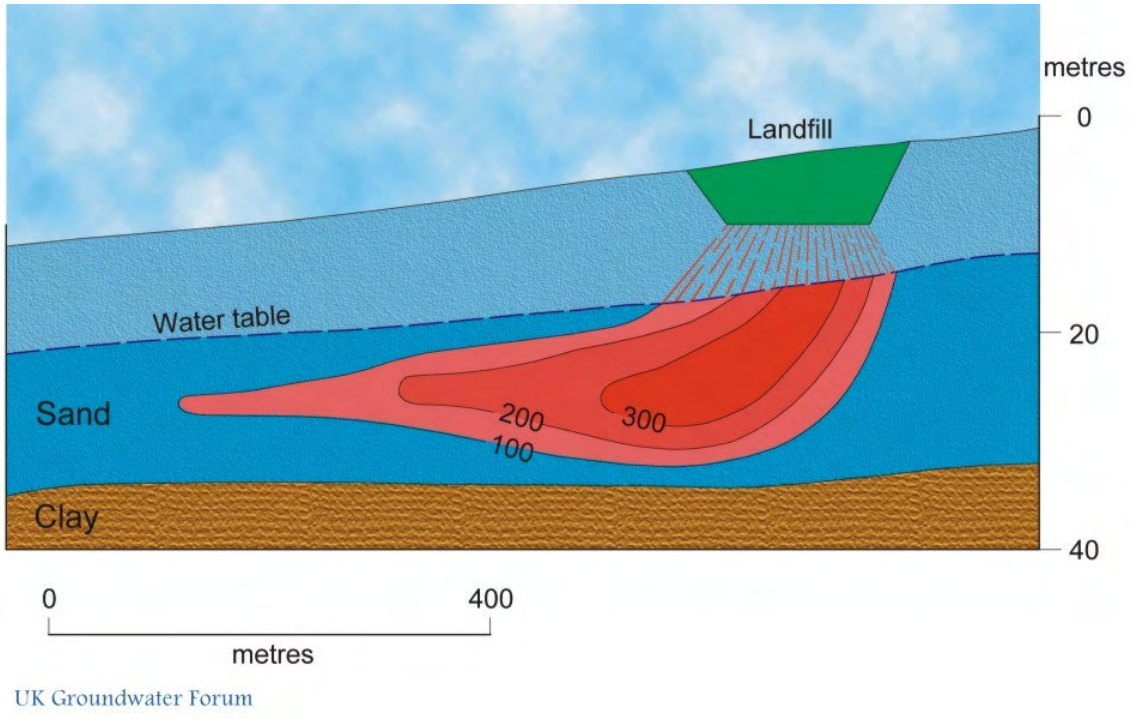
Table 2b: LEACHATE MIGRATION: *PATHWAYS*

Parameters	Points available
GROUNDWATER FLOW REGIME (Horizontal pathway)	
Karstified Groundwater Bodies (Rk)[25]	5
Productive Fissured Bedrock Groundwater Bodies (Rf and Lm)[25]	3
Gravel Groundwater Bodies (Rg and Lg) [25]	2
Poorly Productive Bedrock Groundwater Bodies (Ll, Pl, Pu) [25]	1

Rk Regionally Important Karstified Aquifers
Rf Regionally Important Fissured Bedrock Aquifers
Rg Regionally Important Extensive Sand/Gravel Aquifers
Ll Locally Important Sand/Gravel Aquifers
Lm Locally Important Bedrock Aquifers - Generally Moderately Productive
Lg Locally Important Bedrock Aquifers - Moderately Productive only in Local Zones
Pl Poor Bedrock Aquifers – Generally Unproductive except for Local Zones
Pu Poor Bedrock Aquifers – Generally Unproductive

[25] Refer to DEHLG/EPA/GSI 1999, Groundwater Protection Schemes.

Figure 8: Leachate plume migration (reproduced with permission from UK Groundwater Forum)



Surface Water Drainage

Surface water drainage gives an indication of the likelihood of runoff to surface waters via infiltration through waste and emerging as a spring/seep and moving as surface water runoff. It can be assessed during the site inspection and is a function of the subsoil permeability, aquifer type (transmissivity) and groundwater vulnerability, as well as vegetation cover and depth to water table. A risk score for leachate migration through surface water drainage can be assigned through the use of Table 2c.

Table 2c: LEACHATE MIGRATION: *PATHWAYS*

Parameters	Points available
SURFACE WATER DRAINAGE[26] (surface water pathway)	
Is there a direct connection between drainage ditches associated with the waste body and adjacent surface water body? Yes	2
If no direct connection	0

[26] This element needs to be determined during the site inspection (including walkover survey). The presence of a direct link between surface water drainage from the waste body and any adjacent surface water body implies the existence of a pathway.

4.3.2.2 Landfill Gas Migration Pathway

In the case of landfill gas migration the main pathway of concern is subsoil type/bedrock and the primary receptor is human presence/ occupation where accumulation of landfill gas in explosive concentrations within enclosed spaces can result in injury to people or damage to buildings/structures.

Landfill gas may migrate laterally through the subsoil/bedrock to a receptor if it is present nearby. If the site is underlain and surrounded by permeable unsaturated sands and gravels then there is a greater likelihood of landfill gas migration than if the site is underlain by peat. Similarly landfill gas will migrate through dry fractures in bedrock more quickly than in a till (see Table 2d). This information is obtained from the subsoil maps produced by Teagasc (2006).

A risk score for landfill gas migration pathways can be assigned through use of Table 2d and/or 2e.

Table 2d applies to situations where buildings, structures or other enclosed spaces are present adjacent to or are located within 250m of the waste body. In this case, it is assumed that the waste has been sealed by a capping layer without significant cracks, thereby ensuring that the landfill gas cannot escape upwards and is pushed laterally into natural ground.

Table 2d: LANDFILL GAS: PATHWAY assuming receptor within 250m of source

Parameters	Points available
LANDFILL GAS LATERAL MIGRATION POTENTIAL	
Sand and Gravel, Made ground, urban, karst	3
Bedrock	2
All other Tills (including limestone, sandstone etc – moderate permeability)	1.5
All Namurian or Irish Sea Tills (low permeability)	1
Clay, Alluvium, Peat	1

Table 2e applies to situations where buildings, structures or other enclosed spaces are present above the waste body.

Table 2e: LANDFILL GAS: PATHWAY assuming receptor located above source.

Parameters	Points available
LANDFILL GAS VERTICAL (UPWARDS) MIGRATION POTENTIAL	
Sand and Gravel, Made ground, urban, karst	5
Bedrock	3
All other Tills (including limestone, sandstone etc – moderate permeability)	2
All Namurian or Irish Sea Tills (low permeability)	1
Clay, Alluvium, Peat	1

4.3.3 Receptors

Leachate Migration

There are five main receptor types that are to be considered at the screening stage. The conceptual site model (CSM) should include details of these receptors within the vicinity of the waste body. The presence of a receptor, assuming that a pathway exists, within varying distances of the waste body (hazard) poses different risk scores. In all cases the distances used shall be the minimum distance from the boundary of the waste body to the nearest receptor. The presence of different aquifer types beneath the waste body also has a risk score allocated taking into account the importance of the resource itself (see Table 3c).

Human Presence

The scope of the term human occupation/presence refers to residential dwellings, commercial, leisure and industrial facilities. The location of these facilities may be identified using the An Post geo-directory (or Planning GIS) but should be confirmed during the site inspection. In terms of leachate migration the presence of houses, industries etc. may indicate the presence of private wells and hence is considered to be a potential receptor in the absence of a private well register. This is applying the precautionary principle in relation to potential human health risk.

Table 3a: LEACHATE MIGRATION: *RECEPTORS*

Parameters	Points available
HUMAN PRESENCE (presence of a house indicates potential private wells)	
On or within 50m of the waste body	3
Greater than 50m but less than 250m of the waste body	2
Greater than 250m but less than 1km of the waste body	1
Greater than 1 km of the waste body	0

WFD Protected Areas

The EPA, National Parks and Wildlife Service of the DoEHLG and the RBD Management Projects have identified protected areas as part of the Water Framework Directive requirements. These are subdivided into groundwater dependent terrestrial ecosystems (GWDTE) and also surface water ecosystems SACs, NHAs, bathing water etc. The proximity of any of these features should enable a risk score to be allocated from Table 3b.

Table 3b: LEACHATE MIGRATION: *RECEPTORS*

Parameters	Points available
PROTECTED AREAS (SWDTE or GWDTE)	
Within 50m of the waste body	3
Greater than 50m but less than 250m of the waste body	2
Greater than 250m but less than 1km of waste body	1

Greater than 1 km of the waste body	0
Undesignated sites[27] within 50m of site of the waste body	1
Undesignated sites[27] greater than 50m but less than 250m of the waste body	0.5
Undesignated sites[27] greater than 250m of the waste body	0

Wetlands receive a particular mention in the Ministerial Direction (04/05) in the context of illegal waste activities and an assessment of the potential impacts should be undertaken in all cases where a wetland (including locally important undesignated wetlands) is present on or adjacent to a site where illegal waste activity has been discovered. However, the remedial measures are dependent on the results of the risk posed by the site and the expert advice of the NPWS of the DoEHLG should be obtained. More guidance is outlined in Appendix 4.

Aquifer Category

Information on the aquifer category is important when considering the potential effect of leachate on the potential groundwater resource (aquifer itself). Aquifer maps are downloadable from the GSI website www.gsi.ie. The highest risk score is allocated to regionally important aquifers due to their potential to provide large water supplies (Table 3c).

Table 3c: LEACHATE MIGRATION: *RECEPTORS*

Parameters	Points available
AQUIFER CATEGORY [28](resource potential)	
Regionally Important Aquifers (Rk, Rf, Rg)	5
Locally Important Aquifers (Ll, Lm, Lg)	3
Poor Aquifers (Pl, Pu)	1

Rk Regionally Important Karstified Aquifers
Rf Regionally Important Fissured Bedrock Aquifers
Rg Regionally Important Extensive Sand/Gravel Aquifers
Ll Locally Important Sand/Gravel Aquifers
Lm Locally Important Bedrock Aquifers - Generally Moderately Productive
Lg Locally Important Bedrock Aquifers - Moderately Productive only in Local Zones
Pl Poor Bedrock Aquifers – Generally Unproductive except for Local Zones
Pu Poor Bedrock Aquifers – Generally Unproductive

Public Water Supply

The location of the source of public water or group schemes (the definition of public water supplies does not include private supplies) should be obtained from the local authority or from the register of protected areas (OEA, 2005). It is important to confirm that there is no public/group scheme within 1km of the site and that the aquifer is not a karstic one prior to using a value of zero.

[27] The term 'Undesignated sites' refers to wetland sites that are not designated under the Habitats or Birds Directive or Wildlife Act but are considered to the important on a local scale. Consultation with NPWS is required to identify such sites.
[28] (DOEHLG/EPA/GSI 1999) Groundwater Protection Schemes.

An estimate of the general groundwater flow direction should be included as part of the CSM and therefore the location of the waste body in relation to the receptor should be known and the risk score allocated accordingly. In cases where the groundwater direction is unknown then the worse case scenario should be used. Some public groundwater supplies have source protection areas delineated (available from GSI or relevant LA), which indicate both the outer and inner source protection areas (SO and SI) and where known the score in Table 3d should be applied.

This rating also applies to sources of surface water abstractions for public supply. The flow direction of the river should also be identified as if the surface water public supply is abstracted upstream of the landfill then it will not be affected by leachate seeping in to the river (i.e. no effective pathway) and therefore it should not be considered as a receptor.

Table 3d: LEACHATE MIGRATION: *RECEPTORS*

PUBLIC WATER SUPPLIES (other than private wells)	
Within 100m of site boundary	7
Greater than 100m but less than 300m or within Inner SPA (SI) for GW supplies	5
Greater than 300m but less than 1km or within Outer SPA (SO) for GW supplies	3
Greater than 1km (karst aquifer)	3
Greater than 1km (no karst aquifer)	0

Surface Water Body

The 1:50,000 Discovery Series and 1:10,560 (6-inch) maps should be consulted and information gathered during the site inspection to confirm the connection between any streams or ditches on-site and surface water bodies (as designated under the WFD). Surface water bodies include estuaries and seashore (Table 3e). RBD information/assessment may indicate a surface body 'at risk' and this should be considered during the assessment. Leachate poses a significant risk to all waters regardless of their Classification. All stream sections should be visually inspected for the potential presence of leachate. Any potential access to the watercourses by livestock should be noted during the site inspection. The assimilative capacity of the surface water body should be calculated and considered during the site investigation and impact assessment stage.

Table 3e: LEACHATE MIGRATION: *RECEPTORS*

Parameters	Points available
SURFACE WATER BODIES	
Within 50m of site boundary	3
Greater than 50m but less than 250m	2
Greater than 250m but less than 1km	1
Greater than 1km	0

Landfill Gas Migration

Human Presence/Habitation

There is a risk of landfill gas migration from landfills where biodegradable wastes have been deposited and resulted in gas generation at the landfill site. Landfill gas

may build up in confined spaces such as housing (e.g. basements) or can migrate along services, drains, ducts, and pipelines. The table below indicates a risk score (Table 3f), which varies depending on distance from the edge of the waste body. This does not suggest that there is a problem of landfill gas build up at these distances from landfills but highlights the increased potential risk of such an occurrence, which must be investigated further in Tier 2. The term human occupation/presence refers to residential dwellings, commercial and industrial facilities. In addition, it includes housing for animal livestock including poultry and particular attention should be given to those sites where there is a potential for landfill gas accumulation. The location of these sites may be identified using the An Post geo-directory (or Planning GIS) but should be confirmed during the site inspection.

