SOUTH EAST OF ENGLAND REGIONAL ASSEMBLY

Study into the Arisings and Management of Hazardous Waste and Low Level Radioactive Waste in the South East Region of England

Supplementary Report - Low Level Radioactive Waste

February 2009

Revision Schedule

Study into Hazardous Waste and Low Level Radioactive Waste in the South East

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February 2009

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Executive Summary

Background

RPG9, Waste and Minerals in the South East (revised chapters 10 and 11), sets out the policy for the planning and management of waste in the Region. Although RPG9 and the South East Plan do not specifically provide for the management of radioactive waste, it is recognised that low-level (LLW) and very low level (VLLW) radioactive wastes have hazardous properties that require a specialist waste management approach, similar to that required for hazardous waste which is dealt with through Policy W15.

Since the publication of the South East Plan, the situation in relation to hazardous waste and radioactive waste, its management and available management capacity, has changed and this is reflected in the report of the Panel (Aug 2007) into the South East Plan which identified that there was a need to ensure that the policy reflects such changes.

As such, the Regional Assembly is looking to advance its knowledge in the field of LLW management in anticipation of the preparation of future policy. To facilitate this, the Regional Assembly has appointed Scott Wilson to utilise its knowledge and experience in the management of hazardous and low-level radioactive waste, and in spatial planning, to undertake a study that will supply the necessary background information as a guide towards the development of future facilities for the management of LLW waste across the Region as part of a wider study.

Study Overview

A number of issues have been considered in order to establish an accurate assessment of current LLW waste arising and disposal patterns across the South East, including:

- reviewing arisings and disposal patterns in as much detail as is possible, focussing on both the type(s) of waste and their fate(s), using accepted definitions;
- predicting future waste arisings across agreed broad waste types;
- reviewing current and possible future management technologies; and
- establishing criteria for possible additional facilities, taking into account existing and/or emerging Local Plan/Development Framework policies.

The outcome of the study, presented in this report, is aimed at beginning to identify what strategic thinking might be appropriate in order to meet the broad requirements of Policy W15 above, specifically in relation to low-level radioactive wastes, namely LLW and VLLW.

Study Findings

The provisional outcomes of the low-level radioactive waste study show that:

- LLW and VLLW are each defined by the amount and type(s) of radioactivity they emit, which is not readily comprehensible to the non-specialist, but which respectively approximately equates to waste that has to be deposited to the Low Level Waste Repository and that which can be disposed to ‘standard’ industry waste facilities, with (in the case of high volume movements) and without (in the case of low volume movement) prior notification – see Section 3.3 for clarification;

- Activities resulting in the production of LLW and VLLW radioactive wastes are heavily skewed towards the nuclear industry, but also include the defence industry and a range of medical and industrial activities – see Section 4.1 for clarification;

- As with all wastes for which management is controlled by statute, the responsibility for their management, and eventual disposal in accordance with relevant statute(s) rests with the organisation that created them, be this;

    - individual industrial or health-care organisations for the non-nuclear materials;
    - individual industrial organisations, or a member of the Forces or their contractors for defence-related wastes;
    - individual power generators, for wastes generated at operational nuclear power plants; or
    - the NDA for all those power generation and/or research facilities (numbering in excess of 24) now closed and transferred to 'final closure'.

- As wastes, these materials typically consist of a range of inert (concrete, steel, rubble, dust) and non-inert (cloth, paper and plastic) materials, much as 'typical' non-food based construction/demolition and commercial/industrial waste streams, with LLW skewed towards the C&D and VLLW towards the C&I – see Section 4.1 for clarification;

- Waste with a radioactive emission rate of less than the minimum set for VLLW is classed as a Substance of Low Activity, and is subject to management controls as per any 'controlled' waste;

- The South East region has historically produced both nuclear and non-nuclear LLW and VLLW, with approximate tonnages amounting to less than 4,000 tonnes and less than 400 tonnes per annum, respectively;

- The South East region is expected to continue to be a producer of both nuclear and non-nuclear LLW and VLLW for the foreseeable future, (i.e. for the timeframe covered by this report, and indeed beyond), with projected tonnages amounting to less than 25,000 tonnes and less than 500 tonnes per annum, respectively;

- The majority of the nuclear waste so produced has traditionally been managed in-Region (a substantial amount via the super-compactor site at Winfrith), but exported to the LLWR at Drigg for 'final disposal', a situation which is under review by the NDA on behalf of Government, as long-distance transfer is thereby implicit and the availability of recovery and/or regional/local disposal capacity tacitly excluded;

- The majority of the non-nuclear waste so produced is believed to have been managed and disposed of in-region, via incineration and/or landfilling, although this cannot be absolutely substantiated;

- Based on a detailed examination of nuclear and non-nuclear data-sets, it is evident that treating 'self sufficiency' as an absolute cannot always be considered appropriate, as existing centralised, specialist disposal capacity (the LLWR) continues to underwrite the nuclear portion, even though its longevity and continued safety acceptance is not guaranteed, and this reliance ought therefore to be reconsidered; this is not the case for the non-nuclear portion;

- Whether or not the Region should consider managing waste equivalent to the amount produced within its borders is discussed as a concept, but no definitive outcome recommended;

- Where additional facilities are considered necessary, options for their possible location(s) are frequently strongly influenced by 'external' factors such as Environment Agency guidance, Local Planning Authority policy and/or meaningful transport efficiency, although emerging NDA strategic thinking seeks to establish a hierarchy of location for new facilities, which may result in adverse public reaction; and

- There is considered to be an ongoing need for direct liaison between waste producing umbrella organisations in order to identify future management needs, as, whatever the facility, the authorisation process encompasses the Minerals and Waste Planning Authority, even if there is a supra-regional or National dimension to it. The in-principle provision for the management of LLW and VLLW radioactive waste is therefore implicit in land-use terms, and the potential for provision ought to be reviewed at a Regional level.

Conclusions and Recommendations

In relation to any future revisions of RPG9, the Regional Assembly may wish to consider the addition of a new policy requirement for LLW or revision of W15 to more truly reflect inclusion it. Potential policy change could reflect:

"Waste Development Documents should:

i. Identify and safeguard sites for the storage, treatment and remediation of LLW contaminated soils and demolition waste;

ii. Identify criteria for the determination of large-scale specialist LLW waste facilities; and

iii. Assess available landfill provision and, where necessary, encourage the creation of a protective cell for LLW."

As there is no reason in practice why the Region should not provide more fully for the management of LLW arisings within its own jurisdiction, in general recognition of emerging strategic thinking, additional capacity provision might reasonably by provided/safeguarded for, including:

- The management of all wastes in strict compliance with a 'conventional' hierarchical approach in order to reduce production, maximise recovery/diversion and minimise final disposal, with an increased involvement of the non-nuclear private sector for material recovery/re-use – although this has the potential for adverse public response unless managed appropriately;

- Nuclear LLW/VLLW, based on in-situ, near-surface disposal, for the appropriate fraction (particularly C, D and E wastes, as preferred by SERTAB) and in an appropriate location, in accordance with the emerging NDA 'hierarchy of location' – although this has the potential for adverse public response unless managed appropriately;

- Non-nuclear LLW/VLLW, based on maintaining access for industry to continued landfill and incineration capacity throughout the reaches of the Region, although the long-term liability issues arising from possible EA attitudes to landfill permit surrender will need to be considered as the consultation requirements associated with this is more likely than not to result in a reduced supply of facilities; and possibly

- A new/additional LLW Repository (LLWR2 ?), similar and in addition to that at Drigg, possibly 'shared' with the South West Region, again reflecting the emerging NDA 'hierarchy of location', which could place restrictive limits on possible locations within the region and/or result in adverse public reaction and loss of confidence.

Due to the issues with data availability and quality, the timing of an incoming assessment intended to clarify the non-nuclear radioactive waste sector, and emerging strategic thinking for the nuclear sector, it is considered that this report can only form the basis of an emerging strategy development process. As such, it has been designed to be capable of being updated to reflect a validated 2008 non-nuclear dataset, as it is released, and the emerging NDA strategy, leading to the emergence of a full regional strategy by the end of 2009 or early 2010.

1 INTRODUCTION

1.1 Study Background

Scott Wilson Limited has been engaged by the South East England Regional Assembly to undertake a study into the management of low-level and very low-level radioactive waste within its boundaries, whether or not produced therein.

RPG9, Waste and Minerals in the South East (revised chapters 10 and 11), sets out the policy for the planning and management of waste in the Region. Although RPG9 and the South East Plan do not specifically provide for the management of radioactive waste, it is recognised that low-level radioactive waste (LLW) and very low-level radioactive wastes (VLLW) have hazardous properties that require a specialist waste management approach similar to that required for hazardous waste.

The specialist nature of the management requirements for LLW and VLLW radioactive waste (see Section 3.3 for a more detailed description) is predominantly associated with their radioactivity, i.e. the nature and amount, and while VLLW can and is handled as an admixture with controlled waste, LLW is not. Facilities able and available to receive these wastes and few and far between, even allowing for the on-site burial of on-compressible inert materials, which has the potential to have an adverse on the safe, sustainable and cost-effective management of these waste streams.

In light of the above comment, Policy W15, for hazardous wastes, is assumed to address both LLW and VLLW radioactive wastes. RPG policies were largely incorporated into the draft South East Plan (Regional Spatial Strategy) submitted to government in March 2006, with slight amendments to Policy W15. The revised policy states:

"The Regional Assembly and SERTAB, through the Hazardous Waste Task Group, will maintain guidance on regional hazardous waste management requirements. Current priority needs include:

i. Hazardous waste landfill capacity, particularly to serve the needs of the South and South East of the region;

ii. Treatment facilities for air pollution control residues (from combustion facilities);

iii. Treatment/de-manufacturing plants for waste electronic and electrical equipment, supported by a network of transfer facilities;

iv. A sub-regional network of contaminated C&D waste treatment facilities; and

v. A sub-regional network of landfill cells for stabilised non-reactive hazardous wastes.

Waste Development Documents should:

i. Identify and safeguard sites for the storage, treatment and remediation of contaminated soils and demolition waste;

ii. Identify criteria for the determination of large-scale specialist hazardous waste facilities; and

iii. Assess available landfill provision and, where necessary, encourage the creation of a protective cell for stable hazardous waste."

Since publication of the South East Plan, the situation in relation to radioactive waste, its management and available management capacity, has changed and there is a need to ensure that the policy reflects such changes.

As such, the Regional Assembly is looking to advance its knowledge in the field of LLW management in anticipation of the preparation of future policy. To facilitate this, the Regional Assembly has appointed Scott Wilson to utilise its knowledge and experience in the management of hazardous and low-level radioactive waste, and in spatial planning, to undertake a study that will supply the necessary background information as a guide towards the development of future facilities for the management of LLW waste across the Region.

1.2 Study Aims

The aims of the study are to:

- Review current arisings of low-level (LLW) and very low-level (VLLW) radioactive waste in the region by type, sector and, where possible, by location or source;
- Identify existing management capacity (by type) for different materials within the region;
- Review current inter- and intra-regional movements of LLW and/or VLLW waste, reflecting current use of management and disposal facilities;
- Forecast future potential arisings of LLW and VLLW waste in the region, taking into consideration the effects of legislation, availability and cost of management and disposal;
- Identify future management needs and types of facility that may be required; and
- Provide advice on potential spatial distribution(s) of / broad locations for different facilities, and identify criteria that may be used to refine regional and local planning policy.

In the process, the concept of 'self-sufficiency' has been reviewed, taking account of the fact that Regional boundaries have historically been transparent to both the movement of radioactive waste from the nuclear industry and to commerce. Although no conclusion has been drawn with respect to the South East England Region adopting a self-sufficiency policy, there is sufficient evidence that the region should continue reviewing options in respect of *'providing in-region management capacity for an amount of certain types of radioactive waste, equivalent to that produced within its borders'* as a minimum commitment.

1.3 Study Steering Group

The development of this study has been overseen by the Hazardous Waste Steering Group, comprising representatives from the Environment Agency, the South East England Regional Assembly, the Government Office East and the Waste Planning Authorities.

1.4 Report Outline

The report comprises 7 sections, and is structured as follows:

Section	Description
2	overviews legislative and policy context of the study, highlighting key waste legislation
3	outlines the project background and the main methodology processes used in the study. This includes summarising the primary data sources and definitions employed in relation to waste types and management options
4	presents a review of LLW and VLLW waste production and predicted waste arisings from the nuclear sector
5	presents a review of LLW and VLLW waste production and predicted waste arisings from the non-nuclear sector
6	outlines recommendations for future consideration
7	summarises the findings and conclusions of the study
8	Glossary of scientific and technical terms used

2 REGULATORY FRAMEWORK

The main legislative, policy and other drivers affecting the management of radioactive waste in the UK are outlined in brief below.

2.1 European Directives for Management of Waste

The legislative and policy requirements for waste management in general in the UK are initiated through the various framework directives and strategies developed within the European Union. These are translated into national legislation and strategy for implementation.

The main directives directly or indirectly affecting the management of radioactive waste in the European Union are:

- Radioactive waste is not a 'directive' waste under The Waste Framework Directive (WFD), the directive that provides the basis for the formulation of European and national legislation and strategy, although the management of radioactive waste does get caught if it is of a type where the radioactivity is 'incidental' or it is combined with controlled waste for management and/or disposal;
- The Landfill Directive that provides a framework for the improvement of waste management practice, specifically landfill, and encompasses radioactive waste, as it must be disposed of in such a way as is appropriate for its non-radioactive properties;
- The Waste Incineration Directive (WID) details a framework for the management of waste incineration, aiming to reduce the impact of incineration activities on the environment, and again catches radioactive waste managed in this way, for its non-radioactive properties;
- Directive 2006/117/Euratom - Supervision and Control of Shipments of Radioactive Waste and Spent fuel. This directive details requirements for a system of control and prior authorisation for shipments of radioactive waste and spent fuel. It provides for a compulsory and common system of notification and a standard control document.

In relation to the management of radioactive waste, existing EU legislation does not provide for specific rules to ensure that spent nuclear fuel and radioactive waste is safely managed in an effective and consistent manner throughout the EU. An amended proposal (COM[204]) for a Directive has been prepared that applies to all stages of spent nuclear fuel management and obliges Member States to:

- take all necessary measures to ensure that spent nuclear fuel and radioactive waste are managed in such a way that individuals, society and the environment are protected against radiological hazards;
- ensure that production of radioactive waste is kept to the lowest possible level;
- take all the necessary legislative, regulatory and administrative measures and other steps required to ensure the safe management of spent nuclear fuel and radioactive waste;
- establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework;

- guarantee adequate financial resources to support the management of spent nuclear fuel while respecting the 'polluter pays' principle;

- ensure effective public information and facilitate public participation in order to achieve a high level of transparency.

2.2 National Legislation and Drivers for Management of Waste

The national drivers that directly affect the management of hazardous waste including radioactive materials in the UK comprise waste management regulations and strategy, including:

- The Hazardous Waste Regulations (2005) that implement the requirements of the Hazardous Waste Directive in the UK including requirements for pre-treatment, waste acceptance criteria and waste management in general, which will apply to the non-radioactive elements of radioactive waste, particularly as a recognised management route is as an admixture in healthcare waste, otherwise classified as hazardous waste;

- The Waste Strategy For England 2007 (WS2007) that provides further strategic direction for the minimisation and sustainable management of all waste for the period until 2020 – as evidenced in Section 2.4, the principle of the waste hierarchy and the sustainable management of radioactive wastes is as applicable as it is to non-radioactive; and

- The Pollution Prevention and Control Regulations (2000) as translated into the Environmental Permitting Regulations 2007 that provide the main regulation framework for defined waste management and manufacturing processes in the UK, and although radioactive waste is not a 'controlled' waste, it is caught by regulations during its management and/or disposal if it is of a type where the radioactivity is 'incidental' or it is combined with controlled waste for management and/or disposal.

