SKM ENVIROS

Technical and Economic Aspects of developing a National Difficult Waste Facility (NaDWaF)

July 2010

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1. EXECUTIVE SUMMARY

1.1. Introduction

In August 2009 the Office of Climate, Licensing and Resource Use within the Environmental Protection Agency (EPA) commissioned SKM Enviros to explore the technical and economic aspects of developing a National Difficult Waste Facility (NaDWaF), the principal component of which would be a landfill operation.

The work programme comprised of project Tasks 1-16 culminating in two key deliveries;

1- Overall final report on NaDWaF; and
2- A separate report dealing with radioactive source waste and storage.

Further background to the study and the findings from the study are presented in summary in the following paragraphs.

The responsibility for hazardous waste management planning was assigned to the EPA under the Waste Management Act 1996[1]). The EPA's National Hazardous Waste Management Plan (NHWMP) published in 2008[2] set out priority actions for prevention, collection, self-sufficiency and management of hazardous wastes. The NHWMP identifies three overarching strategic issues related to increasing self-sufficiency that need to be addressed if additional hazardous waste is to be treated in Ireland and export reduced:

- Addressing the deficit in capacity for the substantial waste stream currently exported for thermal treatment (i.e. co-incineration, use as fuel or incineration);
- Development of landfill capacity to manage non-recoverable and non-combustible hazardous wastes and residues, including asbestos; and
- Expansion of other recovery and treatment capacity in Ireland for waste that does not need thermal treatment or landfill – generally referred to as physico-chemical treatment.

The key imperative underpinning this study into the need for a NaDWaF, and the assessment of different options, are the EU principles of "self sufficiency" and the "proximity principle". While these principles should not be interpreted as meaning that Ireland must treat and dispose of all its own waste arisings, it is a key objective for Ireland to improve its ability to become self sufficient. This can only be achieved by demonstrating the need in terms of current and future waste arisings and supporting this with technical and economic assessments to enable infrastructure to be provided.

The development of such a facility should be compatible with the objectives stated in the NHWMP, and any facility must be able to obtain a waste licence and other relevant authorisations to proceed. It must therefore meet or exceed Best Available Technique (BAT) and must be efficacious in the treatment of waste while not causing environmental pollution.

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[1] Waste Management Act, Number 10 of 1996, Section 26.

[2] EPA (2008) National Hazardous Waste Management Plan 2008-2012. Available at: http://www.epa.ie/downloads/pubs/waste/haz/NHWMP2008.pdf

The wastes considered during the course of this study include solid hazardous waste not suitable for incineration. Other wastes considered included out of date marine flares (Time Expired Pyrotechnics(TEPS)), these wastes are considered difficult as their nature and physical properties pose problems for disposal and require special management to avoid risk to human health and the environment. Other difficult wastes were considered initially in the study with a view to explore any management issues and if alternative management practices could be explored further, some of these wastes included, out of date ordnance, non re-saleable seized/confiscated controlled substances, ship and cargo wastes, noxious weeds and contaminated dredging spoils and harbour wastes.

1.2. Hazardous Waste Arisings and Forecasts

The current and expected future arisings were assessed through a desk based assessment of historic hazardous waste data combined with economic forecasts to estimate the types and quantities of waste that may need to be managed at a NaDWaF. Data relating to Ireland and Northern Ireland was considered with a view to considering an all-island facility. For the purposes of predicting future hazardous waste arisings, the year 2008 was selected as a baseline year. This baseline data is presented in **Table 1** below.

Table 1 Management of Reported Hazardous Waste Arisings, 2008 (Excluding Contaminated Soils)

Reporting Year	Onsite at Industry (T)[3]	Offsite in Ireland (T)	Exported (T)	Unspecified (T)	Total (T)
Disposal					
2008	35,592	34,594	67,424	0	137,610
Recovery					
2008	36,446	79,245	89,749	0	181,455[4]
Unspecified Treatment					
2008	0	0	33	0	33
Totals					
2008	72,038	113,839	157,207	0	319,098

The disposal options used by Irish facilities to deal with hazardous waste arisings were assessed by collating the total quantities that were disposed of according to the European Disposal Codes[5] and then by further assessing the breakdown of wastes by EWC codes that went to landfill directly. **Table 2** presents a sub-total of the quantity of hazardous waste sent to landfill in Ireland and abroad in 2008 according to the European Disposal Codes D1 toD15.

[3] (T) = Metric Tonnes.

[4] A total of 23,986 t of waste solvent (1,073 t of halogenated solvent and 22,913 t of non-halogenated solvent) was blended at facilities in Ireland prior to export as waste for use as fuel in cement kilns and incinerators. These quantities are counted in both the ‘treated off-site in Ireland’ and the ‘exported’ columns. They have been discounted in the ‘total’ column to avoid double counting in the total amount of hazardous waste generated. Source: EPA (2008) National Waste Report.

[5] The Waste Framework Directive 2006/912/EC, Annex II A.

Table 2 **Disposal of Reported Hazardous Waste Arisings, 2008 (Excluding Contaminated Soils)**

	TREATMENT/DISPOSAL ROUTE																	
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	DU	Sub Total D1 + D5 (T)	Total (T)
Onsite at Industry (t)																		
2008	12,559							1,791	322	20,897		23					12,559	35,592
Offsite in Ireland (t)																		
2008					7,462				27,131								7,462	34,594
Exported (t)																		
2008	12,217				9,775			2,733	1,792	40,505		226	124	44	8		21,992	67,424
TOTALS																		
2008	24,776	0	0	0	17,237	0	0	4,524	29,245	61,402	0	249	124	44	8	0	42,013	137,610

Hazardous waste types that have that have been consigned to landfill, either in Ireland or abroad (under disposal codes D1 and D5) include construction and insulation materials containing asbestos, filter cakes containing heavy metals, salt cakes, acid and alkali waste, hydrocarbon and solvent contaminated sludges, pharmaceutical wastes, waste paint and varnish containing organic solvents, furnace dust, wastes from thermal processes, gypsum, incinerator maintenance, construction and demolition waste containing dangerous substances and wastes from treatment of ELVs (End of Life Vehicles). There was a significant increase in the generation of contaminated soil in 2008 with 493,107 tonnes reported compared with 188,127 in 2007, half of this waste arose from decommissioning and remediation works undertaken at a closed IPPC-licensed company.

An inventory of landfillable hazardous wastes for Ireland and Northern Ireland was compiled from the quantities of hazardous waste streams generated, see **Table 3**. Reported hazardous waste arisings for disposal codes D1 and D5 from Ireland and Northern Ireland (including contaminated soils) totalled 235,296 tonnes in 2008.

Table 3 Inventory of landfillable hazardous wastes for Ireland and Northern Ireland

Waste Type	EWC Codes
Asbestos and asbestos based materials	17 06 01*; 17 06 05*
Ash	10 01 14*
Furnace dust	10 02 07*
Aggregates	17 09 03*
Filter cakes containing dangerous substances	01 03 07*; 06 03 99; 06 04 05*; 06 05 02*; 11 01 09*; 11 01 98*; 12 01 14*; 19 01 05*;
Wastes from treatment of ELVs	19 10 03*
Wastes from thermal processes	10 10 07*; 10 11 09*; 10 11 13*
Refractories and Linings	16 11 05*
Gypsum	10 11 19*
Wastes from acid/alkali neutralisation	06 01 06*/ 20 01 14*; 06 02 05*/ 20 01 15*
Hydrocarbon and solvent contaminated sludges	07 05 11*
Pharmaceutical wastes	07 05 13*
Contaminated soils	17 05 03*
Stabilised Wastes	19 03 04*; 19 03 06*
Wastes from water treatment works	19 08 06*
Wastes from mechanical treatment of waste	19 12 11*

The baseline data[6] for 2008 was then subjected to economic forecasting factors, as supplied by the Economic and Social Research Institute (ESRI) sustainable development model called ISus. The estimated total tonnages for 2008 to 2025 have been aggregated on a 6 year phase basis and are summarised in **Table 4.**

Table 4 Hazardous Waste Predictions for Landfill, Ireland and Northern Ireland, 2008 – 2025

Baseline Year	Aggregated Predictions		
2008 (T)	2008 - 2013 Average per Year (T)	2014 - 2019 Average per Year (T)	2020 - 2025 Average per Year (T)
235,296 [7]	**216,534**	**277,139**	**306,526**

1.3. Difficult Wastes

Other wastes considered in the study were difficult wastes as their nature and physical properties pose problems for disposal and require special management to avoid risk to human health and the environment. The wastes initially considered included the following;

- Out of Date Ordnance;
- Out of Date Marine Flares (TEPs);
- Non re-saleable seized/confiscated controlled substances;
- Ship and cargo wastes;
- Noxious Weeds; and
- Contaminated dredging spoils and harbour wastes.

The main difficult waste considered was out of date marine flares (TEP). The actual arisings of TEPs are not definitively known and there is lack of regulation dealing with the disposal of such arisings. The manufacture, transport, sale and storage of explosives is regulated by various national and local government bodies, but there is a fragmented approach in the destruction of TEPs. One central facility would be impractical for the storage of TEPs as storage facilities need to be close to the arisings. The disposal of TEP needs specialist knowledge (which the military has) and this expertise would not normally reside in waste management companies. Therefore including a destruction facility at the NaDWaF may not be the most cost effective method of disposal, however the lack of data means the suitability cannot be assessed. Further feasibility should be considered in the establishment of a network of small storage units perhaps at coastguard stations, with a view to collection and destruction being contracted to a suitable private

[6] The ESRI factors have not been applied to 19 01 13 as there is no baseline figures for 2008, therefore figures are based on expected maximum amounts to be generated on an annual basis and remaining constant up to 2025.

[7] This total does not include a tonnage for 19 01 13* fly ash containing dangerous substances as there are no 2008 baseline figures for this waste type.

contractor. It is likely that since volumes are low that shipment (subject to suitable transport arrangements beings made) to a destruction facility in the UK may need to be considered as the volumes arising are so low to warrant the investment in such a facility in Ireland. Another option would be to consider the UK Maritime and Coastguard Agency storage facility in Belfast as a main central facility where TEPs are delivered and stored prior to destruction at a facility in England.

1.4. Radioactive Source Waste

While radioactive waste is not covered under the Waste Management Acts 1996-2008, the Radiological Protection Institute of Ireland (RPII) identified a deficit in the provision of services to ensure the collection and management of radioactive waste. In addition, a high level inter-departmental group, including the EPA and RPII, was established in 2008 to consider and advise Government on the best policy and practice for the safe long term management of Ireland's radioactive waste materials, a national report was presented to the Irish Government in 2009[8].

Information was collated on the current inventory of disused and orphan radioactive sources to determine extent and characteristics of a national store. On this basis of the inventory, containment and operational requirements were addressed. The RPII radioactive source inventory for disused sources comprises of more than 5,820 sources. Only a limited number of sources have any information on the physical form and/or the practice from which the source originated. The majority of the disused sources have half lives and activities such that they are likely to decay to levels lower than the exemption levels within relatively short timescales i.e. < 5 years. The number of more active and longer lived sources for which longer term management solutions are required is quite small and there are only a very small number of high activity sources. For sources currently in use there should already be a "take-back" agreement and therefore there is only likely to be a small number of those which might need to be managed in the longer term.

In addition to the disused sources contained in the inventory of sources there are other radioactive sources and potential sources of radioactive material that merit consideration. Post primary schools in Ireland hold an estimated 1,306 sealed and 835 unsealed radioactive sources, many of which exceed the exemption levels set out in the Ionising Radiation Order[9] . It has been estimated that about 35% of the sealed sources and 56% of unsealed sources may be categorised as disused. Disused sealed radioactive sources are not necessarily radioactive waste, there may be other uses to which a source could be put by a licensee. Once reuse and recycling options have been exhausted then the sources will be declared radioactive waste.

In general, the solution would be for the disposal of the sources as waste but at present there is no disposal route for radioactive materials available in Ireland. The legislation allows for the disposal of sources, under licence from RPII, once they have decayed to a level less than the exemption levels given in the Basic Safety Standards within the EU. In order to make use of this route, sources have to be stored until such time as they have decayed to the appropriate levels.

Disposal involves the isolation of radioactive wastes in a suitable facility without the intention to retrieve, and with minimal requirement for long term surveillance or maintenance. It is the preferred and most sustainable option for the management of sources containing moderate to long lived radionuclides (half life > 5 yrs) because it takes away the burden of managing these wastes

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[8] National Report by Ireland to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, November, 2008.

[9] S.I. No.125 of 2000, Ionising Radiation Order.

from future generations; is more cost-effective in the long term than alternative arrangements; and is less reliant on the continuity of regulatory control.

It should be recognised that in Ireland, with the relatively small number of larger and longer lived sources it may never be considered cost effective to provide a disposal route for these in Ireland and might make more sense to discuss co-operation with other nearby countries in a similar situation to find a joint solution.

Where disused radioactive sources are to be stored for medium to long periods for decay or until the availability of a final disposal option it is important that they are conditioned in order to minimise the risks from radiation and from potential leakage from the sources. For sources with short half lives and low activity levels the most effective approach is to store these until they have decayed to below exemption levels and then to dispose of them, under licence from RPII, to a landfill as non-radioactive waste. They should be retained in storage by the Licensee in the current manner to ensure sufficient level of security and safety, with frequent checks as for operational sources. All remaining sources should be stored until such time as Ireland identifies an ultimate disposal route either in Ireland or together with another country(ies). This is best done in a central facility rather than in multiple facilities on individual Licensee's sites, but only once a full inventory of disused radioactive sources, other radioactive waste in Ireland and potential future arisings have been fully assessed.

The principal requirements for a storage building will be to provide a secure facility that also provides adequate control against the risk to people (workers in the facility and members of the public) and to the environment from radiation or from any leaks of radioactive materials. The conditioning of the waste should be designed to provide passive safety measure and security and the building and the management arrangements will provide additional layers of protection. These can be achieved by a fairly simple building design utilising standard security measures.

An outline design for a suitable facility has been proposed[10] previously. The current inventory includes around 5,000 additional sources; however these are primarily short lived and/or low volume sources. Storage of these additional sources should have limited impact on the size of a facility. It is estimated that around 25 additional 200 litre drums would be required if appropriate waste processing techniques are employed. Even if packaging of these additional wastes were not optimised, resulting in a say 10 fold increase in volume, this equates to less than 300 extra drums i.e. less than 10% of the overall storage capacity (approximately 3000 x 200 l Drums) for a combined storage facility dealing with unsealed radioactive wastes and future arisings of redundant sources for the next 50 years.

1.5. Treatment and Disposal Options

To estimate future capacity need, the predicted arisings were allocated to the different treatment/disposal routes in an allocation matrix. The matrix is presented in **Appendix 3**. Different proportions of the arisings are allocated to different treatment/disposal routes; and the resultant capacities are calculated for the different treatment options and landfill. The estimation process within the matrix takes into account the outputs from different pre-treatment methods (which may make hazardous waste suitable for landfill), as many pre-treatments increase the weight and volume of the material to be landfilled. The allocation of wastes is based on waste type and the ability of the different treatment/disposal options to handle particular wastes streams.

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10 "A facility for the Collection, Compaction and storage of Radioactive Waste Produced in Ireland" – Thesis presented for the partial fulfilment of the Degree of Master of Engineering Design, Christopher Hone, University College Dublin,

The treatment capacity needed in conjunction with this landfill capacity shows that up to 2019 between 235,000 and 260,000 tonnes per annum of hazardous landfill capacity could be required. This reduces to 185,000 tonnes per annual as a result of assuming that treatment techniques advance.

Sensitivity analyses were also undertaken by reducing the arising of contaminated soils used in the prediction model to the 2007 arisings levels, by assuming all flue gas cleaning residues are treated to make the outputs non-hazardous and the effect of both reducing contaminated soils arisings to 2007 levels and the treatment of all flue gas cleaning residues.

Table 5 summarises the estimated landfill capacity need up to 2025. The table highlights the potential impact on the estimated landfill capacity of varying arisings of contaminated soil and the implication of the development of treatment techniques for flue gas cleaning residues. The figures show that under the baseline prediction model, the future capacity need is between 235,000 to 257,000 tonnes per annum up to 2019, reducing to 185,000 tonnes per annum as a result of assuming that treatment techniques advance. However the capacity is significantly affected by assumption on the quantity of contaminated land and the treatment of flue gas cleaning residues and the capacity need could reduce to below 100,000 tonnes per annum.

Table 5 Total Estimated Annual Hazardous Waste Landfill Tonnages

	Annual tonnage		
	2008 – 2013*	2014 - 2019	2020 - 2025
Baseline Prediction Model	257,000	235,000	185,000
Sensitivities			
Reducing contaminated soil arisings to 2007 levels	135,00	129,000	115,000
Treatment of all flue gas cleaning residues resulting in non-hazardous outputs	214,000	195,000	152,000
Reducing contaminated soil arisings to 2007 levels AND Treatment of all flue gas cleaning residues resulting in non-hazardous outputs	92,000	89,000	82,000

* Figures represent the tonnages towards the end of the 6 year period once incineration capacity has come on line.

1.6. Basic Technical Containment of Landfill

Stringent operational and technical requirements are necessary in order to prevent or reduce negative effects on the environment as well as any residual risk to human health, from landfilling of waste, during the whole life cycle of the landfill.

A landfill must be situated and designed so as to meet the necessary conditions for preventing pollution of the soil, groundwater and surface water and ensuring efficient collection of leachate as and when required. The location is considered at the site selection stage as this determines the risk assessments required and any specific containment that may be necessary for a particular location to comply with BAT.

The three basic components of a landfill containment system are capping, covering and lining to control waste, leachate, landfill gas and rain and surface water. A review of international best practice and guidance for this study was carried out. A summary of the different practice and guidance approaches to basic technical containment for hazardous waste landfills in Ireland, the UK and Germany are presented in **Table 6**.

Table 6 Summary of Technical Containment Requirements for Hazardous Waste Landfill

	Landfill Directive	EPA Landfill Design Manual Single Liner (IE)	EPA Landfill Design Manual Double Liner (IE)	EPA BAT (IE)	EA (England and Wales), NIEA and SEPA (UK)	Federal Environment Ministry (DE)
Leachate collection layer	t≥0.5m	t≥0.5m k≥1x10^{-3}m/s	t≥0.5m k≥1x10^{-3}m/s	t≥0.5m k≥1x10^{-3}m/s	t≥0.5m k≥1x10^{-3}m/s	t≥0.5m k≥1x10^{-3}m/s
Artificial sealing liner (geomembrane)	✓	t≥2mm	t≥2mm	✓	✓	t≥2.5mm
Natural mineral layer, or	t≥5m k≤1x10^{-9}m/s	t≥5m k≤1x10^{-9}m/s or	t≥5m k≤1x10^{-9}m/s or	t≥5m k≤1x10^{-9}m/s or	t≥5m k≤1x10^{-9}m/s or	t≥5m k≤1x10^{-9}m/s or
Artificially established mineral layer	t≥0.5m	t≥1.5m, at k≤?	t≥0.5m, at k≤?	t≥0.5m with equivalence in leakage and risk performance	t≥0.5m, at k≤?	t≥0.5m, at k≤1x10^{-10}m/s
Leachate detection layer			t≥0.5m k≥1x10^{-3}m/s			
Bottom artificial sealing liner (geomembrane)			t≥2mm			
Bottom mineral layer			t≥4m k≤1x10^{-9}m/s or t≥1m, at k≤?			

1.7. Provision of All-Island Facility

It is recognised by both jurisdictions of Ireland and Northern Ireland that by creating an all-island waste market, both jurisdictions may benefit from increased competition, reduced waste management costs and improved reliability of service, although the economic gains may be variable in different regions in both jurisdictions. The viability of an all-island approach will vary depending on the quantities and types of waste being considered. This study has considered the potential for a NaDWaF providing an all-island solution for the landfilling of hazardous waste. Consideration has been given to the policy perspective and the implications for the viability of a NaDWaF, in order to identify the merits, barriers and demerits related to the provision of hazardous waste landfill capacity through a NaDWaF.

In 2007, 12,337 tonnes of hazardous waste was exported to landfill from Northern Ireland to England in 2007, in 2008 the quantity decreased significantly to 6,070 tonnes. This volume is too low to justify the development of a disposal/treatment facility in Northern Ireland. This additional volume could increase the viability of an all island solution. However, when these quantities are compared with the estimated future capacity need of approximately 200,000 tonnes per annum, it would suggest that viability of a NaDWaF is not critically dependant on the received hazardous waste from Northern Ireland.

The inclusion of such waste could help to strengthen the business case for a NaDWaF, although any business case should not rely on the hazardous waste from Northern Ireland, as waste producers in Northern Ireland would be able to decide to send their waste to a NaDWaF or to appropriate facilities in the UK. Such decisions are likely to be dependent on the cost and while the transports costs are likely to be lower for a NaDWaF, the gate fee and landfill tax will clearly influence the total cost.

As with the arisings in Ireland, hazardous waste arisings in Northern Ireland from future waste treatment facilities could increase the quantity of waste suitable for disposal at a NaDWaF. Depending on the waste treatment facilities developed, the quantity of hazardous waste suitable for a NaDWaF could increase to around 40,000 tonnes per annum. This could increase the viability of an all island solution but again the decision to use a NaDWaF will generally be an economic decision made by the waste producers.

It should also be noted that the estimated capacity need could be significantly affected by the assumption on the quantity of contaminated soils and the treatment of flue gas cleaning residues. As highlighted in **Chapter 8** the capacity need could reduce to below 100,000 tonnes per annum, at which point the Northern Ireland arisings could have a greater impact on the viability of a NaDWaF.

1.8. Site Selection and Environmental issues

The site selection criteria should be applied in the first instance to identify broad areas of constraint, ensuring facilities are not located too close to residents, in environmentally sensitive areas or which cannot be easily accessed.

Any site being proposed for hazardous waste facility development should be assessed in accordance with the above criteria and demonstrate it can provide sufficient protection of the environment and community through appropriate environmental assessment. While the ultimate decision will be with the Planning Authority, the ability to demonstrate a full and transparent approach to siting will provide a sound platform on which to progress proposals.

The siting of waste facilities, and particularly hazardous waste facilities, is an emotive subject especially for the general public and local communities. By their very nature, hazardous waste facilities have the potential to release pollutants which could be damaging to health and the environment and appropriate siting is essential to ensuring any potential impacts are minimised to an acceptable level.

The development of new and/or expanded hazardous waste facilities is driven by a number of key policy objectives including the *National Hazardous Waste Management Plan (EPA) 2008-2012* (published in 2008) for Ireland and *Towards Resource Management -Waste Management Strategy for Northern Ireland (EHS)*[11] 2006-2020 which seek to provide for appropriate facilities for the management and disposal of hazardous wastes. Development proposals must then be in general conformity with the relevant European Directives, national, regional and local development plans and planning guidance before the planning authority will consider granting their approval.

A site selection exercise is a useful tool in identifying potential areas for development or areas for exclusion. Criteria are produced, relevant to the concerns a hazardous waste facility presents, which allows for a qualitative assessment of sites relative to the environmental, social and feasibility aspects of the development, prior to undertaking full and detailed impact assessment for a preferred site. It can be used to establish if suitable locations exist in the Island of Ireland for hazardous waste facilities, and for the screening and assessing of potential sites proposed.

Co-location of waste treatment and/or disposal facilities with existing waste or IPPC licensed operations has its' merits and demerits. While this study has identified the waste management options, the study cannot pre-empt the actual sites that may be suitable for co-location. While there are approximately 1,200 sites operating with a waste or IPPC licence, many of the sites and activities can be excluded as being unsuitable for co-location, for example food and drink, intensive farming sectors. Further assessment of co-location warrants contact with industry to establish if there is an interest by synergy with the industry and waste sector in hosting or providing capacity.

1.9. Economic and Social Considerations

Five treatment and disposal scenarios, presented in **Table 7** were considered for economic modelling. The primary consideration of the scenarios was to understand the implications of introduction of a NaDWaF. This allowed a comparison between what could happen if no facilities are developed, and also different economic pressures and opportunities that could be experienced from development of NaDWaF for particular waste streams.

Table 7 Treatment/Disposal Scenario Description and Economic Considerations

Scenario	Description	Economic Considerations
Scenario 1 (baseline)	Treatment to continue with existing routes external to Ireland with no new build NaDWaF	Transport and disposal costs to 2025.
Scenario 2 (specialist disposal)	Hazardous waste treatment prior to disposal to hazardous landfill	Cost of hazardous waste treatment facility and hazardous landfill
Scenario 3 (specialist treatment)	Hazardous waste treatment prior to disposal to non-hazardous landfill	Cost of hazardous waste treatment facility and non-hazardous landfill

[11] The Environment and Heritage Service of Northern Ireland was renamed the Northern Ireland Environment Agency in 2008.

Scenario 4 (no treatment)	Hazardous waste, no treatment, direct to hazardous waste landfill	Cost of hazardous landfill
Scenario 5 (storage)	Storage of radiological waste	Cost of storage space (including consideration that a cost of final disposal will still be required)

Economic modelling has been given on the basis of total cost and a functional unit of cost per tonne. It should be noted that import will have additional cost associated with collection and transport within the country of its origin (external to Ireland, if relevant); the costs provided in this section are purely based on Ireland costs. A bespoke modelling tool was developed to aid the analysis of the five potential scenarios and to cover the time periods of 2008 - 2013, 2014 - 2019 and 2020 - 2025.

The analysis of cost for treatment/disposal of waste under the different scenarios are calculated by summing the cost of treatment and disposal specific to 4 of the scenarios and presented in **Table 8**. Total costs for storage are unknown at present because of limited data availability on the subject.

Table 8 Costs for Waste Scenarios (€ Millions)

	2008-13	2014-19	2020-25
Scenario 1 - Current treatment	30.5	35.9	41.0
Scenario 2 - Specialist disposal	45.9	55.1	57.7
Scenario 3 - Specialist treatment	33.6	44.0	49.2
Scenario 4 - No treatment	36.0	35.3	29.6
Scenario 5 - Storage	Unknown	Unknown	Unknown

Specialist disposal is the most expensive option. Maintaining current treatment is given as least cost, but this is based on current assumptions about price increases. In reality these are likely to increase substantially particularly with the increasing restriction on landfill availability. This issue also applies to Scenario 4 (no treatment) as there is a limited likelihood that this option would be possible.

To investigate this in greater depth the costs of individual facilities were investigated. **Table 9** provides a summary of the costs associated with the treatment and disposal facilities.

Table 9 Costs for Waste Facilities (€ million)

	Non-Hazardous Landfill	Hazardous landfill	Stabilisation/ Solidification	Bio-remediation	Soil washing	Thermal desorption
CONSTRUCTION	25	32.85	2.8	3	3	23.8
Cost of land	1.6	1.6	0.3	0.5	0.5	0.3
Planning stages	8	9	0.5	0.5	0.5	1.5
Civil works	14	20	1.5	1.5	1.5	15
Restoration and aftercare	0.9	1.5	0	0	0	0
Equipment	0.5	0.75	0.5	0.5	0.5	7
SERVICES	0.405	0.505	0.54	0.35	0.35	2.39

	Non-Hazardous Landfill	Hazardous landfill	Stabilisation/ Solidification	Bio-remediation	Soil washing	Thermal desorption
Maintenance	0.2	0.3	0.28	0.06	0.06	1.7
Staff costs	0.185	0.185	0.215	0.275	0.275	0.49
Utilities	0.02	0.02	0.045	0.015	0.015	0.2
SERVICES TOTAL OVER LIFETIME	10.125	12.625	10.8	7	7	59.75
Lifetime	25	25	20	20	20	25
TOTAL	35.125	45.475	13.6	10	10	83.55
Apportioned to quantity of waste	200.7 (175,000)	259.9 (175,000)	680 (20,000)	500 (20,000)	500 (20,000)	835.5 (100,000)

The table highlights that the most expensive options are thermal desorption and landfill (hazardous and non-hazardous). The quantities of waste that each of the techniques will treat differ; therefore, relative amounts have also been added (in brackets in the final row). The total costs have then been allocated to amount for a single tonne. This is not allowing any cost for sale of associated by-products, such as for example recovered metals.

A high-level socio-economic assessment of a NaDWaF was carried out using the "*Guidelines and Principles for Social Impact Assessment*"[12]. The assessment steps included;

- Identification of baseline conditions;
- Identification of stakeholder groups and stakeholder concerns;
- Understanding of social and economic concerns;
- Projections of estimated effects; and
- Discussion of key impacts, each treatment method and waste stream.

The results show that there are some key differences between the treatment methods, and between the different primary criteria. A summary of the impacts is presented below:

- For all treatment methods, there is no or a negligible impact expected on Population Characteristics. The only minor negative impact that may be felt as a result of the landfill and thermal desorption is the potential in-migration of workers that may be brought in from outside the immediate area if required;

[12] The Interorganizational Committee on Guidelines and Principles for Social Impact Assessment(1984), these are US-based guidelines that effectively communicate the assessment of social impacts in the context of an EIA.

- Total ratings scores for Community and Institutional Structures for each treatment/disposal option are all positive. This indicates that if there is any change to the baseline during the development phases, the cumulative impact should be at least a minor positive impact, if not a major positive impact. Those treatment/disposal options that present the potential for major positive impacts are landfill and thermal desorption with the potential for large amounts of economic investment, opportunities for local, regional and national business development and opportunities for employment and training provision;

- The cumulative impact on Political and Social Resources for all treatment/disposal options across all development phases is a major negative impact. This is due to the embedded public perceptions of waste treatment/disposal facilities and the management of waste in the long-term;

- Cumulative ratings scores for Individual and Family Changes are negative for all treatment/disposal options but are significantly high against landfill and thermal desorption. This is primarily because the perceptions of risk, health and safety, the actual health risks of development, the attitudes towards the project, and the concerns about social well-being are likely to be heightened for treatment/disposal options that require a large dedicated waste treatment site to be developed; and

- Community Resources presents a negligible impact across all development phases for those treatment/disposal options including stabilisation, solidification, soil washing and bioremediation. The impact on Community Resources for landfill and thermal desorption is predicted to be minor negative impact due to the changes in land use patterns and the security issues.

In summary, when looking at the cumulative impact rating across all socio-economic criteria, all treatment/disposal options present at least a minor negative impact against the baseline conditions. However, two treatment methods including landfill and thermal desorption present a significantly higher negative impact than the other three treatment methods.

It is worth noting that this study is an initial assessment on the potential need for a NaDWaF and is based on estimated impacts, rather than on actual defined impacts.

2. PREFACE

The responsibility for hazardous waste management planning was assigned to the Environmental Protection Agency (EPA) under the Waste Management Act 1996[13]. The EPA produced the first *National Hazardous Waste Management Plan (NHWMP*) in 2001 and this has been replaced by the plan published in 2008[14]. The plan sets out priority actions for prevention, collection, self-sufficiency and management of hazardous wastes.

While the EPA has overall responsibility for the preparation of the plan, a number of public bodies have been nominated to implement the recommendations of the plan. The plan makes recommendations, in accordance with section 26(2) of the Waste Management Acts, 1996-2008, for actions and infrastructure that the EPA consider necessary for improvement in hazardous waste prevention, minimisation and treatment and disposal[15]. The plan's recommendations are based on statistical data, policy and the business environment surrounding hazardous waste management. The key sustainable development objectives for hazardous waste and waste management objectives of the plan are:

- To reduce the generation of hazardous waste by industry and society in general;
- To minimise unreported and unregulated hazardous waste with a view to reducing the environmental impact of such waste,
- To increase self-sufficiency in the management of hazardous waste and to reduce hazardous waste export; and
- To minimise the environmental, social and economic impacts of hazardous waste generation and management.

At the core of the NHWMP is a prevention programme to reduce the gross generation of hazardous waste in certain priority industrial sectors and in households, this programme is also undertaken by the EPA under the National Waste Prevention Programme. The EPA has commenced management of projects on priority hazardous waste streams and with some business sectors including for example small garages and farms. Even with prevention and minimisation programmes there will always be the need for treatment and disposal outlets for hazardous wastes.

The lack of suitable hazardous waste facilities exacerbate uncontrolled movement and disposal of hazardous waste, potentially leading to risk to human health and the environment as well as costly clean up. The needs assessment must consider the technical and economic feasibility of a NaDWaF involving calculations of arisings, potential for supply, technology options as well as a consideration of the social, economic and political impacts and policy needs.

The National Waste Report for the year 2008 produced by the EPA has shown that the total reported quantity of hazardous waste managed in 2008 increased by 5% since 2007. Almost 50%

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[13] Waste Management Act, Number 10 of 1996, Section 26.

[14] EPA (2008) National Hazardous Waste Management Plan 2008-2012. Available at: http://www.epa.ie/downloads/pubs/waste/haz/NHWMP2008.pdf

[15] Section 2(f(ii) of the Waste Management Acts 1996-2008 enables the EPA to make recommendations regarding hazardous waste infrastructure for waste facilities considered necessary throughout Ireland or in any area of Ireland.

of total arisings are exported abroad for treatment or disposal. The largest increase occurred in the treatment of hazardous waste off-site at commercial facilities in Ireland, which rose by a significant 25%. There was a smaller 7% increase in the quantity of hazardous waste exported for treatment abroad, which remained the dominant treatment operation. The treatment of hazardous waste on-site at industrial facilities is declining, with industry favouring the use of commercial hazardous waste treatment facilities in Ireland or abroad. Part of the reason for this is that industry outputs have reduced and so have the subsequent hazardous waste arisings, industry finds that the treatment off-site is more cost effective that operating their own treatment or recovery operations with less waste arisings.

Five European countries (UK, Germany, Belgium, Netherlands and Denmark) received 97% of Irish hazardous waste exports in 2008. These figures do not include contaminated soil exported for treatment. There was a decrease of 2% in the treatment of contaminated soil off-site Ireland in 2008 compared with in 2007, however, there was a large increase in the reported export of contaminated soil to 449,574 t.

Looking forward, the NHWMP identifies three overarching strategic issues related to increasing self-sufficiency that need to be addressed, if additional hazardous waste is to be treated in Ireland and export reduced:

- Addressing the deficit in capacity for the substantial waste stream currently exported for thermal treatment (i.e. co-incineration, use as fuel or incineration); and

- Development of landfill capacity to manage non-recoverable and non-combustible hazardous wastes and residues, including asbestos; and

- Expansion of other recovery and treatment capacity in Ireland.

To inform the discussion on these issues the EPA commissioned this study to explore the technical and economic aspects of developing a NaDWaF.

3. INTRODUCTION

3.1. Objectives of the Study

To put this study in context, the *National Hazardous Waste Management Plan (NHWMP), 2008*, produced by the EPA identified twenty-nine recommendations for dealing with:

- Prevention of hazardous waste;
- Collection of hazardous waste and the enforcement of hazardous waste regulations;
- Infrastructure and moving towards self-sufficiency in hazardous waste management;
- Legacy issues such as contaminated soil and old landfill site management;
- North-south potential for all-island solutions; and
- Implementation.

This study relates specifically to Recommendation No. 20[16] in the NHWMP which deals with infrastructure and self-sufficiency need and specifies the following;

'*Commission a study in 2009 to clarify the technical and economic aspects of providing hazardous waste landfill capacity. Responsible: Environmental Protection Agency'*.

The EPA commissioned a study in August 2009 to explore the technical and economic aspects of developing a National Difficult Waste management Facility. This facility is hereafter referred to as NaDWaF in this report. Such a facility could include pre-treatment options and/or stable non-reactive landfill or hazardous landfill, the term could include a combination of options to be considered in this study.

Technical feasibility would mean that a NaDWaF must be able to obtain a waste licence and other relevant authorisations to proceed. It must therefore meet or exceed best available technique (BAT) and must be efficient in the treatment of waste while not causing environmental pollution and damage to human health. In considering economic feasibility a NaDWaF must provide an economic return, as it is likely that such projects will be funded through investments provided by the private sector, directly or possibly through though public private partnerships. The private sector will not consider such projects if there are low or no returns, therefore public sector support and policy change may be required to encourage such investments.

The primary element of the study is considering the need for a hazardous waste landfill, but other elements considered are treatment technologies prior to landfill, the short and long-term storage and management facilities for other difficult waste streams such as out-of-date ordnance and disused radioactive sources.

The wastes included in the scope of this study are solid wastes generally not suitable for disposal by waste incineration. This study does not deal with the collection of hazardous waste, but does consider import and export of such wastes.

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[16] EPA (2008) National Hazardous Waste Management Plan 2008-2012, Section 8.1 page 86.

The study examines the trends in hazardous waste landfill need in the context of current and likely future waste generation. The key consideration is the application of the EU "self-sufficiency" and "proximity principles" in respect of hazardous waste produced on the island of Ireland. In addressing these principles the feasibility of co-location with existing national waste management facilities and the option of delivery of all-island facilities are considered.

3.2. Study Scope

The key scope of this study was to examine the trends in hazardous waste landfill need in the context of current and likely future waste generation. The study is based on the timescale up to 2025 only.

The specific project tasks included in the project Terms of Reference were as follows;

Task 1: Desk based assessment of current and expected future (to 2025) national need for hazardous waste landfill capacity;

Task 2: Identification and quantification of difficult waste streams not considered suitable for export or destruction by incineration or landfilling, and where long-term storage is considered the best practicable option;

Task 3: Desk based review of current national storage requirements for disused and orphan radioactive sources (in consultation with RPII);

Task 4: Identification of basic technical containment and operational requirements for hazardous waste landfill (having regard to legal obligations, BAT and international best practice);

Task 5: Identification of basic technical containment and operational requirements for disused and orphan radioactive source storage, including source conditioning (having regard to legal obligations and international best practice);

Task 6: Identification and discussion of merits and demerits of alternative difficult waste management/disposal options (for waste not suitable for incineration/export);

Task 7: Identification of site selection criteria for a NaDWaF (including a landfill element & a disused radioactive source element)(having regard to international best practice);

Task 8: Identify the main environmental issues associated with a NaDWaF comprising long-term difficult waste storage and landfill elements;

Task 9: Examination of the benefits and dis-benefits of co-location of a NaDWaF with existing waste management facilities - to include IPPC authorised sites with long-term aftercare/management obligations;

Task 10: Examination of other national difficult waste management synergies (e.g. storage/destruction of out-of-date ordnance or Category 1 MBM);

Task 11: Identify and discuss merits/demerits of any all-island measures/possibilities in relation to the provision of a NaDWaF;

Task 12: Discuss the issues and validity (from a sustainability perspective) of placing stable nonreactive hazardous waste in non-hazardous landfills;

Task 13: Identify and discuss the economic considerations relevant to any decision to establish a NaDWaF;

Task 14: Identify and discuss the social and political issues associated with the establishment of a NaDWaF;

Task 15: Identify and discuss the Governance aspects (including Regulatory) associated with the provision and regulation of a NaDWaF; including the role, if any, and impact of export bans for certain hazardous waste streams; and

Task 16: Identify and discuss the implications for the provision of a NaDWaF under the EU *Proximity* and *Self-Sufficiency* principals.

Tasks 3, 5 and part of Task 7 specifically deal with disused and orphan radioactive source wastes and are dealt with in a separate study and associated report, but presented in summary in Chapter 7 of this report.

The study cannot and does not specifically identify a site, a technology, or specific costs associated with such, but does present the most feasible options based on the waste arisings, current and predicted and relevant associated treatment and disposal options.

The EPA, the public sector generally and the plan can only seek to influence, but not control, private sector investment decisions. Therefore, options for private sector investment are presented solely as options and no attempt is made to evaluate the actual specific economic feasibility of potential investments. Proposals for hazardous waste management infrastructure are expected to have regard to the NHWMP.

The wastes considered in the scope of this study are those generally deemed not suitable for disposal by waste incineration. The study focuses on hazardous waste suitable for landfill, arising from the commercial and industrial sectors, although household hazardous wastes such as asbestos have been considered. The wastes have been considered in terms of hazardous wastes that can be sent to landfill directly and those that can be disposed of to hazardous landfill following pre-treatment or to a stable non-reactive hazardous waste cell. Liquid wastes are not included in this study.

While radioactive waste is not covered under the Waste Management Acts 1996-2008, the Radiological Protection Institute of Ireland (RPII) identified a deficit in the provision of services to ensure the collection and management of radioactive waste. In addition, a high level inter-departmental group including the EPA and RPII, was established in 2008 to consider and advise Government on the best policy and practice for the safe long term management of Ireland's radioactive waste materials, which was presented to the Irish Government in 2009[17].

There are other sources of wastes produced in Ireland that require special management, these wastes are considered "difficult" in that they require special management or there may be security issues with their movement and treatment or there may be no treatment method or capability on the island of Ireland. For such wastes a form of treatment and long term storage may be required. Difficult waste arisings in Ireland are generally not reported in the EPA National Waste Reports, but are managed by other Government Departments and bodies including , Customs and Excise, An

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[17] National Report by Ireland to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, November, 2009.

Garda Síochána and Departments of Defence and Agriculture. Predictions of future generations of such waste are not possible because of the varied nature by which the materials arise and also in the manner or lack of proper data recording, however, this does not mean that measures cannot be put in place to manage such arisings. Some examples of difficult wastes include;

- Out of Date Ordnance;
- Marine Flares;
- Non re-saleable seized/confiscated controlled substances;
- Ship Wastes;
- Noxious Weeds; and
- Contaminated dredging spoils and harbour wastes.

Most types of waste will now become subject to control under the new Waste Framework Directive (2008/98/ EC), required to be transposed by the end of 2010. However, waste resulting from prospecting, extraction, treatment and storage of mineral resources and the working of quarries is excluded[18]**.** To date the Waste Framework Directive regulatory controls have not therefore been applied to mining waste. However, both the Waste Framework Directive and the Landfill Directive (1999/31/ EC) will continue to apply to waste, other than extractive waste, used for the filling in of excavation voids. While the majority of mining wastes are inert, mining wastes which are categorised as hazardous will be required to be deposited in a Category A landfill for mining wastes only[19]. It is unlikely that such landfills will be operated as commercial landfills.

Economic modelling has been given on the basis of total cost and a functional unit of cost per tonne. It should be noted that import will have additional cost associated with collection and transport within the country of its origin (external to Ireland, if relevant); the costs provided in the report are purely based on Ireland costs. The scenarios considered do not include potential co-location economic appraisals as it is not possible to pre-empt what scenarios may be co-located with existing waste management or IPPC facilities.

3.3. Hazardous Waste Management Issues

In 2008, hazardous waste export volumes remained high as a proportion of total generation of hazardous waste. There were marginal increases in on-site and off-site treatment in Ireland. Treatment refers to waste managed in Ireland or abroad. The total reported quantity of hazardous waste (excluding contaminated soil) managed in Ireland in the context of treatment in 2008[20] was 319,098 tonnes, an increase of 5% on 2007 figures. The EPA National Waste Reports (NWR) show a long-term trend whereby the treatment of hazardous waste on-site at industrial facilities is

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[18] Article 2(1)(b)(ii) of Waste Framework Directive (2006/12/ EC)excludes from its scope waste resulting from prospecting, extraction, treatment and storage of mineral resources and the working of quarries are excluded where waste of this kind is "covered by other legislation.

[19] Category A waste facilities used to service waste from the extractive industries, including materials such as inert waste and unpolluted soil resulting from the prospecting, extraction, treatment and storage of mineral resources and the working of quarries and waste resulting from the extraction, treatment and storage of peat (Directive 2006/21/EC of 15 March 2006 on the management of waste from extractive industries and amending Directive 2004/35/EC).

[20] EPA (2009) National Waste Report.

declining in favour of the use of commercial hazardous waste treatment facilities in Ireland or abroad. In 2008, 157,207 tonnes of hazardous waste (excluding contaminated soil) was exported for treatment. Of this figure 89,749 tonnes were recovered by means of use as fuel, solvent and metal recovery. The remaining 67,424 was disposed of by means of landfill, incineration, physico-chemical treatment and other disposal options.

Contaminated soil exported for treatment varies significantly year on year making it difficult for waste companies to make decisions on investment requirements. The NWR (2008) reported 449,574 tonnes exported of which 285,028 tonnes was disposed of mainly to landfill in Germany.

Other than contaminated soil, asbestos is the largest hazardous waste stream in Ireland that requires landfill disposal. A number of the non-hazardous landfills licences do allow for the acceptance of asbestos, there are currently none with a separate cell. Therefore, there is currently no landfill capacity in Ireland for asbestos of stable non reactive hazardous waste. There is no commercially available facility for the landfill of asbestos. KTK landfill, operated by a private operator, was closed to waste acceptance in October 2009.

The cost of exporting asbestos is expensive, particularly for small scale operators and there is the risk of this waste being deposited illegally as a result. The landfilling requirements of asbestos do cause issue in municipal waste landfills as the waste must be deposited in cells separate to the main body of the non –hazardous waste, although this waste can be accepted at a non-hazardous landfill as long as these requirements are adhered to.[21]. The EPA recommend that a network of collection and transfer facilities should be established to capture the small-scale arisings from DIY and small contracting jobs. This could be done through the use of suitable existing civic amenity site network either run by the Local Authorities or the private sector.

A further aspect with landfilling hazardous waste is that a licence cannot be surrendered and with asbestos disposal at a non-hazardous landfill essentially the licence cannot be surrendered for the specific area where the waste has been deposited. This is because for most hazardous wastes typically the risk never diminishes, therefore the facility must be licensed for the foreseeable future and financial provisions must be provided by the operator in perpetuity. Notwithstanding this, given the nature of sinking funds for financial provision, the cost of provision does not increase linearly with time of provision and the additional costs may not be prohibitive.

In Northern Ireland there is no hazardous landfill capacity. While the waste volumes generated are significantly lower than in Ireland, most of the landfillable hazardous material is sent for disposal to the United Kingdom. Therefore there is potential merit in the establishment of an all-island facility and while the regulations governing the movement and management of hazardous wastes in Ireland and Northern Ireland are relatively similar, there are subtle differences in how the regulations are enforced and how the enforcing authorities govern waste. Many businesses find that it is an administrative and financial burden in trying to comply with regulations in both jurisdictions. A north-south working group on hazardous waste was expected to be established to identify barriers to co-operative waste management approaches, however there are no immediate plans for this group establishment.

3.4. Study Approach and Report Structure

The study was carried out in a series of six key inter -related stages which are presented in **Table 10** with the key corresponding study chapters.

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[21] EPA (2006) Technical Guidance on the landfilling of asbestos.

Table 10 Study Stages and Corresponding Report Sections

Stage	Title	Areas/topic addressed	Chapter
1	Policy and Current Regulatory Controls	This stage addresses the required systems, policy and structure that may need to be brought about to regulate and manage such facilities.	Chapter 4
2	Hazardous Waste Arisings and Forecasts	Stage 1 and parts of Stage 2 were carried out concurrently as the stages relate specifically to the identification of current and future quantities of hazardous waste for landfill, difficult wastes management and possible storage requirements for radioactive sources. The stages are about quantifying the extent of the issues and the capacity (both storage and disposal) requirements. Treatment and disposal in Ireland and abroad has also been addressed. Discussion has been presented on some difficult wastes which cannot be quantified and their management issues. The objective of this stage is to provide a preliminary "screening" analysis, so that later stages can focus on a shortlist of waste of waste and best practicable options and facilities. The initial analysis of focus is on Ireland, but waste figures for Northern Ireland have been considered, while the potential for co-operation in facility provision on an all island basis is discussed in a later stage.	Chapters 5 and 6
3	Radioactive Source Waste	The study scope required a number of tasks to be completed specifically relating to radioactive source waste. The tasks were combined as one distinct phase and involved; a desk based review of current national storage requirements for disused and orphan radioactive sources, identification of technical containment and operational requirements for disused and orphan radioactive source storage and site selection criteria for storage or disposal. These elements have been subject to a detailed assessment and have been developed as a stand alone report. The report summary is presented in this study.	Chapter 7
4	Treatment and Disposal Options including technical containment of landfill	As the waste types from Stage 1 were identified and quantified, the options for landfill and other waste management/disposal options were addressed. This stage includes an options appraisal with technical requirements for containment and discussion of the technical requirements for handling stable non reactive hazardous wastes at non-hazardous sites.	Chapters 8 and 9
5	Site Selection and Environmental Issues, all island and co-location	Evaluation of the environmental and site selection issues, including co-location.	Chapters 10, 11 and 12

	considerations		
6	Economic and Social Considerations	Economic assessments were carried out on 5 waste treatment/disposal scenarios, the social impact considerations took account of the management options and waste types and the potential acceptance of the various options.	Chapter 13 and Chapter 14

Our key findings are drawn together in the **Executive Summary**, the detailed conclusions and recommendations are presented in **Chapter 15**.

4. CURRENT POLICY AND REGULATORY CONTROLS

4.1. Introduction

Waste strategy, policy and regulation in Ireland is well documented and summarised in various government publications and at various government and agency sources, including, but not limited to, the EPA National Waste Reports, EPA National Hazardous Waste Management Plan, EPA Waste Prevention Plan and many other sources[22]. This study therefore does not intend to reproduce that information which is already available and current. However, the study in addressing the governance of the provision and regulation of treatment and disposal facilities, has had to have regard for how current governance systems operate and may require change to enable identified treatment and disposal to be implemented in Ireland, this could for example require an export ban on certain hazardous wastes.

It is in this context that this study considers relevant regulation, plans, policies and government structure or lack of, rather than summarising all that may be relevant. In order to establish the governance aspects associated with the provision of a NaDWaF, it is necessary to establish the overall governance of certain wastes in the context of waste management planning, reporting and disposal.

Some of the key governance aspects to consider vary according to the following;

- The types of hazardous wastes covered by the Waste Management Acts;
- Wastes that are regulated by other government agencies that may not be covered by the WMA, but are dealt with by other regulation;
- Sources and current ownership of wastes;
- Waste arisings data;
- Treatment and disposal options for various waste streams, including storage;
- Lack of or insufficient regulation for certain waste streams; and
- Fragmentation of government departments or agencies.

The overall waste arisings and future predictions will enable the need for treatment and disposal to be identified, but without governance direction and/or allocation of suitable bodies or agents, the identification of need and options is meaningless.

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[22] Sources: http://www.epa.ie/downloads/pubs/waste/stats/ and hazardous waste plan http://www.epa.ie/downloads/pubs/waste/haz/ and National Waste Prevention plan http://www.epa.ie/downloads/pubs/waste/prevention/

4.2. Policy Principles

4.2.1. Self-Sufficiency Principle

The concept of the European Union becoming self-sufficient in waste disposal was introduced in a revision to the Waste Framework Directive in 1991[23]. This principle of European self-sufficiency is continued in the latest revision of the Waste Framework Directive, 2008/98/EC[24]. Article 16 of the 2008 Directive states that a network of facilities should:

"*be designed to enable the Community as a whole to become self-sufficient in waste disposal as well as in the recovery of [municipal waste], and to enable Member States to move towards that aim individually, taking into account geographical circumstances or the need for specialised installations for certain types of waste."*

This highlights the aim for all Member States to become self-sufficient for waste disposal but recognises the fact that it can be difficult to develop viable facilities that use the best available techniques in certain geographic locations. One of the key objectives of the NHWMP 2008 is to strive for increased self-sufficiency in the management of hazardous waste and to reduce hazardous waste export. The lack of suitable hazardous waste facilities impacts on this self-sufficiency objective (largely EU driven) as well as exacerbates uncontrolled movement and disposal of hazardous waste, potentially leading to risk to human health and the environment as well as costly clean up.

The environmental benefits from export reduction include a removed risk of hazardous waste spillage on land and at sea in the event of an accident and a reduction in transport-based greenhouse gas emissions. Thirdly, it seeks to provide for "security-of-supply" in outlets, and particularly disposal outlets for hazardous waste, in the unlikely event that it becomes problematic to export hazardous waste to other Member States. However, it is recognised that Ireland is unlikely to achieve complete self-sufficiency.

4.2.2. Polluter Pays Principle

The polluter pays principle (PPP) is one of the fundamental principles of the environmental policy of European Community. The Treaty Establishing the European Community stated that: "*Community policy on the environment [...] shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay.*" The PPP implies that those who cause environmental damage should bear the costs of avoiding it or compensating for it. It is not unreasonable for a society to produce hazardous waste and expect some other society (via export) to take it for disposal without at least examining whether society can provide and pay for this treatment/disposal as a producer.

The principle is inherent in most environmental directives. Article 14 of the Waste Framework Directive 2008 states, "*In accordance with the polluter-pays principle, the costs of waste management shall be borne by the original waste producer or by the current or previous waste holders.*" The Environmental Liability Directive establishes a framework based on the "polluter

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[23] The Waste Framework Directive 91/156/EEC amending 75/442/EEC.

[24] The Waste Framework Directive 2008/98/EC.

pays" principle, according to which the polluter is financially liable when environmental damage occurs.

The PPP is applied to the charging for waste and for pollution incidents, the cost of disposal is therefore borne by the waste holder and cost of operation of a waste facility. Ensuring the cost of disposal is borne by the waste holder, means that the long term aftercare of the NaDWaF needs to be considered in the charges levied. This could have implications for the economic viability from a commercial point for view for waste management companies, as the operator would need to look after the site in perpetuity. Aftercare cost would need to be reflected in the gate fees charged during the operation of the facilities, unless long term institutional care is deemed to be necessary to make the investment in a NaDWaF attractive. Article 18 of the Environmental Directive makes reference to the proximity principle in that an operator causing environmental damage or creating an imminent threat of environmental damage should be financially liable.

With regards to radioactive source waste, given the probable demand for a storage facility and noting that the vast majority of the sources will come from the public sector, it will likely fall to the appropriate Government Department to ensure that the rewards for the establishment and operation of the facility are an adequate incentive.

4.2.3. Proximity Principle

The 1989 *European Waste Strategy* introduced the principle that waste disposal take place as close to the point of production as possible (the proximity principle). The intended objective is to contribute to the development of an integrated network of waste installations using the best practicable environmental option (BPEO). For a specific objective, the procedure establishes the option that provides the most benefits or the least damage to the environment, as a whole and at an acceptable cost, in the long term as well as in the short term. This process is used in Northern Ireland. While the approach has not been formally adopted in Ireland it has been used for example in the *Pilot Strategic Environmental Assessment of the Replacement Midlands Waste Management Plan 2005-2010*.

One of the guiding principles of the United Nations Basel Convention, which entered into force in 1992, is that, in order to minimize the threat to human health and the environment, that hazardous wastes should be dealt with as close to where they are produced as possible.

The Waste Framework Directive, 2008/98/EC, Article 16 also states that a network of facilities should:

"*enable waste to be disposed of or [municipal waste] to be recovered in one of the nearest appropriate installations, by means of the most appropriate methods and technologies, in order to ensure a high level of protection for the environment and public health*."

However, the proximity principle does not specify or require every waste disposal facility to be local. Regional, national and even European level facilities can be appropriate for certain wastes which require special treatment. The point of disposal of waste as close to its production is not always appropriate in the case of the need for a national facility to deal with hazardous waste, therefore examination on a county by county basis for the national need applying the proximity principle cannot be appropriate. Instead proximity will mean within Ireland or the island of Ireland.

Therefore the approach adopted in the NHWMP for the development of a NaDWaF is entirely consistent with the principles of self-sufficiency and proximity through establishing a need and identifying the technical and economic feasibility of developing facilities on the island of Ireland.

4.3. Legislation Framework

4.3.1. Waste Framework Directive 2008/98/EC

The revised Waste Framework Directive (WFD) is far more wide reaching than its predecessor. Member States are required by Article 40 to bring into force the laws, regulations and administrative provisions necessary to comply with the revised WFD by 12 December 2010. The revised WFD revises three existing Directives, the existing WFD[25]; the Waste Oils Directive[26]; and the Hazardous Waste Directive[27]. Ireland already has in place the necessary laws to comply with these three Directives. However, the revised WFD does introduce several new provisions which will require policy decisions to be made before deciding on the necessary transposing legislation.

The amended Directive sets the EU's first waste recycling targets for household and non-hazardous construction and demolition waste. It also enshrines the five-step waste hierarchy into EU law and introduces a definition of by-products that will allow some materials currently defined as waste to become non-wastes. The legal requirements for national waste management plans and waste facilities to be permitted are retained along with the principles of producer responsibility (which is extended), self-sufficiency, proximity and that the cost of disposal is borne by the waste holder in accordance with the polluter pays principle.

The key implications relating to a NaDWaF resulting from the revised WFD are similar to those that have been in place for a number of years, namely:

- The requirement for the Government to consider the need for a NaDWaF as part of its consideration of self-sufficiency and proximity; and
- The requirement for appropriate authorisations to operate.

There are some provisions which could impact on the management of waste and hazardous waste in Ireland. Annex III to the revised WFD lists the hazardous waste properties, there are two changes to the list which are likely to impact on the types and quantities of waste classified as hazardous; and a third change to the way that hazardous waste is managed.

1. The first change is the addition of a new property: ―H13 (*) ‗Sensitizing': substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce non-hereditary congenital malformations or increase their incidence;

2. The second change is that the existing property H13 has been re-numbered to H15. This means that this property ―H15: Waste capable by any means, after disposal, of yielding another substance, e.g. a leachate, which possesses any of the characteristics above now also applies to ―H14 ‗Ecotoxic'. In other words, H14 (ecotoxicity) now has to be considered as a criterion for H15; and

3. The third change arises from Article 18 of the revised WFD which re-enacts the ban on the mixing of hazardous waste with other categories of hazardous waste or with other

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[25] The Waste Framework Directive 2006/12/EC.

[26] The Waste Oil Directive 75/439/EEC, as last amended by Directive 2000/76/EC.

[27] The Hazardous Waste Directive 91/689/EEC.

waste, substances or materials. Article 18(2) provides derogations from the mixing ban and, in particular, allows mixing only where the permitted mixing operation conforms to best available techniques. This requirement applies regardless of who is undertaking the mixing operation, for example the waste producer or a waste contractor. This is a change to the way hazardous waste is managed.

4.3.2. The Landfill Directive 1999/31/EC

The overall aim of the Landfill Directive[28] is to deal with the full social, environmental and economic impacts of landfill as a disposal option while generally improving waste management practices. The directive also aims to reduce greenhouse gas emissions from landfill sites.

It addresses the need for improvements in landfill practices across the EU and contains a mix of strategic objectives for reducing the amount and nature of wastes going to landfill together with strict provisions for the requirement for pre-treatment before disposal, the regulation and management of landfills and changes to construction, operation and aftercare of landfill sites.

The directive brought about changes in waste management across the EU, including:

- A complete ban on the landfill of certain hazardous waste;
- Separate landfills for hazardous, non-hazardous and inert wastes; and
- Introduction of a requirement for treatment of waste prior to landfill and the establishment of acceptance criteria for waste arriving at sites (where such treatment can be justified)..

Council Decision 2003/33/EC[29] on the acceptance of waste to landfill, made under the Landfill Directive, sets out the acceptance criteria including criteria for:

- Wastes that can be deposited at inert landfills;
- Stable non-reactive hazardous waste that can be deposited in a separate cell in a non-hazardous waste landfill; and
- Hazardous waste that can be deposited at a hazardous waste landfills.

This Decision also details the requirements for underground storage facilities covered under Disposal Operation[30] D12 - "Permanent storage *(e.g. emplacement of containers in a mine, ...)"* and the waste that can be accepted at such facilities.

As a NaDWaF is likely to include a hazardous waste landfill, the requirements of the Landfill Directive are critical. Of particular reliance are:

- The design and containment requirements (discussed in Chapter 9);

[28] The Landfill Directive 99/31/EC.

[29] Council Decision 2003/33/EC establishes criteria and procedures for the acceptance of granular waste at landfills pursuant to Article 16 and Annex II of the Directive 1999/31/EC on the landfill of waste.

[30] The Waste Framework Directive 2008/98/EC, Annex 1.