Table 3f: LANDFILL GAS: *RECEPTOR*

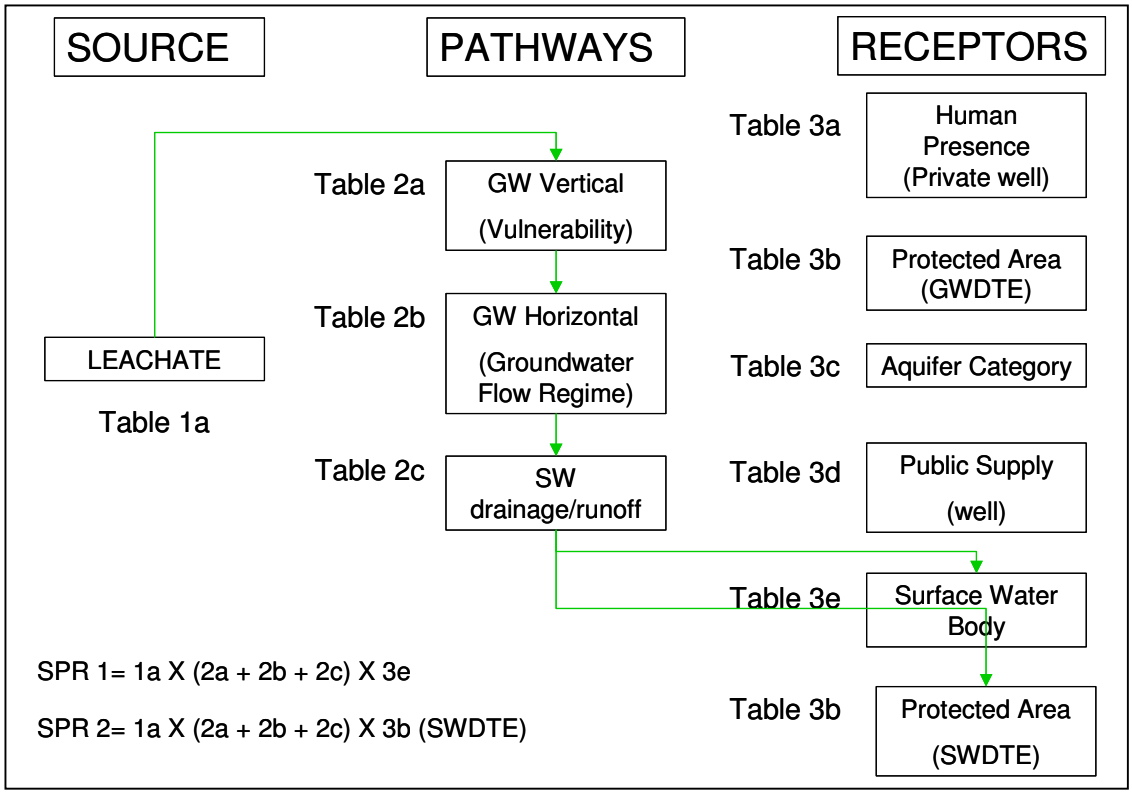
Parameters	Points available
HUMAN PRESENCE	
On site or within 50m of site boundary	5
Greater than 50m but less than 150m	3
Greater than 150m but less than 250m	1
Greater than 250m	0.5

4.4 Risk Prioritisation

4.4.1 S-P-R Linkage prioritisation

Each one of the eleven possible S-P-R linkages should be scored individually. The scoring calculated for each linkage will provide an indication of the relative risk associated with the S-P-R linkage at a site. The following network diagrams illustrate all of the various S-P-R linkages that may be present on any site. The S-P-R linkages are determined during the development of the conceptual model and should be confirmed during the site investigation stage for each individual site. The S-P-R linkages are site specific and all of the linkages may not be present on a given site. It is therefore critical that a comprehensive conceptual model be developed prior to the carrying out of the risk screening.

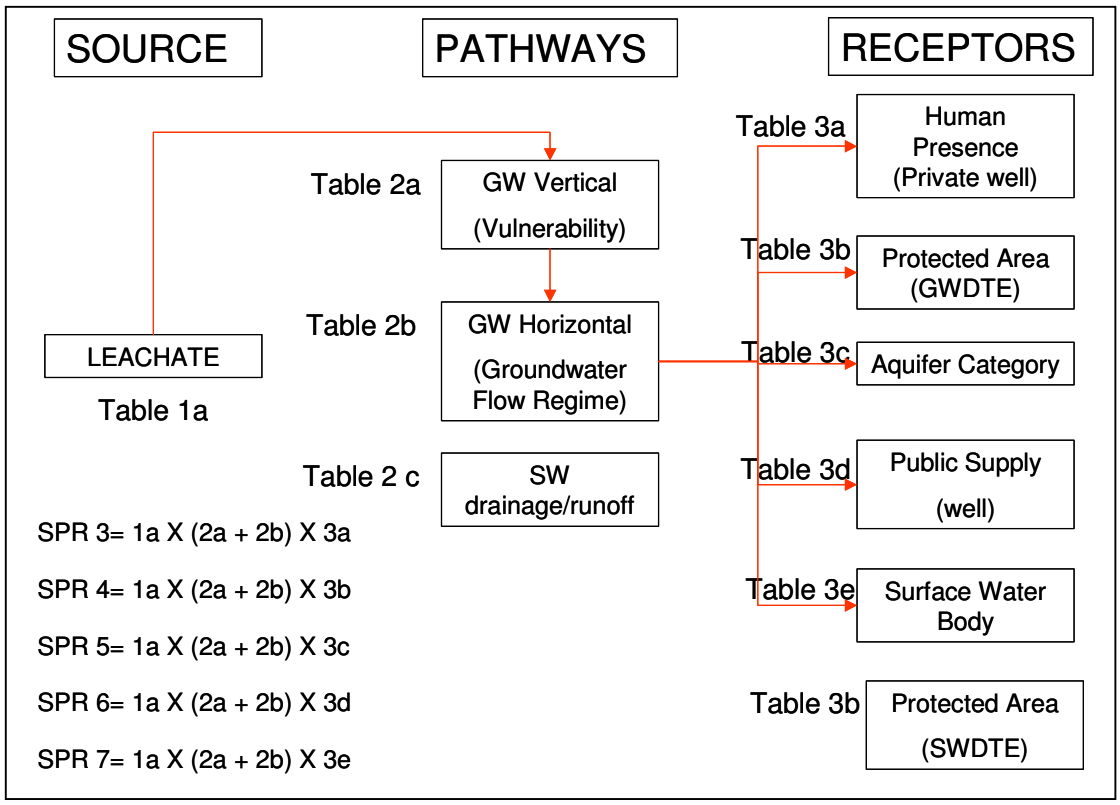
Figure 9: Network Diagram for Leachate Migration through combined groundwater and surface water pathways



Two S-P-R linkage scenarios are shown in Figure 9 above, S-P-R1 relates to a scenario where leachate is present (this is dependent on landfill age and extent as well as waste type – Table 1a) and it migrates downwards through the subsoil (function of groundwater vulnerability Table 2a) into the aquifer, where it then migrates horizontally (function of the groundwater flow regime Table 2b) and discharges to the local drainage system (function of the presence of surface water drainage Table 2c) prior to affecting the associated surface water body receptor (Table 3e) or in the case of S-P-R 2 where it affects a protected area receptor (surface water dependent terrestrial ecosystem Table 3b). This scenario will generally occur where there is an extremely vulnerable poorly productive bedrock groundwater body characterised by low permeability and short flowpaths, with groundwater re-emerging in drains, rather than flowing long distances in the bedrock.

In the case of Figure 10 a number of S-P-R linkage scenarios are shown associated with the groundwater pathways and these linkages should only be assessed when there is an assumption made in the conceptual model that the linkages are present. The appropriate risk score is taken from each of the tables that are mentioned in the equations in Figure 10. A score should only be calculated for the S-P-R linkages that are present. As part of the conceptual model each S-P-R linkage should be illustrated on a network diagram and then the appropriate equations can be applied for each linkage.

Figure 10: Network Diagram for Leachate Migration through Groundwater Pathway



Where the surface water drainage is from direct runoff of rainfall and/or leachate directly from the waste body and the drains are not considered to be fed by the groundwater then the surface water drainage pathway (Table 2c) should be examined (Figure 11). This is where a thick subsoil (low vulnerability) is present and the majority of flow is in the surface water system with very little water percolation downwards to the groundwater body. The receptors in this case are either a surface water body (Table 3e) or where the drains directly feed into a SWDTE (Table 3b). In a limited number of scenarios where the drains feed both receptors then both equations should be used.

Landfill gas may be generated where biodegradable waste is present in the waste body. The potential for landfill gas migration shall be assessed when a potential receptor is present and under circumstances where there are indications that landfill gas is being generated by the waste body, which may pose a risk to a receptor, (Figure 12). The appropriate risk score for the assessment of gas generation shall be taken from Table 1b. There are two possible pathways that have to be assessed; lateral and vertical migration through the subsoil or bedrock. The receptor of concern is 'human presence'. If a dwelling or premises is sited adjacent to the waste body then the potential risk is from lateral movement of the gas through the subsoil and the risk score is dependent on distance and the type of subsoil (Table 2d). Where a building has been built directly on the waste body then an assessment of the vertical movement of landfill gas into the building must be assessed (Table 2e).

In order to make the results more meaningful to decision makers and stakeholders, individual S-P-R linkage scores should be normalised to a rating of 100. This is done by dividing the linkage score by the maximum possible score, which is dependent on the individual linkage, and multiplying by 100 to give a percentage score. The overall site score is considered to be the maximum of the individual normalised S-P-R linkage scores.

Figure 11: Network Diagram for Leachate Migration through Surface Water Pathway only

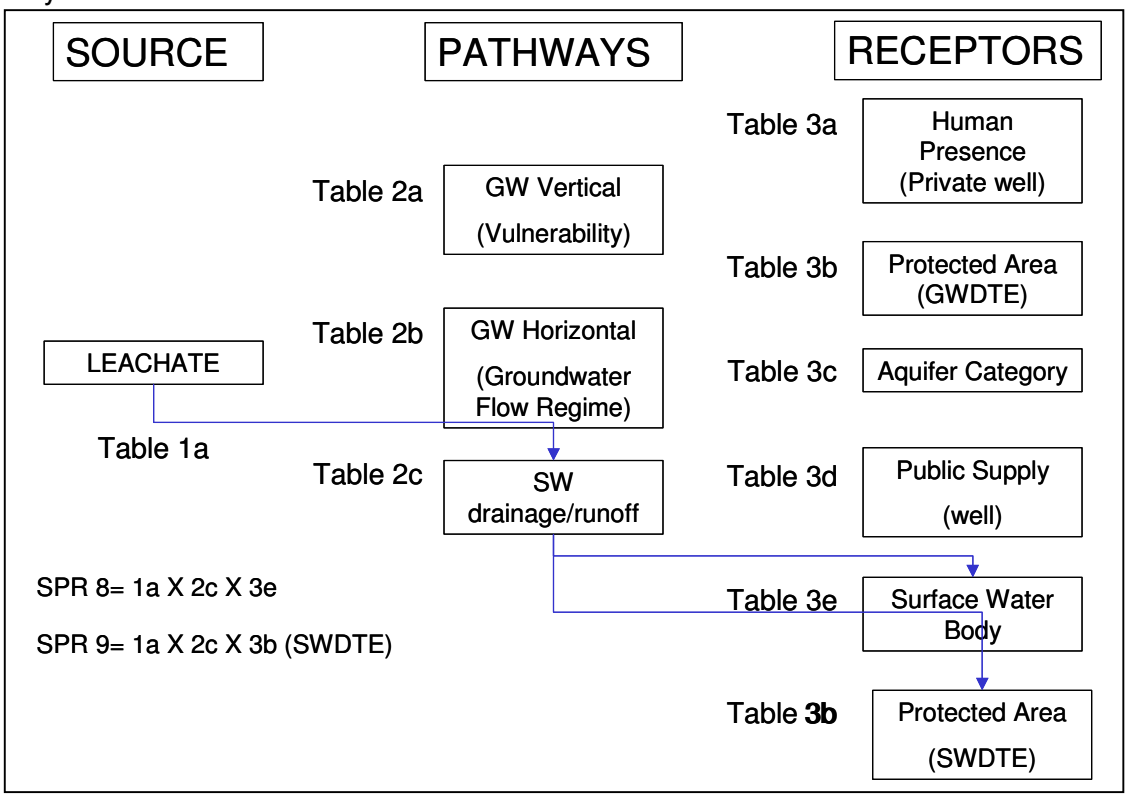
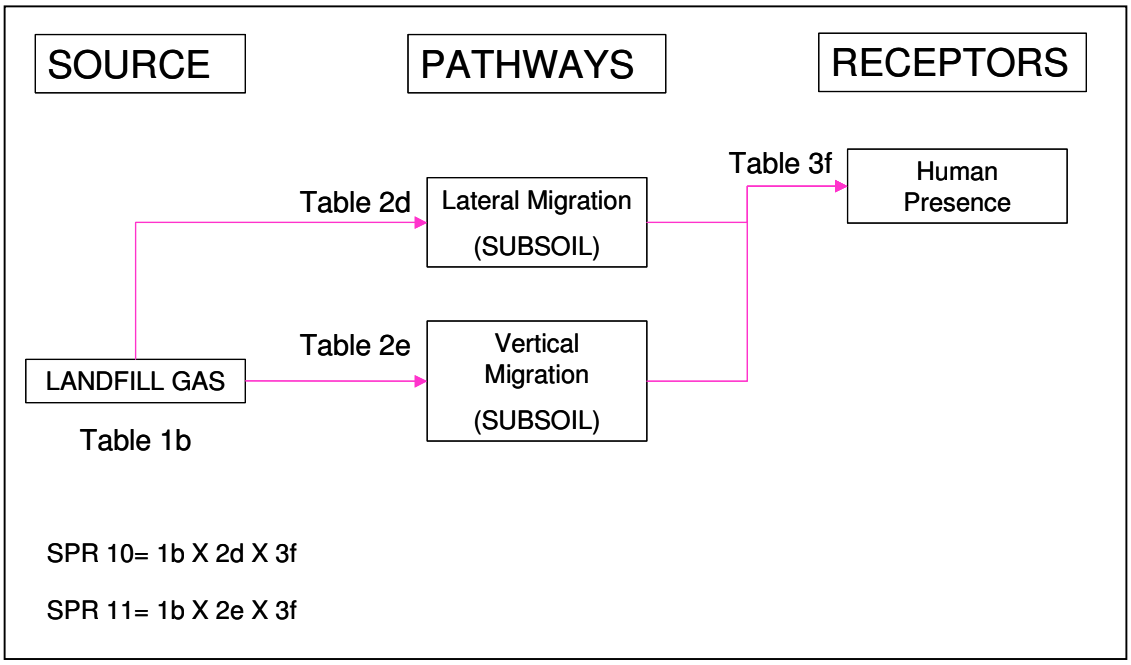


Figure 12: Network Diagram for Landfill Gas Migration Pathways (Lateral and Vertical)



4.4.2 Site prioritisation

Using the methodology developed in Section 4.3, sites can be prioritised relative to each other in terms of overall risk using the maximum of the individual normalised S-P-R scores.