None of these countermand the principle that the organisation that created the waste remains responsible for its management, and eventual disposal, as with any 'controlled' waste.

2.3 National Legislative Drivers for Management of Radioactive Materials

With specific reference to the management of radioactive materials in the UK, this is governed through key pieces of legislation, namely:

Radioactive Substances Act (RSA) 1993

The RSA regulates the keeping/use of radioactive material, to prevent loss to the environment and to control accumulation and disposal of radioactive waste to minimise environmental impact. Disposal of radioactive waste includes discharges of aerial and liquid effluent, deposit or burial of solid radioactive waste, and transfer of radioactive waste from a site.

The RSA requires that:

- If you **keep** or **use** radioactive **materials**, you need a **certificate of registration**; and

- If you **dispose** of or **accumulate** radioactive **waste**, you need a **certificate of authorisation** ; unless

- Your activities are historically exempt from such controls.

Nuclear Installations Act (NIA) 1965

The NIA is aimed primarily at the licensing and operating of a nuclear installation and enables the HSE to attach conditions to the licence in respect to the handling, treatment and disposal of nuclear matter. The main licence conditions that will apply include:

- Restriction on nuclear matter (including waste) that can be introduced/stored on a site;
- Documents, records, authorities and certificates required for compliance;
- Emergency management arrangements;
- Safety documentation;
- Periodic review of safety arrangements;
- Quality assurance detailing the management and procedural arrangements for control and monitoring;
- Operating rules and operational records;
- Control and supervision of operations;
- Examination, inspection, maintenance and testing;
- Accumulation of radioactive waste;
- Disposal of radioactive waste;
- Leakage and escape of radioactive material and radioactive waste; and
- Decommissioning.

Ionising Radiation Regulations (IRR) 1999

IIR specifies the requirements for the radiological protection of workers and the public, and applies to both nuclear licensed and non-licensed sites.

2.4 Other Drivers for Management of Radioactive Materials

Government Policy

Government policy regarding the management of radioactive waste materials is set out in the following policy statements:

- Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom, March 2007 that deals with the management of solid LLW;
- Review of Radioactive Waste Management Policy: Final Conclusions (Cm2919), 1995, HMSO that details the policy for the discharge of liquid and gaseous radioactive discharges;

- Guidance for the Environment Agencies' Assessment of Best Practicable Environmental Option Studies at Nuclear Sites, Feb 2004, that deals with the management of radioactively contaminated land;

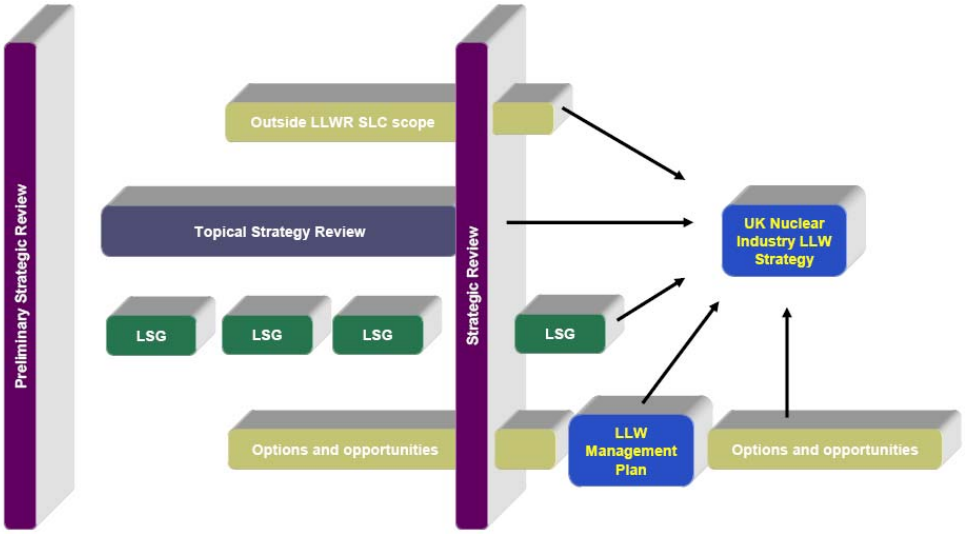
- Disposing of Radioactive Waste to Landfill, issued by the Environment Agency in December 2008, in response to the changes presented by Central Government in the 1st reference in this list.

Evolving Strategies

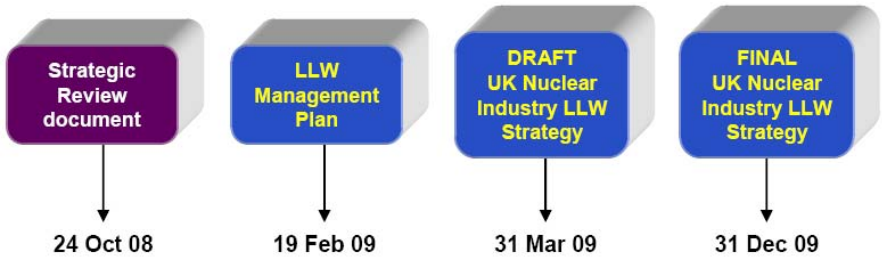
Nuclear Industry LLW Strategy

Since a decision to produce a UK-wide strategy for the management of LLW nuclear radioactive waste was announced via a Government policy statement in 2007 (1st reference above), progress is being made towards strategy adoption in late 2009 or early 2010. The strategy is being developed for DEFRA by the NDA/LLWR Ltd, using a (revised) Terms of Reference dated October 2008. The currently envisaged timeframe for the strategy development and adoption is as presented on http://www.llwrsite.com/llw-strategy-group - due to have been completed and adopted by early 2010.

As with most strategies, the process is split into a number of activities, as below:

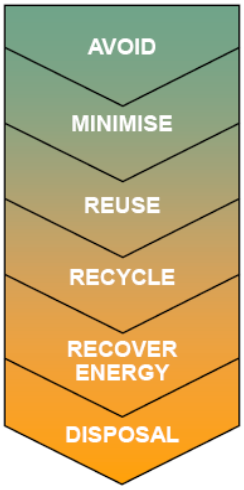


and is intended to provide a number of deliverables:



In common with non-radioactive waste strategies, the LLW strategy will be based around a number of specific activities, covering:

- Formulation of Management Plans – in order to identify management options;
- The use of a risk-based approach – covering Best Practicable Means (BPM) or Best Practicable Environmental Option (BPEO), and As Low As Reasonably Acceptable (ALARA) in order to identify and minimise on- and off-site risks;
- Waste minimisation – using a basic waste hierarchy approach, as below, taken from the NDA's Position Paper No. 1, W&NMPP/001, dated March 2008, itself derived from the Waste Strategy 2007, in order to promote the sought after '3R's' of reduce, re-use and recover (energy);



- The use of the 'proximity principle' in order to minimise transport, reflecting the sustainability and safety issues associated with this;
- Increased use of non-nuclear providers and locations (off-site solutions) in order to provide an increasingly diverse range of management options, divert whatever waste can be diverted away from the LLWR in order to preserve capacity – although this is recognised as a potential issue for adverse public reaction and increased concern; and
- Reduce the costs of operating the repository by 10% of more.

Although far from completed, there are a number of key issues being recognised through the above process, namely:

- The predicted arisings (from RWI 2007) far exceed the capacity for the current LLWR at Drigg, and actions should be taken to 'protect' this capacity, i.e. work to ensure its longevity, for wastes that can only be deposited at it, as recent estimates of capacity exhaustion are as soon as 2020;
- Clear segregation of LLW and VLLW across the nuclear industry is essential if the above situation is not to be exacerbated;

- Disposal to the LLWR involves significant transport/travel, with attendant risks;
- Although amounting to small amounts by comparison, no significant capacity at the LLWR is, or intended to be, set aside for any non-nuclear VLLW/LLW other than that that has to be deposited at it; and
- The establishment of a 'hierarchy of location', championed by NuLeAF (the Nuclear Legacy Advisory Forum), for new facilities, based on:
    - 'local' facilities, based around site-specific provisions at existing or new nuclear sites;
    - 'regional' facilities, again based around existing or new nuclear sites, with disposal agglomerated accordingly;
    - existing off-site facilities, such as incinerators and landfill sites: and
    - lastly, new non-nuclear (off-site) facilities, at either a regional or national level - the requirement for a replacement LLWR is currently predicted for the mid-2030's – although where this might be sited has not been considered, although it will be in accordance with the above 'hierarchy of location'.

The intention of adopting such a hierarchy would be to encourage concentration of LLW facilities at or adjacent to licensed nuclear sites, whilst not ruling out other sites, including dispersed facilities at off (nuclear) site locations.

In the absence of a defined strategy, evolving strategic thinking therefore acknowledges that alternative disposal capacities are required for specific LLW/VLLW waste streams, nuclear and non-nuclear, and ought, where possible/practicable, to take the proximity principle into consideration, and be delivered on a 'regional' basis. This might well include facilities up to and including the principle of an additional LLWR, as is in part evidenced at http://www.llwrsite.com/UserFiles/File/LowLevelWasteStrategyGroup/Feb2009/LSG%20LLW%20Strategy%20-%20Feb%2009.pdf

Non-Nuclear Industry (NNI) Strategy

The 2007 Government policy decision referenced above also includes the non-nuclear industry. Commenced in 2007, work for the NNI strategy is being progressed on behalf of DEFRA by a dedicated Board – the NNI Board – and is intended to have a slightly shorter publication timeframe than the nuclear industry strategy above (NNI prog board08-01 – see Table 3.1), i.e. with publication not expected before the end of 2009.

In common with strategies for non-radioactive wastes, and with the nuclear LLW strategy above in mind, the strategy is also founded on the waste hierarchy principle of avoid, minimise (including decay-storage), re-use, and recycle/recover, and then only dispose of what remains, with incineration (with energy recovery) rated higher than final disposal to land, as per the non-radioactive waste hierarchy presented in the Waste Strategy 2007.

The work so far undertaken has reflected the general absence of good arisings data, and on this basis, a data collection exercise is due to report in early 2009. This work already recognises that, as the majority of VLLW is currently disposed of via incineration prior to the landfill disposal of the residual ash and/or direct disposal to commercial landfill, in the face of increasing reluctance of

commercial operators to accept such materials, some producers are already experiencing reduced disposal options.

Nevertheless, as possible co-disposal with nuclear arisings either involves long-distance transport, the use of facilities which ought to be 'protected' for nuclear radioactive waste and/or will not be available for a considerable period of time, future regional solutions are currently favoured. To this end, active and ongoing discussions with the commercial waste management industry are considered essential, as disposal via existing (and planned) 'municipal' facilities, such as incinerators and/or landfill sites, underwrites current strategic thinking.

In light of these issues, the NDA considers there is a clear need for the actual risks associated with the management of NNI LLW/VLLW to be recognised for what they are, low, and in light of this research has been commissioned from HPA in order to substantiate this position.

3 STUDY METHODOLOGY

With the agreement of the Regional Assembly, this project was undertaken in four distinct Stages as discussed below.

3.1 Study Overview

3.1.1 Data Collection and Review

The initial stage of study involved the collection and review of existing data and information on waste quantities and waste management techniques in respect of low-level and very low-level radioactive wastes – both nuclear and non-nuclear.

3.1.2 Waste Arisings Review

Waste arisings information has been sourced through the NDA UK Radioactive Waste Industry for nuclear waste, and has been reviewed for both 2004 and 2007, and for other sources for the non-nuclear sector.

3.1.3 Waste Management Techniques Review

Information relating to the management of radioactive waste has been sourced from:

- Government policy statements and associated research into the management of radioactive wastes;
- Discussions with representatives from the waste producers (e.g. nuclear and non-nuclear sources), however, due to the sensitive nature of the waste material from a public perception aspect, information provided was purely anecdotal and could only be used from a qualitative point of view; and
- Discussions with representatives from the waste management sector. Again due to the sensitive nature of the waste material from a public perception, aspect information provided was purely anecdotal and could only be used from a qualitative point of view.

3.1.4 Final Reporting

The output of this final Stage is the Regional Study Report, supported by:

- A final definition of need – underwritten by historic data, but firmly seated in substantiated predictions of future arisings;
- A final definition of capacity – underwritten, as above, by historic data, but firmly underwritten by preferred technology options of known performance and capacities;
- Locational selection and other criteria; and
- Policy considerations.

3.2 Data Sources

Information on the generation and management of radioactive waste at a national, regional or sub-regional level within the Region has been drawn from a number of sources, namely:

Table 3.1: Data Sources

Parameter	Date	Source	Comment
Arisings and Disposal Information	2004	UK Radioactive Waste Inventory 2004; Nuclear Decommissioning Authority (NDA)	Data fully validated by the NDA that is not searchable
Arisings and Disposal Information	2007	UK Radioactive Waste Inventory 2007; Nuclear Decommissioning Authority (NDA)	Data fully validated by the NDA that is not searchable
Arisings and Disposal Information	2006/07	Environment Agency Hazardous Waste Interrogator, 2006	Most recent data fully validated by the EA that is fully searchable to WCA level for both arisings and fates
Location Details	-	Nuclear Decommissioning Authority (NDA)	Information regarding nuclear licensed sites in the UK.
Arisings and Management Comments	2005	Disposal of Low Level Radioactive Waste from Non-Nuclear Premises	Summary note only, but with rare reference to VLLW figures
Arisings and Management Comments	2007	Pilot Study to Assess Quantities and Disposal Routes for Solid Radioactive Wastes from Non-Nuclear Industries, Galston Sciences, May 2007	Summary note seen – with general reference to actual figures
Arisings and Management Comments	2007	Dose Implications of Very Low-Level Radioactive Waste Disposal UKRSR09	Summary note only, but with rare reference to VLLW figures
Arisings and Management Comments	2007	Policy for the Long Term Management of Solid Low Level Radioactive Waste – summary of comment and Government Response	Summary note only, but with reference to VLLW figures
Arisings and Management Comments	2008	A Framework For Implementing Geological Disposal	White Paper but with reference to indicative LLW/VLLW figures and management considerations
Arisings and Radioactivity Levels	2008	Discussion Paper on Low Level Radioactive Management	Summary note only, but with good illustrative data
General Observations	2008	Non-Nuclear Industry Radioactive Waste Strategy Development – progress report No. 1	General comments and references

3.3 Waste Definitions

3.3.1 Radioactive Waste Types

The 2007 Inventory describes radioactive waste as 'material that has no further use, and is above a pre-determined level of radioactivity – waste with levels of radioactivity below this threshold, while still radioactive, is not described as such for purposes of identity and management.

