UK Management of Solid Low Level Radioactive Waste from the Nuclear Industry:

Low Level Waste Strategic Review

March 2011
## Document History

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<th>Description</th>
<th>Prepared by</th>
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Executive Summary

The first Low Level Waste (LLW) Strategic Review, published in January 2009, represented a major milestone in development of the LLW strategy. The Strategic Review included the Nuclear Decommissioning Authority’s (NDA) first comprehensive national LLW baseline, integrating LLW strategies, infrastructure, volumes, and costs to inform NDA’s strategic decision-making and the development of the UK Nuclear Industry LLW Strategy and the associated UK LLW Management Plan. The UK LLW Strategy was approved by Government in August 2010. The objectives of this 2010 Strategic Review document is to update the previous 2008 baseline for 2010, focusing on current site LLW strategies, costs, and the available assets and infrastructure (existing and planned) for LLW management. This will inform identification of synergies and opportunities to improve LLW management across the estate as part of ongoing national strategy implementation.

The NDA LLW baseline can be described in terms of several interrelated aspects; current site LLW management strategies, waste volumes, costs and liabilities, and the assets and infrastructure (existing and planned) available for LLW management. For Magnox, Dounreay, and Research Sites, information from Lifetime Plan 10 (LTP10) (submitted March 2010) has been utilised. As Sellafield are currently in the process of establishing a new LTP10 baseline, the latest available ‘provisional’ May 2010 LTP data has been used in this review, noting that some aspects may not have yet been officially approved by NDA. The Sellafield baseline may therefore be subject to change.

The NDA requires all sites to produce an Integrated Waste Strategy (IWS) in accordance with NDA Specification ENG01. These IWSs articulate the site’s LLW management strategy. The current site strategies have been reviewed against the strategic principles outlined within the recently published UK LLW strategy to understand the current level of alignment across the estate with the national strategy. These strategic principles for the management of LLW throughout the UK provide expectations for the implementation of LLW strategy for waste producers, regulatory bodies, and stakeholders. The review of site strategies indicates that, with few exceptions, the IWS documents largely meet the NDA specification. However, there are often weaknesses in describing how the site’s LLW strategy is being implemented in practical terms and demonstration of the linkage with the costs within the LTP baseline. All NDA sites reference application of the waste hierarchy principles as a core part of their waste strategy. However, there appears to be significant variation in the practical application of these principles between sites. It is evident that many of the IWS documents identify similar actions in terms of a requirement to establish the same type of waste route (e.g. Very Low Level Waste (VLLW) disposal to landfill or optimise characterisation). It is notable that waste disposal to LLWR is often still the default strategy, and this may be reflective of the immaturity of alternative waste routes. This is an area that is being developed by LLWR and sites, and perhaps as new waste routes become established, waste disposal will cease to be the default strategy and implementation of the waste hierarchy will be substituted in future site strategies.

A review of the UK’s LLW inventory shows that information on the sites LLW is developing to better identify waste streams and to incorporate new waste disposal routes. The total forecast LLW volume is 4.4 million m$^3$ which arises during 2010 to 2120. This consists of 3.3 million m$^3$ of VLLW and 1.1 million m$^3$ of LLW. Sellafield is the dominant LLW waste generator for the UK, producing roughly 3.3 million m$^3$ of waste (LLW and VLLW) accounting for 76% of the UK’s total waste. Volumes are dominated by VLLW wastes with soil and rubble identified as the main waste stream.

Comparison with previous inventories shows that sites are re-characterising wastes as VLLW leading to a reduction of 0.4 million m$^3$ of LLW between the Waste Inventory Disposition Assessment Model (WIDRAM) 2008 and UK Radioactive Waste Inventory (UKRWI) 2010 figures. The inventory review has also highlighted several areas of improvement that would greatly improve the information generated and allow for a better understanding of the future LLW waste arisings. These areas include consistency of waste reporting tools, reporting of actual waste treatment and disposal routes and improved consistency in characterisation practices.

The costs and liabilities faced by NDA for LLW management include the full lifecycle costs for management and disposal of solid LLW and VLLW generated by operations and decommissioning of NDA’s sites. This includes


the design, construction, operation and decommissioning of any solid LLW management facilities required in addition to the cost of treatment (characterisation, packaging, conditioning, etc), transport, and waste disposal. The cost baseline is used to define a Nuclear Provision (NP) (previously referred to as the Nuclear Liability Estimate (NLE)) which is included within NDA's Annual Report and Accounts (ARAC). The review of cost information shows that the provisional 2010 cost baseline is around £8.9Bn. This has decreased by £0.96Bn from the previous 2008 baseline of £9.86Bn. Since 2008, some projects have been removed from the LTPs (notably the Soil Treatment Plant at Sellafield) and there have been increases and decreases in the cost of other individual elements reflecting changes in scope, unit rate assumptions, and underpinning inventory numbers. In some cases, costs have moved to different categories, for example, the proposed new-build LLW treatment facilities at Sellafield (metal recycling, smelter, thermal treatment) have been removed from the Sellafield LTP. Corresponding supply chain treatment costs are now included within the Sellafield off-site disposal category instead. Magnox Final Site Clearance LLW costs have increased significantly since March 2008, following a fundamental re-estimation of the cost of these activities. There remain several areas where site baselines are not fully aligned with the UK LLW strategy or utilise very conservative assumptions regarding waste volumes and categorisation. It should be noted that the 2010 baseline may be subject to change following finalisation of the Sellafield LTP10 and receipt of Springfield’s data for 2010.

The assets and infrastructure available to manage LLW and VLLW from the UK nuclear industry has been reviewed, including key facilities which are at the planning and development stage. The review highlights that there have been some changes to the facilities that are available to nuclear sites since 2008. Sites have increasing access to metal recycling and thermal treatment facilities. The Studsvik Metal Recycling Facility in West Cumbria has now been successfully operating for over a year and has treated waste from a number of nuclear sites. LLWR have introduced segregated waste services for metallic and combustible waste which will expand options available to waste producers. A number of commercial landfill operators across the UK are seeking authorisations under the Environmental Permitting Regulations 2010 for LLW and VLLW disposal ranging from expansion of existing sites to new dedicated facilities. To facilitate implementation of the waste hierarchy, LLWR are in the process of developing a suite of new packages which are more cost effective and provide more flexibility for treatment purposes. The aim is to reduce reliance on disposal at the LLWR near Drigg in Cumbria.

Within the baseline, there are a number of opportunities for optimisation going forward as the LLW strategy is implemented. The UK LLW Management plan sets out the scope, schedule and approach to delivering these opportunities. These management plan initiatives contribute towards NDA’s strategic objectives for LLW.

The scope of the ACCELS (Acceleration of Element 2 Strategy) programme includes the identification and evaluation of 42 specific opportunities to reduce the cost of LTP baselines across the NDA estate. These opportunities include improved inventory and waste forecasts, use of consistent waste routing assumptions and cost factors, and targeted reductions in capital spend through best use of onsite resources, the supply chain, and economies of scale across the estate. LLWR has worked with each Site Licence Company (SLC) to gather the required underpinning data and review the opportunities. Integrated Project Teams (IPT) comprised of LLWR, NDA, and SLC managers, have been formed to review the largest NDA opportunities at Sellafield and Magnox and develop the forward plan for implementation. This review of the 2010 cost baseline informs how these opportunities are taken forward. The ACCELS programme has identified a further reduction of £1.5 billion saving from the NP and identified several other key areas where the approach will deliver savings. The savings come from a detailed study of the wastes generated during decommissioning and will result in a new NP of £7.4Bn following incorporation of the savings in to the NDA’s ARAC.

The ultimate goal of the programme is to see opportunities formally reflected within a modified LTP. However, NDA can consider whether sufficient confidence exists in the validity of an opportunity to make an adjustment to the annual LLW NP ARAC estimate in advance of any formal change to SLC baselines.