- The hazardous wastes banned from landfill which include explosive, corrosive, oxidising, highly flammable, flammable and hospital and other clinical waste arising from medical or veterinary establishments, which are infectious; and

- The pre-treatment requirement for wastes prior to landfill.

4.3.3. Environmental Liability Directive 2004/35/EC

The Environmental Liability Directive[31] (ELD) sets out requirements that Member States must enact to prevent and remedy environmental damage to protected species and natural habitats; water and land. The purpose of the ELD is to allocate liability for environmental damage and for remedying environmental damage to the liable party which in principle is the "operator", i.e. the one (natural or legal person) who carries out an occupational activity. The activities are listed in Annex iii of the ELD and include waste management operations. The Directive establishes a framework based on the "polluter pays" principle, therefore the polluter is financially liable when environmental damage occurs. Waste management operations in the context of the ELD mean the collection, transport, recovery and disposal of non-hazardous and hazardous wastes, including the supervision of such operations and after-care of authorised sites.

The Department of the Environment Heritage and Local Government (DEHLG) introduced Environmental Liability regulations in 2008 to implement most of the measures of the ELD in Ireland[32] The DEHLG is also in the process of drafting an Environmental Liability Bill 2009, which will implement the remaining measures of the ELD. The EPA is the competent authority with responsibility for enforcing the ELD in Ireland.

The Regulations cover liability for all environmental damage occurring after April 2009 and not for "historic" damage. It is therefore important for industry and business to understand fully their current environmental baselines. There is a strict liability approach in respect of activities or operations that are inherently risky or dangerous to the environment (e.g. industrially licensed facilities or waste facilities). For all other activities and operations liability under the ELD will be fault-based.

While narrower in scope than the Directive, the EPA published guidance on 17 August 2006 regarding the assessment and management of environmental liabilities associated with activities licensed under its waste and IPPC regimes designed to meet the requirements of the Directive.

4.3.4. Environmental Impact Assessment

The EIA Directive (85/337/EEC as amended by 97/11/EC and 2003/35/EC, requires that certain developments be assessed for likely environmental effects (known as environmental impact assessment (EIA) before planning permission can be granted. A planning application is therefore supported by an Environmental Impact Statement (EIS).

The EIA requirements under planning legislation in Ireland were consolidated into Part X of the Planning and Development Act, No. 30 of 2000 and Part 10 of the Planning and Development

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[31] The Environmental Liability Directive 2004/35/EC.

[32] S.I. No. 547 of 2008, The European Communities (Environmental Liability) Regulations.

Regulations 2001[33]. Schedule 5 (Part 1 and Part 2) of the Regulations list projects needing environmental impact assessment.

Planning and Development Regulations 2001, Schedule 5
Part 1- Waste developments requiring EIS
Class 9: Waste disposal installations for the incineration, chemical treatment as defined in Annex IIA to Directive 75/442/EEC under heading D9, or landfill of hazardous waste (i.e. waste to which Directive 91/689/EEC applies) and; **Class 10**: Waste disposal installations for the incineration or chemical treatment as defined in Annex IIA to Directive 75/442/EEC under heading D9, of nonhazardous waste with a capacity exceeding 100 tonnes per day.
Part 2 - Pertains to activities that may require an EIS
11. Other projects (b) Installations for the disposal of waste with an annual intake greater than 25,000 tonnes not included in Part 1 of this Schedule. (h) All installations for the manufacture, packing, loading or placing in cartridges of gunpowder and explosives or for the recovery or destruction of explosive substances.
13. Changes, extensions, development and testing (a) Any change or extension of development which would:- (i) result in the development being of a class listed in Part 1 or paragraphs 1 to 12 of Part 2 of this Schedule, and (ii) result in an increase in size greater than – - 25 per cent, or - an amount equal to 50 per cent of the appropriate threshold, whichever is the greater.

Where a non-hazardous landfill proposes to accept more than 10% (total intake) or 50,000 tonnes (whichever is the least) of stable non-reactive hazardous waste its classification will change to hazardous, either for the entire landfill but at the very least for the cell containing the hazardous waste. The reasoning for these particular limits is that the specific engineering requirements of a separate cell for 50,000 tonnes of hazardous waste would be economically and technically feasible. The 10% is based on the EPA view that from an operational control perspective any waste stream contributing >10% intake is significant with respect to the classification and risk profile of a site[34].

[33] S. I No. 600 of 2001, Planning and Development Regulations.

[34] EPA (2006) Technical Guidance on the landfilling of asbestos.

In 2006, the Planning and Development (Strategic Infrastructure) Act[35] was introduced with two key purposes, to amend the Planning and Development Act 2000 and to provide a more efficient planning consent procedure for strategic infrastructure developments. The Act introduced a new planning consent procedure for certain types of infrastructure projects listed in a new Seventh Schedule to the Principal Act.[36]. The schedule includes the following waste activities related to hazardous waste.

Planning and Development (Strategic Infrastructure) Act
Environmental Infrastructure *3.— Development comprising or for the purposes of any of the following:* *—A waste disposal installation for—* *(a) the incineration, or* *(b) the chemical treatment (within the meaning of Annex IIA to Council Directive 75/442/EEC under heading D9), or* *(c) the landfill of-* *hazardous waste to which Council Directive 91/689/EEC applies (other than an industrial waste disposal installation integrated into a larger industrial facility).*

The new procedure allows persons or bodies seeking planning permission for those types of strategic infrastructures to apply directly to An Bord Pleanála, provided that the development would be of strategic economic or social importance to Ireland or region in which it would be located, or the development would contribute substantially to the fulfilment of any of the objectives in the National Spatial Strategy or in any regional guidelines in force in respect of the area or areas in which it would be situate, or the development would have a significant effect on the area of more than one planning authority. The Board must look at the overall national interest when making a decision as opposed to any particular regional interest.

4.3.5. Regulation (EC) 1013/2006 on the Shipment of Waste

The Regulation sets out the framework for the shipment of waste within, into and out of the European Community and is directly applicable to all Member States[37]. It aims to ensure the environmentally sound and efficient management of waste and implements the Community's obligations under the United Nations Basel Convention and the OECD decision on trans boundary movements of waste.

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[35] Planning and Development (Strategic Infrastructure) Act, No. 27 of 2006.

[36] See Section 5 of the 2006 Act.

[37] Regulations (EC) 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste is supported in Irish law by S.I. 419 the Waste Management (Shipments of Waste) Regulations .

The introduction to the Regulation states that:

"*In the case of shipments of waste for disposal, Member States should take into account the principles of proximity, priority for recovery and self-sufficiency, in accordance with [the Framework Directive] , by taking measures in accordance with the Treaty to prohibit generally or partially or to object systematically to such shipments. Account should also be taken of the requirement laid down in [the Framework Directive], whereby Member States are to establish an integrated and adequate network of waste disposal installations, in order to enable the Community as a whole to become self sufficient in waste disposal and the Member States to move towards that aim individually, taking into account geographical circumstances or the need for specialised installations for certain types of waste."*

In addition, Article 11 of the Regulation sets out methods by which Member States may object to shipments of waste for disposal. One of the grounds for objection relates to promoting the principles of proximity, priority for recovery and self sufficiency in the disposal of waste at both the Community and national level. Therefore Member States have the discretion to prohibit the shipment of waste in order to achieve objectives related to proximity and self sufficiency.

The Regulation also prescribes the procedures that must be followed when waste is exported. There are detailed requirements related to the notification, approval and tracking along with a requirement of a financial guarantee or equivalent insurance to cover cases where a shipment or the recovery or disposal cannot be completed as intended or is illegal. The key implications for the NaDWaF mainly relate to the commercial viability of a facility. Currently many of the waste streams that would be sent to a NaDWaF are exported for treatment or disposal. The viability of a NaDWaF could depend on the facility receiving all the hazardous waste needs to be landfilled. Therefore to provide assurances to potential investors it is likely that the Government would need to prohibit the export of hazardous waste to landfill. In addition, consideration could be given to banning the export of hazardous waste that would be landfill following a treatment process, for example air pollution control residues. Such an approach could increase the viability of a NaDWaF by increasing the range of treatment activities undertaken at the site and the quantities of waste to be managed at the site.

The potential need for an export ban is recognised within the NHWMP, and the plan highlights that an export ban would need to be carefully considered and designed and only implemented when a NaDWaF is operational. The NHWMP also highlights the alternative of an export levy hazardous waste for landfill disposal, recognising that unlike an outright ban on export, a levy would allow industry access overseas facilities and provides a safeguard against uncompetitive gate fees in Ireland.

In September 2009 the Irish Waste Management Association called for ban on the exportation of ash material produced from waste incineration in Ireland on the basis that the material should be managed in Ireland and could potentially result in the creation of jobs and generation of revenue in Ireland. The introduction of a ban on the export of certain wastes would need to be timed with the availability of treatment and disposal capacity in Ireland or on the island or Ireland.

4.3.6. UK Plan for Shipments of Waste

The UK Plan for Shipments of Waste prohibits majority of waste shipments for disposal to and from the UK, i.e. it bans the export of most waste for disposal. The export ban was introduced as the UK has the ability to treat and dispose of its' own hazardous waste. There is a notable except that has implications for the development and viability of a NaDWaF:

"*shipments of hazardous waste between Northern Ireland and the Republic of Ireland, in either direction, for disposal operations specified in this Plan and where the waste is generated and disposed of within Northern Ireland or the Republic of Ireland*"

The disposal operations specified in the Plan are:

- D5 Specially engineered landfill (e.g. placement into lined discrete cells which are capped and isolated from one another and the environment, etc); or
- D10 Incineration on land; and
- D9 Physico-chemical treatment which results in final compounds or mixtures which are discarded by means of any of the operations above.

This exception to the UK disposal ban recognises the distinct geographical situation of Northern Ireland and that an all-island facility would be either geographically closer or the use less complex or more environmentally sound transport routes.

With regards to a NaDWaF, the ability to accept waste from Northern Ireland could increase the economic viability of a facility and the appetite for potential investment due to the increased potential input. However, if a potential facility included the permanent storage in a mine facility, waste from Northern Ireland could not be accepted, as the listed disposal operations, under the current text of the arrangement, do not include D12 Permanent storage (e.g. emplacement of containers in a mine).

A potential disincentive, to using an all-island facility, would be cost of compliance with transfrontier shipment procedures, which could potentially increase the cost in comparison to the cost of disposal in other parts of the UK.

An additional issue that would need to be addressed would be the public perception of disposing of waste from outside Ireland. **Chapter 10** discusses the merits and demerits of an all-island opportunities related to a NaDWaF.

Therefore the provision of common all-island landfill capacity for hazardous waste, including asbestos waste, is possible within UK policy and is not prohibited in Irish policy. Similarly, all-island incineration and physico-chemical treatment capacity may now be planned for and taken into consideration by treatment operators.

4.3.7. Integrated Pollution Prevention and Control (IPPC) Directive (96/61/EC and 2008/1/EC)

The purpose of the IPPC Directive[38] is to achieve a high standard of protection of the environment overall by requiring certain industrial processes (including certain waste management activities), identified in Annex 1, to prevent and/or control emissions from the processes by the use of best available techniques (BAT). If emissions can be reduced further, or prevented altogether, at reasonable cost (the balance of cost against benefit or prevention of harm), then this should be done irrespective of whether any environmental quality standards are already being met. It

[38] The IPPC Directive was codified, the codified Act includes all the previous amendments to Directive 96/61/EC and introduces some linguistic changes and adaptations, e.g updating number of legislation referred to in the text.

requires us not to consider the environment as a recipient of pollutants and waste, but to do all that is practicable to minimise the impact of industrial activities. The BAT approach therefore, in this respect, is a precautionary one.

The specific activities relating to a NaDWaF are Category 5.1:

5.1. Installations for the disposal or recovery of hazardous waste as defined in the list referred to in Article 1(4) of Directive 91/689/EEC, as defined in Annexes II A and II B (operations R1, R5, R6, R8 and R9) to Directive 2006/12/EC and in Council Directive 75/439/EEC of 16 June 1975 on the disposal of waste oils (2), with a capacity exceeding 10 tonnes per day.

The objectives of IPPC and Landfill Directives are complementary. Article 1(2) of the Landfill Directive states that the technical requirements of the IPPC Directive will be fulfilled by compliance with the requirements of the Landfill Directive. Where there is a requirement arising from IPPC and a specific Landfill Directive requirement covering the same matter, the Landfill Directive takes precedence. For example, under IPPC there is a requirement to include BAT based emission limit values or equivalent parameters or technical measures and if necessary, the Permit (or licence as is the case in Ireland) is to include appropriate requirements ensuring the protection of soil and ground water. Annex I of the Landfill Directive contains specific requirements to limit the emission of landfill gas and requirements for the protection of soil and ground water. The effect of Article 1(2) of the Landfill Directive is that these specific Annex I requirements are deemed to satisfy the general PPC requirements in relation to emissions to air and to ground water.

With regards to a NaDWaF, the EPA has prepared BAT notes for certain landfill and waste treatment processes[39]. Therefore any facility proposed must be able to obtain a waste licence and other relevant authorisations to proceed. It must therefore meet or exceed BAT (best available technique) and must be efficacious in the treatment of waste while not causing environmental pollution.

4.4. Conclusions

This chapter has been presented to outline the key directives and associated regulations which an operator must have regard to in the planning, development and operation of a NaDWaF. The development of such a facility must be in accordance with recommendations by the EPA in the NHWMP and any facility must be able to obtain a waste licence and other relevant authorisations to proceed. It must therefore meet or exceed BAT (best available technique) and must be efficacious in the treatment of waste while not causing environmental pollution. Any environmental damage caused by the operator means that they are financially liable when environmental damage occurs.

[39] EPA (2003).BAT Guidance Notes for the Waste Sector: Landfill Activities and EPA (2008) Draft BAT Guidance Notes for the Waste Sector, Landfill Activities.

5. HAZARDOUS WASTE ARISINGS AND FORECASTS

5.1. Introduction

To determine the need for and the potential capacity of a NaDWaF, the future hazardous waste arisings must be determined in order to assess the options for managing a range of hazardous waste streams.

The current and expected future arisings were assessed through a desk based assessment of historic hazardous waste data combined with economic forecasts to estimate the types and quantities of waste that may need to be managed at a NaDWaF. Data relating to both Ireland and Northern Ireland was considered with a view to considering an all-island facility. The wastes included in the assessment are generally deemed not suitable for disposal by waste incineration. For the purposes of predicting future hazardous waste arisings, the year 2008 has been selected as the baseline year for both Ireland and Northern Ireland (with the exception of contaminated soil, where a baseline of 2007 was selected).

This chapter relates to wastes that are reported to the EPA for the purposes of national waste reporting and for which future arisings can be predicted. There are other wastes which arise in Ireland that are not reported to the EPA and for which generation predictions cannot be established., but which are subject to another form of management and reporting, these wastes are considered under **Chapter 6.**

Waste is classified as hazardous when it displays properties that make it dangerous or it is potentially harmful to human health or the environment. Any waste which displays one or more of the hazardous properties listed in Annex III of new Waste Framework Directive (Directive 2008/98/EC) is defined as hazardous waste.[40] . While reducing the hazardous nature of waste is one of the key priorities of treatment options, prevention of the waste in the first instance is the overall priority. One of the guiding principles of the Basel Convention[41] is that in order to minimise the potential threat of hazardous waste to human health and the environment, hazardous wastes should be dealt with as close as possible to where they are produced[42].

The majority of hazardous waste produced in Ireland is generated by industrial facilities, and includes such wastes as solvents, oils, pickling acids, still bottoms, reaction residues and absorbents and filter materials. Households, small businesses, farms, the healthcare sector and the construction sector also generate substantial quantities of hazardous wastes, including but not limited to such wastes as batteries, healthcare risk waste, paint and varnish waste, sheep dip, fluorescent lamps and Waste Electrical and Electronic Equipment. .

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40 EPA (2008) National Waste Report 'List of Terms'.

41 The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, usually known as the Basel Convention, is an international treaty that was designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries (LDCs). The Convention is also intended to minimize the amount and toxicity of wastes generated, to ensure their environmentally sound management as closely as possible to the source of generation.

42 Council Regulation 259/93/EEC (Supervision and Control of Shipments of Wastes) entered into force on 6 May 1994 regulates the movement of all waste within, into and out of the EU. The Regulation implements the Basel Convention and OECD Decision on the transfrontier shipment of waste.

Contaminated soil can also be classified as hazardous waste depending on the concentration of dangerous substances within the soil. It is mostly generated as the result of the remediation and redevelopment of contaminated urban sites, although smaller quantities can also be generated through the re-development of old fuel filling stations and as a result of minor oil leaks. Accurate information on the quantities of contaminated soil generated in Ireland each year is not currently available as some quantities of soil are treated in situ at the point of generation.

5.2. Assessment Methodology

The desk based assessment required the collation of data on the current trends in hazardous waste arisings that can be landfilled, therefore wastes not suitable for landfill were excluded from this overall assessment. Using the current trends in arisings and elements of the Economic and Social Research Institute (ESRI) sustainable development model ISus[43], predictions of hazardous waste arisings up to 2025 were developed.

5.2.1. Sources of Information

Several sources of information were used to compile the data presented in this Chapter, namely the EPA National Waste Reports (NWR) 2004 to 2008 inclusive; specifically the following aggregated datasets underlying the published reports were interrogated:

- Industry Dataset - compiled from Integrated Pollution Prevention Control (IPPC) licensed facilities, PRTR AERs[44] and responses to the voluntary Non IPPC survey. The datasets combined constitute reported industrial data. A scale-up methodology, based on Central Statistics Office (CSO) sectoral employee numbers, is applied to the reported data in order to estimate projected industrial waste quantities;

- Transfrontier Shipment (TFS) Dataset - compiled from TFS records on exported waste;

- Hazardous Waste Facilities Dataset - which reports on the management of hazardous waste at EPA waste-licensed or Local Authority permitted commercial hazardous waste facilities. It also includes data on the quantity of hazardous asbestos waste landfilled in Ireland;

- Northern Ireland Environment Agency (NIEA);

- England and Wales Environment Agency (EA) Hazardous Waste Interrogator; and

- ESRI's Sustainable Development Research Model for Ireland "ISus".

5.2.2. Selection of Datasets

In order to establish a baseline figure of waste arisings and to predict future arisings the datasets were interrogated. Certain data has been excluded and assumptions made, the reasons are

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43 http://www.esri.ie/research/research_areas/environment/isus/

44 PRTR –Pollutant Release and Transfer Register, the EPA is responsible for reporting certain emissions from a range of industrial activities within and outside of the Integrated Pollution Control and Waste Licensing arrangements to the European Commission.

outlined below.

- Industrial waste datasets are available for calendar years 1998, 2001, 2004, 2006 and 2008. TFS and Hazardous Waste Facilities Datasets are available for calendar years 1998 and 2001 to 2008 inclusive. Data relating to calendar years 1998 and 2001 has been excluded from analysis for the following reasons:

  - The EWC codes used pre-2002 were markedly different to those currently in use and may no longer be relevant to the Irish waste sector, in addition many sectors applied incorrect codes to certain wastes, however, the application of correct codes has improved significantly; and

  - The methodologies used by the EPA to compile the data have evolved significantly since 2001.

As the Industry Dataset is not collated during interim reporting years, hazardous waste arisings and management data is rendered incomplete for these years. Interim year data is therefore excluded from the NaDWaF study, comprising calendar years 2002, 2003, 2005 and 2007.

5.2.3. Quantifying Hazardous Waste Arisings and Management

In order to properly assess the true quantity of hazardous waste generated in Ireland on an annual basis the following data was collated:

- The reported quantity of hazardous waste generated and treated on-site at industrial facilities (IPPC and non IPPC);

- The reported quantity of hazardous waste treated off-site at commercial hazardous waste facilities in Ireland; and

- The reported quantity of hazardous waste exported abroad for treatment under TFS notifications.

This methodology assumes that the quantity of hazardous waste managed each year, i.e. the sum of waste managed on-site in Ireland, off-site in Ireland plus sent abroad for treatment, represents the true quantity of hazardous waste generated in Ireland. Contaminated soil arisings are excluded from this data analysis as they represent the largest single hazardous waste arising in Ireland, inclusion of arisings here would skew total predictions. **Table 11** presents trends in total hazardous waste arisings for the period 2004 to 2008 inclusive. Following a decline in hazardous waste generation in 2006, the 2008 reported figures have returned, and exceed the 2004 levels.

Table 11 Management of Reported Hazardous Waste Arisings 2004 – 2008 (Excluding Contaminated Soils)

Reporting Year	Onsite at Industry (T)[45]	Offsite in Ireland (T)	Exported (T)	Unspecified (T)	Total (T)
Disposal					
2008	35,592	34,594	67,424	0	137,610
2006	50,037	33,896	65,130		149,062
2004	53,429	31,506	66,059	0	150,994
Recovery					
2008	36,446	79,245	89,749	0	181,455[46]
2006	38,372	26,976	69,515		134,863
2004	32,899	24,446	99,069	0	156,414
Unspecified Treatments					
2008	0	0	33	0	33
2006	0	0	259	0	259
2004	0	0	372	0	372
Totals					
2008	72,038	113,839	157,207	0	319,098
2006	88,409	60,872	134,903	0	284,184
2004	86,328	55,952	165,500	0	307,780

5.2.4. Disposal of Reported Hazardous Waste Arisings

The disposal options used by Irish facilities (either at source at treatment or at export destination) to deal with hazardous waste arisings were assessed by collating the total quantities that were disposed of according to the European Disposal Codes[47] and then by further assessing the breakdown of wastes by EWC codes that went to landfill directly. **Table 12** categorises disposal of reported hazardous waste, excluding contaminated soils, according to European Disposal Codes for 2004, 2006 and 2008 inclusive. The complete list and description of disposal codes are listed in **Appendix 1**.

Table 12 presents a sub-total of the quantity of hazardous waste sent to landfill in Ireland or abroad in the years 2004, 2006 and 2008 and provides the tonnage of waste according to the European Disposal Code. The recovery operation codes are excluded as this study is specifically addressing the landfillable hazardous wastes. The table presents a split between hazardous waste that is treated on-site and off-site in Ireland and that portion that is exported. The volumes of hazardous waste that were disposed of to landfill directly under D1 code in 2008 have slightly decreased whereas the hazardous waste to landfill under D5 has increased. In addition, it should be noted that the outputs from certain disposal (Codes D9, D10, D13, D14 and D15) are likely to have their final destination as D5.

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45 (T) = Metric Tonnes.

46 A total of 23,986 t of waste solvent (1,073 t of halogenated solvent and 22,913 t of non-halogenated solvent) was blended at facilities in Ireland prior to export for use as fuel in cement kilns and incinerators. The blended solvents were exported as a waste.

47 The Waste Framework Directive 2006/912/EC, Annex 11 A.

Table 12 Disposal of Reported Hazardous Waste Arisings, 2004 – 2008 (Excluding Contaminated Soils)

	TREATMENT/DISPOSAL ROUTE																	
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	DU	Sub Total D1 + D5 (T)	Total (T)
Onsite at Industry (t)																		
2008	12,559							1,791	322	20,897		23					12,559	35,592
2006	13,748			18				479	499	35,121				22	150		13,748	50,037
2004	13,657			18				2,200	72	37,304					178		13,657	53,429
Offsite in Ireland (t)																		
2008					7,462				27,131								7,462	34,594
2006	2,524								31,372								2,524	33,896
2004					3,109				28,397								3,109	31,506
Exported (t)																		
2008	12,217				9,775			2,733	1,792	40,505		226	124	44	8		21,992	67,424
2006	11,685			1	498			1,699	1,709	47,854			1,639		45		12,183	65,130
2004	5,484		53		492			906	4,179	54,471		44	70	20	341		5,976	66,059
Totals																		
2008	24,776	0	0	0	17,237	0	0	4,524	29,245	61,402	0	249	124	44	8	0	42,013	137,610
2006	27,957	0	0	19	498	0	0	2,178	33,580	82,975	0	0	1,639	22	195	0	28,455	149,062
2004	19,141	0	53	18	3,601	0	0	3,106	32,648	91,775	0	44	70	20	519	0	22,742	150,994

A detailed breakdown of the hazardous waste types (excluding contaminated soil) by EWC code that have that have been consigned to landfill, either in Ireland or abroad (under Disposal Codes D1 and D5) is presented in **Table 13** below.

Table 13 Hazardous Waste Landfilled in Ireland (onsite at IPPC facility or offsite at waste licensed facility) or sent for landfill abroad. Disposal codes D1 and D5 only.

Dataset	EWC Code	Waste Description	Fate of waste / Export Destination	2004 (T)	2006 (T)	2008 (T)
Hazardous Waste Facilities	17 06 05*	Construction materials containing asbestos	Landfilled	3,109	2,524	7,462
Industry	01 03 07 *	Filter cakes containing heavy metals	Landfilled onsite		13,748	12,559
	06 03 99	Salt cakes	Landfilled onsite	13,655		
	17 06 05*	C and D containing asbestos	Landfilled onsite	2		
Sub-Total Landfilled in Ireland				16,766	16,272	20,021
TFS	06 01 06*/ 20 01 14*	Acid and alkali waste	Belgium	21		
	06 02 05*/ 20 01 15*	Acid and alkali waste	Belgium	19		
	06 04 05*	Filter cakes containing heavy metals	Germany	19	288	2,518
	06 05 02*	Filter cakes containing heavy metals	Germany	315	664	
	07 05 11*	Hydrocarbon and solvent contaminated sludges	Germany	18	56	79
	07 05 13*	Pharmaceutical wastes	Germany		23	138
			The Netherlands	138		
	08 01 11*	Waste paint and varnish containing organic solvents	The Netherlands		60	
	10 02 07*	Furnace dust	Germany	336		38
	10 10 07*	Wastes from thermal processes	Germany			731
	10 11 13*	Wastes from thermal processes	Germany	588	633	45
	10 11 19*	Gypsum	Germany		4,994	1,901
	11 01 09*	Filter cakes containing heavy metals	Germany	183		

Dataset	EWC Code	Waste Description	Fate of waste / Export Destination	2004 (T)	2006 (T)	2008 (T)
	11 01 08*	Filter cakes containing heavy metals	Germany		20	
	12 01 14*	Filter cakes containing heavy metals	Germany		39	15
	16 11 05*	Incinerator maintenance	Germany		92	5
	17 06 01*	Insulation material containing asbestos	Germany	949	1,863	1,817
	17 06 05*	Construction materials containing asbestos	Germany	3,109	3,430	5,189
	17 09 03*	C and D waste containing dangerous substances	Germany			15
	19 02 05*	Filter cakes containing heavy metals	Germany		20	
	19 10 03*	Wastes from treatment of ELVs	Germany			9,500
	Unknown	Unknown	unknown	282		
Sub-Total Landfilled Abroad				5,976	12,183	21,992
Grand Total				22,742	28,455	42,013

The waste reported under 01 03 07* (waste from physical and chemical processing of metalliferous minerals) is a specific waste stream that is treated at a dedicated facility and it is unlikely that it would be sent to a NaDWaF.

5.2.5. Review of Reported Disposal Codes (except D1 and D5)

To ensure that all relevant EWC codes for landfillable hazardous waste have been captured a review was undertaken of national waste reported Industry, Hazardous Waste Facility and TFS Datasets, (2004, 2006 and 2008), specifically relating to reported disposal codes other than D1 and D5. **Table 14** presents the findings of this review. It identified a total of ten EWC Codes which have been reported as being disposed to landfill (Disposal Codes D1 and D5) and also being managed by means other than landfill (Disposal Codes other than D1 and D5).

Table 14 Potential Landfillable Hazardous Wastes, reported under Disposal Codes other than D1 and D5, 2004, 2006 and 2008

EWC Code	Waste Description	Source Datasets		
		Industry	TFS	Hazardous Waste Facility
06 01 06*	Acid and alkali waste	-	D9, D10	D9
06 02 05*	Acid and alkali waste	-	D9, D10	D9
06 04 05*	Filter cakes containing dangerous substances	-	-	D9
06 05 02*	Filter cakes containing dangerous substances	-	-	D9
08 01 11*	Waste paint and varnish containing organic solvents	-	D10	D9
11 01 09*	Filter cakes containing dangerous substances	D15	D9	D9
11 01 98*	Filter cakes containing dangerous substances	D9	-	D9
12 01 14*	Filter cakes containing dangerous substances	-	D9	D9
17 05 03*	Contaminated soil	-	-	D9
19 02 05*	Filter cakes containing dangerous substances	-	D10, D13	D9

It is important to note that a portion of the hazardous wastes reported as managed directly at landfill (under Disposal Codes D1 and D5) may in fact have been pre-treated before consignment to landfill.

5.2.6. Contaminated Soil Arisings and Management

Contaminated soil remains the largest single hazardous waste type generated in Ireland each year. Information relating to the exact quantities of contaminated soil generated in Ireland on an annual basis is unavailable, as much of this waste stream is treated *in-situ* at point of generation. However, for contaminated soil that is removed offsite, data can be compiled from the TFS and Hazardous Waste Facilities Datasets.

Since 2004 (with the exception of 2005 when only TFS data was compiled) both of these datasets have been compiled on an annual basis by the EPA, therefore it is possible to show trends in the management of contaminated soil across both “full” and “interim” NWR years. **Table 15** presents a breakdown of the reported contaminated soil which was recovered and disposed of in Ireland and also exported abroad for recovery and disposal.

There was a significant increase in the generation of contaminated soil in 2008, half of this waste arose from decommissioning and remediation works undertaken at a closed IPPC-licensed company.

Table 15 Management of Contaminated Soil, 2004 – 2008

:		2004 (T)	2005 (T)	2006 (T)	2007 (T)	2008 (T)
Total Reported (t)		221,137	-	406,904	188,127	493,107
Of which:						
Treatment in Ireland	Recovery	14,838	-	36,872	44,221	43,531
	Disposal	-	-	-	-	2
Exported (Total)	Total	206,299	140,442[48]	370,032	143,906	449,574
	Recovery	35,554	7,184	28,875	17,047	151,891
	Disposal	170,744	133,258	341,158	126,859	297,683
Exported to:						
Germany	Recovery	-		28,570	14,919	135,980
	Disposal	170,744	120,455	341,158	126,859	285,028
Netherlands	Recovery			305	2,128	15,911
	Disposal			-	-	12,655
Elsewhere in Europe	Recovery	100				
	Disposal	-	19,986			
Not specified	Recovery	35,454				
	Disposal	-				

A detailed review of the disposal options used for the management of contaminated soils is presented in **Table 16.** The majority of contaminated soils are exported to Germany for physico chemical treatment (D9), prior to disposal at landfill.

Table 16 Disposal Options for Contaminated Soil, 2004 – 2008

Year	Reported tonnage of contaminated soil exported for disposal (t)	D1 (T)	D5 (T)	D8 (T)	D9 (T)	D13 (T)	D15 (T)
2008	297,683		184,316	80,928	30,263		2,176
2007	126,859		43,928	10,107	67,768	5,056	
2006	341,158	Breakdown unavailable					
2005	140,442	31	2		133,225		
2004	170,744	240	49		170,455		

5.2.7. Northern Ireland Hazardous Waste Arisings and Management

A detailed breakdown of the hazardous waste data produced in Northern Ireland for 2007 and 2008 was not readily available from the Northern Ireland Environment Agency (NIEA) during preparation of this report. Therefore to provide an understanding of the hazardous wastes that could be handled at a NaDWaF under an all-island solution, data was compiled from two sources:

- NIEA: Data on the quantity of asbestos waste landfilled in NI and exported to Scotland in 2007 and 2008; and
- England and Wales Environment Agency (EA) Hazardous Waste Interrogator: Data on the quantity of NI hazardous waste managed in England in 2007 and 2008.

While this approach does not capture all the hazardous waste produced in Northern Ireland it does provide an indication of the material potentially suitable for a NaDWaF since most of the hazardous waste produced in Northern Ireland is managed in England.

5.2.7.1. Asbestos waste

There is currently one active cell for the landfilling of asbestos waste in Northern Ireland. A total of 1,168 tonnes of asbestos waste was landfilled at this site in 2007. A further 527 tonnes of asbestos waste was landfilled at the site in 2008. The NIEA advised that for several months over 2007 and 2008 the site was not permitted to accept asbestos until a further cell was developed. In addition to the asbestos waste landfilled in Northern Ireland, a total of 2,848 tonnes of asbestos waste was exported to Scotland for disposal in 2007. A further 2,370 tonnes of asbestos was exported to Scotland for disposal in 2008[49].

5.2.7.2. Other Hazardous Waste Arisings

Data relating to hazardous waste generated in Northern Ireland and subsequently sent to England and Wales for treatment and disposal was obtained from the EA Hazardous Waste Interrogator[50]. **Table 17** presents this data by 2-digit Chapter EWC Codes[51]. The majority of hazardous waste exported from Northern Ireland to England is disposed to landfill. This is closely followed by hazardous waste exported to England for recycling and reuse.

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[49] Northern Ireland asbestos export data is unconfirmed and preliminary.

[50] The Environment Agency has an on-line hazardous waste database which maintains records of consignments of hazardous waste in England and Wales.

[51] European Waste Catalogue and hazardous Waste List, January 1 2002.

Table 17 Management of Northern Ireland's Hazardous Waste in England, 2007 and 2008

EWC Chapter	Year	Landfill (T)	Incineration with energy recovery (T)	Incineration without energy recovery (T)	Recycling / reuse (T)	Transfer (D) (T)	Transfer (R) (T)	Treatment (T)	Total (T)
02	2007			0.1		0.1			0.1
03	2007			0.1					0.1
04	2007					4			4
05	2007			1	6				7
06	2007			223	4	89		58	373
07	2007			88	392	94	555		1,128
08	2007		17	11	48	115	11	1	204
09	2007				96				96
11	2007			0.15			0.36	91	91
12	2007					6		3	9
13	2007			0	203	9	2		214
14	2007			0	5	15	2		22
15	2007		1	7	8	93	10	21	140
16	2007			23	5,790	34	28		5,874
17	2007	12,268		1		16		28	12,313
18	2007		90	63		1		0	153
19	2007	69			240	8	76	70	464
20	2007			0	1,210	4	36		1,250
Sub-Total 2007		12,337	108	417	8,003	486	720	273	22,344
02	2008					1			1
03	2008					2			2
05	2008			0.1					0.1
06	2008			0.4	0.0	21		3	25
07	2008			150	351	20	586	76	1,183
08	2008			2	104	55	152		313
09	2008				102	13			116
10	2008					9			9
11	2008			0.5		1			2
12	2008					12			12
13	2008			0.1	583	221	75		879
14	2008			3	0	7	1		11
15	2008			1		63			63
16	2008			14	4,934	663	86	14	5,710
17	2008	4,880		0.1		2		451	5,333
18	2008		22	133		9	0.1		164
19	2008	1,190						21	1,211
20	2008			0.3	1,047	17	102		1,166
Sub-Total 2008		6,070	22	304	7,121	1,117	1,001	565	16,201

A total of 12,337 tonnes of hazardous waste was exported from Northern Ireland to England in 2007 for landfill. This quantity decreased significantly to 6,070 tonnes in 2008. **Table 18** summarises the types of Northern Ireland's hazardous wastes by EWC Code disposed to landfill in England in 2007 and 2008.

Table 18 Northern Ireland Hazardous Wastes Landfilled in England, 2007 and 2008

EWC Code	Waste Description	2007 (T)	2008 (T)
17 05 03*	Contaminated Soil	9,750	2,919
17 06 01*	Insulation materials containing asbestos	2,502	1,912
17 06 05*	Construction materials containing asbestos	17	49
19 01 05*	Filter cake from gas treatment	14	8
19 03 04*	Partly stabilised wastes	27	28
19 12 11*	Other wastes (including mixtures of materials) from mechanical treatment of waste containing dangerous substances	28	
19 03 06*	Wastes marked as hazardous, solidified		1,152
19 08 06*	Saturated or spent ion exchange resins		3
Totals		12,337	6,070

5.2.8. Inventory of Landfillable Hazardous Wastes for Ireland and Northern Ireland

In order to accurately assess the need for a NaDWaF, it is necessary to understand the types and quantities of hazardous waste streams that have been generated on the island of Ireland and which have the potential to be disposed of to landfill. **Table 19** collates all-island information, and includes contaminated soil data.

Table 19 EWC Codes for Hazardous Wastes Landfilled, Ireland and Northern Ireland, 2004 - 2008

Waste Type	EWC Codes	Reported by Ireland, Northern Ireland, or Both
Asbestos and asbestos based materials.	17 06 01*; 17 06 05*	Both
Ash	10 01 14*	Ireland
Furnace dust	10 02 07*	Ireland
Aggregates	17 09 03*	Ireland
Filter cakes containing dangerous substances	01 03 07*; 06 03 99; 06 04 05*; 06 05 02*; 11 01 09*; 11 01 98*; 12 01 14*; 19 01 05*; 19 02 05*	19 01 05* reported by Northern Ireland only All other EWCs reported by Ireland only
Wastes from treatment of ELVs	19 10 03*	Ireland

Waste Type	EWC Codes	Reported by Ireland, Northern Ireland, or Both
Wastes from thermal processes	10 10 07*; 10 11 09*; 10 11 13*	Ireland
Refractories and Linings	16 11 05*	Ireland
Gypsum	10 11 19*	Ireland
Wastes from acid/alkali neutralisation	06 01 06*/ 20 01 14*; 06 02 05*/ 20 01 15*	Ireland
Hydrocarbon and solvent contaminated sludges	07 05 11*	Ireland
Pharmaceutical wastes	07 05 13*	Ireland
Contaminated soils	17 05 03*	Both
Stabilised Wastes	19 03 04*; 19 03 06*	Northern Ireland
Wastes from water treatment works	19 08 06*	Northern Ireland
Wastes from mechanical treatment of waste	19 12 11*	Northern Ireland

For the purposes of predicting future hazardous waste arisings, 2008 has been selected as the baseline calendar year for both Ireland and Northern Ireland. **Table 20** summarises landfillable hazardous wastes by EWC codes and associated tonnages for 2008. The data for this table was compiled from three sources –

1. Industrial facilities i.e. disposal route "Landfilled onsite at Industrial Source";
2. Waste-licensed landfills i.e. disposal route "Landfilled in Ireland";
3. TFS i.e. "Exported for Landfill".

To compile **Table 20** a search on each of these datasets, for disposal codes D1 and D5 specifically was performed. A search was then carried out of the EWC codes listed in **Table 20** in each of the three datasets, for any disposal codes other than D1 and D5. This was performed to identify any potential tonnages for these wastes that were not captured in **Table 20** but that are potentially landfillable.

Table 20 Reported Hazardous Waste Arisings for Disposal Codes D1 and D5, Ireland and Northern Ireland, 2008. (Including Contaminated Soils)

EWC Code	Country	Disposal Route	2008 (T)
01 03 07 *	Ireland	Landfilled onsite at Industrial Source	12,559
06 04 05*	Ireland	Exported for Landfill	2,518
07 05 11*	Ireland	Exported for Landfill	79
07 05 13*	Ireland	Exported for Landfill	138
10 02 07*	Ireland	Exported for Landfill	38
10 10 07*	Ireland	Exported for Landfill	731
10 11 13*	Ireland	Exported for Landfill	45
10 11 19*	Ireland	Exported for Landfill	1,901
12 01 14*	Ireland	Exported for Landfill	15

EWC Code	Country	Disposal Route	2008 (T)
16 11 05*	Ireland	Exported for Landfill	5
17 05 03*	Northern Ireland	Exported for Landfill	2,919
	Ireland	Exported for Landfill	184,316
17 06 01*	Northern Ireland	Exported for Landfill	1,912
	Ireland	Exported for Landfill	1,817
17 06 05*	Northern Ireland	Exported for Landfill	2,419
		Landfilled in NI	527
	Ireland	Exported for Landfill	5,189
		Landfilled in Ireland	7,462
17 09 03*	Ireland	Exported for Landfill	15
19 01 05*	Northern Ireland	Exported for Landfill	8
19 03 04*	Northern Ireland	Exported for Landfill	28
19 03 06*	Northern Ireland	Exported for Landfill	1,152
19 08 06*	Northern Ireland	Exported for Landfill	3
19 10 03*	Ireland	Exported for Landfill	9,500
Grand Total			235,296
		Of which generated in Ireland:	226,328
		Of which generated in Northern Ireland:	8,968

5.3. Future Hazardous Waste Arisings

In addition to reviewing the current landfillable hazardous waste, solid hazardous arisings from future facilities and operations need to be considered. For some future operations the prediction of future waste arisings is not possible to determine, this relates to any potential major clean-ups where contaminated soils arisings may need to be treated ex-situ, any hazardous arisings from legacy landfills and future management practices of contaminated harbour, port and marina sediments. The NHWMP recommends a programme for the systematic identification, assessment and action planning for potentially contaminated harbour, port and marina sediments, this recommendation has not yet been actioned.

5.3.1. Incinerator Residues

There is currently one incinerator under construction in Ireland, Indaver's facility at Carranstown, County Meath and an additional two are proposed. If all three facilities operate this will result in quantities of flue gas cleaning residues requiring disposal. A biomass incinerator based at Glenavy, Antrim, Northern Ireland is currently in the planning stage.

The main solid residues from these facilities will include;

- Bottom ash - Bottom ash is generally recovered or sent to non-hazardous landfill throughout Europe, it is normally classed as non-hazardous waste. Pre-treatment is only usually applied if the bottom ash is to be reused in construction of roads for example. Some member states have established leaching criteria to define the quality of recovered materials and how they can be reused. Bottom ash is usually treated as an ash recovery plant;

- Boiler Ash - This waste can be classed as hazardous or non-hazardous depending on the composition of the waste incinerated. It can be reused following treatment like bottom ash

- Flue gas treatment residues - Generally flue gas residues are classed as hazardous as they contain a mix of heavy metals and salts and are alkaline in nature; and

- Furnace ash (from biomass only).

Indaver who are currently constructing the facility in County Meath propose to export bottom ash with flue gas residue if the bottom ash is deemed hazardous. Covanta, operators of the proposed facility at Poolbeg in Dublin intend to export boiler ash and flue gas residue to mainland Europe for treatment.

The proposed quantity of flue gas cleaning residues projected to be generated by each facility is set out in **Table 21** below.

Table 21 Projected Hazardous Flue Gas Cleaning Residues Generation, 2011 onwards

Name of Facility	Operator	Type of Facility	Expected Operational Date*	Type of hazardous wastes to be generated	Projected Tonnes Per Annum*
Carranstown, Meath, Ireland	Indaver (Ireland) Ltd	MRF and Non-hazardous incinerator	2011	Flue Gas Cleaning Residues	3500 - 5000
Poolbeg, Dublin, Ireland	Covanta/Dong on behalf of Dublin City Council	Non-hazardous incinerator	2012	Flue Gas Cleaning Residues	24,000
Ringaskiddy, Cork, Ireland	Indaver (Ireland) Ltd	Community Recycling Park, Waste Transfer Station and Hazardous and Non-hazardous incinerators	2016	Flue Gas Cleaning Residues	6,900
Glenavy Biomass facility, Antrim, Northern ireland	Rose Energy	Biomass fuel for difficult waste streams; poultry bedding, meat and bone meal	Unknown. At planning stage only	Fly ash, Furnace ash	To be confirmed. ~ 40,000

*Operational date refers to date for waste acceptance.

** Based on maximum waste inputs.

The projected quantities of bottom ash likely to be generated by the four incinerators named above are summarised in **Table 22**.Should this waste stream be re-classified as hazardous, this would become a probable waste stream for acceptance at a NaDWaF. This study has not taken account of residues that may arise as hazardous waste from cement kilns that may manage hazardous waste in the future as these volumes cannot be predicted. The generation volumes cannot be predicted accurately as this depends on whether all facilities become operational and at what capacity they will operate.

Table 22 Projected Bottom Ash Generation 2011 onwards

Name of Facility	Projected Quantity of Bottom Ash to be Generated (Tonnes Per Annum)
Carranstown, Meath, Ireland	30,000
Poolbeg, Dublin, Ireland	120,000
Ringaskiddy, Cork, Ireland	23,000
Glenavy , Antrim, Northern Ireland	40,000

5.4. Predicting Future Hazardous Waste Arisings

The Economic and Social Research Institute (ESRI), with financial support from the EPA, has developed a Sustainable Development Research Model for Ireland called ISus. The purpose of this model is to forecast emissions and resource use up to 2025. The current ISus model predicts hazardous waste arisings by NACE code[52] sector and presents the data as a set of four treatment options; disposal to landfill, incineration, recycling and unknown.

5.4.1. Prediction Methodology and Assumptions

The current ESRI ISus model does not allow forecast predictions to be made for hazardous waste arisings according to EWC code. In order to apply predictions to EWC codes, the following methodology was adopted and the accompanying assumptions, risks and actions are outlined.

- All hazardous wastes generated in Ireland and Northern Ireland with landfilling potential were identified during the course of the study and 6 digit EWC Codes were assigned. This information is summarised in **Table 20** and **Appendix 2** provides the full prediction model of future hazardous waste arisings developed for this study.
    - Potential Risks and Actions Taken - None Identified
- Each of the identified EWC Codes were subsequently assigned to a specific NACE Code sector.
    - Potential Risks and Actions Taken
        - ◇ Some EWC codes are generated by more than one sector. *Informed decisions were made for each individual EWC code, based on the information provided in*

[52] NACE Code is a pan-European classification system which groups organisations according to their business activities.

the raw data.

- ◇ The NaDWaF forecast model also assumes that all EWC codes within each NACE sector bear the same relationship to total sector output i.e. uniform growth rates for EWC codes within sectors. *The NaDWaF forecast data is presented with the caveat that the stated projections say nothing about possible changes in waste composition within sectors.*

- ◇ The current ISus Model uses NACE Rev 1.1 codes. *The growth factors provided by ESRI relate to the current ISus Model, therefore the NaDWaF forecast model follows this protocol.*

- ◆ ESRI ISus hazardous waste growth factors were applied to individual EWC Code quantities, within designated NACE sectors.

  - Potential Risks and Actions Taken - None Identified

- ◆ ESRI ISus hazardous waste growth factors were applied equally to hazardous wastes generated in Ireland and Northern Ireland.

  - Potential Risks and Actions Taken

    - ◇ Sectoral growth rates for Northern Ireland may be different to Ireland. *NaDWaF forecast model limitation acknowledged in this regard.*

- ◆ The ESRI ISus model uses "projected" National Waste Report industry data. The NaDWaF forecast model uses "reported" data. Projected industry data is compiled by NACE sector only and does not project quantities on an individual EWC code basis.

  - Potential Risks and Actions Taken

    - ◇ The NaDWaF forecast model will not capture the total quantity of hazardous waste landfilled onsite at industrial facilities, as the data is not scaled up to 100% coverage[53]. *NaDWaF forecast model limitation acknowledged in this regard.*

    - ◇ ESRI confirmed that the hazardous waste growth factors used for the ISus model can be applied to both projected and reported data, without disparity.

Projected growth tonnages for hazardous wastes are presented in **Table 23** (including hazardous contaminated soils) for Ireland and Northern Ireland based on a 6 year aggregated basis, this is detailed in the model provided in **Appendix 2**.

[53] Refer to National Waste Reports for detailed information on scale-up methodology for the industrial sector.

Table 23 Hazardous Waste Arisings Potentially Suitable for Landfill, Ireland and Northern Ireland, Aggregated on 6 year basis, 2008 – 2025

HAZARDOUS WASTE LANDFILLED: AGGREGATED PREDICTIONS 2008 – 2025				
	NACE	**2008 - 2013 Average Per Year**	**2014 - 2019 Average Per Year**	**2020 - 2025 Average Per Year**
Chemical production				
07 05 11* sludges from on-site effluent treatment containing dangerous substances	24	89	141	182
*07 05 13** solid wastes containing dangerous substances		156	246	318
*16 11 05** linings and refractories from non-metallurgical processes containing dangerous substances		6	9	12
Non-metallic mineral production				
*10 11 13 ** glass-polishing and -grinding sludge containing dangerous substances	26	36	50	60
*10 11 19** solid wastes from on-site effluent treatment containing dangerous substances		1,527	2,131	2,524
*12 01 14** machining sludges containing dangerous substances		12	17	20
Metal prod. excl. machinery and transport equip.				
*01 03 07** other wastes containing dangerous substances from physical and chemical processing of metalliferous minerals	27-28	14,190	22,414	28,946
*10 02 07** solid wastes from gas treatment containing dangerous substances		43	68	88
*10 10 07** casting cores and moulds which have undergone pouring, containing dangerous substances		826	1,305	1,685
Electrical goods				
*06 04 05** wastes containing other heavy metals	31-33	2,845	4,494	5,804
Construction				
*17 05 03** soil and stones containing dangerous substances	45	142,642	179,121	195,723
*17 06 01** insulation materials containing asbestos		2,841	3,567	3,898
*17 06 05** construction materials containing asbestos		11,882	14,921	16,304
*17 09 03** other construction and demolition wastes (including mixed wastes) containing dangerous substances		11	14	16
Services (excl. transport)				
*19 01 05** filter cake from gas treatment	50-55, 64-95	8	10	11
*19 01 13** fly ash containing dangerous substances		29,000	35,900	35,900
*19 03 04** wastes marked as hazardous, partly stabilised		27	33	39
*19 03 06** wastes marked as hazardous, solidified		1,124	1,373	1,621
*19 08 06** saturated or spent ion exchange resins		3	4	4

HAZARDOUS WASTE LANDFILLED: AGGREGATED PREDICTIONS 2008 – 2025				
	NACE	2008 - 2013 Average Per Year	2014 - 2019 Average Per Year	2020 - 2025 Average Per Year
*19 10 03** fluff-light fraction and dust containing dangerous substances		9,266	11,321	13,371
Total		**216,534**	**277,139**	**306,526**

5.5. Conclusions

The current and expected future arisings of hazardous waste, suitable for landfilling at a potential NaDWaF, were determined through a desk-based assessment of historic hazardous waste data combined with economic forecast data. The sources of information used during this assessment include EPA National Waste Report datasets; TFS datasets; Northern Ireland Environment Agency data; England and Wales Environment Agency Hazardous Waste Interrogator data; ESRI's Sustainable Development Research Model for Ireland "ISus"; and various direct contacts within the EPA.

Data relating to both Ireland and Northern Ireland was analysed with a view to considering an all-island facility. For the purposes of predicting future hazardous waste arisings, the year 2008 was selected as the baseline year. Using TFS Disposal Codes D1 and D5 only, the following waste types were identified as landfilled at industrial sites in Ireland or sent abroad for landfill in 2008. Fly ash, EWC Code 19 01 13*, is also included in the assessment as a predicted future hazardous waste, from proposed and planned waste incinerator facilities. The 2008 baseline data was then subjected to economic forecast factors, as supplied by the ESRI, to estimate waste arisings from 2008 to 2025 inclusive. The aggregated summary predictions are shown below.

BASELINE YEAR	AGGREGATED PREDICTIONS [54]		
2008 (T)	2008 - 2013 Average per Year (T)	2014 - 2019 Average per Year (T)	2020 - 2025 Average per Year (T)
235,296 [55]	**216,534**	**277,139**	**306,526**

In summary, it is proposed that the waste types in **Table 24** have the potential to be landfilled at a proposed NaDWaF in Ireland.

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[54] The ESRI factors have not been applied to 19 01 13 as there is no baseline figures for 2008, therefore figures are based on expected maximum amounts to be generated on an annual basis and remaining constant up to 2025.

[55] This total does not include a tonnage for 19 01 13* fly ash containing dangerous substances as there are no 2008 baseline figures for this waste type.

Table 24 Potential Landfillable wastes at a NaDWaF

Chemical production
*07 05 11** sludges from on-site effluent treatment containing dangerous substances
*07 05 13** solid wastes containing dangerous substances
*16 11 05** linings and refractories from non-metallurgical processes containing dangerous substances
Non-metallic mineral production
*10 11 13 ** glass-polishing and -grinding sludge containing dangerous substances
*10 11 19** solid wastes from on-site effluent treatment containing dangerous substances
*12 01 14** machining sludges containing dangerous substances
Metal prod. excl. machinery and transport equipment
*01 03 07** other wastes containing dangerous substances from physical and chemical processing of metalliferous minerals
*10 02 07** solid wastes from gas treatment containing dangerous substances
*10 10 07** casting cores and moulds which have undergone pouring, containing dangerous substances
Electrical goods
*06 04 05** wastes containing other heavy metals
Construction
*17 05 03** soil and stones containing dangerous substances
*17 06 01** insulation materials containing asbestos
*17 06 05** construction materials containing asbestos
*17 09 03** other construction and demolition wastes (including mixed wastes) containing dangerous substances
Services (excl. transport)
*19 01 05** filter cake from gas treatment
*19 01 13** fly ash containing dangerous substances
*19 03 04** wastes marked as hazardous, partly stabilised
*19 03 06** wastes marked as hazardous, solidified
*19 08 06** saturated or spent ion exchange resins
*19 10 03** fluff-light fraction and dust containing dangerous substances

A number of recommendations can be established from this desk-based assessment of current and future potentially landfillable hazardous waste arisings, as follows:

- Improved transfer and sharing of data between Ireland and Northern Ireland is necessary to fully establish the requirement and/or viability of an all-island NaDWaF;
- The current ESRI forecast model did not adequately meet the requirements of the NaDWaF study. Although assumptions have been made and documented accordingly, it is recommended that the ISus model is updated for future predictions modelling; and
- The use of Disposal Codes in TFS documents should be reviewed to determine accuracy of the reported information.

6. DIFFICULT WASTES

6.1. Introduction

There is no legal definition in Ireland or any other jurisdiction in Europe for difficult waste. However, the term difficult wastes is commonly used to refer to wastes which by their nature and physical properties pose problems for disposal and require special management to avoid nuisance and pollution or where physical properties of the wastes create serious handling problems. Wastes can also be considered difficult if there is no available treatment technology to allow it to meet waste acceptance criteria limits or if the technology has not yet been commercially proven. This term is also used to capture hazardous and either high-risk wastes that are managed under different legal regimes.

In the context of this study there was a requirement to identify and quantify, where possible, difficult waste streams not considered suitable for export or destruction by incineration or landfilling, and where long-term storage may be considered the best practicable option.

6.2. Background

There are other sources of difficult waste produced in Ireland whose management is not captured in the EPA National Waste Reports, they can include for example, military ordnance, marine flares, animal by-products, and disused and orphan sources of radioactive waste. The NHWMP[56] makes reference to the lack of treatment capacity for explosive or chemically unstable waste which on occasion is destroyed by controlled explosion by the Defence Forces.

This study aims to highlight those difficult wastes that are managed or controlled by various national agencies or government bodies. In doing so, the governance aspect of such wastes has been assessed, data obtained (where available) and discussion held with some of the organisations concerned regarding current management practices, issues arising and where possible if alternative management practices could be explored. While contact was made with relevant organisations, this was purely to understand and establish if there was a management issue with certain waste arisings, in some cases the organisations contacted were content with current management practices in dealing with their own difficult wastes or items that come into their possessions, this would include An Garda Síochána and Department of Defence.

In addressing the difficulty with some waste it was necessary to consider the regulatory background which governs some waste not covered under the Waste Framework Directive.

The wastes considered include the following;

- Out of Date Ordnance;
- Marine Flares;
- Non-re-saleable seized/confiscated controlled substances;
- Ship and cargo wastes;

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[56] NHWMP 2008-2012 (EPA, 2008) Section 6.6.1 Explosive and Unstable waste.

- Noxious Weeds; and
- Contaminated dredging spoils and harbour wastes.

Radioactive Source Wastes are dealt with separately in **Chapter 7.**

6.3. Explosives Regulations

Current explosives legislation in Ireland cover manufacture, keeping and storing, use, sale, conveyance and transport, import and export and deemed explosives[57]. The regulations are derived from primary legislation including Explosives Act (1875), Explosive Substances Act (1883), Explosives Act (1923), Dangerous Substances Act (1972), Carriage of Dangerous Goods by Road Act 1998 (No 43 of 1998) and the Criminal Justice Act 2006 (No 26 of 2006).

There are a number of bodies in Ireland that govern the use, storage, manufacture and import of explosives as follows.

6.3.1. Department of Justice, Equality and Law reform

The Department plays a key role in ensuring the security of Ireland and the safety of its people. Responsibilities in this area include:

- Supporting the effective and co-ordinated management of major emergencies;
- Formulating and implementing policies on firearms and explosives ;and
- Combating the threat posed by terrorism, whether domestic or international.

Any person seeking to import and transport deemed explosives must make an application to the Department.

6.3.2. Local Authorities

Any person seeking to store explosives must submit an application form to the relevant local authority area in which the explosive store is to be located under the Explosives Act 1875 and Stores for Explosives Order 2007 (S.I. 804 of 2007).

6.3.3. Environmental Protection Agency

Under the Protection of the Environment Act 2003, Schedule 1 of the act lists activities that are subject to IPPC licensing. The EPA regulate facilities that manufacture explosives (Class 5.17) and activities that swage[58] by explosives where the production area exceeds 100 square metres (Class 3.7).

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[57] Deemed Explosives , other than fireworks, include marine pyrotechnics (distress, smoke, flare), pyro-breakers (industrial pyrotechnics).

[58] This process is a form of welding dissimilar material using explosive materials.

6.3.4. Health and Safety Authority

The HSA regulate and control the use of explosives in the workplace, such as for example in construction, quarries and mines. One key element of regulation or regulation itself that is absent is pertaining to the disposal of explosive substances, therefore regulations specific to the disposal of out of date or obsolete ordnance or unexploded explosives does not exist.

6.4. Out of Date Ordnance

Ordnance can be defined as military materials such as weapons, ammunition, combat vehicles, and equipment. Out of date ordnance generated by the Defence Forces[59] such as weapons and ammunition will arise from time to time, mainly in the form of legacy ordnance rather than in the form of more recently procured materials. In general this situation is avoided through efficient procurement services within the Defence Forces. The Defence Forces have their own methods and approaches for dealing with their own ordnance that may require disposal or destruction and the approaches follow best practice utilised by the Ministry of Defence in the UK. There are exemptions under the Waste Management (Waste Electrical and Electronic Equipment) Regulations 2005[60] in so far as they do not apply to electrical and electronic equipment which is connected with the protection of the essential interests of the security of any Member State of the European Union including arms, munitions and war material, except which is not intended for specifically military purposes.

There are other materials that are dealt with by the Defence Forces on an ad hoc basis. These are materials that arise from non defence related activity, these wastes can include;

- Chemically unstable wastes- generally unknown chemical wastes that may be too volatile too transport;
- Unexploded explosive ordnance – sometimes includes legacy materials that can be washed up or found by members of the public;
- Seized home-made explosives/explosive devices;
- Fireworks; and
- Time Expired Pyrotechnics (Marine Flares).

Under these circumstances the Army Explosive Ordinance Disposal teams are requested by the Department of Justice to respond to an Aid to Civil Power Request (ACPR), meaning in practice to assist, when requested, the Garda Síochána, who have primary responsibility for law and order. While any persons seeking to transport explosives must make an application to the Department of Justice, Equality and law reform, the Defence Forces are exempt from this requirement under Section 10 of the EC (Carriage of Dangerous Goods by Road) (ADR Miscellaneous Provisions)

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[59] The Permanent Defence Force consists of an Army, an Air Corps and a Naval Service.

[60] S.I. No. 340 of 2005, Part 1, Section 3.

Regulations 2007[61].

In general the Defence Forces destroy such wastes by controlled explosion. The NHWMP states '*this ad hoc approach to managing explosive and unstable wastes should not continue. An appropriate agent of the State should be designated with the responsibility to undertake, in exceptional circumstances, the destruction of explosive and unstable wastes that cannot otherwise be treated in Ireland or shipped abroad. Preferably a fixed facility should be established to deal with these wastes*.'