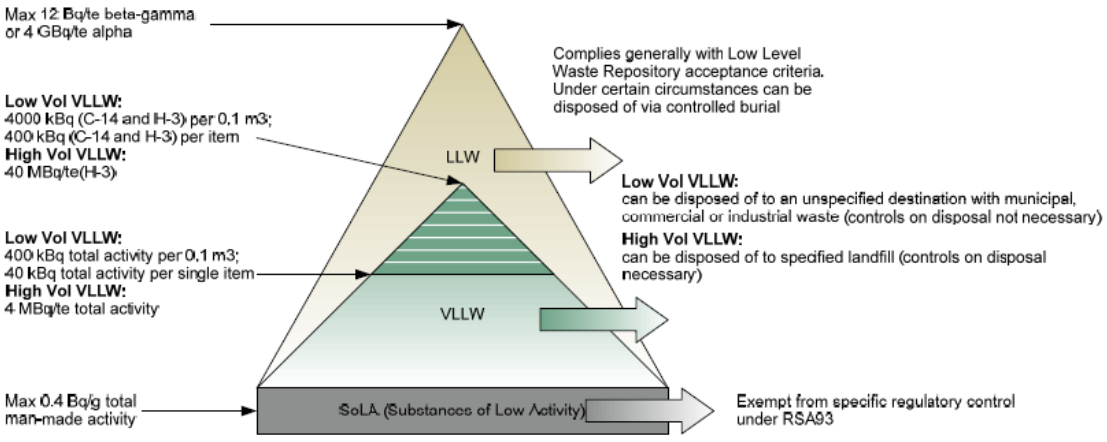
Radioactive waste may therefore arise from both nuclear and non-nuclear activities, as sources of radiation are used across the defence, power generation, medical and manufacturing sectors, as well as at research establishments.

Radioactive waste is divided into three main categories, Low Level (LLW), Intermediate Level (ILW) or High Level (HLW), according to how much radiation it contains and the heat this radioactivity produces. This report is only concerned with LLW, and its sub-category very low level waste (VLLW), although in setting the scene within which this material is created and its disposal managed, brief reference will be made to ILW and HLW.

Radioactive waste types are defined within the Central government policy document on the management of solid low level radioactive waste (2007) as:

Table 3.2: Definition of Radioactive Waste	
Waste Type	**Definition**
Low Level Radioactive Waste (LLW)	*radioactive waste having a content not exceeding four gigabecquerels per tonne (GBq/te) of alpha or 12 Bq/te of beta/gamma activity.*
Very Low Level Radioactive Waste (VLLW)	is categorised as by volume as
	a. Low volume (e.g. dustbin loads) - *'Radioactive waste which can be safely disposed of to an **unspecified** destination with municipal, commercial or industrial waste ("dustbin" disposal), each 0.1m^3 of waste containing less than 400 kilobecquerels (kBq) of total activity or single items containing less than 40kBq of total activity.* *For waste containing cabon-14 or hydrogen-3 (tritium):* ▪ *in each 0.1m^3, the activity limit is 4000kBq for C-14 and H-3 taken together; and* ▪ *for any single item the activity limit is 400kBq for C-14 and H-3 taken together.* *Controls on disposal of this material, after removal from the premises where the wastes arose, are not necessary.'*
	b. High volume (e.g. bulk disposals) - *'Radioactive waste with maximum concentrations of four megabecquerels per tonne (MBq/te) of total activity which can be disposed of to **specified** landfill sites. For waste containing hydrogen-3 (tritium), the concentration limit for tritium is 40MBq/te. Controls on disposal of this material, after removal from the premises where the wastes arose, will be necessary in a manner specified by the environment regulators.'*

or, as demonstrated graphically in the NDA's Position Paper No. 4 (W&NM/PP/004, dated March 2008), as below:



3.3.2 European Waste Codes

There are no European Waste Codes (EWC) that specifically relate to radioactive wastes and material will most likely be classified within relevant codes related to the sector of production (e.g. Healthcare). It is not possible to further identify radioactive wastes from EWC codes without also reviewing the waste description and composition information that would be provided by producers on waste transfer documentation.

3.4 Waste Management/Disposal Definitions ('Fates')

3.4.1 Introduction

Definitions of waste management or disposal options, or 'fates' as used in this study are summarised below:

Table 3.3: Management/Disposal Definitions - 'Fates'

No	Definition	Inferred Activity	Comment
1	Decay Storage	Neither treatment nor disposal	Infers that waste is removed from general circulation until such time as alternative process method(s) become available, as a result of the natural decay of its inherent radioactivity
2	Near Surface Disposal	Final disposal	This is undertaken at near-surface facilities such as Drigg where disposal is by way of compaction, grouting and placement in a concrete vault.
3	In-situ Disposal	Final disposal	This refers to disposal to specific areas of or adjacent to nuclear licensed sites (e.g. like at Sellafield) or to burial at the point of arising.
4	Landfill	Final disposal	Final disposal at specified landfill for LLW and for high volume VLLW, and includes the practice of controlled burial providing it meets the specified regulatory requirements.
5	Incineration	Thermal destruction	Destruction without energy recovery
6	Energy Recovery	As above	As above, with energy recovery
7	General Disposal	Final disposal	This refers to the disposal of low volume VLLW to an unspecified destination together with municipal, commercial or industry wastes. Actual location could be landfill, incineration or some other form of treatment. Receiving organisation/facility does not require specific authorisation to dispose of this waste as long as the non-radioactive element(s) are appropriately provided for.

4 LLW FROM NUCLEAR SOURCES

This section overviews the production and management of LLW from nuclear sources at a national level and also for the South East region specifically. Information has been drawn primarily from the UK Radioactive Waste Inventory 2007 (UK-RWI 2007).

4.1 National Background

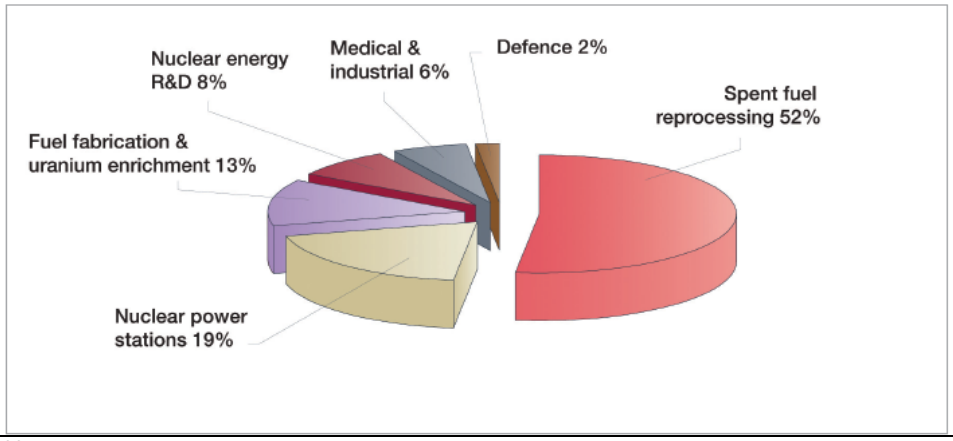
4.1.1 Processes Producing LLW

Within the UK, radioactive waste is produced as a result of:

- Fuel fabrication and uranium enrichment including activities that are carried out at Springfields and Capenhurst;
- Nuclear power reactors including all Magnox, AGR and PWR nuclear power station sites. Wastes may be produced from operational processes, maintenance, decommissioning and site clearance activities;
- Spent fuel reprocessing including all activities at Sellafield (i.e. includes waste associated with defence activities, research and development work and MOX fuel fabrication);
- Nuclear energy research and development including activities at Dounreay (i.e. fast reactor and materials testing reactor spent fuel processing), Harwell (excluding wastes from GE Healthcare Ltd), Windscale, Winfrith, Culham and the Berkeley Centre;
- Defence activities such as the manufacture/maintenance of nuclear weapons and submarines at sites located throughout the UK supporting Ministry of Defence activities; and
- Medical and industrial operations including the activities of GE Healthcare Ltd at Amersham, Cardiff and Harwell, the low level waste repository (LLWR) at Drigg and other minor waste producers (e.g. Industrial sterilisation processes, non-destructive testing of materials and as an element of security activities at UK travel centres such as airports).

A high-level breakdown of the activities from which waste is derived is shown in figure 4.1.1 below:

Figure 4.1.1 Radioactive Waste Production By Activity



Source: 2007 Inventory

4.1.2 LLW Waste Producers

UK-RWI 2007 identifies 35 sites across the UK that produce radioactive waste and their distribution can be seen on figure 4.1.2 below:

Figure 4.1.2 Location of Radioactive Producers in the UK

Source: 2007 Inventory

The majority of the sites are located in England, and these account for around 89% of waste produced each year, including wastes produced throughout the UK that are currently held in Vault 8 at the LLW Repository (LLWR) at Drigg.

4.1.3 LLW Composition

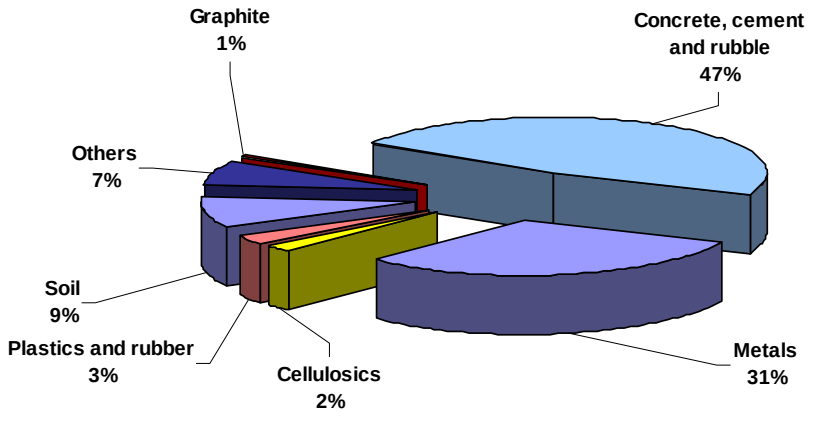
LLW materials are produced across the range of sectors described above and generally comprise:

- Concrete, cement and rubble, mainly from site decommissioning and clearance activities;
- Soils, mainly from site decommissioning and clearance activities; and

- Metals, cellulose-based compounds, plastics, rubber and graphite, from a range of operational, maintenance and decommissioning activities.

The proportion of the different material types found in LLW is shown in Figure 4.1.3a below:

Figure 4.1.3 Composition of LLW

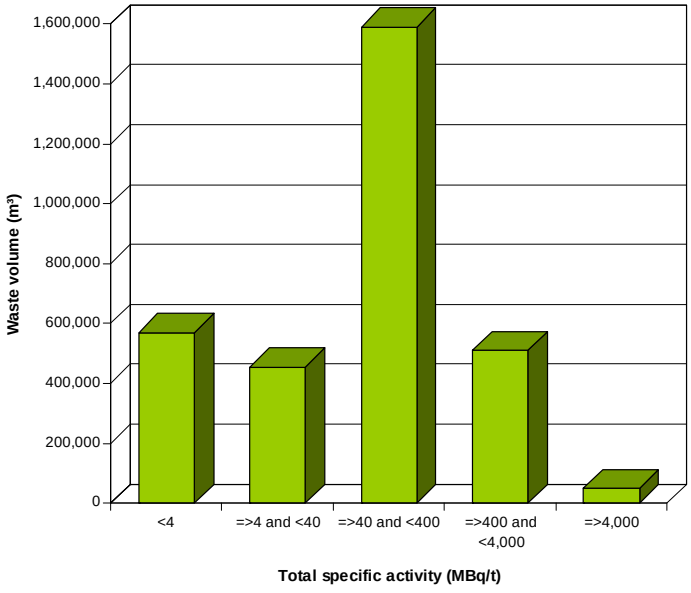


Total mass 3,600,000 tonnes

Source: 2007 Inventory

Radioactivity levels associated with LLW materials are shown in Figure 4.1.3b below:

Figure 4.1.3b LLW Volumes as a Function of Radioactivity Level



Source: 2007 Inventory

4.1.4 Overall Production of Radioactive Wastes

The UK-RWI 2007 records the total volume of radioactive waste from all sources as 3,430,000m^3 with around 93.1% of this material comprising low level radioactive material. This is summarised in Table 4.1.3 below:

Table 4.1.3	***Wastes at 01/04/07 and estimated for future arisings***			
	HLW	**ILW**	**LLW**	**Total**
Volume (m^3)	1,090	236,000	3,190,000	3,430,000
Mass (t)	2,900	270,000	3,600,000	3,900,000
Source: Radioactive Waste Inventory 2007				

In the above table the LLW classification comprises:

- 1,410,000 m^3 (1,500,000t) of VLLW;
- 385,000 m^3 (630,000t) of mixed LLW/VLLW; and
- 1,395,000 m^3 (1,470,000t) of LLW.

The Inventory notes that this material included around 230,000t of material currently held in Vault 8 of the low level waste repository (LLWR) at Drigg and 33,600t of material that had been previously disposed of at Dounreay that is to be retrieved and repackaged. Material that has already been deposited in the trenches at the LLWR has not been included.

Expressed on the basis of radioactivity, LLW/VLLW accounts for less than 0.0003% of the total load associated with all radioactive waste across the UK.

4.1.5 LLW Arisings at 01 April 2007

At 01 April 2007, the recorded volume of total radioactive waste in the UK was 290,000m^3, with around 196,000m^3 being categorised as LLW (including the VLLW as outlined above). The LLW arisings are summarised in table 4.1.5 below:

Table 4.1.5	***LLW Arisings at 01/04/07***		
Type	**Volume (m^3)**	**Mass (t)**	**No of Packages**
Not yet conditioned	36,300	51,000	252
Already Conditioned	160,000	230,000	8,275
Total	**196,000**	**280,000**	**8,527**

Within the above table, it should be noted that materials identified as "not yet conditioned" are untreated or partly treated materials, whereas materials identified as "already conditioned" have been encapsulated in cement-based material, polymer or glass.

The volumes include 19,200m^3 (24,000t) of VLLW and a further 210m^3 (320t) of mixed VLLW/LLW. Additionally, the UK-RWI 2007 also identifies around 2,420m^3 (1,800t) of ILW waste that is expected to become LLW as a result of decontamination or decay storage.

In relation to the source of the above materials:

- 156,000m^3 is waste that has already been conditioned and is in Vault 8 at the LLWR near Drigg;

- 11,200m^3 located at Sellafield, and 10,700m^3 located at Capenhurst, that are in temporary storage, awaiting either consignment to the LLWR, or, if suitable, disposal to 'specified' landfill;

- 6,860m^3 located at Dounreay, where LLW is being stored pending the planned opening of a new disposal facility at the site in 2013;
- Other wastes are being held for characterisation, processing and/or repackaging before being consigned to the LLWR; and
- A small fraction of LLW, about 300m^3, was unsuitable for consignment to the LLWR or disposal to landfill because the wastes do not meet current acceptance criteria. These wastes are managed in much the same way as ILW.

4.1.6 LLW Production Trends

Radioactive waste inventories have been prepared in the UK since 1984. During this time, additional wastes have accumulated, estimates of future arisings have changed with the availability of information and the amendment of waste management plans, and increased quantities of waste are being packaged for long-term management.

In relation to LLW arisings, table 4.1.6 summarises the volume changes from the last inventory in 2004 (both accumulated and estimated future arisings) and an outline of reasons for changes are given below.

Table 4.1.6	***Changes In LLW Volumes between the 2007 and 2004 Inventories***		
Volume (m^3)	**2007 Inventory**	**2004 Inventory**	**Change**
At 1 April (already conditioned)	160,000	1,870	+158,000
At 1 April (not yet conditioned)	36,300	19,000	+17,300
Total at 1 April	196,000	20,900	+175,000
Total in future arisings	3,000,000	2,030,000	+970,000
TOTAL	**3,190,000**	**2,060,000**	**+1,140,000**

The total volume of LLW already created and/or identified across the UK in 2007 inventory is forecast to be 3,190,000m^3, which is an increase of 1,140,000m^3 over the 2004 Inventory. UK-RWI 2007 contains details of newly-reported wastes (e.g. Vault 8 at LLWR, Drigg), and there are revised estimates of LLW volumes as a result of re-evaluation and reclassification of future arisings and changes in the scale of future activities.