This Strategic Review takes into account potential inventory and NP reductions that have been evaluated as part of the ACCELS programme. This review informs the ongoing implementation of the NDA’s LLW Waste Programme which incorporates the outstanding actions from the LLW Management Plan and the ACCELS programme. This programme sets out the framework for the delivery of work packages identified to optimise LLW management in the UK.
Glossary

ACCELS  Acceleration of Element 2 Strategy
ARAC  Annual Report and Accounts
BAT  Best Available Techniques
BPEO  Best Practicable Environmental Option
BPM  Best Practicable Means
BRIMS  British Radioactive waste Information Management System
C&M  Care and Maintenance
C&MP  Care and Maintenance Preparations
CLESA  Calder Landfill Extension Segregated Area
DECC  Department for Energy and Climate Change
DfT  Department for Transport
DIT  Data Input Tool
DQAP  Decommissioning Quality Assurance Programme
DRS  Direct Rail Services
DSO  Decommissioning Strategy Organisation (Magnox)
DSRL  Dounreay Site Restoration Limited
EC  European Commission
EO  Exemption Orders
EP  Environmental Permitting Regulations 2010
ESC  Environmental Safety Case
EU  European Union
FHISO  Full-Height ISO Container
FSC  Final Site Clearance
FY  Financial Year
GBq  Gigabecquerel
HFC  High Force Compaction
HHISO  Half-Height ISO Container
HoW  Head of Waste
HSE  Health and Safety Executive
HVLA  High-Volume Low-Activity waste
HVVLLW  High-Volume Very Low Level Waste
IAEA  International Atomic Energy Authority
ILW  Intermediate Level Waste
IP  Industrial Package
IPT  Integrated Project Team
IWS  Integrated Waste Strategy
LLW  Low Level Waste
LLWR  Low Level Waste Repository
LTP  Lifetime Plan
M³  Cubic Metres
MBq  Megabecquerel
MCP  Management Control Procedures
MoD  Ministry of Defence
MRF  Metal Recycling Facility
NDA  Nuclear Decommissioning Authority
NLE  Nuclear Liability Estimate
NORM  Naturally Occurring Radioactive Materials
NP  Nuclear Provision
OQAP  Operational Quality Assurance Programme
OSD  On-Site Disposal
<table>
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<tr>
<td>OSPAR</td>
<td>Convention for the Protection of the Marine Environment of the North-East Atlantic</td>
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<tr>
<td>OU</td>
<td>Operating Unit</td>
</tr>
<tr>
<td>PAIS</td>
<td>Partner, Assess, Innovate, and Sustain</td>
</tr>
<tr>
<td>PBO</td>
<td>Parent Body Organisation</td>
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<tr>
<td>PCM</td>
<td>Plutonium Contaminated Material</td>
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<tr>
<td>PCP</td>
<td>Programme Control Procedure</td>
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<tr>
<td>PDP</td>
<td>Preliminary Decommissioning Plan</td>
</tr>
<tr>
<td>POCO</td>
<td>Post-Operational Clean-Out</td>
</tr>
<tr>
<td>Preps</td>
<td>Preparations</td>
</tr>
<tr>
<td>PSWBS</td>
<td>Programme Summary Work Breakdown Structure</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
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<tr>
<td>RCA</td>
<td>Radiological Controlled Area</td>
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<tr>
<td>RSA</td>
<td>Radioactive Substances Act 1993</td>
</tr>
<tr>
<td>RSRL</td>
<td>Research Sites Restoration Limited</td>
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<tr>
<td>SED</td>
<td>Safety Environment Detriment</td>
</tr>
<tr>
<td>SEPA</td>
<td>Scottish Environmental Protection Agency</td>
</tr>
<tr>
<td>SLC</td>
<td>Site Licence Company</td>
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<tr>
<td>SQEP</td>
<td>Suitably Qualified and Experienced Person</td>
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<td>SSG</td>
<td>Site Stakeholder Group</td>
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<td>t</td>
<td>Tonnes</td>
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<tr>
<td>TFS</td>
<td>Transfrontier Shipment Authorisation</td>
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<td>THISO</td>
<td>Third-Height ISO Containers</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
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<tr>
<td>UKRWI</td>
<td>UK Radioactive Waste Inventory</td>
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<tr>
<td>US</td>
<td>United States</td>
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<tr>
<td>VLLW</td>
<td>Very Low Level Waste</td>
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<tr>
<td>WAC</td>
<td>Waste Acceptance Criteria</td>
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<tr>
<td>WACM</td>
<td>Winfrith Abrasive Cleaning Machine</td>
</tr>
<tr>
<td>WAMAC</td>
<td>Waste Monitoring and Compaction Facility</td>
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<tr>
<td>WAT</td>
<td>Waste Accountancy Template</td>
</tr>
<tr>
<td>WIDRAM</td>
<td>Waste Inventory Disposition Route Assessment Model</td>
</tr>
<tr>
<td>WRACS</td>
<td>Waste Receipt Assay Characterisation and Supercompaction facility</td>
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1 Introduction

The first Low Level Waste (LLW) Strategic Review was published in January 2009\(^1\). The review included a comprehensive, up-to-date, and robust, assessment of the LLW baseline, potential challenges and opportunities. The review provided the foundation for the development of the UK Nuclear Industry LLW Strategy\(^2\) and associated LLW Management Plan\(^3\).

Given the significant changes to LLW management that have occurred across the estate since 2008, there is a need to update the LLW Strategic Review analysis based on the current situation in 2010. The aims and objectives of this 2010 LLW Strategic Review are as follows:

- Update the UK LLW baseline for 2010
- Use the UK LLW baseline to identify where opportunities and synergies exist for integration of waste management on a national, regional or multi-site basis
- Provide a roadmap to implement opportunities from the Acceleration of Element 2 Strategy (ACCELS) programme

This strategic analysis is undertaken by Low Level Waste Repository Ltd. (LLWR) to inform strategic decision-making by the Nuclear Decommissioning Authority (NDA) when implementing the Nuclear Industry LLW Strategy and LLW Management Plan.

This report focuses on the management of solid radioactive wastes within the NDA estate. The management of contaminated ground and groundwater, liquid and gaseous radioactive wastes will be considered as part of a separate process by NDA.

The cost and inventory LLW Strategic Review focuses on a compilation of the UK LLW inventory 2010 and budgets and costs for LLW management within the NDA estate, as described in Life Time Plans (LTPs) and supporting information produced by the NDA Site Licence Companies (SLCs) in March 2010. Site Integrated Waste Strategies (IWS), LLW management costs and assets & infrastructure have also been evaluated in this review. Collectively, the LTPs show LLW management activities from 2010 through to 2120.
2 Background

2.1 LLW Strategic Review

The LLW Strategic Review\(^1\), published in January 2009, represented a major milestone in development of the LLW strategy. The Strategic Review included the NDA’s first comprehensive national LLW baseline integrating LLW strategies, infrastructure, volumes, and costs to inform NDA’s strategic decision-making and the development of the Nuclear Industry LLW Strategy and the associated National LLW Management Plan. The inventory was based on the WIDRAM 08 (Waste Inventory Disposition Assessment Model) and costs were based on LTP08 submissions.

The review identified an initial 54 potential synergies and opportunities that could reduce NDA’s LLW cost liabilities by more than 10%. These initiatives were qualitatively assessed in terms of potential magnitude of saving and likely timescale to implement. These opportunities subsequently formed the basis for the strategic themes within the UK Nuclear Industry LLW Strategy and the initiatives within the LLW Management Plan.

It was intended that LLWR would undertake a strategic review every two years in order to revisit earlier conclusions in light of developments within the wider industry decommissioning programmes and changes in the waste management policy and regulatory framework.

2.2 UK Nuclear Industry LLW Strategy

In response to the Government’s 2007 LLW Policy\(^4\) NDA have developed a new UK LLW Strategy for the Nuclear Industry\(^2\). Since April 2008, NDA have been working in partnership with LLWR to develop and consult this strategy with government, waste producers, regulators, planning authorities, and other key stakeholders via the National LLW Strategy Group forum.

The UK Nuclear Industry Low Level Waste Strategy, and its accompanying Strategic Environmental Assessment, was published for consultation in June 2009\(^5, 6\). Following consultation, the strategy was updated and approved by Government in August 2010. The strategy is centred around application of the waste management hierarchy, making best use of existing assets, and opening of new fit-for-purpose waste management routes.

2.3 UK LLW Management Plan

The UK Nuclear Industry LLW Management Plan\(^3\) sets out the overall plan for implementing the UK Nuclear Industry LLW Strategy. The updated plan, issued in December 2009, provides detail on 60 initiatives necessary to implement the significant opportunities presented by the UK Nuclear Industry LLW Strategy. The LLW Management Plan identifies the scope, schedule, and resources (how, when, and who) needed to conduct the tasks for improving LLW management through the entire waste lifecycle from waste generation to final disposal, integrating the results of previous strategic studies.

Implementation of the initiatives has the potential to extend the life of LLWR, and have significant environmental and sustainability benefits over the entire waste lifecycle. The detailed initiatives will also help realise the significant opportunities presented in the proposed UK Nuclear Industry LLW Strategy.