The NHWMP further recommends ;

"there are likely to be instances where a fixed facility cannot be reached by certain materials. In such cases, general environmental, procedural and infrastructural conditions should be agreed to deal with issues such as location, process management, and management of emissions and residues. A standing team of experts from relevant public and private organisations should be created to initially discuss and plan the general approach to be adopted in dealing with explosive and unstable chemical wastes and subsequently to be on hand to respond to instances of unstable wastes arising and needing treatment".

6.5. Out of Date Marine Flares

Shipping legislation requires that marine flares are replaced every 4 years[62]. Marine flares that are passed their expiry date are also referred to as, Time Expired Pyrotechnics (TEPs). Arisings of TEPs is seasonal, and as most equipment is serviced and repaired in the spring time, at the beginning of the boating season, this leads to an influx of TEPs during these months. One key safety issue regarding marine flares is that they can become increasingly unstable over time and present further risk when removed from their protective outer packaging.

Marine flares consist of a holding tube containing a small quantity of explosive material. They typically weigh between 160 g (for a hand held flare) and up to and above 450 g (larger parachute or aerial flares). The majority of the weight in the flare consists of the casing, the explosive content in the flare is predominantly <10 g. However, there are variations in manufacturer make and model.

Prior to 2004, the Irish Coastguard managed drop points for TEPs which were periodically cleared and disposed of via the Army. In 2006, the then Department of Marine, Communications and Natural Resources, as the body designated for authorising disposal of TEPs, took over responsibility from the coastguard.

In August 2006, the Department issued a marine notice regarding a scheme for the safe disposal of TEPs[63] whereby individuals or organisations could bring TEPs to chandlers listed in the notice. The TEPs would in turn be transported to the army for safe disposal and destruction. The notice was issued to all shipowners, agents, shipmasters, navigating officers, fishermen, yachtsmen,

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[61] S.I. No. 289 of 2007, Section 10. These Regulations do not apply to vehicles carrying dangerous goods belonging to, or under the control of, the Defence Forces or the armed forces of a country which is a contracting party to the ADR. These regulations revoke S.I. No. 406 of 2006.

[62] S.I. No. 267 of 1947, Merchant Shipping (Life-Saving Appliances) (Amendment) Rules.

[63] Marine Notice No 13 of 2000 - Scheme For Safe Disposal Of Time-Expired Pyrotechnics (TEPs), http://www.transport.ie/viewitem.asp?id=8069&lang=ENG&loc=2018

chandlers and seafarers. The notice advised that misfired or faulty pyrotechnics should not be returned with TEPs and that the Garda Síochána should be notified. Whilst the chandlers were authorised as a collection point for TEPs, there is no disposal regulation to control such wastes.

Under the EC (Carriage of Dangerous Goods by Road) (ADR Miscellaneous Provisions) Regulations 2007 there are exemptions to the requirement for transport documentation for the carriage of marine distress articles to the nearest military barracks as long as they comply with certain requirements regarding packaging and labelling.[64].

The current position is that chandlers will generally only accept TEPs from customers replacing flare stock. Permitted waste transporters are reluctant to handle expired explosives even if they are licensed to accept these. Most chandlers have installed some type of explosives "hold" in addition to their current infrastructure. The normal route for onward disposal still remains the army, through the stores contacting the army directly. Some chandlers will notify and deliver TEPs to the nearest military barracks. Some barracks organise collections of TEPs from the stores directly. There is concern that TEPs are being stockpiled at some locations.

A number of chandlers had approached the manufactures with regards to disposing/recovering of the flares with them. However, manufactures are generally based within the UK or Germany. The manufacturers had been receptive to the idea, but issues again with transport of small volumes of potentially unstable explosive material, was deemed uneconomically feasible as neither the stores nor the manufactures were willing to pay for the secure transport of such materials.

A number of concerns have been raised by chandlers, the coastguard and those involved in shipping, pleasure craft, namely, including;

- Illegal and irresponsible disposal methods being used by sailors and boating operatives, ranging from suggestions that there is potential that TEPs are dumped overboard at sea or in fresh water[65];
- TEPs have been disposed of in bins at marinas;
- TEPs may be stored indefinitely in unsafe places such as garages, on boats or in lock ups, where inexperienced flare handlers may come in contact with these materials; and
- TEPs have been disposed of in household wastes, where risk to waste collectors and people involved in onward management are substantial.

There is no published data or collated data set of TEPs, although under the EC (Carriage of Dangerous Goods by Road) (ADR Miscellaneous Provisions) Regulations, deliveries of TEPs are supposed to be recorded. However, imports of pyrotechnics must be notified by licence application[66] to the Firearms and Explosives Unit of the Department of Justice, Equality and Law Reform under the Explosives Act, 1875. Information on TEP volumes was obtained from discussions with the coastguard.

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[64] S.I. No. 289 of 2007, Section 19. Other miscellaneous exemptions, (g) and (h).

[65] This is practice is illegal under the No. 14/1996: Dumping at Sea Act, 1996.

[66] Licence to import explosives not subject to S.I. 115 of 1995 (Placing on the Market and Supervision of Explosives for Civil uses.

Table 25 Time Expired Pyrotechnics

Information on Arisings of TEPS						
Source of Information	2004	2005	2006	2007	2008	2009
Marine flare sales per year	No information available					
Information on Flares used	No information available					
Information on disposal						
Coastguard	150 to 300 flares per year ~24 kg	0 kg	0 kg	0 kg	0 kg	0 kg
Chandler Take back schemes	> 600 flares per year ~436 kg	> 600 flares per year ~436 kg	> 600 flares per year ~436 kg	> 600 flares per year ~436 kg	> 600 flares per year ~436 kg	> 600 flares per year ~436 kg
Army	No information available					
Garda Síochána	No information available on reported/handled unstable TEP					

NB: Please note that these figures are cumulative conservative estimates comprising of numerical estimates of weight based on numbers of flares handled, and that most of the weight is flare casing. <10% will be explosive material.

6.5.1. Storage of TEPs

The licensing and regulation of stores for explosives is subject to a number of legal requirements under Explosives Act and the Stores for Explosives Order 2007.[67] . Both the licence application form and annual registration forms are available on the Department of Justice, Equality and Law Reform website.[68]. The order states that licence applications should be submitted to the local authority area in which the store is or will be located, although the applications forms state the applications should be submitted to the Secretary of local authority, with copies to Government Inspector of Explosives. The local authority will not grant the licence unless satisfied that the fire officer and An Garda Síochána have inspected the store and confirmed that it meets their requirements. After the granting of a licence, the licensee must ensure that a risk assessment on possible fire and explosion hazards is carried out and that the store is at all times operated under the supervision of a competent person. Construction requirements for the store are also detailed in the Order. Sections 21-29 of Explosives Act 1875 (and Appendix F of the Guide to the Act) deal with registration of stores which must be done annually with the relevant local authority.

One of the key issues with the management of TEPs is the governance of the marine sector which is a very fragmented sector. There are five government departments with responsibilities and within those departments there are further designations of responsibilities. The Departments that have responsibility for maritime matters include;

- Transport and Marine – Maritime Safety;
- Sport and Tourism – Participation and Promotion of Marine Leisure Activities;
- Fisheries – Foreshore and Infrastructural Planning;

[67] S.I. No. 804 of 2007, Explosives Act and the Stores for Explosives Order 2007, Sections 15-20.

[68] Department of Justice, Equality and Law Reform http://www.inis.gov.ie/en/JELR/Pages/Storing_explosives

- Environment – Marine pollution and waste; and
- Trade and Employment – Marine related industry.

The Department of Transports' role in the maritime sector involves the direct provision of various services, including the surveying of ships and the management of marine incidents. The Statement of Strategy 2008-2010 published by the Department is 2008 covers a number of maritime objectives. One objective relates to maritime safety, security and the environment[69]' which is to minimise, through preventative measures, the number and severity of incidents from maritime activity within Ireland's zone of responsibility, that lead to injury or loss of life or damage to property or to the environment.' There is no reference to a system or process to be established for the collection and disposal of pyrotechnics.

The UK had similar issues with lack of regulation and control over TEPs and the Ministry of Defence were called in to carry out disposal for collected TEPs. One of the key concerns was the lack of adequate storage facilities for TEPs. However, following much debate between various government organisations in the UK changes to legislation with regard to the storage and transportation of explosives have been implemented.

The British Marine Federation[70] (BMF) was working closely with the UK government to secure a sustainable and pragmatic long term disposal mechanism over the past number of years. One of the issues arising was whether under the current Waste Framework Directive[71]decommissioned explosives were excluded from its scope (where covered by other legislation). Such wastes included waste armaments e.g. guns, ammunition, marine flares, fireworks and car airbags. The UK Environment Agency advised that such materials are decommissioned explosives. Under the new WFD all "decommissioned explosives" are excluded. In the UK the generally accepted definition of "decommissioned" is an explosive that is out of use - it does not mean that the explosion has been set off. The revised WFD has strengthened the position on decommissioned marine flares in that they will fall outside the control of the WFD. The BMF was given a statement from the UK Environment Agency, excluding TEPs from the scope of the Waste Framework Directive (WFD) and therefore waste management licensing for those premises storing TEPs.

From 1 April 2010 the number of locations where yachtsmen can dispose of TEPs will reduce to just 18 suitable constructed facilities. In December 2009 a collection and disposal contract was awarded to a private company, Ramora UK Ltd[72].by The Maritime and Coastguard Agency (MCA). The MCA, with the assistance of the Department for Transport, will continue to accept TEPs from the public; however the collection and disposal service will no longer be undertaken by the Ministry of Defence (MoD) from the 31 March 2010. Police stations will no longer be able to accept such items as they have no storage facilities for these items.

MCA plan to concentrate available resources on storage improvements to the 18 sites across the UK. There is one MCA site designated on the Island of Ireland which is situated in Belfast.[73]

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69 Department of Transport (2008) Statement of Strategy 2008-2010, Chapter 6- Maritime.

70 www.britishmarine.co.uk/

71 The Waste Framework Directive 2006/12/EC.

72 www.ramorauk.com

73 Full details of locations, contact details and opening times will be posted on the UK MCA web site www.mcga.gov.uk as the new service is rolled out.

6.6. Ships and Cargo Wastes

The port reception facilities directive[74] applies to all ships, including fishing vessels and recreational craft, and aims to reduce the discharge of ship-generated waste and cargo residues into the sea by improving the availability and use of port reception facilities. The European Communities (Port Reception Facilities for Ship-generated Waste and Cargo Residues) Regulations[75] of 2003, oblige harbour masters and port authorities to prepare waste management plans for the management of ship-generated waste and cargo residues at Irish ports and harbours.

The Department of Transport (DoT) provides guidance and regulates the provision of reception facilities for shipping waste material. The port facilities manage the contract details for the waste management contractor. Port facilities do not collect or collate data, this is carried out by waste management company.

Under Section 12 of the regulations, ports are to produce a status report every year to outline changes and they are obligated to submit a revised plan every three years. Waste Management Plans now follow a template produced by the DoT but there is variation in all the plans. DoT is currently collecting and reviewing the revised Waste Management Plans.

In 2009 the DoT developed Safe Seas Ireland (SSI), [76] this is a website where all vessels have to record their "entry into port" form, this form also includes notification of waste. The previous system was a paper exercise that was reported but not regulated. The new system is live but it is embryonic. Some ships and/or companies are exempt and some information is submitted as attachments.

The DoT is not responsible for accident or incidents of hazardous material at sea, this is the responsibility of the coastguard. The Irish Coast Guard said that if an accident or incident occurs landside, then they would work with the relevant Local Authority and associated waste management contractor to perform a cleanup.

Cargo residues are the remnants of any cargo material on board a ship in cargo holds or tanks which remain after unloading procedures and cleaning operations are completed and includes spillage and loading and unloading excesses. The Department of Agriculture, Fisheries and Food (DAFF) enforces import controls on international catering waste (ICW) / swill. There is a system in place based on licensing waste disposal companies to move this material to approved landfills for deep burial. DAFF inspects a percentage of movements on a risk basis via Portal Inspectors. This waste is normally incinerated in other countries and rendering is an option in Ireland, it has been tried but because the waste material contained plastic and paper (plates and containers) it makes the rendering process unviable at present. The management of this material may pose a difficulty with the diversion of biodegradable waste from landfill. However, it would be expected that this material will be disposed via incineration when such facilities become operational.

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[74] Directive 2000/59/EC, The port reception facilities for ship-generated waste and cargo residues.

[75] S.I. No. 117 of 2003, European Communities (Port Reception Facilities for Ship-generated Waste and Cargo Residues) Regulations.

[76] www.safeseas.ie

The main issue would appear to relate to international catering wastes for which a system is in place. It is probably more practical for such waste to be incinerated, however, a dedicated cell for such high-risk material could be set aside at a NaDWaF.

6.7. Noxious Weeds.

Noxious weeds are undesirable native plants designated for control under the Noxious Weeds Act and associated regulations[77]. The plants include, ragwort, thistle, dock, common barberry and some wild hops. Ragwort is highly poisonous to animals, while the other weeds impact on crop yields. The Act aims to promote good grassland management practice and weed control on farmland and associated managed lands to reduce the spread of weeds and minimise their adverse impact on agricultural production. Under the Act, it is an offence not to prevent the growth and spread of noxious weeds. The owner, occupier, user or manager of lands on which these weeds are grow is liable, upon conviction, to a fine. In the case of margins of public roads, the local authority is charged with the maintenance of such roads. The Department of Agriculture, Fisheries and Food has responsibility for media campaigns and advice on the control of noxious weed and farm inspections. In addition, the control of noxious weeds is a cross-compliance requirement for the Single Farm Payment under Good Agricultural and Environmental Condition since 2005 and failure to comply with this condition may result in a reduction in the Single Farm Payment for the Department. Teagasc provide advice on control methods for farmers and developers whose lands contain ragwort.

The proliferation of noxious weeds such as ragwort is cause of much debate. The best practicable method for removing ragwort is pulling and disposal through burning or landfill. Cutting is generally not an appropriate method as ragwort when cut remains poisonous and seeds can still disperse. Using herbicides to control ragwort is effective if the correct timing and rates of application are used, however most herbicides will affect other plant species.

Other legislation that must be taken into consideration when managing noxious species includes Section 40 of the Wildlife Act 1976[78], as amended by Section 46 of the Wildlife (Amendment) Act 2000[79] (which places restrictions on the destruction of vegetation on uncultivated land during the period from 1 March to 31 August in any year), and to the Habitats Regulations 1997-2005 which protects Ecologically sensitive or important areas.

The National Roads Authority (NRA) published *Draft Guidelines on the management of noxious weeds on National Roads, January 2008*. The guidelines provides best management practice guidelines in the construction of new roads, primarily with regards to preventing the spread of noxious and invasive species[80]. In 2008 the NRA were considering the provision of a dedicated financial allocation to local authorities to specifically address the control of noxious weeds on the approximately 5,500 kilometres of national road. However, this allocation never occurred.

There is no specific data pertaining to the volume of noxious weeds that may require disposal by

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[77] Noxious Weeds Act, No. 38 of 1936 and S.I No 103/1937 – Noxious Weeds (Thistle, Ragwort and Dock) Order, 1937 and S.I No 120/1958 – Noxious Weeds (Common Barberry) Order, 1958, S.I No 189/1965 – Noxious Weeds (Male Wild Hop Plant) Order, 1965, S.I No 194/1973 – Noxious Weeds (Wild Oat) Order, 1973.

[78] The Wildlife Act 1976.

[79] The Wildlife (Amendment) Act, 2000.

[80] Guidelines on the Management of Noxious Weeds and Non-Native Invasive Pant Species on National Roads, Unpublished report by National Roads Authority, Draft available http://www.nra.ie/Publications/

methods other than burning. Noxious weeds can be landfilled, and guidance does indicate that such waste should be disposed via deep burial and while this waste is biodegradable, the waste framework directive does exempt some waste where pre-treatment does not contribute to the overall environmental protection.

The Waste Management (Prohibition of Waste Disposal by Burning) Regulations 2009 [81]makes more explicit the offence of disposal of waste by uncontrolled or unregulated burning. There are exemptions to the regulations which can allow the burning of certain agricultural wastes. This exemption applies until 1st January 2014, after this date such activities will require registration with local authorities and be subject to the Facility Permit Regulations. Individuals can make an application to a local authority to burn agricultural waste provided they can demonstrate that there is no alternative option in the waste hierarchy. It is probably more practical for such waste to be incinerated, however, a dedicated cell for such high-risk material could be set aside at a NaDWaF.

6.8. Contaminated Dredging Spoils

Dredging spoils include material from town quays, ports including all berths, shipping areas and the estuarial channels to the sea. Ports have a legal obligation to dredge in order to keep the channels at shipping depth. Depending on the quantity and nature of the dredged material involved several options are available for the subsequent handling and management of dredging material. The options include;

- Beneficial reuse e.g. beach nourishment, land reclamation, construction;
- Disposal on land in licensed land fill sites; and
- Disposal at sea.

In 2008, 11,536.80 tonnes of uncontaminated dredging spoil was deposited at Ballealy landfill, County Dublin. Most uncontaminated dredging spoil is deposited at sea. An average of 16 permits per year have been granted for dumping at sea since 1996. These cover a quantity of approximately 2 million tonnes of material per year.

Dumping at sea is regulated under the Dumping at Sea Acts, 1996 and 2004[82].. Dumping at Sea Permits are granted for the disposal of dredge material from ports, harbours and marinas (in the absence of suitable alternative reuse and disposal methods. Permits for Dumping at Sea were granted by the Department of Agriculture up till end of 2009, this is now the responsibility of the EPA. Permit holders must indemnify and keep indemnified Ireland and the Minister for Agriculture, Fisheries and Food against all damages or claims made in relation to dumping at sea. Permits require an assessment of sediment quality to be undertaken in accordance with the *Guidelines for the Assessment of Dredge Material* issued by the Marine Institute in April 2006[83].

Permit applications usually have to be accompanied by reports of site surveys, benthic surveys, dispersion models, chemical analysis of the material, grain size and other surveys that may be required. Approvals for dumping at sea are based on the advice of the Marine Licence Vetting

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[81] S.I. No. 286 of 2009, The Waste Management (Prohibition of Waste Disposal by Burning) Regulations.

[82] Dumping at Sea Act , No. 14 of 1996 and No. 35 of 2004.

[83]http://agriculture.gov.ie/media/migration/fisheries/coastalzonemanagement/dumpingatsea/Assessmentofdredgematerial2006.pdf f

Committee (MLVC). This is an inter agency group, which manages the application and vetting process for dumping at sea.

6.9. Harbour wastes

The NHWMP recommended a programme for the systematic identification, assessment and action planning for potentially contaminated harbour, port and marina sediments, the Department of Transport is the body responsible for this study, at the time of writing this report, a programme had not yet commenced.

It is difficult to predict future arisings of sediments that may require treatment and landfill. It is likely that some of this waste would be treated in-situ, with some amounts requiring treatment at a treatment facility and/or disposal. This study has therefore not considered future arisings of contaminated dredging spoil as it is not possible to predict volumes that may require treatment and disposal.

6.10. Conclusions and Recommendations

The waste considered under the term “difficult” included, Out of Date Ordnance, Out of Date Marine Flares (time expired pyrotechnics (TEPs)), non re-saleable seized/confiscated controlled substances, ship and cargo wastes; noxious weeds, contaminated dredging spoils and harbour wastes. Radioactive Source Wastes are dealt with separately in **Chapter 7.** The wastes for which we are able to provide recommendations for only include TEPs but comment is provided on other arisings. The reasons being;

- Out of date ordnance generated by military operations do not occur on a regular basis and are dealt with appropriately by the Department of Defence;
- Seized/ controlled confiscated substances are dealt with appropriately by An Garda Síochána and at the time of writing, An Garda Síochána did not consider it necessary to address this waste arising in this study;
- Ships and cargo waste, while generally not hazardous waste, the issues arising are that generally such wastes can only be managed through deep burial at landfill, in other jurisdictions this waste is incinerated. Landfill operators will likely cease the acceptance of such wastes in an effort to comply with the diversion of biodegradable wastes to landfill targets. While these wastes are captured in national waste reporting, the actual quantities arising and the specific thereof are unknown. This waste arising has no bearing on a NaDWaF.
- Noxious weeds –can continue to be landfilled, or may be sent for incineration when a facility becomes operational, a cell may be set aside at a NaDWaF to dispose of such wastes also;
- Contaminated dredging spoils and harbour wastes – The NHWMP recommends a programme for the systematic identification, assessment and action planning for potentially contaminated harbour, port and marina sediments, this recommendation has not yet been assigned. It is therefore difficult to predict future arisings. It is likely that some of this waste would be treated in-situ, with some amounts requiring treatment at a treatment facility or disposal.

A key waste arising requiring the introduction of a co-ordinated management policy is time expired pyrotechnics (TEPs). The issues surrounding such wastes are outlined above in Section 6.4. But in summary the actual arisings are not definitively known and there is lack of regulation dealing with the disposal of such arisings. The manufacture, transport, sale and storage of explosives is regulated by various national and local government bodies, but there is a fragmented approach in the destruction of TEPs. One central facility would be impractical for the storage of TEPs as storage facilities need to be close to the arisings, also the disposal of TEP needs specialist knowledge (which the military has) and this expertise would not normally reside in waste management companies. Therefore including a destruction facility at the NaDWaF may not be the most cost effective method of disposal. However the lack of data means the suitability cannot be assessed. The EPA in the NHWMP recommend that an appropriate agent of the state is appointed, most likely the emergency services for the management of TEPs. Further feasibility should be considered in the establishment of a network of small storage units perhaps at coastguard stations, with a view to collection and destruction being contracted to a suitable private contractor. It is likely that since volumes are so low that shipment to a destruction facility in the UK may need to be considered as the volumes arising are so low to warrant the investment in such a facility in Ireland. Another option would be to consider the UK Maritime and Coastguard Agency storage facility in Belfast as a main central facility where TEPs are delivered and stored prior to destruction at a facility in England.

7. RADIOACTIVE SOURCE WASTES

7.1. Introduction

Radioactive waste is excluded from the scope of the Waste Framework Directives where the waste is regulated by other legislation and although strictly speaking outside the scope of the National Hazardous Waste Management Plan, the Radiological Protection Institute of Ireland (RPII) has indicated that there is a deficit in the provision of services to ensure the collection and management of radioactive waste in particular legacy radioactive waste. A detailed study reviewing the current national storage requirements for disused and orphan radioactive sources in Ireland, has been produced as a separate report. This chapter summarises the main points raised in the detailed report.

Ireland is a non-nuclear state but like advanced western countries makes use of radioactive materials in the form of sealed and un-sealed sources in medicine, research, education and industry and these activities give rise to waste materials such as disused sealed sources. Whilst Ireland does not have the scale of radioactive materials of a nuclear state there is still the requirement to protect the public from the risks that radioactive sources present.

All activities involving the use of radioactive materials must conform to basic regulatory standards based on the international standards of radiological protection. In national legislation the regulatory framework is provided by the Radiological Protection Act, 1991 and specifically in the Radiological Protection Act, 1991 (Ionising Radiation) Order S.I .125 of 2000, which implemented Council Directive 96/29/ EURATOM commonly known as the Basic Safety Standards Directive. The Act provided for the establishment of the RPII and gives effect to the Convention on Early Notification of a Nuclear Accident, Convention on Assistance in the Case of Nuclear Accident or Radiological Emergency and the Convention on the Physical Protection of Nuclear Material.

As part of the regulatory framework, all activities in Ireland holding radioactive material or irradiation devices can only do so under licence from the RPII. Since the early 1990s, RPII has only issued licences for the use of radioactive sources on the condition that there is a “take-back” agreement with the supplier whereby once a source is no longer required or has reached the end of its useful life, it is returned to the supplier.

A definition of radioactive waste is contained in the European Communities (Supervision and Control of Certain Shipments of Radioactive Waste and Spent Fuel) order, 2009[84]: “radioactive waste” means radioactive material in gaseous, liquid or solid form for which no further use is foreseen by the countries of origin and destination, or by a natural or legal person whose decision is accepted by these countries, and which is controlled as radioactive waste by a regulatory body under the legislative and regulatory framework of the countries of origin and destination

7.2. Review of current national storage requirements for radioactive sources

If not adequately controlled spent or disused radiation sources present a risk to the public and the environment. As a consequence, sources pose safety and security risks which must be addressed by designing and applying appropriate systems in their storage and management. The

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84 S.I. No.86 of 2009 European Communities (Supervision and Control of Certain Shipments of Radioactive Waste and Spent Fuel) Order.

International Atomic Energy Agency (IAEA) have developed a system whereby radiation sources are categorized by the active ratio A/D, where 'A' is the activity of the source and 'D' is defined as the activity above which a source is considered to be "a dangerous source". The system describes the relative radiation hazard for both individual sources and dispersed radioactive material (Category 1 – Personally extremely dangerous to Category 5 – Not dangerous).

The RPII radioactive source inventory for disused'[85] sources comprises of more than 5,820 sources, including over 380 sources containing unknown radionuclides and several other entries with undetermined numbers of sources. The inventory also includes 1,400 slugs[86] (containing approximately 2500 kg) of natural uranium, a few grams of enriched uranium (93%), an undetermined number of Tc-99 generator cores and other sources comprising over 50 different identified radionuclides. Only a limited number of the sources have any information on the physical form and/or the practice from which the source originated. It is therefore difficult to determine with certainty which items listed in the inventory are sealed sources. Based on the IAEA source categorization scheme there were no Category 1 or Category 2 sources identified while only 3 sources belonged to Category 3. A total of 27 sources fell into Category 4 and over 3780 sources were determined to belong to Category 5 while approximately 2003 sources that lacked the necessary data to determine the IAEA category.

In addition to the disused sources contained in the inventory of sources there are other radioactive sources and potential sources of radioactive material that merit consideration. Post primary schools in Ireland hold an estimated 1,306 sealed and 835 unsealed radioactive sources, many of which exceed the exemption levels set out in the Ionising Radiation Order[87] . It has been estimated that about 35% of the sealed sources and 56% of unsealed sources may be categorised as disused.

The disused sources were also reviewed against the exempt levels given in legislation and for those with sufficient information on the time taken for them to decay to this level calculated. The majority of the sources currently designated as disused in Ireland have half lives and activities such that they are likely to decay to levels lower than the exemption levels within relatively short timescales i.e. < 5 years. The number of more active and longer lived sources for which longer term management solutions are required is quite small and there are only a very small number of high activity sources. For sources currently in use there should already be a "take-back" agreement and therefore there is only likely to be a small number of those which might need to be managed in the longer term. The other sources including sources from smoke detectors, schools and lightening protectors will also need to be included in consideration of the future management arrangements for disused sources.

7.3. Identification of technical containment and operational requirements for radioactive source storage

It is important to note that a disused sealed radioactive source is not necessarily radioactive waste. There may be other uses to which a source could be put by the same Licensee or by another Licensee for the same or a different application. The first step in the waste hierarchy is to prevent or minimise the generation of the waste in the first place. It is vital to ensure that a good record is

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85 Disused only sources are radioactive source that are no longer in use and for the most part are of no further use and are awaiting disposal or return to the manufacturer or supplier.

86 The terms slug, element, boat, pellet, fuel element for example are simply generic terms used to refer to the arrangement of the geometry associated with the canned uranium.

87 S.I 125 of 2000, Ionising Radiation Order.

kept of the sources held by Licensees and that tight control is kept on the purchase of new sources; first checking that a suitable source does not exist in the custody of that Licensee or if possible other Licensees.

Another option includes re-use whereby when a source is no longer required for the purpose for which it was obtained then the first step is to see whether there is a further use for it by the Licensee, or by another Licensee, in order to avoid it becoming a waste from the RPII viewpoint. Where a source cannot be re-used in its current form or condition, but where the radionuclide, activity level and form are suitable, it may be possible for the radioactive material to be removed for re-manufacture into a new source or sources.

Once reuse and recycling options have been exhausted then the sources will be declared as radioactive waste. In general, the solution would be for the disposal of the sources as waste but at present there is no disposal route for radioactive materials available in Ireland. The legislation allows for the disposal of sources, under licence from RPII, once they have decayed to a level less than the exemption levels given in the Basic Safety Standards within the EU. In order to make use of this route, sources have to be stored until such time as they have decayed to the appropriate levels.

Disposal involves the isolation of radioactive wastes in a suitable facility without the intention to retrieve, and with minimal requirement for long term surveillance or maintenance. It is the preferred and most sustainable option for the management of sources containing moderate to long lived radionuclides (half life > 5 yrs) because it takes away the burden of managing these wastes from future generations; is more cost-effective in the long term than alternative arrangements; and is less reliant on the continuity of regulatory control. Two broad concepts for the disposal of radioactive wastes are “near surface disposal” and disposal in “deep geological facilities”. Several disposal options based on various combination of the depth, use of engineered barriers and overall design features can also be used.

The key considerations in the design of facilities for the disposal of disused sealed radioactive sources include the characteristics of their constituent radionuclides, particularly the half lives, type and energy of emissions, and activity concentrations of the radionuclides. Sources with moderate to long half lives and high energies such as Caesium-137, Cobalt-60 and Strontium-90 are the most problematic and will require keeping in isolation for several hundreds to thousands of years before they decay to safe levels.

In order to minimise the risk associated with the storage of radiation sources a number of fundamental principles should be followed such as the safe design of both sources and facilities, regular safety assessments of the facility, physical security during use, transport and storage of sources, conditioning of spent sources, labelling of sources, high standards of training and retaining for staff, detailed records of all sources, proper and efficient disposal of sources and the establishment of an emergency plan for dealing with accidents. The key requirement for any storage facility is the safe and secure containment of, and the restriction of unauthorised access to, the kept sources.

Source storage facilities may be single mono-functional units or may be complexes with multiple functional compartments to cater for the different types and stages of storage operation; for instance interim, decay and long term storage. Storage facilities may also comprise treatment or conditioning units, or both. The design specification of a storage facility will depend on its intended function and the form, properties, volumes and condition of sources it is intended to keep – for instance whether the shielding provided by the packaging/ conditioning sufficiently attenuates radiation to below the relevant dose limits or whether the structure of the facility is intended to serve as the principal radiation shield.

In 2000, an EC commissioned study investigating the management of disused sealed radioactive sources in member states revealed that all EU member states have some form of regulatory infrastructure based on end user licensing regimes controlling the ownership of sealed radioactive sources. Although most member states maintained records of the total number of radioactive sources in use/ present in the country, the extent of this information varied widely, consisting of only Licensee details in some cases. Few countries had arrangements for post-licensing monitoring of sources. Some member states discouraged long term storage of disused sources at Licensees' premises while no member state had a final route suitable for the disposal of all disused sources. In most EU member states, there was a central waste management organisation (often the regulator or other Government body) responsible for coordinating all activities relating to management, storage and the ultimate disposal of disused sources.

The storage of disused radioactive sources is a multi-tiered process commencing with the planning stage and culminating in the retrieval of the sources for final disposal. When the need for a storage facility for redundant radioactive sources has been identified, the first step is to assess the storage requirements – what type, capacity and feature is required of the store. The operation of a source storage facility should follow a set of well documented procedures and operational limits based on the outcome of a safety assessment of the facility. These procedures should prescribe specifications regarding operational management, radiological criteria and requirements for personnel, and should cover all aspects of the facility's operations, from reception of waste consignments, to handling, emplacement in storage, monitoring and record keeping. The storage of sources containing long lived radionuclides is a temporary measure and the sources would ultimately have to be disposed of. Thus, retrievability should be a vital component of the repository design. When a permanent disposal route becomes available, the inventory of source packages will be removed for disposal.

It should be recognised that in Ireland, with the relatively small number of larger and longer lived sources it may never be considered cost effective to provide a disposal route for these in Ireland and might make more sense to discuss co-operation with other nearby countries in a similar situation to find a joint solution. Where disused radioactive sources are to be stored for medium to long periods for decay or until the availability of a final disposal option it is important that they are conditioned in order to minimise the risks from radiation and from potential leakage from the sources.

7.4. Identification of site selection criteria related to the storage or disposal of radioactive sources.

If the decision is made to provide a central storage facility for disused radioactive sources in Ireland one of the key issues will be the location for such a facility. In considering location a number of issues have to be taken into account such as safety and environmental protection, security, record keeping, public opinion, ownership, financial and insurance considerations and general issues of stability. There will be a need to carry out a full safety assessment to identify any specific safety or environmental related issues relating to the location of the facility. Another key issue in deciding on the location for a central storage facility will be its security. Whilst only the few largest sources have the capacity to cause any significant hazard to human health or to the environment it is clear that the loss or theft of any radioactive material can cause considerable public concern. It is therefore vital for the long term storage of disused radioactive sources, and potentially other radioactive wastes, that they be secure from any deliberate or accidental risk of loss, theft or diversion.

In selecting a location for the facility it will also be important to consider the impact of public opinion. Good consultation will be vital and there could be advantages to sitting the facility somewhere where this type of material is already held. Involvement of stakeholders in the process of making strategic decisions of national importance is vital if general support for the resulting decision is to be achieved. The question of the ownership and operation of the facility will also have an effect on the location. For Ireland an early option would be to look at whether one of the current public sector Licensees could relatively easily host such a facility either operated by them or a private company under contract to a Government Department or agency.

There may also be advantages to co-locating a central storage facility with another facility handling or storing hazardous materials or hazardous waste. This would allow co-operation on the general public consultations and also on the issues of security. Given the importance of this national requirement it is recommended that a wide consultation is undertaken in order to ensure widespread buy-in to the final adopted solution. This would involve all stakeholders including Governmental Departments and Agencies (including EPA and RPII), current Licensees, possible “management and operations” contractors and representatives of the public and special interest groups.

7.5. Design of a central storage facility

The design of a central storage facility will be dependant on a number of factors including, likely final disposal routes for the different sources or groups of sources, the level of shielding required for the sources to protect people and environment; and the volume of conditioned waste which will require to be stored.

The principal requirements for the storage building will be to provide a secure facility that also provides adequate control against the risk to people (workers in the facility and members of the public) and to the environment from radiation or from any leaks of radioactive materials. The conditioning of the waste should be designed to provide passive safety measure and security and the building and the management arrangements will provide additional layers of protection. These can be achieved by a fairly simple building design utilising standard security measures.

Another major consideration will be the location of conditioning operations. It is common for a waste handling or storage company to specify Waste Acceptance Criteria or Conditions for Acceptance which will define the limits on what waste can be received and what physical and chemical condition will be acceptable. It would be possible for these to require a consignor to precondition the waste to the defined specification. Given the relatively large number of consignors however, each with a relatively small number of disused sources, it may be sensible for the conditioning to be carried out in a central location. This would allow for consistency and a high level of assurance of the levels of conditioning and may also provide an economical solution, where the “polluter pays” principle by charging the consignor appropriately. If this approach were to be taken then this would require the central facility to include not only space for the storage of the conditioned waste but also suitable storage for sources awaiting conditioning and then a conditioning facility itself.

An outline design for a suitable facility has been proposed[88] previously. The current inventory includes around 5000 additional sources; however these are primarily short lived and/or low volume sources. The overall storage capacity for all radioactive wastes is estimated to be of the order of 3,000 x 200 l drums over the next 50 years, i.e. an annual a throughput of around 60 x 200 l drums (current stocks estimated at around 300 x 200 l drums). To put this in context this equates to receipt of about 2 freight containers per year in future and an initial elevated throughput of less

[88] “A facility for the Collection, Compaction and storage of Radioactive Waste Produced in Ireland” – Thesis presented for the partial fulfilment of the Degree of Master of Engineering Design, Christopher Hone, University College Dublin,

than 1 freight container per month (if existing stocks are transferred within a year).

There are a number of international models on where a central conditioning and storage facility could be sited and how it might be managed. Given the importance of this national requirement it is recommended that a wide consultation is undertaken in order to ensure widespread buy-in to the final adopted solution. This would involve all stakeholders including Governmental Departments and Agencies (including EPA and RPII), current Licensees, possible “management and operations” contractors and representatives of the public and special interest groups.

7.6. Conclusions and Recommendations

It should be recognised that in Ireland, with the relatively small number of larger and longer lived sources it may never be considered cost effective to provide a dedicated geological disposal site for these in Ireland and it might make more sense to discuss co-operation with other nearby countries in a similar situation to find a suitable geological disposal site. This approach is already being taken within the EU.

An overall approach for the management of radioactive sources in Ireland is as follows:

- For the sources with short half lives and low activity levels the most effective approach is to store these until they have decayed to below exemption levels and then to dispose of them, under licence from RPII, to a landfill as non-radioactive waste. They should be retained in storage by the Licensee. This would be appear to be a suitable approach for at least 2656 of the sources for which there is currently sufficient information in the RPII database to determine it but would also apply to any of the other sources which have short half lives and relatively small activity levels. For on-site storage it should be sufficient to manage these in the current manner to ensure sufficient level of security and safety, with frequent checks as for operational sources.

- The possibility for all of the other sealed sources to be returned to the manufacturer under their duty of care arrangements should be more fully explored. An approach to a waste management company, such as Energy Solutions, for a quote for such a service should be made by Licensees who have full detailed information on all of their sources.

- For the remainder of the sources, it will be necessary to store them until such time as Ireland identifies an ultimate disposal route either in Ireland or together with another country(ies). It is concluded by IAEA as well as others that this is best done in a central national facility rather than in multiple facilities on individual Licensee’s sites as this provides opportunities to adopt stringent safety standards and harness the benefits of economies of scale[89], and rigorous security measures.

- Sources should be suitably conditioned to ensure their safety and security. An example of suitable option would be by embedding them in concrete, probably in 200 litre steel drums, with the conditioning carried out in the central facility.

- The central facility should be designed once the full inventory of disused radioactive sources, other radioactive waste in Ireland and potential future arisings have been fully assessed (taking into account the outcome from (a) and (b) above

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89 IAEA-WS-G-6.1 (2006) Storage of Radioactive Waste : Safety Guide http://www-pub.iaea.org/MTCD/publications/PDF/Pub1254_web.pdf

- It is recommended that all stakeholders (including current Licensees, RPII, EPA, potential operators and the public) should be involved in the decision process in order to identify the options for a suitable location for such a facility, including the option of co-location with a hazardous waste facility; and the possible models for the ownership and management of such a facility and the key attributes for the decision making process which should follow thereafter. These would include, but not be limited to, safety, security, stability, indemnity and cost. This analysis should be carried out by an experienced MCA facilitation team.

8. WASTE MANAGEMENT OPTIONS

8.1. Introduction

In order to estimate the future capacity need an assessment of treatment options is required since some pre-treatment methods can increase the weight and volume of the material to be landfilled. Combined with this assessment, the requirement to pre-treat certain waste streams is considered.

The suitability of these options to contribute to the management of the key waste streams identified in **Chapter 5** has been assessed and evaluated to identify input, outputs, cost and throughputs required, it is assumed that any new treatment or disposal facilities will require a waste licence to operate. A capacity matrix was developed to estimate future capacity need and the predicted arisings were allocated to the different treatment/disposal routes in a detailed allocation matrix, this matrix is presented in **Appendix 3.**

8.2. Need for Pre-treatment Prior to Landfill

Article 6(a) of the Landfill Directive (1999/31/EC) states that:

"*Member states shall take measures in order that only waste that has been subject to treatment is landfilled. This provision may not apply to inert waste for which treatment is not technically feasible, nor to any other waste for which such treatment does not contribute to the objectives of this Directive, as set out in Article 1, by reducing the quantity of the waste or the hazards to human health or the environment.*"

The Landfill Directive was transposed into national legislation by Waste Management (Licensing) Regulations[90]. The EPA will not grant a waste licence for a new landfill facility unless it is satisfied that it will comply with all relevant requirements as specified in the Landfill Directive

The objective of pre-treatment is to increase the recycling and recovery of resources and to reduce the environmental impact of disposing of waste to landfill. However many residual hazardous wastes are themselves the products of such recovery processes and/or cannot themselves be recycled or recovered further and therefore must be disposed of in a manner that minimises the risk to human health and the environment. Therefore in considering the management of such hazardous wastes there is a need to consider whether the pre-treatment of waste prior to landfill will contribute to the Directive's objectives by reducing:

- The quantity of waste being landfilled; or
- The hazardousness of waste landfilled:

Many of the available treatment options increase the quantity of waste being landfilled without removing the hazards, albeit the risk associated with the waste may then be reduced. For example if asbestos fibres are immobilised by solidification, the waste strictly is still carcinogenic, by composition, but the treatment has removed the risk to receptors on a long-term basis.

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[90] Waste Management (Licensing) Regulations, 2000 (S.I. No.185 of 2000), the Waste Management (Licensing) (Amendment) Regulations, 2002 (S.I.No.336 of 2002) and the European Communities (Amendment of Waste Management (Licensing) Regulations, 2002) (S.I.N0.337 of 2002) and Waste Management (Licensing) Regulations, 2004 (S.I. No 395 of 2004).

Therefore in the assessment of estimated arisings and future capacity need, consideration is given to the need to pre-treat a waste stream, taking account of:

- The potential to change the hazardous nature of the waste;
- The impact on the quantity of waste to be landfilled; and
- The need to treat a waste stream to meet the waste acceptance criteria.

8.3. Treatment Options

There are several different treatment options available for difficult wastes which could be used in Ireland. The options chosen are dependent upon the type and quantity of material available. Some of the techniques can be used independently or in combination to treat the waste. The main options are:

8.3.1. Stabilisation/Solidification

Stabilisation involves the addition of reagents to a contaminated material (e.g. soil or sludge) to produce more chemically stable output. Solidification is the process that encapsulates the contaminant. Stabilisation and solidification can also be used for low level radioactive wastes.

The most common form of stabilisation and solidification is the addition of a cement based mixture, which limits the solubility/mobility of the waste constituents though vitrification (melting with glass-like components) is also used. Techniques can be carried out in-site or ex-situ. In the stabilisation process the hazardous components (e.g. heavy metals) are adsorbed on to materials such as clay or activated carbon and there is an interaction between the sorbents and the waste. The output from the process would normally still be hazardous by definition but the leaching characteristics of the waste are often changed which would allow the waste to meet the waste acceptance criteria to be suitable for disposal at a stable non-reactive hazardous waste cell at a non-hazardous landfill.

In addition, both stabilisation and solidification will increase the weight of waste to be landfilled by a factor of 1.5 to 2. Therefore if the purpose of the stabilisation/solidification is solely to meet the requirement to pre-treat the waste prior to landfill, it is unlikely to contribute to the objectives of reducing the quantity or hazardousness of waste.

8.3.2. Bioremediation

Bioremediation is the microbial breakdown of organic contaminants, similar to the composting process. It can be used to reduce the concentrations of hydrocarbon within contaminated soil. However, its use is limited by soil conditions and nature of contaminants and also requires space and time. Due to the time and space requirements by bioremediation techniques they would normally be focused at producing a useable output or treating land in-situ to remove the need to excavate and dispose of the soil.

8.3.3. Soil Washing

Soil washing is a water-based process for removing contaminants such as hydrocarbons and metals. It is a volume reduction process and it works in one of the following ways:

- By dissolving or suspending contaminants in the wash solution (which can be sustained by chemical manipulation of pH for a period of time); or

- By concentrating contaminants into a smaller volume of soil through particle size separation, gravity separation and attrition scrubbing.

Soil washing would normally be focused at producing a useable output. The clean fraction should be the bulk of the soil and the portion of the contaminated soil separated during washing can be disposed of to hazardous landfill.

8.3.4. Thermal Desorption

Thermal desorption is the heating of sludges or soils to drive off organic contaminants. There are two types of thermal desorption:

- Low temperature where the waste is heated to 200oC. The volatile organic compounds are distilled off and re-condensed to produce a thinners type material or a Secondary Liquid Fuel suitable for use in cement kilns. Providing the organic contaminants are removed and are the only cause of the hazardous classification, the remaining solid residue should be non-hazardous and can be used as aggregate or sent to landfill. This process is suitable for treating paints, inks, adhesives and resins in their solid, liquid or sludge form; and

- High temperature where the waste is heated to 400oC under vacuum. The volatile organic fraction is distilled off and condensed. The recovered liquid can be reused as a Secondary Liquid Fuel. Ferrous metals can be recovered from the desorbed solids before they are sent to be used as aggregates or non-hazardous landfill (again providing the organic contaminants are removed and are the only cause of the hazardous classification). This process is suitable for contaminated soil, oil sludges, filter cakes, paint sludges, phosphate sludges and mercury contaminated wastes

Thermal desorption normally operates as a batch process and multiple desorption units can be used in series to treat large quantities of waste.

8.3.5. Physico-chemical

Physico-chemical treatment techniques would not normally be used to treat the wastes identified in this study and it is the outputs from these processes that are likely to be managed at a NaDWaF, such as for example, filter cakes. The main physico-chemical treatment techniques are:

8.3.5.1. Oxidation techniques

Oxidation changes the chemical components of the waste to a less hazardous state. It is most commonly used to treat cyanide and sulphide waste. The process results in a liquid and sludge that require further treatment.

8.3.5.2. Reduction techniques

The most common use is for reducing Chrome VI by reacting it with sodium bisulphite or sodium metabisulphite. Such processes usually result in liquid waste for further treatment or sewer discharge, and sludge for landfill.

8.3.5.3. Neutralisation

Neutralisation is the mixing of acid and alkali wastes to produce a solution with a pH ≈ 7 and a sludge. The neutralised liquid can be processed through a waste water treatment plant. The sludge from the process is usually hazardous as a result of being contaminated with heavy metals and would need further treatment and/or disposal at hazardous landfill. This method is widely used for the treatment of pickling acids and acid catalysts.

8.3.5.4. Precipitation

Precipitation involves the removal of dissolved components in solution by:

- Changing the pH;
- A chemical reaction;
- Changing the temperature to solidify dissolved components.

Precipitation can be combined with processes that remove solids, such as sedimentation, filtration and centrifugation. This method is often used to remove metals from waste water. A variety of re-agents are used (include calcium hydroxide, sodium carbonate or sodium sulphide) to generate metal precipitation leaving an effluent to be discharged and a concentrate that can be recycled or disposed to landfill.

8.4. Disposal Options

8.4.1. Stable Non-Reactive Hazardous Waste Landfill Cell

A stable non-reactive hazardous waste cell is a separate cell within a non-hazardous landfill site which can accept:

- Waste which has been treated, by a process such as stabilisation or solidification, in order to meet the acceptance criteria set out in Council Decision 2003/33/EC91; or
- Wastes which are "stable non-reactive" without treatment, such as asbestos. The term stable, does not mean that the waste is stabilized as provided in European Commission Decision (2001/118/EC) amending Decision 2000/532/EC as regards the list of wastes. That defines stabilized wastes to be ones that have been treated so that they are no longer hazardous (i.e., stabilized wastes have had the hazard removed, whereas, in stable hazardous wastes the hazard is still present).

8.4.2. Hazardous Waste Landfill

Hazardous wastes can be disposed of at hazardous waste landfill sites provided the wastes meet

[91] Council Decision 2003/33/EC on establishing criteria and procedures for the acceptance of waste at landfills.

the acceptance criteria set out in Council Decision 2003/33/EC. The acceptance criteria set limit values for:

- Leaching characteristics;
- Loss on ignition (LOI); and
- Total organic carbon (TOC).

Wastes which do meet the acceptance criteria cannot be landfilled and would need to be treated so produce an output that could be landfilled or recovered.

8.5. Assessment of Key Waste Streams and Treatment Options

The suitability of the waste management options to contribute to the management of the key waste streams identified in **Chapter 5** has been assessed and evaluated to identify:

- Their ability to treating/disposing of the key waste streams;
- Required input/throughput capacities required;
- Output from the treatment processes, in terms of quantities and disposal requirements;
- Licensing and permitting requirements; and
- Indicative cost of each option.

Table 26 summarises the findings and provides the basis for the capacity needs matrix.

Table 26 Assessment of Treatment Options

Option	Ability to treating/disposing of the key waste streams	Required input/throughput capacities required	Output from the treatment processes	Licensing requirements	Indicative development cost of each option
Stabilisation/ Solidification	Sludge from effluent treatment, glass polishing grinding sludge, machining sludges, Heavy metal wastes Filter cake from gas treatment.	UK plants such as CSG Lanstar treat 10-20,000 tonnes per year.	Solid waste suitable for landfill in hazardous waste landfill or SNRHW cell.	Licence	1-2 million Euro
Bioremediation	Contaminated soils in situ and ex situ	Dependant upon site specific factors	Soil suitable for aggregate and reuse. Soil for landfill	Licence	Dependant upon site specific factors
Soil Washing	Ex Situ treatment of contaminated soils	From 15,000-100,000 tonnes per annum depending upon the plant chosen (10-50 tonnes/hour)	Soil for reuse. Liquid for treatment. Residue for landfill	Licence	From €100, 000
Thermal Desorption	Contaminated soils Contaminated sludges	1,500-2,000 tonnes per year per unit* (1-2 tonnes dry material/hour)	Secondary Liquid Fuel Residue for aggregate or landfill	Licence	1 Million Euro (there can be economies of scale for different units.) (indicative gate fee €500/tonne)
Stable Non-reactive Hazardous Waste Landfill Cell	Asbestos contaminated materials Solid wastes from effluent treatment Stabilised hazardous wastes Solidified hazardous wastes	Throughput and cost depends on the amount of engineering that is required on the landfill, and lost airspace if cell has to be totally separated.	N/a	Licence	Millions of Euro per cell
Hazardous landfill	Contaminated soils Treated hazardous wastes Asbestos wastes Stabilised/solidified hazardous wastes	Throughput and cost depends on the amount of engineering that is required on the landfill.	N/a	Licence	Millions of Euro
*Calculation for throughput based on 250 working days of 6-8 hours per day.					

8.6. Assessment of Future Capacity Needs

To estimate future capacity need, the predicted arisings, as detailed in **Chapter 5** and supporting **Appendix 2**, were allocated to the different treatment/disposal routes in a detailed allocation matrix. The detailed allocation matrix is presented in **Appendix 3**. Within the matrix, different proportions of the arisings are allocated to different treatment/disposal routes; the matrix then calculates the resultant capacities for the different treatment options and landfill. The estimation process within the matrix takes into account the outputs from different pre-treatment methods (which may make hazardous waste suitable for landfill), as many pre-treatments increase the weight and volume of the material to be landfilled. The allocation of wastes is based on waste type and the ability of the different treatment/disposal options to handle particular wastes streams.

The estimated future capacity is heavily dependent on the quantities of two particular waste streams, contaminated soils and flue gas cleaning residues (that could result from the thermal treatment of waste in the future). Therefore a series of sensitivity analyses have been undertaken to assess the implications for the capacity estimates of a reduction in these two waste streams.

8.6.1. Assumptions

To estimate future capacity a series of assumptions need to be made in the allocation of wastes and in the estimation process. The key assumptions are:

- Certain waste streams can be landfilled without further treatment (either hazardous waste landfill or separate cell in non-hazardous waste landfill), because it is treated at the point of production or the treatment would not contribute to the objectives of the Landfill Directive, with the estimate based on waste type;
- A proportion of contaminated soils can be treated by in-situ or ex-site treatment methods (such as bio-remediation and soil washing) resulting in non-hazardous outputs and the proportions of waste treated via such route increases over time as techniques advance;
- Stabilisation/solidification will increase the weight of waste by a factor of 2, up to 2013, with the factor reducing 1.5 from 2014 as techniques advance[92]; and
- All stabilised/solidified waste remains hazardous by definition.

Waste classified under 01 03 07*(other wastes containing dangerous substances from physical and chemical processing of metalliferous minerals) would be managed at existing facilities.

8.6.2. Capacity Estimates - Baseline Prediction Model

The annual landfill tonnages resulting from the baseline prediction model are summarised in **Table 27** and the treatment capacity needed in conjunction with this landfill capacity is summarised in **Table 28**. The estimates show that up to 2019 between 235,000 and 260,000 tonnes per annum of hazardous landfill capacity could be required. This reduces to 185,000 tonnes per annum as a

[92] The assumption is based on one used in Defra's Hazardous Waste Forum, Treatment and Capacity Task Force Status Report (2004) on future capacity needs in the UK. The Treatment and Capacity Task Force included industry representatives who agreed it was a realistic assumption.

result of assuming that treatment techniques advance.

Table 27 Annual Hazardous Waste Landfill Tonnages - Baseline Prediction Model

	Annual tonnage		
	2008 – 2013*	2014 - 2019	2020 - 2025
Direct to landfill	78,000	90,000	50,000
Landfilled following treatment**	168,000	132,000	120,000
Direct to SNRHW[93] Cell	11,000	13,000	15,000
Total	257,000	235,000	185,000
* Figures represent the tonnages towards the end of the 6 year period once incineration capacity has come on line; ** A proportion of this tonnage may be suitable for disposal in a SNRHW Cell.			

Table 28 Treatment Capacity (Base Assumptions)

	Annual tonnage		
	2008 – 2013	2014 - 2019	2020 - 2025
Stabilisation/ Solidification	84,000	88,000	80,000
Bio-remediation	7,000	18,000	39,000
Soil Washing	7,000	18,000	39,000
Thermal Desorption	7,000	18,000	39,000

8.6.3. Sensitivity Analyses

To assess the impact on future capacity need three sensitivity analyses were undertaken:

1) Reducing the arising of contaminated soils used in the prediction model to the 2007 arisings levels;

2) All flue gas cleaning residues are treated to make the outputs non-hazardous; and

3) The effect of both reducing contaminated soils arisings to 2007 levels and the treatment of all flue gas cleaning residues

8.6.3.1. Reducing contaminated soil arisings to 2007 levels

The future capacity required is critically dependant on the quantity of contaminated soils (17 05 03*) produced, which can vary considerably year on year. In the base year (2008) there was a significant tonnage of contaminated soils exported to landfill, over 180,000 tonnes. However, in the previous year (2007) only 44,000 tonnes of contaminated soils were exported to landfill. Therefore the effect on capacity need of a reduced contaminated soil arisings has been assessed. Using a

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[93] SNRHW is Stable non-reactive hazardous waste.

baseline arising of 44,000 tonnes, the forecast model predicts the following annual arising:

- 40,900 tonnes per annum between 2008 and 2013;
- 51,400 tonnes per annum between 2014 and 2019; and
- 56,100 tonnes per annum between 2020 and 2025.

The resultant capacity needs are summarised in **Table 29** and **Table 30** and show that if contaminated soils were generated at 2007 levels, then the hazardous waste capacity reduces significantly.

Table 29 Annual Hazardous Waste Landfill Tonnages: Reducing contaminated soil arisings to 2007 levels

	Annual tonnage		
	2008 – 2013*	2014 - 2019	2020 - 2025
Direct to landfill	27,000	32,000	22,000
Landfilled following treatment**	97,000	84,000	78,000
Direct to SNRHW Cell	11,000	13,000	15,000
Total	135,000	129,000	115,000

* Figures represent the tonnages towards the end of the 6 year period once incineration capacity has come on line;

** A proportion of this tonnage may be suitable for disposal in a SNRHW Cell.

Table 30 Treatment Capacity: Reducing contaminated soil arisings to 2007 levels

	Annual tonnage		
	2008 – 2013	2014 - 2019	2020 - 2025
Stabilisation/ Solidification	49,000	56,000	52,000
Bio-remediation	2,000	5,000	11,000
Soil Washing	2,000	5,000	11,000
Thermal Desorption	2,000	5,000	11,000

8.6.3.2. Treatment of all flue gas cleaning residues

The other waste stream that could have a significant impact on the future arisings is flue gas cleaning residues. In the future there could be treatment options (such as pH Adjustment or weathering/carbonation) that could result in the treatment of flue gas cleaning residues with no hazardous waste outputs to landfill. The resultant capacity needs are summarised in **Table 31** and **Table 32** and show that while there is a reduction in capacity need, the effect is not as significant as a reduction in contaminated soil arisings.

Table 31 Annual Hazardous Waste Landfill Tonnages: Treatment of all flue gas cleaning residues resulting in non-hazardous outputs

	Annual tonnage		
	2008 – 2013*	2014 - 2019	2020 - 2025
Direct to landfill	78,000	90,000	50,000
Landfilled following treatment**	125,000	92,000	87,000
Direct to SNRHW Cell	11,000	13,000	15,000
Total	214,000	195,000	152,000
* Figures represent the tonnages towards the end of the 6 year period once incineration capacity is available. ** A proportion of this tonnage may be suitable for disposal in a SNRHW Cell.			

Table 32 Treatment Capacity: Treatment of all flue gas cleaning residues resulting in non-hazardous outputs

	Annual tonnage		
	2008 – 2013	2014 - 2019	2020 - 2025
Stabilisation/ Solidification	62,000	61,000	58,000
Bio-remediation	7,000	18,000	39,000
Soil Washing	7,000	18,000	39,000
Thermal Desorption	7,000	18,000	39,000

8.6.3.3. Reducing contaminated soils arisings to 2007 levels and the treatment of all flue gas cleaning residues

This sensitivity combines the effect of the two previous sensitivities and show that the capacity need could reduce to below 100,000 tonnes per annum. The resultant capacity needs are summarised in **Table 33** and **Table 34**.

Table 33 Annual Hazardous Waste Landfill Tonnages: Treatment of all flue gas cleaning residues resulting in non-hazardous outputs

	Annual tonnage		
	2008 – 2013*	2014 - 2019	2020 - 2025
Direct to landfill	27,000	32,000	22,000
Landfilled following treatment**	54,000	44,000	45,000
Direct to SNRHW Cell	11,000	13,000	15,000
Total	92,000	89,000	82,000
* Figures represent the tonnages towards the end of the 6 year period once incineration capacity is available. ** A proportion of this tonnage may be suitable for disposal in a SNRHW Cell.			

Table 34 Treatment Capacity: Treatment of all flue gas cleaning residues resulting in non-hazardous outputs

	Annual tonnage		
	2008 – 2013	2014 - 2019	2020 - 2025
Stabilisation/ Solidification	27,000	29,000	30,000
Bio-remediation	2,000	5,000	11,000
Soil Washing	2,000	5,000	11,000
Thermal Desorption	27,000	29,000	30,000

8.6.3.4. Treatment of all export contaminated soils

In addition to the export of contaminated soils to landflll, contaminated soils are also exported for physico-chemical treatment. If all these contaminated soils were managed in Ireland this could increase the treatment and disposal capacity required. If contaminated soil were to be treated in Ireland, treated soil would be potentially available as an engineering resource for the same redevelopment works where it was generated. **Table 35** set out the contaminated soils exported to physico-chemical treatment in 2007 and 2008 and the forecast model predictions of arisings.

Table 35 Contaminated Soils Exported to Physico-chemical Treatment in 2007 and 2008 and Predicted Future Arisings

	Export of physico-chemical treatment	Predicted Annual Arisings (Tonnes)		
		2008 – 2013*	2014 - 2019	2020 - 2025
2007	68,000 tonnes	51,628	64,831	70,840
2008	30,000 tonnes	23,055	28,952	31,635

If it is assumed that 50% of these arisings are sent to stabilisation/solidification and 50% are sent to treatment methods that result in non-hazardous outputs, the implications for hazardous waste landfill and stabilisation/solidification capacity are summarised in **Table 36.**

Table 36 Potential Additional Capacity Resulting from Physico-chemical Treatment in Ireland.