In relation to the overall increase in the total volume of LLW, the main reasons behind the increases are:

- The inclusion in the inventory of newly reported VLLW with a volume totalling about 1,760,000m^3 – made up of decommissioning waste from Sellafield (1,260,000m^3), Capenhurst (10,000m^3), Springfields (385,000m^3), Harwell (82,500m^3) and Devonport (18,000m^3);
- Accumulations of LLW at Harwell from the recent decommissioning of the Graphite Low Energy Experimental Pile (i.e. GLEEP reactor);
- The inclusion in the inventory for the first time the LLW in vault 8 of LLWR (156,000m^3), as this material is deemed to be in storage until such times as the vault is finally capped and the UK Government authorises the resultant change in status;
- Future arisings of empty uranium hexafluoride containers (57,900m^3) at Capenhurst have been included for the first time;
- Decommissioning activities at Chapelcross during Care and Maintenance preparations have been reassessed and a further 51,300m^3 is anticipated; and

- About 33,600m^3 of LLW previously disposed of at Dounreay has now been included as future arisings, as it is planned to recover this material and package it for disposal in the proposed new facility.

In addition to the overall increase in LLW volume noted in UK-RWI 2007, some estimates of LLW volumes were lower than the 2004 Inventory, and the main changes noted are:

- Removal from UK-RWI 2007 of contaminated soil and building foundation estimated volumes (508,000m^3) due to be generated at Sellafield. These estimates have been removed from the Inventory as they are not yet well characterised and therefore there is considerable uncertainty in the volume that might arise

- Additional detailed characterisation work on the contaminated land at the AWE sites in Aldermaston has provided a greater understanding of volumes and activity levels expected. As a result of this work there has been a large reduction in the volume of long-lived alpha contaminated land needing extraction and disposal and confirmation that soils contaminated with relatively short-lived tritium are close to background and therefore are predicted not to form part of the disposal inventory on site closure. The overall result is a volume estimate that is lower by about 365,000m^3; and

- In addition to the inclusion of VLLW and decrease in contaminated land LLW estimates at Sellafield, there has been a reassessment of other LLW arisings from operations and decommissioning that indicates estimates are lower by about 61,900m^3.

4.1.7 Future Forecasted LLW Arisings

UK-RWI 2007 provides estimates of future waste arisings that are based on projections made by the organisations that operate sites where radioactive waste is produced. Projections are generated on the basis of their assumptions as to the nature, scale and timing of future operations and activities; and represent their planning positions at 01 April 2007.

Table 4.1.7 provides a summary of the volumes and masses of HLW, ILW and LLW from all sources projected to arise after 1 April 2007.

Table 4.1.7	***Forecast Arisings***			
	HLW	**ILW**	**LLW**	**Total**
Volume (m^3)	-646	143,000	3,000,000	3,140,000
Mass (t)	-440	160,000	3,400,000	3,500,000

In relation to LLW, the following has been noted in UK-RWI 2007 that:

- The forecast future arisings of LLW are about 3,000,000m^3 – more than half of this volume comprises either waste that falls into the VLLW sub-category (1,390,000m^3) or mixed VLLW/LLW waste from Springfields (385,000m^3);

- About 56% (1,660,000m^3) of all forecast future LLW arisings is from Sellafield – much of the other LLW is from Magnox power stations (425,000m^3) and Springfields (387,000m^3), with smaller contributions from AGR power stations (105,000m^3), Dounreay (91,200m^3) and Harwell (85,800m^3);

- Approximately 87% (2,600,000m^3) of all forecast future arisings are from decommissioning of existing reactors and other facilities and the remediation of contaminated ground – only about 13% (400,000m^3) is from operations, about half of which is from Sellafield;

- About 56% (1,460,000m^3) of decommissioning and site remediation wastes is associated with the dismantling and demolition of spent fuel reprocessing and other facilities at Sellafield. The decommissioning of uranium processing and fabrication facilities at Springfields is forecast to produce 345,000m^3, and final stage decommissioning of reactors and ancillary plant at Magnox and AGR power stations is forecast to produce 319,000m^3 and 61,500m^3 respectively;

- Forecast annual arisings of LLW are on average about 50,000m^3 in the period up to 2030 – the rate of arisings does not fall off after 2010 because as plant operations end and power stations shut down LLW continues to arise from POCO and decommissioning activities; and

- Arisings after 2030 are largely determined by the timing of decommissioning programmes - first at Sellafield and then at the power stations - and can fluctuate quite markedly from one year to the next. The forecast peak annual volume arising is over 100,000m^3. Between 2030 and 2049 the average annual arising is about 20,000m^3, and between 2050 and 2069 is over 30,000m^3. During the period of final dismantling and site clearance activities at power stations between about 2077 and 2125 the average annual volume of LLW is about 16,000m^3.

Accuracy of Forecast Predictions

Projections will most likely need to be amended as plans and arrangements are developed or are changed for commercial, policy or funding reasons, or if improved data become available.

Forward plans for operators have continued to be developed since 01 April 2007 and as such certain assumptions used in preparing data for the 2007 Inventory have already been revised or are being reviewed. This means that there will be, or are likely to be, some changes to waste estimates that can affect either or both the quantity and timing of future arisings.

It should be noted that the UK-RWI 2007 data does not include any reference to future nuclear generating capacity, which is known to be being considered for Dungeness C site.

The expected changes to assumptions used to prepare UK-RWI 2007 are outlined below:

a. Fuel Manufacturing and Uranium Enrichment

In respect of the UK fuel business:

- The final Magnox reactor station at Wylfa is scheduled to shut down by the end of 2010, and as a result Magnox fuel production is assumed to have ceased by 2008;

- Springfields currently manufactures the final uranium metal fuel elements for Magnox reactors, oxide fuels for AGRs, intermediates for export and has the potential to manufacture LWR fuel. Future operations at Springfields will depend on commercial strategies and the outlook for the worldwide nuclear power industry. The UK-RWI 2007 scenario assumes that oxide fuel, product manufacture and uranium enrichment operations cease by 2030;

- Capenhurst currently supplies enriched uranium for oxide fuel manufacture and future operations depend on the outlook for the worldwide nuclear power industry. UK-RWI 2007 assumes uranium enrichment operations cease by 2030;

- Sellafield SMP operations for the fabrication of MOX fuel are currently scheduled to operate to 2020, although operations depend on future levels of business; and

- Assumptions could be revised to accommodate an extension of AGR lifetimes or the renaissance of nuclear energy generation in the UK and overseas

b. Nuclear Power Station Operations

Power station operating lifetimes reflect existing corporate plans but could be revised as a result of market conditions or technical and safety issues. In relation to the current corporate plans:

- It should be noted that the UK-RWI 2007 data does not include any reference to future nuclear generating capacity, which is known to be being considered for Dungeness C site

- Predicted lifetime assumptions for the remaining operational Magnox stations (Oldbury and Wylfa) correspond with the latest dates for end of generation and as such any alternative operational scenarios are those limited to earlier closure; and

- Possible alternative lifetime assumptions for the AGR and PWR stations are early closure or extended operation.

Longer or shorter operating lifetimes for power stations would not have a significant effect on overall future waste volumes from the stations, which are dominated by wastes from decommissioning.

c. Reprocessing of Spent Fuel At Nuclear Power Stations

UK-RWI 2007 assumes that all spent Magnox fuel, SGHWR and WAGR fuel, about 3,300tU of AGR fuel, and about 4,400tU of overseas LWR fuel, are reprocessed and that any new business for Thorp is dependant on market, NDA and ministerial influences.

Additionally, AGR and Sizewell B fuels forecast to arise over UK power station lifetimes have not been included in UK-RWI 2007. In the event that these assumptions change:

- It is estimated that there will be 5,500tU of AGR fuel waste generated, and that if this were to be reprocessed as currently, the packaged waste volumes are estimated to be about 400m^3 of HLW, 11,000m^3 of ILW and 11,000m^3 of LLW – additional volumes of LLW will arise from waste treatment and site services facilities; and

- Sizewell B fuel waste is currently assumed to be held in long-term storage, although a number of treatment and reprocessing options may be available. In the event that Sizewell B fuel was to be reprocessed, then the packaged waste volumes are estimated to about 90m^3 of HLW, 3,000m^3 of ILW and 4,500m^3 of LLW. These figures assume the reprocessing of 1,200tU of fuel. As before, additional volumes of LLW will arise from waste treatment and site services facilities.

d. Nuclear Research and Development

Nearly all major R&D facilities in the UK, built over the past 50 years to support nuclear energy generation and fuel cycle operations, have been closed, and are either decommissioned or in the process of being decommissioned. In relation to the remaining facilities:

- The JET fusion facility is assumed to operate until the end of 2010, although operational lifetime could be extended in support of ITER – no significant impact on radioactive waste volumes is anticipated if the 2010 date changes due to low levels of waste arising annually; and

- The timetables and waste arisings provided by UKAEA for the operation and decommissioning of the major facilities at Dounreay, Harwell, Windscale, Winfrith and Culham are based upon the accelerated programmes originally presented to the NDA at the end of 2006 – however, the implementation of these programmes will be subject to sufficient available funding from the NDA.

e. Ministry of Defence Activities

There are four areas where changes may occur:

- Spent fuel from nuclear powered submarines has not yet been declared as 'waste' is currently held in long-term storage at Sellafield, and therefore does not appear on any data-base;

- There may be changes in relation to the long-term future of the Eskmeal battery, and therefore no steps have yet been taken to estimate the volume of wastes likely to arise from decommissioning of the battery;

- The MoD project dealing with the interim storage of laid-up submarines (Project ISOLUS) addresses the process for deciding and implementing future policy for managing the hulls and the reactors of decommissioned nuclear submarines, and again, any programme changes will inevitably affect future waste arisings; and

- All MoD land is subject to a detailed contamination survey, termed a Land Quality Assessment (LQA), and in light of the ongoing LQA programme, the current volume estimate for contaminated land in the UK Inventory is potentially subject to significant change, depending on the outcome of the assessments.

f. Nuclear Materials

The UK has large stocks of spent nuclear fuel from research and demonstration reactors, along with by-products of Magnox spent fuel re-processing and uranium enrichment processes that have no currently designated reprocessing route. Options for effective management of these materials, including the proportions to be retained as 'strategic stock', will be determined by the Government in consultation with the NDA and other stakeholders.

4.1.8 Radioactive Wastes Not Included In UK-RWI 2007

Waste Types

Within UK nuclear programmes, there has been, and will continue to be, accumulations of radioactive materials that are not currently classed as waste, primarily due to their potential value. It is recognised that changes in environmental, safety or economic conditions may change the classification of this material to waste in the future, and as such longer term management programmes need to take this material into consideration.

During 2007, the Committee on Radioactive Waste Management (CoRWM) prepared a separate report on the materials not covered by the main UK-RWI 2007 that identified two main groups of other materials:

- Civil nuclear materials that are not currently deemed to be waste, comprising irradiated and unirradiated fuels, uranium, plutonium and thorium; and

- Land that is potentially contaminated and miscellaneous materials that are not well characterised.

The main materials identified are:

a. Irradiated fuels comprise nuclear fuels that are or have been used to power nuclear reactors - when the material has reached the end of its life it is termed 'spent fuel', which typically contains uranium (96%), plutonium (1%) and 'waste' (3%). Following separation and via reprocessing, the uranium and plutonium can be reused to make new fuel. Most spent fuel generated in the UK is reprocessed and stored at Sellafield with the remaining fuel being stored at Sizewell or a small amount at Dounreay;

b. Unirradiated fuels are the fuels which have not yet been used to power nuclear reactors and mainly comprises fuels at fabrication plants awaiting shipment, fuel at power stations waiting loading into reactors and a small amount of research fuels;

c. Plutonium is a radioactive element that is created in nuclear reactors due to the 'burning' of uranium in the reactor. The plutonium is reprocessed from spent fuels as plutonium oxide powder that can in turn be used as a component of mixed oxide fuel (MOX) used by overseas customers;

d. Uranium is the naturally occurring radioactive material used for the manufacture of nuclear fuels. Uranium recovered from spent fuel reprocessing can be re-enriched and reused in new nuclear fuels;

e. Thorium is also a naturally occurring radioactive material that can be mined, extracted and processed to make nuclear reactor fuel, although this is only done on an experimental basis in the UK currently. Other non-nuclear uses of thorium are in illuminants, electron emitters, ceramics, glass, catalysts and specialist alloys;

f. Contaminated land materials are primarily due to ground and building foundations at nuclear sites having become contaminated with radioactivity over the lifetime of the plant. Materials generally comprise soils, concrete and other rubble that will arise at the time of final plant decommissioning and clean-up. Information relating to the actual composition of these materials is generally poor and estimates can be somewhat speculative due to uncertainty about regulatory requirements and disposal routes, poorly defined decommissioning/clean-up plans and limited characterisation work completed to date;

g. Miscellaneous wastes and materials generated from planned future activities are generally associated with the operation of planned new facilities and subsequent decommissioning/clean-up of such facilities in the future; and

h. Other miscellaneous wastes and materials comprise a small mount of radioactive waste, for which no final treatment, packaging or disposal routes have yet been identified.

Predicted Waste Arisings

In relation to the predicted arisings associated with the materials not currently reported in UK-RWI 2007, estimates have been sought from the NDA and organisations that operate sites in the UK.

The predicted arisings are:

a. Irradiated Fuels

Table 4.1.8a	***UK Owned Irradiated Fuel Stocks and Estimated Future Arisings (tHM)***			
Location	**Description**	**Stock At 01 April 2007**		**Estimated Future Arisings**
		In Reactor	**In Storage**	
Sellafield	Magnox Fuel AGR Fuel SGHWR Fuel Other Fuels		~ 1,200 ~ 2,800 ~ 120 ~ 350	- - 0 0
Dounreay	Various		13	0
Magnox Power Stations	Magnox Fuels	3,900	180	570
AGR/PWR Power Stations	AGR/PWR Fuels	~ 1,700	~ 440	~ 3,000
Others	Various		8	0

b. Unirradiated Fuels

Table 4.1.8b	***UK Owned Unirradiated Fuel (mass as tHM)***	
Location	**Description**	**Stock at 01 April 2007**
Sellafield	MOX Fuel	~ 3
Dounreay	Various	18
All UK Sites	Magnox Fuel	720
All UK Sites	AGR Fuel	~ 200
All UK Sites	PWR Fuel	~ 30

c. Plutonium, Uranium and Thorium

Table 4.1.8c	***UK Owned Plutonium, Uranium and Thorium (mass as tHM)***	
Location	**Description**	**Stock at 01 April 2007**
All UK Sites - Plutonium	PuO_2	~ 81*
All UK Sites - Uranium	DNLEU	~ 70,000
All UK Sites - Uranium	HEU	1.44
All UK Sites - Thorium	-	0

Notes

- * plutonium stocks are quantities identified at 31/12/2006.
- DNLEU materials exclude around 11,000 tHM of overseas owned materials.
- DNLEU arisings assume continuation of uranium enrichment operations to 2030.
- HEU are residues from reprocessing & fuel fabrication currently in stock - no future arisings.
- No reported thorium stocks or expected future arisings.

d. Contaminated Land

Predicted total volume is around 13,000,000 m^3 - around 98% is predicted to be soils and 2% building foundations. Based on current information, about 90% of the material is likely to be classed as VLLW and some of the soils may not ultimately require remediation at all, merely decay storage.