A high score indicates either a high risk or high level of uncertainty, which requires further examination through Risk Assessment Methodology Tier 2:Site Investigations and Testing. For local authorities this provides a mechanism by which they can prioritise site investigations starting with the highest risk / high uncertainty sites and progress to low risk. The high-risk sites should be considered before the high uncertainty sites. It also allows newly discovered sites to be assessed and then placed on the ranking scale. There are three bands of risk HIGH (Class A) – MODERATE (Class B) – LOW (Class C).

Sites with a score greater than or equal to 70% for any of the site-specific S-P-R linkages are considered to be potentially high-risk or high uncertainty sites and site investigations should be commenced as soon as possible. The risk screening shall be re-run following the site investigations to confirm the risk status of the site prior to being allocated to Class A. These sites will have to apply for a waste regularisation licence or permit through an administrative system, which will be established for the purpose in the context of Section 22 of the Waste Management Acts, 1996 to 2005.

Class B sites are defined as sites where any of the site-specific S-P-R linkages have a score between 40% and 70% and site investigations are required to verify the risk status. Class B sites will have to apply for a regularisation licence or permit through an administrative system, which will be established for the purpose in the context of Section 22 of the Waste Management Acts, 1996 to 2005.

The lowest risk scoring sites (Class C) are those where the maximum individual S-P-R linkage score being no more than 40%, these sites are not considered to pose a significant risk to the environment or human health. A verification report on the risk status of the site may be submitted as part of the regularisation process through an administrative system, which will be established for the purpose in the context of Section 22 of the Waste Management Acts, 1996 to 2005. While a Class C site is deemed not to pose a risk at the time of the evaluation a hazard may still be present. It is critical, therefore that if there is a proposed change in land-use then a re-appraisal of the risk, based on detailed site investigations, shall be carried out. All appropriate information shall be made available to the planning authority during the assessment of any planning application for a change in use.

A review of all the sites taking account of any new information shall be undertaken on an annual basis and in any case all sites should be re-assessed after 5 years to take account of further guidance issued and any change to the land use or new developments in the vicinity of the site.

4.4.3 Assigning a Risk Classification

The facility risk classification assigned at this stage represents the intrinsic risk that the site poses to the environment. It does not take account of any mitigation measures that may have been put in place nor any proposed measures.

Where there are site-specific monitoring data available for a site then this data should be consulted at this stage to confirm (or otherwise) the assigned classification. If the monitoring data indicates that the environment has been impacted by the landfill and the risk screening indicates that the site had a low risk classification then the site

should be treated as a high-risk site so that further investigations are carried out on a prioritised basis.

It is not acceptable to reduce the risk classification purely on the basis that the data indicates that there is no impact. This is particularly true when assessing illegal landfills, as there is a time lag that exists between the placement of waste and its degradation and subsequent leachate (and/or landfill gas) migration.

However, as stated above, the initial designation of the site does not take into account existing or proposed mitigation measures. Where actions have been taken, which will break the S-P-R linkages or materially reduce the level of risk, and then the risk classification of the site may be lowered accordingly in consultation with the regulatory authority.

The risk classification is assigned at this stage, which influences the scoping of the site investigations. The methodology should be re-applied following the site investigation where the level of confidence in the data has increased. A site shall be preliminarily assigned a risk classification depending on the risk score ranges in Table 5 below.

Table 5: Risk Classification

Risk Classification	Range of Risk Scores
Highest Risk (Class A)	Greater than or equal to 70% for any individual SPR linkage
Moderate Risk (Class B)	Between 40-70% for any individual SPR linkage
Lowest Risk (Class C)	Less than or equal to 40% for any individual SPR linkage

Chapter 5 Risk Assessment Methodology Tier 2: Site Investigations and Testing

5.1 Introduction

The guidance provided in this section draws heavily on previously prepared site investigation guidance and the reader should refer to the documentation listed in the reference list in Chapter 9 (this is not an exhaustive list of guidance on best practice) and in particular to the following:

- Investigation of potentially contaminated sites – Code of Practice, BS 10175:2001, British Standards Institution, UK.
- Code of Practice for Site Investigations, BS 5930:1999. British Standards Institution, UK.
- Contaminated Land Management: Ready Reference, J. Nathanail, P Bardos, P. Nathanail, 2002 Land Quality Press and EPP Publications.
- Landfill Manuals: Investigations for Landfills (1995), EPA, Wexford.
- Hydrogeological Risk Assessments for Landfills and the Derivation of Groundwater Control and Trigger Levels, Environment Agency, 2003.
- Technical Aspects of Site Investigation in relation to Land Contamination: Vol.1 R&D Technical Report P5-065/TR, Environment Agency, 2000.
- Technical Aspects of Site Investigation in relation to Land Contamination: Vol.2 Text Supplements. R&D Technical Report P5-065/TR, Environment Agency, 2000.
- All relevant CIRIA publications (see Chapter 9).

The objectives in the design of the site investigation (SI) programme should be clearly defined at the outset and should be site specific. All site investigations are informed by the conceptual site model (CSM) and the risk classification of the site that is established by the Risk Assessment Tier 1: Conceptual Site Model, Risk Screening and Prioritisation. The information obtained through the application of the walkover survey checklist (see Appendix 2) will further inform the scope of the site investigation. A communication plan should be prepared to inform all relevant persons (including adjacent landowners) of the site investigation works. Any findings of the site investigation works that may indicate a significant risk to any person or property shall be communicated to the persons involved and advice given on any appropriate actions that should be taken.

The highest-risk sites (Class A sites) should have a sufficiently detailed site investigation programme that will provide information to confirm (or otherwise) its risk classification as well as informing the quantitative risk assessment to be undertaken as part of Tier 3 and subsequent recommendations for remediation. In the case of the lowest-risk sites (Class C) the investigations should be planned such that there is sufficient information to verify the site categorisation and allow recommendations to be made on the follow up actions (should they be required).

It is important to continually evaluate the information provided at each stage of the SI and modify the design of the investigation programme if unexpected results are found which have the potential to create important implications for the objectives of the site investigation.

All site investigations must be supervised at all times by a suitably qualified, trained and experienced person, who is a registered professional with chartered status (or equivalent) awarded by a relevant professional body, and who has successfully conducted similar investigations at other sites.

In all cases a Health and Safety Plan should be developed and adhered to during the works. The Health and Safety Plan must conform to all relevant Health and Safety legislation.

5.2 Objectives of the Site Investigation

The overall objective of the site investigations (SI) is to provide information that allows an assessment to be made regarding the existence of significant pollutant linkages on site, which may lead to remediation measures having to be put in place.

In drawing up the objectives for the site investigation (SI) the following general questions should be considered (derived from BS 10175:2000):

What questions does the SI need to be able to provide answers to?

What information is needed and to what level of detail and accuracy?

What is the purpose of the SI in respect to the risk assessment methodology under consideration?

Although the questions above remain the same the answers may vary depending on the risk status/classification of the site. The answers to these questions will define the scope of the site investigation and then further consideration will have to be given to the optimum SI methods to be employed.

Full advantage should be taken of all data, which is already available in order to minimise the necessary extent of new site investigation works. Considerable information has been obtained during the desk study stage, which may be considered as the preliminary investigation stage. It should always be consulted when answering the questions.

5.2.1 Highest Risk Sites

A non-exhaustive list of questions that should be posed for the highest risk sites (Class A sites) prior to defining the site investigation programme are outlined below:

- What questions does the SI need to be able to provide answers to?
  - Are the data that were used in the conceptual model and risk screening exercise valid and accurate?
  - Is there a need for specialist input e.g., ecologist etc?
  - Is there biodegradable or hazardous waste present?
  - What is the potential for landfill gas migration?
  - Is there a natural geological barrier in place?
  - Is there the possibility of a direct discharge of a listed substance to groundwater?
  - What is the degree of hydraulic connectivity between groundwater and surface water?

- Are there any impacts evident?
- What remediation measures are required?
- Have any remedial measures been put in place and have they been effective?

- What information is needed and to what level of detail?
  - Waste type and age across the site
  - Depth of waste
  - Depth and composition of any capping layer
  - Leachate monitoring[29]
  - Subsoil type, thickness and permeability (in-situ or laboratory testing required)
  - Bedrock type
  - Aquifer type and groundwater flow regime
  - Hydrogeological properties
  - Groundwater level and flow direction
  - Groundwater Trigger levels to be established[30]
  - The location and hydrological setting of Surface water drainage, including details of water levels and flow rates
  - Surface water classification
  - Ecological survey including value and functions (see Appendix 4)
  - The requirements of compliance points to be defined for monitoring.
  - The requirements for monitoring for landfill gas within the waste body and at the nearest receptors (including the need for installation of monitoring points and use of gas probes)
  - The requirements for monitoring of surface waters for typical leachate parameters as well as List 1 and 2 substances.
  - Monitoring of groundwaters both up gradient and down gradient of the site for typical leachate parameters as well as List 1 and 2 substances (including the need for installation of monitoring boreholes).

- What is the purpose of the SI in respect to the risk assessment?
  - Confirmation that the site is a Class A site and the situation warrants further quantitative risk assessment and remediation.
  - Collection of sufficient data for quantitative risk assessment.
  - Collection of sufficient data to demonstrate the effectiveness of remediation options proposed.

[29]EPA 2003, Landfill Manuals: Landfill Monitoring (2nd edition) and Environment Agency 2002, The monitoring of Landfill Leachate, Groundwater and Surface Water.
[30]Section 4 Hydrogeological Risk Assessments for Landfills and the Derivation of Groundwater Control and Trigger Levels, EA, 2003

5.2.2 Moderate Risk Sites

The information required for the moderate risk sites (Class B sites) is not as detailed as the highest risk sites (Class A sites), however, it should be considerably more than that outlined below for lowest risk sites (Class C sites) the general information requirements will be dictated by;

What questions does the SI need to be able to provide answers to?

What information is needed and to what level of detail and accuracy?

What is the purpose of the SI in respect to the risk assessment?

5.2.3 Lowest Risk Sites

For low risk sites (Class C sites), as much of the information as possible should be obtained through simple physical observations. The following questions will typically need to be posed.

- What questions does the SI need to be able to provide answers to?
  - Are the data that were used in the conceptual model and risk screening exercise valid and accurate?
  - Are there any impacts evident?
  - Have any remedial measures been put in place?

- What information is needed and to what level of detail and accuracy?
  - Are landfill gas and/or leachate currently being generated at the site?
  - Monitor for landfill gas at nearest receptor
  - Is there any leachate seepage? If yes,
    - Sample adjacent surface waters
    - Sample all private wells within 250m
  - Has the site sufficient cover material in place to minimise infiltration into the waste body[31]?

- What is the purpose of the SI in respect to the risk assessment?
  - Verify that the site does not pose a risk to the environment or human health.
  - It forms the basis for recommended remedial measures (if any).

5.3 Phases of Site Investigation

The level and extent of the Site Investigation Programme is governed by the degree of risk, which the site poses to the environment. Detailed below are the different levels of site investigation, which can be applied and ranges from a preliminary

[31] Refer to EPA Landfill Manuals: Site Restoration and Aftercare 1999

investigation to a main investigation and, in some cases, specialist additional investigations, which may be required for further investigation of particular situations.

It is envisaged that the level of Site Investigation for the various categories of site would be as follows:

Preliminary Investigation – Desk Study and Site Inspection (including Walkover survey) (Tier 1) – all sites

Exploratory Investigation (Tier 2) – all Class A, B and C Sites

Main Investigation (Tier 2) – Class A and B Sites

Additional Investigations (Tier 2) – site specific, but should be carried out for each class of site as appropriate.

5.3.1 Preliminary Investigation

The Preliminary Investigation is an integral part of the Tier 1 of the Code of Practice. It comprises a desk study and site inspection (including walkover survey) and the reader is referred to Sections 3.4 and 4.1, which outline respectively the procedures to be followed in the site inspection and the manner in which the information thus obtained should be applied to the development of a conceptual model.

5.3.2 Exploratory Investigation

Exploratory Investigations shall be carried out to confirm the initial conceptual model prior to designing the Main Investigation programme or may be used to verify that the site is a Class C site. It shall investigate the landfill gas regime and leachate regime, the investigation may consist of trial holes, landfill gas sampling at the nearest receptors and also some landfill gas and leachate monitoring within the waste body itself. Some water sampling may be necessary to confirm that there is no evidence of impacts from the waste body.

5.3.3 Main Investigation

The amount of information required in the Main Investigation varies depending on the nature of the site and the preliminary site classification that has been assigned as a result of the desk study and site inspection, which will influence the possible requirements for remedial measures. The investigations should be carefully designed to enable a full assessment of the risk to be made and to confirm (or otherwise) the presence of source-pathway-receptor (S-P-R) linkages identified in the Preliminary Investigation. GPS should be used to determine the grid reference for all site investigation locations and where relevant, topographic information to ordnance datum m O.D (Malin) should be obtained.

5.3.4 Additional Investigation

Additional investigations may be required where 'hot spots' have been detected during the main investigations or where the findings of the main investigation are contrary to the Preliminary/Exploratory Investigations. In some cases specialist investigations such as ecological surveys or dye tracing etc may be required to fully understand the S-P-R linkages. These additional investigations should be decided upon on a site-by-site basis. The simple small stream risk score assessment methodology[32] developed by the Western River Basin District Management project

[32] Downloadable from the www.wrbd.ie website.

may be a useful tool to assess impacts on surface waters from adjacent waste disposal sites.

5.4 Scoping the Site Investigation

In all cases the site investigation should consider the conceptual site model (CSM) and the source-pathway-receptor (S-P-R) linkages identified during the Risk Assessment Tier 1: Conceptual Site Model, Risk Screening and Prioritisation and the information requirements prompted by an analysis of the questions posed in section 5.2. The importance of having a suitably qualified person to design the scope of the works should not be under-estimated as it will enable expert decisions to be made on a site-by-site basis, following due consideration of the most appropriate scientific and technical information. The scope of the Site Investigation should allow for flexibility in the methods of investigation as the actual requirements may vary depending on the ground conditions that are encountered during the site investigations. A site plan indicating the proposed site investigations and sampling locations shall be drawn up prior to the commencement of the works.