	Potential Additional Annual Tonnage		
	2008 – 2013*	2014 - 2019	2020 - 2025
Hazardous Waste Landfill	23,000 to 52,000	22,000 to 49,000	24,000 to 53,000
Stabilisation/ Solidification	12,000 to 26,000	14,000 to 32,000	16,000 to 35,000

8.7. Summary of Future Capacity Needs

The estimated landfill capacity needed is summarised in **Table 37**, the table highlights the potential impact on the estimated landfill capacity of varying arisings of contaminated soil and the implication of the development of treatment techniques for flue gas cleaning residues. The figures show that under the baseline prediction model, the future capacity need is between 235,000 to 257,000 tonnes per annum up to 2019, reducing to 185,000 tonnes per annum as a result of assuming that treatment techniques advance. The assumption is based on an assumption used in Defra's Hazardous Waste Forum, *Treatment and Capacity Task Force - Status Report on future capacity needs in the UK*. It is also a precautionary assumption as it tries not to overestimate the quantity.

However , the capacity is significantly affected by assumption on the quantity of contaminated land and the treatment of flue gas cleaning residues and the capacity need could reduce to below 100,000 tonnes per annum.

Table 37 Total Estimated Annual Hazardous Waste Landfill Tonnages

	Annual tonnage		
	2008 – 2013*	2014 - 2019	2020 - 2025
Baseline Prediction Model	257,000	235,000	185,000
Sensitivities			
Reducing contaminated soil arisings to 2007 levels	135,000	129,000	115,000
Treatment of all flue gas cleaning residues resulting in non-hazardous outputs	214,000	195,000	152,000
Reducing contaminated soil arisings to 2007 levels AND Treatment of all flue gas cleaning residues resulting in non-hazardous outputs	92,000	89,000	82,000

* Figures represent the tonnages towards the end of the 6 year period once incineration capacity is available.

9. HAZARDOUS LANDFILL TECHNICAL CONTAINMENT AND OPERATIONAL REQUIREMENTS

9.1. Introduction

The development of a hazardous waste landfill in Ireland needs to be economically feasible as well as technically feasible. The facility must be able to obtain the necessary authorisations through planning and waste licensing; it therefore must meet or exceed BAT (best available technique) and be able to demonstrate its effectiveness in treating waste while not causing damage to human health and the environment.

This section addresses technical and operational requirements of a hazardous waste landfill and of a Stable Non-Reactive Hazardous Waste (SNRHW) cell at a non-hazardous landfill having regard for European Directives, national legislation, best available technique guidance, Environmental Protection Agency guidance and international best practice. The documentation reviewed as part of this assessment is presented in **Appendix 4** and referenced where relevant in this chapter.

The principal regulation governing the landfill of waste is the Landfill Directive[94]**.** The objective of the Directive is to prevent or reduce as far as possible negative effects on the environment from the landfilling of waste, in particular on surface water, groundwater, soil, air and human health, by introducing stringent technical requirements for waste and landfills. An inherent principle in the Environmental Liability Directive is that the operator should adopt these measures so that their exposure to financial liabilities is reduced, therefore the operator whose activity has caused environmental damage or imminent threat is held financially liable.

The Directive defines the different categories of waste (municipal waste, hazardous waste, non-hazardous waste and inert waste) and applies to all landfills, defined as waste disposal sites for the deposit of waste onto or into land and was transposed into national legislation by the Waste Management (Licensing) Regulations[95]. Under these Regulations the EPA will not grant a waste licence for a new landfill facility unless it is satisfied that it will comply with all relevant requirements as specified in the Landfill Directive.

9.2. Overall Requirements

Given the relatively low arisings in Ireland of hazardous wastes suitable for landfilling, and the geographically dispersed nature of those arisings, a balance must be achieved between minimum effective size of a facility and distance travelled to it. This may mean a single facility, located at an economic and environmental centroid; or more than one facility, each closer to centres of generation of hazardous waste for landfill.

For a hazardous landfill development to proceed the technical feasibility must be addressed, together with the economic feasibility. The facility design and operation must be able to obtain a

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[94] The Landfill Directive 1999/31/EC.

[95] Waste Management (Licensing) Regulations S.I. No.185 of 2000, the Waste Management (Licensing) (Amendment) Regulations, S.I.No.336 of 2002, European Communities (Amendment of Waste Management (Licensing) Regulations S.I.No.337 of 2002, and Waste Management (Licensing) Regulations S.I No. 395 of 2004.

waste licence, it must therefore meet or exceed BAT available technique (BAT) and must be effective in the treatment of waste while not causing environmental pollution and damage to human health.

A planning application for a hazardous waste landfill will be required to be accompanied by an environmental impact statement as this proposed activity is such that an environmental impact assessment is required, see **Chapter 4** for more detail. If the proposed development would be of strategic economic or social importance to Ireland or region in which it would be located, an application can be made directly to An Bord Pleanála under the Planning and Development (Strategic Infrastructure) Act of 2006.

Annex 1 of the Landfill Directive lays down seven general requirements for all classes of landfills and includes: location, water control and leachate management, protection of soil and water, gas control, nuisances and hazards, stability and barriers.

The World Health Organisation's *Site Selection Criteria for New Hazardous Waste Facilities*[96], present guidance[97] on site selection for new hazardous waste management facilities which detail screening criteria to eliminate unsatisfactory areas, highlight promising areas, assess the suitability of selected areas with particular emphasis on soil and groundwater and finally to evaluate and rank sites.

9.2.1. Technical containment

Stringent operational and technical requirements are necessary in order to prevent or reduce as far as possible negative effects on the environment in particular the pollution of surface water, groundwater, soil, air, and on the global environment, including greenhouse effect, as well as any residual risk to human health, from landfilling of waste, during the whole life cycle of the landfill. A landfill must be situated and designed so as to meet the necessary conditions for preventing pollution of the soil, groundwater and surface water and ensuring efficient collection of leachate as and when required.

The location is considered at the site selection stage as this determines the risk assessments required and any specific containment that may be necessary for a particular location to comply with BAT. Landfills for hazardous waste must meet the requirements and approach stipulated for all landfills, with certain additional requirements in respect of their accepting hazardous wastes and any local conditions as may be appropriate. The following requirements are therefore pertinent:

9.2.1.1. Geological and Hydrogeological Requirements

The location of a landfill must take into consideration requirements relating to the geological and hydrogeological conditions in the area. The potential risks to groundwater and surface water need to be assessed in detail due to their ecological and economic value as major natural resources. A national strategy for Groundwater Protection[98] was published in 1999 to provide geological and hydrogeological information to assist in the location of potentially polluting developments in less

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[96] World Health Organisation (1993) Site Selection Criteria for New Hazardous Waste Facilities, WHO Regional Publications.

[97] Site Selection for New Hazardous Waste Management Facilities, Regional Publication, No. 46, 1993.

[98] Groundwater Protection Schemes in Ireland, Geological Survey of Ireland,1999.

vulnerable areas and identify appropriate measures to minimise the potential for pollution from these activities. In addition the Institute of Geology of Ireland has produced guidance on geology in environmental impact statements.[99].

It is normally necessary to use an analytical model to assess the risk associated with unplanned passage of pollutants through the environment and their impact on receptors[100]. Pathway analysis provides the link between potential emissions and receptors by describing the processes through which pollutants may traverse the environment. A range of hydrogeological risk assessment tools are available, from simple screening to complex models. Most models incorporate probabilistic approaches to deal with uncertainty, generating a range of probabilistic impacts for each scenario. It is important to select the appropriate level of sophistication as needs, complexities, priorities and data allow. This needs a clear understanding of the underlying conceptual models and assumptions in selection of the appropriate tool. The WHO guidance states that estimates of risk should not be based on the worst case scenario as conservative assumptions can lead to difficult and expensive design specifications.

Hydrogeological Risk Assessment Models

UK - LandSim2

Developed for use by the Environment Agency for England and Wales, LandSim2[101] is a hydrogeological risk assessment tool developed for landfill design. It is a probabilistic model which uses the Monte Carlo[102] simulation technique to generate the output values used in a quantitative risk assessment of landfill site performance in relation to groundwater protection.

It allows the consideration of environmental performance of liner and leachate collection systems. The model provides a range of output values, their range reflective of the uncertainty in input values. LandSim2 is based on a site specific conceptual model, with the landfill assumed above the water table. More sophisticated flow and containment transport models may be required on varied geology or highly sensitive aquifers.

LandSim2 can represent multiple phases and sites, with different input data for each and consider several options for liner construction, such as the single and double composite liner systems presented hereafter. The model can estimate combined impact of several phases in addition to that of individual phases and take account of retardation, dispersion and background water quality. However, as with any model the output is affected by the quality of the input information. It is particularly important that accurate post-landfill directive hazardous waste leachate characteristics are used in the model, as they may differ considerably from leachate from a non-hazardous waste landfill. **Table 38** illustrates the typical input parameters for the LandSim 2 model.

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[99] Geology in Environmental Impact Statements – A Guide, Institute of Geology of Ireland, 2002.

[101] LandSim2 - http://www.landsim.com/

[102] Monte Carlo simulation techniques - a class of computational algorithms that rely on repeated random sampling to compute their results. Monte Carlo methods are often used in simulating physical and mathematical systems.

Table 38 Typical Input Parameters to LandSim2

Source	Infiltration
	Cell geometry (base area, top area, sump location and diameter)
	Leachate (identify parameters, concentrations, calculate declining source term) – It is important to use hazardous waste leachate
	Leachate collection system (none, piped, layer)
	Engineered containment barrier (range of options, thicknesses, hydraulic conductivity of mineral layer, cation exchange capacity (CEC) of the mineral layer)
Pathways	Unsaturated zone (length, moisture content, density, hydraulic conductivity, CEC, dispersivity)
	Vertical pathway (length, porosity, conductivity, dispersivity)
	Aquifer pathway (pathway length, pathway width, mixing zone thickness, hydraulic conductivity, hydraulic gradient, pathway porosity, dispersivity)
Targets	Location of Monitoring well (located on the down-gradient edge of each cell to measure impact on groundwater from that cell)
	Compliance point (located where appropriate to measure combined impact from all cells)

The LandSim2 model can be setup to run a range of options to allow comparison of event scenarios, such as:

- Declining source term (determines whether leachate concentrations are allowed to decay);
- Retardation (controls whether cation exchange (for NH4), partition coefficients, or neither are used);
- Biodegradation (can be specified for each component of the pathway);
- Hydraulics (calculations are limited to leachate head, leakage (from defects / damage e.g. pinholes, holes or tears) and travel time);
- Time history (detailed information on contaminant breakthrough, travel times and concentrations);
- Plume generator (shows view of expected concentrations); and
- Landfill assumed to be above the water table.

Typically, the LandSim2 model results present the 50%ile (most likely) and 95%ile (worst case) maximum retarded contaminant concentration at monitoring well and compliance point locations for a given leakage through the base of the landfill and head acting on the engineered containment system. These contaminant concentrations can be compared against relevant standards such as the EC Groundwater Directive 2006/118/EC, EC Water Framework Directive 2000/60/EC and EU Drinking Water Directive 98/83/EC. This is an iterative process, where further design measures may be required to improve the performance of the landfill engineering until appropriate levels of confidence are achieved.

A particular advantage of LandSim2 is that it can take into account degradation of the engineered containment system and generate 20,000 year predictions, which is useful when considering hazardous waste which may represent perpetual risk.

Other Hydrogeological Risk Assessment Models

Where a site's characteristics are complex, LandSim2 may be supplemented by more specialised models. Risk Assessment Model software (RAM) is a spreadsheet based risk assessment modelling tool developed by ESI Ltd for assessing the risk to the water environment from contaminated land. RAM is designed for staged risk assessment and supports a four level remedial target methodology, the fourth stage of which considers dilution at the receptor and attenuation in the unsaturated and saturated zone. It uses the same Monte Carlo probabilistic analysis as LandSim2 but is not as widely utilised for landfill applications.

AMBER is a modelling tool developed by Enviros Software Solutions Ltd originally for radiological safety cases, and now sold by Quintessa[103], which allows users to define and solve sophisticated compartmental models. Amber allows for contaminants to decay with time into other contaminants and hence is particularly useful for modelling risks from radioactive source waste.

9.2.1.2. Liner Design

The lining system protects the surrounding environment including soil, groundwater and surface water by containing leachate generated within the landfill, preventing ingress of groundwater and assisting in the control and migration of landfill gas. The selected liner system must achieve consistent performance and be compatible with the expected leachate for the design life of the facility.

The protection of soil, groundwater and surface water is achieved by the combination of a geological barrier and a basal liner during the landfill operational/active phase and by the combination of a geological barrier and a top liner during the passive phase/post closure.

The nature of any geological barrier is determined by examination of geological and hydro-geological conditions below and in the vicinity of a landfill site and undertaking an impact assessment to ensure sufficient attenuation capacity is provided to prevent a potential risk to soil and groundwater. The landfill directive requires that the landfill base and sides should consist of a mineral layer which satisfies permeability (K) and thickness requirements with a combined effect in terms of protection of soil, groundwater and surface water at least equivalent to the one resulting from the following requirements[104]:

- Landfill for hazardous waste: K ≤ 1.0 × 10- 9 m/s; thickness ≥ 5 m; and
- Landfill for non-hazardous waste: K ≤ 1.0 × 10- 9 m/s; thickness ≥ 1 m.

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103 Quintessa - www.quintessa-online.com/

104 Annex 1 – Section 3. Protection of Soil and Groundwater, subsection 3.2 of Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste .

Where the geological barrier does not naturally meet the above conditions it can be completed artificially and reinforced by other means giving equivalent protection. An artificially established geological barrier should be no less than 0.5m thick. In addition to the geological barrier, an artificial seal and a leachate collection layer of ≥ 0.5m thickness must be added to ensure that leachate accumulation at the base of the landfill is kept to a minimum.

In 2000, the EPA developed and published a landfill design manual[105] as part of a series of publications on landfill related activities. The objective of the manual was to set a standard in the design of landfills and to establish criteria and procedures for the selection, management, operation and termination of use of landfill sites. The manual is a comprehensive guide to the requirements for technical containment and also identifies the basic operational requirements for hazardous waste facilities and a dedicated cell within a non-hazardous waste landfill for receipt of Stable Non-Reactive Hazardous Waste (SNRHW).

The manual details the requirements of a liner system. A liner must be provided for the protection of soil, groundwater and surface water. The liner system may consist of a natural or artificially established mineral layer possibly combined with a geomembrane that must have prescribed permeability and thickness requirements. The manual lists two options, dependent on types of hazardous waste, for a hazardous waste landfill liner as described in **Table 39**, though it is accepted that alternative other construction materials and systems may yield alternative design solutions (subject to BAT).

Table 39 EPA Landfill Manual Options for Hazardous Waste Landfill Liner

Option 1: Single Composite Liner	A minimum 0.5m thick leachate collection layer having a minimum hydraulic conductivity of 1×10^{-3}m/s
	At minimum a 2mm HDPE or equivalent flexible membrane in the upper component of the composite liner
	A base and side wall mineral layer of minimum thickness 5m of permeability ≤ 1.0 ×10-9 m/s, and that a minimum 1.5m of the 5m thick mineral layer directly below the flexible membrane should be constructed in a series of compacted lifts no thicker than 250mm when compacted.
Option 2: Double Composite Liner	A minimum 0.5m thick leachate collection layer having a minimum hydraulic conductivity of 1x10-3m/s
	A top composite liner consisting of: a minimum 2mm HDPE or equivalent geomembrane and a 1m thick layer of compacted soil with a hydraulic conductivity ≤ 1,0 × 10-9 m/s constructed in a series of compacted lifts no thicker than 250mm when compacted or a 0.5m artificial layer of BES constructed in two 250mm layers.
	A minimum 0.5m thick leachate detection layer having a minimum hydraulic conductivity of 1x10-3m/s, or a geosynthetic material that

[105] EPA (2000) Landfill Manuals- Landfill Site Design.

	provides equivalent performance,
	A bottom composite liner consisting of: a minimum 2mm HDPE or equivalent flexible membrane, a minimum base and side wall mineral layer of minimum thickness 4m with a hydraulic conductivity ≤ 1.0 × 10-9 m/s, and that a minimum 1m of the 4m thick mineral layer directly below the flexible membrane should be constructed in a series of lifts no thicker than 250mm when compacted.

Note: There is a required 1:50 fall and leachate head restriction specified,

In 2003, the EPA produced guidance notes[106] on the determination of Best Available Techniques (BAT) in relation to landfill activities. To reflect changes in legislation and to incorporate advances as they arise additional guidance notes[107] were produced in 2008 to act as a follow on from the 2003 BAT guidance. In terms of liner design the BAT guidance notes 2003 provide specific advice on engineered liner systems, stability and settlement, surface water and groundwater management and leachate and landfill gas management. The BAT guidance notes 2008 provide additional information in terms of risks to the environment and control techniques, environmental liabilities, emissions limit values and compliance monitoring.

Best available techniques (BAT) is defined as the "most effective and advanced stage in the development of an activity and its methods of operation, which indicate the practical suitability of particular techniques for providing, in principle, the basis for emission values designed to prevent or eliminate or where that is not practicable, generally to reduce an emission and its impacts on the environment as a whole".

In the identification of BAT, emphasis is placed on pollution prevention techniques rather than end-of-pipe treatment. The determination of BAT needs to consider the following, taking account of the likely costs and advantages of measures and of the principles of precaution and prevention:

- Use of low-waste technology;
- Use of less hazardous substances;
- Furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate;
- Comparable processes, facilities or methods of operation, which have been tried with success on an industrial scale;
- Technological advances and changes in scientific knowledge and understanding;
- The nature, effects and volume of the emissions concerned;

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[106] EPA (2003) BAT Guidance Notes for the Waste Sector: Landfill Activities.

[107] EPA (2008) Draft BAT Guidance Notes for the Waste Sector, Landfill Activities.

- The commissioning dates for new or existing activities;
- Length of time needed to introduce the best available techniques;
- Consumption and nature of raw materials (including water) used in the process and their energy efficiency;
- The need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it;
- The need to prevent accidents and to minimize the consequences for the environment.
- Information published by the European Commission on best available techniques, associated monitoring, and developments in them, or by international organisations, and such other matters as may be prescribed.

The BAT guidance 2003 states that when selecting the appropriate lining system the design should take into consideration: material availability, results of source testing, type and nature of waste to be accepted at the facility, local geology and hydrogeology, the level of protection required by the surrounding environment, and the need to ensure the stability and long term integrity of the lining system. The selection of the lining system should be supported by a risk assessment and in general the lining system should not rely on a single level of protection. The construction phase should follow a Construction Quality Assurance (CQA) Plan to ensure and demonstrate that the lining system has been constructed in accordance with design specification.

The BAT guidance 2003 states that the design of a liner for hazardous waste should as a minimum meet the criteria as detailed in **Table 40**.

Table 40 BAT Guidance for Lining Hazardous Waste Landfill

A drainage layer ≥ 0.5 metres thick, with minimum hydraulic conductivity of 1x10-3 m/s. the slope of the base should also have a minimum fall of 1 in 50
An artificial sealing liner, and
A mineral layer of minimum thickness 5.0m with a hydraulic conductivity ≤1.0 x 10-9 m/s, or
An artificial mineral layer of minimum thickness 0.5m with a hydraulic conductivity ≤1.0 x 10-9 m/s.

Liner Design - International Best Practice

The Landfill Regulations (Northern Ireland) 2003, S.R. No. 496, the Landfill Regulations (England and Wales) 2002, S.I. No. 1559 and the Landfill Regulations (Scotland) 2003, S.I. No. 235 transpose the landfill directive into the UK. The three sets of Regulations provide the same details on technical containment for hazardous waste as identified in the Landfill Directive.

Germany is the largest market in Europe for hazardous waste management services. The German Federal Government transposed the Directive on the Landfill of Waste by introducing the

Ordinance on Landfills and Long-term Storage Facilities in 2002[108]. This document sets out the minimum requirements for the geological barrier and base sealing system. Other requirements pertaining to the construction of the disposal area are defined in numbers 9.1 to 9.6 of TA Abfall (1991).

The basal liner for hazardous waste landfills as specified in the Ordinance is described in **Table 41**.

Table 41 Standard structure of the geological barrier and the base sealing system (Federal Ministry of Environment, Nature Conservation and Nuclear Safety, WA II 5, 2002)

System Component[1,2]	Class III (hazardous waste landfill)
Mineral drainage layer[3]	d ≥ 0.5m, k ≥ $1x10^{-3}$m/s
Protection layer	required
Plastic sealing liner d ≥ 2.5mm	required
Geological barrier or	k ≤ $1x10^{-9}$m/s, d ≥ 5m
Mineral sealing layer - at least 2 layers[2]	d ≥ 0.5m, k ≤ $1x10^{-10}$m/s
Note 1. Should the geological barrier fail to meet the requirements by virtue of its natural properties, it may be completed and improved by means of additional technical measures. The requirements relating to the geological barrier shall also be deemed to have been met if similar protective effect is achieved via the combined effect of the permeability coefficient, layer thickness and pollutant retention capabilities of the layers between the landfill base and the highest available groundwater aquifer, whilst observing the required minimum thickness.	
Note 2. The permeability coefficient k must be observed at i=30 (laboratory reading)	
Note 3. At the application of the landfill operator, the competent authority may admit deviations from the layer thickness and the permeability coefficient of the drainage layer. Provided it is proven that the hydraulic capacity is sufficient in the long term to prevent accumulation of water in the body of the landfill. A layer thickness of 30cm must not be undercut.	

9.2.1.3. Capping Design

A capping system normally includes a series of components which are selected to meet a number of objectives such as minimising infiltration of water, promoting surface water drainage, controlling gas migration and providing a physical separation between waste and animal life. The principal function of the capping system is to minimise the infiltration of water into the waste and consequently reduce the amount of leachate being generated. The components of a landfill capping system may include topsoil, subsoil, a drainage layer, a barrier layer and a gas drainage layer (where required).

The Landfill Directive states that if the competent national authority, after a consideration of the potential hazards to the environment, finds that the prevention of leachate formation is necessary, a surface sealing may be prescribed. Recommendations for the surface sealing include; a gas drainage layer (where required), an artificial sealing liner, an impermeable mineral layer, a drainage

108 Ordinance on Landfills and Long Term Storage Facilities, (Landfill Ordinance -Dept V) of 24 July 2002 – Federal Ministry of the Environment, Nature Conservation and Nuclear Safety – WA II 5 –

layer (> 0.5 m) and top soil cover (>1.0 m).

The *EPA Landfill Design Manual* recommends a capping system described in **Table 42** for hazardous waste landfills. The BAT guidance 2003 for landfill capping describes a minimum standard of capping landfills for hazardous waste which is the same as that described in the *EPA Landfill Design Manual*.

Table 42 Hazardous Landfill Capping

A topsoil layer of 150 to 300mm and subsoil of at least total 1m thickness
A drainage layer of minimum thickness 0.5m with hydraulic conductivity $>1.0x10^{-4}$ m/s
A compacted mineral layer of minimum thickness 0.6 metres with hydraulic conductivity $< 1.0x10^{-9}$ m/s in intimate contact with a 1mm flexible membrane liner

The German Ordinance (Regulations) on Landfills and Long-term Storage Facilities[109] sets out a standard structure for the surface sealing system for Class **III** hazardous waste landfills as described in **Table 43**.

Table 43 Standard structure of surface sealing system (

System Component	Class III (hazardous waste landfill)
Vegetation	Required
Re-cultivation layer	d ≥ 1.0m
Drainage layer – Note 1	d ≥ 0.3m, k ≥ 1x10-3m/s
Protective layer	required
Plastic sealing liner	d ≥ 2.5mm
Mineral seals - Note 2,3	k ≤ 1x10-10m/s, d ≥ 0.5m
Gas drainage layer – Note 4	Required in some cases
Compensatory layer – Note 4	d ≥ 0.5m
Note 1 - At the application of the landfill operator, the competent authority may admit deviations from the layer thickness and the permeability coefficient of the drainage layer. Provided it is proven that the hydraulic capacity of the drainage layer and the stability of the re-cultivation layer are guaranteed in the long term	
Note 2 -The permeability coefficient k must be observed at i=30 (laboratory reading). The material composition and installation technology should be selected in such a way as to minimise the risk of mud crack formation	
Note 3 - The competent authority may admit deviation of the lime content, provided proper functioning of the seal is not impaired.	
Note 4 - The competent authority may admit deviations from the requirements provided the correct functioning of the layers is not impaired.	

109 Federal Ministry of Environment, Nature Conservation and Nuclear Safety, WA II 5, 2002.

9.2.1.4. Leachate Extraction and Treatment

The collection of leachate is an integral part of the environmental control engineering for landfills. A leachate collection and removal system forms an important component of the landfill liner system comprising a drainage layer, a filter layer, leachate collection pipes and sumps or header pipe system and leachate monitoring points.

The rate of leachate generated will be influenced by the water balance calculations for the site, waste inputs, operations and moisture in the waste. The engineering requirements for the site preparation, operation and closure may significantly reduce leachate generation after closure, and limit significant generation to precipitation on the active area. The unit cost of treating leachate increases as the total volume decreases but is likely to be considerably higher for leachate from a hazardous waste landfill, due to its composition, than from a non-hazardous waste site as discussed below.

Leachates sampled from hazardous waste landfills in EU member states were analysed[110] and found to have the following characteristics;

- Limited or no effect of biological activity;
- TOC typically < 100mg/l; and
- Highly variable but with some common characteristics most notably: salinity several times higher than leachate from non-hazardous waste landfills and higher levels of site specific metals.

Leachate must be characterised for any given site by consideration of the intended waste streams, their pre-treatment and method of placement. The method and location of treatment will then be indicated from consideration of the rate and duration of leachate generation, its predicted characterization, and the availability of merchant treatment facilities. Annex I of the Landfill Directive refers to water control and leachate management as a general requirement for all classes of landfills. It states that appropriate measures should be taken in order to treat leachate collected from the landfill to an appropriate standard required for discharge.

The EPA BAT guidance notes 2003 advise that a landfill should be designed to minimise the generation of leachate, contain what is generated and provide a means of removing it for treatment or disposal. Particularly sensitive receptors in the event of leachate escape should be identified along with any factors which would give rise to larger than necessary volumes of leachate being generated or increase the risk of leachate escape. Management techniques such as keeping the active filling area as compact as possible and prompt application of daily cover should be used, small cell size will also reduce leachate production.

Leachate that has been removed from the landfill must be managed by one of the following options;

- Treatment onsite followed by licensed discharge,

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[110] Environment Agency (2004) Improved definition of leachate source term from landfills; Phase 1: review of data from European landfills; Science Report P1-494/SR1.

- Pre-treatment onsite followed by accepted disposal for further treatment at an authorised and technically capable waste water treatment works (WWTW) or treatment facility, or
- Accepted disposal for treatment offsite at an authorised and technically capable WWTW.

Treatment methods outlined in the EPA Site Design Manual are divided into four main categories as follows:

1. Physical/chemical pre-treatment (air stripping, coagulation/precipitation);
2. Biological treatment (aerobic suspension growth, aerobic fixed film, anaerobic);
3. A combination of both physical/chemical pre-treatment and biological treatment; and
4. Advanced treatment such as activated carbon adsorption, reverse osmosis, chemical oxidation, evaporation or reed bed treatment.

In respect of hazardous waste landfill leachate, the main applicable treatment processes are likely to be physical/chemical and advanced processes, given the effective absence of biological activity.

The Environment Agency for England and Wales guidance for the treatment of leachate[111] from landfills describes a range of treatment processes but not specifically in relation to hazardous or difficult wastes. The most likely processes to be effective with these wastes, which are characterised by low organic content, are a range of physical and chemical processes such as:

- Reverse osmosis, which has been used to treat leachate from landfills that have received residues from municipal solid waste incinerators with up to 99.8% reduction in the concentration of dioxins in the treated effluent;
- Solids removal by sedimentation / settlement with the aid of coagulants / flocculates;
- Chemical oxidation processes; and
- Activated carbon.

9.2.2. Surface Water/Groundwater Control

The landfill design should incorporate features to prevent surface water and groundwater entering the landfill, such as lining and capping the landfill. In addition, measures should be put in place to prevent contamination of surface water and groundwater by controlling ancillary activities such as fuel storage, chemical storage and septic tanks. Appendix B of EPA Landfill Site Design Manual outlines a series of physical cut-off techniques and pumped groundwater control methods for the exclusion of groundwater from ingress into the landfill. These include displacement barriers such as steel sheet piling, excavated barriers such as slurry walls, injection barriers such as grouting, together with a range of pumped control measures mostly designed to increase drawdown.

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[111] Environment Agency for England and Wales, Guidance on the Treatment of Landfill Leachate - Sector Guidance Note IPPC S5.03 – February 2007.

Annex I of the Landfill Directive requires that operators;

- Control water from precipitation entering the landfill body, and
- Prevent surface water and/or groundwater from entering the landfilled waste.

The BAT guidance notes 2003 provide techniques and controls for surface water and groundwater management at the design and operational phase by preventing leachate escape from the landfill and/or by diverting or otherwise protecting the groundwater or surface water.

The EC Water Framework Directive 2000/60/EC enacted in Ireland through the European Communities (Water Policy) Regulations 2003 and amendments Regulations 2005 and 2008 establishes a framework for the protection of surface and groundwater. The Directive requires member states to establish river basin districts and for each of these a river basin management plan. The measures provided for in the river basin management plans seek to;

- Prevent deterioration, enhance and restore bodies of surface water, achieve good chemical and ecological status of such water and reduce pollution from discharges and emissions of hazardous substances;
- Protect, enhance and restore all bodies of groundwater, prevent the pollution and deterioration of groundwater, and ensure a balance between groundwater abstraction and replenishment, and
- Preserve protected areas.

Specific river basin management plans will clearly play a significant role in selecting suitable locations for a difficult waste disposal facility. Further to the Water Framework Directive, the Groundwater Directive 2006/118/EC establishes a regime which sets underground water quality standards and introduces measures to prevent or limit inputs of pollutants into groundwater. The directive establishes quality criteria that takes account local characteristics and allows for further improvements to be made based on monitoring data and new scientific knowledge. The directive thus represents a proportionate and scientifically sound response to the requirements of the Water Framework Directive (WFD) as it relates to assessments on chemical status of groundwater and the identification and reversal of significant and sustained upward trends in pollutant concentrations. Member States have to establish the standards at the most appropriate level and take into account local or regional conditions.

In order to respond further to the requirements of the Water Framework Directive (2000/60/EC) and the Groundwater Directive (2006/118/EC) the European Communities Environmental Objectives (Groundwater) Regulations 2010, S.I. No. 9 of 2010 were developed and came into effect in January 2010. The regulations establish a new strengthened regime for the protection of groundwater by establishing clear Environmental Objectives, Groundwater Quality Standards and Threshold Values for the classification of groundwater and the protection against pollution and deterioration.

The regulations also introduce the legal basis for a more flexible, proportionate and risk based approach to implementing the legal obligation to prevent or limit inputs of pollutants into groundwater which already exists under the old Groundwater Directive (80/69/EEC)[112] River Basin Management Plans. River basin management plans will influence the location of a future hazardous waste disposal facility, as consideration must be given to the existence and vulnerability of water bodies in the vicinity.

9.2.3. Landfill Gas Control

The generation of landfill gas is an inevitable consequence of the disposal of non-inert waste to landfill. Even an engineered, hazardous landfill, with an absence of biodegradable wastes, will generate certain types of landfill gas, depending on the composition of the disposed waste.

Three processes result in the generation of landfill gas, - the general bacterial decomposition of biodegradable waste which is the main feature in municipal landfills, volatilisation of chemical substances, such as paints or residues in solvent contaminated soils, resulting in the release of NMVOCs (non-methane volatile organic carbons), and chemical reactions that may take place when incompatible waste types in the landfill body come in contact. For example, if bleach and ammonia come in contact with each other within the landfill, a variety of toxic gases may be produced, including chlorine gas, nitrogen trichloride or hydrazine, to name but a few. Of the above mechanisms, waste volatilisation tends to be the most prominent source of landfill gas generation in a hazardous landfill.

Good operational management and control should be able to limit the potential of incompatible wastes coming into contact with each other, by documenting incoming waste types and ensuring confined placement of certain wastes. However, it is more difficult to forecast what type of gases may be generated from aged or leached materials that have become chemically altered within the landfill. These may include nitrogen, oxygen, ammonia, sulfides, hydrogen, carbon monoxide, and nonmethane volatile organic compounds (NMVOCs) such as trichloroethylene, benzene, and vinyl chloride, as well as reactive or explosive substances associated with the specific hazardous waste deposited. The precise composition depends on the wastes deposited in the site, and trace gas composition in a hazardous landfill may change within a matter of hours, even at any single monitoring borehole. The nature and variability of hazardous wastes makes the prediction of gas generation from a difficult waste facility uncertain.

9.2.3.1. Risk Assessment

The potential risk of gas production in an engineered hazardous waste landfill facility should be assessed by the landfill operator, when the types of wastes that will be deposited are determined. While this may change over time, the waste licence will specify the list of wastes that may be accepted. Based on the waste types, a gas management programme should be put in place at the site. This will evaluate the potential chemical risks and the possible gas migration pathways within the landfill. An assessment of leachate quality may also provide indications of whether gas production is anticipated.

Landfill gas has the potential to be released from a landfill in two ways:

- Subsurface migration, and

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[112] Groundwater Directive 80/68/EEC.

- Release to the atmosphere.

Subsurface Migration of Landfill Gases

The release of gases from an engineered hazardous landfill is generally low, but an assessment should still be completed of the potential for the generation and release of gases to the subsurface.

The landfill liner will be required to be resistant to the chemical composition of the leachate and gases that will be generated in the landfill, and must be capable of preventing lateral migration of any gas out of the site. As part of the risk assessment, the following issues should be considered:

- Potential for the generation of NMVOC's or other volatiles;
- Potential generation of gas from chemical reactions between leacahte and wastes;
- The risk of migration of landfill gas in the subsurface beyond the site; and
- The likelihood of off-site properties of sensitive receptors being reached,such as via subsurface ducts or service lines.

The Gas Management Programme should include considerations relating to Health and Safety including a commitment to monitor trigger levels at the perimeter of the site and ensuring H&S thresholds for CO2, CH4 and NMVOC's are not exceeded within any on-site buildings or confined spaces. Gas detection alarms for these indicator compounds should be provided permanently in the site buildings. Any buildings or areas that contain electrical equipment or any potential source of ignition, should be provided with warning signs and safety protocols to be taken in the presence of volatile compounds.

The Gas Management Programme should further contain a contingency plan, outlining steps to be taken in the event of landfill gas being detected outside of the hazardous waste site perimeter. The contingency plan should include;

- A conceptual design of the landfill gas control systems;
- A response plan describing the procedure to be followed in the event of an unacceptable increase in volatile compound concentrations within the buffer area, off- site, or within the facility buildings or confined spaces; and
- Procedures for notification of the EPA and of the subsequent implementation of the contingency plan.

Release of Landfill Gases to the Atmosphere

The risk assessment should investigate the potential of landfill gas being generated and released to the atmosphere. This assessment should consider;

- The potential likelihood of incompatible wastes and leachate coming in contact and releasing volatiles;
- The percentage of biodegradable materials that may inadvertently enter the landfill (i.e organic matter within contaminated soils);

- The levels of leachate within the facility;
- The facility layout, such as slopes, natural surroundings of the site;
- The type of daily and final cover to be used (wood chippings will contribute to methane generation);
- The phasing of the landfilling and expected operational life of the facility; and
- Any activities to control or alter the moisture content within the facility.

9.2.3.2. Gas collection and control systems

In order to manage the gas generated in a landfill it is necessary to plan for gas collection infrastructure on site. These technologies include means to collect, control and treat gases. The provision of a gas collection system is a requirement of EPA landfill waste licences.

Landfill gas can be collected by either a passive or an active collection system. A typical collection system, either passive or active, is composed of a series of gas collection wells placed throughout the landfill. he number and spacing of the wells depend on landfill-specific characteristics, such as waste volume, density, depth, and area. As gas is generated in the landfill, the collection wells offer preferred pathways for gas migration. The technical requirements of landfill gas collection and control systems are specified in the EPA *Landfill BAT Notes 2008*, and EPA *Landfill Site Design Guide 2000*.

The Gas Management Programme should contain details of an active gas collection system that will be implemented in the event of significant amounts of gas being generated in the hazardous waste site. The gas collection system may have to include plans for secondary fuel provision, where hazardous gases require flaring, however the landfill does not produce sufficient methane as primary fuel. Depending on the outcome of the risk assessment, the Gas Management Programme may also have to provide plans for pre-treatment or scrubbing of specific trace components before flaring can safely be carried out. Alternatively t the destruction efficiency of volatile organic compounds and mixtures by the proposed flare should be detailed.

It is considered unlikely that a hazardous landfill without biodegradable waste will have the potential for gas utilisation.

9.2.3.3. Landfill Gas Monitoring

As part of the risk mitigation strategy, monitoring and sampling of the in-situ waste should be carried out once landfill operations have commenced. Weekly grab sampling of indicator parameters should be carried out, to determine whether any gases are being generated, and what the trace gas composition is. Toxic or explosive gases are of the greatest concern and monitoring for these may consist of the most typical components such as H2S and CH4 or less common compounds such as HCN or H2.

At least three boreholes should be provided in each phase of the landfill, to provide an ongoing assessment of landfill gas generation. If indicator trigger levels are exceeded (i.e. 1.5% v/v CO_2, or 1% v/v CH_4) then more detailed trace-gas sampling should be carried out.

A weather station should be installed at the engineered hazardous waste landfill facility site to record wind speed, wind direction, barometric pressure and rainfall. These parameters are important factors in the assessment of impact of the landfill gas emissions, so that correlations between air quality measurements, wind direction and wind speed can be made.

9.2.4. Air Emission Control

Emissions to the atmosphere that occur during facility construction and operations will include dust from earth moving, excavation, the placing of wastes and the placing of the cover, as well as ambient and vented landfill gases and vapours. Air quality may also be affected by odours associated with waste materials, volatile organic compounds (VOCs) from vehicles accessing and moving around site or from contaminated soils. The most significant air pollutants arising from a facility for difficult waste are likely to be asbestos, dust from disposal of incinerator ash or fibres from SNRHW. A comprehensive range of mitigation measures are discussed in the EPA BAT guidance 2008.

The following control techniques are used at landfills for the minimisation of dust and fine particulates, as specified in the Landfill BAT Note 2008:

- Dusty waste may be pre-treated (conditioned) using water – sometimes a "wetting agent" needs to be incorporated. Alternatively the waste might only be accepted if it is bagged.
- All waste containing asbestos must be treated as a "Hazardous Waste" as defined in the Waste Management Acts 1996-2008, where the concentration of asbestos exceeds the threshold concentration (0.1%). The Landfill Directive, Article 6 (c) (iii) allows for hazardous wastes which are stable and non-reactive, to be accepted at non-hazardous landfills, provided it is deposited in a separate cell in specifically limited quantities. This is likely to enable suitably packaged/pretreated bonded asbestos waste to continue to be landfilled at appropriate sites. Reference should be made to Council Decision 2003/33/EC establishing criteria and procedures for the acceptance of waste at landfills, where criteria are given for acceptance of hazardous waste, including construction materials containing asbestos, at landfills for non-hazardous waste. Reference should also be made to the EPA *Technical Guidance on the Landfilling of Asbestos Waste (EPA, 2006)*.
- Prompt compaction after discharge from the vehicle delivering the waste, followed by covering with suitable material (natural or artificial cover materials) to sufficient depth.
- Provision of spray equipment around active tipping area if dusty waste is a regular problem;
- Use of paved site roads where appropriate;
- Regular sweeping of surfaced site roads;
- Regular spraying of site roads;
- Avoidance of placing waste during unfavourable meteorological conditions; and
- Seeding of capped surfaces as soon as restoration layers emplaced.

Potential emissions to air and elimination/control techniques guidance will be similar to those set out for non-hazardous landfills. However, there may be other emissions risks to air including fugitive asbestos fibres or other materials containing hazardous dusts.

Effects may be direct (health effects associated with ingestion, nuisance from odours, acid deposition on vegetation.) and indirect (media or materials become contaminated by chemicals in the air).

9.2.4.1. Sampling and analysis procedures

The principles associated with the monitoring and nuisance control at a municipal waste landfill apply equally to hazardous waste landfill. An engineered hazardous landfill operational plan must include a monitoring programme for the emissions to atmosphere, including dust deposition, respirable dust (PM_{10}; $PM_{2.5}$), reduced sulphur compounds and NMVOC's, as well as any compounds of specific concern to the site. The monitoring programme should include metrological data from an onsite weather station.

In assessing the impact of potential air emissions from a hazardous waste landfill, due consideration must be given to existing ambient background conditions as well as relevant Air Quality Standards set either under the Irish Air Quality Standards Regulations 2002 (S.I. 271 of 2002 which has replaced S.I. 244 of 1987) or the EU Framework Directive on Air Quality (96/62/EC) and its Daughter Directives (1999/30/EC and 2000/69/EC).

9.2.5. Odour Control

Offensive odours arise at landfill site from a number of sources particularly:

- Malodorous wastes;
- Leachate; and
- Landfill gas.

The control of odours needs to be proactive and good landfill practices can greatly reduce odours emanating from a site. This is applicable to hazardous and non-hazardous landfills.

9.2.5.1. Management Techniques

The following management techniques are used to minimise odour risk at landfills:

- Pre-treatment of odour forming waste;
- Operation of appropriate waste acceptance procedures;
- Preparation & operation of an Odour Management Plan;
- Regular review of landfill gas monitoring and management protocols;
- Effective management of cell phasing and size; and

- Regular monitoring of capped areas (interim and final) for fugitive VOC emissions.

9.2.5.2. Control Techniques

The following techniques are used at landfills for the control of odours:

- Minimisation of open tipping face area.
- Prompt replacement, compaction and covering of wastes.
- For facilities accepting odour forming wastes, provision of a minimum buffer distance of 750m between the landfill footprint and any sensitive receptor.
- Immediate burial of odorous wastes.
- Restriction of loads known to be particularly odorous.
- Restrict tipping activities during periods of adverse meteorology.
- Upgrading and sealing of sump covers.
- Aeration of leachate storage areas.
- Improvements in landfill gas collection, venting and combustion systems.
- Monitoring and regulation (balancing) of gas extraction wells.
- Use of horizontal and vertical gas extraction wells.
- Use of gas extraction pipework to maintain negative air pressure within the body of gas producing waste.
- Use of gas collection pipework at the top of the cell side slopes.
- Use of auxiliary fuel in landfill gas flare systems to support gas combustion.
- Condensate removal.
- Use of appropriate materials for daily, interim and final cover/capping.
- During periods when the rate of landfill gas production alone is insufficient to allow the operation of landfill gas combustion equipment, the use of auxiliary fuels should be considered.
- Covering or burial of waste excavated during the installation of leachate or landfill gas management systems.
- The use of odour neutralising sprays/aerosols at times when either climatic or waste acceptance site monitoring indicates heightened risk to identified receptors (for example inversions or calms).

- Use of odour neutralising additives in wastes during transport from transfer station to landfill site.

Air quality may be affected by dust from the tracking of vehicles over site, odours associated with waste materials, volatile organic compounds (VOCs) from vehicles accessing and moving around site or from contaminated fill. At hazardous waste facilities, there could also be accidental releases of volatile chemicals, uncontrolled chemical reaction during inadvertent mixing of non compatible chemicals or fire involving organic wastes which could lead to emissions to the air.

Effects may be direct (health effects associated with ingestion, nuisance from odours, acid deposition on vegetation.) and indirect (media or materials become contaminated by chemicals in the air).

9.2.5.3. Nuisances and Hazards

A key item in the effective management and control of landfill operations is the control of nuisances. All of the potential impacts of a landfill site should be identified at the risk screening phase of the conceptual model development and refined at the planning application stage. Detailed measures to mitigate the impacts should be included in the landfill design and set out in the permit application. Annex I of the landfill directive requires measures to be taken for all classes of landfill to minimise nuisances and hazards arising from landfilling activities through;

- Noise and traffic;
- Formation and aerosols, and
- Fire

The *EPA Landfill Manual for Landfill Operational Practices* describes general nuisance control and states that the general impacts of landfill operations on local amenities should be considered at the planning stage. Potential impacts should be addressed by clear operating procedures with a view to their minimisation. During the operating phase all complaints should be logged and fully investigated. Waste acceptance procedures for hazardous and difficult wastes are designed to minimise hazards from an environmental and health and safety perspective.

The BAT guidance notes 2003 detail techniques and controls to be implemented in the management of nuisances such as dust/fine particles (PM_{10}), odour, litter, noise and vibration, vehicles, birds, vermin, insects, mud, fires and security. Information is provided on management, elimination and control techniques which apply to hazardous, non-hazardous and inert landfill facilities and are based on the EPA Landfill Manuals.

In the UK the Environment Agency has produced guidance[113] for the waste sector detailing recommendations for nuisance control in relation to dust, aerosols, litter, birds, vermin, fires, mud on roads, odour, noise and vibration and traffic. Although many of the potential nuisances at non-hazardous waste landfills are likely to be less at hazardous waste landfills due to the reduced biological activity, nonetheless their control is still most important.

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[113] Environment Agency (2007) Guidance for the Landfill Sector – Technical Requirements of the Landfill Directive and Integrated Pollution Prevention and Control.

9.2.6. Waste Acceptance

The Council of the European Union decision 2003/33/EC established criteria and procedures for the acceptance of waste at landfills[114]. The Council Decision sets out criteria for acceptance of waste at;

- Inert waste landfills;
- Non-hazardous waste landfills;
- Hazardous waste acceptable at landfills for non-hazardous waste;
- Hazardous waste landfills, and
- Underground storage.

Hazardous waste acceptable at landfills for non-hazardous waste should be stable and non-reactive; interpreted by the Environment Agency (England and Wales) as meaning the leaching behaviour of the waste will not change adversely in the long-term, under landfill design conditions or foreseeable accidents[115]. The Council Decision sets leaching limit values for prescribed components (such as metals, sulphate, DOC and TDS) and other acceptance criteria (TOC, pH, ANC). The Council Decision advises that member states set criteria for monolithic waste to provide the same level of environmental protection as set out by the leaching limits prescribed for granular hazardous waste accepted at landfills for non-hazardous waste. Member states must also set criteria to ensure that waste will have sufficient physical stability and bearing capacity, and set criteria to ensure that hazardous monolithic wastes are stable and non-reactive before acceptance in landfills for non-hazardous waste.

The Council Decision specifically refers to construction materials containing asbestos and other suitable asbestos waste that may be landfilled at landfills for non-hazardous waste in accordance with Article 6(C)(iii) of the landfill directive without testing, provided that certain requirements are met:

- Fibres should be bound by a binding agent or packed in plastic;
- The landfill only accepts construction material containing asbestos and other suitable asbestos waste. However, these wastes may also be landfilled in a separate cell of a landfill for non-hazardous waste, if the cell is sufficiently self contained;
- In order to avoid dispersion of fibres, the zone of deposit is covered daily and before each compacting operation with appropriate material and, if the waste is not packed, it is regularly sprinkled with water;
- A final top cover is put on the landfill cell in order to avoid dispersion of fibres; and

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114 European Union decision 2003/33/EC established criteria and procedures for the acceptance of waste at landfills. pursuant to Article 16 and Annex II of the Landfill Directive (1999/31/EC).

115 http://www.environment-agency.gov.uk/static/documents/Business/lfd_1__2005780.pdf

- No works are carried out on the landfill cell that could lead to the release of fibres e.g. drilling.

Furthermore, for landfills receiving only construction material containing asbestos, the requirements set out in Annex I, point 3.2 and 3.3 of the Landfill Directive can be reduced, if the specified requirements are fulfilled. This means the requirements for engineered containment can be reduced to a 1m thick compacted clay layer instead of a 5m thick compacted clay layer or equivalent.

For landfilling waste at hazardous waste landfills the Council Decision sets limiting values for leaching of prescribed components (metals, sulphate, DOC, TDS) and other criteria (LOI, TOC, ANC).

For monolithic hazardous waste accepted at hazardous waste landfills the Council Decision advises that member states must set criteria to provide the same level of environmental protection as given by the leaching limit values prescribed for granular hazardous waste.

For acceptance of waste at underground storage sites, a site specific safety assessment as defined in Annex A of the Council Decision must be carried out. This outlines a safety philosophy for underground storage, namely the requirements of the Water Framework Directive 2000/60/EC, for the protection of groundwater bodies and requires the identification of the hazard (the waste), receptors (biosphere and groundwater), pathways and impact if substances were to reach the receptor. For underground storage of hazardous waste the criteria for leaching as prescribed for landfill do not apply.

The acceptance criteria for underground storage can be obtained only by referring to the local conditions. This requires a demonstration of the suitability of the strata for establishing a storage facility, i.e. an assessment of the risks to containment, taking into account the overall system of the waste, engineered structures, cavities and the host rock. For underground storage a site specific risk assessment of the installation must be carried out for both the operational and post operational phases. From these assessments, the required control and safety measures can be derived and the acceptance criteria developed. The following assessments are required;

- Geological assessment;
- Geomechanical assessment;
- Hydrogeological assessment;
- Geochemical assessment;
- Biosphere impact assessment;
- Assessment of the operational phase;
- Long term assessment, and
- Assessment of the impact of all the surface facilities at the site.

Appendix A of the Council Decision 2003/33/EC identifies wastes excluded from underground storage, these are biodegradable, pungent smelling, generate toxic or explosive gases, or are insufficiently stable. The Decision advises that member states may produce a list of wastes acceptable at underground storage facilities in accordance with Article 4 of the Landfill Directive and also advises that wastes can only be deposited in an underground storage securely separated from mining activities. The Decision provides additional considerations for two particular types of underground storage, namely; salt mines and hard rock, as follows;

- Salt mines – In salt mines the salt is considered to provide total containment; and

- Hard Rock – For mines in hard rock, the directive defines underground storage as at depths of several hundred metres below ground level. The safety philosophy is that the facility would be constructed to be passive i.e. requiring no maintenance, but would not obstruct recovery of the waste or the ability to undertake future corrective measures. The main concept is isolation of the waste from the biosphere, as well as natural attenuation of any pollutants leaking from the waste. For certain substances this isolation may be required for thousands of years. It is envisaged that the facility would either be purpose built or located in a former mine where the mining activities had ceased.

For non-hazardous waste the Decision sets limiting values for prescribed components (such as metals, sulphate and DOC) but advises that member states set criteria for monolithic waste to provide the same level of environmental protection. Also, non-hazardous gypsum based materials should be disposed of only at landfills for non-hazardous waste in cells where no biodegradable waste is accepted. The limit values for total organic carbon and dissolved organic carbon of gypsum based materials should be the same as stated for hazardous waste acceptable at landfills for non-hazardous waste.

The BAT guidance notes 2003 state that it is essential for all landfill operators to ensure that only those wastes for which the facility was designed, and which are permitted by the licence are deposited. The guidance notes list the Landfill Directive as the legislative document to be adhered to in terms of pre-treatment, waste characterisation, compliance testing and on-site verification of waste. To ensure compliance with the Landfill Directive it is essential that procedures are put in place by the operator to check that the waste delivered to the facility has been pre-treated and checked prior to disposal.

The EA published guidance on the interpretation of the waste acceptance requirement of the Landfill (England and Wales) Regulations 2002 (as amended) in June 2006. **Table 44** gives an overview of the landfill options provided from the EA guidance.

Table 44 Overview of Landfill Options (Interpretation of Landfill Regulations England and Wales)

Site Class	Subclass	Wastes Acceptable
Hazardous		Granular hazardous waste Monolithic hazardous waste Asbestos waste displaying other hazards Inert waste for cover and engineering
Hazardous	Asbestos mono-cell	Asbestos waste displaying no other hazards Inert waste for cover and engineering
Hazardous	Gypsum mono-cell	Hazardous wastes including those with a high gypsum (or ther sulphate) content that meet the total organic carbon (TOC) and dissolved organic carbon (DOC) WAC for stable non-reactive hazardous wastes (SNRHW). Inert waste for cover and engineering

Site Class	Subclass	Wastes Acceptable
Hazardous	Underground storage	Wastes shown to be acceptable by the site specific risk assessment, but not wastes listed as excluded
Non-hazardous	SNRHW (Stable Non-Reactive Hazardous Waste)	SNRHW Nonhazardous waste that meets the WAC for SNRHW Non-hazardous wastes with a high gypsum or other sulphate content Inert waste
Non-hazardous	Asbestos mono-cell	Asbestos waste displaying no other hazards Inert waste for cover and engineering
Non-hazardous	Underground storage	Non-biodegradable wastes not listed as hazardous provided they are shown to be acceptable by site specific risk assessment and are not listed as excluded.
Non-hazardous	Underground storage in SNRHW cell (found acceptable by site specific risk assessment)	SNRHW Nonhazardous waste that meets the WAC for SNRHW Non-hazardous wastes with a high gypsum or other sulphate content Inert waste
Non-hazardous	Underground storage in asbestos mono-cell (found acceptable by site specific risk assessment and not listed as excluded)	Asbestos waste displaying no other hazards Inert waste for cover and engineering

The Environment Agency for England and Wales, (2006) *Guidance for waste destined for disposal in landfills*, version 2, outlines the full WAC for inert, non-hazardous and hazardous landfills, with special provisions relating to;

- Stable non-reactive hazardous wastes (SNRHW) deposited in landfills for non-hazardous wastes, in cells not used for the deposit of biodegradable waste;
- Asbestos wastes;
- Gypsum wastes , and
- Underground storage.

The guidance refers to three kinds of full waste acceptance criteria; a list of inert wastes which can be accepted without testing, leachate limit values and limit values for other parameters.

For hazardous granular waste accepted at hazardous waste landfills, the Environment Agency for England and Wales has selected the EU directive leachate limit values at L/S = 10 l/kg and states that such wastes must have either an in-situ shear strength of at least 50kPa for cohesive waste, or an in-situ bearing ratio of at least 5% for non-cohesive waste. In addition guidance reiterates the ban on disposal of tyres (except when used as engineering materials) and liquids. Hazardous granular waste can be treated to make it monolithic, but the waste can only be accepted at a landfill, if before the monolithic stage of the treatment process, the waste met a limit for LOI of 10% or TOC of 6%.

For monolithic hazardous waste accepted at a hazardous waste landfill (such as those with characteristics of cementations material) the regulations introduce additional leaching limit values together with additional limits for pH, EC, and ANC. Components for the additional values are evaluated using the 64day tank test (NEN 7345). In addition, monolithic hazardous wastes must have a mean unconfined compressive strength of at least 1MPa after 28 days curing. There are further requirements on the dimensions and fracture spacing of the monolith of greater than 400mm.

The regulations allow for the authorised acceptance of specified hazardous wastes with leaching characteristics for inorganic components that exceed those in the regulations by up to 3 times under certain circumstances and at specific landfills. For consideration of acceptance of hazardous waste which exceeds limits for organic components a detailed report is required.

The UK Department of Environment Food and Rural Affairs (DEFRA) has produced specific regulatory guidance for the separation of SNRHW, asbestos and gypsum from other wastes[116].

The category of SNRHW allows waste with a low potential for leaching to be deposited in cells with a lower standard of containment than that required for other hazardous wastes. The Environment Agency for England and Wales has selected the EU directive leachate limit values at L/S = 10 l/kg for granular SNRHW. In addition, granular SNRHW must have an in-situ shear strength of at least 50 kPA for cohesive waste, or an in-situ bearing ratio of at least 5% for non-cohesive waste.

The guidance note sets leaching limit values for Monolithic SNRHW. As with monolithic hazardous wastes, monolithic SNRHW must also have a mean unconfined compressive strength of at least 1MPa after 28 days curing, together with requirements on dimensions of the monolith and fracture spacing.

The Environment Agency for England and Wales considers that monolithic wastes will normally be wastes that have been deliberately treated to solidify them and strongly bond them. These requirements would apply to any monolithic material, whether it has the characteristics of cement or otherwise.

It should be noted that non-hazardous wastes deposited in cells with SNRHW must meet the same criteria and therefore must not biodegrade.

Wastes that are only hazardous because of their asbestos content can be deposited in separate “mono-cells” at non-hazardous waste facilities. In addition to the requirements of the 2003/33/EC directive, the Regulations specify that;

- Once placed the waste must be covered immediately to a depth of at least 250mm;
- Daily cover of 1m thickness; and
- Final top cover of 2m thickness before restoration materials.

The rationale behind the use of “mono-cells” for the disposal of asbestos is to ensure that this waste remains physically separated from the main body of waste at the site and isolated from the landfill gas extraction system.

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[116] http://www.defra.gov.uk/environment/waste/strategy/legislation/landfill/documents/reg-interpret.pdf)

Wastes which contain asbestos plus other hazardous materials must be disposed of at a hazardous waste facility, however, they can be disposed of within a sufficiently contained area, that does not necessarily have to be a separate “mono cell”. Under these circumstances the waste must still be adequately covered using a suitable material, such as contaminated soil and it is advised that the designated area is up gradient of the leachate collection point to limit contamination of leachate with asbestos fibres.

Gypsum wastes and other wastes with a high sulphate content are neither inert nor stable and non-reactive, because they biodegrade. Therefore, they must be separated from biodegradable wastes if disposed at a non-hazardous landfill. If they are classified as hazardous because of other hazardous components, they must be deposited at a hazardous waste facility. The regulations consider gypsum based and other high sulphate bearing wastes to be classified as having more than 10% sulphate in any one load.

The guidance treats underground storage in the same way as other kinds of landfill, except with regard to the waste acceptance criteria. In addition to the list of wastes in Appendix A of Council Directive 2003/33/EC which are excluded from underground storage, the UK guidance advise a site specific risk assessment to determine which remaining wastes are acceptable. Many of the elements of the risk assessment will be the same as for a landfill, but the key differences are;

- A greater emphasis on understanding the geomechanical behaviour of the cavity;
- A better understanding of the deep geology and hydrogeology, and
- A better understanding of environmental impact extending into geological time.

Practical waste acceptance criteria and basic site procedures for handling hazardous waste are also provided in the *Guidelines for Operators of Hazardous Waste Landfills* produced by the Republic of Latvia in 2006[117]. The guidelines provide information on waste acceptance, testing, hazard rating, proper management and disposal, record keeping and reporting.

9.2.7. Monitoring Emissions and Setting Trigger Levels

Potential environmental problems associated with the landfilling of waste are mitigated by engineering and operational controls, and assessed by monitoring. In the absence of environmental monitoring programmes the impact of a landfill on the surrounding environment cannot be assessed.

Standards and practices have however been steadily improving and many new technologies have been adapted or specifically designed using BAT to control and monitor the processes within a landfill. The Landfill Directive sets stringent operational and technical requirements for waste and landfills and provides for measures, procedures and guidance to prevent or reduce negative impacts on the environment and on human health.

Article 12 and 13 of the Landfill Directive requires member states to put in place measures to

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[117] Guidelines for Operators of Hazardous Waste Landfills, LV 2006/IB/EN/01 TL, Republic of Latvia, 2006 – Capacity Building of State Hazardous Waste Management Agency.

ensure that landfill operators follow a monitoring programme, notify the competent authority of any significant adverse environmental effects and return to the competent authority an annual environmental monitoring report.

Annex III of the Landfill Directive refers to monitoring of emissions and protection of groundwater. If surface water is present it shall be monitored at a minimum of two points: one upstream and one downstream from the facility. The directive requires monitoring of groundwater at a minimum of one point in the inflow region and two points in the outflow region. Monitoring of agreed parameters must be carried out before filling operations to establish a baseline then during operations and aftercare at prescribed intervals.

Trigger levels need to be set for groundwater quality based on specific hydrogeological conditions of the landfill site taking into account the direction and velocity of the groundwater flow. Trigger levels should be set which allow the operator to take corrective measures to prevent any significant adverse environmental effects. It is the responsibility of the operator to identify trigger levels based on site investigation for agreement with the competent authority and monitor agreed parameters at prescribed frequencies.