It should be noted that in line with current regulatory requirements contaminated soils at Sellafield are reported as existing stock although excavation/remediation is not anticipated until the period 2024 - 2100.

e. Miscellaneous Waste and Materials

Table 4.1.8d	*Miscellaneous Waste & Materials (m^3)*			
Site	**Stream Identifier**	**Stream Description**	**Stock At 01 April 2007**	**Future Arisings**
Sellafield	2D64	Magnox interfacial crud – ILW	<10	10
	2D80	Uranium Residues in Magnox Fuel Storage Pond – ILW	16	0
	2D97	Miscellaneous Trench Silt ILW/LLW	43	430
	2F28	Interfacial Crud ILW/LLW	0.12	0.25
	2Y60	Miscellaneous Minor Wastes - ILW	~~40	~~10
	2Y61	Lead - ILW	~~0	~~50
	2Y62	Oils and Solvents - ILW	~~1	~~90
	2Y63	Metallic Wastes: Plant and Equipment - ILW	~~180	~~260
	2Y64	Sludges, Resins and Flocs - ILW	~~50	~~80
	2Y65	Miscellaneous Minor Wastes - LLW	~~130	~~100
	2Y66	Lead - LLW	~~10	~~100
	2Y68	Metallic Wastes: Plant and Equipment - LLW	~~100	~~310
	2Y69	Sludges, Resins and Flocs - LLW	~~1	~20
Capenhurst	2B13	Technetium Contaminated Uranic Residues	21.75	0
	2B14	Uranic Residues	8.5	0
All sites		**Total**	**~~610**	**~~1,460**

4.2 LLW from Nuclear Sources in the South East Region

4.2.1 Sites Producing LLW in the South East Region

The nuclear industry sites located in the South East Region are:

- MoD defence locations at AWE Aldermaston and HMNB Portsmouth;
- Power generating site operated by British Energy at Dungeness B;
- Medical/industrial research and manufacturing operated by GE Healthcare Ltd at Amersham and Harwell; and
- NDA decommissioned sites at Culham, Harwell and Dungeness A.

In each case, the organisation responsible for each of these sites is responsible in law for the appropriate management of such wastes, be this locally or more distantly focussed.

4.2.2 Typical LLW Waste Composition Based on Overall South East Arisings

In relation to LLW available at 01 April 2007 and predicted future arisings for the South East, the typical waste compositions are shown in table 4.2.2 below.

Table 4.2.2	***Summary of LLW Material Content, expressed in tonnes***													
Site	**Metals**					**Organics**		**Inorganics**				**Soil**	**Not Specified**	**Overall Total**
	Steels	**Magnox**	**Aluminium**	**Zircaloy**	**Other Metals**	**Cellulose**	**Other Organics**	**Concrete**	**Graphite**	**Sludges & Flocs**	**Other Organics**			
AWE Aldermaston	3,300	0.2	720	0	1,400	2,100	3,700	3,700	37	810	76	9,000	2,000	26,843
HMNB Portsmouth	1.8	0	13	0	0.4	0.4	0.4	1.1	0	0	0.4	1.7	0	33
Dungeness B	17,000	0	38	0	76	570	1,500	1,200	2,100	190	98	250	-1,337	21,685
Amersham	1,100	0	18	0	350	2,000	2,700	220	0	0	410	250	640	7,688
Harwell (GE)	14	0	0	0	0	26	0	1.4	0	0	0	0	27	68
Culham	6,600	0	0	0	580	20	460	5,600	0	0	0	0	890	14,150
Dungeness A	11,000	0	22	0	20	380	1,100	20,000	4.7	1.3	51	1,500	790	34,869
Harwell (NDA)	7,000	0.2	61	0.2	780	62	390	25,000	550	74	62	98,000	11,000	142,980
Minor Producers	1,100	0	100	0	1.2	520	1,700	4,100	210	0	0.3	2,100	980	10,812
TOTAL	47,116	0.4	972	0.2	3,208	5,654	11,550	59,822	2,902	1,075	698	111,102	14,990	259,128
% of Overall Total	18.18	-	0.38	-	1.24	2.18	4.46	23.09	1.12	0.42	0.27	42.88	5.78	

4.2.3 LLW Waste in the South East Region at 01 April 2007

At 01 April 2007 the recorded volume of total radioactive waste in the South East was 10,987m^3 with around 3,837 m^3 being categorised as LLW. The LLW arisings are summarised in table 4.2.3 below:

Table 4.2.3	***LLW Arisings In South East Region at 01 April 2007***				
Site	**Operator**	**Volume (m^3)**	**No of Packages**	**Packaged Volume (m^3)**	**Conditioned Volume (m^3)**
AWE Aldermaston	MoD	1,150	0	0	0
HMNB Portsmouth	MoD	6.75	0	0	0
Dungeness B	British Energy	96.3	0	0	0
Amersham	GE Healthcare Ltd	0	0	0	0
Harwell	GE Healthcare Ltd	0	0	0	0
Culham	NDA	150	0	0	0
Dungeness A	NDA	206	0	0	0
Harwell	NDA	2,210	0	4.78	3.82
Minor Producers	Various	17.4	0	0	0
TOTAL	**All Sites**	**3,836.45**	**0**	**4.78**	**3.82**

The South East LLW arisings at 01 April 2007 equates to around 1.96% of the UK total LLW.

4.2.4 Forecast LLW Production in the South East

Estimated future LLW arisings for the South East are summarised in table 4.2.4 below:

Table 4.2.4	***Forecast LLW Arisings In South East Region, expressed in tonnes/period referred to***									
Site	**2007**	**2008-2009**	**2010 - 2014**	**2015 - 2019**	**2020 - 2029**	**2030 - 2039**	**2040 - 2059**	**2060 - 2099**	**Post 2100**	**Total**
AWE Aldermaston	1,220	2,520	6,200	5,510	8,400	7,180	4,150	2,010	0	37,200
HMNB Portsmouth	0.8	1.6	4	4	3	2	2	0	0	17.4
Dungeness B	30.2	60.4	151	2,440	3,290	12	24	48	11,000	17,100
Amersham	430	1,140	2,600	2,050	4,100	4,640	0	0	0	15,000
Harwell (GE)	20	40	40	0	0	0	0	0	0	100
Culham	10	20	1,320	5,240	0	0	0	0	0	6,730
Dungeness A	256	1,020	1,630	1,370	272	21	42	84	23,400	28,100
Harwell (NDA)	120	654	82,100	8,090	248	0	0	0	0	91,200
Minor Producers	19.2	31.7	15.7	0	0	0	0	0	0	66.6
TOTAL	**2,106.2**	**5,487.7**	**94,060.7**	**24,704**	**16,313**	**11,855**	**4,218**	**2,142**	**34,400**	**195,514**

4.2.5 LLW Production Trends in the South East

From the UK-RWI 2007, production trends in the South East are:

Table 4.2.5	***LLW Production Trends In South East* - Volume (m^3)**			
Site	**Waste Type**	**2007 Inventory**	**2004 Inventory**	**Change**
AWE Aldermaston	Already Conditioned at 01/04/07	0	0	0
	Not Yet Conditioned at 01/04/07	1,150	1,260	-110
	Total Future Arisings	37,200	381,000	-344,000
HMNB Portsmouth	Already Conditioned at 01/04/07	0	0	0
	Not Yet Conditioned at 01/04/07	0	6	- 6
	Total Future Arisings	14.4	18.2	- 3.8
Dungeness B	Already Conditioned at 01/04/07	0	0	0
	Not Yet Conditioned at 01/04/07	0	0	0
	Total Future Arisings	17,100	12, 900	+ 4,200
Amersham	Already Conditioned at 01/04/07	0	0	0
	Not Yet Conditioned at 01/04/07	0	50	- 50
	Total Future Arisings	15,000	18,200	- 3,200
Harwell (GE)	Already Conditioned at 01/04/07	0	0	0
	Not Yet Conditioned at 01/04/07	0	0	0
	Total Future Arisings	100	160	- 60
Culham	Already Conditioned at 01/04/07	0	0	0
	Not Yet Conditioned at 01/04/07	150	100	+ 50
	Total Future Arisings	6,580	16,700	-10,100
Dungeness A	Already Conditioned at 01/04/07	0	0	0
	Not Yet Conditioned at 01/04/07	0	250	- 250
	Total Future Arisings	31,000	34,700	- 3,700
Harwell (NDA)	Already Conditioned at 01/04/07	2	26.4	-24
	Not Yet Conditioned at 01/04/07	2,210	318	+ 1,890
	Total Future Arisings	91,200	20,600	+ 70,600
TOTAL	**Already Conditioned at 01/04/07**	**2**	**26.4**	**- 24**
	Not Yet Conditioned at 01/04/07	**3,510**	**1,984**	**+ 1,526**
	Total Future Arisings	**198,194.4**	**484,278.2**	**- 286,083.8**

In relation to the above trends, the most significant changes are:

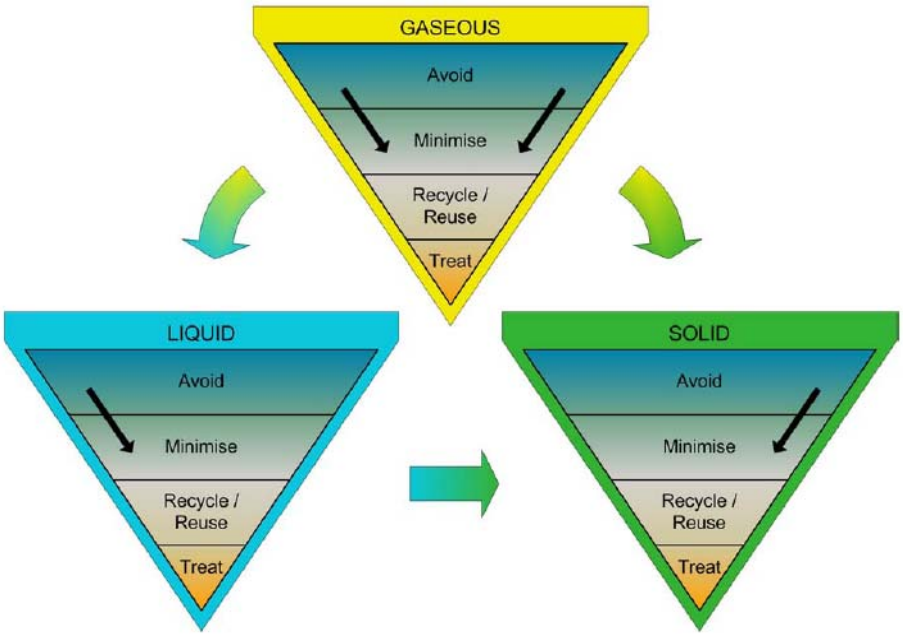
- Inclusion of accumulated VLLW materials at Harwell due to decommissioning of GLEEP that has significantly increased the volume of materials expected to be generated at this location; and

- Additional detailed characterisation work on the contaminated land at the AWE sites in Aldermaston has provided a greater understanding of volumes and activity levels expected. As a result of this work there has been a large reduction in the volume of long-lived alpha contaminated land needing extraction and disposal and confirmation that soils contaminated with relatively short-lived tritium are close to background and therefore are predicted not to form part of the disposal inventory on site closure. The overall result is a volume estimate that is lower by about 365,000m^3.

4.3 Waste Management Techniques

4.3.1 Waste Hierarchy

At a fundamental level, the management of radioactive waste ought to follow a hierarchical approach, much as non-radioactive waste, although there is evidence from the emerging LLW strategy being developed by the NDA, that in the past, this approach has perhaps not been that rigorously pursued. As taken from the NDA's Position Paper No. 1, W&NMPP/001, dated March 2008, this approach is now considered essential, and ought to follow the steps identified below:



'Treat' differs from phase to phase, and for LLW/VLLW (all solid) covers incineration (with or without energy recovery) and/or final disposal to landfill or the LLWR.

4.3.2 Conditioning of LLW

In respect of waste management techniques currently being employed for the management of LLW generated from nuclear sources, it has been noted that an increasing quantity of waste is being 'conditioned'. Conditioning changes the material composition of the wastes and generally involves immobilisation of the waste in cement-based or polymer matrices.

In terms of current arisings of LLW (i.e. at 01/04/07), most is immobilised in low viscosity cement within mild steel ISO containers held at LLWR at Drigg. Other small volumes of LLW have been immobilised in cement-based matrices at:

- Berkeley and Hunterston A – sludge;
- Hinkley Point A – used filters;
- Harwell – sludge/
- Windscale – decommissioning waste from WAGR (3 packages);
- Aldermaston – sludge; and
- Devonport – sludge, ion exchange material and used filters.

4.3.3 Storage and Disposal Techniques

Storage and disposal techniques currently employed for the management of LLW include:

- Dounreay disposal facility - this consists of six shallow trenches that have been used for LLW disposal from the site and from the adjacent Vulcan site. Total disposals to this facility were around 33,600m^3 and as the site does not meet current standards this LLW is to be retrieved, repackaged into containers and then consigned to a new solid LLW disposal facility planned at the site;

- Interim temporary storage of current LLW arisings at Dounreay - this material is unconditioned and will ultimately be immobilised in cement and transferred to the new site LLW disposal facility once this is operational.;

- Near- surface disposal at the LLWR near Drigg has taken place since 1959 - about 800,000m^3 of waste has been disposed in a series of clay-lined trenches and covered with soil up to 1995;

- Interim storage in Vault 8 at the LLWR near Drigg - since 1988 most LLW has been placed in large metal containers, similar to shipping containers that are then filled with cement and placed in an engineered concrete vault (Vault 8). Suitable LLW is first super-compacted under high pressure of up to 2,000 tonnes per square metre to minimize its volume. At 01 April 2007 the containers occupy nearly 200,000m^3 of vault space and are deemed to be in interim storage until such times as the vault is covered with a suitable cap and the UK Government reclassifies it as disposed;

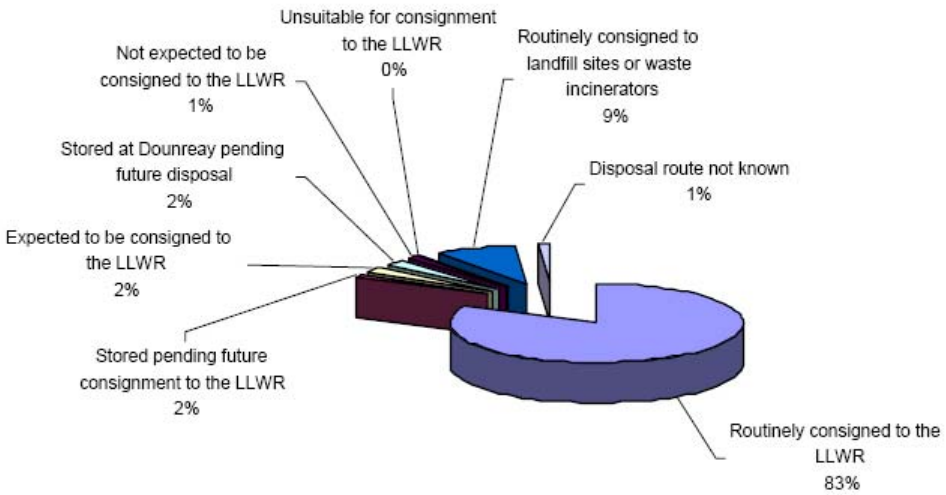
- Interim storage of LLW at sites other than Drigg pending expected transfer at a future date to the LLWR;

- Final disposal in off-site landfills or similar in-situ facilities may be employed for bulk wastes classified as high volume VLLW where such disposals are authorised. Other disposal routes that may be employed for this material included incineration. High volume VLLW is included in UK-RWI 2007 where there is reasonable certainty in the volume arisings; and

- Off-shore disposal practices employed between 1949 and 1982 are no longer in use.