5.5 Methods of Investigation[33]

An appropriate Health and Safety Plan, conforming to all relevant Health and Safety legislation, shall be drawn up and adhered to during the site investigations. Each site investigation programme shall be designed taking account of the appropriate methods available to achieve the objectives of the site investigation as established and following an analysis, which has been carried out in accordance with the procedure set out in Section 5.2.

5.5.1 Non-Intrusive Investigations

5.5.1.1 Walkover survey

A walkover survey will have already been undertaken by a competent person as part of the Risk Assessment Methodology Tier 1: Conceptual Site Model, Risk Screening and Prioritisation, in accordance with the check list in Appendix 2 and the advice provided in Section 3.4 of this Code of Practice.

5.5.1.2 Geophysics[34]

Geophysical techniques are indirect methods of investigation that use the properties of the subsurface, such as electrical resistivity and density, to indicate a change in ground conditions. These techniques can be used when a site has contrasting physical properties and may in some cases be cost effective in locating anomalies prior to further investigations by drilling or trenching. Geophysical measurements do not remove the requirement for intrusive ground investigations, but provides wide coverage and/or cross-sectional data, which greatly enhances the value of point data from intrusive investigations and can prove valuable in verifying the ground conditions between individual intrusive investigations such as boreholes.

[33] The reader is referred to BS5930: 1999 and BS 10175:2000 for further details.
[34] Refer to Section 4.2 CLM: Ready Reference 2002 and EPA 1999 Landfill Manuals: Site Investigations.

TYPE	DESCRIPTION
Conductivity Surveys	It uses a time varying electromagnetic (EM) field to induce current, which creates a secondary field. It can be used to give an indication of disturbed ground, interpret variations in groundwater quality and the presence of metallic objects.
Resistivity Surveys	This method passes a current into the ground through two metal electrodes and the potential difference measured between two similar electrodes. It provides an imaged-contoured two-dimensional cross-section. It may be used to provide information on the different layers in the ground (may detect extent of waste body), lateral changes in resistivity (water table) or local anomalous areas (swallow holes)
Microgravity	This method measures the changes in the gravity values arising from vertical and lateral density variations in the subsurface.
Magnetic Profiling	It detects changes in magnetic field and may locate areas of fill, faults, metallic objects or mine shafts.
Seismic Refraction	Seismic waves are produced and accurately measuring the time taken for them to travel from the point of origin to the geophones. It is used to locate boundaries within the ground between materials having different values for the velocity of shock waves. Greatest use is in determining depth to rock and fracture zones at shallow depths.
Ground Penetrating Radar	This method provides a measurement of reflected microwave frequency EM radiation pulsed into the subsurface. It has a high resolution of near surface targets including plastic pipes, metallic objects, voids and mines.

5.5.1.3 Ecological Surveys

An ecological survey (which may include a hydraulic assessment) may be required where waste has been deposited in or within 1km of a designated protected area or an undesignated wetland. The scope of the survey shall include assessment of the function and value of the wetland (Appendix 4). A suitably qualified person shall undertake these surveys and shall consult with the local National Parks and Wildlife Service.

5.5.2 Intrusive Investigations [35]

TYPE	DESCRIPTION
Trial pits and trenches[36]	Formed by hand digging or by use of a tracked excavator. Bulk disturbed samples of soil and subsoil can be obtained. It allows detailed examination of the ground conditions in three dimensions. Trial hole profiles should be photographed and logged in accordance with BS 5930:1999.
Hand augers	There are many different types available and the most useful allowing a core sample to be taken. They allow an examination of the soil profile but may achieve limited

[35] Refer to Section 4.3 CLM: Ready Reference (2002) and EPA Landfill Manuals: Site Investigations (1999)
[36] For health and safety reasons trial pits and trenches greater than 1.2m deep should not be entered unless shored.

	penetration depths in till with cobbles or stones present or in areas of Made Ground.
Cable Percussion Boring (Shell and auger)	It is used to penetrate through subsoils and allows disturbed subsoil samples to be taken and analysed. The diameters range from 150-300mm and the maximum borehole depth is 60m. It uses a cutting shoe and shell or bailer. It operates using percussive action and may achieve limited penetration depths in till with cobbles or stones present or in areas of Made Ground.
Rotary Open Hole Drilling	Drilling method where the drill bit is rotated on the bottom of drill-string in the borehole while drilling fluid or compressed air is pumped down to the bit to both lubricate the bit and flush cuttings/drill debris up the borehole. Samples will consist of flushed cuttings brought to the surface. 'Air Rotary' is the most common form of drilling used in Ireland.
Rotary Core Drilling	Most commonly used in the mineral industry this method also uses a rotating drill string, but uses a hollow diamond tipped core barrel to recover an undisturbed sample of rock or material, which can be studied in detailed to give an accurate description of the material encountered in the borehole

5.5.3 Sampling Strategies

Sampling locations for waste type, subsoil, groundwater or surface water and landfill gas are a critical aspect in the design of any site investigation programme. The scope and extent of sampling requirements should be informed by the risk classification, which has been assigned to the site in the Risk Assessment Methodology Tier 1: Conceptual Site Model, Risk Screening and Prioritisation. The design of the programme should allow some latitude in order to provide the necessary flexibility for modification should the conditions encountered on site be materially different to the anticipated conditions. A strategy shall be developed in accordance with best practice and taking into account the nature of the sampling to assess the extent and type of waste; subsoil type and thickness, groundwater level and quality, surface water flow and quality and the presence (or otherwise) of landfill gas and any other issues identified during the desk study and site inspection.

It is important to note that waste in illegal sites is potential evidence against those that carried out the illegal dumping. The excavation of trial holes or other intrusive investigations carried out as part of a risk assessment may uncover evidence, which shall be subject to a strict chain of custody and preservation. Best practice for the handling of evidence shall be followed as outlined in Section 2.4 Evidence Gathering of the Environmental Enforcement Network Manual.

The strategy should be flexible to allow for any anomalous material or strata being sampled. The reasons for choosing sampling locations should be documented and the number and locations of samples should be sufficient to inform the risk assessment. All samples should be appropriately labelled and all chain of custody procedures followed. In the case of water quality analysis, the parameters required to be monitored and their minimum reporting limits (see Appendix D, EPA 2003) should be specified in the sampling strategy or in the site investigation specification.

The following guidance documents and standards should be consulted when devising a sampling strategy:

- EPA 2003, Landfill Manuals: Landfill Monitoring (2nd edition).
- EPA 1999, Landfill Manuals: Site Investigations.
- CLR Report No. 4 1994 – Sampling Strategies for Contaminated Land, DoE, Contaminated Land Research (CLR) Report.
- BS 5930: 1999, Code of Practice for Site Investigations.
- BS 10175: 2000, Investigation of potentially contaminated sites – Code of Practice.
- BS 6068 Water Quality: Sampling (parts 6.1-6.6 and 6.11-6.12, 6.14)
- BS 8855 Soil analysis (all parts)
- CLM: Ready Reference 2002, Section 3.1 Soil sampling strategies.
- CLM: Ready Reference 2002, Section 3.2 Groundwater sampling/monitoring strategies.
- CLM: Ready Reference 2002, Section 3.3 Gas sampling/monitoring strategies.

5.6 Reporting Requirements

A detailed interpretive report is required to be submitted on the site investigations and shall be compiled by a suitably competent person. The content of all site investigation reports shall include as a minimum the following sections:

Content

Summary

Introduction

Objectives

Methodology

On-site investigations

On-site observations

Assumptions

Sampling and analysis

Interpretation

Conclusions

Recommendations

Annexes/appendices

Site location map including sampling and site investigation locations

Trial hole logs and Geological logs

Analytical results

Test results i.e., particle size distribution, packer tests, etc.

Monitoring results

The site investigation report shall form part of the overall report for the site and the conclusions should be integrated into the risk assessment and remediation reports. Any identified impacts should be made known to the landowner and in particular if analytical results for any domestic well or public supply source exceeds the drinking water standards then the owner/users of the supply shall be informed.

Chapter 6 Tier 3: Refinement of CSM and Quantitative Risk Assessment

6.1 Refinement of CSM

Following the programme of site investigations, in the Risk Assessment Methodology Tier 2: Site Investigations and Testing, as outlined in Chapter 5, the information, which has been obtained should be used where necessary to refine the conceptual site model (CSM) and the risk screening exercise should be repeated to confirm the initial risk ranking assigned in the Risk Assessment Methodology Tier 1: Conceptual Site Model, Risk Screening and Prioritisation.

The source-pathway-receptor linkages and their relative importance should have been confirmed by the site investigations. In some cases a linkage will have been deemed not to exist thus eliminating that particular risk, while conversely, previously unknown linkages will have been identified, which lead to a re-appraisal of the risk designation for the site. The refinement of the CSM is an important stage as the initial screening was based on Preliminary/Exploratory Investigation information and it is essential that confirmation of the risk classification is assigned only following a thorough risk screening exercise based on good quality information.

The refinement of the conceptual model allows the known risks to be evaluated and the degree of uncertainty be established thus allowing for a decision to be made in relation to the quantitative risk assessment.

6.2 Quantitative Risk Assessment (QRA)

A quantitative risk assessment is required where the site is deemed following the risk screening process to intrinsically pose a high or moderate risk to the environment or human health. There are two basic types of quantitative risk assessments: Generic Quantitative Risk Assessment, which uses relevant generic assessment criteria (GAC)(i.e. values which are generally applicable to an entire class or group e.g. based on proposed future land use) or guidelines, and Detailed Quantitative Risk Assessment which uses site-specific assessment criteria using RA tools and models. The decision on which type of QRA that should be used is site specific and is dependent on the sensitivity of the site and also on the confidence in the available data. In any case the quantitative risk assessment should be detailed enough to allow remedial measures to be proposed with certainty of a successful outcome. The assumptions made should always be clearly defined. More detailed information may be obtained from CLM 2002 and the UK Environment Agency's publications on Hydrogeological Risk Assessment (EA, 2003) and the Guidance on the Management of Landfill Gas (EA, 2004).

6.2.1 Representative Site Concentrations

Prior to applying either a generic QRA or a detailed QRA, the site-specific information, on the leachate concentrations, surface water and groundwater quality, as well as information on the levels of landfill gas being produced, must be known. This information should be available from the site investigation programme. When assessing the results one has to bear in mind whether or not a particular analytical

value is representative of the entire site or whether it represents a hotspot concentration.

6.2.2 Generic QRA

When applying a generic QRA the risk shall be assessed for each pollutant linkage by comparing the representative site concentration with generic assessment criteria (or screening levels). The assessment should include simple assessments of the predicted impact of the landfill on all the receptors. Guideline values are considered to be the parametric concentration values, which should be applied as generic assessment criteria and are not the same as clean-up levels or target levels.

The generic assessment criteria must be

- Authoritative and scientifically based;
- Relevant and appropriate for the site;
- Conservative and protective (assuming a worse-case scenario); and
- Not site specific.

If the representative site concentrations are all below the generic assessment criteria (GAC) then the risk is deemed to be acceptable and no further action is required, so long as the appropriate assessment criteria were correctly applied in the first instance.

If the representative site concentrations are greater than the generic assessment criteria (GAC) then the risk may be unacceptable and remedial measures may be required or, alternatively, it may be necessary to carry out detailed quantitative risk assessment prior to making a decision with respect to remedial measures. The appropriate course of action is ultimately dependent on the extent of the exceedance and shall be agreed with the relevant authority prior to proceeding with any further risk assessment or remedial measures.

6.2.3 Detailed QRA

A detailed QRA requires that site-specific assessment criteria be developed. The representative site concentrations are compared to the site-specific criteria. Site-specific assessment criteria (SSAC) are derived using detailed data on the contaminant (e.g. chemical form), pathway (e.g. attenuation rates), and receptor (e.g. time on site). Accredited risk assessment tools should only be used by suitably qualified /experienced persons. The SSAC are usually more onerous than GAC and only apply to the site they were developed for.

Each individual receptor is modelled e.g. Human Health, Groundwater, Surface waters, Ecology etc. Different risk assessment modelling tools[37] are available as well as numerical groundwater flow models (e.g. Modflow), numerical contaminant fate and transport models and other receptor specific models (LandSim, GasSim, LandGen). Agreement must be obtained from the relevant authority prior to any model being used.

6.3 Risk Evaluation

Following the application of either a Generic QRA or Detailed QRA an evaluation of the overall risk of the site needs to be made. This requires that the critical receptors,

[37] Refer to Land Contamination Risk Assessment Tools: An Evaluation of Some Commonly Used Methods, EA, 2000.

the degree of uncertainty relating to the site and the data used, as well as the assumptions made, be identified and the associated risks evaluated.

Chapter 7 Remediation Techniques

7.1 Introduction

The selection of suitable remediation options is dependent on the results of the quantitative risk assessment process as outlined in Chapter 6. The necessary measures to remediate the site are likely to be subject to an assessment of their suitability by either the Environmental Protection Agency or the local authority depending on their risk classification and on the legislative requirements.

In relation to illegal sites that came into existence since a waste licensing regime was put in place, the Ministerial Direction (WIR 04/05) states 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;
- Places of special interest such as high amenity areas.

In all of these cases, prior to embarking on the risk assessment process, it is to be assumed that the waste shall be removed from the site except only where it can be shown that an alternative solution provides greater protection to the environment and the health of the local population. The remediation plan for these sites should therefore centre on the removal of waste from the site and the manner in which this is to be done. In almost all such cases, the majority of waste is likely to be required to be removed and the only circumstance where waste can remain on the site is where it can be clearly demonstrated that this will lead to greater protection of the environment or enhancement of the environment and greater protection of the health of the local population.

7.2 Regularisation of Sites

Arising from the European Court of Justice Decision C-494/01 against Ireland in relation to the implementation of Directive 75/442/EEC[38] on Waste, an administrative system- in the context of Section 22 of the Waste Management Acts 1996 to 2005 – will be established to regularise the position of those sites, which have been identified as historical waste disposal sites and which have been subjected to a risk assessment in accordance with this Code of Practice.