The progress and performance of every initiative and associated activities are reviewed routinely by the LLWR National Strategy Team and formally at all UK LLW Strategy Group meetings. The plan is reviewed annually to reflect the results of completed initiatives and incorporate new initiatives as required.
2.4 ACCELS

In 2009, the NDA requested that LLWR enhance its role as the “UK Integrator” for LLW management within the NDA estate. In response to this, LLWR developed a new programme, the Acceleration of Element 2 Strategy (ACCELS), representing a programmatic approach to support implementation of the national LLW programme in the UK (known as Element 2 strategic work scope in support of NDA)\(^1\). Substantial savings to the NDA lifecycle baseline are possible by taking an integrated approach to LLW management. The ACCELS programme has the following objectives:

- Provide enhanced integration across SLCs with increased alignment with the UK Nuclear Industry LLW Strategy.
- Develop a step-change improvement in LLW inventory and forecast quality.
- Deliver effective management of the LLW Nuclear Provision (NP)\(^1\) within the NDA estate.

The scope of the ACCELS programme is summarised in Figure 1 below:

**FIGURE 1 – OVERVIEW OF ACCELS PROGRAMME**

The ACCELS key work strands involve:

1. Providing enhanced integration across SLCs with increased alignment with the *UK Nuclear Industry LLW Strategy*.
2. Delivering a step-change improvement in LLW inventory and forecast quality.
3. Delivering effective management of the NP within the NDA estate.
4. Increasing the uptake of LLWR’s waste management services across the estate.

Phase 1 of the ACCELS programme up to March 2010 included the identification of targeted opportunities to reduce the overall NP and development of a plan to realise these opportunities. From April 2010 onwards, Phase 2 of ACCELS involved the implementation of these opportunities and the formal revision of site plans to reflect the integration and savings in LLW management. These opportunities will be incorporated in to the NDA’s Annual Report and Accounts (ARAC).

This strategic review is an important part of improving the inventory forecasts and reducing the NP by establishing the current baseline in 2010. This is discussed further in Sections 4 and 5 below.

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\(^1\) The Nuclear Provision was previously referred to as the Nuclear Liability Estimate (NLE).
3 Strategic Review Process

This timeline of the evolution of each of the LLW Strategic Review elements is shown in Figure 2 below:

**FIGURE 2 – STRATEGIC REVIEW TIMELINE**

**LLW Strategic Review Timeline**

Since January 2009 when the first LLW Strategic Review was published, a range of activities have been undertaken by NDA and LLWR to support the development and implementation of the National LLW Strategy. This includes significant consultation with SLCs and other stakeholders via the UK LLW Strategy Group and other forums and a high-level 'like-for-like' analysis of the LLW inventory and cost baseline in 2009.

This 2010 strategic review is being undertaken in a phased manner, based on the availability of information. The first version (September 2010) focused on integrated waste strategies, cost baseline, and assets and infrastructure. The document has also been updated based on the National Inventory 2010 data. This version is the final 2010 Strategic Review, which takes into account potential inventory and NP reductions that have been evaluated as part of the ACCELS programme. The outputs from these reviews have been fed back into the baseline (see section 5.3 and 5.4).

The 2010 LLW Strategic Review will inform ongoing implementation of the actions identified in the LLW Management Plan and ACCELS programme. The future programme of works from the ACCELS programme will then be amalgamated with the LLW Management Plan and delivered as part of the National LLW Programme.
4 LLW Baseline

4.1 Definitions

Solid radioactive wastes have been produced, stored and disposed of by various industries in the UK since the 1920s. The main sources of waste generation since the 1950s onwards have been nuclear energy development, nuclear power generation and the weapons industry. In addition, hundreds of non nuclear industry users of radioactive materials produce radioactive wastes, for example universities, hospitals, the pharmaceutical industry, research establishments and the oil and gas industry.

In the UK solid radioactive wastes are defined according to three main categories: low, intermediate and high level wastes. Low Level Waste represents a broad category spanning a range of five orders of magnitude of radioactivity. Solid LLW is generated in many locations across the UK today, from the operation of power stations and fuel facilities to the decommissioning and clean-up of nuclear sites.

Low Level Waste is defined in Government Policy[4] as “radioactive waste having a radioactive content not exceeding 4 gigabecquerels per tonne (GBq/te) of alpha or 12 GBq/te of beta/gamma activity”.

Very Low Level Waste (VLLW) is a sub-category of LLW that comprises:

- Low Volume VLLW (‘dustbin loads’) - wastes that can be safely disposed of to an unspecified destination with municipal, commercial or industrial waste, each 0.1 cubic metre of material containing less than 400kBq (kilobecquerels) of total activity, or single items containing less than 40kBq of total activity. There are different limits for carbon-14 and tritium in wastes containing these radionuclides.

- High Volume VLLW (bulk disposals) – wastes with maximum concentrations of 4MBq (megabecquerels) per tonne of total activity that can be disposed of to specified landfill sites. There is a different limit for tritium in wastes containing this radionuclide.

The principal difference between the two VLLW categories is the need for controls on the total volumes of high volume VLLW being deposited at any one particular landfill site. Low Volume VLLW is generated principally by “small users”, while most High Volume VLLW is produced at nuclear sites.

The policy also notes that the definition of LLW might change in future if a new national disposal facility were developed with acceptance criteria different from those for the current LLWR in Cumbria.

The UK government, in conjunction with the environmental regulators, is currently undertaking a review of the Exemption Order (EO) regime under the Environmental Permitting Regulations 2010/Radioactive Substances Act 1993 (RSA 93). Government are considering moving towards a system of risk-based radionuclide specific limits in line with the European approach. A formal public consultation[8] has been undertaken by Government during 2009 and 2010 with new limits intended to be brought into force in 2011.
4.2 Approach to Baseline Compilation

The UK LLW baseline can be described in terms of several interrelated aspects namely:

1. Current site LLW management strategies
2. LLW Inventory
3. Costs and liabilities associated with LLW management
4. Assets and infrastructure (existing and planned) for LLW management

The sites covered by this review are shown in Table 1 below.

**Table 1 – NDA Sites Included within Baseline**

<table>
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<tr>
<th>SLC</th>
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<tr>
<td><strong>Sellafied</strong></td>
<td>Sellafield</td>
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<td></td>
<td>Windscale</td>
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<td>Capenhurst</td>
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<td>Chapelcross</td>
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<td><strong>Magnox South</strong></td>
<td>Berkeley</td>
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<td>Winfrith</td>
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Note: Springsfield is no longer an NDA site, however, NDA still retains liability for certain legacy waste management activities.

For Magnox, Dounreay and RSRL the baseline has been measured at 1st April 2010 which coincides with the submission of LTPs from most SLC’s and NDA’s ARAC conventions. As Sellafield sites are currently in the process of establishing a new LTP10, the latest available provisional data from May 2010 has been used, noting that some aspects may not have yet been officially approved by NDA.

These baseline aspects have been summarised for each site in the NDA estate from information provided in LTP 2010 submissions or provisional LTP information sourced direct from Sellafield, as appropriate.

This information has then been ‘rolled-up’ to provide a national perspective for the NDA estate as a whole. The key findings from compilation of the LLW baseline are described in more detail in Sections 4.3 to 4.6 below for each aspect. It should be noted that a number of potential issues and inconsistencies between different data sets were identified during the review process which are discussed in the relevant sections below.
4.3 Current Site LLW Management Strategies

4.3.1 Review Approach

The NDA requires all sites to produce an IWS in accordance with ENG01\textsuperscript{[9]}. In addition some SLCs (e.g. Magnox North and Magnox South) produce an overview strategy across all of its sites. In ENG 01, the NDA states that an IWS is a strategy which describes:

- How a site optimises its approach to waste management in an integrated way
- The waste streams and discharges expected from current and future operations
- Actions that are required to improve the sites approach to waste management

To understand the current baseline LLW management strategies at each site, a review of IWS's across the NDA estate has been completed.

NDA have identified a number of strategic principles appropriate for the management of LLW throughout the UK in the UK Nuclear Industry LLW Strategy\textsuperscript{[2]}. The principles considered relevant to this strategic review have been reproduced in Table 2 below, and each site IWS has been reviewed against these principles (see Appendix A). An ID (A – H) has been used to identify the principle in each SLC or site review table.