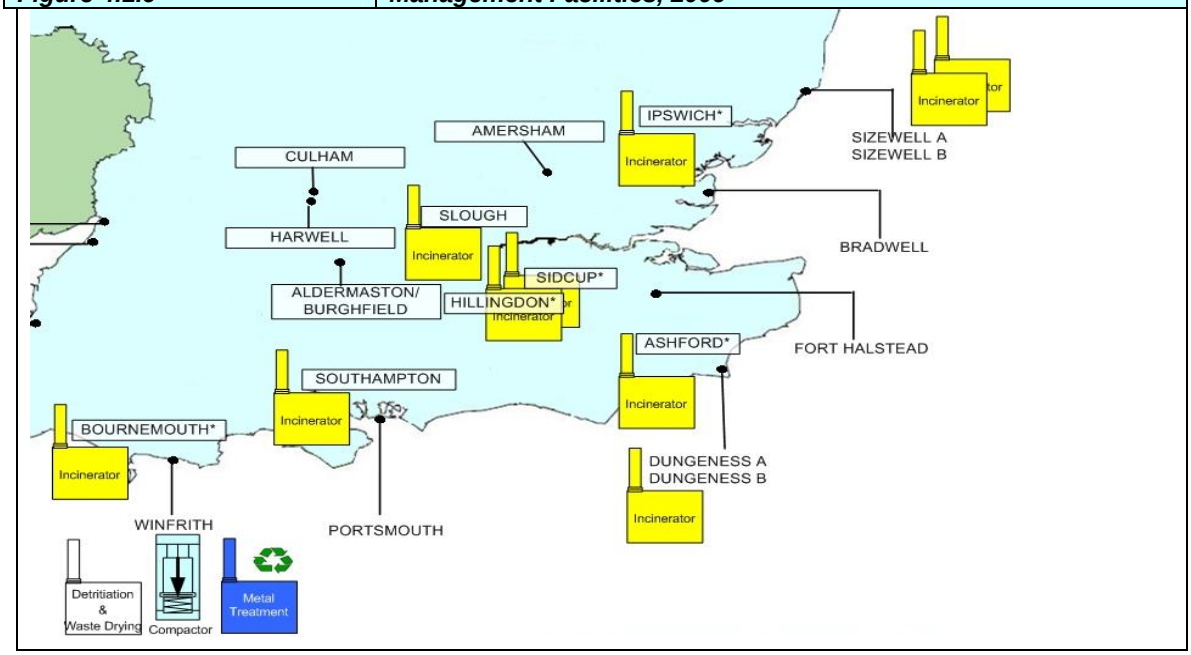
In respect of the management of LLW arising at 01 April 2007, the activity distribution of the techniques employed is shown in Figure 4.1.8 below:

Figure 4.1.8 | ***Management Routes for LLW at 01 April 2007***



In addition, the management and disposal activity distribution for the UK can be viewed at http://www.llwrsite.com/UserFiles/File/LowLevelWasteStrategyGroup/Fourth%20Meeting/StrategyGroup4-2-StrategicReview-November2008.pdf, from which those facilities directly relevant to the South East (with the exception of the LLWR) are illustrated in Figure 4.1.9, below, those incinerators marked (*) denoting those which may not be alpha-emitting:

Figure 4.1.9 ***Management Facilities, 2009***



4.3.4 Waste Management in the South East

Disposal routes for nuclear LLW waste produced in the South East of England are not specifically identified in UK-RWI 2007, although it is understood that interim storage is provided at the producing sites, and the majority of LLW material is anticipated to be transferred to LLWR at Drigg.

4.3.5 Future Waste Management Capacity

Forecast Waste Management Needs

Based on the current and future LLW arisings outlined in UK-RWI 2007, capacity requirements are (based on pre-compacted volume figures):

Table 4.3.4a ***LLW Capacity Requirements - Volume*** **(m^3)**

Category	At 1.4.2007	Future arisings								Total
		2007-2009	2010-2014	2015-2019	2020-2029	2030-2039	2040-2049	2050-2099	Post 2100	
Routinely consigned to the LLWR	161,000	45,700	75,300	57,200	56,900	31,600	19,300	0	0	447,000
Stored pending future consignment to the LLWR	3,170	350	165	233	265	155	0	0	0	4,340
Expected to be consigned to the LLWR	4,830	9,230	69,900	59,800	101,000	50,600	36,400	0	0	332,000
Stored at Dounreay pending future disposal	4,670	2,760	5,390	9,690	45,500	4,330	0	0	0	72,300
Not expected to be consigned to the LLWR	2,270	2,420	77,400	7,300	557	557	557	278,000	231,000	600,000

Unsuitable for consignment to the LLWR	304	20.6	32.5	27.2	21.8	0	0	852	12,000	13,300
Routinely consigned to landfill sites or waste incinerators	17,400	65,200	139,000	87,400	236,000	165,000	79,200	730,000	180,000	1,700,000
Disposal route not known	2,830	1,330	5,370	3,690	11,300	125	165	896	0	25,700
Total	196,000	127,000	372,000	225,000	451,000	252,000	136,000	1,010,000	423,000	3,190,000

LLWR Facility near Drigg

The LLWR facility near Drigg houses a near-surface repository for LLW materials produced throughout the UK. Waste for consignment to the LLWR must comply with the site's Conditions for Acceptance (CfA) that stipulates certain materials must not be present in the waste, and places limits on the maximum concentration of certain radionuclides for which the LLWR has authorised annual disposal limits. To comply with the CfA, wastes must also have a valid Waste Stream Characterisation Document (WSCD) at the time of disposal that describes the physical, chemical and radionuclide content, gives estimated arisings, conditioning and packaging information, and a justification of assessment methodology.

During the last 10 years LLW consignments to the LLWR at Drigg have totalled 105,000m^3 and future capacity in an additional engineered concrete vault will be subject to Environment Agency authorisation for further disposals and planning consent being agreed. For current operational planning purposes, it is currently assumed that the site could be full by 2020, although a long-stop date of 2050 has also been considered (see http://www.llwrsite.com/UserFiles/File/LowLevelWasteStrategyGroup/Feb2009/LSG%20LLW%20Strategy%20-%20Feb%2009.pdf.

In respect of capacity utilisation at Drigg, table 4.3.4b below details historic annual consignment levels at the facility along with forecast utilisation.

Table 4.3.4b	***Capacity Utilisation at LLWR, Near Drigg***		
Historic Annual Consignments		**Future Predicted Consignments**	
Year	**Total volume (m^3)**	**Year**	**Total volume (m^3)**
2001	6,100	2007	15,400
2002	10,800	2008	14,500
2003	11,400	2009	14,600
2004	12,900	2010	14,500
2005	12,800	2011	14,900
2006	12,900	2012	13,200
Note: Volume is for waste and its primary containment		*Note: Volume is the packaged volume and reflects the effect of both waste compaction and containerisation*	

In respect of the predicted waste consignments, the values are packaged volumes for waste streams that are identified in UK-RWI 2007 as routinely consigned to the LLWR (99%) or in interim storage pending future consignment to the LLWR (1%). A further 70,000m^3 are identified as "expected to be disposed of to the LLWR" over the same period. Most of this waste is concrete, steel, rubble and soil from facilities decommissioning.

It is, however, acknowledged that potential capacity at the LLWR is well below the forecast volume of LLW that must be managed in the future (NDA emerging strategy), even allowing for compaction-related volume reductions, and that the continued existence of the facility may in any event be undermined by any failure to establish the long-term safety case, which has yet to be confirmed.

Dounreay Disposal Facility

Currently around 34,000 m^3 of LLW previously disposed off at Dounreay has been identified for retrieval, repackaging and consignment to a new site LLW disposal facility. Future anticipated consignments for the new facility are summarised in table 4.3.4c below.

Table 4.3.4c	***Predicted Consignments At Dounreay* - Total volume (m^3)**	
Period	**Operational LLW**	**Decommissioning LLW**
At 01 April 2007	3838.1	3025.8
2007	241.8	1053.5
2008 - 2009	483.6	1298
2010 - 2014	428.2	8459.2
2015 - 2019	273.6	12,739
2020 - 2029	148.7	56 386.1
2030 - 2039	0	4329.6
2040 - 2099	0	0
Post 2100	0	0
Note: volumes are for untreated materials only		

Other Storage Arrangements

Other interim storage arrangements for LLW materials are expected to be provided at individual sites of production pending transfer to the LLWR or disposal at another appropriate licensed facility (e.g. landfill or incineration). In this respect, attention is drawn to a previous options assessment undertaken for the on-site disposal of LLW at the Dungeness site, which in the event did not result in the establishment of a facility for a mixture of technical and public confidence reasons.

Government Identified Options

The present UK Government strategy for long term management of LLW can be summarized as:

- Disposal of suitable LLW in near-surface facilities; and
- Disposal of the relatively small volume of LLW nor suitable for near-surface disposal at geological disposal facilities along with all ILW and HLW.

However, delivery of the above policy is affected by:

- Capacity limitations at the existing LLWR in respect of future LLW arisings;
- Diminishing availability of landfill sites for lower activity LLW;
- No new LLWR facilities yet identified, much less developed; and
- No facilities for disposing of LLW materials not suitable for near-surface disposal with ILW and HLW have been developed – these materials are currently being stored.

To assist with delivery of Government strategy, two new policy documents were issued in 2007 for management of solid LLW and in 2008 for the implementation of geological disposal facilities. The new approaches are designed to introduce a more flexible approach to the management of radioactive waste materials (see section 6.1) and the NDA has been appointed as the body responsible for delivering these policies.

4.4 Data Quality Considerations

UK-RWI 2007 identified the following data quality considerations:

- Existing waste - there is a high level of confidence in the volume as this is based on measurements;

- Predictions of operational wastes - reasonable confidence in estimates of future arisings from operations within the next 5 years with increasing uncertainty for more distant predictions due to anticipated changes in operational plans from environmental, safety and economic factors;

- Predictions of decommissioning wastes - greater levels of uncertainty particularly for wastes at the lower end of the LLW activity range due to uncertainty about regulatory requirements and disposal routes, lack of definition of site decommissioning and clean up plans, and the fact that much characterisation work remains to be carried out. This makes estimation of waste volumes somewhat speculative. The current Inventory only includes materials that are sufficiently well characterised - as decommissioning projects progress through initial scoping studies, detailed planning and then implementation, and as ground contamination surveys are extended and refined, volume estimates can be determined with increasing certainty; and

  Predictions of packaged volumes - the current Inventory reports volumes once they have been packaged for long-term management, however, packaging schemes are still primarily in the development stage (especially for decommissioning wastes) and as such there is greater uncertainty in the resulting volumes than there is in waste volumes at the point of generation.

5 LLW FROM NON-NUCLEAR SOURCES

5.1 National Background

5.1.1 Production Sources and Definitions

Non-nuclear waste is capable of being generated at any location which involved in the production or use of radioactive sources for non-nuclear purposes – and as a result of this, is almost inevitably not captured in the previously referenced 2007 Inventory.

Only LLW (low-level waste) and VLLW (very low-level waste), as defined in Section 3.3.1 above, radioactive waste is produced in a non-nuclear context.

Most of the non-nuclear radioactive sources used in industry and the medical profession originate from the Amersham site, operated by GE Healthcare Ltd, to which they are returned once 'spent'. The management of this element of radioactive waste, (i.e. the emitter sources, as opposed to material contaminated as a result of exposure to emitters), is therefore captured within the 2007 Inventory, and has been reported on in Section 4.

Actual sources of non-emitter waste are numerous, although, as there is no definitive list (maintained either by the EA or other relevant authorities) against which to report, these are understood to include:

- RSA registered sites, including medical care and vetinary facilities;
- medical/industrial/nuclear R&D facilities;
- commercial/industrial applications, for example those involved in non-destructive testing;
- the MOD;
- educational establishments;
- the waste sector; and
- some construction/energy sites

It may therefore be assumed that non-nuclear waste production is almost certainly to be spread across the whole of the UK, and indeed each Region within it, perhaps concentrated in centres of higher population density and/or centres of industrial activity, and this report should be considered on this assumption.

Non-nuclear radioactive wastes are defined as per Section 3.3.1 of this report, although only LLW and VLLW apply in this context, there being no waste produced other than these types outside the nuclear industry.

5.1.2 EWC

The linkages between EWCs and nuclear waste have previously been discussed in Section 3, and this remains relevant to non-nuclear waste arisings.

5.1.3 Arisings

Research in conjunction with this report has shown that there is no national data-base of non-nuclear LLW and VLLW radioactive waste arisings; nor is there any individual regional data-base.

What data there is available has been obtained from the last three references presented in Table 3.1. This shows, on a UK level, combined arisings levels for LLW and VLLW of some 5,400 cubic metres for 2002/03, and some 3,600 tonnes for 2005.

On this basis, UK non-nuclear LLW/VLLW production rates are at or around 1% of the amount produced by the nuclear industry, which, spread as it is across the whole of the country, has benefits-of-scale implications for management and final disposal which do not otherwise apply to the nuclear industry.

Split between the constituent parts of the UK, using the proportions to be found in Section 5.3.1 to follow, this equates to some 3,000 tonnes annualised production for England and Wales combined.

In the absence of detailed data, it has not been possible to verify the above information, and this must therefore be considered only as an initial, 'working' estimate.

5.1.4 Impact of Legislative Changes

Incoming or recent legislation that impinges on non-nuclear radioactive waste are the 2007 Central government and 2008 Environment Agency documents referred to in Table 3.1,

An ongoing study (being undertaken by Atkins on behalf of DTI (as an integral part of the ongoing NNI LLW strategy development, as referenced in Section 2.4), and due to report late 2008 or early 2009) is intended to begin to establish new, co-ordinated, national policy for the management of non-nuclear LLW and VLLW waste. This work will begin to accurately quantify the arisings of LLW and VLLW in a way that lends itself to continuing validation, and more accurately track management and disposal routes, as neither are currently required. However, it will not be in a position to recommend policy until late 2009 at the earliest.

The net result of this combined approach to improved definition and management is, based on experience with hazardous wastes, likely to increase the apparent amount produced and improve the traceability of disposal.

5.2 LLW and VLLW in the South East Region

5.2.1 Present Arisings

Working from the national data presented in Section 5.1.3, and using only a simplified method of apportionment (i.e. 10 region-equivalents), leaves an estimated 350 to 400 tonnes per annum to be managed across the South East region.

In waste terms, this is a small amount to be managed, which brings its own challenges.

5.2.2 Likely Future Arisings

In the absence of any verifiable methodology for predicting future changes in non-nuclear LLW or VLLW radioactive waste arisings, as in part these are likely to be population-based and in part improved definition based, it is felt that a nominal cap of arisings of some 500 tonnes per year by 2026 is not unreasonable, pending the outcome of the study referenced in Section 5.1.4.

5.3 Waste Management Techniques

5.3.1 General

Research undertaken in 2005 ('Disposal of Low Level Radioactive Waste from Non-Nuclear Premises', UCL, to the LLW management policy workshop) showed that there are in the order of 1200 non-nuclear premises across the UK (in the order of 1000 in England and Wales) authorised to dispose of radioactive waste AND an undefined number of premises making disposals within the conditions of individual exemption orders.

Further research for 2007, reported in Dose Implications of Very Low-Level Radioactive Waste Disposal, UKRSR0, suggests that the number of premises is now around 690, of which 80% were located in England and Wales, 14.5% in Scotland and the remainder in Northern Ireland.

These disposals are authorised by the EA in England and Wales (SEPA in Scotland; EANI in Northern Ireland) on the basis of a three-phase system, reviewed in more detail to follow, based around the Radioactive Substances Act (RSA) 1993.