7.3 Remediation Techniques

The remediation strategy report needs to identify the pollutant linkages and examine ways of breaking the linkages. Depending on the waste type and the source-pathway-receptor linkages, different remediation techniques may be required. It is not possible to outline the appropriate technique for different scenarios in this guidance document and the reader is referred to the reference list for more detailed discussion of different remediation techniques and their applicability. Reference should be made

[38] Directive 2006/12/EC of the European Parliament and of the Council of the 5 April 2006 on waste codifies Council directive 75/442/EEC of 15th July 1975 on waste as amended by Council Directive 91/156/EEC of 18 March 1991.

to the EPA Landfill Manuals: Landfill Site Design (EPA, 2000) and Restoration and Aftercare (EPA, 1999).

The chosen remediation option should be designed for intervention within the Conceptual Site Model such that there is no significant pollutant linkage remaining after the remediation has taken place. In the case of sites where there is a direct discharge of List 1 substances to groundwater consideration shall be given to the requirements of the Groundwater Directive (80/68/EEC) and in some cases the new Groundwater Directive (2006/118/EC) when determining the appropriate remediation option.

Following execution of the remediation works a validation report is required on individual historical waste disposal sites to demonstrate that the S-P-R linkage has been broken.

The remediation proposals will be assessed through the administrative system established in the context of Section 22 of the Waste Management Acts 1996 to 2005 as an integral part of the authorisation process and site-specific measures will be set out in the licence/permit conditions for unregulated waste disposal sites (closed landfills).

Chapter 8 Reporting Requirements

8.1 Introduction

This section outlines the reporting requirements for Environmental Risk Assessment of individual sites, which have been evaluated using the Code of Practice. Each Environmental Risk Assessment Report should be accessible to the reader and presentation should take the form of suitable text, figures and tables.

In all cases an individual file shall be opened for each site that has been identified in the Section 22 Register and all relevant information shall be stored on the file. The reporting requirements below are considered a minimum and each local authority should develop appropriate data management procedures to ensure that information may be easily accessed over time and available in electronic format, where possible. The web based data management system' *WMA Section 22 Register'* developed by the Agency shall be used to record information for the Section 22 Register.

8.2 Risk Assessment Methodology Reporting

8.2.1 Risk Screening

A report is required to be prepared for each site risk screening exercise undertaken. The report shall focus on the conceptual model and also the calculation of the risk scores using the S-P-R linkage equations. The report may be used to verify compliance with the methodology set out in the Code of Practice.

The report shall comprise of;

- Walkover survey report.
- Appropriate illustrations of the conceptual model (e.g. plan and cross sections).
- A network diagram (or similar) is required which illustrates all the source-pathway-receptor linkages that have been considered as part of the assessment.
- A suite of relevant GIS maps (all at the same appropriate scale), which were applied as discrete layers of information in the risk assessment with the outline of the waste body indicated on the maps as well as a scale bar, which clearly indicates the distance involved. This will allow a check on the data used in the risk screening tables.
- A completed set of S-P-R linkage equations (refer to Section 4.4) that were used in the risk screening.
- A summary description of the conceptual model including details of any impact data, which is available or remediation measures that have taken place.

8.2.2 Site investigations

A detailed site investigation report is required and the requirements are set out in Section 5.6.

8.2.3 Quantitative Risk Assessment

A full detailed report setting out the steps followed and the assumptions made in relation to the quantitative risk assessment is required. It should clearly describe the

assessment criteria applied and in the case of a detailed quantitative risk assessment, both the source and justification for the use of the site-specific assessment criteria shall be provided.

8.2.4 Recommendations

A comprehensive report shall be submitted to the relevant competent authority on the recommendations for the measures to be taken on each site. Upon completion of the agreed remediation option, a detailed verification report shall be submitted, which demonstrates that the S-P-R linkage(s) has been broken and that the remediation has been successful (or otherwise).

Chapter 9 References and Reading Material

British Standards

BS 5930:1999 Code of Practice for Site Investigations, British Standards Institution, UK.

BS EN 25667-1 Water Quality. Sampling – Part 1: Guidance on the design of sampling programmes (dual numbered as BS 6068 – 6.1).

BS EN 25667-2 Water Quality. Sampling – Part 2: Guidance on sampling techniques (dual numbered as BS 6068 – 6.2).

BS EN 25667-3 Water Quality. Sampling – Part 3: Guidance on the preservation and handling of samples (dual numbered as BS 6068 – 6.3).

BS 6068 – 6.4 Water Quality. Sampling. Guidance on sampling from lakes, natural and man-made.

BS 6068 – 6.5 Water Quality. Sampling. Guidance on sampling of drinking water and water sampling and handling.

BS 6068 – 6.6 Water Quality. Sampling. Guidance on sampling of rivers and streams.

BS 6068 – 6.11:1993 Water Quality. Sampling. Guidance on sampling of groundwaters.

BS 6068 – 6.12 Water Quality. Sampling. Guidance on sampling of bottom sediments.

BS 6068 – 6.14 Water Quality. Sampling. Guidance on quality assurance of environmental water sampling and handling.

BS 10175:2001 Investigation of potentially contaminated sites – Code of Practice, British Standards Institution, UK.

EPA Landfill Manuals

EPA 1995, Landfill Manuals: Investigations for Landfills, EPA, Wexford.

EPA 1995, Landfill Manuals: Landfill Monitoring, EPA, Wexford.

EPA 1997, Landfill Manuals: Landfill Operational Practices, EPA, Wexford.

EPA, 1999, Landfill Manuals: Restoration and Aftercare, EPA, Wexford.

EPA 2000, Landfill Manuals: Landfill Site Design, EPA, Wexford.

EPA 2003, Landfill Manuals: Landfill Monitoring (2nd edition), EPA, Wexford.

Other EPA Publications

EPA 2003. Methodology for Assessment of Hazardous Waste Disposal Sites. ERTDI Report No. 16. Environmental Protection Agency

EPA (2004) Preparation of Guidance Documents and Assessment Tools on Environmental Liabilities Risk Assessment and Residuals Management Plans incorporating Financial Risk Assessment. Phase 2 Baseline Information Gathering – Draft report, Environmental Protection Agency, Wexford.

OEE 2005, Environmental Enforcement Network Manual, Environmental Protection Agency, Wexford.

EPA 2005, Register of Protected Area for implementation of the Water Framework Directive, OEA, 2005.

EPA 2006, National Waste Report 2004. Environmental Protection Agency, Johnstown Castle Estate, Wexford.

EPA (2006) Methodology for the Identification of Waste Disposal or Recovery Sites EPA, Dublin

Contaminated Land Research Reports

DoE 1994, A framework for assessing the impact of contaminated land on groundwater and surface water. CLR 1. Report by Aspinwall & Co. Volumes 1 & 2.

DoE 1994, Guidance on preliminary site inspection of contaminated land. CLR 2. Report by Applied Environmental Research Centre Ltd. Volume 1 and Volume 2.

DoE 1994, Documentary research on industrial sites. CLR 3. Report by RPS Group plc.

DoE 1994, Sampling strategies for contaminated land. CLR 4. Report by The Centre for Research into the Built Environment, The Nottingham Trent University.

DoE 1995, Prioritisation & categorisation procedure for sites which may be contaminated. CLR 6. Report by M J Carter Associates.

DoE 1997, A quality approach for contaminated land consultancy. CLR 12. Report by the Environmental Industries Commission in association with the Laboratory of the Government Chemist.

Environment Agency Publications

Environment Agency 1999a, The EC Groundwater Directive (80/68/EEC) and the Waste Management Licensing Regulations,1994. Internal Guidance on the interpretation and application of Regulation 15 of the Waste Management Licensing Regulations,1994 (the protection of groundwater) with respect to landfill. Environment Agency, Bristol.

Environment Agency 1999b, Strategic Risk Assessment: Further Developments and Trials. R & D Technical Report E2-001/1, Environment Agency, UK

Environment Agency 2000a, A practical Guide to Environmental Risk Assessment for Waste Management Facilities. Guidance Note, 25. Environment Agency, UK

Environment Agency 2000b, Further Development of the POPPIE Database – Development of a Groundwater Contamination Risk Assessment Methodology R & D Technical Report E127, Environment Agency, UK

Environment Agency 2000c, Technical Aspects of Site Investigation in relation to Land Contamination: Vol.1 R&D Technical Report P5-065/TR, Environment Agency, UK

Environment Agency 2000d, Technical Aspects of Site Investigation in relation to Land Contamination: Vol.2 Text Supplements. R&D Technical Report P5-065/TR, Environment Agency, UK

Environment Agency 2000e, Guidance on the Assessment and Monitoring of natural attenuation of contaminants in groundwater. R&D publication No. 95. Environment Agency.

Environment Agency 2001, Guide to Good Practice for the Development of Conceptual Models and the Selection and Application of Mathematical Models of Contaminant Transport Processes in the Subsurface. Environment Agency National Groundwater and Contaminated Land Centre Report, Solihull, UK.

Environment Agency 2002a, The monitoring of Landfill Leachate, Groundwater and Surface Water. Environment Agency, UK

Environment Agency 2002b, Landfill Directive Regulatory Guidance Note 2 – Interim Waste Acceptance Criteria and Procedures, UK

Environment Agency 2002c, Landfill Directive Regulatory Guidance Note 3 – Groundwater Protection: Locational Aspects of landfills in planning consultation responses and permitting decisions, UK

Environment Agency 2002d, Strategic Risk Assessment Phase II, R&D Technical Report E2-041/TR. Environment Agency, Bristol, UK.

Environment Agency 2003a, Hydrogeological Risk Assessments for Landfills (and the derivation of Groundwater Control and Trigger Levels), Environment Agency, Bristol, UK.

Environment Agency 2003b, Participatory Risk Assessment: Involving Lay Audiences in Environmental Decisions on Risk. R&D Technical Report E2-043/TR/01, Environment Agency, Reading, UK.

Environment Agency 2004, Environment Agency Guidance on Assessment of Risks from Landfill Sites. Environment Agency, UK

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Barry, D.L., Summersgill, IM and Gregory, R,G (2001). Remedial Engineering for Closed Landfill Sites, CIRIA Report C557.

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DETR and Insititute of Environment and Health 2000, Guidelines for Environmental Risk Assessment and Management. Revised Departmental Guidance. The Stationary Office, London.

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CEC 2006, Directive 2006/118/EC of the European Parliament and of the Council on the protection of groundwater against pollution and deterioration.

CEC 2003, Council Decision (2003/33/EC) 'establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to the landfill directive 1999/31/EC.

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CEC 1980, Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances. Council of the European Communities, O.J. L 20/43.

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CEC 1991. Council Directive 91/156/EC of 18th March 1991 on Waste. Council of the European Communities, O.J. L 078/32

CEC 1991, Council Directive 91/689/EEC of 12 December 1991 on hazardous waste. Council of the European Communities,

CEC 1999. Council Directive 1999/31/EC of the 26th April 1999 on the landfill of waste. Council of the European Communities. O.J. L 182/19

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DEHLG 2005. Policy guidance pursuant to Section 60 of the Waste Management Act, 1996 (as amended) Circular WIR: 04/05, May 2005. Department of Environment, Heritage and Local Government.

APPENDIX 1: Methodology for the Identification of Waste Disposal or Recovery Sites in Ireland

Methodology for the Identification of Waste Disposal or Recovery Sites in Ireland

Office of Environmental Enforcement,
EPA

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Methodology for the Identification of Waste Disposal or Recovery Sites in Ireland

1. INTRODUCTION

1.1. Purpose

The Environmental Protection Agency developed this guidance following a request from the Minister for the Environment, Heritage and Local Government. It follows from the Ministerial Direction issued on the 3rd May 2005, which directed local authorities to comply with the requirements of Section 22 of the Waste Management Acts 1996 to 2003, in the current review of their Waste Management Plans. The Ministerial Direction in turn was part of the response by the Irish Government to the European Court of Justice ruling in case C-494/01 in order to demonstrate that the necessary measures are now being taken in Ireland, in terms of the structures, legislation and policy approach, to ensure a correct implementation of the provisions of the Council Directive 75/442/EEC of 15 July 1975 on waste as amended by Council Directive 91/156/EEC of 18 March 1991 and thereby fulfil the obligations under this Directive.

Specifically this guidance relates to the identification of sites at which 'waste disposal or recovery activities have been carried on'. Further guidance, which will be in the form of a Code of Practice, likely to be published in the spring 2007 by the Agency in relation to the carrying out of an environmental risk assessment at these sites.

It is likely that the application of this methodology will lead to the identification of a relatively large number of sites; however, the risk posed by many of these sites is likely to be low. This is particularly true for old municipal landfills, which have a limited potential to release pollutants and emissions to the environment. It is, however, necessary to identify these sites and then carry out a formal risk screening exercise to identify the level of risk posed by the sites.

It is anticipated that the number of sites that will have to undergo a comprehensive quantitative risk assessment will be small in comparison to the overall number of sites identified.

1.2. Scope

The European Court of Justice ruling in case C-494/01 noted that in Ireland the management of waste-related facilities by municipal authorities was not subject to a permit system until the 1996 Waste Management Act and its implementing regulations were adopted. As regards waste managed by private operators, the court ruling noted that disposal has been subject to such a system since 1980, while waste recovery has been since 1998 and that all of this was contrary to the requirements of the 1977 Framework Waste Directive. The Court concluded that -

"Ireland had not yet met its obligation, by which it had been bound since 1977, to ensure that all municipal landfills hold the requisite permit. The failure to fulfil obligations, which is the result, all at once, of extremely belated transposition of Article 9 of the Directive, of systematically refraining from requiring existing unauthorised activities to cease while the licensing procedure took place, and of a lack of appropriate measures for ensuring that facilities were promptly made subject to the domestic system finally set up, was as at that date both general and persistent in nature".

Ireland is now dealing with this legacy by

- Identifying all relevant sites which were not regulated since July 1977-the date for transposition of the Framework Waste Directive-these are primarily old municipal waste disposal sites but may also include unauthorised private sites which may come to attention and this methodology is intended to assist in that identification process
- Undertaking risk assessments on all of these sites, and
- An administrative system, in the context of Section 22 of the Waste Management Acts 1996 to 2005, will be established to regularise the position of these sites.

As to the identification process, the statutory basis for this already exists under section 22 (7)(h) of the Waste Management Act, which states that: -

" a waste management plan shall…. include information on or otherwise have regard to
-the identification of sites at which waste disposal or recovery activities have been carried on,
-the assessment of any risk of environmental pollution arising as a result of such activities,

-measures proposed to be taken , or, where such an assessment has already been made, measures taken, in order to prevent or limit any such environmental pollution,
-the identification of necessary remedial measures in respect of such sites, and
-measures proposed to be taken or where measures have already been identified, measures taken to achieve such remediation, having regard to the cost-effectiveness of available remediation techniques."