The Waste Management Acts1996-2008, through the Waste Management (Licensing) Regulations and the Local Government (Water Pollution) Act, 1977 and subsequent amendments gives effect to Council Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances. The purpose of the Directive is to eliminate pollution from List I substances and to reduce pollution from List II substances. “Pollution” is the unacceptable impact of a discharge, rather than the discharge itself. Therefore whilst it is feasible, and desirable, to require the prevention of pollution, this is not so for discharges themselves, as described below). The groundwater directive provides a “prevent or limit” approach to the protection of groundwater with the discharge of List I substances (to be replaced by the term “hazardous” substances) to groundwater being prevented.

It is technically difficult to demonstrate that no hazardous substances will enter groundwater. There is always a lower reporting limit for analyses, and predictive probabilistic assessments produce progressively smaller finite numbers with decreasing risk rather than zeros.

The practical interpretation of no discernible discharge is that hazardous substances must not exceed the minimum reporting values (MRVs) at the point of compliance. The presence of any hazardous substances should be environmentally trivial. A large amount of dilution at the water table cannot make a potentially significant hazardous substance loading “not discernible.”

Assessment of necessary measures must be preceded by investigation to determine pathways and is a site-specific judgement. A reasonable measure would be one where the necessary technical precautions to prevent inputs to groundwater are technically feasible, not disproportionately costly and are within the control of the operator. Such measures could include: source control, alteration of discharge mechanism, treatment of the discharge, interception or diversion of contaminated groundwater, and diversion to another disposal route. In addition any measures taken should not result in a net environmental disbenefit. If there is actual pollution, or a substantial risk of such pollution, remedial measures must be taken. Cost-benefit assessment is not a factor in deciding whether to take action in such cases but may be a consideration in determining which precautions will be imposed as conditions on a permit.

In order to prevent pollution and achieve a high degree of environmental protection the use of BAT is recommended such as proper design, effective management and selection of appropriate processes and technologies. The EPA BAT Guidance Notes for the Waste Sector, Landfill Activities, 2008 provides an inventory of potential emissions to air, water, land, noise and vibration and heat, for a hazardous waste landfill, with each potential emission linked to emission limitation and control techniques.

The guidance outline techniques for the prevention and minimisation of emissions to groundwater, soil and air and set out emission levels that are achievable using BAT. Methods are also proposed for the monitoring of emissions from landfill facilities. For all landfill site trigger levels need to be agreed and set for groundwater quality based on specific hydrogeological conditions.

9.2.8. Stability

The need for a landfill to remain physically stable at all stages of development, operation and in the long term is obvious. However, whether a containment design has been developed in consideration of BAT, or on prescriptive requirements, or has been developed on a risk-based approach, the durability of the containment lining and capping systems and the service life of geosynthetic components, such as flexible membrane liners, also depend directly on a number of aspects of stability.

In addition, both the basal subsidence potential and landfilled waste settlement potential are stability issues which may compromise the containment of waste, leachate and waste degradation products. Geological deposits that are known to have or be susceptible to developing karst features such as limestone and calcareous sandstone may present unacceptable risks to the overall stability of the landfill's engineered containment lining systems and through e.g. collapse and disruption of the basal sub-grade and consequently the containment lining system. In addition to these geotechnical engineering issues, karst aquifer's are widely used as a resource but are vulnerable to diffuse and point source pollution.

The presence and extent of, and depth to sub-surface cavities within karst areas is difficult to predict as karst surface features (sinks, sinkholes, dolines etc) may be hidden beneath superficial (quaternary) geological deposits or further below the surface (cavities, caves etc).

Site specific risk assessments to mitigate against the potential failure of lining systems (including basal sub-grade); waste body instability and groundwater pollution will be necessary. A suitable starting point to a staged or phased risk assessment process will be to review publicly available information as held by the Geological Survey of Ireland, including bedrock mapping, their Karst Database and publication *The Karst of Ireland, Limestone Landscapes, Caves and Groundwater Drainage Systems.* Such background information should be used in conjunction with information gathered at the site level from walkover surveys (ideally by a geologist or geoscientist), reviews of historical maps and previous site investigation reports for example.

Similarly, mining history may affect containment landfill stability and integrity and, where applicable, should be investigated. As above, a good starting point will be to review information held by the Geological Survey of Ireland in their Minerals Programme database[118] . However, the seismicity of Ireland is such that correctly designed landfill site formation and containment engineering works are unlikely to be compromised by the scale of seismic event likely to occur.

Stability analysis necessarily forms a major part of the containment landfill design process in which the following elements are assessed:-

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118 http://www.gsi.ie/Programmes/Minerals/Databases

- Relevant natural slopes;
- Basal sub-grade;
- Site formation works;
- Perimeter void slopes;
- Basal lining systems without and with staged placement of waste;
- Perimeter lining systems without and with staged placement of waste;
- Temporary waste slopes;
- Permanent waste slopes and
- Capping and restoration systems.

In practice, stability analysis of the basal lining system without waste present is covered by the analyses applied to the sub-grade and to the perimeter lining systems.

Proven, accurate, numerical methods, which are either computer model or spreadsheet based, are available for the assessment of all relevant aspects of stability of the aforementioned elements, including sub-grade settlement potential and waste settlement potential.

Annex I of the Landfill Directive describes stability requirements of emplaced waste as being in such a way as to ensure stability of the mass of waste and associated structures, particularly in respect of the avoidance of slippages. Where an artificial barrier is established it must be ascertained that the geological substratum, considering the morphology of the landfill, is sufficiently stable to prevent settlement that may cause damage to the barrier.

The BAT Guidance Notes for Landfill, 2008, requires the stability of liner systems during facility preparation and filling with waste to be assessed with regard to: subgrade stability, inter-liner stresses and slip planes in all potential circumstances; liner systems incorporating geosynthetics / geotextiles / geocomposite drainage blankets and their performance under non-ideal circumstances; the effects of varying leachate head, cellular filling and temporary slopes and the effects of variations in waste types and characteristics.

The critical issues for BAT for stability relate to liner failure during construction and operational phases and slippage of waste during operation.

The UK regulations have set strength criteria for granular and monolithic hazardous wastes, as well as granular and monolithic SNRHW as described earlier. These are designed to limit the risk of slippage failure in the emplaced waste body but do not remove the need for waste slope stability and settlement assessments.

9.2.8.1. Stability Risk Assessment for Landfill Development

Stability assessment is part of a risk-based design approach for all of the site formation slopes, lining systems, capping systems, temporary waste slopes and permanent waste slopes which are components of the proposed landfill development. The assessment of related natural slopes should be included. The approach is "risk-based" since the appropriate numerical values for the factors of safety against which the designs are produced should be developed in consideration of risk to life, risk to containment integrity and commercial risk.

On this basis it is appropriate that a formal Stability Risk Assessment is prepared which is made up of the slope stability analyses needed to support the design of each component slope, containment system and related elements such as the sub-grade, the basal lining system and waste slopes. Concise, valid guidance on the structure and overall approach to Stability Risk Assessment for landfills is set out in Environment Agency *Generic Stability Risk Assessment Template*, Environment Agency (March 2003). The stability of the sub-grade is conventionally included in a landfill Stability Risk Assessment but, where they are appropriate, the mining scenario, assessment of seismicity and the numerical prediction of post-capping waste settlement are normally the subjects of separately reported assessments, due to their comparative complexity particularly if geosynthetic components such as flexible membrane liners and geotextiles are included in the containment lining and capping systems.

Conventional rotational and translational slope stability analyses are normally applied to:-

- Relevant natural slopes;
- Site formation works and slopes;
- Perimeter void slopes;
- Basal lining systems with staged placement of waste;
- Perimeter lining systems without and with staged placement of waste;
- Temporary waste slopes;
- Permanent waste slopes and, under certain circumstances,
- Capping and restoration systems.

Multi-layer (veneer) stability analyses are normally applied to:-

- Basal lining systems with staged placement of waste;
- Perimeter lining systems without and with staged placement of waste; and
- Capping and restoration systems,

Some of the most comprehensive review of and guidance on landfill stability analytical methods is presented in Environment Agency Research and Development *Technical Report No. 1 Literature review for the stability of landfill lining systems* (October 2002) together with Environment Agency Research and Development *Technical Report No. 2, Guidance on the stability of landfill lining systems* (January 2003).

Environment Agency (October 2002) describes in detail the multi-layer stability analysis method of Koerner and Hwu (1991) and Environment Agency (January 2003) shows examples of a method developed by Jones and Dixon (1998). Another method which more directly enumerates the contribution of each factor which provides a part of the overall factor of safety against multi-layer failure on any interface is that of Giroud, Williams, Pelte and Beech (1995). It is usually considered appropriate to apply methods such as these to the assessment of multi-layer lining system and multi-layer capping system analysis.

One exception to this advice is the case of the analysis of a multi-layer system which has waste or other materials placed above in a “stockpiled” rather than a “layered” configuration. In this case, it is appropriate to address the analysis of multi-layer stability using Janbu analysis of non-circular slip surfaces, Janbu (1973).

Steep perimeter lining systems may require the analyses of the potential for drag-down failure and strain analysis to determine the magnitude of deflections during construction and landfilling. Geotechnical stain analysis software such as FLAC, Itasca (2005), should be applied to the latter case.

To achieve the planned post-settlement profile for a landfill it is necessary to design a pre-settlement profile which takes account of the post-capping waste settlement which will occur at the site. If, at the design stage, the total post-capping settlement is underestimated, the restoration surface will degrade to a profile which will be below the planned post-settlement profile and this has potential to cause degradation and breach of the capping system, poor surface water drainage, unplanned ponding of water on the restoration surface and the blockage of landfill gas control and collection systems by condensate trapped as a result of unplanned settlement effects.

Settlement due to waste degradation is likely to be limited in a hazardous waste landfill. However, should it prove necessary, accurate predictions of post-capping waste settlement for a particular site can be made by applying numerical post-capping waste settlement modelling based on waste processes, Thomas and Cooke (2007). The input to such modelling must be site-specific waste data in terms of defined waste streams and the corresponding tonnages, rates and duration of waste landfilling in each phase.

9.2.9. Facility Management

As per Article 8 of the landfill directive member states’ competent authorities must take measures to ensure that landfill permits are only issued to an operator who is technically competent to manage the site and that the landfill shall be managed in such a manner that the necessary measures are taken to prevent accidents and limit their consequence. The EPA is the competent authority responsible for the licensing of waste recovery and disposal activities. Prior to the commencement of disposal operations, the EPA shall inspect the site in order to ensure that it complies with the relevant conditions of the permit.

The EPA landfill manual on landfill operational practices[119], describes good practice in operating an landfill facility, covering issues such as; record keeping, staffing, infrastructure, waste emplacement (filling, compaction, phasing, cover and capping), leachate (collection, control and treatment), nuisance control and safety. However, this publication does not distinguish between different types of landfill (hazardous, non-hazardous, and inert). The BAT guidance notes for landfill 2003, outlines

[119] EPA (1997) Landfill Manuals – Landfill Operational Practices.

three key areas for facility management, namely;

- Experience and competent management, as required under The Waste Management Acts 1996- 2008;
- An Environmental Management System (EMS); and
- Accident prevention, as required by the IPPC Directive.

Operators of waste facilities in Ireland are required to attend the FAS Waste Management Training Course which is the recognised training for site operators at manager and deputy manager levels. Internationally recognised qualifications in waste management are provided by the UK Waste Management Industry Training and Advisory Board. This organisation provides training in waste management including a qualification of Certificate in Technical Competence Level 4, Waste Management Operations Managing Landfill Hazardous Waste.

9.3. Summary of containment approaches for landfill

A summary of the different approaches to basic technical containment for hazardous waste landfills in Ireland, the UK and Germany are presented in **Table 45.**

Table 45 Summary of Technical Containment Requirements for Hazardous Waste Landfill

	Landfill Directive	EPA Manual Single Liner (IE)	EPA Manual Double Liner (IE)	EPA BAT (IE)	EA (England and Wales), NIEA and SEPA (UK)	Federal Environment Ministry (DE)
Leachate collection layer	t≥0.5m	t≥0.5m k≥1x10^{-3}m/s	t≥0.5m k≥1x10^{-3}m/s	t≥0.5m k≥1x10^{-3}m/s	t≥0.5m k≥1x10^{-3}m/s	t≥0.5m k≥1x10^{-3}m/s
Artificial sealing liner (geomembrane)	✓	t≥2mm	t≥2mm	✓	✓	t≥2.5mm
Natural mineral layer, or	t≥5m k≤1x10^{-9}m/s	t≥5m k≤1x10^{-9}m/s or	t≥5m k≤1x10^{-9}m/s or	t≥5m k≤1x10^{-9}m/s or	t≥5m k≤1x10^{-9}m/s or	t≥5m k≤1x10^{-9}m/s or
Artificially established mineral layer	t≥0.5m	t≥1.5m, at k≤?	t≥0.5m, at k≤?	t≥0.5m, with equivalence in leakage and risk performance to Landfill Directive Standard	t≥0.5m, at k≤?	t≥0.5m, at k≤1x10^{-10}m/s
leachate detection layer			t≥0.5m k≥1x10^{-3}m/s			
Bottom artificial sealing liner (geomembrane)			t≥2mm			
Bottom mineral layer			t≥4m k≤1x10^{-9}m/s or			

	Landfill Directive	EPA Manual Single Liner (IE)	EPA Manual Double Liner (IE)	EPA BAT (IE)	EA (England and Wales), NIEA and SEPA (UK)	Federal Environment Ministry (DE)
			t≥1m, at k≤?			

Note: An artificially established liner must demonstrate equivalence from leakage control of general risk control perspectives with regards to the Landfill Directive default requirements.

All the approaches to containment adopt the same minimum thickness of 0.5m for the leachate collection layer with a prescribed minimum hydraulic conductivity of $1x10^{-3}$m/s.

The German regulations prescribe a geomembrane of 2.5mm minimum thickness while the EPA manual prescribes a 2mm minimum thickness. The UK approach is more risk based and does not prescribe a minimum thickness.

The Irish, German and UK approaches all provide an option of whether to use a natural clay layer or to use an artificially established mineral layer (such as bentonite enhanced sand). The landfill directive requirements for a natural mineral layer of at least 5m thickness with maximum hydraulic conductivity of $1x10^{-9}$m/s has been adopted in Ireland, Germany and the UK. However, the layer thickness and maximum hydraulic conductivity vary in the case of an artificially established mineral layer. The UK and Ireland follow a risk based approach for the maximum allowable hydraulic conductivity of the artificially established mineral layer, whereas Germany prescribes that this should be a maximum of $1x10^{-10}$m/s.

Germany and the UK follow the directive's requirement for a minimum 0.5m thickness for the artificial mineral layer, while Ireland opt for a higher minimum thickness of 1.5m if using the EPA Manual's single composite liner approach. The EPA's double composite liner uses two mineral layers as well as two artificial seals. Other technical solutions are possible subject to the demonstration of equivalence of BAT.

The risks posed from seepage of contaminants into groundwater are most commonly assessed in Ireland and the UK using probabilistic models which provide quantitative outputs that can be used to assess the performance of a specific landfill design approach with respect to protection of groundwater. In the UK, the Environment Agency for England and Wales funded the development of LandSim2, a hydrogeological risk assessment tool, widely used for landfill design. LandSim2 inputs characteristics of the source-pathway-target and presents the results in terms of the 50%ile and 95%ile maximum retarded contaminant concentration at monitoring well and compliance point locations for a given leakage through the base of the landfill and head acting on the engineered containment system. These results can then be compared to relevant water quality standards and the landfill design altered if necessary.

The site management issues of operating a hazardous waste landfill have been identified and discussed. They are summarised as follows;

- Waste Acceptance Criteria - Council Directive 2003/33/EC sets out criteria for the acceptance of waste at different classes of landfill. These criteria are effectively leaching limit values for prescribed components such as metals, sulphate, DOC, TDS and other acceptance criteria (TOC, pH and ANC). The Directive prescribes leaching limits for the following types of waste accepted at the following classes of landfill;
  - Hazardous landfill accepting granular hazardous waste;
  - Non-hazardous landfill accepting non-hazardous high gypsum content waste; and
  - Non-hazardous landfill accepting SNRHW.

The directive does not prescribe WAC for underground storage, but rather advises that a site specific assessment should be undertaken.

The Environment Agency for England and Wales sets out waste acceptance criteria for hazardous landfills with special provisions relating to;

- SNRHW deposited in landfills for non-hazardous waste, in cells not used for the deposit of biodegradable waste;
- Asbestos wastes;
- Gypsum wastes; and
- Underground storage.

Closure and Aftercare- Annex III of the landfill Directive 1999/31/EC mentions a period of 30 years for which sufficient financial provision must be made for aftercare, however in the case of a hazardous waste landfill the competent authority may require environmental monitoring beyond this period and until the surrender of the site's licence has been accepted. As part of the site's closure a surface sealing system will be required. The EPA landfill design manual recommends that this should consist of a mineral layer of minimum 0.6m thickness with hydraulic conductivity < $1x10^{-9}$m/s in immediate contact with a 1mm HDPE liner;

Stability – The EPA's BAT guidance notes for the waste sector provide a comprehensive list of requirements for assessing stability, especially in relation to interlayer liner stability during construction and operations. Computer modelling programmes such as Slope are typically used to provide quantitative data for assessing the stability risks. There are inherent risks of slippage failure of emplaced waste for certain waste types. The EA for England and Wales sets strength criteria of 50kPa (cohesive) or an in-situ bearing ratio of 5% (non-cohesive) for granular hazardous waste and 1MPa for monolithic hazardous wastes;

Control of Surface and Groundwater Ingress into the Landfill – there are several key directives which refer to the control of surface and groundwater's, namely the Water Framework Directive 2000/60/EC, the Groundwater Directive 2006/118/EC and of course the Landfill Directive 1999/31/EC. At a national level Ireland has the River Basin Management Plans, EPA BAT guidance notes for the waste sector and EPA Design Manual guidance to consider. The common aim of all these directives and guidance is to protect water bodies from pollution.

Monitoring Emissions and Setting Trigger Levels – The Landfill Directive requires trigger levels for environmental monitoring to be set so that operators can take corrective measures to prevent significant adverse environmental effects. The EPA Design Manual for Landfill Monitoring provides a comprehensive guide to setting trigger levels, parameters and monitoring frequencies.

Facility Management – The EPA BAT guidance for landfills outlines the key areas for facility management as having: an experienced and competent management, an Environmental Management System (EMS), and accident prevention.

Nuisances and Hazards - The most likely significant nuisances or hazards arising from a facility for difficult waste will be dust from disposal of incinerator ash or fibres from SNRHW. A comprehensive range of mitigation measures are discussed in the EPA BAT guidance and the EA (England and Wales) WAC.

Leachate Extraction and Treatment – Leachate collects in the base of the cell in an engineered granular layer of prescribed thickness and hydraulic conductivity. It is extracted via vertical extraction towers or side slope risers and piped for storage and treatment. Depending upon the characterisation of the leachate, treatment is likely to be by one of are several physico-chemical processes such as referred to in the Environment Agency (England and Wales) Guidance for the Treatment of Landfill Leachate. The treatment strategies outlined in the EPA BAT Guidance refer to;

- Treatment on-site followed by discharge to watercourse
- Pre-treatment onsite followed by further treatment off-site
- Treatment off-site

The Winsford Rock Salt mine case study offers an illustration of the main elements of the option to store waste underground. The elements covered are; site description, site engineering, WAC, pollution control and post-operation closure.

A Case Study for Underground Storage Option – Winsford Rock Salt Mine in Cheshire, England
This is a facility operated by Minosus Limited for the permanent storage of drummed and contained industrial waste, 170m below ground. The facility utilizes a specific worked-out area of the Winsford Rock Salt Mine for long-term storage of hazardous wastes, taking advantage of the natural barrier provided by the 200 million year old salt deposits between the void space and the biosphere, the stable nature of the mine, its constant temperature, low humidity and absence of groundwater and unwanted gas.
Site Description The facility comprises a 0.6 hectare waste reception facility above ground and an underground storage area of 75 hectares. The total mine area being 6.5 km^2. Rock salt reserves are extensive, and active production is anticipated to continue for 50 to 70 years (from 2001). As part of the Environmental Statement prepared during the planning process a detailed Baseline Geology and Hydrogeology Report was prepared. The Northwich Halite Formation is bounded above and below by low permeability mudstones and marls, and to the east and west by major faults, which leaves the salt workings comparatively dry. The main sources of moisture are condensation from ventilation air and groundwater flow paths from superficial deposits and 'wet' rock-head, which makes its way into the mine via, faulted boundaries, mineshafts and exploratory boreholes. These flows have been successfully stopped by grouting. Permissible wastes accepted at the facility include wastes from thermal processes, inorganic chemical processes, shaping and physical and mechanical surface treatments, incinerated wastes from waste management facilities and waste water treatment plants and construction and demolition wastes including contaminated soils. Wastes delivered to the facility are only accepted in standard steel and plastic drums or standard 1m^3 polypropylene woven bags with polyethylene liners. The maximum quantities of waste accepted are 600 tonnes per day and 75,000 tonnes per annum. The maximum capacity of the facility is 2M m^3 and the planned life of the facility is 20 years (from 2001).
Site Engineering

The facility is comprised of (i) surface buildings for waste reception, handling and operational temporary storage, and (ii) underground storage. These are linked by an underground vehicles route. Only wastes that are compatible with the characteristics and conditions of long term underground storage are permitted at the facility. All wastes are delivered in containers and remain in containers within the underground storage area. Hence, the primary containment system is the drums and bags in which the waste is delivered. Specialist transit capsules are used for the transport of wastes from the surface reception facilities to the underground storage areas. The disposal area comprises existing working areas formed by previous salt mining, which can be used directly following only minor preparatory works. The disposal area s zoned for different waste types.
Waste Acceptance Criteria The waste acceptance criteria follow a series of steps to prevent unsuitable wastes being accepted at the facility. These steps include; Initial screening (e.g. is the waste biodegradable), physical form (e.g. does the waste fail a slump test), Physical properties (does the waste react with moisture or air to produce gas), prohibited hazardous properties (e.g. explosive, infectious), acceptable hazardous properties (e.g. toxic, carcinogenic), third party approval.
Pollution Control The design and operational procedures at the facility are such that leachate or gases requiring a programme of environmental monitoring are not generated. Atmospheric monitoring within the mine is carried out as directed by best practice for mine working and nuisance monitoring of ambient dust is carried out at the surface. Monitoring of dust, fibres and particulates is carried out in operational areas above and below ground for health and safety.
Post-Operation Closure Decommissioning and sealing off the underground storage facility at the end of waste operations will be by the installation of bulkheads in each of the roadways which connect the storage area to the rest of the mine and surface. Two types of bulkheads are proposed. Control bulkheads have no means of access through them and are capable of resisting full hydrostatic pressure from surface level. Precautionary bulk heads have the same capability but with watertight doors built into them for access. Both will be constructed from mass concrete. The concept, involves the adoption of a multi-barrier system within each bulkhead comprising a mechanical barrier, a pressurized saturated brine barrier and a sealing barrier.

9.4. Sustainability Considerations for Landfilling Non-reactive hazardous waste

Sustainability is a complex concept that can mean many things to different audiences. While the term “sustainability” is definitive, realistically in a waste management context it is an objective that is unlikely to be achieved fully; a more accurate term would be “reduced unsustainability”, but “sustainability” has been used in this report to mean a non-absolute term capable of greater or lesser attainment.

Perhaps the most appropriate definition of sustainable development in respect of this project was defined by the UN Brundtland Committee as “*development that meets the needs of today without undermining the capacity of future generations to meet their needs”.* Sustainability can also mean that each generation ensures that what they leave over does not represent a burden to the next in the form of technical or financial burdens.

The EPA encourages the development and introduction of new and innovative technologies and techniques which meet BAT criteria, and look for continuous improvement in the overall environmental performance of a facility's activities as part of sustainable development. The Draft BAT Notes for Landfill 2008, state that in the Irish context, BAT is considered to reference adequate financial provision for at least 50 years. In the case of hazardous waste landfill facilities there is no end date for financial liabilities and aftercare, hazardous waste usually does not degrade or diminish in risk and so the aftercare requirements should be in perpetuity. This interpretation could also apply to non-hazardous waste landfills if the volume of stable non-reactive hazardous waste accepted exceeds10% of overall waste intake per annum.

The key sustainable development objectives for waste and waste management are to:

- Reduce the hazardousness of waste (a concept promoted by the Basel Convention);
- Minimise the amount of waste which is produced;
- Make best use of the waste which is produced; and
- Eliminate the pollution from waste.

The principles of sustainable waste management may be applied at two levels:

- At the strategic planning level, encompassing waste prevention, minimisation, treatment and characteristics, and the planning issues associated with site selection;
- At the site specific level, encompassing the design and control features for the facility.

Together these will determine whether, overall, a planned site meets sustainable development objectives. The term "sustainable landfilling" could therefore be described in a broad sense as a landfill that minimises its long-term management obligations, both in extent and complexity.

In the context of hazardous waste landfills, the material to be deposited is principally the by-product of a treatment process, and therefore the result of processes higher up the waste hierarchy. For the material to be acceptable for landfill it must meet the Waste Acceptance Criteria for the appropriate class of landfill. Where the treatment process is one of stabilisation or solidification the material landfilled is likely to present a reduced hazard in terms of availability and mobility of species of concern, but remains hazardous by definition as it originated.

The technical requirements of the construction, filling and capping of landfills then further limit the emissions to the local environment to an acceptable level. The key issues with sustainability of landfills are emissions and emission control. For sustainability of a hazardous waste or SNRHW landfill, the combination of material type, technical engineering measures and site characteristics should be such as to:

- Reduce the level of hazard remaining in the deposited material;
- Limit the "worst-case" probable emissions to those acceptable in the local environment over a long timescale;
- Considering the potential failure of synthetic liner elements of the basal lining system; and
- Considering long-term leaching behaviour of the deposited material;

Where possible, providing passive, gravity-based systems for the control of surface water, groundwater where appropriate, leachate, and any gas; such that long-term maintenance obligations are small, and stable in the immediate environment and does not pose a threat or cause any unacceptable emission.

9.4.1. Identifying Sustainability Considerations

Landfill practice has evolved over the past 30 years generally to incorporate engineered containment of the wastes to minimise rainfall ingress into the wastes, to restrict the generation of landfill leachate and minimise its depth and the associated risk to local water resources. With this approach, degradation of the wastes can be very slow, taking possibly hundreds of years before it no longer represents any form of hazard.

In the context of development of a hazardous waste landfill or a SNRHW the first consideration in designing a sustainable landfill would be to ensure the waste being accepted is the product of pre-treatment and that suitable controls systems are incorporated to reduce impact on future generations.

On sustainability of placing stable non-reactive hazardous waste in cells at non-hazardous sites, the key issues are the long term aftercare of such facilities and the ability to surrender the licence. Potentially the disposal of SNRHW at non-hazardous landfills could also increase the number of sites for which long term aftercare would be needed.

Another consideration is the issue of the obligations being passed on to future generations, therefore management controls post-closure should be small, passive, and non-critical. This might include no pumped groundwater controls and leachate to be minimised by comprehensive cap. There should be no gas emissions from SNRHW.

10. POTENTIAL FOR ALL-IRELAND MEASURES

10.1. Introduction

It is recognised by both jurisdictions that by creating an all-island waste market, both jurisdictions may benefit from increased competition, reduced waste management costs and improved reliability of service, although the economic gains may be variable in different regions in both jurisdictions. The viability of an all-island approach will vary depending on the quantities and types of waste being considered. This study has considered the potential for a NaDWaF providing an all-island solution for the landfilling of hazardous waste. Consideration has be given to the policy perspective and the implications for the viability of a NaDWaF, in order to identify the merits, barriers and demerits related to the provision of hazardous waste landfill capacity through a NaDWaF.

10.2. Policy Context

The development of an all island hazardous waste disposal facility is supported in various documents produced by government departments in both Ireland and Northern Ireland, these are summarised below:

- Statement of Facility Needs for Hazardous Waste in Northern Ireland (2005), EHS: "Northern Ireland generates less than 10% of the total hazardous waste arisings on the island of Ireland, while the Republic of Ireland exports between 60-80% of its hazardous wastes. Exploring the potential for all-island solutions would appear to make sense from the point of view of both North and South." (

- National Hazardous Waste Management Plan 2008-2012 (2008) EPA: "There are potentially considerable economies of scale to be achieved through full opening of the Northern Ireland and Republic of Ireland waste markets."

- Common Hazardous Waste Chapter (2006) in Northern Ireland Waste Management Plans[120]. The (Hazardous Waste Management) Forum advocates the implementation of the recommendations in the draft review of the UK Management Plan on the Export and Import of Waste, to enable all island solutions for both recovery and disposal operations to be implemented, where these are in accordance with the sub-regional Waste Management Plans."

- Comprehensive Study on the All-Island Economy (2006) InterTrade Ireland: "The provision of essential infrastructure such as water supply and waste management will be needed to support sustainable economic development and enhance business competitiveness on the island."

- National Development Plan 2007-2013 (2007) Department of the Environment and Local Government: "The Government will be pursuing co-operation with Northern authorities in the development of the [National Development] Plan's environmental services programme in the areas of water supply, waste water, waste management and climate change."

In relation to spatial planning across the island, the Northern Ireland Regional Development

[120] Arc21 Waste Management Plan, Southern Waste Management Partnership Waste Management Plan, North West Region Waste Management Group Waste Management Plan.

Strategy (RDS) *Shaping Our Future* was published by the Department of the Environment in 2001. This preceded the publication of the National Spatial Strategy (NSS) in Ireland in 2002 and as such it was possible to involve a key member of the team responsible for the preparation of the RDS on the expert advisory group supporting the preparation of the NSS. This has resulted in a significant consistency in the approach across the two documents and the Governments have in place a solid basis for planning for future spatial development of the island. A new collaborative spatial planning framework is being produced which will ensure infrastructure providers understand what the strategic development objectives are for the island of Ireland.

In addition, an all island facility is supported by the waste planning groups in Northern Ireland, arc21, SWAMP and NWRWMG. Each of these groups is a collection of a number of local authorities for the purposes of waste planning. Each has produced its own Waste Management Plan for the management of municipal wastes for the period up to 2020. The Groups made a decision in the production of these Plans, to prepare a common chapter on Hazardous Waste and as such all three groups have a common approach to the management of hazardous wastes, including the consideration of the benefits of an all-island facility. The Department of the Environment for Northern Ireland has recently consulted on a proposed Waste Bill which includes for amendments in legislation to allow for the development of a Single Waste Disposal Authority in Northern Island. If this is adopted, it is likely that a National Waste Management Plan will be prepared for Northern Ireland.

In Ireland, hazardous waste management planning is the responsibility of the EPA and the framework for development is provided for by the National Hazardous Waste Management Plan 2008-2012. In relation to all island solutions, the Plan recommends that proposals for hazardous waste disposal infrastructure, including landfills and other large scale infrastructure such as incinerators and alternative treatment installations, should take all-island considerations into account for capacity planning purposes.

These documents highlight that at a national/regional level the principle of an all-island facility has been accepted.

10.3. Viability Implications

Chapter 5 highlights that in 2007 12,337 tonnes of hazardous waste was exported to landfill from Northern Ireland to England, and that in 2008 the quantity decreased significantly to 6,070 tonnes. This volume is generally considered to be too low to justify the development of a disposal/treatment facility in Northern Ireland. This additional volume could increase the viability of an all island solution. However when these quantities are compared with the estimated future capacity need of approximately 200,000 tonnes per annum (based on the Baseline Prediction Model, see **Chapter 8**), it would suggest that viability of a NaDWaF is not critically dependant on the received hazardous waste from Northern Ireland.

The inclusion of such waste could help to strengthen the business case for a NaDWaF, although any business case should not rely on the hazardous waste from Northern Ireland, as waste producers in Northern Ireland would be able to decide to send their waste to a NaDWaF or to appropriate facilities in the UK. Such decisions are likely to be dependent on the cost, and while the transport costs are likely to be lower for a NaDWaF, the gate fee and landfill tax will clearly influence the total cost.

As with the arisings in Ireland, hazardous waste arisings in Northern Ireland from future waste treatment facilities could increase the quantity of waste suitable for disposal at a NaDWaF. Depending on the waste treatment facilities developed, the quantity of hazardous waste suitable for a NaDWaF could increase to around 40,000 tonnes per annum (Statement of Facility Needs). This could increase the viability of an all island solution but again the decision to use a NaDWaF will generally be an economic decision made by the waste producers and subject to the waste hierarchy.

It should also be noted that the estimated capacity need could be significantly affected by assumption on the quantity of contaminated land and the treatment of flue gas cleaning residues. As highlighted in **Chapter 8** the capacity need could reduce to below 100,000 tonnes per annum, at which point the Northern Ireland arisings could have a greater impact on the viability of a NaDWaF.

10.4. Benefits, Barriers and Disbenefits of an all-island solution

10.4.1. Benefits

The Comprehensive Study on an all-island Economy discusses the benefits of all-island collaboration, which are obviously dependent on the area of collaboration. Those identified for an all-island waste facility have been used to identify the benefits of an all-island solution with respect to a NaDWaF:

- New markets - the development of a hazardous waste treatment and/or disposal facility will open up markets in the waste management industry which are currently unavailable to either Northern Ireland or Ireland. This would include hazardous waste collection opportunities, delivering waste to the facility, additional waste transfer stations expanding on the services currently provided by the waste management industry on the island of Ireland.

- Economies of scale – the provision of a single treatment/disposal facility, while requiring greater capacity to accept waste from the North as well as the South, is likely to generate economies of scale on the cost of treatment per tonne, as the overall capital cost is recovered more quickly by the acceptance of more waste. This would require more detailed modelling to fully understand what these economies might be and will be highly dependent on the facility type, the technology proposed and the location of the facility (as transport costs could outweigh reduced gate fees).

- Proximity principle – the Waste Framework Directive advocates that waste should be disposed of or otherwise managed as close as possible to the location it is generated. An all-island facility could reduce the transport of waste to GB and other locations. However the fully benefits can only be determined once potential sites are identified, as if a NaDWaF was developed in the south-west of Ireland the proximity consideration for hazardous waste from Northern Ireland would be different when compared to a centrally located facility.

- Reduced transport costs/emissions – this would need to be fully modelled to identify savings, and will be highly dependent on the location of the facility and the mode of transport. Currently wastes are transported to the ports for export to Great Britain and other locations and a well sited facility could reduce the road transport costs and thus carbon emissions associated with the management and disposal of hazardous wastes.

An additional benefit would be a potential reduction in the number of facilities that need long-term aftercare. However as arisings in Northern Ireland are likely to be too low to justify the development of a disposal/treatment facility in Northern Ireland, waste from Northern Ireland would be managed at existing facilities in the UK, could mean this benefit would not be realised.

10.4.2. Barriers

A study[121] undertaken by PWC on regulatory barriers to trade on behalf of InterTrade Ireland reported the following general barriers experienced by businesses operating in both jurisdictions:

- Access to information and signposting;
- VAT-related issues;
- Other tax and insurance related issues;
- Exchange rates and pricing;
- Repetition and duplication of data requirements; and
- Recognition of accreditations and qualifications.

While these barriers are not specific to the movement of hazardous wastes, they are likely to just as much apply to waste management trade and dissuade organizations from pursuing business operations across both countries.

10.4.2.1. Waste Shipment Cost

The UK Plan for the Shipments of Waste[122] now specifically allows for the shipments of hazardous waste between Northern Ireland and Ireland for the purposes of landfill disposal, incineration on land and treatment prior to disposal by either of the above means. The type of facility developed would require to be in accordance with the Import and Export Plan in order for an all-island facility to be feasible.

However, imports and exports of waste are governed by the Transfrontier Shipment of Waste Regulations 2007 in Northern Ireland and by the Waste Management (Shipments of Waste) Regulations in Ireland. These regulatory instruments make provision for the notification of the competent authority (EPA and NIEA) for all hazardous transboundary shipments of disposal. The costs associated with the notification process could increase the treatment/disposal costs of moving wastes from Northern Ireland to Ireland, as opposed to the current practice of exporting for Northern Ireland to Great Britain. This would have to be modelled to establish whether the cost of the notification fees combined with the transportation cost (which are location dependent) and the gate fees and taxes is more or less than the shipping costs to Great Britain.

A fee is associated with this notification process, currently £450 notification fee and £25 for each shipment in Northern Ireland and an annual fee of €250-600 plus a tonnage fee of €0.30-2.50 per tonne in Ireland. In addition there is a requirement for shipments of waste to have insurance to cover the cost of any mismanagement or illegal disposal, the cost of this insurance would add to the overall cost.

However each movement of hazardous waste is subject to a consignment fee within each country

[121] InterTrade Ireland (2009) Regulatory Barriers to Cross Border Trade .

[122] UK Department for Environment, Food and Rural Affairs (Defra) (2007) UK Plan for the Shipments of Waste.

and this would need to be factored in to the overall cost assessment. In Northern Ireland this fee is £10-24 per consignment, depending on the waste type and the system is administered by the NIEA. In Ireland the Waste Management (Movement of Hazardous Waste) Regulations[123] provide for a consignment note system for movement of waste within or through Ireland which is administered by the local authorities. Fees for consignment notes range across local authorities but are in the range €6-25 per movement. In 2007, Dublin City Council became the designated competent authority in respect of the import of waste into or from Ireland under the 2007 Waste Management (Shipment of Waste) Regulations[124] and therefore all transfrontier shipments of waste originating in any local authority area in Ireland, that are subject to the prior written notification procedures must be notified to and through Dublin City Council at the National TFS Office. The TFS office charge an annual administration fixed fee of €500 for Amber waste and €250 for Green waste, a tonnage fee also applies of €2.50 for Amber waste and €0.60 for Green waste. Transfrontier shipment to an all-island facility would benefit from harmonising of systems.

10.4.2.2. Public Acceptability

The social impacts of a NaDWaF are discussed in detail in **Chapter 14**, however public acceptability could be a significant in relation to an all-island facility. Gaining public acceptance for any waste management facility, in Ireland, can be very difficult and this is often compounded when a facility accepts hazardous waste. Therefore gaining public acceptance for a facility that accepts hazardous waste from Northern Ireland is likely even more problematic.

Equally if a NaDWaF was located in Northern Ireland, it would also be difficult to obtain public acceptance, particularly as the majority of waste would be imported from Ireland.

10.5. Disbenefits

The main disbenefit of a NaDWaF would be the perceived or actually disbenefits to any host community, although such disbenefits would be more associated with the NaDWaF itself as opposed to the fact that a small proportion of the input arose in Northern Ireland. Attitudes towards a NaDWaF are highly likely to negative with concerns about social well-being and health being prominent and such concerns would need to be mitigated from the outset. The social impacts of a NaDWaF are discussed in detail in **Chapter 14.**

10.6. Conclusions

The regulatory framework allows for the movement of hazardous wastes between the jurisdictions, but this limited to landfill disposal, incineration on land and treatment prior to disposal by either method. The acceptance of waste from Northern Ireland could increase the viability of an all island solution. However based the estimated future capacity need it would suggest that viability of a NaDWaF is not critically dependant on the received hazardous waste from Northern Ireland. While the inclusion of such waste could help to strengthen the business case for a NaDWaF, any business case should not rely on the hazardous waste from Northern Ireland, as waste producers in Northern Ireland would be able to decide to send their waste to a NaDWaF or to appropriate facilities in the UK. An export ban, in support of an all island facility, for wastes originating in Northern Ireland wanting to go to UK is unlikely.

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[123] S.I. No. 147 of 1998.

[124] S.I. No 419 of 2007.

The main barriers to an all-island solution are:

- Financial (both the disposal cost and the waste shipment costs), although these can only be examined in detail when potential locations for a NaDWaF are known; and .

- Public acceptability, although any disbenefits would be more associated with the NaDWaF itself as opposed to the fact that a small proportion of the input arose in Northern Ireland.

11. SITE SELECTION

11.1. Introduction

The site selection process is required to be robust from the onset, employing a set of criteria and appropriate decision making tools (either qualitative or quantitative or a combination of the two) as planning strategies and development decisions are scrutinised far more on site specific issues by the public and relevant authorities.

In terms of hazardous or difficult waste the process is different to municipal waste planning as there is no legal requirement by local authorities to plan locally for hazardous waste management. Most hazardous waste facilities are located in terms of national need. The objective of this study is to identify the specifics of this need for hazardous waste treatment and landfill, the site selection process therefore must take account of;

- **Strategic Positioning** – what optimum location in terms of a region or national presence;
- **Need** - Is there a demonstrable need both in Ireland and Northern Ireland?;
- **Alternatives** - Is there a robust set of criteria which will allow for a comparative assessment of potential sites and technology options?; and
- **Adherence to Policy** - Does the type, scale and design of a NaDWaF comply with local, regional and national policy and guidance?

When the need has been established the first stage is to exclude areas that are considered unsuitable for landfill, before progressing with the site selection. After considering the need issues, several key criteria groupings can be used from which individual criteria can be developed such as;

- **Geology** - taking advantage of favourable environmental geomorphological features and thus reducing the importance of these criteria in the site selection process. Especially landfill disposal of hazardous waste in terms of slope stability and risk of erosion;
- **Climatic Considerations** - Temperature, prevailing wind direction , precipitation;
- **Other Potential Environmental Impacts** - Noise, ecology, landscape visual, archaeology, ground and surface water contamination, local amenity, transport and health;
- **Land use Constraints** - Local, regional and national designations; and
- **National Policy Adherence** - Proximity principle, reducing waste miles.

11.2. Regional and Local Policy

11.2.1. Planning Policy

The selection of sites must have regard to the existing planning framework in Ireland and consideration should be given to how any proposals will relate to existing planning policy designations and policy statement. For example, whether sites are allocated as green belt or areas or allocated for other types of development such as mineral extraction, housing, industry or recreation. The key reference documents are:

- Irish National Spatial Strategy;
- County, City and Local Area Development Plans;
- National Hazardous Waste Management Plan; and
- Regional Waste Plans.

It may be useful to consider development contribution opportunities under Section 48 of the Planning and Development Act 2000, the Strategic Infrastructure Act 2006 or planning agreements under Section 40 of the Planning (NI) Order 1991, and the social and economic benefits that may be generated from the development of particular sites.

11.2.1.1. National Spatial Strategy

The National Spatial Strategy (NSS) 2002-2020[125] in Ireland provides a 20 year framework for national planning to guide policies, programmes and investment. It aims to achieve more balanced development within a well-planned spatial structure. Effective waste management infrastructure is identified as essential to achieving the aims of the Strategy. Substantial progress has been made at national level in implementing the Strategy, which is having an increasing influence on policies and programmes across a number of Government Departments and agencies, including:

- **The National Development Plan (NDP) 2007-2013**[126] which aligns the Strategy centrally within it through a specific chapter on balanced regional development. The National Spatial Strategy has been a key influence on the National Development Plan 2007-2013 which is Ireland's €184 billion investment plan, integrating strategic development frameworks for regional development, rural communities, all-island co-operation and protection of the environment with common economic and social goals. The Plan provides for €750 million investment in waste management, however facilities for the treatment or disposal of hazardous wastes are not specifically targeted. The NDP Annual Report 2007[127]provides an update on the implementation of the NDP in 2007. It makes no reference to the management of hazardous wastes.

- **A Gateway Innovation Fund (GIF)** provided for in the NDP 2007-2013 which aims to enhance the growth of the 9 gateway cities and towns identified under the NSS. An initial exchequer allocation of €300m was provided through the Fund to operate initially on a pilot basis for the period 2008-2010. Under the management of the Department of Environment, Heritage and Local Government, a detailed scheme for the operation of the new Fund was to be produced.

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125 The National Spatial Strategy for Ireland 2002-2020 (2002) Department of the Environment, Heritage and Local Government, The Stationary Office [http://www.irishspatialstrategy.ie/pdfs/Completea.pdf]

126 The National Development Plan 2007-2013 (2007) Irish Government The Stationary Office [http://www.ndp.ie/documents/ndp2007-2013/NDP-2007-2013-English.pdf]

127 National Development Plan Annual Report 2007 (2007) Irish Government The Stationary Office [http://www.ndp.ie/documents/publications/annual/NDP_AnnualReport2007.pdf]

- At Regional level, a key policy bridge between national development priorities and local planning has been put in place with the adoption in mid 2004 of **Regional Planning Guidelines (RPG's**). There are 8 Regional Authorities in Ireland whose functions include the preparation of Regional Planning Guidelines (RPGs). Regional authorities must take account of the NSS including any updates when preparing and making regional planning guidelines. The guidelines address waste management at a regional level and are the framework within which county, city, town and local area development plans are made.

- At County and City level, **Integrated Planning Frameworks** are in place for almost all gateways.

11.2.1.2. Shaping Our Future

In Northern Ireland the Regional Development Strategy (RDS)[128]) aims to provide a strategic and long-term perspective on the North's future development up to the year 2025. It provides a spatial framework for action to influence the future distribution of activities throughout Northern Ireland. The RDS addresses a range of social, environmental and community issues, which are relevant to delivering the objectives of achieving sustainable development and social cohesion in Northern Ireland.

The document contains a number of Strategic Planning Guidelines (SPGs) which set out the spatial framework. Under SPG ENV 5 "*To respond to the implications of climate change and promote more prudent and efficient use of energy and resources, and effective waste management"* In 2008, the first five year review of the Strategy was published[129] which revised SPG ENV 5 in line with current legislation and policy related to waste management:

"*ENV 5.4 Promote a Waste Management Strategy for Northern Ireland:*

- *Work in partnership with industry and other stakeholders to create an economy based on sustainable waste management practices, assessing potential climate impacts, sites at risk and options for effective planning;*

- *Provide an integrated network of recycling and composting, recovery, treatment and landfill facilities to meet identified waste management needs;*

- *Locate waste management facilities convenient to major centres of waste production and key transport corridors, to minimize environmental impacts on residential neighbourhoods and tranquil rural areas; and*

- *Supporting and influencing opportunities for reducing the amount of waste generated."*

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[128] Shaping our Future: Regional Development Strategy for Northern Ireland 2025 (2001) Department for Regional Development, Corporate Document Services, Belfast [http://applications.drdni.gov.uk/publications/document.asp?docid=5567]

[129] Shaping Our Future: Adjustments to the Regional Development Strategy 2025 (2008) Department for Regional Development, Corporate Document Services, Belfast [http://www.drdni.gov.uk/rds_adjustments.pdf]

11.2.1.3. Planning Guidance

The Department of the Environment, Heritage and Local Government produces a number of Planning Guidelines to help planning authorities, developers and the general public. Planning authorities are required to have regard to these guidelines in the performance of their functions. Guidance in relation to the development of a hazardous waste facility includes:

- Landscape and Landscape Assessment;
- Environmental Impact Assessment;
- Development Management Guidelines; and
- The Planning System and Flood Risk Management;

In Northern Ireland, planning guidance is provided in the form of Planning Policy Statements. Planning Policy Statements set out the policies of the Department of the Environment on particular aspects of land-use planning and apply to the whole of Northern Ireland. Their contents will be taken into account in preparing development plans and are also material to decisions on individual planning applications and appeals.

Development Plans

In Ireland, the Development Plan is the main instrument for regulation and control of development at the county level. It sets out a vision and an overall strategy for the proper planning and sustainable development for the county for a six-year period. It also sets out guiding policies and objectives for the development of the area in terms of physical growth and renewal, economic, social and cultural activity, and environmental protection and enhancement. The Plan must take account of various national and regional strategies and guidelines. All planning applications are measured against the development plan and planning permission will normally only be given where the application is in accordance with the plan. Local Area Plans are prepared for specific towns and areas within the remit of the planning authority.

In Northern Ireland development plans apply the regional policies of the Department of the Environment at the appropriate local level and inform the general public, statutory authorities, developers and other interested bodies of the policy framework and land use proposals that will be used to guide development decisions within their local area.

Planning

In Northern Ireland, development control is the responsibility of the Planning Service, an agency within the Department of the Environment, in accordance with the Planning (NI) Order 1991. The Review of Public Administration, scheduled to take place in 2011, will transfer this function to local authorities, except in the case of strategic planning proposals, which will continue to be determined by the Strategic Projects Unit within Planning Service. Strategically important planning applications may avail of the formalised Pre Application Discussion (PAD) process, which aims to identify potential problems early in the process to improve the prospects of reaching a decision quickly.

In Ireland, development control is the responsibility of the local authority, in accordance with the Planning and Development Act 2000. Decisions may be subject to independent review by An Bord Pleanála. However, categories of development deemed to be Strategic Infrastructure

Development are subject to a specialised application procedure which requires the application to be made directly to An Bord Pleanála rather than the local planning authority, under the Planning and Development (Strategic Infrastructure) Act 2006. The Act eliminates the requirement for projects to obtain local authority approval in the first instance, thus potentially reducing the time for decisions to be made.

Waste Management Planning

Regional Waste Management Plans

The management of municipal and other waste in Ireland is provided for in the Regional Waste Management Plans prepared by local authorities in both Ireland and Northern Ireland. The regional waste plans, once made, become a subset of the development plans. There are thirteen waste plans on the Island of Ireland, three in Northern and ten in Ireland, as described in **Table 46** below.

Table 46 Regional Waste Management Groups

Ireland	Northern Ireland
Dublin Region	Arc21 (Antrim, Ards, Ballymena, Belfast, Carrickfergus, Castlereagh, Down, Larne, Lisburn, Newtownabbey and North Down councils)
Cork Region (Cork City and County)	SWaMP (Armagh, Banbridge, Cookstown, Craigavon, Dungannon and South Tyrone, Fermanagh, Newry and Mourne and Omagh councils)
Connaught Region (Galway City and County, Leitrim, Mayo, Roscommon and Sligo)	NWRWMG (Ballymoney, Coleraine, Derry, Limavady, Magherafelt, Moyle and Strabane councils)
South East Region (Waterford City and County, Carlow, Kilkenny, South Tipperary, Waterford and Wexford)	
Clare/Kerry/Limerick Region	
North East Region (Cavan, Louth, Meath, Monaghan)	
Midlands Region (Laois, Longford, North Tipperary, Offaly and Westmeath)	
Donegal	
Kildare	
Wicklow	

Many stakeholders in the waste sector in Ireland have expressed views that the waste plans have had no benefit for the management of waste, but have perhaps hindered inter regional co-operation and even inter county co-operation within waste regions. The City and County Managers Association (CCMA) produced a position paper on waste management in 2007[130] which highlighted the need for national co-ordination. The paper states that, "*It may also be the case that over-reliance on the regional structure tends to inhibit the planned development of strategic infrastructure for the country as a whole*". The CCMA is of the view that there is a strong need emerging for national co-ordination, both in the framing of sustainable policy and in the

[130] CCMA (2007) The Local Authority Perspective on the Realities of Irish Waste Management, a Position Paper Presented by the City and County Managers' Association, 23rd April 2007.

development of the necessary infrastructure across the region.

Some, however, suggested that the RWMPs should simply be cast aside in favour of a national waste board, or waste management authority. In Northern Ireland proposals for a Single Waste Disposal Authority are currently the subject of public consultation and are likely to form part of the local government reforms planned for 2011.

National Hazardous Waste Management Planning

Hazardous waste management is provided for in the National Hazardous Waste Plan prepared by the EPA. Hazardous waste is not considered in the regional waste plans.

The Waste Management Strategy for Northern Ireland[131], published in March 2000, identified the need to minimise the quantity of hazardous waste that is produced and reduce the hazardous nature of wastes. The three sub-regional Waste Management Plans, adopted by the District Councils in January 2003, proposed that a working group be established to identify the preferred hazardous waste management solutions for the longer term. The NIEA (then Environment and Heritage Service), in support of this proposal, agreed to facilitate the establishment of a Hazardous Waste Forum in Northern Ireland, bringing together key stakeholders to advise on a way forward for hazardous waste reduction, recovery and management. The Forum published *Hazardous Waste In Northern Ireland, An Action Plan for its Environmentally Sound Management in 2004*[132]

One of the four objectives of the action plan is:

"To ensure the provision of the hazardous waste management facilities required to meet the new legislative requirements. A particular concern is to ensure that adequate capacity is available in the short to medium term, during the initial transitional period following the end of co-disposal and the introduction of newly defined hazardous wastes.

In response to the recommendations of the action plan the Department of the Environment produced a statement of Facility Needs[133] in 2005 which identified the facilities to be provided and the opportunities for all-island collaboration in the management of hazardous wastes.

11.3. Site Selection Criteria

In selecting a suitable site for a hazardous waste facility, it is important that a transparent and clear structured procedure is developed to allow fair and objective selection of sites in accordance with the 1998 Aarhus Convention[134] . The siting of a facility requires the public to understand the need, the containment and the operation of a facility. An important part of the process is the development of site selection criteria based on key environmental criteria identified from the section above. In producing criteria and scoring for site selection consideration has been given to IPPC Directive (Annex V Public Participation in decision making), the Landfill Directive (Annex 1 – General

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[131] Department of the Environment (2000) Waste Management Strategy for Northern Ireland.

[132] Northern Ireland Hazardous waste Forum (2004) Hazardous Waste In Northern Ireland, An Action Plan for its Environmentally Sound Management, s.n.

[133] Department of the Environment (2005) Statement of Facility Needs for Hazardous Wastes in Northern Ireland.

[134] UNECE (2001) Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention).

Requirements for all classes of landfill) the EPA's Draft Landfill Manual on Site Selection[135] and the Northern Ireland Department of the Environment's Planning Policy Statement[136]. As there currently no commercial hazardous landfills in Ireland the EPA manual is focused primarily on non-hazardous and inert landfills, and while the manual provides some guidance relevant for hazardous landfill, the World Health Organisation's Site Selection Criteria for New Hazardous Waste Facilities[137], have also been considered.

Site selection criteria should also address existing site conditions, planning policy, land availability and commercial matters such as proximity to waste arisings and accessibility.

In assessing areas for development, each selection criteria should be assigned a "score" based on the potential impact a hazardous waste facility may produce. Alternative ways of measuring sites against the site-specific objectives are available, but could be considered less appropriate. In particular, quantitative scoring methods (where a score is given to each objective) do not encourage an expert planning and environmental decision to be taken in relation to both individual criterion and the cumulative site evaluation. This results in scores for each location being added up and compared between locations to define the most appropriate sites. This approach is considered to be flawed as individual significant effects that might preclude development have the potential of being lost within the overall score.

The following scoring system can be used:

- Positive - Placing a facility in this location would have a positive impact in relation to the criterion;
- Neutral - placing a facility in this location would be neutral (neither overtly positive or negative) in relation to the criterion;
- Minor Negative - placing a facility in this location would be negative but not insurmountable in relation to the criterion; and
- Major Negative - Placing a facility in this location would be highly undesirable in relation to the criterion.

The scoring can then be used to assess the suitability of a site or a comparison of several sites. Detailed information on each of the criteria is detailed below.

11.3.1. Land Use Constraints

The existing land use of the site and its surrounds will be a material consideration. It will be necessary to consult the relevant County Development Plan to establish the land use zoning which may be residential, agricultural, commercial or of high amenity value.

Typically, new sites for waste management facilities should not be sited close to residential areas

[135] EPA (2006) Manual on Site Selection Draft for Consultation.

[136] Department of the Environment (2002) Planning Policy Statement 11 Planning and Waste Management.

[137] World Health Organisation (1993) Site Selection Criteria for New Hazardous Waste Facilities, WHO Regional Publications.

due to intrinsic residential amenity concerns associated with such operations. However, amenity concerns need to be balanced with the requirements of the proximity principle which states that where practicable waste should be treated in an environmentally sound manner as close to the source of waste generation as possible. Similarly proposed waste management facilities should not have a detrimental effect on the existing economic use of the land. For example, sites on the best and most versatile agricultural land and areas containing valuable mineral resources should be avoided.

11.3.2. Accessibility

In identifying potential locations for waste related developments and in assessing potential sites, regard must be given to the degree to which the site's accessibility is suitable. The impact of the site on the transportation network and the suitability of its access will be related to the following:

- Access to the site must conform to the relevant Department of Transport, National Roads Authority and Department of Transportation standards and have regard to issues such as visibility;
- Approach roads and their current or proposed character and width must be suitable to accommodate the proposed development;
- Accessibility of the site to the primary road network and motorways;
- Accessibility of the site to modes of transport other than road, including railway lines.

The accessibility of a site also needs to be considered with respect to the effect of using the local road infrastructure on residential amenity and site neighbours.

11.3.3. Waste Arisings

The proximity of a potential site to hazardous waste arisings likely to require treatment or disposal is a key consideration both in identifying potential sites and in assessing their suitability for development for waste related purposes. Locating a site close to a source of waste arisings is related to the objectives of the "Proximity Principle", which together with the concept of regional self-sufficiency is central to the waste management concepts identified in the waste framework directives.

11.3.4. Geology and Soils

Landfills should not generally be located in geologically unstable areas such as areas underlain by karstified limestone, unstable or weak soils, those with potential for subsidence and saturated soils. The EPA's *Draft Site Selection Manual*[138] recommends that landfills should, where possible, not be placed on "regionally important aquifers" of high vulnerability rating as defined by category R4 areas with high value aquifers of significant or potential use under the Geological Survey of Ireland Guidelines..

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[138] EPA (2006) Manual on Site Selection, Draft for Consultation.

In addition to these, geologically inferior areas requiring excessive site engineering works to protect the environment from contamination may be prohibitively expensive. The natural geology of an area can actually contribute towards reducing or mitigating the environmental risk associated with waste facilities and this should be considered in assessing sites.

11.3.5. Landscape and Visual

Landscape constraint areas include areas those being of distinctive character and/or special scenic value. Specifically these include:

Ireland	Northern Ireland
Special scenic landscapes Areas of visual quality Landscape conservation area	Areas of Outstanding Natural Beauty Local Landscape Policy Areas

Assessment of visual impact needs to consider the proposed site when viewed from main transport routes and sensitive public vantage points. Visual impact should be assessed against the nature of the local landscape and how any new structure or landform created by a waste management facility would integrate into the local landscape. It is also appropriate to consider both short and long distance views of the site and the effect hedgerows and other features may have in limiting views of the site. In considering the potential impacts of a waste management facility on landscape character and visual impact it is appropriate to consider the following:

- Effects on the local landscape character, urban setting of the built development/massing and lighting of buildings;
- Interruption of the existing use and introduction of new use and activity;
- Disturbance and removal of habitat and landscape features such as trees and hedgerows, which contribute to the landscape of the site and/or area;
- Loss of integrity of long established habitats and features and/or loss of locally individual features;
- Potential damage to existing landscape features, for example at access points to the site and along public roads;
- Loss of the existing landform;
- Introduction of alien features into the landscape, such as buildings and mitigation measures; and
- Removal of existing vegetation cover.

11.3.6. Nature conservation

Nature conservation constraint areas studies should consider:

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

In addition, impact on non-statutory sites including sites of local conservation importance, woodlands and countryside parks should also be considered. All these areas are considered key constraints on account of the importance attached to them by planning policies contained within the relevant development plans. It should also be noted that individual flora and fauna species also benefit from statutory protection and that these will often be found outside protected areas. Such species can only be confirmed from assessments on a site by site basis. The main effects to ecology are likely to occur during the preparation and construction of the site/facility, although there may also be impacts on surrounding habitats and wildlife during the operation of a waste management facility. Compensatory habitats, can if necessary, be factored into closure and aftercare plans.

11.3.7. Water resources

The possible groundwater sensitivity of sites should be considered in terms of the geology and hydrogeology of the locality. Details of a specific site's hydrogeological characteristics, resource classification and licensed and unlicensed groundwater abstraction records can be considered as part of an assessment of alternative sites exercise, and will also form part of a more detailed site evaluation.