5.3.2 Management, Storage and Disposal Techniques

Storage and disposal techniques currently employed for the management of non-nuclear VLLW and LLW, while based around those previously described in Section 3.4.1, follow the principles of Best Practical Means (BPM), Best Practicable Environmental Option (BPEO) and ALARA (as low as reasonable acceptable). They are designed to reduce the amounts produced, with the management of materials then based around the minimisation of transport off-site and then only in a manner that minimises the potential for impact on the environment and the public. As a result, actual techniques reflect the nature and amount of the radioactive content of the waste concerned, are at the 'lower' end of the complexity scale, and include:

- Decay storage – applicable to organisations authorised to dispose and making disposals via exemptions;
- Dustbin disposal – via disposal as an admixture with 'ordinary' refuse, where the receiving landfill site or incinerator need not be specifically authorised to receive radioactive waste, and therefore the operator of which may or may not be aware of any receipt – (see UKRSR03, Development of a Framework for Assessing the Suitability of Controlled Landfill to Accept Disposals of Solid Low-Level Radioactive Waste) – NOTE while it may be that the majority of 'dustbin wastes' are managed via the hazardous waste system, and indeed there is a degree of anecdotal evidence to support this presumption this is not necessarily always the case;
- Special precautions burial – again via landfill, although in this instance to one specifically authorised or the receipt and disposal of proscribed radioactive substances, and therefore more likely than not to be a hazardous or nuclear industry in-house landfill; and
- Incineration, sites registered under RSA93 for LLW and non-registered sites for VLLW – for radioactive waste not suitable for landfill, and is therefore disposed of to an appropriately authorised incinerator

Knowing the types of locations from which non-nuclear radioactive waste is likely to have arisen from, it is considered that most waste arisings will most likely either be managed as clinical (EWC18) or not described (EWC16) wastes. On this basis, it is considered that to infer management and disposal via those routes most commonly used by these waste types is likely to be representative of non-nuclear radioactive wastes as well.

The management of wastes of this nature is undertaken by the Environment Agency using a number of controls, see LLW Guidance Note, 'Disposing of Radioactive Waste to Landfill', on the basis of the following summarised requirements:

Type of LLW disposal	Destination	Consigning site		Receiving site	
		Type of RSA authorisation	Radiological impact assessment needed to support application?	Need for RSA authorisation?	Type of radiological impact assessment needed
LV – VLLW[3]	Landfill or incineration	Standard VLLW conditions	No	No	N/A
HV – VLLW	Specific landfill	Transfer authorisation	No	Yes	Sufficient to demonstrate acceptable impacts – simple approach likely to suffice
Controlled burial	Specific landfill	Transfer authorisation	No	Yes	Sufficient to demonstrate acceptable impacts
Disposal to dedicated disposal site (LLW, including HV-LLW)	Dedicated site, off nuclear site	Transfer authorisation	No	Yes EP-type conditions may be applied through RSA authorisation	Sufficient to demonstrate acceptable impacts
	Dedicated disposal site, on or adjacent to nuclear site: Receiving site is consigning site. Disposal facility will need to hold RSA authorisation. EP-type conditions may be applied through RSA authorisation				

5.3.3 Waste Management in the South East

Disposal routes for non-nuclear LLW and VLLW waste produced in the South East of England are not specifically identified in any database to which the authors of this report have had access. However, the Galston Science report of May 2007 (Table 3.1), based on 2006 data, provides a summary for the management of LLW/VLLW waste in the South East Region, to which end management routes of 40% landfilled and 60% incinerated were identified for VLLW, as well as with 58% incinerated, 24% to the LLWR, 14% to (decay) storage and 4% to controlled burial (adjacent, i.e. in situ, landfill).

Anecdotal evidence gathered during this study indicated that receiving sites, whether management or final disposal may indeed not be aware that they are handling such wastes, if they are managed/disposed of as 'dustbin wastes', as there is no obligation to declare such materials anywhere within the disposal chain.

Those sites that are specifically authorised to receive such materials almost invariably chose not to declare the fact publicly, and via their authorisations route(s) are provided with a method of not having to do so.

On this basis, it is therefore almost impossible to identify what non-nuclear waste may, or indeed may not, have gone to which facility with any degree of certainty, and although the authors have been made personally aware (anecdotally) of disposal routes that are used, these cannot be revealed for reasons of commercial confidentiality.

Disposal facilities that may have received such materials are most likely to include:

- Any transfer site authorised for the management of clinical (ECW18) and/or similar wastes;
- Any treatment centre authorised for the processing of clinical (ECW18) wastes – as above;
- Any landfill site authorised for the disposal of the full range of hazardous waste – in the absence of any of these sites being currently active across the Region, this category therefore does not now apply, although pre-2005 special waste landfill sites are known to have received such material;
- Any landfill sites authorised for the disposal of non-hazardous MSW and/or MSW-type wastes – this could in theory apply to any non-hazardous landfill across the Region, although anecdotal evidence again suggests that the actual number is unlikely to be more than one or two of the largest sites per county;
- Any incinerator authorised for the destruction of solid hazardous clinical waste – there are less than 6 of these across the region, and again anecdotal evidence suggests that all of these are likely to be receiving non-nuclear radioactive waste; and
- Any incinerator authorised for the destruction of non-hazardous MSW – this could in theory apply to any on-hazardous incinerator across the Region, although no anecdotal evidence has been identified that suggests which, if any, are being used for this purpose.

5.3.4 Future Waste Management Capacity

Forecast Waste Management Needs

In the absence of reliable and accurate data on the arisings of non-nuclear waste, or on their methods of management or disposal, it is difficult to accurately predict future management needs, or indeed where geographically this might take place. This position is unlikely to be clarified before the end of 2009 at the earliest, as previously referenced, and most probably before the end of 2010 if meaningful, trend-setting, data-sets are to be available.

Never-the-less, it is considered that, as a minimum, current disposal capacities and route flexibilities need to be protected, or, as was recognised in the UCL 2005 report previously referred to, loss of disposal could lead to restrictions being imposed on the use of non-nuclear emitters – which, for a number of industries, could place un-welcomed restrictions on their ability to practice.

It should be noted that since the UCL 2005 report was produced, the number of hazardous landfill sites across the country has diminished dramatically – and for the South East, this issue could therefore already have commenced, as out-of-Region landfill is already a necessity.

Influence ought therefore to be put to ensuring an adequate 'cover' of incineration and landfill capacities for the receipt and final disposal of non-nuclear radioactive waste, both LLW and VLLW, in such a way as the current confidentiality issues remain intact.

6 FUTURE LLW/VLLW WASTE MANAGEMENT CONSIDERATIONS

6.1 Government Policy Considerations

6.1.1 LLW Management Plans

Incoming policy matters are intended to ensure that future management plans must be:

- Developed by waste managers in a form and to a level of detail suitable for consideration by relevant regulators. All nuclear sites hold these plans including holdings and predicted arisings;
- Proportionate, for non-nuclear sites, to the scale of production and holdings as agreed with the regulator; and
- Informed by assessments of potential radiation exposure and its associated risk.

6.1.2 Waste Management Considerations

Waste Minimisation

Waste managers should detail waste minimisation within the management plan including:

a. Avoid creating the waste;

b. Reduce arisings (by mass and activity) – through design and operation or processes/equipment and making appropriate use if waste characterisation, sorting, segregation, volume reduction and surface contamination removal;

c. Minimise disposal quantity through decay storage, reuse and/or recycling and incineration; and

d. Disposal – may include incineration for some forms.

Consideration of All Practicable Options

Waste management considerations should take into account all practicable options in achieving their aims, to include:

- Being based on assessment of all practicable options for long term management – subject to a satisfactory risk assessment and optimisation study;
- Working on the basis that Central Government believes that disposal to an appropriately engineered facility (below or above ground) with no intent to retrieve should be the end-point after the application of the waste hierarchy;
- In relation to landfill disposal, government sees no reason to preclude the burial of radioactive waste from nuclear sites from the list of options to be considered, provided that the necessary safety assessments have been carried out to the satisfaction of the regulator;

- Consideration of decay storage for shorter-lived LLW prior to final disposal can be included subject to preparing an appropriate safety case and securing the necessary regulatory approvals;

- Some LLW will have hazardous/toxic properties that must also be considered – this will mean that incineration as a means of treatment or disposal may be considered for some wastes (e.g. clinical waste containing biological hazards);

- Use of incineration and subsequent ash disposal will be subject to production of an appropriate safety case and necessary regulatory approval;

- For operational LLW and decommissioning there should be a presumption by the waste manager towards management solutions that can be implemented early; and

- Provision of long-term storage or disposal should take account the potential future effects of climate change (e.g. increased sea levels).

Proximity Principle and Transport of Waste

The use of centralised facilities such as Drigg may continue to be the appropriate point of disposal for some 'non-inert' elements of nuclear LLW, although, given its location and central function to current nuclear disposals:

- Options appraisals should however consider the intrinsic hazard of some forms of LLW, including the application of the proximity principle on a case by case basis in order to establish near-surface disposal, for example for selected C, D and E materials, when in-site disposal could be considered as a viable option for all nuclear sites; and

- Transport should be explicitly considered, taking into account the volume, type and activity of the waste as well as the distance it has to be transported for each option - Note transport regulations currently in place govern the movement of LLW.

Import and Export

Transfer shipment across national boundaries is governed by The Transfrontier Shipment of Radioactive Waste Regulations 1983, which are under review. Require prior notification and regulator approval must be received before any import or export.

UK policy has been reviewed:

a. Export of LLW to other OECD and EU countries will only be authorised or consented by a competent UK authority in light of assessment of all practicable options and authorisation should not be permitted except for recovery of re-usable materials OR treatment that makes subsequent storage/disposal more manageable. If the waste will add materially to that needing to be disposed off in the destination country then the presumption is that the material will be returned to the UK to a timescale agreed by the competent authorities in each country; and

b. Import of LLW will only be authorised by competent UK authority in light of an assessment of all practicable options, and that it complies with all EU/UK legislation. Import should only be permitted for recovery of re-usable materials OR treatment that makes subsequent storage/disposal more manageable. If the waste will add materially to that needing to be disposed of in the UK then the presumption is that the material will be returned to the source country to a timescale agreed by the competent authorities in each country.

Non-Nuclear LLW Management

This matter covers all radioactive waste production other than that from military and civil nuclear licensed sites.

Due to the diverse nature of the producers and that they generally produce LLW of lower activity concentrations and amounts, the government's view is that as a general principle it is appropriate that communities should take greater responsibility for how their 'own' non-nuclear LLW is managed.

In the past, this has mainly been dependant on landfill and incinerator – and unless there are any fundamental changes to current activities, this reliance will continue.

Central Government wishes that the wider impact on the environment, including the need for long-distance transport, needs to be considered in the maintenance of these and any future disposal routes, and in acknowledging the need for a UK wide strategy, believes this involves the following steps:

a. First – estimate the extent and geographical distribution of LLW arisings – to be done by government in association with NDA;

b. Second – government/NDA process to develop a UK-wide strategy and identification of the future arrangements needed for delivery. Strategy to emphasise the importance of waste hierarchy, particularly avoidance and will involve appropriate stakeholder engagement; and

c. Third - ensure provision of appropriate opportunities within national, regional and local planning strategies, recognising that:

- the strategy won't in itself deliver the facilities without investment by the private sector – may need to consider how to provide the facilities if these proved to be unavailable; and

- reliance will be needed from all associated regulators in order to maximise the consistency of any regulatory approach, including the provision of advice to all producers.

Disposal Options

Nationally, it is recognised that:

- Disposal to facilities have yet to be constructed to take ILW;

- Disposal to near-surface facilities, where disposal is by way of compaction, grouting and placement in a concrete vault, is currently restricted to Drigg, which is located where it is primarily for historic reasons, which ought not to preclude the development of other facilities elsewhere;

- Disposal to specific areas within, or adjacent, to nuclear licensed sites (e.g. like the site at Sellafield) or disposal at facilities that might in future be constructed at or adjacent to nuclear sites, could release other 'local' facilities;

- In-situ disposal – i.e. burial at point of arising – could release 'local' facilities, particularly for C, D and E materials;

- Disposal at specified landfill sites for LLW and high volume VLLW could well be continued, and indeed expanded for nuclear wastes, providing it meets the specified regulatory requirements;

- General disposal of low volume VLLW to an unspecified destination(s), together with municipal, commercial or industry wastes could be continued, subject to confidentiality issues; and

- Incineration of non-nuclear VLLW, as above, is likely to continue to provide a realistic future option.

6.2 Principles of Future LLW Waste Management for the Region

6.2.1 Principles of Self-Sufficiency

Under the principle of self-sufficiency, as originally defined in WS2000 and more recently expanded upon in WS2007, Government policy requires that most waste should be treated or disposed of within the region in which it is produced. Further, sufficient capacity should be made available at this level in order to manage the expected quantity of waste likely to be created for at least 10 years. On a basic level, this principle could as well be applied to radioactive waste, as for other types. However, this does not acknowledge the fact that LLW and VLLW radioactive waste constitute a wide range of materials, which may require an equally wide range of management methods, nor does it recognise that for nuclear sources, the amount of waste to be created is fairly well known. These two issues will influence any delivery of 'self-sufficiency' for radioactive waste, although for some management routes, adhering to too rigid a timeframe could adversely compromise service delivery – 10 years being far too short for some waste-streams.

The draft South East Plan and RPG9 promoted the principle of self-sufficiency at regional and county (WPA or sub-regional) level. Strategy policies seek to ensure that Waste Local Plans and Local Development Frameworks do not encourage continued imports of waste from outside the region, and that they aim to achieve county level self-sufficiency. It is not believed that these approaches were intended to address radioactive waste, particularly not that arising from the nuclear industry.

The question of Regional self-sufficiency remains unanswered in principle, and varied in practice, although the minimisation of waste-miles and radioactive waste management equally sits at the centre of Regional aims.

PPS10 reflects this principle, through the requirement for regional planning bodies and local authorities to identify in development plan documents the sites and areas suitable for new or enhanced waste management facilities.

In the process of undertaking this study, the concept of 'self-sufficiency' has been explored and reviewed against the fact that the management of radioactive waste is both a Government function and part of a commercial business, and therefore does not necessarily acknowledge arbitrary boundaries such as regions or counties. The movement of waste 'across' these boundaries is therefore, in practice, not of prime relevance, given that management providers and facilities already exist in order for current arisings to have been managed. However, as a corresponding principle, the management of waste as close to its source of production *as is practicable* is to be supported, and the use of more distant facilities may be a result of single 'supply' locations (e.g. the LLWR at Drigg), as much as local capacity 'deficiencies'.

Taking the principles of the waste business as a base from which to work, self-sufficiency is perhaps best defined as being that the South East Region should move towards being able to *'provide in-region management capacity for an amount of radioactive waste equivalent to that produced within its borders'* on a rolling annual basis, providing that this can be done so in a way which realises true benefits of scale.

This approach recognises that:

- Regional boundaries are transparent to both commerce and the movement of non-LLW radioactive waste;
- complete self-sufficiency may practically be prevented by the range and amount of wastes to be managed, and by their inherent danger – relevant principally in respect of the more intractable, nuclear radioactive wastes; and
- capacity release is rarely instantly available and may in fact never be capable of being realised as a result of external constraints – see Section 8.3.