This provision requires the identification and assessment of all sites irrespective of their commencement date. While the main focus of this guidance and the Code of Practice will be on sites that require permitting under the Waste Framework Directive, older sites may also be identified by local authorities during the course of the exercise, which may represent a significant risk to human health or the environment and these also fall within the scope of section 22(7)(h) of the Waste Management Act. Such sites, where identified, should be included in the list of sites so that a proper evaluation of the risks posed by the sites can be conducted.

In addition, local authorities are required under Section 26(2) of the WMA to identify sites at which 'waste disposal activities, being activities that to a significant extent involved hazardous waste, have been carried on'. This site identification exercise is also to be used to satisfy this requirement.

Waste Disposal and Recovery activities are those defined in the Third and Fourth Schedule of the Waste Management Acts, 1996 to 2003. Activities that should be considered during the identification phase have been divided into two distinct categories, which reflect the likelihood of the site having been used for recovery/disposal of waste. This categorisation will allow sites

- known to have been used for waste disposal/recovery to be placed on a register and to be put through a risk screening process (guidance to be provided by EPA) in a timely manner, and

- suspected to have been used for waste disposal/recovery, to be investigated further, prior to being placed on the register where such use is confirmed through investigation.

Non-Licensed Closed Landfills (Activities considered appropriate for inclusion in Section 22 and 26 Registers)

The Ministerial Direction contained in Circular WIR 04/05 of 3rd May 2005 prioritised the preparation by local authorities of "…an inventory and risk assessment of all non-licensed closed landfills…" in fulfilment of Section 22 of the Waste Management Act.

In discharging these obligations to identify non-licensed closed landfills, local authorities should prioritise efforts in focussing upon such Primary Activities where there is a strong likelihood that waste disposal has taken place as follows:

- Landfill
- Illegal waste disposal
- Land reclamation including infilling of wetlands
- Sites used habitually for Fly Tipping

The scope of Section 22 of the Waste Management Act extends beyond non-licensed closed landfills and includes "the identification of sites at which waste disposal or recovery activities have been carried on, the assessment of any risk of environmental pollution arising as a result of such activities".

If such other sites should come to the attention of the local authority during the application of the Site Identification Methodology and it is considered that they may pose a risk to the environment or human health, then they should also be subjected to Risk Assessment.

Following the successful identification and risk assessment of the non-licensed closed landfill sites in accordance with the priority assigned within the Ministerial direction, it will be necessary to identify and subject to a risk assessment all other sites at which waste disposal or recovery activities have been carried on. In this regard, it will be a requirement in the longer term to examine further Primary Activities and Secondary Activities as follows:

PRIMARY ACTIVITIES (strong likelihood that waste disposal or recovery activities took place)

Mining[1]

Scrap yards or car dismantlers (Metal recycling/ELVs)

Waste storage/transfer facilities

Composting facilities

Recycling facilities

[1] Consult with EPA and GSI for listing of mine sites within LA functional area

SECONDARY ACTIVITIES (possibility that waste disposal or recovery activities took place)

Extraction industries including quarries surface impoundments including lagoons

Tanneries (IPPC)

Manufacturing- metals, glass, paper, textile, chemical, asbestos, pharmaceutical, etc. (IPPC)

Solvent or organic substances recovery (IPPC or Waste licence)

Sludge recovery or disposal

Brownfield sites including gasworks (redevelopment areas)

Railway lands (depots)

Petrol Storage areas and Stations (age and scale)

2. METHODOLOGY

2.1. Approach

The identification methodology is primarily based on a desk study of different information sources with verification comprising of both a desk study element and in some cases a site inspection/visit. A site inspection is required in cases where there is insufficient information available from the desk study to complete the forms in Appendix A.

It is very important to reduce the level of uncertainty in the data as much as possible at the identification and verification stages so that only sites with a likelihood of having being used for waste disposal or recovery are considered for risk assessment. It is intended that the 'primary' activities would be considered first with a phased approach being used to allow for further examination of possible sites arising from 'secondary' activities. It is likely that a local authority will, through the knowledge of its own staff (particularly older or retired local authority engineers/overseers) and records, be in a position to identify candidate sites from 'primary' activities quickly. For instance, information on old municipal landfills will be readily available to local authorities and sites that can be readily identified should be catalogued first.

The 'secondary' activities include sites that, due to the activities that have taken place on site, may have had waste disposed of on-site or have become contaminated. These sites should be included on the possible sites list and further work should be undertaken on a phased based to confirm or rule out waste activities at the site and/or the presence of contamination. The type of contamination on sites as a result of the secondary activities should be noted and investigated to determine whether it was as a result of waste activities or by other means. While in some cases waste activities may not have taken place at a particular site, other activities may have led to a site becoming contaminated and it is important that this information be captured so that appropriate steps can be taken by the local authority to deal with any environmental or human health risks arising from the contamination.

This methodology sets out the information sources that are available as well as highlighting other tools, which may be useful in identifying unauthorised or old closed sites. While it is not meant to be prescriptive, a check-list is provided in Appendix A so that all actions taken are both systematic and documented and therefore local authorities can demonstrate their compliance with the guidance.

2.2. Desk Study Phase 1: IDENTIFICATION

Step 1: Identify all KNOWN Waste Disposal or Recovery Sites

A non-exhaustive list of sources of information is provided below. These sources should be used when identifying sites that have been used for the primary activities listed above. Each local authority should consult these sources and document any findings or otherwise in the Check Lists in Appendix A. These sites should then form the basis of a Section 22 register. Local authorities should commence Step 1 immediately.

Local Authority records and knowledge (including questionnaire to staff and retired staff)
Waste Plans
Special Waste Plans
Section 22 registers (existing)
Section 55 notices
Section 18 notices

Complaints databases
LA Permit register
An Foras Forbatha Reports[2]
EPA Waste Reports (including the National Waste Database report)
EPA IPPC licensed facilities (includes on-site landfills)
EPA licensed waste disposal and recovery sites
Environmental Protection Agency/Department of Communications, Marine and Natural Resource (Geological Survey of Ireland and Exploration and Mining Division)[3]
EPA Small Scale Study EPA register of former mine sites (1996)

Step 2: Identify POSSIBLE Waste Disposal or Recovery Sites

The list of 'secondary activities' mentioned above is the starting point for the development of a list of further 'possible' sites. The identification of the past uses of a site and the collection of information is normally the first stage of the process of establishing whether or not waste has been disposed of on-site or if the site is contaminated. Information required relates to the processes used, raw materials, wastes residues and methods of disposal. Indications that waste has been disposed of or recovered on-site may be gathered from the sources below but additional information may need to be obtained to verify that this was the case. This verification may be in the form of interviews with companies, site inspections or other methods. Sites that are subject to IPPC licensing can be excluded from this further investigation by local authorities, as the enforcement of licence conditions by the EPA should control/remediate any possible contamination. However, the sites that are known by the Agency to be contaminated should be included on the section 22 (or 26) registers.
Work in this area will be an ongoing process and may take a number of years. As sites are confirmed as locations where waste disposal or recovery has taken place, they will then be placed or added on to the section 22 (or 26) register.
A list of data sources is provided below and any information obtained should be included in the check-list in Appendix A. The data shall be stored in the EPA web-based data management system ' WMA Section 22 Register'.
The list also includes suggested methods that may be used to assist in the identification of unknown unauthorised disposal sites. These methods include comparison of aerial photographs from the 1970's, 1995 and 2000 (more recent photos in some areas), which provides a good method of identifying changes in land use and use of sand and gravel pits etc., satellite imagery and aerial surveys where the use of a light aircraft may be an effective tool.
Different methods will be appropriate depending on the circumstances of each local authority area.

[2] Addendum on Tipsite Statistics to National Database on Waste, An Foras Forbatha, 1986
[3] Characterisation of Historic Mine Sites in Ireland and their environmental risks (Environmental Protection Agency/Department of Communications, Marine and Natural Resource (GSI and EMD) 2005

Permit register
Toxic and Dangerous Waste Register
Waste Oils Register
Derelict Buildings
Dangerous Buildings
Planning files (re-development)
LA complaints database
EPA complaints database
EPA possible applicant files
GSI quarries directory/ LA quarry registers
National Roads Authority investigations
Ordnance Survey maps (1:10,560)
Aerial Photography
Satellite Imagery (e.g. Quickbird)
Thermal Imagery
Remote Sensing
Aerial Survey (e.g. light aircraft)
Google Earth
Placing of Newspaper advertisements

Other supplementary sources may also yield further important information on individual sites e.g. Coillte, Health Boards, Fire Service, Insurance Companies.

The sites identified from these data sources and other methods should be included on a list of possible sites with the same information documented as for sites that are placed directly onto the register. However, additional work, which may be in the form of a site inspection or obtaining information from a land owner, may be required to demonstrate that certain sites were used for waste disposal/recovery and hence these sites should not be placed on the register until such confirmation is obtained. The compilation of a register is an iterative process.

Step 3: Identify Possible Hazardous Waste Producers/Users in functional area

As mentioned already there is a requirement under section 26 (2) of the WMA to identify sites at which *'waste disposal activities, being activities that to a significant extent involved hazardous waste, have been carried on'* therefore it is beneficial for local authorities to gather information at this stage on industries and or sites where hazardous material was used. Additional information should then be obtained to determine whether or not hazardous waste was disposed of on-site or at off-site local landfills in the proximity of the industries concerned. Further guidance is provided in the National Hazardous Waste Plan and in the ERTDI Report Series No.16[4].

The following information sources should be examined and any information gathered should be documented in the check-list in Appendix A.

IPPC Annual Environmental Reports (AERs)
Toxic and Dangerous Waste Register
Waste Oils Register
Solvent Users Directory (EPA project)
Trade Directories (e.g. Kompass, Golden Pages)
Geodirectories
Oil companies
Sheep dipping baths

Prior to any site being placed on a Section 26 'register' it should be verified that the waste disposal activities involved to a significant extent hazardous waste. In many cases this will only be known following a site investigation. It is therefore suggested that sites, where waste disposal is known to have occurred and where there is some suspicion that hazardous waste was deposited, should be first placed on a Section

[4] Methodology for Assessment of Hazardous Waste Disposal Sites (EPA, 2003)

22 register and put through the risk screening process and subsequent site investigations prior to being placed on a section 26 register. However, any suspicion regarding the presence of hazardous waste should be well documented in the check-list and supporting evidence provided in the comments section.

Step 4: Identify Possible Impacts

During the collation of the above information any impact data should be documented on the check-list. Additional sources of information, which can serve to identify impacts from candidate sites, are outlined below:

Water Pollution notices
Walkover survey
EPA and Local Authority Monitoring reports/results
River Basin District Impact reports
Catchment Monitoring Projects
Landfill monitoring results
Planning files
Section 4 register
Section 16 register
Residual visual impact on landscape

This information will assist in the risk screening process and in the prioritisation of sites. Any site that has an impact associated with it shall be placed on the section 22 register for further investigation and risk assessment. Information should be stored on the WMA Section 22 Register data management system.

2.3. Desk Study Phase 2: DATA COLLECTION AND VERIFICATION

The data that is required to be obtained for all sites on the Section 22 register is outlined in Appendix A. This information will then be used in the risk assessment process. It is essential that there is a high level of confidence in this data and therefore the verification step is necessary both in terms of the site having been used for waste disposal/recovery and also the information on the extent and type of waste that has been disposed/recovered.

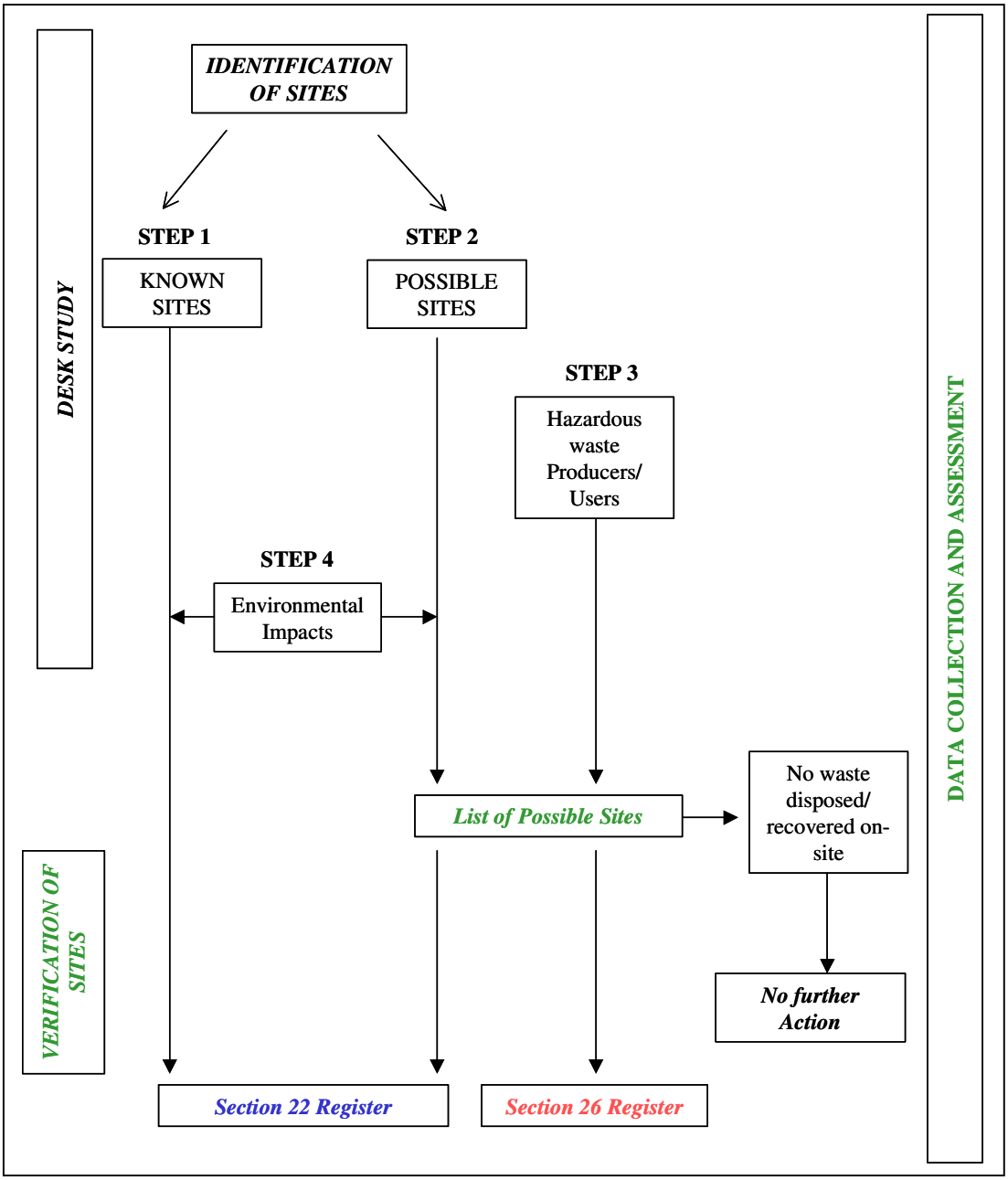
Step 1 Determine the likelihood that site was used for waste disposal or recovery and also obtain information on the types of wastes involved. This information can be obtained using the following methods;

Interviews
Walkover survey
Records (LA)
Existing site investigation reports
Local knowledge

Step 2 Determine extent and type of waste from

Records (LA)
Existing site investigation reports
Aerial Photographs
Field Mapping
Satellite Imagery
Ordnance Survey mapping (1:10,560 - 1:50,000)
Geophysics
Site investigations (existing)

Figure 1: Stages in the development of a Section 22 and 26 register



Some of the detailed Step 2 verification procedures outlined above may need to be carried out during the site investigations aspect of the associated risk assessment process. An example is where the waste type is thought to be non-hazardous but there are no records to demonstrate this. Some assumptions have to be made to proceed to the risk screening process but these should be documented in the comment section of Table 2 in Appendix A.