The proximity of a proposed site to surface watercourses should also be considered in terms of environmental sensitivity. The EPA and Fisheries Boards may raise concerns particularly if the scheme would involve potentially polluting discharges to watercourses of good quality and/or in high amenity or close proximity to abstraction points for residential or industrial use. Land in close proximity to abstraction points and areas susceptible to flooding are unlikely to be considered suitable localities for landfills.

The potential effects on surface and groundwater of developing a waste management facility relate mainly to the formation and operation of landfill sites. All other forms of waste related development have a potential to affect groundwater resources if appropriate protection measures are not taken.

11.3.8. Amenity, air quality and environmental nuisance

Key environmental impacts of waste related activities relate to amenity and to the effects of air emissions, and odours, dust, noise and other nuisances generated on the site and its environs. A number of waste related developments have the potential to release gaseous emissions into the atmosphere.

The effects on the site as an amenity will be important in the assessment. Many tourism and recreation services are built around the natural, built and cultural heritage of an area and it is important to protect these resources as far as possible.

The effects of noise generated by on and off-site traffic movements and plant during construction and operation of a waste related development will be to surrounding land uses, in particular sensitive receptors and to wildlife. The introduction of noise to an area may also have an effect on the overall character of the area.

The effects of dust and exhaust emissions from plant during construction and operation will have an impact on sensitive receptors close to the site and may also cumulatively have an effect on the amenity of surrounding land uses. It may also have potential adverse effects on flora and fauna. Sensitivities are also associated with emissions from combustion processes such as those related to energy from waste plants.

Table 47 below describes the methodology for assigning a “score” to criteria, according to the potential impacts a hazardous facility may produce.

Table 47 Site Selection Criteria Scoring

	Positive	Neutral	Minor Negative	Major Negative
Planning Policy	Sites where waste development is consistent with land use designations in the relevant Development Plans and/or where development will help to meet specific planning policy objectives	No specific planning policy constraints designated on-site or in close proximity to the site	The development of a waste management facility has the potential to be contrary to existing or proposed planning polices related to the site or its environs.	Site located within a specific plan designation such that development of a site for waste related activities would be a significant departure from existing planning policies.
Land Use Constraints	Site of sufficient size, general setting and conditions to accommodate the relevant hazardous waste development	No specific land use constraints	Uncertainties over suitability of site size to accommodate the scale of waste facility proposed. Potential land use constraints associated with the nature of neighbouring land uses, sensitive receptors	Site of insufficient size and/or inappropriate setting to accommodate the required waste development. Site may also be in close proximity to sensitive receptors i.e. such as school or hospital
Accessibility	Very good access and direct connection to primary transportation network with capacity to accommodate proposed development and/or potential for road improvements as part of waste proposals.	No specific access constraints either locally or on the wider transport network.	Potential access/road junction/highway capacity constraints subject to detailed assessment	Poor junction layout and/or access roads unsuitable for waste vehicles with no apparent possibility of improvement.
Waste Arisings	Site is situated close to major source of hazardous waste arisings and/or in close proximity to other waste related activities, such as transfer stations	Site offers no specific advantages or disadvantages with respect to its proximity to waste arisings.	Site situated some distance from major source of waste arisings. Uncertainties exist as to whether waste collection vehicles serving nearby sources of waste arisings could directly serve the site. Uncertainties over the compatibility of the location in the context of other existing waste related activities.	Site is remote from main source of hazardous waste arisings and/or other related waste activities.
Geology and Soils	Where there is potential for the site's natural geology to mitigate against potential environmental impacts.	The location of the facility on the site will have no affect on the geology or soils.	The site is located on a designated site of geological interest located within or adjacent to the site, that will not however be damaged or destroyed by the proposed development, or site located on any other prominent but undesignated geological feature that will be destroyed or damaged by the proposed development. In addition, a potential mineral resource or poor quality soils close to the site that may be affected by the development.	The site is located within or immediately adjacent to an internationally or nationally designated site that will be damaged or destroyed by the proposed development, or a significant area of high quality or rare soil type that will be destroyed or damaged by the development. A significant or active mineral resource, such as an opencast mine or quarry, that lies within the site that will be sterilised by the proposed development. Proposed site is located on a regionally important aquifer or geologically unstable ground.
Landscape and Visual	Poor existing landscape and visual characteristics of site area will be improved by new development and associated site works i.e. landscaping,	The proposals complement the scale, landform and pattern of the existing	The proposals are not fully integrated or cannot be completely mitigated into the existing landscape and are out of scale with the landscape or at odds with the local	The development proposals would be very damaging to the landscape in that they are at complete variance with the landform, scale and patterns of the landscape and are highly visual and

	removal of derelict/unsightly buildings	landscape and incorporate measures for mitigation to ensure that the site will blend in well with the surrounding landscape features and elements. The development will maintain existing landscape character in an area which is not a designated landscape that is either of national or local high quality, nor is vulnerable to change i.e. not AONB	landscape pattern or landform. The development will impact on certain views into and across the site and will have an adverse impact on a landscape of recognised quality or on vulnerable and important characteristic features or elements. The development will conflict with local and national policies to protect open land and nationally recognised countryside.	extremely intrusive. The development would irrevocably damage or degrade, diminish or even destroy the integrity of characteristic features and elements and their setting and would cause a very high quality or highly vulnerable landscape to be irrevocably changed and its quality very considerably diminished. There are no measures that would protect or replace the loss of a nationally important landscape and the development cannot be reconciled with government policy for the protection of nationally recognised countryside
Nature Conservation	There is potential for significant enhancement of a site's ecological value eg uniting previously fragmented areas through habitat creation work, the diversion of traffic away from a designated site and the provision of new design features such as hedges, ponds, ditches, scrub, linear woodland, grasslands and geological exposures to provide general wildlife gain	The proposals will not impact on any known sites of ecological interest either on or near to the site.	The site comprises a site of local interest or the potential exists for disturbance of a site of more than local interest. If even in the light of full information, it cannot be clearly demonstrated that the proposed development will not have an adverse effect on the sites integrity, then the impact should be assessed as a significant negative	The proposals will have a direct impact on a site of acknowledged importance. For example, the integrity of the site will be adversely affected, in terms of the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the population levels of species for which it was classified. Alternatively specific rare species located on or in close proximity to the site would be adversely affected.
Water Resources	Where there is potential for improvements to local water resources as a result of changes in use. For example, replacement of existing operations with proposals offering operations with significantly improved mitigation measures	The site is remote from any sensitive receptors	The operation of waste management activities on-site may result in local adverse effects if mitigation measures/site management practices are not effective	The site is situated in very close proximity to sensitive water resources such as ground water aquifers and mitigation measures are unlikely to prove effective
Amenity, Air Quality and Nuisance	Where there is potential for improvements to local sensitive receptors and/or local air quality standards as a result of changes in use. For example, replacement of existing operations with proposals offering operations with significantly improved mitigation measures.	The site is remote from any sensitive receptors.	The operation of waste management activities on-site may result in local adverse effects if mitigation measures / site management practices are not effective.	The site is situated in very close proximity to neighbouring land uses that are very sensitive to noise air, quality and other nuisance-related impacts. Mitigation measures are unlikely to prove effective.

The criteria in **Table 47** could be used for assessment with respect to its suitability for development for hazardous waste treatment and disposal facilities. Where the site is already being used for some form of waste management purpose, intensification of the use or additional waste activities should be considered. The assessment criteria does not assign a score to each site, which will ultimately determine its suitability or otherwise for development. Instead, criteria are assessed qualitatively and can be reviewed in terms of their overall suitability as a hazardous waste facility. However in general, a site which has a major negative score for any criteria may be considered unsuitable.

One of the key aspects of appropriate site identification and environmental protection is the detailed impact assessments which are necessary to identify potential negative impacts from a facility and the means by which these can be addressed in order to reduce risk to an acceptable level. This is discussed in further detail in the sections below.

11.4. Environmental Issues

The legal means of assessing a proposed development's potential impact on the environment is through the Environmental Impact Assessment (EIA) Directive [139]. The EIA requirements under planning legislation have been consolidated into Part X of the Planning and Development Act 2000 and Part 10 of the Planning and Development Regulations 2001.

The decision as to whether a development is likely to have significant effects on the environment must be taken with reference to the criteria set out in Schedule 7 of the Planning and Development Regulations 2001[140]. Guidelines on the contents of an EIS and advice notes on current practice have been prepared by the EPA[141].

Section 2 of 1989 Regulations details the information to be included in an Environmental Impact Statement (EIS) which must accompany a planning application for an EIA scheduled project and include;

Human beings	Flora	Fauna
Soil	Water	Air
Climate	Landscape	Material Assets
Cultural Heritage		

This section explores the main environmental issues associated with the development of a hazardous waste storage, treatment and disposal facility, in accordance with the requirements of the EIA Directive.

[139] Environmental Impact Directive 85/337/EEC, as amended by Council Directive 97/11/EC on the effects of projects on the environment,

[140] S.I. No 600 of 2001, Planning and Development Regulations.

[141] EPA (2002) Guidelines on Information to be contained in EIS and EPA (2003) Advice Notes on Current Practice in the Preparation of EIS.

11.4.1. Human beings

Waste facilities have the potential to produce emissions which may be harmful to humans. The ingestion of groundwater or organisms which have accumulated contaminants in the water or soils, or air dispersed pollutants from the facility such as PM10, bio-aerosols and odour, can have impacts on the health of humans. Additionally, the direct contact with contaminated groundwater, surface water or soils could have detrimental effects on health.

The development of the facility may have positive impacts on the local economy and employment during its construction and operation. Communities and individuals can however be negatively affected by the displacement and disruption of households and family connections as result of land sold for development, from nuisance caused by noise, dust, odour and light and by the cumulative impact on residents of several unpopular facilities in the area. Often the perceived negative impacts on local businesses from the effects of a hazardous waste facility can be brought into the decision making process.

The development of a hazardous waste facility can impact the local land use by altering the current surrounding population, commercial and industrial activities, agricultural use and open spaces. Additionally the volume and type of traffic access to the facility may have an impact on the local residents and businesses.

Some of the less obvious impacts on human beings are in relation to local government, finance and public services. The revenue obtained from property taxes could be affected by the development and this could in turn affect expenditure on local roads and infrastructure used by nearby businesses and residents.

11.4.2. Flora and Fauna

The potential impacts on flora and fauna from contaminated waters and polluted airborne emissions are similar to those of human beings, through direct contact and ingestion. Additionally disturbance to and destruction of habitats during construction of the facility can result in loss or displacement of plants and animals. The operation of the facility can generate noise and litter problems which could potentially, for example impact on the flora and fauna in the surrounding area.

11.4.3. Soil

During construction of the facility, soils may be impacted through physical disturbance and through the destruction of soil structure from the soil compaction activities of heavy foot and vehicular traffic. The use of heavy machinery can lead to destruction of the soil matrix from moving or mixing soils. This results in soil compaction, increased bulk density, reduced capacity for aeration and water filtration and increased mechanical impedance to root penetration, all of which are detrimental to plant growth.

Soils can be polluted by contaminated surface waters and run off, leaching, accidental spillages and aerial deposition. Although many of these issues should be mitigated by the design of the facility.

11.4.4. Water

The physical disturbance of surface waters through diversion, realignment, banking and abstraction may cause changes in hydrology such as water flow, velocity, level, retention time, flood peak and stratification. The discharge of effluents and deposition of air pollutants to surface waters can lead to the addition of contaminants and sediments to the water body.

During construction, soil compaction and the removal of topsoil, to expose lower permeability subsoils may affect groundwater levels. Once operational, groundwater levels may also be affected by the provision of artificial surfaces, engineered drainage systems and structures/buildings. Activities during construction and operation can result in leaching of contaminants in soils, leakage of leachate and spillages (e.g. oils, hydraulic fluids, chemicals) and contaminated drainage, entering groundwater and affecting quality.

11.4.5. Air

Air quality may be affected by dust from the tracking of vehicles over site, odours associated with waste materials, volatile organic compounds (VOCs) from vehicles accessing and moving around site or from contaminated fill.. At hazardous waste facilities, there could also be accidental releases of volatile chemicals, uncontrolled chemical reaction during inadvertent mixing of non compatible chemicals or fire involving organic wastes which could lead to emissions to the air.

Effects may be direct (health effects associated with ingestion, nuisance from odours, acid deposition on vegetation.) and indirect (media or materials become contaminated by chemicals in the air).

11.4.6. Climate

Direct impacts on local climate from hazardous waste management facilities are likely to be undetectable. The carbon emissions associated with the transport of materials to the facility an also contribute towards change in climate. Restoration design can be such that it helps towards balancing carbon emissions.

11.4.7. Landscape

The development of a hazardous waste facility may impact landscape through displacement of existing landscape components by introduction of the new landuse. This may include removal of open space, trees, hedgerows, water bodies or field patterns. There may also be an impact from the specific components of construction, operation and restoration activities.

Receptors of landscape impacts include residents, workers, vehicle drivers and passengers, walkers and amenity users.

11.4.8. Material Assets and Cultural Heritage

The EPA advice notes on the *Current Practice in the Preparation of Environmental Impact Assessments (2003)*, defines material assets as “resources that are valued and intrinsic to specific places, they may be either human or natural origin and the value may arise for either economic or cultural reasons."

Economic assets include air and water and non renewable resources, settlements, transportation infrastructure, utilities and ownership and access. These could be both positively an negatively impacted by the development of waste management facilities, for example through the development of improved transport infrastructure to service the facility.

Cultural assets include archaeology, architecture, historic sites and structures, folklore and tradition and religion and belief. These may be disturbed physically through the construction of the facility or also through altering the landscape setting and thus the appreciation of some cultural heritage.

11.5. Conclusions and Recommendations

The risks posed by hazardous waste disposal and treatment facilities are dependent on what is done with the waste, ie, encapsulate and isolate it or change its physical and chemical properties. Landfills pose a risk to the ground and the groundwater beneath them, while at treatment facilities the inadvertent mixing of wastes can present potential hazards such as toxic emissions or fires. With each there is also the risks associated with the transport and storage of these wastes.

The siting, expansion and operation of hazardous waste facilities has the potential to impose significant impacts on the surrounding environment and communities. Understanding and addressing these is an important part of the siting process. The location of such facilities in particular areas can pose significant risks of pollutant releases and possible exposure to humans and the natural environment. Areas may be unsuitable for development due to their soils, terrain, groundwater sensitivity or weather conditions. In addition, their proximity to residential areas or amenity areas could make their development inappropriate

It is recommended that a study is undertaken to ascertain the availability of appropriate sites on the island of Ireland which would be suitable for the development of a hazardous waste facility including the potential for co-location.

The site selection criteria should be applied in the first instance to identify broad areas of constraint, ensuring facilities are not located too close to residents, in environmentally sensitive areas or which cannot be easily accessed.

Any site being proposed for hazardous waste facility development could be assessed in accordance with the above criteria, and demonstrate that it can provide sufficient protection of the environment and community through appropriate environmental assessment. While the ultimate decision will be with the relevant Planning Authority and the EPA, the ability to demonstrate a full and transparent approach to siting will provide a sound platform on which to progress proposals.

12. POTENTIAL FOR CO-LOCATION

12.1. Introduction

The study requested the consideration of potential benefits and disbenefits of co-location of a NaDWaF with existing waste management facilities and facilities that operate under an IPPC licence. Other co-location options that could be considered include development at brownfield sites or legacy landfills.

In this chapter we explore those areas which could be considered more thoroughly and present our conclusions on the viability of co location and the main criteria for assessing a site's suitability for co-location.

It is likely that the private sector could approach operators of IPPC licensed facilities to consider co-location, indeed some IPPC licensed operators have been approached regarding the acceptance of wastes, such as for example meat and bone meal (MBM) for use as fuel as an alternative to coal. However this is not co-location, but the reuse of waste as a fuel.

In the UK co-location is considered in the context of siting complimentary waste management facilities and is considered a priority option in waste management strategies, this co-location context refers to the location of a waste recovery facility with a municipal landfill or an IPPC licenced activity, for example.

This report cannot pre-empt the level of interest that may exist in relation to co-location but it is important to highlight that the majority of IPPC licensed sites are operated by the private sector, the majority of landfills are operated by the public sector and all hazardous waste treatment facilities are operated by the private sector.

12.2. Considerations

There are a number of considerations to be taken into account when investigating co-location, many of these considerations have been addressed in previous chapters of this report and include;

- Operational compatibility;
- Policy and regulatory context;
- Waste types, volumes and management options;
- Containment requirements;
- Economic/social;

Other aspects for consideration include;

- Activity Selection – eg which IPPC or waste licensed facility, or other ?
- Ownership of sites for co-location.

12.2.1. Operational Compatibility

There are a number of EPA regulated IPPC activities involving very large waste management elements, such as landfill. Moreover, some of these elements will require long term aftercare (e.g mine sites). Accordingly there may be certain synergies and operational compatibility aspects for co-location of a NaDWaF.

12.2.2. Policy and Regulatory Context

The Waste Framework Directive (WFD) states that waste should be disposed of at the nearest suitable location, thus reducing the environmental impacts associated with waste transport and ensuring Member States take responsibility for their own wastes. The co- location of hazardous waste facilities with other waste facilities or industrial IPPC licensed sites could contribute towards the compliance with the WFD and the Proximity Principle. In order for this element to apply it would be necessary to locate the facility either at an industrial site producing quantities of hazardous waste requiring treatment or disposal or at an industrial or waste facility in close proximity to a number of hazardous waste producing sites. Alternatively, certain hazardous waste treatment facilities will stabilize the hazardous waste such that it may be disposed of or stored at a non- hazardous facility, such as landfill, therefore the co location of these facilities would be sensible. The cost of the waste disposal will be borne by the waste producer, thereby applying the "polluter pays" principle.

One of the recommendations of the NHWMP is to provide for, in regional planning guidelines and local area and county development plans, the co-ordinated management of contaminated soil where these plans include the redevelopment of docklands or other brownfield sites (e.g. former industrial sites or gasworks, timber preservers, petrol stations, waste disposal and recovery activities for example). Plans should, where technically and economically feasible and environmentally favourable, provide for the co-ordinated management of contaminated soil from the area as a whole from the perspective of preferentially treating the soil in situ or at authorised facilities in Ireland, in preference to export, thus allowing for the use of treated soil in Ireland.

There are also EIA implications that need to be considered in relation to the acceptance of hazardous waste at say existing non-hazardous landfill. Article 48(1) of the Waste Management (Licensing) Regulations 2004 require the classification of all landfill facilities. It is therefore necessary to articulate how much suitable hazardous waste can be deposited in a non-hazardous landfill before its designation has to be altered. No limits are specified in the Directive regarding the amount of stable non-reactive hazardous waste that can be accepted at a non-hazardous facility. The EPA view has been taken that where a non-hazardous landfill proposes to accept more than 10% (total intake) or 50,000 tonnes (whichever is the least) of stable non-reactive hazardous waste its classification will change to hazardous - if not for the entire landfill but at the very least for the cell containing the hazardous waste[142].

The reasoning for these particular limits is that the specific engineering requirements of a separate cell for 50,000 tonnes of hazardous waste would be economically and technically feasible. The 10% is based on the view that from an operational control perspective any waste stream contributing >10% intake is significant with respect to the classification and risk profile of a site. Additionally, and as stated earlier the environmental risk profile for the site changes when hazardous waste is deposited. This will influence the indemnities required for both accidental and

142 EPA (2006) Technical Guidance on the landfilling of asbestos.

planned liabilities.

12.2.3. Waste types and volumes and management options

The waste types, volumes and management options for hazardous waste will be the key considerations in determining a suitable facility for co-location. The hazardous waste types and volumes predicted to arise up to 2025 have been presented in **Chapter 5**. The largest component of the predictions is contaminated soils. The disused and orphan radioactive sources wastes have been identified in **Chapter 7.** The difficult wastes specifically identified include out of date marine flares or time expired pyrotechnics (TEPs).

The suitability of a range of waste management options to contribute to the management of the key waste streams identified in **Chapter 5** has been assessed and evaluated to identify input, outputs, cost and throughputs required. A capacity matrix developed to estimate future capacity need and the predicted arisings allocated the different treatment/disposal routes in a detailed allocation matrix, this matrix is presented in **Appendix 3.** The waste management options considered included:

- Stabilisation and Solidifications;
- Bioremediation;
- Soil washing;
- Thermal Desorption; and
- Physico-chemical treatment.

The disposal options considered are stable non-reactive hazardous waste landfill cell and hazardous landfill. The figures show that under the baseline prediction model, the future capacity need is between 235,000 to 257,000 tonnes per annum up to 2019, reducing to 185,000 tonnes per annum as a result of assuming that treatment techniques advance. However the capacity is significantly affected by assumption on the quantity of contaminated land and the treatment of flue gas cleaning residues and the capacity need could reduce to below 100,000 tonnes per annum.

12.2.4. Containment requirements

The containment requirements for a hazardous waste landfill are well established. The facility design and operation therefore must be able to obtain a waste licence and other relevant authorisations to proceed. It must therefore meet or exceed BAT best available technique (BAT) and must be effective in the treatment of waste while not causing environmental pollution and damage to human health**.** A landfill must be situated and designed so as to meet the necessary conditions for preventing pollution of the soil, groundwater and surface water and ensuring efficient collection of leachate as and when required. With co-location the consideration will be the assessment of combined risk and potential cumulative impact from an existing facility and a new facility.

12.2.5. Economic/social

The economic scenarios presented in **Chapter 13** do not include potential co-location economic appraisals as it is not possible to pre-empt what scenarios may be co-located with existing waste management or IPPC facilities. Co-location may result in management and aftercare efficiencies which will reduce operational costs.

The current interaction of a site with a local community will be pertinent to any future planning or addition of activities to that site's operations. The expected facility lifespan of an existing IPPC or waste licenced operation may be clear, but the introduction of a new activity that may require long –term aftercare would present a further concern for affected and interested parties.

12.2.6. Activity Selection

The site selection criteria presented in **Table 46** could be applied to a shortlist of sites that may be suitable for further co-location consideration. These criteria could be adapted to consider the addition of a NaDWaf to an existing licensed facility. There are approximately 900 sites operating with IPPC licences and approximately 300 sites operating under waste licences granted by the EPA in Ireland. Many of these sites could be excluded on a number of grounds including;

- Waste arisings not suited to particular co-located activity;
- Enforcement issues at site;
- Location and environmental issues; and
- No capacity or remaining void for further development.

Apart from EPA licensed sites, brownfield sites and some legacy landfills that require remediation are a potential consideration at site selection stage where it is likely that contaminated soil arisings will contain hazardous substances and require treatment. The treated soils can then be put to use on the site, thus enabling remediation. In 1999, the EPA produced a *Country Report for Contaminated Sites in Ireland*, the total number of industrial activities that were identified as posing a risk to soil and groundwater have been estimated at between 1,985 – 2,371.

12.2.7. Ownership of sites for co-location

The ownership, public or private, of a currently licensed site will play a key role in the potential for co-location. Key to this would be whether it would fit in with an operator's other core activities or would it be marginal. In determining who might host or operate a NaDWaF some other issues which would need to be considered include determining who might actually be interested in carrying out this work. It is understood that early approaches to potential hosts in the context of disused and orphan radioactive source waste did not illicit any real interest in taking on this responsibility. This issue could perhaps be partly overcome if there were sufficient financial incentives.

12.3. Benefits and Disbenefits of Co-location

Table 48 identifies some of the potential benefits and dis-benefits of co-locating a NaDWaF with existing waste management facilities and industrial facilities. The requirement for possible waste or IPPC licence review, or new applications, environmental risk assessments and impact assessments are not considered dis-benefits, as these assessments and permissions will be required regardless of co-location or not.

Table 48 Benefits and Dis-Benefits of Co-location

Benefits	Dis-benefits
Area of established waste management or industrial use in terms of planning and permitting	Difficulty defining source of any contaminant release and historic pollution in the event of imminent risk to the environment or damage to the environment
Economies of scale , if a treatment facility for contaminated soil is located at a brownfield site	Community perception issues and public acceptability
Infrastructure such as road access, utilities, leachate treatment facilities may already be constructed	Potential cumulative environmental effects in terms of multiple waste uses on one site.
Integrated waste facilities compliant with waste planning policy could encourage the co-location of waste management facilities.	
Reduction in waste 'miles' and compliance with the proximity principle as was.	
Containment of potential environmental incidents, theoretically easier.	More legislative 'loopholes' to pass through before hazardous facility is acceptable. Especially if site is not used for this purpose at present.
Potential reduction in the number of facilities needing long term aftercare	
Potential to open up new markets for hazardous waste treatment with operators that have the capacity and experience in treating/disposing of waste	For certain wastes it may be difficult for existing waste operators to demonstrate they are suitably competent, eg storage of radioactive source wastes or disposal of TEPs
Reduce need to develop at Greenfield sites	

12.4. Conclusions and Recommendations

On a wider site selection scale areas that may be unsuitable for development may be due to their soils, terrain, groundwater sensitivity or weather conditions. In addition, their proximity to residential areas or amenity areas could make their development inappropriate. However on a co-location selection basis, the considerations addressed above will need to be taken account of.

13. ECONOMIC APPRAISAL

13.1. Introduction

The objective of this chapter is to provide a generic economic assessment model to provide indicative cost for the development and operation of treatment/disposal options. The scenarios considered do not include potential co-location economic appraisals as it is not possible to pre-empt what scenarios may be co-located with existing waste management of IPPC facilities.

This chapter explores:

- Waste requiring treatment, highlighting those areas where no treatment route currently exists for a particular waste type (the categories and quantities of hazardous wastes were collated previously as described in Chapter 5) in addition the possibility of potential savings from effective recovery of materials is considered where appropriate;

- Waste treatment scenarios based on the following assumptions of potential treatment types:

  - Scenario 1 (baseline): treatment to continue with existing routes external to Ireland with no new build NaDWaF (transport and disposal costs to 2025);

  - Scenario 2 (specialist disposal): hazardous waste treatment prior to disposal to hazardous landfill;

  - Scenario 3 (specialist treatment): hazardous waste treatment prior to disposal to non-hazardous landfill;

  - Scenario 4 (no treatment no treatment prior to landfill): hazardous waste, no treatment, direct to hazardous waste landfill;

  - Scenario 5 (storage): storage of radiological waste.

- Forecasting of economic implications for each of the scenarios are given (for example, the impact that rising landfill tax could have to inform any decisions associated with NaDWaF); and

- Cost-benefit analysis a summary of the economic modelling information for each of the scenarios is presented through a cost-benefit analysis. Assumptions are provided where appropriate within this chapter. . It is important to note that any investors seeking information on the feasibility of a waste treatment or disposal operation should perform their own feasibility test as local factors could have significant impact on the costs presented in this report.

13.2. Baseline – Waste Arisings and Management

The waste types and current treatment/disposal of hazardous waste was explored in **Chapter 5**. It focused on landfillable elements of hazardous wastes. Therefore, it does not include all hazardous waste arisings, for example it does not include solvents as they are generally recovered in Ireland or sent abroad for treatment (but bulked in Ireland first). It highlighted that in 2008, the total tonnage of hazardous waste (excluding contaminated soil classed as hazardous) that was landfilled was 42,013. The majority of this was disposed outside of Ireland with just 7,462 tonnes of asbestos taken to a commercial waste landfill in Ireland.

To effectively consider the economic implications associated with a potential facility, a number of waste treatment/disposal scenarios presented in **Table 49** are explored. This allows comparison of scenarios if no facilities are developed, and also different economic pressures and opportunities that could be experienced from development of NaDWaF for particular waste streams. The scenarios considered are:

Table 49 Treatment/Disposal Scenario Description and Economic Considerations

Scenario	Description	Economic Considerations
Scenario 1 (baseline)	Treatment to continue with existing routes external to Ireland with no new build NaDWaF	Transport and disposal costs to 2025.
Scenario 2 (specialist disposal)	Hazardous waste treatment prior to disposal to hazardous landfill	Cost of hazardous waste treatment facility and hazardous landfill
Scenario 3 (specialist treatment)	Hazardous waste treatment prior to disposal to non-hazardous landfill	Cost of hazardous waste treatment facility and non-hazardous landfill
Scenario 4 (no treatment)	Hazardous waste, no treatment, direct to hazardous waste landfill	Cost of hazardous landfill
Scenario 5 (storage)	Storage of radiological waste	Cost of storage space (including consideration that a cost of final disposal will still be required)

The primary consideration of the waste treatment/disposal scenarios is to understand the implications of introduction of a hazardous waste landfill. We have also considered the costs of other elements such as hazardous waste treatment facilities and storage. As stated previously, the wastes included in the scope of this study are not generally deemed to be suitable for disposal by waste incineration. Economic modelling has been given on the basis of total cost and a functional unit of cost per tonne. It should be noted that import will have additional cost associated with collection and transport within the country of its origin (external to Ireland, if relevant); the costs provided in this section are purely based on Ireland costs.

13.3. Methodology for Economic Modelling

A bespoke modelling tool has been developed to aid the analysis of the five potential waste treatment/disposal scenarios. This model was developed for the purpose of this project using excel software, analysis of this type tends to be completed on a project-by-project basis rather than having a general tool available to be used because of the intricacies of the assumptions and boundaries that need to be considered. The detailed modelling tool is included in **Appendix 5**. The current disposal quantities have been used to provide a baseline picture of treatment/disposal quantities. The percentages that the baseline provides has been used to forecast alternative waste treatment/disposal and treatment quantities. The economic modelling is based on the cost for disposal (incorporating treatment), calculated from a per tonne basis. The associated costs for construction and operation of each facility type are considered separately in this chapter.

The modelling has been developed to cover the time periods of 2008 to 2013, 2014 to 2019 and 2020 to 2025. An assessment has been completed on a total waste treatment/disposal basis through projections of tonnages to 2025. Assumptions have been made for environmental and compliance costs for a non-hazardous and hazardous landfill as well as community gain funds that may be associated with landfill.

The figures are based on the original annual hazardous waste landfill tonnages (these figures constitute Scenario 1). The breakdown for each scenario is summarised in **Table 50** to **Table 53**.

The data represents a yearly average for each of the time periods (2008 to 2013, 2014 to 2019 and 2020 to 2025).

Table 50 Scenario 1 – Current Treatment

LANDFILL DISPOSAL			
	2008-13	2014-19	2020-25
Direct to landfill	78,000	90,000	50,000
Landfill after treatment	168,000	132,000	120,000
Direct to SNRHW cell	11,000	13,000	15,000
TOTAL	257,000	235,000	185,000
ASSOCIATED TREATMENT			
Stabilisation/solidification	84,000	88,440	80,400
Bioremediation	6,720	18,480	39,600
Soil washing	6,720	18,480	39,600
Thermal desorption	6,720	18,480	39,600

The data considered for Scenario 1 is derived from **Chapter 8** on assessment of future capacity needs. It demonstrates that roughly 65% is subject to landfill after treatment and 30% goes direct to landfill (in 2008 to 2013 period). The amount sent for treatment is set to decline in the 2014 to 2019 period to 56% with 38% going direct to landfill. Finally, treatment levels increase in 2020 to 2025 period to 65% sent for treatment and 27% going direct to landfill.

Table 51 Scenario 2 – Specialist Disposal

LANDFILL DISPOSAL			
	2008-13	2014-19	2020-25
Direct to landfill	0	0	0
Landfill after treatment (hazardous landfill)	246,000	222,000	170,000
Direct to SNRHW cell	11,000	13,000	15,000
TOTAL	257,000	235,000	185,000
ASSOCIATED TREATMENT			
Stabilisation/solidification	123,000	148,740	113,900
Bioremediation	9,840	31,080	56,100
Soil washing	9,840	31,080	56,100
Thermal desorption	9,840	31,080	56,100

Scenario 2 considers hazardous waste treatment prior to disposal to a hazardous landfill. The relative percentages of the treatment options have been maintained as was applied to the Scenario 1 (the base scenario). In this scenario there is no waste direct to landfill.

Table 52 Scenario 3 – Specialist Treatment

LANDFILL DISPOSAL			
	2008-13	2014-19	2020-25
Direct to landfill	0	0	0
Landfill after treatment (non-hazardous landfill)	246,000	222,000	170,000
Direct to SNRHW cell	11,000	13,000	15,000
TOTAL	257,000	235,000	185,000
ASSOCIATED TREATMENT			
Stabilisation/solidification	123,000	148,740	113,900
Bioremediation	9,840	31,080	56,100
Soil washing	9,840	31,080	56,100
Thermal desorption	9,840	31,080	56,100

The breakdown of Scenario 3 is considering the treatment of waste prior to disposal in a non-hazardous landfill. Therefore, the same figures have been used as for Scenario 2 but landfill after treatment is to a non-hazardous landfill, which means associated costs do differ.

Table 53 Scenario 4 – No Treatment

LANDFILL DISPOSAL			
	2008-13	2014-19	2020-25
Direct to landfill	257,000	235,000	185,000
Landfill after treatment	0	0	0
Direct to SNRHW cell	0	0	0
TOTAL	257,000	235,000	185,000
ASSOCIATED TREATMENT			
Stabilisation/solidification	0	0	0
Bioremediation	0	0	0
Soil washing	0	0	0
Thermal desorption	0	0	0

Scenario 4 uses no treatment methods and the waste is sent direct to landfill.

Scenario 5 is concerned with the storage of radiological waste. From the analysis of the information available it is clear that the majority of the sources currently designated as disused in Ireland have half lives and activities such that they are likely to decay to levels lower than the exemption levels within relatively short timescales. This is likely to be true of many of the sources currently in use. The number of more active and longer lived sources for which longer term management solutions are required is quite small and there are only a very small number of high activity sources. For sources currently in use there should already be “take-back” arrangements and therefore there is only likely to be a small number of those which might need managed in the longer term. The other sources including sources from ICSDs, schools and lightening protectors will also need to be included in consideration of the future management arrangements for disused sources.

From consideration of the options reviewed in **Chapter 8** in conjunction with the analysis of the current disused sources the conclusion was that for the sources with short half lives and small activity levels the most effective approach is to store these until they have decayed to below exemption levels and then to dispose of them, under licence from RPII, to a landfill as non-radioactive waste. There are no nuclear power stations and no nuclear fuel cycle activities in Ireland. There are 2.5 tonnes of natural uranium in storage on the campus of a university, which was previously incorporated in a sub-critical assembly. This material is stored in the building in which it was previously used. Other than in relation to these uranium sources, the application of the Convention is limited to radioactive waste arising from the medical, industrial and research applications of radioisotopes.

While all the sources referred to above are held in secure locations, it would be clearly preferable to have them all placed in a dedicated storage facility. This would help ensure longer term security and remove the ever present risk that a source will be inadvertently disposed of with other scrap material, particularly if the legal owner is placed in receivership or if the premises, where it is held, is sold. The very large capital cost associated with a disposal facility is a significant factor, especially given the long time (of the order of 20 years and more to achieve site identification, initial investigations, planning permission, other permissions and excavation/construction) between the start of work towards a geological disposal option and the emplacement of waste in the facility[143].

Storage is a necessary phase in safely managing most types of radioactive waste. During the storage phase, for example, the radiation levels and heat generation intensities may decrease to more manageable levels. Also, storage is a necessary part of waste treatment and conditioning programmes. Storage has been carried out safely within the past few decades, and there is a high degree of confidence that it can be continued safely for limited periods of time. Recent estimates of the US storage facility at Yucca Mountain places its cost for construction, operation and decommissioning at $54.8 billion. Obviously this facility is much larger than Ireland would need but it is safe to assume that a facility would be a substantial investment. Therefore, it has not been included in the detailed economic modelling because it is likely to be substantially greater than other scenarios and would still require the cost of final disposal for the waste so it is difficult to apportion it to a yearly amount and we would assume no additional new radioactive waste would require addition to the centralised storage facility.

13.3.1. Treatment Methods

The treatment methods investigated include stabilisation/solidification, bioremediation, soil washing and thermal desorption. Most of these treatment methods would require an EPA licence and demonstration of BAT. Calculations have been based on ex-situ treatment only.

13.3.1.1. Stabilisation/solidification

Cement stabilisation involves the mixing of soils with cement by means of mixing with the injection of a solidification agent. The processes are applicable to a wide range of mixed contaminants in a range of soils. It can transfer difficult materials to a more manageable form. Disadvantages of the process are that it can result in an increase in the volume for treatment. Its effectiveness depends on good mixing and organic contaminants can be problematic in a cement system, but it is a

[143] For more information please see: http://mrws.decc.gov.uk/en/mrws/cms/home/What_is_geolog/What_is_geolog.aspx

relatively quick technique. Typical costs of this technique average €58 per tonne.[144]

13.3.1.2. Bioremediation

Biological treatment methods rely on the natural metabolic processes of living organisms (e.g. bacteria, fungi and higher plants) to destroy contaminants or convert them to a less toxic or less available form. The processes usually involve metabolisation of carbon-bearing substrates by organisms to generate energy for growth and reproduction. Bioremediation is commonly more effective for water-soluble contaminants since most biological activity takes place in this phase. Bioremediation can be effective provided conditions are optimised. Apart from not being able to create optimum conditions, other limitations to bioremediation include the production of intermediate products which may be more toxic, long timescales and difficulties in achieving stringent concentrations in soil. The advantages of the technique are that the technology is commercially available and has been used successfully on a number of sites in the UK and Europe. The cost of biological treatment is generally lower than other treatment methods and many biological treatment techniques do not give rise to process residues requiring further treatment or disposal. Therefore, the process is available and can be cost efficient but it is not effective for some contaminants (eg metals) or with clay/silt soils where there is a high groundwater table. Some of the techniques require large process areas and long time periods to achieve acceptable concentrations. Typical costs of this technique average €74 per tonne.

13.3.1.3. Soil washing

Soil washing by chemical treatment is a process that adds chemicals to excavated soil to transfer the contaminants to a leachate. The leachate is then treated. This technique can transfer difficult material to a form more amenable to treatment. It can result in the contamination being destroyed and for some contaminants (e.g. dioxins/PCBs) it is one of the few viable methods for removal/treatment. To be economic the "clean" fraction should be the bulk of the soil, which can then be used as fill material from excavation. The relatively small proportion of contaminated soil separated during washing can be either disposed to an appropriate hazardous waste facility of further treated (at a considerably lesser volume than the original soil). Cost effectiveness is achieved by being able to significantly offset the cost of soil washing treatment and limited disposal against the disposal of the whole soil. An advantage of this technique is that it can treat mixed organic/inorganic contaminants. However, waste streams normally require additional treatment and silt/clay materials are more difficult to treat. Some treatment techniques render soils unsuitable for future use. The disadvantage of the technique is that it requires the input of a chemical reagent which can be both expensive and hazardous. Successful implementation of the technique is usually difficult with mixed contamination. Its effective can be limited by high concentrations of contaminants in the soil. Post treatment processing may be required. The products of treatment can be phytotoxic thus sterilising soils. It is typically a longer term strategy. Typical costs of this technique average €63 per tonne [145].

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[144] Federal Remediation Technologies Roundtable (FRTR) Agencies, Solidification /Stabilization http://www.frtr.gov/matrix2/section4/4_9.html and CIRIA SP109. Remedial Treatment for contaminated land. Volume IX. In situ methods of remediation. 1996 and CIRIA SP107. Remedial Treatment for contaminated land. Volume VII. Ex situ methods for soils, sludges and sediments. 1996.

[145] Federal Remediation Technologies Roundtable (FRTR) Agencies, Separation http://www.frtr.gov/matrix2/section4/4-18.html and CIRIA SP107. Remedial Treatment for contaminated land. Volume VII. Ex situ methods for soils, sludges

13.3.1.4. Thermal desorption

Thermal desorption is the transfer of contaminants to a vapour phase by volatilisation and treatment or destruction of off-gases. Following volatilisation the contaminants can be condensed for further treatment (in concentrated form) of the off-gases can be treated to destroy the contaminants. The advantages of these thermal techniques are that contaminants are removed from soil relatively quickly and destroyed. They are one of the few feasible disposal routes for some contaminants (e.g. explosives). The techniques are difficult with clay soils. Emission control procedures are required and there is a risk of explosion with some contaminants. Thermal desorption typically costs an average of €146 per tonne.

13.3.2. Typical Costs of Treatment/Disposal Facilities

The previous section listed likely gate fees associated with the various treatment methods. These have also been used to assess the cost of the different waste treatment/disposal scenarios. The degree to which one can know what gate fees will be from one period to the next is somewhat limited. The introduction, locally of a new facility can perturb the local market for waste management such that yesterday's gate fees are irrelevant today.

Therefore, it has also been decided to look at the capital costs associated with set-up of a new facility to help understand the ultimate costs of different waste treatment options. Costs for the facility itself will vary significantly based on the following factors:

- Cost of land acquisition (including environmental liability risk);
- Scale of facility;
- Facility utilisation rate;
- Choice of technology;
- Extent/purity of source separation;
- Operating costs;
- Regulatory consent and compliance requirements/changes;
- Restoration and aftercare (particularly for landfill);
- Nature and length of contracts; and;
- Revenue for sale of end products.

Exact figures regarding capital costs for waste facilities are subject to issues regarding commercial confidence. Therefore, the following figures are collated based on studies within the field. Not all costs have been included, for example business taxes payable to the local authority for the facilities

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and sediments (1996) and Federal Remediation Technologies Roundtable (FRTR) Agencies, Chemical Extraction http://www.frtr.gov/matrix2/section4/4_15.html are not included and there has been no consideration of inflation over the lifetime of the facility.

The principal sources of data for the following sections are:

- Costs for Municipal Waste Management in the EU, report to Directorate General Environment, European Commission, http://ec.europa.eu/environment/waste/studies/pdf/eucostwaste.pdf ;
- WRT142 - *Evaluating the Costs of 'Waste to Value' Management*, Defra funded project (2006); and
- The demise of landfill co-disposal: the repositioning of UK hazardous waste management practice in a European setting (2005) Wastes Management World.

13.3.2.1. Non-Hazardous Landfill

Table 54 provides an indication of costs for a 175,000 tonne non-hazardous landfill. These are a rough indication and a level of variance will apply depending on the scale of the facility.

Table 54 Capital Costs for a Landfill

Purchase Required	Cost €
Cost of land	1.6 million
Planning stages (including permissions and assessments)	8 million
Civil works (concrete, offices, weigh bridge, utilities, materials.)	14 million
Restoration and aftercare	0.9 million
Equipment	0.5 million

Yearly maintenance will also need to be considered. Average maintenance is set at 1% of the capital costs (this is an estimate based on examples of a similar size facility and nature, maintenance levels are calculated based on the EC report calculations). Therefore, yearly maintenance would be approximately €200,000. In addition, utility costs are likely to require approximately €20,000 per year and annual regulatory compliance could be in the region of €40,000[++]. Community gain funds can be allocated at between €0.50 to €1 (Index Linked) for every tonne of waste accepted for disposal. For the purposes of this study we assume a flat figure of €1 per tonne during the lifetime of the facility.

Assumptions regarding staff levels include:

- 1 director at €60,000 per year;
- 1 manager at €35,000 per year;
- 3 general operatives at €30,000 per year, equating to a total of €90,000.

The yearly operational costs for a landfill total €0.4 million. Assuming the operational life of the landfill is 25 years the operational costs equate to an approximate total of €10.1 million over the lifetime of the facility.

13.3.2.2. Hazardous Landfill

Table 55 provides an indication of costs for a 175,000 hazardous landfill. These are a rough indication and a level of variance will apply depending on the scale of the facility.

Table 55 Capital Costs for a Hazardous Landfill

Purchase Required	Cost €
Cost of land	1.6 million
Planning stages (including permissions and assessments)	9 million
Civil works (concrete, offices, weigh bridge, utilities, materials.)	20 million
Restoration and aftercare	1.5 million
Equipment	0.75 million

Yearly maintenance also needs to be considered. Average maintenance is set at 1% of the capital costs (this is an estimate based on examples of a similar size facility and nature). Therefore, yearly maintenance would be approximately €300,000. In addition, utility costs are likely to require approximately €20,000per year and annual regulatory compliance could be in the region of €60,000^{++}. Community gain funds can be allocated at between €0.50 to €1 (Index Linked) for every tonne of waste accepted for disposal. For the purposes of this study we assume a flat figure of €1 per tonne during the lifetime of the facility.

Assumptions regarding staff levels include:

- 1 director at €60,000 per year;
- 1 manager at €35,000 per year;
- 3 general workers at €30,000 per year, equating to a total of €90,000.

The yearly operational costs for a hazardous landfill total €0.5 million. Assuming the operational life of the landfill is 25 years the running costs equate to an approximate total of €12.6 million over the life of the facility.

13.3.2.3. Stabilisation / Solidification

Table 56 provides an indication of costs for an ex-situ stabilisation/solidification 20,000 tonne facility. These are a rough indication and a level of variance will apply depending on the scale of the facility.

Table 56 Capital Costs for a Stabilisation / Solidification Facility

Purchase Required	Cost €
Cost of land	0.3 million
Planning stages (including permissions and assessments)	0.5 million
Civil works (concrete, offices, weigh bridge, utilities, materials.)	1.5 million
Equipment	0.5 million

Yearly maintenance will also need to be considered. Average maintenance is set at 10% of the capital costs (this is an estimate based on examples of a similar size facility and nature and taking into account addition of solidification material). Therefore, yearly maintenance would be approximately €280,000. In addition, utility costs are likely to require approximately €45,000 per year. Assumptions regarding staff levels include:

- 1 director at €60,000 per year;
- 1 manager at €35,000 per year;
- 4 general operatives at €30,000 per year, equating to a total of €120,000.

The yearly operational costs for an ex-situ stabilisation / solidification facility total €540,000. Assuming the operational life of the facility is 20 years the running costs equate to an approximate total of €10.8 million over the life of the facility.

13.3.2.4. Bioremediation

Table 57 provides an indication of costs for a 20,000 tonne facility. These are a rough indication and a level of variance will apply depending on the scale of the facility.

Table 57 Capital Costs for a Bioremediation Facility

Purchase Required	Cost €
Cost of land	0.5 million
Planning stages (including permissions and assessments)	0.5 million
Civil works (concrete, offices, weigh bridge, utilities, materials.)	1.5 million
Equipment	0.5 million

Yearly maintenance will also need to be considered. Average maintenance is set at 2% of the capital costs (this is an estimate based on examples of a similar size facility and nature). Therefore, yearly maintenance would be approximately €60,000. In addition, utility costs are likely to require approximately €15,000 per year. Assumptions regarding staff levels include:

- 1 director at €60,000 per year;
- 1 manager at €35,000 per year;
- 6 general workers at €30,000 per year, equating to a total of €180,000.

The yearly operational costs for an ex-situ bioremediation facility total €350,000. Assuming the operational life of the facility is 20 years the running costs equate to an approximate total of €7 million over the life of the facility.

13.3.2.5. Soil Washing

Table 58 provides an indication of costs for a 20,000 tonne facility. These are an indication and a level of variance will apply depending on the scale of the facility.

Table 58 Capital Costs for a Soil Washing Facility

Purchase Required	Cost €
Cost of land	0.5 million
Planning stages (including permissions and assessments)	0.5 million
Civil works (concrete, offices, weigh bridge, utilities, materials.)	1.5 million
Equipment	0.5 million

Yearly maintenance will also need to be considered. Average maintenance is set at 2% of the capital costs (this is an estimate based on examples of a similar size facility and nature). Therefore, yearly maintenance would be approximately €60,000. In addition, utility costs are likely to require approximately €15,000 per year. Assumptions regarding staff levels include:

- 1 director at €60,000 per year;
- 1 manager at €35,000 per year;
- 6 general workers at €30,000 per year, equating to a total of €180,000.

The yearly operational costs for an ex-situ bioremediation facility total €350,000. Assuming the operational life of the facility is 20 years the running costs equate to an approximate total of €7 million over the life of the facility.

13.3.2.6. Thermal Desorption

The following costs in **Table 59** are a rough indication and a level of variance will apply depending on the scale of the facility. There is a limited amount of data available associated with costs for thermal desorption due to limited practical experience to date. Therefore, these costs are interpreted from scaling down costs for an incinerator facility.

Table 59 Capital Costs for a Thermal Desorption Facility

Purchase Required	Cost €
Cost of land	0.3 million
Planning stages (including permissions and assessments)	1.5 million
Civil works (concrete, offices, weigh bridge, utilities, materials.)	15 million
Equipment	7 million

Yearly maintenance will also need to be considered. Average maintenance is set at 7% of the capital costs (this is an estimate based on similar examples). Therefore, yearly maintenance would be approximately €1.7 million. In addition, utility costs are likely to require approximately €0.2 million per year. Assumptions regarding staff levels include:

- 1 director at €60,000 per year;
- 2 managers at €35,000 per year, equating to a total of €70,000;
- 12 general operatives at €30,000 per year, equating to a total of €360,000.

The yearly operational costs for a thermal desorption facility total €2.4 million. Assuming the operational life of the facility is 25 years the running costs equate to an approximate total of €59.8 million over the life of the facility.

13.4. Conclusion

The analysis of cost for treatment/disposal of waste under different scenarios gives the following total forecast costs, presented in **Table 60**. These are costs presented in € and are calculated by summing the cost of treatment and disposal specific to each scenario considered.

Table 60 Costs for Waste Scenarios (€ Millions)

	2008-13	2014-19	2020-25
Scenario 1 – current treatment	30.5	35.9	41.0
Scenario 2 – specialist disposal	45.9	55.1	57.7
Scenario 3 – specialist treatment	33.6	44.0	49.2
Scenario 4 – no treatment prior to landfill	36.0	35.3	29.6
Scenario 5 – storage	Unknown	Unknown	Unknown

Total costs for storage are unknown at present because of limited data availability on the subject. In addition, there is no alternative to this treatment route for this type of waste. The costs that have been used (per tonne) for this analysis are as given in **Table 61.**. It is important to note that changes to landfill tax will affect these basic costs and future verification may be required based on actual tax levels.

Table 61 Waste Costs € on a Per Tonne Basis (landfill costs are based on a gate fee and therefore include landfill tax)

	2008-13	2014-19	2020-25
Standard gate fee	90	100	110
Hazardous gate fee	140	150	160
Stabilisation/solidification	58	68	78
Bioremediation	74	84	94
Soil washing	63	73	83
Thermal desorption	146	156	166

The analysis highlights that at present specialist disposal is the most expensive option. Maintaining current treatment is given as least cost, but this is based on current assumptions about price increases. In reality these are likely to increase substantially particularly with the increasing restriction on landfill availability. This issue also applies to Scenario 4 (no treatment) as there is a limited likelihood that this option would be possible.

To investigate this in greater depth the costs of individual facilities were investigated. **Table 62** provides a summary of the costs associated with the treatment and disposal facilities.

Table 62 Costs for Waste Facilities (€ million)

	Non-Hazardous Landfill	Hazardous landfill	Stabilisation/ Solidification	Bio-remediation	Soil washing	Thermal desorption
CONSTRUCTION TOTAL OVER LIFETIME	25	32.85	2.8	3	3	23.8
Cost of land	1.6	1.6	0.3	0.5	0.5	0.3
Planning stages	8	9	0.5	0.5	0.5	1.5
Civil works	14	20	1.5	1.5	1.5	15
Restoration and aftercare	0.9	1.5	0	0	0	0
Equipment	0.5	0.75	0.5	0.5	0.5	7
SERVICES	0.405	0.505	0.54	0.35	0.35	2.39
Maintenance	0.2	0.3	0.28	0.06	0.06	1.7
Staff costs	0.185	0.185	0.215	0.275	0.275	0.49
Utilities	0.02	0.02	0.045	0.015	0.015	0.2
Environmental Regulatory Compliance	0.04	0.06				
Community Gain Funds	0.175	0.175				
SERVICES TOTAL OVER LIFETIME	15.5	18.5	10.8	7	7	59.75
Lifetime	25	25	20	20	20	25
TOTAL	40.5	51.35	13.6	10	10	83.55
Apportioned to quantity of waste	231.4 (175,000)	293.4 (175,000)	680 (20,000)	500 (20,000)	500 (20,000)	835.5 (100,000)

The table highlights that the most expensive options are thermal desorption and landfill (hazardous and non-hazardous). The quantities of waste that each of the techniques will treat differ; therefore, relative amounts have also been added (in brackets in the final row). The total costs have then been allocated to amount for a single tonne. This is not allowing any cost for sale of associated by-products for example recovered metals.

The landfill options are the cheapest, however, if factoring issues such as landfill tax for example are taken into account these costs are likely to increase even more significantly. Plus there is the restriction on land availability so having sufficient availability for construction of the landfill is unlikely.

14. SOCIO-ECONOMIC ASSESSMENT

14.1. Introduction

This chapter provides the methodology and results of a high-level socio-economic assessment of the development of a NaDWaF in Ireland. This is necessary in order to indicate the feasibility of a development of this type in a socio-economic context. The objectives of this assessment are to identify key potential impacts in order to inform and guide future strategic planning of a NaDWaF.

Chapter 13 provided an economic appraisal of the proposed NaDWaF, this chapter provides further detail regarding the overall social and economic context for a development of this type within Ireland.

14.2. Baseline Data Collection

The geographical area covered by the socio-economic assessment includes Ireland and for the purposes of considering an "all-island" solution, Northern Ireland. Key socio-economic data for these geographic areas is sourced from the websites[146] of the Central Statistics Office (CSO) and the website for the Economic and Social Research Institute (ESRI) in Ireland and from the Northern Ireland Neighbourhood Information Service (Northern Ireland Statistics and Research Agency (NISRA). The most current available data from both sources was used for this study.

14.3. Assessment Methodology

To assess the socio-economic impacts of the project the "Guidelines and Principles for Social Impact Assessment" (May 1994)147 were used. These were prepared by the Inter-Organisational Committee on Guidelines and Principles for Social Impact Assessment[148.] They have been used to guide the identification of socio-economic impacts. At present there are no EU or Irish-based guidelines for socio-economic assessment. Although these guidelines used are US-based, they are thought to effectively communicate the assessment of social impacts in the context of an EIA and other assessment contexts. The assessment guidelines do not make reference to community gain and associated funding, this aspect is however dealt with separately in Section 14.7.

The assessment steps that have been undertaken include:

- Identification of baseline conditions – current baseline conditions have been established using key data sources for the geographic focus areas.
- Identification of stakeholder groups– a stakeholder map has been produced based on groups that could be affected by the proposed facility, including those that live nearby and those that

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146 www.cso.ie and www.esri.ie and www.ninis.nisra.gov.uk.

147 These are US-based guidelines but are the only ones published that effectively communicate the assessment of social impacts in the context of an EIA.

148 US-based decision makers recognised a need for better understanding the social consequences of projects, programs and policies. In response to this need a group of social scientists formed the Inter organisational Committee on Guidelines and Principles for Social Impact Assessment (SIA), with the purpose of outlining a set of guidelines and principles that will assist agencies and private interests in fulfilling their obligations regarding social assessment. The committee included representatives from a number of organisations including the US Dept of Commerce, Rural Sociological Society and a number of socio-economic academics.

have an interest in the project but may not live in close proximity. It should be noted that this is a generic assessment as the assessment cannot be site specific.

- An understanding of potential stakeholder concerns – potential stakeholder concerns have been identified for each of the stakeholders presented in the stakeholder map. At this stage, these concerns are only predicted as consultation has been undertaken as yet.

- Understanding of social and economic impacts – potential social and economic impacts have been identified and assessed by considering the following variables:

  - Probability of the event occurring;
  - Number of people potentially affected;
  - Duration of impacts (long-term vs. short-term);
  - Value of benefits and costs to impacted groups (intensity of impacts);
  - Extent that the impact is reversible or can be mitigated;
  - Likelihood of causing subsequent indirect “secondary” impacts; and
  - Uncertainty over possible effects.

- Projections of estimated effects – the social and economic impacts have been assessed for each of the primary treatment/disposal methods identified in earlier tasks. The primary treatment methods include stabilisation and solidification, bioremediation, soil washing, thermal desorption, landfill and hazardous landfill. The guideline list of social impacts as provided by the Inter-Organisational Committee is used and key economic impacts are added where deemed appropriate. The impacts are estimated and taken from findings of previous examples of similar projects, and take into account how key stakeholders would respond in terms of attitudes to the proposed treatment methods. The assessment of socio-economic impacts is presented in **Appendix 6.**

- Discussion of key impacts – each significant impact is discussed highlighting the reasons for assigning the significance rating;

- Summary of socio-economic impact of each treatment method – the total socio-economic impact rating is calculated for each treatment method by first calculating the total for each socio-economic sub-section and then calculating the total for all sub-sections. This is compared to the range of significance ratings to indicate the overall significance rating for each treatment method.

- Prediction of cumulative socio-economic impacts for each waste stream – the mix of treatment methods preferred for each waste stream is used to calculate the weighting of the significance rating awarded to each treatment method. It is then possible to calculate the cumulative significance rating for the predicted socio-economic impacts involved in the treatment of each waste stream.

14.3.1. Magnitude and Significance Criteria

The assessment methodology has been based on the descriptions included in **Table 63**. The descriptions indicate the measurable level of impact on the host community. In this case, the host community would be Ireland, and if an all-island solution were being sought, this would also include Northern Ireland.

Table 63 Magnitude and Significance Criteria

Impact magnitude	Major	Moderate	Slight	Negligible
Description	More than 100 people affected at any one time	Up to 100 people affected at any one time	20 people at most affected at any one time	0 to 3 people affected at any one time
Impact Significance	Key Significant	Significant	Not significant	
Description	Will affect someone's quality of life on a daily basis	Will affect someone's quality of life periodically	No effect on quality of life	

14.4. Demographic Baseline

It is necessary to present the baseline of the social and economic status of the host communities (at this stage, the host communities would be at the national spatial scale, i.e. countries) and economies in which the potential development of pre-treatment and disposal facility would be situated. This includes Ireland and for the purposes of considering an "all-island" solution, Northern Ireland (NI). The demographic data for Ireland has been taken from the website for the Central Statistics Office for Ireland [149]and from the website for the Economic and Social Research Institute[150].. Demographic data for Northern Ireland was obtained from the Northern Ireland Neighbourhood Information Service.[151]. **Table 65** presents the demographic data obtained for both Ireland and Northern Ireland.

Table 64 Demographic Data

Data	Ireland	Northern Ireland	All Island Total
All people (2006)	4,239,848	1,741,619	5,981,467
All people over 15[152]	3,317,081	1,287,211	4,604,292
All dwellings / household spaces	1,769,613	658,426	2,428,039
	n/a	n/a	
All dwellings / household spaces with residents	1,553,080	626,718	2,179,798
	87.8%	95.2%	
All people over 15 years of	829,102	129,741	958,843

[149] http://www.cso.ie

[150] http://www.esri.ie

[151] Northern Ireland Statistics and Research Agency (NISRA) http://www.ninis.nisra.gov.uk/

[152] Age structure for Northern Ireland taken from Census 2001 (KS02 dataset), figures for Ireland obtained from Census data from 2006.

Data	Ireland	Northern Ireland	All Island Total
age with a qualification of third level degree or higher (Ireland) / GNVQ, NVQ, HND, or Degree (Northern Ireland)	24.9%	10.0%	
All people over 15 years of age with no qualifications[153]	514,085 15.5%	494,277 38.4%	1,008,362
All people over 15 years of age in labour force (and up to 74 years in Northern Ireland)	2,132,800 50.3%	1,056,000 60.6%	3,188,800
All people in labour force in employment	2,034,900 95.4%	686,644 65.0%	2,721,544
All people over 15 years of age in employment: Manufacturing and Industry sectors	293,900 14.4%	97,365 14.1%	391,265
All people over 15 years of age in employment: Construction sector	251,600 12.4%	64,321 9.4%	315,921
All people over 15 years of age in employment: Service sectors[154]	297,500 14.6%	95,058 9.0%	392,558
All people over 15 years of age in employment: Communication and Transport Industries	164,000 8.0%	37,206 3.5%	201,206
NB: Statistics for NI for economic activity and employment industries have been taken from Census 2001, whereas these statistics for Ireland are from latest Census 2006. Datasets used were the most comparable in terms of topic and coverage. Key statistics for population for both Ireland and Northern Ireland are from 2006 data.			