**TABLE 2 - LLW STRATEGY PRINCIPLES**

<table>
<thead>
<tr>
<th>ID</th>
<th>LLW Strategy Principle</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>High standards of health, safety, security, environmental protection and public acceptability are central to the development of appropriate waste management plans and their implementation</td>
</tr>
<tr>
<td>B</td>
<td>Waste prevention should be implemented by all producers of LLW wherever practicable</td>
</tr>
<tr>
<td>C</td>
<td>Effective characterisation and segregation of waste and material that will become waste is critical to flexible management of LLW</td>
</tr>
<tr>
<td>D</td>
<td>Given the diverse physical, chemical and radiological nature of LLW, the availability of proportionately regulated waste management routes is essential</td>
</tr>
<tr>
<td>E</td>
<td>The development of new waste routes or approaches to the management of LLW requires early and proactive engagement with local and national stakeholders</td>
</tr>
<tr>
<td>F</td>
<td>Availability of flexible waste management routes is essential for hazard reduction and decommissioning and the continued operation of the nuclear and non-nuclear industries</td>
</tr>
<tr>
<td>G</td>
<td>Integration of strategies for all wastes (both radioactive and conventional) is important nationally and at a site level; waste plans will be consistent with, and complement, national strategy and Government Policy</td>
</tr>
<tr>
<td>H</td>
<td>Waste Management decisions should be supported by sound business cases and demonstrate the use of robust decision-making processes to identify the most advantageous option</td>
</tr>
</tbody>
</table>

It is noted that the review against the NDA strategic principles has been completed solely by examining the documentation provided by the site licensees. It is recognised that sites may indeed operate in full alignment with LLW strategy principles and it is merely that the IWS’s do not articulate actual practices sufficiently clearly. The latest available version of the IWS has been utilised and where appropriate supporting documentation has been considered.
To support the review against the LLW strategy principles, context is provided to LLW management by summarising information in a datasheet for the following aspects for each SLC or site:

- Summary of LLW Strategy
- Status
- Waste Volumes
- Origin of Waste
- Current waste routes
- Organisation and Management
- Changes from previous IWS
- Opportunities for Improvement
- Principal LLW Issues for the Site (risks)

These datasheets are included in Appendix A.

4.3.2 Summary of Findings

This review of site IWSs indicates that, whilst the strategies largely meet the NDA specification requirements, there are often weaknesses in describing how the SLC/site LLW strategy is being implemented in practical terms and demonstration of the linkage with costs within the LTP baseline. Whilst recognising the role of the overarching strategies, the site IWS often does not clearly state the proposed strategy for LLW beyond the baseline approach – namely, disposal of LLW to LLWR. Certain sites do present a more detailed representation of strategy (e.g. Sellafield and RSRL) and it is recommended that other sites consider this approach.

It is also worth emphasising that too often the baseline strategy is stated as continuing with disposal to LLWR, without clearly demonstrating how this is likely to change within the framework provided by the strategy. It is also important to note that whilst all sites recognise the importance of programme integration, implementing the waste hierarchy, and improving characterisation, it is recommended that these are formally incorporated into the sites statement of strategy. The diagrammatic representation of LLW strategy used by Sellafield is an example of good practice.

The NDA require that a site optimise its approach to waste management in an integrated way and describe key interrelationships between waste streams in order to demonstrate overall integration and optimisation. This review has highlighted a number of weaknesses in this area. In general terms, all waste types are included and discussed in the documents, but their interrelationships are not. This is particularly the case between radioactive and non-radioactive wastes.

The NDA document ENG 01[9] provides the specification for content and format of a site IWS and ENG 02[10] provides more detailed guidance on the content. Whilst there is some divergence in approach and format, sites are largely producing an IWS at a similar standard that meets the NDA specification. Examples of good practice with site documents are:

- Magnox North provides a statement of LLW strategy,
- RSRL provides figures for Harwell and Winfrith illustrating waste stream strategy
- Sellafield provides a useful visual overview of LLW Strategy.
- Capenhurst provides a visual overview of the waste management decision making process incorporating the waste hierarchy
- Magnox South presenting a characterisation strategy
The LLW strategic principles for the management of LLW throughout the UK are in place to provide expectations for the implementation of LLW strategy for waste producers, regulatory bodies, and stakeholders. The review of IWSs indicates that these principles are typically reflected in statements made in the SLC/site strategies. In some cases, however, IWSs do not fully reflect the importance of characterisation and integration of waste stream strategies or more detail is absent.

Each IWS notes the opportunity to utilise reuse and recycling routes for certain waste types (typically metal waste). However, whilst there is evidence of good practice, (for example, Harwell provides waste stream route and volume post segregation of exempt waste), there is often a lack of depth to such statements and the impact of such activities on final disposal volume. This may be reflective of the relative maturity of the IWSs but it is recommended that future IWSs seek to understand the implications of treatment and alternative disposal routes. This will have direct correlation to the NDA aims and key principles underpinning the IWS and may ultimately replace disposal as the default strategy. In addition, the IWSs universally present evidence of progress and success. It is recommended that sites show how the original baselines are evolving to a more optimised strategy. For example, whether utilisation of new routes made available via the LLWR segregated waste services increases.

The requirement to meet the NDA specification results in IWSs being large and complex documents which can sometimes contain large amounts of generic management system information. Indeed, as decommissioning progresses and the IWSs mature, it is likely that the complexity of these documents will increase. There is also a great deal of repetition between and within documents in the context of LLW strategy, the principles established in this strategy, the need for transparency and stakeholder engagement as well as a need to understand progress. A review of the current IWS specification is recommended with a view to simplifying some aspects of the requirements while requiring more specific detail on other aspects such as integration and LTP costs.

It is evident that many of the IWS documents identify similar actions in terms of a requirement to establish the same type of waste route (e.g. VLLW disposal to landfill or optimise characterisation). A coordinated approach is therefore recommended consistent with the existing UK LLW Management Plan initiatives on developing LLWR Segregated Waste Services and a joined-up approach on waste characterisation.

The NDA requires sites to underpin their waste management strategies with robust decision making processes and sound business cases. All sites note the application of proven decision-making approaches (Best Practicable Environmental Option - BPEO / Best Practicable Means – BPM, now Best Available Technique - BAT) as well as the use of the NDA Safety Environment Detriment (SED) process to assist prioritisation. However, few present evidence of waste decisions being supported by a business case. Indeed, Hinkley Point A is one of the few sites to explicitly identify a business case produced to support a waste route decision. All NDA sites are subject to the NDA’s sanctioning process which includes production of robust business cases to justify that plans represent best value for money [11].

It is recommended that development of a review programme is considered within the LLW Management Plan to provide feedback as to the effectiveness of LLW strategy implementation and help to promote future implementation of the strategic principles.

4.4 LLW Inventory

4.4.1 Introduction

The reporting of LLW information is required by various international obligations [16]. A UK Radioactive Waste Inventory (UKRWI) is generated every three years to satisfy the following requirements:

1. European Commission (EC) periodic reporting on radioactive waste, spent fuel quantities, summary of national strategies and other pertinent information (known as the Situation Report)[17]

2. International Atomic Energy Agency (IAEA) joint convention on the ‘Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management’ in accord with the requirements set out in Article 32[18]
LLW Inventory information is used by strategic authorities such as the NDA to implement Government strategy on the management of radioactive waste and underpin future plans in regards to the clean up and decommissioning of civil nuclear facilities. Waste forecasts are also used by the supply chain to inform investment decisions.

The inventory information itself is currently collected and managed in several databases. These include the UKRWI; Waste Accountancy Template (WAT) data which is used to underpin the NDA LTPs and IWS submissions; and bespoke data-sets used by site waste teams. There is also the WIDRAM\[^{19}\], an integrated dataset for LLW, sourced exclusively from the UKRWI dataset and WAT submissions from the NDA sites.

The WIDRAM inventory was extensively updated in 2008 to form the previous strategic review baseline. The current baseline presented in this report, measured as at 1st April 2010, has been taken exclusively from the 2010 UKRWI, published by the Department of Energy and Climate Change (DECC)\[^{20}\], as this is the most up to date source of data.

A detailed description of the process used to compile the 2010 inventory is included in Appendix B. The inventory is described further in terms of volumes, material types, time phase, activity levels, UK regional distribution, non-nuclear arisings and potentially contaminated land in the following sections below.