Step 3 Data collection

Data collection is a continual process that starts at Phase 1 and continues throughout the process. As a result of the data collection procedures applied in Step 1 and Step 2, a minimum amount of information should have been assembled on the all sites

investigated (Table 2). There should be a high level of confidence that the site has been used for waste disposal or recovery at some time in the past (or present). The information required to complete Table 2 (a separate table is required for each site) is as follows and this information shall be stored in the WMA Section 22 Register web based data management system;

Delineate area on map (1:50,000) (GIS shape file)
GPS or grid co-ordinates of centre point and boundary
Period of operation
Authorisation (if any)
Type of Waste Activity (Disposal or Recovery)
Waste Type
Include a note if hazardous waste producer/users in catchment area or if evidence (or suspicion) of hazardous waste disposed at the site.
Type of contamination (if present)
Height or thickness of landfilled area
Approximate tonnage of waste present
Lined/unlined
Comment on known impacts
Assumptions made

The Waste Type shall be described in accordance with the waste streams as outlined below

Construction and Demolition Waste

Manufacturing Waste

Mining and Quarrying Waste

Municipal Waste

End of Life Vehicle and Scrap Metal

Hazardous Waste

Contaminated Soil

Energy, Gas and Water Supply Waste

Dredge Spoils

Drinking Water Sludges

Urban Wastewater Sludges

Agricultural Waste

In order to facilitate transfer of data into the Risk Assessment Code of Practice a GIS shape file should be generated which delineates the aerial extent of the landfill and has associated data fields attached. The associated data shall include as a minimum: the type and thickness of waste or contaminant present; the period of operation of the site and the assumptions made. This layer will then form the starting point for the associated environmental risk assessment screening process.

2.4. Desk Study Phase 3: ASSESSMENT OF DATA

At the end of Phase 2 each local authority should have a complete listing of waste disposal and/or recovery sites within their functional area. The list and register of sites should be sub divided into sites used for disposal of waste and sites used for recovery of waste, as the risk assessment methodology used may be slightly different

The list of sites should be divided into known sites that are to be placed on the section 22 register and sites that may require additional information to be gathered on them prior to being placed on a register. This will allow the local authority to proceed with the risk screening of those sites known to have been used for waste disposal/recovery while at the same time gathering additional information of the list of possible sites. After the risk screening, the risk status of each site shall be known and should be catalogued on the register Sites cannot be removed from the Section 22 or 26 register if waste was disposed of or recovered on site.

If sites were known to have to a significant extent been involved in hazardous waste disposal then they should be placed also on a section 26 register. If there is insufficient evidence that significant amounts of hazardous waste was deposited in the site then this should be noted and the site undergo further investigation following the risk screening to confirm or rule out the presence of hazardous waste prior to deciding whether or not to list the site on the section 26 register.

APPENDIX A

DATA CHECK LISTS

TABLE 1: Sources of information CHECK LIST

Source of Information	Reviewed Y/N	Comment
Local Authority Sources		
Local Authority records and knowledge (including questionnaire to staff)		
Section 22 registers (existing)		
Waste Plans		
Special Waste Plans		
Section 55 notices		
Section 18 notices		
Complaints databases (LA and EPA)		
LA Permit registers		
Toxic and Dangerous Waste Register		
Waste Oils Register		
Derelict Buildings Register		
Dangerous Buildings Register		
Planning files (re-development)		
LA quarry registers		
EPA Sources		
EPA Waste Reports (including the National Waste Database report)		
EPA IPPC licensed facilities		
EPA licensed waste disposal and recovery sites		
IPPC reports (on-site landfills)		
IPPC AERs		
EPA possible applicant files		
Other Sources		
An Foras Forbatha Reports		
Trade Directories (COMPASS etc)		
GSI quarries directory		
Aerial Photography		
Remote Sensing		
Aerial Survey (e.g. light aircraft)		
Newspaper advertisements		

Signed: Date:

TABLE 2: Site Information CHECK-LIST

ID number	
Site Name	
Location (attach 6" map)	
County Council	
Easting (6 digits)	
Northing (6 digits)	
Source of information	
Owner/Occupier	
Waste Activity	
Period of Operation	
Authorisation	
Waste Type	
Estimated tonnage of waste	
Hazardous waste present or unknown	
Verification method	
Known Impacts	
Risk Score	To be obtained following the application of the CoP.
Comments	

Signed …….
Date ……..

References

CEC (1975). Council Directive 75/442/EEC of 15th July 1975 on Waste. Council of the European Communities, O.J. L 194

An Foras Forbatha (1985). Addendum on Tipsite Statistics to National Database on Waste.

CEC (1991). Council Directive 91/156/EC of 18th March 1991 on Waste. Council of the European Communities, O.J. L 078/32

DEHLG (1996). *Waste Management Act, 1996.* Statutory Number 10 of 1996. Government Publications Office, Dublin 2.

Grennan, E (1996). EPA Small Scale Study - EPA register of former mine sites. Sligo RTC.

CEC (1998). Council Directive 1999/31/EC of the 26th April 1999 on the landfill of waste. Council of the European Communities. O.J. L 182/19

EPA (2003). *Methodology for Assessment of Hazardous Waste Disposal Sites*. ERTDI Report No. 16. Environmental Protection Agency

Environmental Protection Agency/Department of Communications, Marine and Natural Resource (GSI and EMD) 2005, *Characterisation of Historic Mine Sites in Ireland and their environmental risks.*

DEHLG, (2005). Policy guidance pursuant to section 60 of the Waste Management Act, 1996 (as amended) Circular WIR: 04/05, May 2005. Department of Environment, Heritage and Local Government.

EPA (2006), *National Waste Report 2004.* Environmental Protection Agency, Johnstown Castle Estate, Wexford.

APPENDIX 2: Walkover Survey Checklist

Walkover Survey Checklist		
Information	Checked	Comment (include distances from site boundary)
1. What is current Land Use?		
2. What are the neighbouring Land Uses?		
3. What is the size of the site?		
4. What is the topography?		
5. Are there potential receptors (if yes, give details)?		
Houses		
Surface water features (if yes, distance and direction of flow)		
Any wetland or protected areas		
Public Water Supplies		
Private Wells		
Services		
Other buildings		
Other		
6. Are there any potential sources of contamination (if yes, give details)?		
Surface waste (if yes, what type?)		
Surface ponding of leachate		
Leachate seepage		
Landfill gas odours		
7. *Are there any outfalls to surface water?* (If yes, are there discharges and what is the nature of the discharge?)		
8. Are there any signs of impact on the environment? (If yes, take photographic evidence)		
Vegetation die off, bare ground		
Leachate seepages		
Odours		
Litter		
Gas bubbling through water		
Signs of settlement,		

subsidence, water logged areas		
Drainage or hydraulic issues		
Downstream water quality appears poorer than upstream water quality		
9. Are there any indications of remedial measures? (Provide details)		
Capping		
Landfill gas collection		
Leachate collection		
10. Describe fences and security features (if any)		
Any other relevant information?		

APPENDIX 3: Application of the Waste Management (Landfill Levy) Regulations 2002

Waste Management (Landfill Levy) Regulations 2002 Calculation of Weight of Waste Deposited at an Unauthorised Landfill

Background

The purpose of this note is to give guidance, to local authorities and other interested parties, in relation to the application of the Waste Management (Landfill Levy) Regulations 2002[1] ("the 2002 Regulations") in respect of the calculation of weight of waste deposited at an unauthorised landfill as per Article 6(3) - the determination of levy liability. It does not purport to provide and should not be relied upon as a legal interpretation of the meaning or effect of the legislation. Reference must be made to the Regulations for their detailed provisions and they should be read in conjunction with the Waste Management Act, 1996 (as amended).

The relevant local authority from 1st June 2002 must calculate the volume and weight of landfill at all unauthorised sites in order to assess the liability of these sites for the landfill levy. Unauthorised landfill in Ireland can be grouped into three categories:

Open Pit – infilling waste into pre-existing pits normally associated with geological/mineral/aggregate extraction. Such open pits can be large in volume and dimensions. Records for such original pits and dimensions should be widely available in older Ordnance Survey maps, aerial photographs, Geological Survey records and local authority planning documents. Filling of open pits with waste may occur on a medium to long-term scale ranging from weeks to years;

Excavated Pit – deposit of waste into freshly dug ground. Such pits are often small in dimension and can be filled in a shorter timescale of days to weeks. Their elucidation can be difficult since no records of such will be apparent;

Ground – land raise by waste on areas of poor ground, often-boggy ground at estuaries, raised bog, and mountain bog. Also at or beside roads and railways.

Calculating the Weight of Waste Deposits at Sites where there is a Weighbridge

The basic method of calculating the weight of waste is by weighing it at the time of disposal. If there is a weighbridge at the landfill site it should be used.

Calculating the Weight of Waste Deposits at Sites where there is no Weighbridge

Where a weighbridge is not available at an unauthorised landfill site or where there are no records/dockets/gate records of waste the preferred method for the calculation of the landfill levy is by a volume-based method which requires the accountable person to estimate the volume of waste and weight of waste disposed at the landfill from 1st June 2002 as per the 2002 Regulations. It is the responsibility of accountable person to ensure that all loads delivered to site are assessed and recorded as per Article 10 and Article 6(2) of the regulations.

[1] S.I. No. 86 of 2002

The methods for determining volume are:

3.1 Excavation to determine the depth/volume of waste;
3.2 Field survey/levelling, aerial photography or remote sensing techniques to determine the contours of waste and hence calculate the volume of waste.

Excavation by mechanical excavator or track mounted vehicle of all waste deposited into landfill since 1st June 2002. Waste should be excavated and deposited into trucks, which lie alongside the excavation. A written record in respect of each vehicle load of waste should be made as per Article 10 of the 2002 Regulations. Proper environmental safeguards must be put in place during this operation to avoid pollution or contamination of the surrounds. Each truckload of waste should then be sent for disposal to a licensed landfill. The weight and details of each load recorded at the receiving landfill's weighbridge should be used to amend the accountable person's written record.

It is the responsibility of the accountable person to obtain accurate information. The calculated volumes should be converted to weights using the conversion table set out in the Schedule to the 2002 Regulations (Schedule 2. (c)).

This requires: (a) site surveying or (b) aerial photography or remote sensing[2] techniques to determine the contours of waste deposited since 1st June 2002:

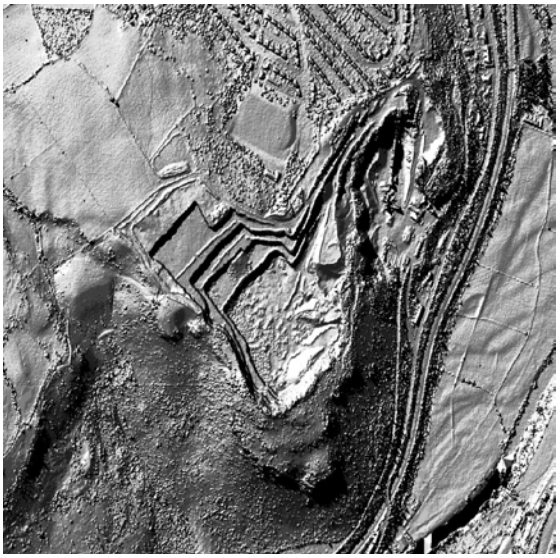
(a) A detailed topographical map (minimum scale 1:10,560 or 1:2,500) of the site prior to the deposition and depths of waste deposited would be necessary to provide a topographical base. Field surveying can be carried out to determine the contours. GPS and/or total station survey laser instruments offer more versatility. Surveying work can be labour intensive and costs may be significant.

(b) The assessment of topographic contours using aerial photography or remote sensing techniques can cover larger areas without the need for detailed site work (as in (a) above), but have less accuracy. The methods for determining the contours are:
(i) Aerial photography and existing maps and digital terrain model
(ii) Very high-resolution digital aerial photography
(iii) High resolution satellite imagery
(iv) Laser Based System (LIDAR)

Ordnance Survey Ireland (OSI) completed aerial photographs for the whole country in 1995 and 2000. The best vertical precision from these photographs is 2-3m. New photography may be needed for greater clarity. All data can be purchased as digital terrain model (DTM) maps from OSI, for use as a base to computer GIS programmes. Costs – Indicative only – Ordnance Survey Office DTM €160 for a 20km by 20km tile.
Very high-resolution digital aerial photography. Image resolution can be 0.15m and a vertical precision of 0.5m or better might be expected. This is a German based system.
IKONOS 1m and Quickbird 0.62m images are available in stereo. These images are not acquired routinely for Ireland and are a customised order. The data are similar in

[2] Remote Sensing: The acquisition and measurement of data/information on some property(ies) of a phenomenon, object, or material by a recording device not in physical, intimate contact with the feature(s) under surveillance; techniques involve amassing knowledge pertinent to environments by measuring force fields, electromagnetic radiation, or acoustic energy employing cameras, radiometers and scanners, lasers, radio frequency receivers, radar systems, sonar, thermal devices, seismographs, magnetometers, gravimeters, scintillometers, and other instruments. U.S. Office of Naval Research

nature to aerial photographs and a vertical precision of 2-3m might be expected in a DTM produced from them.
LIDAR is a laser-based system, mounted in a helicopter or airplane. It works by measuring the two-way travel time between the pulse of light emitted by the system and the reflectance from the ground. The time is then converted to surface elevation. The system typically produces DTM with 1m-2m horizontal spacing and better than 0.2m vertical accuracy.