14.4.1. Discussion of Demographic Characteristics

Key figures describing the socio-economic characteristics of the island of Ireland are described below, including population, economic activity, employee skills, and business development.

Population

The total population for Ireland was 4,239,848 persons in 2006, compared to 1,741,619 in Northern

[153] Proportion of the population in Ireland with no qualifications has been taken from ‘Persons, Males and Females Aged 15 Years and Over Classified by Highest Level of Education Completed, 2006’ dataset, and is the figure for those people whose highest level of education is primary level and have no formal education. For Northern Ireland I, this figure has been taken from the Census 2001 for people with no qualifications including GCSE or equivalent.

[154] Number of people over 15 years of age employed in services sector in Ireland includes accommodation and food services activities, administrative and support service activities, and public administration and defence, and compulsory social security, and the figure for Northern Ireland includes those working in hotels and catering and public administration.

Ireland in 2006. The population density in Ireland in 2002 was 56 people per square kilometre, whereas in Northern Ireland it was 119 people per square kilometre[155]. This indicates that although there is a much higher population in Ireland, there is much more available land space than in Northern Ireland because the population density in Ireland is approximately half of that in Northern Ireland. It is therefore assumed that there is a substantial amount of land in Ireland that could be put forward for the potential development of identified waste treatment facilities.

The population projections for Ireland and Northern Ireland are 1.5% (between 2011 and 2026) and 0.7% (between 2008 and 2013) respectively[156]. It is possible to use these estimated projections to predict the population total for the island of Ireland in 2030, when the development of the waste treatment facilities would be complete and they would be expected to be fully operational. The projected population for Ireland in 2030 is 5,511,802 (an increase of approximately 1.25 million people) and for Northern Ireland is 1,985,445 (an increase of approximately 0.25 million people).

Economic Activity

The number of people in Ireland and Northern Ireland at working age (above age of 15 years) is 3,317,081 and 1,287,211 respectively. The number of people within this population that is classed as being in Ireland s' labour forces, either working or actively seeking work, is 2,132,800 in Ireland and 1,056,000 in Northern Ireland. This equates to 50.3% of the population at working age in Ireland and 60.6% in Northern Ireland. The actual proportion of the population in the labour force who are actually employed is 95.4% in Ireland and 65.0% in Northern Ireland.

In 2006, the employment rate for Ireland was 68.1% and was 68.7% in Northern Ireland[157]. This indicates that the rate of employment is similar in both Ireland and Northern Ireland. The unemployment rate in Northern Ireland was 4.2% in 2006, compared to 8.5% in Ireland in 2006. This has increased in the current economic climate to 6.3% in Northern Ireland (sourced from the Labour Force Survey) in the first quarter of 2009 and to 11.0% in Ireland in the same period (sourced from the Live Register of employment for the CSO). Therefore, although the economic climate may change over the next few years and provide opportunities for employment elsewhere, there is a surplus employee base in Ireland, more so than in Northern Ireland, for which employment opportunities can be provided by the development of waste treatment/disposal facilities in the near future.

The proportion of people in the labour force who are employed in the construction sector is 12.4% in Ireland and 9.4% in Northern Ireland. Ireland had a strong construction sector and therefore, would be assumed to have the necessary skills to undertake the majority of the construction work

155 The figure for Northern Ireland was taken from the KS01 dataset from Census 2001. The figure was originally provided in people per hectare (1.19) and has been multiplied up to be comparable to the figure provided for ROI, people per square kilometre. The figure for ROI was taken from 2002 Census of Population – Volume 1 – Population Classified by Area (Available at: http://www.cso.ie/census/documents/vol1_press.pdf).

156 Population projection for ROI obtained from CSO publication entitled 'Regional Population Projection figures 2011-2026 (Available at: http://www.cso.ie/releasespublications/documents/population/2008/reg_pop_proj_figures_tables1-7.xls). Population projections for Northern Ireland obtained from NISRA publication entitled 'Statistics Press Notice-2008 Based Population Projections (Available at: http://www.nisra.gov.uk/archive/demography/population/projections/popproj08.pdf).

157 Employment rate for Ireland taken from a publication *Measuring Ireland's Progress 2006* from the CSO website: http://www.cso.ie/releasespublications/documents/other_releases/2006/progress2006/measuringirelandsprogress.pdf) and for Northern Ireland from the Labour Market Structure by Local Government District in 2006 http://www.ninis.nisra.gov.uk/mapxtreme/viewdata/Labour_Market/Labour_Force_Survey/Local_Area_Database/Labour_Force_Survey_Local_Area_Database_2006.xls).

necessary to develop the chosen waste treatment/disposal facilities. Any specialist work would need to be contracted in from outside of Ireland/ Northern Ireland if the expertise were not available within the island. The proportion of the labour forces working in manufacturing or industry is similar in both Ireland and Northern Ireland, with 14.4% and 14.1% of the populations respectively working in this sector. The proportion of the labour forces in Ireland and Northern Ireland working in transport industries is 8.0% and 3.5% respectively. These figures indicate that there would be an existing employee skills base that can be utilised during operation of the facilities, and an established network of businesses that could be used for supporting the operations of each waste treatment/disposal facility.

The number of people at working age with no qualifications was 514,085 in Ireland and 494,277 in Northern Ireland according to the datasets used above. This accounts for 15.5% and 38.5% of the Ireland and Northern Ireland populations' over 15 years of age. The number of people within these populations that were identified as having a qualification of third level degree or higher (Ireland) or GNVQ, NVQ, HND, or Degree (Northern Ireland) was 829,102 and 129,741 (24.9% and 10.0% respectively). These figures indicate that there is population at working age and potentially within the labour force that would be suitable for both skilled and unskilled work at the waste treatment/disposal facilities.

Stakeholder Identification and Predicted Concerns

A number of stakeholders that would have an interest or be affected by the proposed treatment/disposal have been identified as shown in the general stakeholder mapping in **Figure 1.** The arrows highlight the links that are present between the different groups.

Figure 1 Generic Stakeholder mapping of Proposed National Difficult Waste Facility in Ireland and Northern Ireland

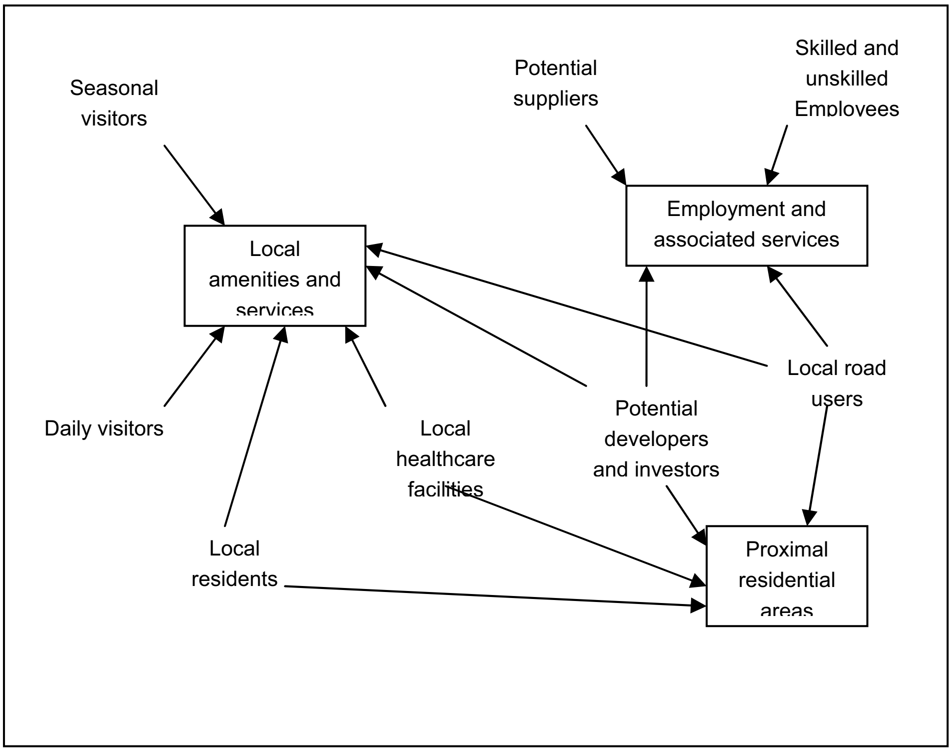

Table 65 represents a prediction of stakeholders' most likely areas of interest or concern. These have been derived based on professional judgement, and compared against the top three priority areas for improving local quality of life indicated by a report published by the Audit Commission *Quality of Life Indicators'*[158]. It is important to note that there are two key points and limitations that must be considered when looking at the nature of interest and concerns expressed by stakeholders in relation to a development. These include:

- Although no consultation has been undertaken as yet to derive actual stakeholder interests and concerns, initial concerns expressed by stakeholders during a consultation exercise are commonly based on perceptions and therefore this has been replicated in this exercise; and

- There may be some bias in the concerns expressed due to the type of interest the stakeholder in question has in the development.

Table 65 Assessment of potential stakeholder interests and concerns

	Stakeholders			
Potential Concerns	Local residents	Visitors	Business owners	Local government and public authorities
Access to local amenities	✓	✓		
Health	✓			✓
Employment opportunities	✓			✓
Business development			✓	✓
Road safety	✓	✓		✓
Travel on local roads	✓	✓	✓	✓
Impact on property price	✓			

Table 65 highlights a generic assessment of the greatest potential perceived impacts that may be raised by stakeholders in relation to the development of treatment/disposal facilities to manage hazardous waste within Ireland and Northern Ireland without exporting it, would be:

- Travel on local roads – all main stakeholder groups could be affected by the estimated increase in HGV use of local roads extending their journey times and potentially increasing the amount of money that needs to be spent on road maintenance;

- Road safety – as above road safety would therefore also be an expected issue for all stakeholder groups. Increased HGVs may result in a direct risk of accident for local residents and visitors, requiring extra vigilance to be taken by local business owners in taking responsibility for their delivery drivers and customers, or indirectly by local government through the development of road safety initiatives in the area and through potential higher costs of healthcare in treating injured people involved in road traffic accidents (RTAs);

- Employment – it would be expected that the opportunities for employment brought by the development of such waste treatment/disposal facilities would interest local residents and the local government and authorities as it could be a source of income to the local economy as well as wider Irish economy;

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[158] Audit Commission (2003) Quality of Life Indicators: A good practice guide to communicating quality of life indicators, April 2003.

- Business Development – the development of waste treatment facilities to deal with identified hazardous wastes would provide opportunities for the development of associated services, either already established or new businesses, to complete the necessary supply chain and could again bring economic benefits to the wider area; and

- Health – there may be a number of health concerns associated with the development of various waste treatment/disposal facilities needed to deal with the identified hazardous wastes (albeit perceived or actual). This could result in direct potential health risks for local residents (and certainly a strong perception of such risks) and indirectly economic costs for healthcare services and local government in the surrounding area.

14.5. Impact Assessment

The socio-economic impact assessment is undertaken for each treatment/disposal option considered in the waste matrix and covered in the economic appraisal. The principles of this socio-economic impact assessment are consistent with that used in the Environmental Impact Assessment (EIA) of a proposed development. In this case, the tool is being used at a much earlier stage in the planning process. Each treatment/disposal option is assessed against the socio-economic assessment criteria, based on the generic estimated impacts of the development of that facility type. The primary limitation in using this tool at this stage is the lack of site specificity in the assessment of impacts, the tool also does not deal with positive impacts such as community gain funding.

The socio-economic assessment criteria, grouped in five sub-sections (A-E), are based on the guideline list of social impacts as provided by the Inter-Organisational Committee. Key economic impacts that have been highlighted in the identification of stakeholder interests and concerns, and considered important for consideration through professional judgement, are also included under the appropriate sub-sections. The sub-sections are shown in **Table 66**.

Table 66 Socio-economic assessment criteria

Socio-economic assessment sub-sections				
A) Population Characteristics	**B) Community and Institutional Structures**	**C) Political and Social Resources**	**D) Individual and Family Changes**	**E) Community Resources**
i. Population change	i. Employment opportunities	i. Extent of affected parties	i. Perceptions of risk, health and safety	i. Change in community infrastructure
ii. Ethnic and racial distribution	ii. Training, skills and qualifications	ii. Trust in Political Institutions	ii. Health risks from development	ii. Land use patterns
iii. Relocated populations	iii. Business development		iii. Residential stability	iii. Security
iv. Seasonal residents	iv. Economic investment		iv. Attitudes towards project	iv. Impact on property price
	v. Employment equity of minority groups		v. Concerns about social well-being	v. Access to local amenities (including public

Socio-economic assessment sub-sections				
A) Population Characteristics	**B) Community and Institutional Structures**	**C) Political and Social Resources**	**D) Individual and Family Changes**	**E) Community Resources**
	vi. Local/regional/national linkages			rights of way)
	vii. Industrial/commercial diversity			
	viii. Travel around the area			

For each treatment method, significance ratings are assigned under all of the sub-criteria for each of the five primary criteria as listed above. This is repeated for all of the four development phases i.e. planning, construction, operation and decommissioning). A total is calculated for each of the primary criteria across all development phases, which then allows a total to be calculated for each treatment method. The significance ratings used are shown below in **Table 67**. The full socio-economic impact of each of the treatment/disposal options is included in **Appendix 6.**

Table 67 Significance rating for assessing socio-economic impacts

Rating	Significance level
2	Major positive increase to baseline conditions
1	Minor positive increase to baseline conditions
0	Equal to baseline conditions
-1	Minor negative decrease to baseline conditions
-2	Major negative decrease to baseline conditions

A colour-coding system has been used to provide visual recognition of the predicted impacts of the various treatment methods. This has been used against the totals for each of the primary criteria and then again for the totals for each treatment method. The colour coding system used is indicated below in **Table 68**.

Table 68 Colour-coding of significance rating for socio-economic impact assessment

Rating	Significance level
>+10	Minor positive increase through to major positive increase to baseline conditions

Rating	Significance level
>+10 / -10 <	Equal to baseline conditions to minor negative decrease / positive increase
>-10	Minor negative decrease through to major negative decrease to baseline conditions

14.5.1. Discussion of Key Impacts

The key impacts within each assessment criteria are presented below. The planning, construction, operation and decommissioning phases of the treatment/disposal options are addressed and a summary of the main impacts during each phase for treatment/disposal options are presented.

A) Population Characteristics

Population Change

There may be a minor impact on population change during the construction of a facility either via in-migration from outside the immediate local area on a daily basis to work at the site, or on a weekly basis if contractors need to be sourced from outside of the area. However, if it was necessary it would only affect facilities that required development on a dedicated site, such as when developing a landfill or thermal desorption facility. It would not be an impact for those treatment/disposal options that could be developed in-situ. In addition, this impact would be temporary for the duration of the construction phase only.

There would be no impact on population change during the operational phase for any of the treatment/disposal options except for thermal desorption as this method is likely to need an employee base of approximately 50 personnel. Employment of local people would be prioritised which would boost the employment rate of the immediate local area. If positions could not be filled from within the local population, positions would be filled from outside the area. This may cause a slight increase in local population, but it would only be minor.

There would be no impact on population through decommissioning of any of the treatment/disposal options except for thermal desorption. It is likely that specialist contractors would be required to lead the decommissioning of the facility alongside the existing employee base. Therefore, there would be a slight increase in population on a weekly basis for a temporary period. Again, this impact would only be a minor negative impact.

Ethnic and Racial Distribution, Relocated Populations, Seasonal Residents

No impact on ethnic and racial distribution, relocated population or seasonal residents during the planning, construction, operation or decommissioning of the treatment/disposal options would be expected.

B) Community and Institutional Structures

Employment Opportunities

It is expected that there would be job positions associated with the planning phase of each of the potential waste treatment/disposal options. This would include regulatory bodies, such as the EPA and the local government, and other contractors that might include construction and design engineers, architects, geotechnical engineers, and environmental consultants, depending on what treatment facility is being proposed.

The construction phase of treatment/disposal options including stabilisation and solidification, soil washing and bioremediation would require very few, if any, dedicated construction workers, especially if the treatment is proposed to be undertaken in-situ. Significant additional employment positions would be available during the construction phase of treatment methods that would require built facilities to be developed, such as landfill and thermal desorption. Positions would include dedicated construction workers, architects, engineers, and regulatory personnel.

Those treatment/disposal options that would definitely be operated at a dedicated location, such as thermal desorption and landfill, would require a number of employees to operate them, for example between 20 and 50 depending on the size of the facility. Treatment/disposal options including stabilisation and solidification, bioremediation, and soil washing that can be undertaken in-situ or at an external location, would require a small number of dedicated workers during operation, for example below 10.

Decommissioning of all treatment/disposal options, as long as they are undertaken at a dedicated site, would require a dedicated employee base to complete the phase. In this assessment it has been deemed that the impact of opportunity for employment during decommissioning for those t treatment/disposal options that could be undertaken in-situ or at a dedicated site is negligible because the number required is minimal if at all. The positive impact caused by workers required to complete decommissioning of the landfill would be long-term as land restoration would be expected to be included in its decommissioning plans.

Training, Skills and Qualifications

Opportunities for the provision of training, skills and obtaining qualifications during the planning phase is possible, but it would not be directly attributed to the proposed development of a hazardous waste treatment method. Therefore, the impact rating for this sub-criteria for each treatment/disposal option has been deemed to be negligible.

There is potential for the development of local skills in general construction and skilled trades during the construction phase of a proposed treatment method that requires a dedicated site to be built, especially thermal desorption and landfill. The emphasis for the provision of such opportunities will be on the contractors and sub-contractors used. This will be a short-term, indirect positive impact of the construction of the proposed facility. However, it is unlikely that treatment/disposal options including solidification, stabilisation, bioremediation and soil washing would present any opportunities for training during this phase as construction of a built development would not be required.

During the operational phase, there would be opportunities for the provision of training and gaining qualifications in all treatment/disposal options. There would be a diversity of skills as employment and training would be provided in innovative, modern technologies that would be different to any technology that has previously been used in Ireland.

There is potential for the development of local skills during the decommissioning phases of the landfill and thermal desorption treatment/disposal options, but not of the stabilisation, solidification, bioremediation and soil washing methods.

Due to the specialist nature of constructing, operating and decommissioning of landfills and thermal desorption facilities, the emphasis for the provision of training opportunities will be on the contractors and sub-contractors used who might need to be sourced from outside of the local, or even regional, area. However, there remains great potential for the local population to increase their skill base, gain training and obtain qualifications in diverse industrial waste technologies over a long-term period.

Business Development and Economic Investment

There would be no impact on business development and economic investment during the planning phase of the various treatment/disposal options. Therefore this impact has been rated as negligible for each method.

For those treatment/disposal options that would require construction at a dedicated site, there would be a possible negative impact on potential economic investment, and subsequently on business development, in the local area immediately surrounding the proposed site. There is potential for the environmental nuisances caused by construction to dissuade potential investors in the local area. The negative impact on economic investment and business development is thought to be short-term. The impact on the economic investment potential or business development in the surrounding area of treatment/disposal options including stabilisation, solidification, bioremediation and soil washing would be negligible as the construction required would be minimal if at all.

During the operation of a built treatment facility it is expected that there would be a net positive impact on the economic investment potential for the local area in the long-term. For those treatment methods that are undertaken in-situ the impact would probably be negligible because there has been no significant change made to the local area.

For all treatment/disposal options, there would be a positive indirect impact on local businesses contracted to supply goods and services to the treatment facility or site. This impact would continue for the entire life of the facility or treatment method.

The immediate impact of the decommissioning of a treatment facility that has been built and situated on a dedicated site will result in a reduction in economic investment at the site and immediate surrounding area. This negative impact may extend to a longer-term impact depending on the land remediation required at the site to ensure it is fit for future development. For those treatment/disposal options that were undertaken in-situ, the impact of decommissioning on economic investment potential depends on the remediation requirements of the site in which it is undertaken. For example, a requirement for major land remediation will result in a significant, long-term negative impact on economic investment potential in the surrounding area.

There would be a negative indirect impact on businesses and suppliers that will have developed links with the treatment facility or site. This impact has the potential to be significant if the business is unable to access substitute partnerships and links.

Employment Equity of Minority Groups

Employment opportunities during all phases and for all treatment/disposal options will be made available to all ethnic, racial and minority groups. The most suitable people for positions will be recruited in terms of their qualifications, skills and experience. Therefore, there will be no impact on the employment equity of minority groups.

Local, Regional and National Linkages

There would be significant local, regional and national linkages created by the development of a built hazardous waste treatment facility during the planning, construction and operational phases.

This could potentially be a long-term positive impact that would last for the lifetime of the facility and possibly beyond decommissioning depending on the strength of the relationships and linkages made. However, the impact of decommissioning would have a short and medium-term negative impact of breaking linkages at the local, regional and national levels. The rating of this sub-criteria against the decommissioning phase for landfill and thermal desorption methods has accounted for both of these possible outcomes and has been rated as a minor negative impact as the most direct impact felt would be the breaking of linkages.

There would be a negligible or even no impact produced by the development of treatment/disposal options that require minimal or no construction and do not use a dedicated site. These treatment/disposal options include solidification, stabilisation, bioremediation, and soil washing. This is because there would be much fewer links required and made at the local, regional and national levels as there would not be a need for high level planning applications, public consultation or joined-up working in order for it to be undertaken.

Industrial and Commercial Diversity

During the planning phase there would be no impact on industrial and commercial diversity for any of the treatment/disposal options.

During the construction and operational phase, there would be a direct, positive impact on the industrial and commercial diversity in the chosen locality and region as a result of the development of a landfill and thermal desorption. This is also the case for the operational phase of stabilisation, solidification, bioremediation and soil washing, but is not necessarily the case during the construction phase as there would be minimal construction necessary. These treatment/disposal options and host businesses would not have previously had any hold in any hazardous market in Ireland as the waste would previously have been stockpiled and exported for treatment. In addition, the development of all of the treatment methods could result in the further diversity of industrial and commercial businesses within the local, regional and national area that would be developed to support the operations of the treatment/disposal options and that feature within their supply chains.

The decommissioning of all of the treatment methods would result in a negative impact on the industrial and commercial diversity in the area.

Travel around the area

During the planning phase there would be no impact on travel around the local area for any of the t treatment/disposal options.

During the construction phase, there is likely to be a potentially significant negative impact on the travel around the local area of the chosen site for the landfill and the thermal desorption treatment option. There would be no impact on travel around the sites put forward for solidification, stabilisation, soil washing or bioremediation if they were proposed to be undertaken in-situ. If these options were proposed to be undertaken at designated treatment sites, the impact on travel around the locality during their construction would be minimal and possibly even negligible as very little built construction would be necessary.

The significance of the negative impact on travel around the area during the operation of the landfill and thermal desorption would be negative, but only minor. This is because there is not predicted to be a significant amount of waste generated that will require transporting to the sites. The impact of travel resulting from the operation of the solidification, stabilisation, soil washing or bioremediation methods would be negligible if undertaken in-situ and result in a minor, negative impact if needed to be transported to a dedicated site.

The impact of decommissioning of a landfill and thermal desorption facility would require specialist contractors and would more than likely result in a significant negative impact on travel of the local area for a temporary period. This is because there would most probably be a large team of workers accessing the site on a daily basis during weekdays, and HGVs would need to access the site to clear it. The impact of decommissioning of the other treatment/disposal options on travel would be negligible, or at most minor negative, as the extent of the decommissioning works would be much less. The team required to complete the decommissioning works of these treatment/disposal options would be much less and there would be very little machinery / built structures to remove from site that would require HGVs to access it.

C) Political and Social Resources

Extent of Affected Parties

During the planning phase, the extent of the affected parties would be greatest as it would include community and interest groups, local residents, local business owners, and also statutory and non-statutory consultees that would range from the EPA through to national conservation groups. All of these groups would need to be considered during the consultation phase of the proposed development, and would need to be included in any stakeholder engagement undertaken.

During the construction and operation of any of the treatment/disposal options, the parties that would be affected by the development of the treatment/disposal options would primarily be those in close proximity to the sites. Affected parties would include community and amenity interest groups, local residents, and local business owners. The range of impacts during this phase would include disruption to the environment including noise, air quality and dusk, and health and safety risks due to HGVs on the local roads and environmental emissions.

The extent of affected parties during the decommissioning of the treatment/disposal options would again include local residents, community groups and local business owners. This is because the impacts of decommissioning would centre on dust emissions, impacts on travel in the local area, and impacts on local business development due to the closure of a key industrial centre. However, affected parties may also include organisations or people that represent wider contexts and issues due to the significance of the closure of a national waste treatment facility.

Trust in Political Institutions

There is likely to be a continued significant, negative impact on the trust of interested parties in the political institutions involved in the development of all of the proposed treatment/disposal options. This is because it is likely that all interested parties will either not be fully informed of the project's aims and objectives, or even if they are informed, may not agree with the project's aims and objectives. This impact is likely to be felt throughout planning and construction, and at least for the first couple of years of the operation of the proposed treatment method, if not for the lifetime of the project in some cases.

D) Individual and Family Changes

Perceptions of Risk, Health and Safety

Risk, health and safety will not be an issue for the public during the planning phase for any of the treatment/disposal options. This is because all work for planning will be done at external offices with very little site work being undertaken. There will be some risk and health and safety issues for workers that access the site to undertake environmental assessment and inspections, but these risks should be adequately covered and mitigated through the contractors' health and safety policies and standards.

For those treatment/disposal options that are developed on dedicated sites, such as landfill and thermal desorption, perceptions of risk, and health and safety being an issue will be more significant. The interested and affected parties may perceive that there will be at least a minor negative impact on risk, and health and safety during the construction on these sites. The potential for intruders accessing the site due to the fact that parts of the site may be unlit and not perceived to be manned 24 hours a day 7 days a week, poses the potential for a health and safety incident. There would be a range of construction equipment on site and unstable or uneven land that would have the potential to cause injury.

There would be no perceptions of risk, and health and safety issues during the preparation phase of those treatment/disposal options that are undertaken in-situ, and only minor negative impact during the preparation for these treatment/disposal options if they are undertaken at a dedicated site. This is because there would be very minor construction works needed to develop a site for treatment/disposal options including stabilisation, solidification, soil washing, and bioremediation.

During operation of all treatment/disposal options, the perception of risk, health and safety would be minimal. This is because the perception of the site as being easily accessible to potential intruders would reduce dramatically. Security measures would be in place and the site's operations would be secure, which would result in virtually no potential for health and safety incidents if intruders were to access the site. This would be the case at the sites for all treatment/disposal options, whether they were undertaken at a dedicated site or in-situ.

During decommissioning, there would be virtually no perception of risk, health and safety issues for treatment/disposal options including stabilisation, solidification, soil washing and bioremediation. This is because there would not be much decommissioning works necessary to clear the site used, whether it be in-situ or in a dedicated site. However, there would be a minor, negative perception of the risk, and health and safety issues surrounding the decommissioning of a landfill or thermal desorption site. This would be due to the potential for intruders accessing the site due to it potentially being unlit and not perceived to be manned 24 hours a day 7 days a week, which poses the potential for a health and safety incident through potential injury to intruders. There would be a range of demolition equipment on site and unstable or uneven land that would have the potential to cause injury.

Health risks from the Development

During the planning, construction, operation and decommissioning phases of the development of treatment/disposal options including stabilisation, solidification, soil washing, and bioremediation the health risks of the development would be minor, if not negligible. This is because the amount of waste being dealt with would be low and, if undertaken in-situ, would not be being transferred and would be managed under the existing sites' established safety standards and procedures.

During the planning phase of the landfill and thermal desorption treatment/disposal options, there would be no health risks of the development. During the construction, operational and decommissioning phases of the development there would be minor health risks as a result of the development. This is because there will be potential environmental nuisances, such as dust emissions, odour, negative impact on landscapes, and increased traffic movements during these phases.

Attitudes towards Project

During the planning, construction and operational phases of each of the treatment/disposal options there is likely to be a significant, negative attitude towards the project. Like the impact on trust in political institutions, this will be due to the level and type of information that is provided to the local communities and interested parties, and largely due to the embedded attitudes within the host community to a project of this type. The attitudes and significance of the impact will be greater for those treatment/disposal options that require a dedicated treatment site to be developed. This impact would primarily be negative, and would be medium to long-term for the entire life of the project, up to an estimated 30 years.

Attitudes towards the treatment/disposal options during the decommissioning phase of the treatment method would be dependent on a number of factors. These include the substitute proposals to deal with the waste previously dealt with by the facility, the plans to redevelop the land on which the facility would sit, and the strength of the relationship between the management of the facility, council representatives and local community and interested parties during the life of the facility. There will be a slight positive impact in terms of attitudes towards the project due to the fact that the facility would no longer be present, which is largely linked to the perceptions of the impacts of such facilities during their operation.

Concerns about Social Well-being

During the planning phase, there would be no direct impact on social well-being from any of the treatment/disposal options.

During the construction and operational phase of the treatment/disposal options that require a dedicated site to be built, especially for landfill and thermal desorption, social well-being may be negatively affected by the works. This is because the works undertaken during these phases may cause disturbances to normal daily life due to increased transport on the roads, changes to landscapes, environmental nuisances and would have the potential disturb access via public rights of way. This impact on social well-being would be made more significant if the site location was in a rural location or a particularly built up location, and if the nearest affected residents were elderly, the very young or ill.

During the decommissioning phase of the works for treatment/disposal options undertaken at a dedicated site, there would be minor impacts on the social well-being of the local community. Reasons for this would be similar to those during the construction period. For those treatment/disposal options that would be undertaken in-situ, there would be very few, if any, concerns about social well-being as there would be very little decommissioning works required.

E) Community Resources

Changes in Community Infrastructure

During the planning phase, there would be no direct impact on social well-being from any of the treatment/disposal options.

During the construction, decommissioning and initial period of operations for those treatment/disposal options that require a dedicated site, there would most probably be changes to the community infrastructure in the immediate area surrounding the site. This may include changes to access routes, new or different businesses operating in the area, and even in-migration of sub-contractor workers on a daily or weekly basis.

For the majority of the operational phase of each of the treatment/disposal options, there would be no changes to community infrastructure. Any changes that would take place would be made at the start and end of the operational phase, leaving approximately 30 years in which these changes would then become the established community infrastructure.

Land-use Patterns

During the planning stages of each of the treatment/disposal options, there would be no impact on land use patterns.

The significance of the impact on land use patterns during construction and operation of a treatment method would be dependent on the final site location. If the site is brownfield, the siting of a waste treatment facility will constitute a re-development for industrial use and would usually be more favourable than a Greenfield site being developed for industrial use.

During the decommissioning of the facility there would be a significant negative impact on the land use as it will change from being an industrial land use, to a derelict site. However, the significance of this impact will be reduced if options to redevelop the land for community use or other beneficial use are in place prior to decommissioning.

Security

During planning, there would be no impact on security of the site or surrounding area for any of the treatment/disposal options.

During construction and decommissioning of treatment facilities that are located on a dedicated site, there would be an increased risk of breached security. There may be opportunities for crime and the potential for incidents involving intruders. This is because a construction site provides an inhospitable environment as it is not normally lit and not permanently inhabited. In addition, there may be equipment left on site during non-working hours (or it may be perceived that there is equipment left on site). There is potential for intruders to attempt to access the site with the intent of theft. There is also the potential for fly-tipping due to the presence of an unlit construction site and the perception that waste construction material may mask the tipping of other wastes on the site. There would be a need for appropriate security measures to prevent such occurrences.

During the operational phase of a development of any treatment facilities, there would be a reduced or even negligible risk of security breaches. This is because the site would be made secure with Closed Circuit Television and a perimeter fence. There would be an indirect, positive impact during the operational phase on the potential for crime at the site and in the immediate surrounding area. The potential for intruders to access the site would be much reduced, and there would be virtually no way of accessing the site. The site would be made secure and all operations and equipment would be secured, therefore, there would be no risk of theft.

For those treatment/disposal options that would be undertaken in-situ, there would be a slight risk of security breach, but these risks would be much reduced and even negligible in all phases due to the works being undertaken on an established site.

Impact on Property Prices

Impact on property price was initially considered as part of this assessment. However, the following issues mean this analysis has subsequently not been possible due to uncertainty in the data.. The level of impact from waste facilities is unconfirmed; references were identified but none were considered to be suitably conclusive, the following references were investigated:

- "*Benefits Transfer for Disamenity from Waste Disposal"* (Brisson and Pearce; CSERGE working paper[159]**).** This work describes a maximum decline in house price of 12.8% occurring at the site of a waste landfill and that the effect will have fallen to 0% at a distance of 5.5km from the facility –however, due to the fact that this analysis relates to non-hazardous landfill sites only and not to hazardous waste treatment facilities, and because this evidence is based on effects in America and there has been no such analysis undertaken within Ireland or the UK, this evidence alone was not considered to be suitably conclusive;

- Defra undertook a study on the adverse impacts associated with landfill[160] which is often quoted in response to queries about house price impacts. However, this does not deal with the range of facilities that is being covered in this feasibility study and therefore this information could not be used;

- There are studies available in academic journals on social impacts associated with industrial developments (including the Journal of Environmental Management**161)** however, none investigated a similar scale or location and there would still be uncertainty as they do not provide information on a suitable equivalent facility;

- Uncertainty and significant variability regarding house price data due to low numbers of housing and associated few sales within the region; and

- Uncertainty over the existing impact of industry or other factors within close proximity to the area on property prices.

Therefore, the impact on property price during all development phases and for each waste treatment method was recorded as 0, representing negligible and no change from the baseline.

Access to Local Amenities
During planning, there would be no impact on security of the site or surrounding area for any of the treatment/disposal options.

During the construction, operation and decommissioning of the treatment/disposal options undertaken on a dedicated site, there may be potential for access to local amenities to be disrupted. This may include diverted access roads or changes to access for public rights of way. However, this impact is very much dependent on local details, and therefore it is not possible to assign a impact assessment rating.

14.6. Summary of Assessment Results

The assessment provides and estimation of the socio-economic impact of the preferred treatment/disposal options for dealing with hazardous wastes identified in **Chapter 5**. It is evident that there are some key differences between the treatment methods, and between the different primary criteria. A summary of the impacts is presented below:

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159 http://www.uea.ac.uk/env/cserge/pub/wp/wm/wm_1995_06.pdf

160 http://www.defra.gov.uk/environment/waste/landfill/disamenity.htm

161 http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6WJ7-45J5B0V-16&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=87960fc8c3ea8c552ba2369a13766fa9

- For all treatment methods, there is no or a negligible impact expected on Population Characteristics. The only minor negative impact that may be felt as a result of the landfill and thermal desorption is the potential in-migration of workers that may be brought in from outside the immediate area if required;

- Total ratings scores for Community and Institutional Structures for each treatment/disposal option are all positive. This indicates that if there is any change to the baseline during the development phases, the cumulative impact should be at least a minor positive impact, if not a major positive impact. Those treatment/disposal options that present the potential for major positive impacts are landfill and thermal desorption with the potential for large amounts of economic investment, opportunities for local, regional and national business development and opportunities for employment and training provision;

- The cumulative impact on Political and Social Resources for all treatment/disposal options across all development phases is a major negative impact. This is due to the embedded public perceptions of waste treatment/disposal facilities and the management of waste in the long-term;

- Cumulative ratings scores for Individual and Family Changes are negative for all treatment/disposal options but are significantly high against landfill and thermal desorption. This is primarily because the perceptions of risk, health and safety, the actual health risks of development, the attitudes towards the project, and the concerns about social well-being are likely to be heightened for treatment/disposal options that require a large dedicated waste treatment site to be developed;

- Community Resources presents a negligible impact cross all development phases for those treatment/disposal options including stabilisation, solidification, soil washing and bioremediation. The impact on Community Resources for landfill and thermal desorption is predicted to be minor negative impact due to the changes in land use patterns and the security issues.

In summary, when looking at the cumulative impact rating across all socio-economic criteria, all treatment/disposal options present at least a minor negative impact against the baseline conditions. However, two treatment methods including landfill and thermal desorption present a significantly higher negative impact than the other three treatment methods. The primary reasons for this are presented below:

- These treatment/disposal options would definitely require a waste treatment facility to be developed on a dedicated site, whereas the other three cold be undertaken in-situ of where the waste is generated;

- The environmental and physical footprint of these two treatment/disposal options would be considerably greater than those that would be required for the other treatment/disposal options; and

- The expected facility lifespan of approximately 30 years (and potential long term aftercare associated with landfill sites) would present a further concern for affected and interested parties, compared to the other (and potential long term aftercare associated with landfill sites)that may not be operated for a long time span.

The key to minimising and managing these potential negative impacts of landfill and thermal desorption is to ensure that effective consultation and engagement is undertaken. It is particularly important as key negative impacts tend to centre on people’s beliefs associated with the proposed project, including the extent of affected parties, trust in political institutions, and attitudes towards the project. Careful consultation and engagement could reduce the extent of interested and affected parties that are concerned along with people's negative perceptions and beliefs in the impacts of the proposed facility. This could help maintain other stakeholder's level of trust in political institutions and attitudes towards the development. Whilst these impacts cannot be eradicated effective consultation could ensure they can be significantly reduced.

It is worth noting that this study is an initial assessment and is based on estimated impacts rather than actual, definitive impacts. Therefore, at this stage (prior to the identification of a site and planning), the use of the socio-economic impact assessment criteria is more of a guideline to what the expected socio-economic impacts of the choice the identification of a site and could be.

14.7. Community Gain

The concept of community gain was first introduced under the Agreed Programme for Government in 2002. The programme identified a number of areas for improvement and associated policy development in a wide variety of areas. Waste was included as a key objective and in 2002, the concept of community gain was mentioned as follows;

'*We will develop further the concept of community gain in association with the delivery of major infrastructure proposals under the local authority waste management plans'*.

Since 2002 it became standard practice for a condition to be attached to the grant of planning permission or a waste licence for major pieces of waste infrastructure, this condition required operators to contribute to a special fund to be used to support certain initiatives in the local area where the waste infrastructure is to be located. The contribution has generally been set on the basis of an amount per tonne of waste accepted. In some cases a one off contribution has been made during the first year of operation of a waste facility and then a contribution per tonne of waste thereafter.

The 2004 Government Policy Document on progress with waste management and planning in Ireland, *Taking Stock Moving Forward*, made reference to the *Agreed Programme for Government* from 2002 and adopted community gain funding as, "*a valid instrument in terms of the delivery of major waste facilities, Government policy in relation to the concept of community gain will be applied by the relevant authorities in their decisions on applications for planning consent for such facilities".'*

The community gain concept has been criticised for being an instrument introduced to "buy-off" objecting communities in the vicinity of proposed significant waste facilities. However, the concept of community gain recognises that modern waste facilities are required and they have to be located somewhere, therefore communities in those locations should accrue some benefit for the chosen location.

The most recent *Agreed Programme for Government* (2007-2012) introduced the concept of:

"*establishing community monitoring arrangements of major waste management facilities, including on-line monitoring where appropriate, with specific powers/rights to information"* .

This concept has now become inherent in most waste licences granted by the EPA.

14.8. Recommendations

It is recommended that the use of the socio-economic assessment tool (in **Appendix 6**) be considered for use in future stages of the development of treatment and disposal options. Firstly, it can be used in the process of site selection. Key criteria from the list can be used in addition to other criterion to compare alternative sites. The criteria that is drawn out and used could be consulted upon to identify those criteria that are considered most significant; otherwise it would be at the discretion of the site developers.

Secondly, it can be used as the basis for a detailed socio-economic assessment of the chosen site and chosen facility type in support of an eventual planning application. This tool is extremely useful when site specific information is known, including the socio-demographic characteristics of an area, the existing and historic land uses on and surrounding the site, the relationship of the local people with the local governing authorities, and the range of amenities and business types available in the local area. It allows significance ratings to be determined for each sub-criterion, indicates key benefits and negative impacts of a proposed development, and highlights areas that would require further mitigation and consideration. Therefore, this socio-economic impact assessment tool would be extremely useful in supporting a proposed hazardous waste treatment/disposal facility through planning application and beyond to aid its continued efforts to minimise the socio-economic impact and optimise the benefits.

As the waste to be dealt with is hazardous and “difficult”, there are likely some health risks associated with it. These health risks may be perceived and / or actual. The planning for the management of this waste would benefit from the use of Health Impact Assessment tool as it enables a policy, programme or project to be judged as to its potential effects on the health of a population, and the distribution of those effects within the population[162]. The EPA funded the development of a Health Impact Assessment tool by the Institute of Public Health in Ireland (IPH)[163]. It can be used at the consultation stage to inform the local community and stakeholders of the proposed and potential developments, to gain their view on interests and concerns relating to the health risks involved with the proposals, and generate a prioritised list of health interests and concerns of the stakeholders. Ideally, it aims to develop an action plan that can be used to ensure that a compromise is reached between the proposed development and the mitigation and prevention of any potential health problems related to it. It is recommended that the use of Health Impact Assessment is considered in going forward with further planning for the management of such waste streams in Ireland.

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[162] Definition taken from Gothenburg Consensus Paper: Health Impact Assessment, Main Concepts and Suggested Approach, December 1999, published by the European Centre for Health Policy.

[163] Health Impact Assessment: Screening for health impacts - Institute of Public Health in Ireland (IPH), Published in June 2010

15. CONCLUSIONS AND RECOMMENDATIONS

15.1. Introduction

There has generally been a downward trend in the amount of hazardous waste arisings between 2004 and 2007. In 2008 there was a 5% increase in hazardous waste arising, Ireland produced 319,098 tonnes of hazardous waste (this includes all forms of hazardous waste), of which 157,207 tonnes were exported for treatment and disposal due to the lack of facilities in Ireland to treat and dispose of nationally produced hazardous waste. The tonnage disposed of was 67,424. These figures do not include contaminated soil which can vary significantly on an annual basis, with 493,1207 generated in 2008 compared with 188,127 tonnes in 2007.

An inventory of landfillable hazardous wastes for Ireland and Northern Ireland was compiled from the quantities of hazardous waste streams generated. Reported hazardous waste arisings for disposal codes D1 and D5 from Ireland and Northern Ireland (including contaminated soils) totalled 235,296 tonnes in 2008.

The lack of capacity for the treatment and disposal of hazardous waste means it is difficult for Ireland to increase and improve its self-sufficiency in the management of hazardous waste, which is a stated aim of the National Hazardous Waste Management Plan (NHWMP). In addition the lack of suitable hazardous waste facilities can lead to uncontrolled movement and disposal of hazardous waste, potentially leading to risk to human health and the environment as well as costly clean up To address this issue the NHWMP recommended that at least one hazardous waste landfill should be developed in Ireland, capable of accepting the wide range of hazardous wastes that would otherwise be exported for landfill.

This study explores the technical and economic aspects of developing a National Difficult Waste Management Facility (NaDWaF), the primary element of which will be a hazardous waste landfill. In addition to hazardous waste there are other sources of waste arisings produced in Ireland that require special management and a NaDWaF may be the most practicable option for treatment/disposal for hazardous, difficult and radioactive source wastes.

The key conclusions from the study are as follows:

15.2. Need for a NaDWaF

At the core of the NHWMP is a prevention programme to reduce the gross generation of hazardous waste. Even with prevention and minimisation programmes there will always be the need for treatment and disposal outlets for hazardous wastes. Ireland is unlikely to achieve complete self-sufficiency in waste management, however an increase in self sufficiency for treatment and disposal of hazardous waste in Ireland and/or Northern Ireland and a reduction in export is a key objective of the NHWMP.

There is going to be a demand for disposal capacity for ash from the municipal incinerators currently under development.

In principle there is acceptance at policy level in Ireland and Northern Ireland for the development of all-island waste management facilities. The regulatory framework allows for the movement of hazardous wastes between the jurisdictions, but this is limited to landfill disposal, incineration on land and treatment prior to disposal by either method. The acceptance of waste from Northern Ireland could increase the viability of a NaDWaF. However, based on the estimated future capacity need it would suggest that viability of a NaDWaF is not critically dependant on the received hazardous waste from Northern Ireland. While the inclusion of such waste could help to strengthen the business case for a NaDWaF, any business case should not rely on the hazardous waste from Northern Ireland, as waste producers in Northern Ireland would be able to decide to send their waste to a NaDWaF or to appropriate facilities in Great Britain.

The main barriers to an all-island solution are:

- Financial (both the disposal cost and the waste shipment costs), although these can only be examined in detail when potential locations for a NaDWaF are known; and
- Public acceptability, although any disbenefits would be more associated with the NaDWaF itself as opposed to the fact that a small proportion of the input arose in Northern Ireland.

The analysis of trends in hazardous waste arisings and hazardous waste disposal in Ireland and abroad enabled a baseline year of 2008 to be established and future arisings estimated. The total baseline tonnage for 2008 for waste arisings is 235,296. Hazardous waste arisings suitable for landfill were estimated using the ESRI forecast model, ISus. The estimated total tonnages for 2008 to 2025, aggregated on 6 year basis are summarised in **Table 69**.

Table 69 Hazardous Waste Suitable for Landfill Predictions, Ireland and Northern Ireland, Aggregated on 6 year basis, 2008 – 2025

	Estimated Average Annual Tonnage between:		
	2008 - 2013	2014 - 2019	2020 - 2025
Hazardous Waste Suitable for Landfill	216,534	277,139	306,526

The largest component of these estimates is contaminated soils. The landfill capacity needed to manage these arisings will depend on the treatment required to ensure the waste to be landfilled meets the Waste Acceptance Criteria, as many pre-treatments increase the weight and volume of the material to be landfilled.

A range of suitable treatment options are discussed in **Chapter 8** and include;

- Stabilisation and Solidifications;
- Bioremediation;
- Soil washing;
- Thermal Desorption; and
- Physico-chemical treatment.

The disposal options considered are stable non-reactive hazardous waste landfill cell and hazardous landfill.

Capacity estimates were developed by allocating the range of hazardous wastes to the different treatment/disposal routes and estimating the potential output to landfill. However the capacity estimates could be significantly influenced by quantity of contaminated soils produced based on 2008 figures and the production of flue gas cleaning residues in future. Therefore sensitivity analyses were undertaken to assess the potential implications.

Table 70 summarises the estimated landfill capacity required up to 2025.. The table highlights the potential impact on the estimated landfill capacity of varying arisings of contaminated soil and the implication of the development of treatment techniques for flue gas cleaning residues. The figures show that under the baseline prediction model, the future capacity need is between 235,000 to 257,000 tonnes per annum up to 2019, reducing to 185,000 tonnes per annum as a result of assuming that treatment techniques advance. However the capacity is significantly affected by assumption on the quantity of contaminated soil arisings and the treatment of flue gas cleaning residues and the capacity need could reduce to below 100,000 tonnes per annum.

Table 70 Total Estimated Annual Hazardous Waste Landfill Tonnage Capacity

	Annual tonnage		
	2008 – 2013*	2014 - 2019	2020 - 2025
Baseline Prediction Model	257,000	235,000	185,000
Sensitivities			
Reducing contaminated soil arisings to 2007 levels	135,000	129,000	115,000
Treatment of all flue gas cleaning residues resulting in non-hazardous outputs	214,000	195,000	152,000
Reducing contaminated soil arisings to 2007 levels AND Treatment of all flue gas cleaning residues resulting in non-hazardous outputs	92,000	89,000	82,000

15.3. Difficult Waste

The wastes considered under the term “difficult” included, Out of Date Ordnance, Out of Date Marine Flare (time expired pyrotechnics (TEPs)), non re-saleable seized/confiscated controlled substances, ship and cargo wastes, noxious weeds, contaminated dredging spoils and harbour wastes. The wastes for which recommendations are provided for only include TEPs but comment is provided on other arisings. The reasons being;

- Out of Date Ordnance generated by military operations do not occur on a regular basis and are dealt with appropriately by the Department of Defence, this practice will continue;

- Non re-saleable seized/confiscated controlled substances are dealt with appropriately by An Garda Siochána and Customs Office;

- International catering waste, while generally not hazardous waste, the issues arising under EU Animal By-Products regulations are that such risk wastes can only be managed through deep burial in a municipal waste landfill, in other jurisdictions this waste is incinerated. These wastes are captured in national waste reporting and quantities arising and the specifics thereof are not significant;

- Noxious weeds – Regulations provide for the prevention and control of certain noxious weeds such as Ragwort, There is no specific data pertaining to the volume of noxious weeds that may require disposal by landfilling or methods other than burning. Noxious weeds can be landfilled, and guidance does indicate that such waste should be disposed via deep burial. However, a proliferation of landfilling of such wastes will impact on the ability of landfill operators to divert BMW from landfill. In most European countries noxious weeds are disposed via incineration.

- Contaminated dredging spoils and harbour wastes – The NHWMP recommends a programme for the systematic identification, assessment and action planning for potentially contaminated harbour, port and marina sediments, this recommendation has not yet been assigned. It is therefore difficult to predict future arisings although it is likely that some of this waste would be treated in-situ, with some amounts requiring treatment at a treatment facility or disposal.

A key waste arising requiring the introduction of a co-ordinated management policy is Out of Date Marine Flare (time expired pyrotechnics (TEPs)). In summary the actual arisings are not definitively known and there is lack of regulation dealing with the disposal of such arisings. The manufacture, transport, sale and storage of explosives is regulated by various national and local government bodies, but there is a fragmented approach in the destruction of TEPs. One central facility would be impractical for the storage of TEPs as storage facilities need to be close to the arisings, also the disposal of TEP needs specialist knowledge (which the military has) and this expertise would not normally reside in waste management companies. Therefore including a destruction facility at the NaDWaF may not be the most cost effective method of disposal, however the lack of data means the suitability cannot be assessed. The EPA in the NHWMP recommend that an appropriate agent of the state is appointed, most likely the emergency services for the management of TEPs. Further feasibility should be considered in the establishment of a network of small storage units perhaps at coastguard stations, with a view to collection and destruction being contracted to a suitable private contractor. It is likely that since volumes are so low that shipment to a destruction facility in the UK may need to be considered as the volumes arising are so low to warrant the investment in such a facility in Ireland, subject to suitable transport arrangements.. Another option would be to consider the UK Maritime and Coastguard Agency storage facility in Belfast as a main central facility where TEPs are delivered and stored prior to destruction at a facility in England.

15.4. Radioactive Source Wastes

While radioactive waste is not covered under the Waste Management Acts 1996-2008, the Radiological Protection Institute of Ireland (RPII) identified a deficit in the provision of services to ensure the collection and management of radioactive waste. In addition, a high level inter-departmental group including the EPA and RPII, was established in 2008 to consider and advise Government on the best policy and practice for the safe long term management of Ireland's radioactive waste materials, which was presented to the Irish Government in 2009 (*National Report by Ireland to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, November, 2008)*.

Information was collated on the current inventory of disused and orphan radioactive sources to determine extent and characteristics of a national store. On the basis of the inventory, containment and operational requirements were addressed. The RPII radioactive source inventory for disused sources comprises of more than 5,820 sources. Only a limited number of sources have any information on the physical form and/or the practice from which the source originated. The majority of the disused sources are likely to decay to levels lower than the exemption levels within relatively short timescales i.e. < 5 years. The number of more active and longer lived sources is quite small and there are only a very small number of high activity sources. For sources currently in use there should already be a "take-back" agreement and therefore there is only likely to be a small number of those which might need to be managed in the longer term.

In addition to the disused sources contained in the inventory of sources there are other radioactive sources and potential sources of radioactive material. Post-primary schools in Ireland hold an estimated 1,306 sealed and 835 unsealed radioactive sources, many of which exceed the exemption levels set out in the Ionising Radiation Order[164] . It has been estimated that about 35% of the sealed sources and 56% of unsealed sources may be categorised as disused.

Disused sealed radioactive sources are not necessarily radioactive waste, there may be other uses to which a source could be put by a licensee. Once reuse and recycling options have been exhausted then the sources will be declared radioactive waste.

In general, the solution would be for the disposal of the sources as waste but at present there is no disposal route for radioactive materials available in Ireland. In order to make use of this route, sources have to be stored until such time as they have decayed to the appropriate levels.

Disposal involves the isolation of radioactive wastes in a suitable facility without the intention to retrieve, and with minimal requirement for long term surveillance or maintenance. It is the preferred and most sustainable option for the management of sources containing moderate to long lived radionuclides (half life > 5 yrs) because it takes away the burden of managing these wastes from future generations; is more cost-effective in the long term than alternative arrangements; and is less reliant on the continuity of regulatory control.

It should be recognised that in Ireland, with the relatively small number of larger and longer lived sources it may never be considered cost effective to provide a disposal route and it might make more sense to discuss co-operation with other nearby countries in a similar situation to find a joint solution. Where disused radioactive sources are to be stored for medium to long periods for decay or until the availability of a final disposal option, it is important that they are conditioned in order to minimise the risks from radiation and from potential leakage from the sources. For sources with short half lives and low activity levels the most effective approach is to store these until they have decayed to below exemption levels and then to dispose of them, under licence from RPII, to a landfill as non-radioactive waste. They should be retained in storage by the Licensee in the current manner to ensure sufficient level of security and safety, with frequent checks as for operational sources.

All remaining sources should be stored until such time as Ireland identifies an ultimate disposal route either in Ireland or together with another country(ies). This is best done in a central facility rather than in multiple facilities on individual Licensee's sites, but only once a full inventory of disused radioactive sources, other radioactive waste in Ireland and potential future arisings have been fully assessed. A central facility should only be designed once the full inventory of disused radioactive sources, other radioactive waste in Ireland and potential future arisings have been fully assessed.

It is recommended that all stakeholders (including current Licensees, RPII, EPA, potential operators and the public) should be involved in the decision process in order to identify the options for a suitable location for such a facility, including the option of co-location with a hazardous waste facility; and the possible models for the ownership and management of such a facility and the key attributes for the decision making process which should follow thereafter.

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[164] S.I .No.125 of 2000, Ionising Radiation Order.

15.5. Technical Requirements and Site Selection

The Landfill Directive is the principal regulation governing the landfill of waste and is transposed into national legislation by Waste Management (Licensing) Regulations[165]. The EPA will not grant a waste licence for a new landfill facility unless it is satisfied that it will comply with all relevant requirements as specified in the Landfill Directive and supporting national legislation,

The facility design and operation therefore must be able to obtain a waste licence and other relevant authorisations to proceed. It must therefore meet or exceed BAT best available technique (BAT) and must be effective in the treatment of waste while not causing environmental pollution and damage to human health.

A landfill must be situated and designed so as to meet the necessary conditions for preventing pollution of the soil, groundwater and surface water and ensuring efficient collection of leachate as and when required. A number of technical containment requirements are pertinent for the design and operation of a hazardous waste landfill and of a Stable Non-Reactive Hazardous Waste (SNRHW) cell at a non-hazardous landfill. The basic technical requirements are well defined, however, the site location, whether a new site or co-located, will determine the risk assessments required and any specific containment that may be necessary for a particular location to comply with BAT. Site specific assessments would be required as part of the environmental impact assessment process, the outcome of which should provide for mitigation measures should impacts or potential environmental risks be identified.

15.6. Social-and Economic Appraisal

An economic appraisal was undertaken to provide a generic indication of the potential costs associated with developing a NaDWaF. The appraisal considered four scenarios in detail. The estimated Indicative Costs for Waste Scenarios (€ Millions) are demonstrated in **Table 71** below.

Table 71 Estimated Indicative Costs for Waste Scenarios (€ millions)

	2008-13	2014-19	2020-25
Scenario 1 - current treatment	30.5	35.9	41.0
Scenario 2 - specialist disposal	45.9	55.1	57.7
Scenario 3 - specialist treatment	33.6	44.0	49.2
Scenario 4 - no treatment prior to landfill	36.0	35.3	29.6

In addition, a high-level socio-economic assessment of developing a NaDWaF in Ireland was undertaken. The assessment considered impact on Population Characteristics, Community and Institutional Structures; Political and Social Resources; Individual and Family Changes and Community Resources.

165 Waste Management (Licensing) Regulations S.I. No.185 of 2000, the Waste Management (Licensing) (Amendment) Regulations, S.I.No.336 of 2002, European Communities (Amendment of Waste Management (Licensing) Regulations S.I.No.337 of 2002, and Waste Management (Licensing) Regulations S.I No. 395 of 2004.

In summary, when looking at the cumulative impact rating across all socio-economic criteria, all treatment methods present at least a minor negative impact against the baseline conditions. However, landfill and thermal desorption present a significantly higher negative impact than the other treatment methods considered. The reasons include perceptions of risk, health and safety, the attitudes towards the project, and the concerns about social well-being are likely to be heightened for treatment methods that require a large dedicated waste treatment site to be developed, the environmental and physical footprint; and the expected facility lifespan and aftercare.

The key to minimising and managing these potential negative impacts is to ensure that effective consultation and engagement is undertaken. Careful consultation and engagement would reduce the extent of interested and affected parties that are concerned along with people's negative perceptions and beliefs in the impacts of the proposed facility. This would help maintain other stakeholder's level of trust in political institutions and attitudes towards the development. Whilst these impacts cannot be eradicated, effective consultation would ensure they can be significantly reduced.

It is worth noting that this is an initial assessment and is based on estimated impacts rather than actual, definitive impacts. It is recommended that the use of the socio-economic assessment tool (in **Appendix 6**) used in this assessment be considered for use in future stages of the development of a hazardous waste treatment and landfill, as:

- It can be used in the process of site selection; and
- It can be used as the basis for a detailed socio-economic assessment of the chosen site and chosen facility type in support of an eventual planning application.

In addition it is recommended that the use of Health Impact Assessment is considered in going forward with the development of a NaDWaF.