### 4.4.2 Volumes

The cumulative raw arisings of LLW and VLLW between 2010 and 2120 are shown in Figure 3. The figure shows that there is a total raw volume of around 4.4 million m\(^3\) of LLW and VLLW forecast to be generated up to 2120, the current end date of NDA’s decommissioning programme. Once conditioned and packaged this is expected to increase to 4.5 million m\(^3\). The most significant period of waste generation is between 2040 and 2050 due to decommissioning activities at Sellafield and is shown by a steeper gradient on the chart. Waste is then produced gradually until about 2080 when the rate of annual waste arisings increases as a result of Final Site Clearance (FSC) activities on a number of Magnox sites.

**Figure 3 – Cumulative forecast raw arisings of UK LLW and VLLW**

![Figure 3](image)

Around 3.3 million m\(^3\) (75\%) of the inventory is declared by the waste producers as VLLW. This includes a significant proportion of mixed VLLW and LLW which reflects the historic label of High Volume Low Activity...
(HVLA) material (<1Bq/g alpha and 40Bq/g beta/gamma) used in the nuclear industry. This aspect is considered further in Section 4.4.4.

It should be noted that the LLW inventory forecast does not include much of the contaminated land at Sellafield (potentially up to 13 million m³) which is yet to be characterised[21]. The inventory does not include any waste arising from potential new nuclear power stations or the raw stock volume of ‘disposed’ LLW already emplaced into Vault 8 at the LLWR. The contaminated land element of the 2010 UKRWI is described further in section 4.4.9.

Figure 4 shows the raw annual arisings for LLW and VLLW. Over the next 20 years the rate of LLW generation is expected to be between 10,000 and 30,000m³ per year. Between 2030 and 2080, LLW arisings average approximately 6,000m³ per year. Subsequent peaks of LLW arisings occur due to final decommissioning and site clearance, before tailing off to zero at 2120. For VLLW the trend is similar to LLW up to 2025, beyond which several peaks of VLLW arisings are expected due to decommissioning activities at Sellafield.

**FIGURE 4 – ANNUAL RAW ARISINGS OF UK LLW AND VLLW**
The collective raw volume and percentage share of UK LLW and VLLW by waste producer is described in Figure 5 below:

**FIGURE 5 – RAW WASTE ARISINGS OF ALL LLW (INCLUDING VLLW) BY WASTE PRODUCER (m$^3$)**

![Diagram showing raw waste arisings of all LLW (including VLLW) by waste producer.](image-url)

The individual raw volumes and percentage share of both UK LLW and VLLW by waste producer is described in Figures 6 and 7 below.

**FIGURE 6 – RAW WASTE ARISINGS OF LLW ONLY BY WASTE PRODUCER (m$^3$)**

![Diagram showing raw waste arisings of LLW only by waste producer.](image-url)
Sellafield Ltd (including Capenhurst) is forecast to contribute over a third of the total LLW and the vast majority of VLLW (about 90%). There are also notable arisings of VLLW from Research Sites and Springfields. Four of the nineteen NDA sites do not currently specify any wastes as VLLW within their inventories which will affect the percentage share of the VLLW waste streams. It is expected that in reality, some proportion of the declared LLW for these 4 sites will turn out to be VLLW during decommissioning or additional waste streams will be created upon further analysis.

4.4.3 Material contents

The total LLW (including VLLW) volume of 4,427,586m³ is equivalent to 4,698,042te when converted to weight based on the density of each wastestream. LLW streams comprise a broad spectrum of materials including concrete, rubble, soils, plastics, ferrous and non-ferrous metals and cellulosic materials. These materials can be classified according to the potential for volume reduction into broad categories of metals, compactables, incinerables and un-compactables. The total LLW and VLLW waste stream by material composition is shown in Figure 8.
Figure 9 shows the basic proportion of materials to be found in the raw LLW arisings only between 2010 and 2120. Soil and rubble (45%) and metals (41%) constitute the majority share of LLW arisings.

**FIGURE 9 – MATERIAL PROPORTIONS IN RAW LLW ARISINGS BETWEEN 2010 AND 2120 (TE)**

![Pie chart showing material proportions](image)

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
<th>Quantity (te)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil/Rubble</td>
<td>45%</td>
<td>529,985</td>
</tr>
<tr>
<td>Metals</td>
<td>41%</td>
<td>483,969</td>
</tr>
<tr>
<td>Soft Organics</td>
<td>5%</td>
<td>57,772</td>
</tr>
<tr>
<td>Graphite</td>
<td>1%</td>
<td>13,071</td>
</tr>
<tr>
<td>Wood</td>
<td>1%</td>
<td>13,127</td>
</tr>
<tr>
<td>Plastic/Rubber</td>
<td>4%</td>
<td>42,044</td>
</tr>
<tr>
<td>Other</td>
<td>3%</td>
<td>35,678</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>1,175,645</strong></td>
</tr>
</tbody>
</table>

In terms of how these materials are apportioned across the UK Regions, the majority are forecast to arise in the North West which accounts for almost a third (380,000te) of the total LLW materials inventory. Sites within Scotland and South West region are also forecasting significant proportions of materials arisings, totalling 422,000te between them or 36% of the total LLW materials inventory as shown in Table 3 below.
TABLE 3 – RAW LLW MATERIALS BY UK REGION BETWEEN 2010 AND 2120

<table>
<thead>
<tr>
<th>UK Region</th>
<th>Graphite (te)</th>
<th>Metals (te)</th>
<th>Plastic / Rubber (te)</th>
<th>Soft Organics (te)</th>
<th>Soil / Rubble (te)</th>
<th>Wood (te)</th>
<th>Unknown Material (te)</th>
<th>Regional Totals (te)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North West</td>
<td>1,408</td>
<td>168,938</td>
<td>14,231</td>
<td>35,907</td>
<td>137,046</td>
<td>8,051</td>
<td>14,980</td>
<td>380,561</td>
</tr>
<tr>
<td>North East</td>
<td>566</td>
<td>12,801</td>
<td>1,373</td>
<td>471</td>
<td>2,672</td>
<td>15</td>
<td>1,078</td>
<td>18,976</td>
</tr>
<tr>
<td>West Midlands</td>
<td>-</td>
<td>80</td>
<td>5</td>
<td>7</td>
<td>-</td>
<td>3</td>
<td>15</td>
<td>110</td>
</tr>
<tr>
<td>East Midlands</td>
<td>-</td>
<td>208</td>
<td>22</td>
<td>55</td>
<td>821</td>
<td>11</td>
<td>-</td>
<td>1,117</td>
</tr>
<tr>
<td>South West</td>
<td>3,048</td>
<td>60,477</td>
<td>4,557</td>
<td>3,013</td>
<td>70,613</td>
<td>1,034</td>
<td>2,801</td>
<td>145,543</td>
</tr>
<tr>
<td>South East</td>
<td>2,151</td>
<td>48,785</td>
<td>8,327</td>
<td>6,908</td>
<td>36,636</td>
<td>1,314</td>
<td>3,736</td>
<td>107,857</td>
</tr>
<tr>
<td>East</td>
<td>269</td>
<td>33,771</td>
<td>3,411</td>
<td>1,723</td>
<td>59,070</td>
<td>196</td>
<td>1,758</td>
<td>100,198</td>
</tr>
<tr>
<td>Wales</td>
<td>4,217</td>
<td>29,537</td>
<td>1,355</td>
<td>1,320</td>
<td>90,142</td>
<td>137</td>
<td>938</td>
<td>127,645</td>
</tr>
<tr>
<td>Scotland</td>
<td>1,249</td>
<td>122,274</td>
<td>7,528</td>
<td>7,957</td>
<td>128,046</td>
<td>2,366</td>
<td>6,911</td>
<td>276,331</td>
</tr>
<tr>
<td>Other</td>
<td>165</td>
<td>7,097</td>
<td>1,235</td>
<td>412</td>
<td>4,939</td>
<td>-</td>
<td>84</td>
<td>13,931</td>
</tr>
<tr>
<td></td>
<td>13,071</td>
<td>483,969</td>
<td>42,044</td>
<td>57,772</td>
<td>529,985</td>
<td>13,127</td>
<td>32,301</td>
<td>1,172,269</td>
</tr>
</tbody>
</table>

The slight variation between unknown material in Table 3 and ‘Other’ in Figure 9 is due to discrepancies in the UKRWI reporting procedure.