The image (above) is an example of the LIDAR output to DTM. It shows a quarry outline (Copyright Infoterra).

The volumes of waste deposited can be calculated from the contours obtained in steps (a) or (b) above, using common engineering techniques such as the use of the planimeter or simple 'volumes from contour lines' algebra. Examples of both may be found in various textbooks on surveying[3].
Any calculations should be to a minimum 1m accuracy for both the vertical and horizontal scales. It is the responsibility of the accountable person to obtain accurate information.
The calculated volumes should then be converted to weights using the conversion table set out in the Schedule to the 2002 Regulations (Schedule 2(c)).

4. Enquiries

Enquiries may be made to the undersigned

Dr. Jonathan Derham
Senior Inspector
Office of Licensing and Guidance,
EPA, Wexford

e-mail: j.derham@epa.ie

or

Kevin Motherway
Inspector
Office of Licensing and Guidance,
EPA, Inniscarra, Cork

e-mail: k.motherway@epa.ie

[3] **Surveying.** A. Bannister, S. Raymond, and R. Baker. 6th Edition. Longman Scientific & Technical. ISBN 0-470-21845-2

APPENDIX 4 Wetlands – Protection, Conservation and Assessment

Introduction

Wetlands perform very important functions at both a local and global scale, provide resources important for human welfare and represent a valuable cultural and natural heritage. Apart from the Antarctic continent, wetlands are the only major ecosystem that is the subject of an international treaty, the Ramsar Convention[1] of which Ireland is a contracting party. The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty, which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. However, despite the above, wetlands were until very recently regarded mistakenly by many simply as unproductive land whose conversion to a more profitable use, mainly agriculture, was beneficial to society. Alternatively, they were considered simply as wastelands ideally suited to the disposal of wastes. The un-sustainability of both approaches is now recognised and they are no longer considered acceptable practices.

The European Union (EU) issued a Communication on the Wise Use of Wetlands[2] in 1995, which outlines the importance of wetlands and their functions for human welfare, notes the increasing loss of wetlands at both a global and EU level and states its commitment to wise use of wetlands in the context of sustainable development and in accordance with the Ramsar Convention. This document provides a strategic basis for a policy development in relation to the sustainable use of wetland resources and the conservation of their functions and values in the EU. The Commission recently produced another useful document, which provides guidance on the role of wetlands in the implementation of the Water Framework Directive (European Commission, 2003).

Under the Ramsar Convention wetlands are defined as “areas of marsh, fen, peatland, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish, or salt, including marine waters, the depth of which at low tide does not exceed six metres[3].”

The wise use of wetlands was described as “ human use so that they may yield the greatest continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations”, this “in a way compatible with the maintenance of their “physical, biological or chemical components, such as soil, water, plants, animals and nutrients, and the interaction between them”[4].

Wetland Conservation

Wetland conservation has benefited from a number of different EU Directives especially the Birds Directive[5], and Habitats Directive[6] and more recently from the

[1] http://www.ramsar.org
[2] Reference to the Commission Communication to the Council and the European Parliament – Wise use and Conservation of Wetlands (COM (95) 189 final, 29.05.1995)
[3] Common Understanding given at the Convention of Wetlands of International Importance especially as Waterfowl Habitat, Article 1(1)
[4] Conference of the Contracting Parties of the Ramsar Convention.
[5] Directive on the conservation of wild birds (79/409/EEC)
[6] Directive on the conservation of natural habitats and wild fauna and flora (92/43/EEC)

Water Framework Directive (WFD)[7]. These and their implementing legislation have allowed the designation of a series of protected area networks: Special Protection Areas (SPAs) for birds, and Special Areas of Conservation (SACs) for habitats and species. In addition, the Wildlife (Amendment) Act, SI No 38 of 2000, allows for the designation of Natural Heritage Areas for habitats, species and, geological and geomorphological sites.

The Birds and Habitats Directives have been transposed into Irish Law by the European Communities (Conservation of Wild Birds) Regulations, 1985 (S.I. No. 291 of 1985) and the E.C. (Natural Habitats) Regulations, 1997 (S.I. No. 94 of 1997) and subsequent amendments and the Wildlife Act (S.I. No 38 of 2000). The National Parks and Wildlife Service (NPWS) of the Department of Environment, Heritage and Local Government is the enforcement organisation with respect to the Habitats and Birds Directives and Wildlife Acts. Under the legislation and regulations it has the power to specify potentially damaging actions, which may adversely impact on protected areas, as Notifiable Activities. These activities, which include infilling designated wetlands, require prior assessment and approval from the Minister before they can be undertaken. However, in those cases where these actions are regulated by other regulatory bodies it is the responsibility of those bodies to ensure that their actions are compatible with the protection of the site. In other words with respect to the Habitats Directive in relation to dumping of waste in wetlands the appropriate regulatory authority is the Local Authority.

All SPAs, SACs and NHAs designated for water dependant habitats and species will be included in the Register of Protected Areas for each River Basin District established under the Water Framework Directive. This listing means that water quality and quantity requirements necessary for the conservation of these sites must be taken into account in drawing up River Basin Management Plans. In addition, the WFD requires the identification and protection of groundwater dependent terrestrial ecosystems (GWDTE) but does not specify the minimum size of ecosystem that needs to be assessed. However, it is the intention that designated areas will be assessed first and individual undesignated areas will be assessed on a case-by-case basis as and when resources permit.

In addition, wetlands have been afforded special consideration in terms of illegal waste activity in the Ministerial Direction (Circular WIR: 04/05) whereby it indicates that a risk assessment should be undertaken and that wetland sites (as well as NHAs, SACs or SPAs) should be remediated (which may include removal of the waste) in the case of illegal waste facilities which are discovered.

Wetland Assessments

For the purposes of this CoP, especially in relation to risk assessment, mitigation and remediation, it is useful to divide wetlands into those whose hydrology and ecology are dependant on surface water and those dependant on groundwater. However, it is important to recognise that the ecology of any site may be dependant on both water sources to varying degrees and different habitats and species will have different sensitivities to changes in water regimes and water quality. In general surface water dependency and the linkages between a landfill and a wetland receptor are reasonably easily identified, while groundwater dependency is more problematic.

All the Irish wetland types listed below are considered to be groundwater dependant to varying degrees. Three basic categories can be recognised:

[7] Directive establishing a Framework for community Action in the field of Water Policy

Highly groundwater dependant ecosystems where reductions in quantity/quality would cause major adverse changes in ecosystem structure and function in the short to medium term. These include:

- turloughs;
- fens, in particular rich fens and flushes;
- springs;
- marl lakes; and
- dune slacks.

Dependant ecosystems, which, although surface water may be a dominant influence at certain times, are usually dependent on some groundwater input to retain their current ecology in the medium to long term. These include:

- rivers;
- lakes;
- swamps;
- estuaries;
- lagoons;
- freshwater marshes;
- poor fens and flushes;
- transition mire and quaking bog;
- riparian woodland;
- wet willow-alder-ash woodland;
- bog woodland;
- non-marine caves; and
- machairs.

Independent to locally dependent ecosystems where surface water is the dominant influence and where groundwater is generally only locally important. Groundwater may however be very important in the maintenance of appropriate hydrological conditions. These ecosystems include:

- raised bogs; and
- upland and lowland blanket bogs.

In line with the Ministerial Direction an assessment should be made on the impact an illegal waste activity is having on any wetland (i.e. includes undesignated sites). When illegal activities are discovered, the Risk Assessment (Figure 1) has to be undertaken and should include the following stages.

DESK STUDY

Determine the location of the designated sites (NHAs, SACs, SPAs), pNHAs, candidate SACs and locally important sites – these are given equal status and are automatically considered as receptors. RBDMPs have maps showing the wetland sites on the register of protected areas and whether they are considered to be GWDTE. NPWS of the DoEHLG have maps of all non-wetland NHAs, SPAs, SACs. Any infilling on designated sites is considered a notifiable action.

WALKOVER SURVEY

Any wetlands present within 250m of an unregulated waste site should be identified during the walkover stage of the risk assessment and a risk screening score applied. The wetland should be associated with the broad type of wetland.

SITE INVESTIGATIONS

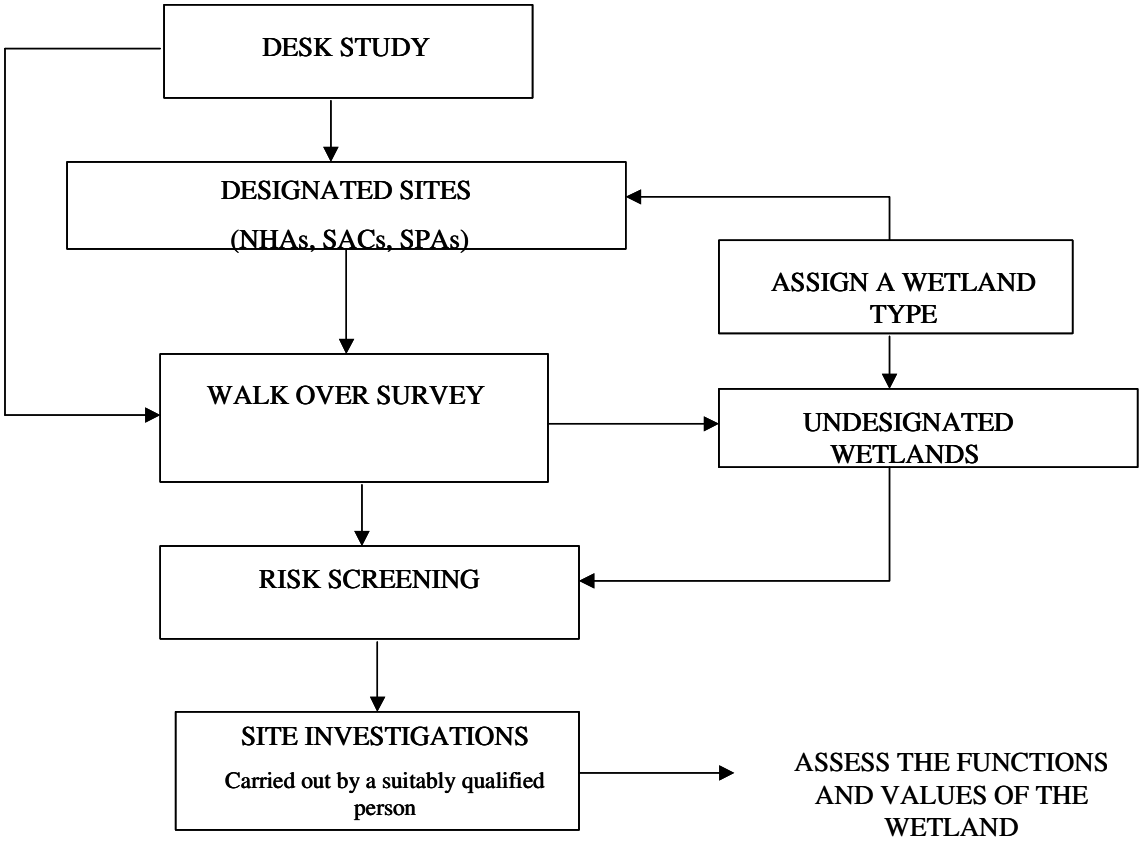
Having regard to the broad wetland categorisation, which has been assigned following the Site Inspection (including walk over survey), guidance should be obtained from the NPWS to outline the minimum requirements for the programme of Site Investigations to be undertaken when undertaking a risk assessment of illegal waste activities.

Further assessment shall be carried out during the site investigation stage in consultation with the National Parks and Wildlife Service of the DoEHLG.

The assessment as a minimum shall consider the value and the functions of the wetland. Some functions that wetlands provide are; flood and erosion control; improved water quality; carbon sequestration and storage; and, provision of habitats for a wide range of aquatic and wetland dependent plant and animal species. Ecological and hydrological surveys /assessments must be carried out

In all cases a suitably qualified person shall carry out the surveys and assessments.

Figure 1: CODE OF PRACTICE FOR ILLEGAL WASTE SITES



Waste Regulations – Licensing and Permitting
The infilling of designated wetlands by either landfill, or through improvement or development of land, or through land reclamation is no longer an acceptable practice. Accordingly, illegal landfills should not be allowed to remain in-situ in wetlands under circumstances where it is deemed (following an assessment) to result in a negative impact.

Infilling of designated wetlands should not be allowed and a permit should be not be granted for wetland pNHAs, NHAs, SACs, SPAs, and locally important sites.

For other non-wetland designated sites infilling is a notifiable action and consultation should be held with the NPWS prior to making a determination with respect to the permit. Permits can only be allowed when it has to been demonstrated that the infilling will not have a significant negative impact.
For undesignated wetlands, a permit application will have to address the potential impacts both on the wetland itself and on the services that it provides (flood relief, water quality, biodiversity). The local authority shall consult with the NPWS of DoEHLG, OPW (flood remit), Fisheries Board and the RBDs (Water quality section of LA).

Figure 2 provides a flow-chart of these procedures.

A permit application, which may be submitted by an operator seeking to carry out an in-situ remediation of an illegal site, which has involved the infilling of wetlands but is not considered to result in a negative impact, must address all impact and potential impacts:

On the wetland itself, and the services, functions and value that the wetland provides (e.g. flood relief, water quality, biodiversity etc.)

Such a permit application must contain sufficient detail and information so as to allow the competent authority to make a determination that the infilling of the wetlands will not have an adverse impact on the environment following execution of the proposed remediation works. Remediation of a wetland or removal of waste from a wetland shall be supervised by an ecologist or suitably qualified and experienced person.

Figure 2: Waste Management Permits