Appendices

Appendix 1 European Disposal Codes

Appendix 2 Prediction model of future hazardous waste arisings

Appendix 2 Detailed allocation matrix of future capacity needs

Appendix 3 Legislation and Guidance Considered for landfill design

Appendix 4 Economic Modelling Tool for NaDWaF

Appendix 5 Socio-economic Assessment of Treatment/Disposal Options

Appendix 1 European Disposal Codes

Waste Framework Directive 2006/12/EC ANNEX II A DISPOSAL OPERATIONS		
D1. Landfill	D2. Land Treatment	D3. Injection
D4. Impoundment	D5. Engineered Landfill	D6. Release to waters
D7. Release to sea	D8. Biological Treatment	D9. Physico chemical treatment
D10. Incineration on land	D11 Incineration at sea	D12 Permanent storage (e.g., emplacement of containers in a mine)
D13. Blending or mixing prior to submission to any of the operations numbered D1-D12	D14. Repackaging prior to submission to any of the operations numbered D1-D12	D15. Storage pending any of the operations numbered D1-D12

Appendix 2 Prediction Model of Future Hazardous Waste Arisings

Appendix 2 Prediction model of future hazardous waste arisings

HAZARDOUS WASTE, LANDFILLED Unit: tonnes	NACE	2008	2009	2010	2011	2012	2013	2008 - 2013 Average	2014	2015	2016	2017	2018	2019	2014 - 2019 Average	2020	2021	2022	2023	2024	2025	2014 - 2019 Average
Chemical production																						
*07 05 11**		**79**	79	80	87	100	110	**89**	120	131	138	145	152	160	**141**	169	175	180	185	190	194	**182**
*07 05 13**		**138**	138	139	153	175	193	**156**	210	228	241	253	266	280	**246**	295	306	315	323	331	339	**318**
*16 11 05**	24	**5**	5	5	6	6	7	**6**	8	8	9	9	10	10	**9**	11	11	11	12	12	12	**12**
Non-metallic mineral production																						
*10 11 13**		**45**	30	26	31	41	44	**36**	47	50	50	51	52	53	**50**	55	56	58	60	63	66	**60**
*10 11 19**		**1,901**	1,272	1,106	1,319	1,726	1,840	**1,527**	1,990	2,101	2,118	2,142	2,179	2,256	**2,131**	2,323	2,372	2,450	2,549	2,661	2,785	**2,524**
*12 01 14**	26	**15**	10	9	10	14	15	**12**	16	17	17	17	17	18	**17**	18	19	19	20	21	22	**20**
Metal prod. excl. machinery & transport equip.																						
*01 03 07**		**12,559**	12,559	12,685	13,890	15,925	17,520	**14,190**	19,152	20,747	21,941	23,021	24,176	25,445	**22,414**	26,826	27,806	28,647	29,438	30,154	30,807	**28,946**
*10 02 07**		**38**	38	38	42	48	53	**43**	58	63	66	70	73	77	**68**	81	84	87	89	91	93	**88**
*10 10 07**	27-28	**731**	731	738	808	927	1,020	**826**	1,115	1,208	1,277	1,340	1,407	1,481	**1,305**	1,561	1,618	1,667	1,713	1,755	1,793	**1,685**
Electrical goods																						
*06 04 05**	31-33	**2,518**	2,518	2,543	2,785	3,193	3,513	**2,845**	3,840	4,160	4,399	4,615	4,847	5,101	**4,494**	5,378	5,575	5,744	5,902	6,046	6,177	**5,804**
Construction																						
*17 05 03**		**187,235**	114,026	107,473	123,201	160,086	163,831	**142,642**	173,380	179,933	178,997	179,184	179,746	183,490	**179,121**	186,486	188,358	191,729	196,410	202,401	208,954	**195,723**
*17 06 01**		**3,729**	2,271	2,140	2,454	3,188	3,263	**2,841**	3,453	3,584	3,565	3,569	3,580	3,654	**3,567**	3,714	3,751	3,818	3,912	4,031	4,162	**3,898**
*17 06 05**		**15,597**	9,499	8,953	10,263	13,335	13,647	**11,882**	14,443	14,989	14,911	14,926	14,973	15,285	**14,921**	15,535	15,691	15,971	16,361	16,860	17,406	**16,304**
*17 09 03**	45	**15**	9	9	10	13	13	**11**	14	14	14	14	14	15	**14**	15	15	15	16	16	17	**16**
Services (excl. transport)																						
*19 01 05**		**8**	7	7	8	8	8	**8**	9	9	9	10	10	10	**10**	10	11	11	11	12	12	**11**
*19 03 04**		**28**	26	26	26	28	29	**27**	31	32	33	34	35	36	**33**	37	37	39	40	41	43	**39**
*19 03 06**		**1,152**	1,079	1,070	1,089	1,146	1,205	**1,124**	1,263	1,318	1,355	1,390	1,432	1,479	**1,373**	1,508	1,541	1,585	1,637	1,695	1,763	**1,621**
*19 08 06**		**3**	3	3	3	3	3	**3**	3	3	4	4	4	4	**4**	4	4	4	4	4	5	**4**
*19 10 03**	50-55, 64-95	**9,500**	8,902	8,826	8,978	9,453	9,937	**9,266**	10,412	10,868	11,172	11,467	11,809	12,198	**11,321**	12,436	12,711	13,072	13,500	13,975	14,535	**13,371**
Predictions Model Sub-Total (Applying ESRI Growth Factors)		**235,296**	**153,202**	**145,877**	**165,162**	**209,415**	**216,250**	**187,534**	**229,564**	**239,461**	**240,315**	**242,260**	**244,780**	**251,053**	**241,239**	**256,462**	**260,142**	**265,423**	**272,183**	**280,360**	**289,184**	**270,626**
19 01 13* fly ash containing dangerous substances The ESRI factors have not been applied to 19 01 13 as there is no baseline figures for 2008, therefore figures are based on expected maximum amounts to be generated on an annual basis and remaining constant up to 2025		29,000	29,000	29,000	29,000	29,000	29,000	**29,000**	35,900	35,900	35,900	35,900	35,900	35,900	**35,900**	35,900	35,900	35,900	35,900	35,900	35,900	**35,900**
Predictions Model Grand Total		**264,296**	**182,202**	**174,877**	**194,162**	**238,415**	**245,250**	**216,534**	**265,464**	**275,361**	**276,215**	**278,160**	**280,680**	**286,953**	**277,139**	**292,362**	**296,042**	**301,323**	**308,083**	**316,260**	**325,084**	**306,526**

Appendix 3 Detailed Allocation Matrix of Future Capacity Needs

	Short Class	Description	Average Annual Predicted Tonnage 2008 - 2013	2014 - 2019	2020 - 2025
01 03 07*	waste from the further physical and chemical processing of metalliferrous minerals	other wastes containing dangerous substances from physical and chemical processing of metalliferous minerals	14,190	22,414	28,946
06 04 05*	metal containing wastes	wastes containing other heavy metals	2,845	4,494	5,804
07 05 11*	waste from the MFSU of pharmaceuticals	sludges from on-site effluent treatment containing dangerous substances	89	141	182
07 05 13*		solid wastes containing dangerous substances	156	246	318
10 02 07*	wastes from the iron and steel industry	solid wastes from gas treatment containing dangerous substances	43	68	88
10 10 07*	wastes from casting of non ferrous pieces	casting cores and moulds which have undergone pouring, containing dangerous substances	826	1,305	1,685
10 11 13*	wastes from manufacturing of glass and glass products	glass-polishing and -grinding sludge containing dangerous substances	36	50	60
10 11 19*		solid wastes from on-site effluent treatment containing dangerous substances	1,527	2,131	2,524
12 01 14*	wastes from shaping (including forging, welding, pressing, drawing, turning, cutting and filing)	machining sludges containing dangerous substances	12	17	20
16 11 05*	waste linings and refractories	linings and refractories from non- metallurgical processes containing dangerous substances	6	9	12
17 05 03*	soil and dredging spoil	soil and stones containing dangerous substances	142,642	179,121	195,723
17 06 01*	insulation materials	insulation materials containing asbestos	2,841	3,567	3,898
17 06 05*		construction materials containing asbestos	11,882	14,921	16,304
17 09 03*	other construction and demolition wastes	other construction and demolition wastes (including mixed wastes) containing dangerous substances	11	14	16
19 01 05*	wastes from incineration or pyrolysis of municipal and similar commercials, industrial and institutional wastes	filter cake from gas treatment	8	10	11
19 01 13*		fly ash containing dangerous substances	29,000	35,900	35,900
19 03 04*	stabilised/solidified wastes	wastes marked as hazardous, partly stabilised	27	33	39
19 03 06*		wastes marked as hazardous, solidified	1,124	1,373	1,621
19 08 06*	wastes from water treatment plants not otherwise specified	saturated or spent ion exchange resins	3	4	4
19 10 03*	wastes from shredding of metal-containing wastes	fluff-light fraction and dust containing dangerous substances	9,266	11,321	13,371
			Increase in weight from stabilisation/solidification		

	% to between 2008 - 2013: Direct to Landfill	Stabilisation/ Solidification	Bio-remediation	Soil Washing	Thermal Desorption	SNRHW Landfill Cell	Other Treatment Methods	2008 - 2013 Potential Annual Hazardous Landfill
01 03 07*							100%	-
06 04 05*	50%	50%						4,270
07 05 11*		50%					50%	90
07 05 13*	50%	50%						230
10 02 07*		100%						90
10 10 07*		50%					50%	830
10 11 13*		50%					50%	40
10 11 19*	50%	50%						2,290
12 01 14*		100%						20
16 11 05*	100%							10
17 05 03*	50%	35%	5%	5%	5%			171,170
17 06 01*		75%				25%		4,970
17 06 05*		25%				75%		14,850
17 09 03*	50%	50%						20
19 01 05*	50%	50%						10
19 01 13*		75%					25%	43,500
19 03 04*	100%							30
19 03 06*						100%		1,120
19 08 06*	100%							-
19 10 03*	50%	50%						13,900
		2						257,400

	% to between 2014 - 2019: Direct to Landfill	Stabilisation/ Solidification	Bio-remediation	Soil Washing	Thermal Desorption	SNRHW Landfill Cell	Other Treatment Methods	2014 - 2019 Potential Annual Hazardous Landfill
01 03 07*							100%	-
06 04 05*	50%	50%						5,620
07 05 11*		50%					50%	110
07 05 13*	50%	50%						310
10 02 07*		100%						100
10 10 07*		50%					50%	980
10 11 13*		50%					50%	40
10 11 19*	50%	50%						2,660
12 01 14*		100%						30
16 11 05*	100%							10
17 05 03*	45%	25%	10%	10%	10%			147,770
17 06 01*		75%				25%		4,900
17 06 05*		25%				75%		16,790
17 09 03*	50%	50%						20
19 01 05*	50%	50%						10
19 01 13*		75%					25%	40,390
19 03 04*	100%							30
19 03 06*						100%		1,370
19 08 06*	100%							-
19 10 03*	50%	50%						14,150
	/solidification	1.5						235,300

	% to between 2020 - 2026: Direct to Landfill	Stabilisation/ Solidification	Bio-remediation	Soil Washing	Thermal Desorption	SNRHW Landfill Cell	Other Treatment Methods	2020 - 2025 Potential Annual Hazardous Landfill			
01 03 07*							100%	-	OK	OK	OK
06 04 05*	50%	50%						7,260	OK	OK	OK
07 05 11*		50%					50%	140	OK	OK	OK
07 05 13*	50%	50%						400	OK	OK	OK
10 02 07*		100%						130	OK	OK	OK
10 10 07*		50%					50%	1,260	OK	OK	OK
10 11 13*		50%					50%	50	OK	OK	OK
10 11 19*	50%	50%						3,160	OK	OK	OK
12 01 14*		100%						30	OK	OK	OK
16 11 05*	100%							10	OK	OK	OK
17 05 03*	20%	20%	20%	20%	20%			97,860	OK	OK	OK
17 06 01*		75%				25%		5,360	OK	OK	OK
17 06 05*		25%				75%		18,340	OK	OK	OK
17 09 03*	50%	50%						20	OK	OK	OK
19 01 05*	50%	50%						10	OK	OK	OK
19 01 13*		60%					40%	32,310	OK	OK	OK
19 03 04*	100%							40	OK	OK	OK
19 03 06*						100%		1,620	OK	OK	OK
19 08 06*	100%							-	OK	OK	OK
19 10 03*	50%	50%						16,710	OK	OK	OK
	olidification	1.5						184,700			

Capacity required	2008 - 2013	2014 - 2019	2020 - 2025
Stabilisation/ Solidification	84,000	88,000	80,000
Bio-remediation	7,000	18,000	39,000
Soil Washing	7,000	18,000	39,000
Thermal Desorption	7,000	18,000	39,000

Landfilled	2008 - 2013	2014 - 2019	2020 - 2025
Direct	78,000	90,000	50,000
Following treatment	168,000	132,000	120,000
Direct to SNRHW Cell	11,000	13,000	15,000
Total	257,000	235,000	185,000

Note: all figures are round to the nearest 1,000 tonnes

Assumptions

Certain waste streams can be landfilled without further treatment (either hazardous waste landfill or separate cell in non-hazardous waste landfill), because it is treated at the point of production or the treatment would not contribute to the objectives of the Landfill Directive, with the estimate based on waste type

Proportion of contaminated soils can be treated by in-situ or ex-site treatment methods (such as bio-remediation, soil washing etc) resulting in non-hazardous output

Stabilisation/solidification will increase the weight of waste by a factor of 2;

All stabilised/solidified waste remains hazardous

01 03 07* would be managed at existing facilities

Additional/Changed Assumptions

Improvements in stabilisation/solidification techniques reduces weight increase from a factor of 2 to a factor of 1.5;

			Average Annual Predicted Tonnage			% to between 2008 - 2013							2008 - 2013
	Short Class	Description	2008 - 2013	2014 - 2019	2020 - 2025	Direct to Landfill	Stabilisation/ Solidification	Bio- remediation	Soil Washing	Thermal Desorption	SNRHW Landfill Cell	Other Treatment Methods	Potential Annual Hazardous Landfill
01 03 07*	waste from the further physical and chemical processing of metalliferrous minerals	other wastes containing dangerous substances from physical and chemical processing of metalliferous minerals	14,190	22,414	28,946							100%	-
06 04 05*	metal containing wastes	wastes containing other heavy metals	2,845	4,494	5,804	50%	50%						4,270
07 05 11*	waste from the MFSU of pharmaceuticals	sludges from on-site effluent treatment containing dangerous substances	89	141	182		50%					50%	90
07 05 13*		solid wastes containing dangerous substances	156	246	318	50%	50%						230
10 02 07*	wastes from the iron and steel industry	solid wastes from gas treatment containing dangerous substances	43	68	88		100%						90
10 10 07*	wastes from casting of non ferrous pieces	casting cores and moulds which have undergone pouring, containing dangerous substances	826	1,305	1,685		50%					50%	830
10 11 13*	wastes from manufacturing of glass and glass products	glass-polishing and -grinding sludge containing dangerous substances	36	50	60		50%					50%	40
10 11 19*		solid wastes from on-site effluent treatment containing dangerous substances	1,527	2,131	2,524	50%	50%						2,290
12 01 14*	wastes from shaping (including forging, welding, pressing, drawing, turning, cutting and filing)	machining sludges containing dangerous substances	12	17	20		100%						20
16 11 05*	waste linings and refractories	linings and refractories from non- metallurgical processes containing dangerous substances	6	9	12	100%							10
17 05 03*	soil and dredging spoil	soil and stones containing dangerous substances	40,894	51,352	56,111	50%	35%	5%	5%	5%			49,070
17 06 01*	insulation materials	insulation materials containing asbestos	2,841	3,567	3,898		75%				25%		4,970
17 06 05*		construction materials containing asbestos	11,882	14,921	16,304		25%				75%		14,850
17 09 03*	other construction and demolition wastes	other construction and demolition wastes (including mixed wastes) containing dangerous substances	11	14	16	50%	50%						20
19 01 05*	wastes from incineration or pyrolysis of municipal and similar commercials, industrial and institutional wastes	filter cake from gas treatment	8	10	11	50%	50%						10
19 01 13*		fly ash containing dangerous substances	29,000	35,900	35,900		75%					25%	43,500
19 03 04*	stabilised/solidified wastes	wastes marked as hazardous, partly stabilised	27	33	39	100%							30
19 03 06*		wastes marked as hazardous, solidified	1,124	1,373	1,621						100%		1,120
19 08 06*	wastes from water treatment plants not otherwise specified	saturated or spent ion exchange resins	3	4	4	100%							-
19 10 03*	wastes from shredding of metal-containing wastes	fluff-light fraction and dust containing dangerous substances	9,266	11,321	13,371	50%	50%						13,900
			Increase in weight from stabilisation/solidification				2						135,300

	% to between 2014 - 2019							2014 - 2019
	Direct to Landfill	Stabilisation/ Solidification	Bio- remediation	Soil Washing	Thermal Desorption	SNRHW Landfill Cell	Other Treatment Methods	Potential Annual Hazardous Landfill
01 03 07*							100%	-
06 04 05*	50%	50%						5,620
07 05 11*		50%					50%	110
07 05 13*	50%	50%						310
10 02 07*		100%						100
10 10 07*		50%					50%	980
10 11 13*		50%					50%	40
10 11 19*	50%	50%						2,660
12 01 14*		100%						30
16 11 05*	100%							10
17 05 03*	45%	25%	10%	10%	10%			42,370
17 06 01*		75%				25%		4,900
17 06 05*		25%				75%		16,790
17 09 03*	50%	50%						20
19 01 05*	50%	50%						10
19 01 13*		75%					25%	40,390
19 03 04*	100%							30
19 03 06*						100%		1,370
19 08 06*	100%							-
19 10 03*	50%	50%						14,150
	/solidification	1.5						129,900

	% to between 2020 - 2026							2020 - 2025			
	Direct to Landfill	Stabilisation/ Solidification	Bio- remediation	Soil Washing	Thermal Desorption	SNRHW Landfill Cell	Other Treatment Methods	Potential Annual Hazardous Landfill			
01 03 07*							100%	-	OK	OK	OK
06 04 05*	50%	50%						7,260	OK	OK	OK
07 05 11*		50%					50%	140	OK	OK	OK
07 05 13*	50%	50%						400	OK	OK	OK
10 02 07*		100%						130	OK	OK	OK
10 10 07*		50%					50%	1,260	OK	OK	OK
10 11 13*		50%					50%	50	OK	OK	OK
10 11 19*	50%	50%						3,160	OK	OK	OK
12 01 14*		100%						30	OK	OK	OK
16 11 05*	100%							10	OK	OK	OK
17 05 03*	20%	20%	20%	20%	20%			28,060	OK	OK	OK
17 06 01*		75%				25%		5,360	OK	OK	OK
17 06 05*		25%				75%		18,340	OK	OK	OK
17 09 03*	50%	50%						20	OK	OK	OK
19 01 05*	50%	50%						10	OK	OK	OK
19 01 13*		60%					40%	32,310	OK	OK	OK
19 03 04*	100%							40	OK	OK	OK
19 03 06*						100%		1,620	OK	OK	OK
19 08 06*	100%							-	OK	OK	OK
19 10 03*	50%	50%						16,710	OK	OK	OK
	olidification	1.5						114,900			

Capacity required	2008 - 2013	2014 - 2019	2020 - 2025
Stabilisation/ Solidification	49,000	56,000	52,000
Bio- remediation	2,000	5,000	11,000
Soil Washing	2,000	5,000	11,000
Thermal Desorption	2,000	5,000	11,000

Lanfilled	2008 - 2013	2014 - 2019	2020 - 2025
Direct	27,000	32,000	22,000
Following treatment	97,000	84,000	78,000
Direct to SNRHW Cell	11,000	13,000	15,000
Total	135,000	129,000	115,000

Note: all figures are round to the nearest 1,000 tonnes

Code	Short Class	Description	Average Annual Predicted Tonnage 2008 - 2013	2014 - 2019	2020 - 2025
01 03 07*	waste from the further physical and chemical processing of metalliferrous minerals	other wastes containing dangerous substances from physical and chemical processing of metalliferous minerals	14,190	22,414	28,946
06 04 05*	metal containing wastes	wastes containing other heavy metals	2,845	4,494	5,804
07 05 11*	waste from the MFSU of pharmaceuticals	sludges from on-site effluent treatment containing dangerous substances	89	141	182
07 05 13*		solid wastes containing dangerous substances	156	246	318
10 02 07*	wastes from the iron and steel industry	solid wastes from gas treatment containing dangerous substances	43	68	88
10 10 07*	wastes from casting of non ferrous pieces	casting cores and moulds which have undergone pouring, containing dangerous substances	826	1,305	1,685
10 11 13*	wastes from manufacturing of glass and glass products	glass-polishing and -grinding sludge containing dangerous substances	36	50	60
10 11 19*		solid wastes from on-site effluent treatment containing dangerous substances	1,527	2,131	2,524
12 01 14*	wastes from shaping (including forging, welding, pressing, drawing, turning, cutting and filing)	machining sludges containing dangerous substances	12	17	20
16 11 05*	waste linings and refractories	linings and refractories from non- metallurgical processes containing dangerous substances	6	9	12
17 05 03*	soil and dredging spoil	soil and stones containing dangerous substances	142,642	179,121	195,723
17 06 01*	insulation materials	insulation materials containing asbestos	2,841	3,567	3,898
17 06 05*		construction materials containing asbestos	11,882	14,921	16,304
17 09 03*	other construction and demolition wastes	other construction and demolition wastes (including mixed wastes) containing dangerous substances	11	14	16
19 01 05*	wastes from incineration or pyrolysis of municipal and similar commercials, industrial and institutional wastes	filter cake from gas treatment	8	10	11
19 01 13*		fly ash containing dangerous substances			
19 03 04*	stabilised/solidified wastes	wastes marked as hazardous, partly stabilised	27	33	39
19 03 06*		wastes marked as hazardous, solidified	1,124	1,373	1,621
19 08 06*	wastes from water treatment plants not otherwise specified	saturated or spent ion exchange resins	3	4	4
19 10 03*	wastes from shredding of metal-containing wastes	fluff-light fraction and dust containing dangerous substances	9,266	11,321	13,371

Code	% to between 2008 - 2013: Direct to Landfill	Stabilisation/ Solidification	Bio-remediation	Soil Washing	Thermal Desorption	SNRHW Landfill Cell	Other Treatment Methods	2008 - 2013 Potential Annual Hazardous Landfill
01 03 07*							100%	-
06 04 05*	50%	50%						4,270
07 05 11*		50%					50%	90
07 05 13*	50%	50%						230
10 02 07*		100%						90
10 10 07*		50%					50%	830
10 11 13*		50%					50%	40
10 11 19*	50%	50%						2,290
12 01 14*		100%						20
16 11 05*	100%							10
17 05 03*	50%	35%	5%	5%	5%			171,170
17 06 01*		75%				25%		4,970
17 06 05*		25%				75%		14,850
17 09 03*	50%	50%						20
19 01 05*	50%	50%						10
19 01 13*		75%					25%	-
19 03 04*	100%							30
19 03 06*						100%		1,120
19 08 06*	100%							-
19 10 03*	50%	50%						13,900
Increase in weight from stabilisation/solidification		2						213,900

Code	% to between 2014 - 2019: Direct to Landfill	Stabilisation/ Solidification	Bio-remediation	Soil Washing	Thermal Desorption	SNRHW Landfill Cell	Other Treatment Methods	2014 - 2019 Potential Annual Hazardous Landfill
01 03 07*							100%	-
06 04 05*	50%	50%						5,620
07 05 11*		50%					50%	110
07 05 13*	50%	50%						310
10 02 07*		100%						100
10 10 07*		50%					50%	980
10 11 13*		50%					50%	40
10 11 19*	50%	50%						2,660
12 01 14*		100%						30
16 11 05*	100%							10
17 05 03*	45%	25%	10%	10%	10%			147,770
17 06 01*		75%				25%		4,900
17 06 05*		25%				75%		16,790
17 09 03*	50%	50%						20
19 01 05*	50%	50%						10
19 01 13*		75%					25%	-
19 03 04*	100%							30
19 03 06*						100%		1,370
19 08 06*	100%							-
19 10 03*	50%	50%						14,150
/solidification		1.5						194,900

Code	% to between 2020 - 2026: Direct to Landfill	Stabilisation/ Solidification	Bio-remediation	Soil Washing	Thermal Desorption	SNRHW Landfill Cell	Other Treatment Methods	2020 - 2025 Potential Annual Hazardous Landfill			
01 03 07*							100%	-	OK	OK	OK
06 04 05*	50%	50%						7,260	OK	OK	OK
07 05 11*		50%					50%	140	OK	OK	OK
07 05 13*	50%	50%						400	OK	OK	OK
10 02 07*		100%						130	OK	OK	OK
10 10 07*		50%					50%	1,260	OK	OK	OK
10 11 13*		50%					50%	50	OK	OK	OK
10 11 19*	50%	50%						3,160	OK	OK	OK
12 01 14*		100%						30	OK	OK	OK
16 11 05*	100%							10	OK	OK	OK
17 05 03*	20%	20%	20%	20%	20%			97,860	OK	OK	OK
17 06 01*		75%				25%		5,360	OK	OK	OK
17 06 05*		25%				75%		18,340	OK	OK	OK
17 09 03*	50%	50%						20	OK	OK	OK
19 01 05*	50%	50%						10	OK	OK	OK
19 01 13*		60%					40%	-	OK	OK	OK
19 03 04*	100%							40	OK	OK	OK
19 03 06*						100%		1,620	OK	OK	OK
19 08 06*	100%							-	OK	OK	OK
19 10 03*	50%	50%						16,710	OK	OK	OK
olidification		1.5						152,400			

Capacity required	2008 - 2013	2014 - 2019	2020 - 2025
Stabilisation/ Solidification	62,000	61,000	58,000
Bio-remediation	7,000	18,000	39,000
Soil Washing	7,000	18,000	39,000
Thermal Desorption	7,000	18,000	39,000

Lanfilled	2008 - 2013	2014 - 2019	2020 - 2025
Direct	78,000	90,000	50,000
Following treatment	125,000	92,000	87,000
Direct to SNRHW Cell	11,000	13,000	15,000
Total	214,000	195,000	152,000

Note: all figures are round to the nearest 1,000 tonnes

			Average Annual Predicted Tonnage		
	Short Class	Description	2008 - 2013	2014 - 2019	2020 - 2025
01 03 07*	waste from the further physical and chemical processing of metalliferrous minerals	other wastes containing dangerous substances from physical and chemical processing of metalliferous minerals	14,190	22,414	28,946
06 04 05*	metal containing wastes	wastes containing other heavy metals	2,845	4,494	5,804
07 05 11*	waste from the MFSU of pharmaceuticals	sludges from on-site effluent treatment containing dangerous substances	89	141	182
07 05 13*		solid wastes containing dangerous substances	156	246	318
10 02 07*	wastes from the iron and steel industry	solid wastes from gas treatment containing dangerous substances	43	68	88
10 10 07*	wastes from casting of non ferrous pieces	casting cores and moulds which have undergone pouring, containing dangerous substances	826	1,305	1,685
10 11 13*	wastes from manufacturing of glass and glass products	glass-polishing and -grinding sludge containing dangerous substances	36	50	60
10 11 19*		solid wastes from on-site effluent treatment containing dangerous substances	1,527	2,131	2,524
12 01 14*	wastes from shaping (including forging, welding, pressing, drawing, turning, cutting and filing)	machining sludges containing dangerous substances	12	17	20
16 11 05*	waste linings and refractories	linings and refractories from non- metallurgical processes containing dangerous substances	6	9	12
17 05 03*	soil and dredging spoil	soil and stones containing dangerous substances	40,894	51,352	56,111
17 06 01*	insulation materials	insulation materials containing asbestos	2,841	3,567	3,898
17 06 05*		construction materials containing asbestos	11,882	14,921	16,304
17 09 03*	other construction and demolition wastes	other construction and demolition wastes (including mixed wastes) containing dangerous substances	11	14	16
19 01 05*	wastes from incineration or pyrolysis of municipal and similar commercials, industrial and institutional wastes	filter cake from gas treatment	8	10	11
19 01 13*		fly ash containing dangerous substances			
19 03 04*	stabilised/solidified wastes	wastes marked as hazardous, partly stabilised	27	33	39
19 03 06*		wastes marked as hazardous, solidified	1,124	1,373	1,621
19 08 06*	wastes from water treatment plants not otherwise specified	saturated or spent ion exchange resins	3	4	4
19 10 03*	wastes from shredding of metal-containing wastes	fluff-light fraction and dust containing dangerous substances	9,266	11,321	13,371
			Increase in weight from stabilisation/solidification		

	% to between 2008 - 2013							2008 - 2013
	Direct to Landfill	Stabilisation/ Solidification	Bio- remediation	Soil Washing	Thermal Desorption	SNRHW Landfill Cell	Other Treatment Methods	Potential Annual Hazardous Landfill
01 03 07*							100%	-
06 04 05*	50%	50%						4,270
07 05 11*		50%					50%	90
07 05 13*	50%	50%						230
10 02 07*		100%						90
10 10 07*		50%					50%	830
10 11 13*		50%					50%	40
10 11 19*	50%	50%						2,290
12 01 14*		100%						20
16 11 05*	100%							10
17 05 03*	50%	35%	5%	5%	5%			49,070
17 06 01*		75%				25%		4,970
17 06 05*		25%				75%		14,850
17 09 03*	50%	50%						20
19 01 05*	50%	50%						10
19 01 13*		75%					25%	-
19 03 04*	100%							30
19 03 06*						100%		1,120
19 08 06*	100%							-
19 10 03*	50%	50%						13,900
		2						91,800

	% to between 2014 - 2019							2014 - 2019
	Direct to Landfill	Stabilisation/ Solidification	Bio- remediation	Soil Washing	Thermal Desorption	SNRHW Landfill Cell	Other Treatment Methods	Potential Annual Hazardous Landfill
01 03 07*							100%	-
06 04 05*	50%	50%						5,620
07 05 11*		50%					50%	110
07 05 13*	50%	50%						310
10 02 07*		100%						100
10 10 07*		50%					50%	980
10 11 13*		50%					50%	40
10 11 19*	50%	50%						2,660
12 01 14*		100%						30
16 11 05*	100%							10
17 05 03*	45%	25%	10%	10%	10%			42,370
17 06 01*		75%				25%		4,900
17 06 05*		25%				75%		16,790
17 09 03*	50%	50%						20
19 01 05*	50%	50%						10
19 01 13*		75%					25%	-
19 03 04*	100%							30
19 03 06*						100%		1,370
19 08 06*	100%							-
19 10 03*	50%	50%						14,150
	/solidification	1.5						89,500

	% to between 2020 - 2026							2020 - 2025			
	Direct to Landfill	Stabilisation/ Solidification	Bio- remediation	Soil Washing	Thermal Desorption	SNRHW Landfill Cell	Other Treatment Methods	Potential Annual Hazardous Landfill			
01 03 07*							100%	-	OK	OK	OK
06 04 05*	50%	50%						7,260	OK	OK	OK
07 05 11*		50%					50%	140	OK	OK	OK
07 05 13*	50%	50%						400	OK	OK	OK
10 02 07*		100%						130	OK	OK	OK
10 10 07*		50%					50%	1,260	OK	OK	OK
10 11 13*		50%					50%	50	OK	OK	OK
10 11 19*	50%	50%						3,160	OK	OK	OK
12 01 14*		100%						30	OK	OK	OK
16 11 05*	100%							10	OK	OK	OK
17 05 03*	20%	20%	20%	20%	20%			28,060	OK	OK	OK
17 06 01*		75%				25%		5,360	OK	OK	OK
17 06 05*		25%				75%		18,340	OK	OK	OK
17 09 03*	50%	50%						20	OK	OK	OK
19 01 05*	50%	50%						10	OK	OK	OK
19 01 13*		60%					40%	-	OK	OK	OK
19 03 04*	100%							40	OK	OK	OK
19 03 06*						100%		1,620	OK	OK	OK
19 08 06*	100%							-	OK	OK	OK
19 10 03*	50%	50%						16,710	OK	OK	OK
	olidification	1.5						82,600			

Capacity required	2008 - 2013	2014 - 2019	2020 - 2025
Stabilisation/ Solidification	27,000	29,000	30,000
Bio- remediation	2,000	5,000	11,000
Soil Washing	2,000	5,000	11,000
Thermal Desorption	2,000	5,000	11,000

Lanfilled	2008 - 2013	2014 - 2019	2020 - 2025
Direct	27,000	32,000	22,000
Following treatment	54,000	44,000	45,000
Direct to SNRHW Cell	11,000	13,000	15,000
Total	92,000	89,000	82,000

Note: all figures are round to the nearest 1,000 tonnes

	Export of physico-chemical treatment	Predicted Annual Arisings (Tonnes)		
		2008 – 2013*	2014 - 2019	2020 - 2025
2007	68,000	51,628	64,831	70,840
2008	30,000	23,055	28,952	31,635
Factor		2	1.5	1.5
% to Stabilisation/ Solidification in 2007	50%	26,000	32,000	35,000
% to Stabilisation/ Solidification in 2008	50%	12,000	14,000	16,000
Additonal Landfill 2007		52,000	48,000	53,000
Additonal Landfill 2008		24,000	21,000	24,000

Appendix 4 Legislation and Guidance Considered for Landfill Design

1. Environmental Protection Agency, 2001. National Hazardous Waste Management Plan. ISBN 1-84095-074-9
2. Environmental Protection Agency, 2008. National Hazardous Waste Management Plan 2008 – 2012. ISBN 978-1-84095-298-8
3. Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste. Official Journal of the European Union.
4. Waste Management (Licensing) Regulations, 2000. Statutory Instrument No.185 of 2000
5. Waste Management (Licensing) (Amendment) Regulations, 2002. Statutory Instrument No. 336 of 2002
6. Waste Management (Licensing) Regulation 2004. Statutory Instrument Number 395 of 2004. Office of the Attorney General.
7. Directive 2006/12/EC of the European Parliament and of the Council of 5 April 2006 on Waste. The Waste Framework Directive. Official Journal of the European Union.
8. Council Decision 2003/33/EC Establishing Criteria and Procedures for the Acceptance of Waste at Landfills pursuant to Article 16 of an Annex II to Directive 1999/31/EC
9. Environmental Protection Agency, 2000. Landfill Manuals: Landfill Site Design. ISBN 1-84095-026-9
10. Environmental Protection Agency, 1997. Landfill Manuals: Landfill Operational Practices. ISBN 1-899965-5055
11. Environmental Protection Agency, 2000. Landfill Manuals: Landfill Monitoring. 2nd Edition. ISBN 1-84095-127-3
12. Environmental Protection Agency, 2003. BAT Guidance Notes for the Waste Sector: Landfill Activities.
13. Environmental Protection Agency, 2008. Draft BAT Guidance Notes for the Waste Sector, Landfill Activities.
14. The Landfill Regulations (Northern Ireland), 2003. Statutory Rule 2003 No. 496. TSO.
15. The Landfill Regulations (England and Wales), 2002. Statutory Rule 2002 No. 1559. TSO.
16. The Landfill Regulations (Scotland), 2003. Statutory Rule 2003 No. 235. TSO.
17. Federal Government Ordinance on Landfills and Long-Term Storage Facilities and Amending the Ordinance on Environmentally Compatible Storage of Waste from Human Settlements and on Biological Waste-Treatment Facilities, 2002.
18. European hazardous waste Management Services Market, 2007. Research and Markets Brochure, Dublin.
19. Gesamtfassung der Zweiten Allgemeinen Verwaltungsvorschrift zum Abfallgesetz (TA-Abfall), 1991.
20. US Environmental Protection Agency, 1989. Requirements for Hazardous Waste Landfill Design, Construction and Closure.

21. Environment Agency, 2006. Guidance for waste destined for disposal in landfills. Interpretation of the Waste Acceptance Requirements of the Landfill (England and Wales) Regulations 2002 (as amended version 2).

22. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. The Water Framework Directive. Official Journal of the European Union.

23. Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration. The Groundwater Directive. Official Journal of the European Union.

24. European Communities Environmental Objectives (Groundwater) Regulations, S.I. No. 9 of 2010

25. Environmental Protection Agency, 2003. Landfill Manuals: Landfill Monitoring. ISBN 1-84095-127-3.

26. Environment Agency, 2007. Guidance on the Treatment of Landfill Leachate – Sector Guidance Note IPPC S5.03.

27. Robinson, H.D., Bone, B.D., Knox, K., & Picken, A., 2003. Leachate Quality from UK Landfills after Implementation of the Landfill Directive: Hazardous Wastes. International Waste Management and Landfill Symposium, Sardinia 2003.

28. Guidelines for Operators of Hazardous Waste Landfills, LV 2006/IB/EN/01 TL, Republic of Latvia, 2006 – Capacity Building of State Hazardous Waste Management Agency.

29. World Health Organization, European Series No. 46. Site Selection for New Hazardous Waste Management Facilities, 1993, ISBN 92 890 1309 5

30. Environment Agency (March 2003), [Landfill PPC Permit Application] Part B of Application Form for the Landfill Sector, Section C – Stability Risk Assessment Report, Generic Stability Risk Assessment Template

31. Environment Agency R&D Technical Report P1-385/TR1 (2002) Stability of Landfill Lining Systems: Report No 1 Literature Review. ISBN 1 85705 945 X

32. Environment Agency R&D Technical Report P1-385/TR2 (January 2003) Stability of Landfill Lining Systems: Report No 2 Guidance. ISBN 1 85705 945 X

33. Giroud, J.P., Williams, N.D., Pelte, T. and Beech, J.F. (1995) Stability of geosynthetic-soil layered systems on slopes. Geosynthetics International, Vol 2, No 6, 1115-1148.

34. Itasca, (2005), FLAC Fast Lagrangian Analysis of Continua User's Guide, Pub. Itasca Consulting Group Inc., Minneapolis

35. Janbu, N. (1973) Slope stability computations, in Embankment Dam Engineering: Cassagrande Memorial Volume, (eds Hirschfield and Poulos). John Wiley, New York, 47-86.

36. Jones, D.R.V. and Dixon, N, (1998) The stability of geosynthetic landfill liner systems Geotechnical Engineering of Landfills, 99-117. Thomas Telford, London.

37. Koerner, R.M., and Hwu, B-L, (1991) Stability and tension considerations regarding cover soils on geomembrane lined slopes. Geotextiles and Geomembranes, 10(4), 335-355

38. Thomas, R.L. and Cooke, S.D. (2007) Landfill waste settlement prediction by numerically modelling waste processes. Proceedings Sardinia 2007, Eleventh International Landfill Symposium, CISA publisher, Cagliari

Appendix 5 Economic Modelling Tool

Scenario 1	**Baseline**	Treatment to continue with existing routes external to Ireland with no new build NaDWF										
Scenario 2	**Specialist disposal**	Hazardous waste treatment prior to disposal to hazardous landfill										
Sceanrio 3	**Specialist treatment**	Hazardous waste treatment prior to disposal to non-hazardous landfill										
Scenario 4	**No treatment**	Hazardous waste, no treatment, direct to hazardous waste landfill										
Scenario 5	**Storage**	Storage of radiological waste										
Breakdown for each scenario per year												
SCENARIO 1 - current treatment												
	LANDFILL DISPOSAL							LANDFILL DISPOSAL				
		2008-13	2014-19	2020-25					2008-13	2014-19	2020-25	
	Direct to landfill	78,000	90,000	50,000				Direct to landfill	30%	38%	27%	
	Landfill after treatment	168,000	132,000	120,000		relative percentages		Landfill after treatment	65%	56%	65%	
	Direct to SNRHW cell	11,000	13,000	15,000				Direct to SNRHW cell	4%	6%	8%	
	TOTAL	257,000	235,000	185,000				TOTAL	100%	100%	100%	
	ASSOC. TREATMENT							ASSOC. TREATMENT				
		2008-13	2014-19	2020-25					2008-13	2014-19	2020-25	
	Stabilisation/solidification	84,000	88,440	80,400				Stabilisation/solidification	50%	67%	67%	
	Bioremediation	6,720	18,480	39,600				Bioremediation	4%	14%	33%	
	Soil washing	6,720	18,480	39,600				Soil washing	4%	14%	33%	
	Thermal desorption	6,720	18,480	39,600				Thermal desorption	4%	14%	33%	
SCENARIO 2 - specialist disposal												
	LANDFILL DISPOSAL							LANDFILL DISPOSAL				
		2008-13	2014-19	2020-25					2008-13	2014-19	2020-25	
	Direct to landfill	0	0	0				Direct to landfill	0%	0%	0%	
	Landfill after treatment	246,000	222,000	170,000		relative percentages		Landfill after treatment	96%	94%	92%	
	Direct to SNRHW cell	11,000	13,000	15,000				Direct to SNRHW cell	4%	6%	8%	
	TOTAL	257,000	235,000	185,000				TOTAL	100%	100%	100%	
	ASSOC. TREATMENT							ASSOC. TREATMENT				
		2008-13	2014-19	2020-25					2008-13	2014-19	2020-25	
	Stabilisation/solidification	123,000	148,740	113,900				Stabilisation/solidification	50%	67%	67%	
	Bioremediation	9,840	31,080	56,100				Bioremediation	4%	14%	33%	
	Soil washing	9,840	31,080	56,100				Soil washing	4%	14%	33%	
	Thermal desorption	9,840	31,080	56,100				Thermal desorption	4%	14%	33%	
SCENARIO 3 - specialist treatment												
	LANDFILL DISPOSAL							LANDFILL DISPOSAL				
		2008-13	2014-19	2020-25					2008-13	2014-19	2020-25	
	Direct to landfill	0	0	0				Direct to landfill	0%	0%	0%	

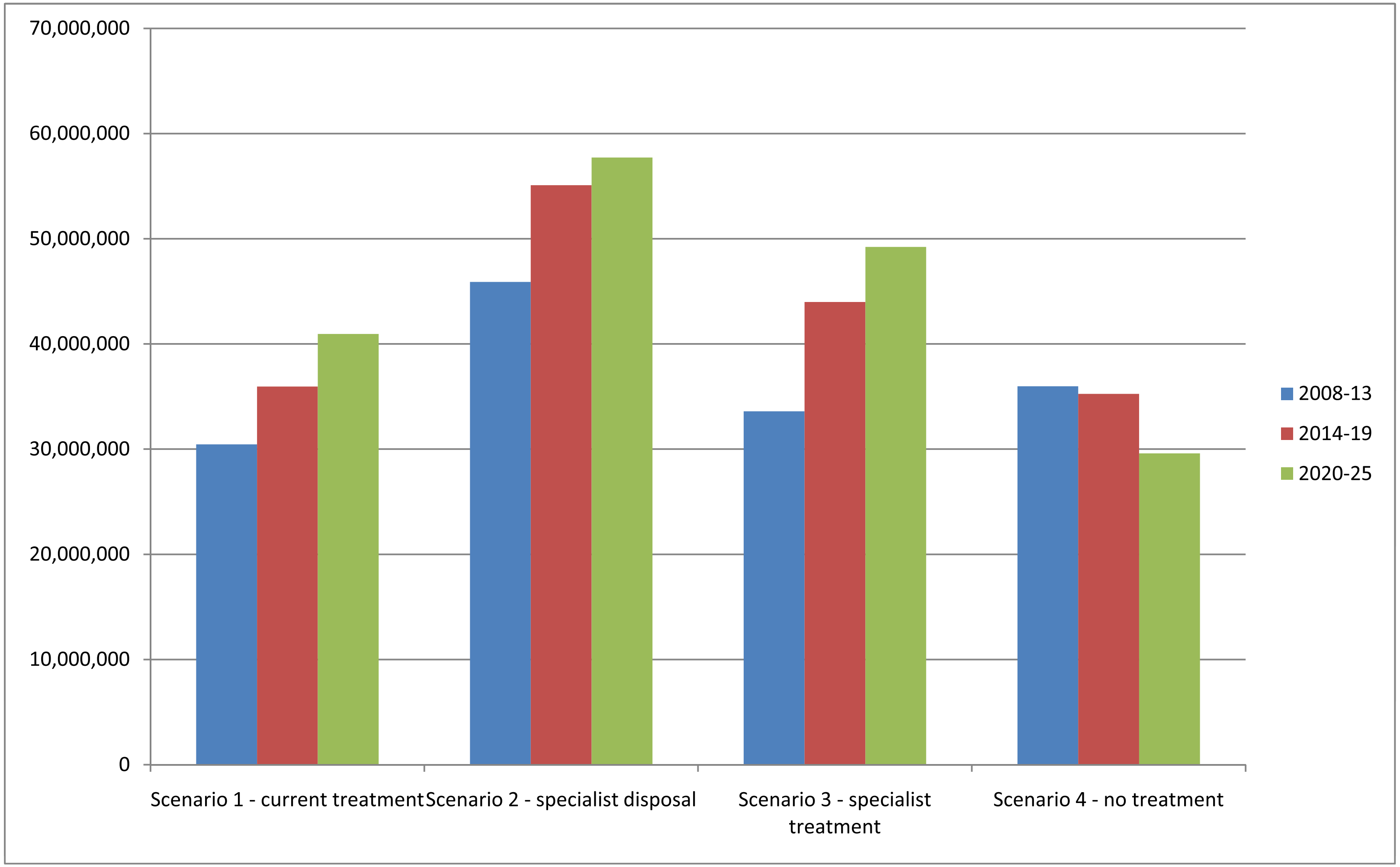
	Landfill after treatment	246,000	222,000	170,000		relative percentages		Landfill after treatment	96%	94%	92%	
	Direct to SNRHW cell	11,000	13,000	15,000				Direct to SNRHW cell	4%	6%	8%	
	TOTAL	257,000	235,000	185,000				TOTAL	100%	100%	100%	
	ASSOC. TREATMENT							ASSOC. TREATMENT				
		2008-13	2014-19	2020-25					2008-13	2014-19	2020-25	
	Stabilisation/solidification	123,000	148,740	113,900				Stabilisation/solidification	50%	67%	67%	
	Bioremediation	9,840	31,080	56,100				Bioremediation	4%	14%	33%	
	Soil washing	9,840	31,080	56,100				Soil washing	4%	14%	33%	
	Thermal desorption	9,840	31,080	56,100				Thermal desorption	4%	14%	33%	
SCENARIO 4 - no treatment												
	LANDFILL DISPOSAL							LANDFILL DISPOSAL				
		2008-13	2014-19	2020-25					2008-13	2014-19	2020-25	
	Direct to landfill	257,000	235,000	185,000				Direct to landfill	100%	100%	100%	
	Landfill after treatment	0	0	0		relative percentages		Landfill after treatment	0%	0%	0%	
	Direct to SNRHW cell	0	0	0				Direct to SNRHW cell	0%	0%	0%	
	TOTAL	257,000	235,000	185,000				TOTAL	100%	100%	100%	
	ASSOC. TREATMENT							ASSOC. TREATMENT				
		2008-13	2014-19	2020-25					2008-13	2014-19	2020-25	
	Stabilisation/solidification	0	0	0				Stabilisation/solidification	0%	0%	0%	
	Bioremediation	0	0	0				Bioremediation	0%	0%	0%	
	Soil washing	0	0	0				Soil washing	0%	0%	0%	
	Thermal desorption	0	0	0				Thermal desorption	0%	0%	0%	
Scenario 5 - storage - dealt with separately as just concerned with radioactive waste												

Costs per tonne (Euros)																
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Standard gate fee	90	90	90	90	90	100	100	100	100	100	110	110	110	110	110	110
Hazardous gate fee	140	140	140	140	140	150	150	150	150	150	160	160	160	160	160	160
Stabilisation/solidification	58	58	58	58	58	68	68	68	68	68	78	78	78	78	78	78
Bioremediation	74	74	74	74	74	84	84	84	84	84	94	94	94	94	94	94
Soil washing	63	63	63	63	63	73	73	73	73	73	83	83	83	83	83	83
Thermal desorption	146	146	146	146	146	156	156	156	156	156	166	166	166	166	166	166

SCENARIO 1 - current treatment (COST EUROS)					
	LANDFILL DISPOSAL				
		2008-13	2014-19	2020-25	
	Direct to landfill	7,020,000	9,000,000	5,500,000	
	Landfill after treatment	15,120,000	13,200,000	13,200,000	
	Direct to SNRHW cell	1,540,000	1,950,000	2,400,000	
	TOTAL	**30,453,760**	**35,948,160**	**40,954,000**	
	ASSOC. TREATMENT				
		2008-13	2014-19	2020-25	
	Stabilisation/solidification	4,872,000	6,013,920	6,271,200	
	Bioremediation	497,280	1,552,320	3,722,400	
	Soil washing	423,360	1,349,040	3,286,800	
	Thermal desorption	981,120	2,882,880	6,573,600	
SCENARIO 2 - specialist disposal					
	LANDFILL DISPOSAL				
		2008-13	2014-19	2020-25	
	Direct to landfill	0	0	0	
	Landfill after treatment	34,440,000	33,300,000	27,200,000	
	Direct to SNRHW cell	1,540,000	1,950,000	2,400,000	
	TOTAL	**45,898,720**	**55,092,360**	**57,726,500**	
	ASSOC. TREATMENT				
		2008-13	2014-19	2020-25	
	Stabilisation/solidification	7,134,000	10,114,320	8,884,200	
	Bioremediation	728,160	2,610,720	5,273,400	
	Soil washing	619,920	2,268,840	4,656,300	
	Thermal desorption	1,436,640	4,848,480	9,312,600	
SCENARIO 3 - specialist treatment					
	LANDFILL DISPOSAL				
		2008-13	2014-19	2020-25	
	Direct to landfill	0	0	0	
	Landfill after treatment	22,140,000	22,200,000	18,700,000	
	Direct to SNRHW cell	1,540,000	1,950,000	2,400,000	
	TOTAL	**33,598,720**	**43,992,360**	**49,226,500**	
	ASSOC. TREATMENT				

		2008-13	2014-19	2020-25	
	Stabilisation/solidification	7,134,000	10,114,320	8,884,200	
	Bioremediation	728,160	2,610,720	5,273,400	
	Soil washing	619,920	2,268,840	4,656,300	
	Thermal desorption	1,436,640	4,848,480	9,312,600	
SCENARIO 4 - no treatment					
	LANDFILL DISPOSAL				
		2008-13	2014-19	2020-25	
	Direct to landfill	35,980,000	35,250,000	29,600,000	
	Landfill after treatment	0	0	0	
	Direct to SNRHW cell	0	0	0	
	TOTAL	**35,980,000**	**35,250,000**	**29,600,000**	
	ASSOC. TREATMENT				
		2008-13	2014-19	2020-25	
	Stabilisation/solidification	0	0	0	
	Bioremediation	0	0	0	
	Soil washing	0	0	0	
	Thermal desorption	0	0	0	

	2008-13	2014-19	2020-25
Scenario 1 - current treatment	30,453,760	35,948,160	40,954,000
Scenario 2 - specialist disposal	45,898,720	55,092,360	57,726,500
Scenario 3 - specialist treatment	33,598,720	43,992,360	49,226,500
Scenario 4 - no treatment	35,980,000	35,250,000	29,600,000
Scenario 5 - storage			



	Landfill	Hazardous landfill	Stabilisation/Solidification	Bioremediation	Soil washing	Thermal desorption
CONSTRUCTION	**25**	**32.85**	**2.8**	**3**	**3**	**23.8**
Cost of land	1.6	1.6	0.3	0.5	0.5	0.3
Planning stages	8	9	0.5	0.5	0.5	1.5
Civil works	14	20	1.5	1.5	1.5	15
Restoration and aftercare	0.9	1.5	0	0	0	0
Equipment	0.5	0.75	0.5	0.5	0.5	7
SERVICES	**0.405**	**0.505**	**0.54**	**0.35**	**0.35**	**2.39**
Maintenance	0.2	0.3	0.28	0.06	0.06	1.7
Staff costs	0.185	0.185	0.215	0.275	0.275	0.49
Utilities	0.02	0.02	0.045	0.015	0.015	0.2
SERVICES TOTAL OVER LIFETIME	10.125	12.625	10.8	7	7	59.75
Lifetime	25	25	20	20	20	25
TOTAL	***35.125***	***45.475***	***13.6***	***10***	***10***	***83.55***
Apportioned to quantity of waste	200.7 (175,000)	259.9 (175,000)	680 (20,000)	500 (20,000)	500 (20,000)	835.5 (100,000)

Appendix 6 Socio-economic Assessment of Options

	TREATMENT METHOD 1 - SNRHW / Hazardous Landfill	Development Phase				Total per socio-ec criterion
	Socio-economic assessment criteria	**Planning**	**Construction**	**Operation**	**Decommissioning**	
A	**Population Characteristics**					**-1**
i	Population change	0	-1	0	0	-1
ii	Ethnic and racial distribution	0	0	0	0	0
iii	Relocated populations	0	0	0	0	0
iv	Seasonal residents	0	0	0	0	0
B	**Community and Institutional Structures**					**12**
i	Employment opportunities	1	1	1	1	4
ii	Training, skills and qualifications	0	1	1	1	3
iii	Business development	0	0	2	-2	0
iv	Economic investment	0	2	-2	2	2
v	Employment equity of minority groups	0	0	0	0	0
vi	Local/regional/national linkages	2	1	2	-1	4
vii	Industrial/commercial diversity	1	1	2	-1	3
viii	Travel around the area	0	-2	-1	-1	-4
C	**Political and Social Resources**					**-15**
i	Extent of affected parties	-2	-2	-1	-2	-7
ii	Trust in political institutions	-2	-2	-2	-2	-8
D	**Individual and Family Changes**					**-19**
i	Perceptions of risk, health and safety	0	-2	-1	-1	-4
ii	Health risks from development	0	-1	-1	0	-2
iii	Residential stability	0	0	0	0	0
iv	Attitudes towards project	-2	-2	-2	-1	-7
v	Concerns about social well-being	-1	-2	-2	-1	-6
E	**Community Resources**					**-7**
i	Change in community infrastructure	0	-1	0	-1	-2
ii	Land use patterns	0	-2	-2	2	-2
iii	Security	0	-1	1	-1	-1
iv	Impact on property price	0	0	0	0	0
v	Access to local amenities including public rights of way	0	-1	-1	0	-2
				Overall significance rating		**-30**

	TREATMENT METHOD 2 - Stabilisation / Solidification	Development Phase				Total per socio-ec criterion
	Socio-economic assessment criteria	**Planning**	**Construction**	**Operation**	**Decommissioning**	
A	**Population Characteristics**					**0**
i	Population change	0	0	0	0	0
ii	Ethnic and racial distribution	0	0	0	0	0
iii	Relocated populations	0	0	0	0	0
iv	Seasonal residents	0	0	0	0	0
B	**Community and Institutional Structures**					**2**
i	Employment opportunities	1	0	1	0	2
ii	Training, skills and qualifications	0	0	1	0	1
iii	Business development	0	0	1	-1	0
iv	Economic investment	0	0	0	0	0
v	Employment equity of minority groups	0	0	0	0	0
vi	Local/regional/national linkages	0	0	0	0	0
vii	Industrial/commercial diversity	0	0	1	-1	0
viii	Travel around the area	0	0	-1	0	-1
C	**Political and Social Resources**					**-12**
i	Extent of affected parties	-2	-1	-1	-1	-5
ii	Trust in political institutions	-2	-2	-2	-1	-7
D	**Individual and Family Changes**					**-5**
i	Perceptions of risk, health and safety	0	-1	0	0	-1
ii	Health risks from development	0	0	0	0	0
iii	Residential stability	0	0	0	0	0
iv	Attitudes towards project	-2	-1	-1	0	-4
v	Concerns about social well-being	0	0	0	0	0
E	**Community Resources**					**0**
i	Change in community infrastructure	0	0	0	0	0
ii	Land use patterns	0	0	0	0	0
iii	Security	0	0	0	0	0
iv	Impact on property price	0	0	0	0	0
v	Access to local amenities including public rights of way	0	0	0	0	0
				Overall significance rating		**-15**

	TREATMENT METHOD 3 - Bioremediation	Development Phase				Total per socio-ec criterion
	Socio-economic assessment criteria	**Planning**	**Construction**	**Operation**	**Decommissioning**	
A	**Population Characteristics**					**0**
i	Population change	0	0	0	0	0
ii	Ethnic and racial distribution	0	0	0	0	0
iii	Relocated populations	0	0	0	0	0
iv	Seasonal residents	0	0	0	0	0
B	**Community and Institutional Structures**					**2**
i	Employment opportunities	1	0	1	0	2
ii	Training, skills and qualifications	0	0	1	0	1
iii	Business development	0	0	1	-1	0
iv	Economic investment	0	0	0	0	0
v	Employment equity of minority groups	0	0	0	0	0
vi	Local/regional/national linkages	0	0	0	0	0
vii	Industrial/commercial diversity	0	0	1	-1	0
viii	Travel around the area	0	0	-1	0	-1
C	**Political and Social Resources**					**-12**
i	Extent of affected parties	-2	-1	-1	-1	-5
ii	Trust in political institutions	-2	-2	-2	-1	-7
D	**Individual and Family Changes**					**-5**
i	Perceptions of risk, health and safety	0	-1	0	0	-1
ii	Health risks from development	0	0	0	0	0
iii	Residential stability	0	0	0	0	0
iv	Attitudes towards project	-2	-1	-1	0	-4
v	Concerns about social well-being	0	0	0	0	0
E	**Community Resources**					**0**
i	Change in community infrastructure	0	0	0	0	0
ii	Land use patterns	0	0	0	0	0
iii	Security	0	0	0	0	0
iv	Impact on property price	0	0	0	0	0
v	Access to local amenities including public rights of way	0	0	0	0	0
				Overall significance rating		**-15**

	TREATMENT METHOD 4 - Soil Washing	Development Phase				Total per socio-ec criterion
	Socio-economic assessment criteria	**Planning**	**Construction**	**Operation**	**Decommissioning**	
A	**Population Characteristics**					**0**
i	Population change	0	0	0	0	0
ii	Ethnic and racial distribution	0	0	0	0	0
iii	Relocated populations	0	0	0	0	0
iv	Seasonal residents	0	0	0	0	0
B	**Community and Institutional Structures**					**2**
i	Employment opportunities	1	0	1	0	2
ii	Training, skills and qualifications	0	0	1	0	1
iii	Business development	0	0	1	-1	0
iv	Economic investment	0	0	0	0	0
v	Employment equity of minority groups	0	0	0	0	0
vi	Local/regional/national linkages	0	0	0	0	0
vii	Industrial/commercial diversity	0	0	1	-1	0
viii	Travel around the area	0	0	-1	0	-1
C	**Political and Social Resources**					**-12**
i	Extent of affected parties	-2	-1	-1	-1	-5
ii	Trust in political institutions	-2	-2	-2	-1	-7
D	**Individual and Family Changes**					**-5**
i	Perceptions of risk, health and safety	0	-1	0	0	-1
ii	Health risks from development	0	0	0	0	0
iii	Residential stability	0	0	0	0	0
iv	Attitudes towards project	-2	-1	-1	0	-4
v	Concerns about social well-being	0	0	0	0	0
E	**Community Resources**					**0**
i	Change in community infrastructure	0	0	0	0	0
ii	Land use patterns	0	0	0	0	0
iii	Security	0	0	0	0	0
iv	Impact on property price	0	0	0	0	0
v	Access to local amenities including public rights of way	0	0	0	0	0
				Overall significance rating		**-15**

	TREATMENT METHOD 5 - Thermal desorption	Development Phase				Total per socio-ec criterion
	Socio-economic assessment criteria	**Planning**	**Construction**	**Operation**	**Decommissioning**	
A	**Population Characteristics**					**-3**
i	Population change	0	-1	-1	-1	-3
ii	Ethnic and racial distribution	0	0	0	0	0
iii	Relocated populations	0	0	0	0	0
iv	Seasonal residents	0	0	0	0	0
B	**Community and Institutional Structures**					**17**
i	Employment opportunities	1	2	2	-1	4
ii	Training, skills and qualifications	0	2	2	-1	3
iii	Business development	0	1	2	-2	1
iv	Economic investment	2	2	2	0	6
v	Employment equity of minority groups	0	0	0	0	0
vi	Local/regional/national linkages	2	1	2	-1	4
vii	Industrial/commercial diversity	2	1	2	-1	4
viii	Travel around the area	0	-2	-1	-2	-5
C	**Political and Social Resources**					**-15**
i	Extent of affected parties	-2	-2	-2	-1	-7
ii	Trust in political institutions	-2	-2	-2	-2	-8
D	**Individual and Family Changes**					**-21**
i	Perceptions of risk, health and safety	0	-2	-2	-1	-5
ii	Health risks from development	0	-1	-1	0	-2
iii	Residential stability	0	0	0	0	0
iv	Attitudes towards project	-2	-2	-2	-1	-7
v	Concerns about social well-being	-2	-2	-2	-1	-7
E	**Community Resources**					**-7**
i	Change in community infrastructure	0	-1	0	-1	-2
ii	Land use patterns	0	-2	-2	0	-4
iii	Security	0	-1	1	-1	-1
iv	Impact on property price	0	0	0	0	0
v	Access to local amenities including public rights of way	0	0	0	0	0
				Overall significance rating		**-29**

Treatment method	A) Population Characteristics	B) Community and Institutional Structures	C) Political and Social Resources	D) Individual and Family Changes	E) Community Resources	Total
	Socio-economic assessment criteria					
1: SNRHW / Hazardous Landfill	-1	12	-15	-19	-7	-30
2: Stabilisation / Solidification	0	2	-12	-5	0	-15
3: Bioremediation	0	2	-12	-5	0	-15
4: Soil Washing	0	2	-12	-5	0	-15
5: Thermal Desorption	-3	17	-15	-21	-7	-29