The expected arisings each year are shown in Figure 10. This figure assumes the annual waste arisings for each waste stream has a standard composition (i.e. the percentage makeup of the wastestreams stays constant over the time it arises).
Figure 11 shows material arisings categorised as LLW over identified time periods. From the figure it can be seen that the major waste generating periods are from 2010 through to 2030 and 2060 to 2100 with roughly 400,000t generated in each period. The periods are dominated by soil and rubble and metal waste generation suggesting both the near and long-term strategy needs to specifically address these diverse material types.
In terms of metals, almost 190,000te are forecast to arise between 2010 and 2030, averaging 9,400te per annum. The rate of metals then gradually slows down to almost 2,200te per annum over the following period 2030 to 2060 before rising again to almost 3,200te per annum between 2060 and 2100.

In terms of potentially combustible materials encompassing plastics and rubber, soft organics and wood, almost 59,000te are forecast to arise between 2010 and 2030, averaging almost 3,000te per annum. The rate of combustible materials then decreases to an average of 832te per annum from 2030 to 2060 before decreasing further to about 360te per annum between 2060 and 2100. This analysis however, precludes materials designated ‘other’ which could account for a further 30,000te of potentially combustible waste between 2010 and 2100.

In terms of soil and rubble, over 110,000te are forecast to arise between 2010 and 2030, averaging 5,500te per annum. The rate of soil and rubble generation then gradually slows down to about 1,700te per annum over the following period 2030 to 2060 before rising again to almost 7,300te per annum between 2060 and 2100 in line with increased decommissioning activities on the NDA sites.

Graphite forecasts indicate very little will arise between 2010 and 2060 (164te). However, between 2060 and post 2100 almost 13,000te will be generated in line with increased decommissioning activities at various reactor sites operated by Magnox.

Figure 12 shows the relative proportions of materials in the VLLW arisings. The majority of the VLLW is soil and rubble with metals comprising about 8% of the waste. Soft organics and other materials represent 5%, whilst all other remaining materials each constitute less than 1% each of the total mass.

FIGURE 12 – MATERIAL PROPORTIONS IN RAW VLLW ARISINGS BETWEEN 2010 AND 2120 (TE)

In terms of how VLLW materials are apportioned across the UK regions, the majority are forecast to arise in the North West which accounts for 95% (about 3.3 million te) of the total VLLW materials inventory. Sites within Scotland and South East region are the next largest contributors, forecasting 160,000te or 4% of the total VLLW materials inventory as shown in Table 4 below.
### Table 4 – Raw VLLW Materials by UK Region between 2010 and 2120

<table>
<thead>
<tr>
<th>UK Region</th>
<th>Graphite (te)</th>
<th>Metals (te)</th>
<th>Plastic / Rubber (te)</th>
<th>Soft Organics (te)</th>
<th>Soil / Rubble (te)</th>
<th>Wood (te)</th>
<th>Unknown Material (te)</th>
<th>Regional Totals (te)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North West</td>
<td>1,826</td>
<td>293,452</td>
<td>21,490</td>
<td>59,538</td>
<td>2,821,632</td>
<td>45,682</td>
<td>37,515</td>
<td>3,281,135</td>
</tr>
<tr>
<td>North East</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>West Midlands</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>East Midlands</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>South West</td>
<td>-</td>
<td>13</td>
<td>4,576</td>
<td>4,781</td>
<td>3,594</td>
<td>383</td>
<td>2,653</td>
<td>16,000</td>
</tr>
<tr>
<td>South East</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>125,849</td>
<td>-</td>
<td>-</td>
<td>125,849</td>
</tr>
<tr>
<td>East</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4,756</td>
<td>-</td>
<td>-</td>
<td>4,756</td>
</tr>
<tr>
<td>Wales</td>
<td>-</td>
<td>548</td>
<td>457</td>
<td>2,323</td>
<td>4,800</td>
<td>1,951</td>
<td>911</td>
<td>10,991</td>
</tr>
<tr>
<td>Scotland</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>32,452</td>
<td>-</td>
<td>-</td>
<td>32,452</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
<td>12</td>
<td>-</td>
<td>-</td>
<td>54</td>
<td>-</td>
<td>7</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td><strong>1,826</strong></td>
<td><strong>294,025</strong></td>
<td><strong>26,523</strong></td>
<td><strong>66,642</strong></td>
<td><strong>2,993,137</strong></td>
<td><strong>48,016</strong></td>
<td><strong>41,086</strong></td>
<td><strong>3,471,255</strong></td>
</tr>
</tbody>
</table>

The expected arisings each year are shown in Figure 13. This figure assumes the annual waste arisings for each waste stream has a standard composition (i.e. the percentage makeup of the wastestreams stay constant).

**Figure 13 – Annual VLLW Arisings by Material Content (te)**

![Graph showing annual VLLW arisings by material content](image)
Figure 14 shows material arisings categorised as VLLW over identified time periods. From the figure it can be seen that the major waste generating periods are from 2030 through to 2100 with roughly 1,000,000te generated in each period. The dominant waste stream is soil and rubble generated during decommissioning and FSC activities.

FIGURE 14 - VLLW MATERIAL ARISINGS BY TIME PERIOD (TE)

In terms of VLLW metals, almost 16,000te are forecast to arise between 2010 and 2030, averaging about 800te per annum. The rate of metal waste generation then increases significantly to over 4,000te per annum from 2030 to 2060 before slowing down to almost 1,400te per annum between 2060 and 2100.

Some VLLW metal wastes are expected to arise in the short term. This would suggest early action is required to ensure the government strategy is implemented through application of the waste management hierarchy. Effective management of this waste stream would minimise the impact on the LLWR void space and prevent the needless disposal of a recyclable resource.

In terms of potentially combustible VLLW materials encompassing plastics and rubber, soft organics and wood, almost 23,000te are forecast to arise between 2010 and 2030, averaging almost 1,100te per annum. The rate of generation of waste combustible materials then increases significantly to almost 29,000te per annum over the following period 2030 to 2060 before decreasing further to about 850te per annum between 2060 and 2100. However, this analysis precludes materials designated ‘other’ which, if all combustible, could account for a further 62,000te of waste between 2010 and 2100.

In terms of soil and rubble, almost 286,000te are forecast to arise between 2010 and 2030, averaging 14,300te per annum. The rate of soil and rubble then increases significantly to about 27,000te per annum from 2030 to 2060 and remains at that level through to 2100 in line with the increased decommissioning activities on the NDA sites.

Graphite forecasts indicate very little will arise between 2010 and 2030 (138te). However, between 2030 and 2060 about 1,000te are forecast to be generated. Interestingly all VLLW graphite arisings are forecast to be generated as a result of ongoing decommissioning by the Springfields site.
4.4.4 Activity Distribution

LLW is defined in the ‘Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom’[4] as radioactive waste having a radioactive content not exceeding 4,000 Bq/g alpha and 12,000 Bq/g beta/gamma. VLLW is defined in the policy as having less than 4 Bq/g total activity. In addition to volume and material data, waste producers are required to provide radiological data on the activity content of each wastestream. This is reported as ‘Total activity by stream’ and is split into specific radionuclides for each waste stream.

It should be noted that for 61 of the 655 LLW streams no activity information was provided in the 2010 UKRWI, equating to a total raw volume of 50,000 m³ including stock and future arisings. Consequently, the total activity of LLW streams in the 2010 Inventory may be underestimated. Nonetheless, this activity remains a very small fraction of the total activity from all wastes.

Analysis of the reported activity data has highlighted significant inconsistencies with some waste streams being declared as LLW when they are in fact VLLW (and vice versa). Figure 15 below shows large quantities of waste declared as VLLW, but with total activity values of 4-40Bq/g. About 3.1 million m³ of waste declared by consignors as VLLW exceeds the 4Bq/g activity band.

**FIGURE 15 – ACTIVITY DISTRIBUTION OF LLW AND VLLW VOLUMES**

Furthermore, based on the activities declared by consignors in the inventory, around 0.2 million m³ of LLW has activity levels less than 4Bq/g and hence should be classified as VLLW. At face value, the activity data in the inventory would suggest only 0.26 million m³ of the VLLW inventory is truly VLLW rather than the 3.3 million m³ declared.