This in turn infers a degree of continued import:export, into and out of the region, without requiring it. In addition, while the management of non-nuclear radioactive waste has always been, is, and will continue to be market-driven, emerging NDA strategy, in part designed to protect the existing LWWR from 'over-use', will also see the progressive introduction of market-driven behaviours, especially as the strategy forces managers to consider radioactive waste via a management hierarchy, and a total of 54 potential cost/resource saving initiates have been identified thus far through the strategy development process, which have the potential to save several £billion over the coming 10-20 years.

This approach is therefore, essentially in accordance with the emerging Regional Strategy, as well as individual county/sub-regional plans or frameworks.

6.2.2 Need vs. Environmental Effects

One of the main aims of the planning system is to balance the demand for development against the protection of the environment. With respect to the development/release of waste management infrastructure, PPS10 promotes the development of sustainable waste management policies to provide a balance between the sites required to satisfy identified needs of the region with the potential environmental and other impacts.

Regional capacity supply may therefore be constrained by pre-existing out-of-region provision, taking into account the potential environmental effects associated with satisfying a particular need. Is it, for example, better to continue to use a more remote, pre-existing facility, rather than cause adverse neighbour impact as a result of a new one, and how remote does a facility need to be if, for example, it is nevertheless within a reasonable travel time/distance to the majority of the arisings that it attracts. This applies both to:

- in-region, where neighbour/stakeholder impacts will need to be balanced against reduced transport, (i.e. at what point does the potential nuisance associated with a new facility outweigh the transport savings); or

- out-of-region, where increased transport may be offset by using 'spare' capacity at an existing facility, (i.e. is it better to continue to use existing capacity at 'marginal' capacity costs).

Disposal by landfill, whether of nuclear or non-nuclear industry waste, will inevitably be constrained in part by the principles of RGN3 – which will provide absolute geographical constraints.

Disposal by incineration will inevitably be constrained by the pre-existence of appropriate capacity – which will result in general locational constraints, likely to be access, transport or base-waste capacity driven.

Both of the above limitations will be further constrained by the willingness of developers or operators to consider the management of radioactive materials in a positive light – and be influenced by issues associated with confidentiality.

6.2.3 Extension vs. New Site

Evidence supports the theory that it is frequently easier to seek to extend an existing facility than it is to obtain authorisation for a new one, although it is equally obvious that this observation depends on the existing facility being in the 'right' location and being accepted by its surrounding neighbours. This is likely to have been a key element of the discussions that resulted in the acquisition by EDF of British Energy – in that it is more probable that the construction of another nuclear power plant adjacent to an existing one will prove a more straightforward development than elsewhere.

This issue could be realised in order to provide additional near-surface disposal capacity at existing/new power plants than at 'remote' locations.

Likewise, it is possible for an existing facility to be located where it is for purely historic reasons, although this history may be genuinely underwritten by an appropriateness which would be difficult to replicate with a replacement/new facility, e.g. discharge consent, land-use, access rights, etc.

It is frequently preferable to seek to extend existing facilities, but only if such an extension does not compromise land-use policies or contribute to an existing impact, such that it renders it in conflict with the site selection criteria as presented below. This would accord with the evolving 'hierarchy of location', as discussed in Section 2.4.

This could both mitigate for and against the provision of additional LLWR capacity at Drigg and/or elsewhere, but ought to be used at a Regional level to more towards compliance with 'self-sufficiency', where applicable and/or appropriate.

6.2.4 Network of Local Facilities vs. Large Centralised Facilities

Most waste management facilities have a pre-determined minimum throughput below which their commercial viability is questionable, although it is acknowledged that this level may be widely different for differing facilities, or indeed for technology for use at similar facilities, especially for the management of radioactive waste across the nuclear and non-nuclear sectors. Likewise, arisings of individual waste types may, or may not, be spread equally across either the Region, or individual WCAs, or indeed they may be focussed in a small number of locations, and waste production at any one location may or may not be 'significant'.

The cumulative effect of all of these variables means that there is no simple answer to the premise of whether big or small is beautiful. Rather, it is considered unlikely that there would be sufficient need for more than one near-surface disposal facility at any one nuclear power plant. However, this single-location per site approach would nevertheless result in a significant move towards one of the NDA's emerging preferred options, in that it avoids some costs associated with centralised facilities, and could accord with the 'hierarchy of location' presented in Section 2.4. If implemented for C, D and E wastes, for example, this would move significantly towards the opinion expressed by SERTAB, that the 'local' management of heavy, 'inert' waste would be best, as it could be undertaken without involving off-site transport.

Extrapolating this further, could result in the tacit acceptance of support for a 'southern LLWR', given the know capacity issues associated with Drigg, and its non-central location, although the outstanding safety-case associated with any LLWR could yet remain an issue.

In contrast, the management of non-nuclear radioactive waste will almost inevitably continue to be based around a relatively large number of small producers – although final disposal is again likely to be concentrated a smaller number of individual facilities, mainly locally (regionally) located.

6.3 Recommendations

6.3.1 Policy Issues

As a matter of policy, a formal declaration of whether the Region wishes to move towards some degree of 'self-sufficiency' ought to be considered and adopted. It is accepted that this could well be 'fate' based, reflecting particular regional circumstances, such as:

- the pre-existence of individual facilities;
- confirmation that part or parts of the Region lend themselves towards RGN3 compliance; or
- a recognition that pre-existing specialist facilities out-of-region will continue to be used for certain processes, based on the historic drivers for their location.

The establishment of such a policy approach ought to acknowledge that different 'fates' may well be assessed from different aspects and with differing outcomes.

In relation to any future revisions of RPG9, the Regional Assembly may wish to consider the addition of a new policy requirement for LLW or revision of W15 to more truly reflect inclusion of LLW. Potential policy change could reflect:

"Waste Development Documents should:

a. Identify and safeguard sites for the storage, treatment and remediation of LLW contaminated soils and demolition waste;

b. Identify criteria for the determination of large-scale specialist LLW waste facilities; and

c. Assess available landfill provision and, where necessary, encourage the creation of a protective cell for LLW."

6.3.2 Priorities

Data presented in Sections 4 and 5, confirms that the following capacity judgements can be made for the Region, in that there is:

- A total absence of true merchant hazardous waste landfill capacity, where LLW could otherwise be received, subject to RGN3 locational criteria being met;

- In-sufficient in-region treatment capacity, as in-region treatment capacity is likely to be based on current or new processes at existing sites that enable some element of re-processing for recovery, as most nuclear fuel reprocessing is done at Sellafield (See section 4 above), although there may be an element of re-processing on single sources wastes transferred back to the like of GE Healthcare Ltd, but no hard evidence of this has been identified;

- Sufficient transfer capacity, operating both into and out of the Region, for the period assessed, likely to be based on interim storage at producer sites rather than any new facility, unless incoming guidance results in any loss as a result of inappropriateness;

- Sufficient clinical/healthcare incineration capacity, although in the absence of an incontrovertible evidence as to what is happening, suspect that VLLW incineration is being undertaken at existing facilities – any new sites should consider provision for incineration of VLLW (i.e. disposal at point of generation – proximity argument); and

- Limited alternative WID compliant combustion capacity for 'problematic' wastes, although there is doubt that this would be a viable option primarily due to public perception issues, and also due to the potential impact on product quality (e.g. cement) from the sites incinerating the material.

7 Conclusions

7.1 Data Management Considerations

This study was undertaken using the most current validated data available at the time of writing, namely the 2007 and 2004 RWI Inventories and due to data quality issues discussed above, it is recommended that the policy is reviewed in light of:

- Updated RWI releases on existing capacity and predicted future capacity;
- Updated nuclear industry business, operational and decommissioning plans; and
- Provision of more detailed waste characterisation on site remediation plans.

In respect of non-nuclear industry information data, this has been found to be virtually impossible to track under the current regulatory reporting regimes and data source issues that need to be addressed are:

- Accessibility to data and information held by the regulator (namely Environment Agency) – no information was able to be sourced at the time of the study from the EA except for that which is currently on the Agency web-site in relation to general radioactive material issues. Information pertaining to potential non-nuclear producers (e.g. those with an RSA authorisation) could only be accessed on either a company or town basis via the public register making it virtually impossible to accurately assess these sources;

- Access to output from the 'Atkins' report, due in late 2009; and

- Considerable effort in respect of public perception issues will be required if waste management facilities and operators are to be openly engaged in respect of radioactive waste issues.

For these reasons, the absolute validity of the outcomes to this study must be considered as weakened for lack of sufficient data.

Re-benchmarking of all elements must therefore be undertaken as and when future data-sets are released.

7.2 Policy Considerations

Data reviewed during this study confirms that to seek to move towards complete self-sufficiency at a regional level is considered to be essential for non-nuclear wastes and preferable for nuclear wastes – LLW and VLLW only.

However, as a matter of policy, a formal declaration of whether the Region wishes to move towards some degree of 'net self-sufficiency' in respect of LLW/VLLW radioactive waste ought to be considered and adopted. 'Net self-sufficiency' in this instance is defined as '*providing for the management in-region of an amount of LLW/VLLW radioactive waste equivalent to that produced within the regions borders*'.

It is accepted that this approach could justifiably be 'fate' based, reflecting particular circumstances, such as the pre-existence of individual facilities, a recognition that part or parts of the Region lend themselves towards RGN3 compliance for the disposal of 'hazardous' materials to land, or a recognition that pre-existing specialist facilities out-of-region will continue to be used for certain processes, based on the historic drivers for their location.

Nevertheless, it is considered that the adoption of an aspirational move towards net self-sufficiency would demonstrate regional commitment towards sustainable waste management, as espoused by PPS10. This commitment could then be reflected in emerging LDFs, with their possible allocation of site-specific activities.

It is considered that this is most likely to be realised through the release of hazardous landfill and incineration capacities, suited for the disposal of non-nuclear wastes, together with individual power-plant based near-surface disposal for in-situ arisings, together with a south of England equivalent to the LLWR at Drigg, although this could equally well be based in any RGN3-compliant areas of either the west of the South East, or east of the South West, regions.

Strategically, it is considered essential that the non-nuclear industrial producers of radioactive waste ought to be supported with the continued provision of suitable treatment and disposal facilities within the regions from which the waste arises. This should apply to both incineration and landfill-based – but only after policy compliance has maximised the use of the waste hierarchy in order to minimise 'final' disposal requirements. Nevertheless, it should be recognised that a theoretical excess of supply might be required in order to ensure suitable geographical coverage across the region – which is considered as equally important. This sits well with both the principles of both the proximal management/disposal of (any) waste as close to its location of production as well as enshrining the sustainability of final disposal, by minimising transport wherever possible.

Similarly, it is also considered essential that the disposal of LLW radioactive from the nuclear industry is provided for at a strategic, i.e. regional, level only after options for the near-surface in-situ disposal options have either been exhausted (for reasons of land/location unsuitability) and/or disposal to a 'higher' location, i.e. the exiting and/or any new 'southern' LWWR (LLWR2) is required for technical or safety reasons.

7.3 Future Management Provision

Without a specific commitment to regional self-sufficiency, the absolute need for additional management capacity or facilities could be interpreted as being absent when based on data, as reviewed above.

Setting this aside, however, the Region may otherwise take the decision that some additional capacity ought to be provided within its boundaries, for reasons of commerce support and service provision, and could chose to do this on the basis of the 'hierarchy of location', as espoused in Section 2.4, i.e. on (nuclear) site being preferred to off (nuclear) site, locally or regionally oriented.

On this basis, the following is considered as a reasonable minimum:

- New hazardous waste landfill capacity, preferably in at least two separate locations so as to minimise transport and maximise benefits of scale through importation, each suited for the disposal of non-nuclear LLW and VLLW wastes, but possibly limited nuclear as well, although issues of post-closure liability will need to be addressed if the operators of merchant facilities are to be incentivised to participate, as the views of the EA to potential long-term liabilities associated with radioactivity remain an unknown;

- Continued release of incineration capacity for non-nuclear wastes, subject to the same EA-related and locational caveats as above;

- The release of near-surface landfill disposal capacities within power-plants, for example as has in the past been considered at Dungeness, and for specific waste types, for example C, D

and E (in order to minimise un-necessary transport), subject to RGN3 compliance; and possibly

- The development, possibly shared with the South West Region, of an additional LLWR repository, as an additional facility to that at Drigg, with improved transport characteristics, especially if used in conjunction with the current super compaction unit at Winfrith.

In reviewing future management provisions, the:

- Assumptions used in the 2007 data set should be reviewed biennially in order to identify and track changes, so that these can be accurately reflected in capacity and need determinations; and

- Non-nuclear arisings data should be accurately collected, collated and benchmarked before any absolute determinations are made – thereafter to be reviewed as above.

8 Glossary

AGR fuel	Advanced Gas-cooled Reactor
ALARA	As Low As Reasonably Acceptable
AWE	Aldermaston (atomic) Weapons Establishment
BPEO	Best Practicable Environmental Option
BPM	Best Practicable Means
C&D	Construction and Demolition (wastes)
C&I	Commercial and Industrial (wastes)
C, D and E wastes	Construction, Demolition and Excavation (wastes)
CfA	Conditions for Acceptance
CoRWM	Committee on Radioactive Waste Management
DEFRA	The UK Government department which, with the environment departments of Wales, Scotland and Northern Ireland, sets policy for UK radioactive waste management
DNLEU	Depleted, Natural and Low Enriched Uranium
DTI	Department of Trade and Industry
EA	Environment Agency
EANI	Environment Agency, Northern Ireland
EU	European Union
EWC	European Waste Codes
GLEEP reactor	Graphite Low Energy Experimental Pile
HEU	Highly Enriched Uranium
HLW	High Level (radioactive) Waste
HMSO	Her Majesty's Stationary Office
HPA	Health Protection Agency
HSE	Health and Safety Executive
ILW	Intermediate Level (radioactive) Waste
IRR	Ionising Radiation Regulations
ITER	International Tokamak Research and Engineering (project) – experimental nuclear fusion reactor
LDF	Landfill (waste) Development Framework
LLW	Low Level (radioactive) Waste
LLWR	Low Level Waste Repository – located at Drigg in Cumbria
LQA	Land Quality Assessment
Magnox	An alloy of magnesium used for fuel element cladding in natural uranium fuelled gas-cooled power reactors. Also a generic name for this type of reactor.
MoD	Ministry of Defence
MOX	Mixed Oxide Fuel
MSW	Municipal Solid Waste
NDA	Nuclear Decommissioning Authority
NIA	Nuclear Installations Act
NNI	Non-Nuclear Industry
NuLeAF	the Nuclear Legacy Advisory Forum
OECD	Organisation for Economic Co-operation and Development
POCO	Post Operational Clean-Out – refers to vitrified, HLW
PPS10	Planning Position Statement No. 10

PuO_2	Plutonium Oxide
PWR	Pressurised Water Reactor
R&D	Research and Development
RGN3	Regulatory Guidance Note No. 3
RPG9	Regional Planning Guidance No. 9
RSA	Radioactive Substances Act
RSA93	Radioactive Substances Act 1993
RWI 2007	(UK) Radioactive Waste Inventory, 2007
SEPA	Scottish Environment Protection Agency
SGHWR	Steam Generating Heavy Water Reactor
SLC	Site Licence Company
SoLA	Substances of Low Activity
tHM	Tonnes of Heavy Metal
UCL	University College, London
UKAEA	United Kingdom Atomic Energy Authority
VLLW	Very Low Level (radioactive) Waste
WAGR	Windscale Advanced Gas-cooled Reactor at Sellafield
WCA	Waste Collection Authority
WFD	Waste Framework Directive
WID	Waste Incineration Directive
WPA	Waste Planning Authority
WS2000	The Waste Strategy For England 2000
WS2007	The Waste Strategy For England 2007
WSCD	Waste Stream Characterisation Document