However, the significant peak of VLLW in the 4-40Bq/g total activity band is mainly due to a single large decommissioning stream from the Sellafield site (waste stream i.d.2D148 on the UKRWI). This stream has a reported activity of 4.9Bq/g (i.e. only slightly above the <4Bq/g boundary) and highlights the need for improved characterisation, especially for wastes that border bands of activity which influence their future treatment and disposal options. Effective characterisation of wastes is highlighted in the UK’s LLW strategy as one of the key principles to best manage the LLW. This waste stream has been the subject of an ACCELS study to look at the expected volume and activity. This review is summarised in section 5.3 and 5.4.
For VLLW, 22 of the 33 wastestreams currently designated as VLLW have specific activities in the inventory of more than 4 Bq/g with two streams not having any activity declared at all. Historically the nuclear industry has used an ‘unofficial’ classification of HVLA which was typically defined as LLW with activity of <1Bq/g Alpha and <40Bq/g Beta/Gamma to represent low-activity decommissioning and site remediation wastes. Although this has now been superseded by the ‘official’ definition of High Volume Very Low Level Waste (HVVLLW) in the UK policy (i.e. <4Bq/g total activity[4]) it is possible that a number of these HVLA wastestreams which effectively straddle the new policy definition have been labelled as VLLW.

There may be several reasons for this, such as the lack of detailed characterisation, current lack of specific route for VLLW, or the fact that some wastestreams may be partly LLW and partly VLLW, but are declared as either LLW or VLLW.

Based on experience of actual decommissioning projects both internationally and in the UK, it is expected that there will be large volumes of VLLW arising from decommissioning and much of the volume currently classified as LLW will ultimately turn out to be VLLW or exempt. Given the current discrepancies within the inventory it is difficult to estimate these proportions with a high degree of confidence. This issue is discussed further in section 5.4.

4.4.5 Intermediate Level Waste (ILW) – LLW boundary wastes

Wastes with activities close to the boundary between ILW and LLW, 4 GBq/te of alpha or 12 GBq/te of beta/gamma activity, may cause difficulties for disposal. There is a potential for some wastestreams that are currently assumed to be ILW to be disposed of as LLW once they have been conditioned or properly characterised. This could potentially add to the volume for disposal at LLWR, however, it would reduce the volume disposed of to the Geological Disposal Facility (GDF). The 2 mechanisms for these wastes to be accepted are:

- Changes to the LLWR Waste Acceptance Criteria (WAC) following a revision of the Environmental Safety Case (ESC) to align acceptance criteria with the IAEA waste classification scheme. Such changes would adopt a further waste categorisation based on nuclide half-lives. ILW containing predominantly short lived radionuclides (less than 30 years) may be acceptable for disposal at LLWR.

- ILW that marginally exceeds the LLW limit may need to be conditioned prior to disposal. The additional mass of non-radioactive materials used to facilitate treatment can be sufficient to reduce the specific activity to such an extent that the conditioned waste changes classification from ILW to LLW. It must be made clear that the dilution of ILW to consciously achieve LLW disposal is not an acceptable practice and should never be performed as a deliberate technique. However, some waste may legitimately be treated and result in waste suitable for disposal at LLWR.

These wastes are currently classified as ILW in the UKRWI but may contribute to the total volume to be disposed of at LLWR. As such, further work may be required to identify these waste streams.

Some LLW is also unable to be disposed of at the LLWR due to its chemical composition or failure to meets the WAC. This waste is currently planned for disposal direct to the GDF. As part of the GDF development, the NDA have produced a “Derived Inventory”[27] to support the development of the generic safety case. The Baseline inventory for ILW and LLW shows a total of 15,655.6 m³ of conditioned LLW destined for disposal at the GDF. There may be a number of opportunities to dispose of these wastes in a more optimal way through these will require further evaluation. The report further discussed potential changes to waste handling and other factors resulting in a lower inventory estimate of 10,869.9 m³ and an upper estimate of 143,712.7 m³.

4.4.6 UK Regional Distribution of the Waste

LLW and VLLW are widely distributed throughout the United Kingdom due to the geographical distribution of nuclear sites. The majority of waste is held at the 19 sites owned by the NDA on behalf of the UK government. However, there are also significant volumes of waste at Ministry of Defence (MOD) sites and those managed by commercial operators such as EDF Energy (formerly British Energy).
Over the next 10 years the majority of LLW and VLLW will arise in the North West region of the UK, predominantly in the county of Cumbria, which generates almost 75% of the regions waste or 160,000m³ in terms of raw volume. The next largest contributing regions are Scotland and the South East who between them are forecasting about 230,000m³ over the same period. The UK regional distribution of both LLW and VLLW raw volumes for the next 10 years (2010-2020) and entire lifetime (2010-2120) are shown in Figures 16 and 17 below.

**FIGURE 16 – 10 YEAR UK REGIONAL DISTRIBUTION OF RAW LLW AND VLLW (2010 – 2020)**
FIGURE 17 – 110 YEAR UK REGIONAL DISTRIBUTION OF RAW LLW AND VLLW (2010 – 2120)
Tables 5 and 6 below, show the total LLW and VLLW raw volumes arising by UK region during the periods 2010-2020 and 2010-2120.

**TABLE 5 – 10 YEAR UK REGIONAL DISTRIBUTION OF LLW AND VLLW RAW VOLUMES BETWEEN 2010-2020 (M³)**

<table>
<thead>
<tr>
<th>UK Region</th>
<th>LLW Volume</th>
<th>VLLW Volume</th>
<th>Total Waste Volume</th>
<th>Percentage of Total Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>North West</td>
<td>125,177</td>
<td>91,593</td>
<td>216,770</td>
<td>43.3%</td>
</tr>
<tr>
<td>North East</td>
<td>7,103</td>
<td>-</td>
<td>7,103</td>
<td>1.4%</td>
</tr>
<tr>
<td>West Midlands</td>
<td>62</td>
<td>-</td>
<td>62</td>
<td>0.0%</td>
</tr>
<tr>
<td>East Midlands</td>
<td>730</td>
<td>-</td>
<td>730</td>
<td>0.1%</td>
</tr>
<tr>
<td>East</td>
<td>6,599</td>
<td>-</td>
<td>6,599</td>
<td>1.3%</td>
</tr>
<tr>
<td>South West</td>
<td>15,396</td>
<td>9,375</td>
<td>24,771</td>
<td>5.0%</td>
</tr>
<tr>
<td>South East</td>
<td>35,766</td>
<td>58,038</td>
<td>93,804</td>
<td>18.7%</td>
</tr>
<tr>
<td>Wales</td>
<td>5,935</td>
<td>2,677</td>
<td>8,612</td>
<td>1.7%</td>
</tr>
<tr>
<td>Scotland</td>
<td>104,035</td>
<td>36,228</td>
<td>140,263</td>
<td>28.0%</td>
</tr>
<tr>
<td>Other</td>
<td>1,675</td>
<td>-</td>
<td>1,675</td>
<td>0.3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>302,488</strong></td>
<td><strong>197,912</strong></td>
<td><strong>500,400</strong></td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 6 – 110 YEAR UK REGIONAL DISTRIBUTION OF LLW AND VLLW RAW VOLUMES BETWEEN 2010-2120 (M³)**

<table>
<thead>
<tr>
<th>UK Region</th>
<th>LLW Volume</th>
<th>VLLW Volume</th>
<th>Total Waste Volume</th>
<th>Percentage of Total Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>North West</td>
<td>439,264</td>
<td>3,170,443</td>
<td>3,609,707</td>
<td>81.5%</td>
</tr>
<tr>
<td>North East</td>
<td>14,051</td>
<td>-</td>
<td>14,051</td>
<td>0.3%</td>
</tr>
<tr>
<td>West Midlands</td>
<td>100</td>
<td>-</td>
<td>100</td>
<td>0.0%</td>
</tr>
<tr>
<td>East Midlands</td>
<td>730</td>
<td>-</td>
<td>730</td>
<td>0.0%</td>
</tr>
<tr>
<td>East</td>
<td>83,166</td>
<td>2,992</td>
<td>86,158</td>
<td>1.9%</td>
</tr>
<tr>
<td>South West</td>
<td>116,599</td>
<td>18,204</td>
<td>134,803</td>
<td>3.0%</td>
</tr>
<tr>
<td>South East</td>
<td>101,986</td>
<td>88,786</td>
<td>190,772</td>
<td>4.3%</td>
</tr>
<tr>
<td>Wales</td>
<td>95,626</td>
<td>10,500</td>
<td>106,126</td>
<td>2.4%</td>
</tr>
<tr>
<td>Scotland</td>
<td>232,747</td>
<td>44,551</td>
<td>277,298</td>
<td>6.3%</td>
</tr>
<tr>
<td>Other</td>
<td>7,841</td>
<td>-</td>
<td>7,841</td>
<td>0.2%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,092,110</strong></td>
<td><strong>3,335,476</strong></td>
<td><strong>4,427,586</strong></td>
<td></td>
</tr>
</tbody>
</table>

For a further breakdown of LLW and VLLW volumes by UK County Council area during the periods 2010-2020 and 2010-2120, see Appendix C.
The county of Cumbria is forecast to contribute 75% of the LLW and VLLW within the UK over the period 2010-2120, representing 3.3 million m$^3$ of waste. The majority of this volume is VLLW (about 2.9 million m$^3$) with a relatively small amount being LLW (about 0.4 million m$^3$). The county itself consists of four NDA sites and two MOD sites, as illustrated by Figure 18.

**FIGURE 18 – RADIOACTIVE WASTE GENERATING SITES IN THE COUNTY OF CUMBRIA**

As expected, the Sellafield, Calder Hall and Windscale sites contribute the majority of the waste from within the county and represents some 95% of the counties LLW (0.37 million m$^3$) and 88% of the VLLW (2.93 million m$^3$). LLWR is the next largest contributor forecasting ~18,000m$^3$ of LLW over its operational lifetime.

### 4.4.7 Analysis of Historic Disposals at the LLWR

Between the 1$^{st}$ April 2005 and 31$^{st}$ March 2010, LLWR received 2,561 containers from both the nuclear and non-nuclear industries.

As shown in Figure 19 below, the majority of containers arrived in the form of an Industrial Package (IP) IP-2 approved Half Height ISO (HHISO) with the number of receipts steadily declining from 612 in 2005/2006 to only 296 during 2009/2010. This decline in waste receipts is likely to be due to improvements in waste management across the NDA estate resulting from:

- Application of the waste hierarchy
- Improved characterisation practices on site
- Improved segregation practices
- Implementation of alternative waste routes through LLWR waste services
- Improved waste awareness on sites

Despite the reduction in the number of container receipts, HHISO’s have been consistently utilised and represent about 90% of the annual container receipts received at the LLW Repository site.
Third height Isofreight containers (THISO) are also used in some cases for dense materials. A number of other miscellaneous packages are sometimes used to dispose of 'non-standard' wastes or direct disposal of large items.

Figure 19 – Actual Container Receipts at the LLW Repository since 2005/2006 Financial Year

Figure 20 shows how these receipts are represented in terms of packaged volume.

Figure 20 – Packaged Volume Receipts at the LLW Repository since 2005
As shown in Figure 20, a total of around 50,000m$^3$ of waste has been received at the site equating to an average of 10,000m$^3$ of packaged volume per annum. Interestingly the packaged volume has been reduced by 50% when comparing the 05/06 to 09/10 financial years. This reduction equates to 3% of the void space in vault 9 saved annually.

Figure 21 shows how these receipts are represented in terms of their associated activity levels.

**FIGURE 21 – ACTIVITY DISTRIBUTION OF HISTORIC DISPOSALS SINCE 2005**

As shown in Figure 21, of the 2,561 containers received by LLW Repository during the period 1st Apr 2005 to 31st Mar 2010, about 65% or 1,647 of the containers had specific activities of less than 200Bq/g of which, 137 containers had an activity of less than 4Bq/g. Interestingly about 98% of the containers were less than 4000Bq/g.

4.4.8 Retrospective Volume Analysis of the 2010 UK Radioactive Waste Inventory against previous Inventories

Forecast LLW volumes have varied significantly since the first UKRWI in 1984 and continue to do so with the introduction of sub-categories like VLLW. However the past decade has seen greater consistency with the LLW volumes averaging about 1.4 million m$^3$ per inventory. According to the most recent UKRWI in 2010, LLW volumes are now at their lowest point (about 1.1 million m$^3$) since records began.

Since the introduction of VLLW as a category in the 2007 UKRWI, the LLW proportions have decreased significantly with VLLW volumes accounting for at least 50% of the overall LLW inventory. This is particularly evident in the 2010 UKRWI where VLLW accounts for 75% of the LLW (about 3.3 million m$^3$) with the most significant proportion (87%) arising post 2040 through to the end of FSC.
Figure 22 shows how the LLW and VLLW volumes recorded in the 2010 UKRWI compare against previous inventories.

**FIGURE 22 – OVERVIEW OF RADIOACTIVE WASTE INVENTORIES SINCE 1994**

As shown in Figure 22, the LLW volumes have reduced by greater than 50% since the 1994 UKRWI and have seen a significant reduction of almost 0.4 million m$^3$ between WIDRAM 2009 and the 2010 UKRWI. Volumes of VLLW have also increased over the same period. This reduction of LLW and increase in VLLW of recent times is mainly attributed to the incorporation of improved forecasts from the decommissioning mandate figures in the Sellafield Ltd submission. The volumes of VLLW from Sellafield are considered further in section 5.4.

### 4.4.9 Potentially Contaminated Land

In addition to the waste reported in the 2010 UKRWI, a supplementary report\(^{[21]}\) describes the volumes of potentially contaminated land throughout the UK.

In total, 13.2 million m$^3$ of potentially contaminated land has been identified by waste producers. As can be seen in Figure 23, the North West region accounts for 99% of the potentially contaminated land in the UK and is distributed over three nuclear licensed sites which are operated by both Sellafield Ltd and Springfields. The other notable contribution is from the Aldermaston site based in the South East region of the UK.
Options for management of this potentially contaminated land at Sellafield are still under consideration. This land will require remediation during the period 2045-2100 (section 4.4.2). Clearly, the amount of material currently being estimated would require significant investment to be safely managed.

The Springfield’s and Aldermaston arisings are based on limited analysis and further investigation work is foreseen during 2010/11 at the Springfield’s site and after building decommissioning at the Aldermaston site.

Currently, LLWR Ltd is working in collaboration with the NDA to gain a clearer understanding of the quality of ground and groundwater on NDA sites. Information regarding contaminated ground and the potential wastes arising from its management has been gained from LTP submissions and to a lesser extent WATs. LTP submissions do not always provide a comprehensive picture of the status of land quality on a particular site, or of the waste management liabilities associated with it. During 2010 an Excel-based Data Input Tool (DIT) and associated guidance were developed to enable SLCs to provide more detailed baseline information on land quality which will be updated year on year. This information will also be used by SLCs to assist planning and management of land quality, and will enable NDA and LLWR Ltd to plan the near, medium and long-term requirements for the UKs radioactive waste management capability.

The DIT was issued to SLCs in the summer of 2010 and data captured for the most significant three areas of potential concern on each NDA site. Analysis of the data is currently ongoing and will be reported in a ‘Land Quality Strategic Review’ to be issued in the spring of 2011. It is intended that in future years SLCs will provide information for all areas of known or potentially contaminated ground and groundwater on their sites. This will enable optimised use of resources for land quality management, and an increasingly accurate forecast of wastes arising from it over time.

4.4.10 Non-Nuclear Industry Volumes

Small quantities of LLW and VLLW are generated from numerous of non-nuclear industry users of radioactive materials including hospitals, pharmaceutical, research and educational organisations, and the oil and gas industries. These organisations use a diverse range of treatment and disposal routes including incineration, landfill and LLWR. Unlike the nuclear industry, there is no consolidated reporting of waste inventory and hence the information available for these sectors is somewhat limited. The data that is available has been summarised by DECC as part of their “Strategy for the management of solid low level
radioactive waste from the non-nuclear industry in the United Kingdom" consultation document[22]. The findings of this review are summarised here along with other sources of information.

To support the non nuclear industry strategy consultation process, DECC commissioned a survey of waste producers across these sectors. Of the 877 facilities that held RSA 93 authorisations, 766 were successfully contacted. However, only 172 organisations returned useable data, a return of under 20%. As such, the data may not be representative of total UK arisings and estimates made must be treated with caution. Total annual waste quantities from the responders are shown in Table 7. Table 7 also shows a breakdown of the current disposal routes identified in the non-nuclear strategy report.

**Table 7 - Annual Quantities of Waste Arisings and Current Method of Disposal.**

<table>
<thead>
<tr>
<th>Disposal route</th>
<th>Cubic Metres</th>
<th>Tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposal by Incineration (VLLW and LLW)</td>
<td>50,183</td>
<td>17.8</td>
</tr>
<tr>
<td>Disposal by Landfill (VLLW)</td>
<td>880</td>
<td>32.2</td>
</tr>
<tr>
<td>Disposal by controlled burial (i.e. LLW)</td>
<td>29</td>
<td>0</td>
</tr>
<tr>
<td>Disposal to LLWR</td>
<td>53</td>
<td>0.27</td>
</tr>
<tr>
<td>Use of Decay storage (followed by disposal as conventional waste)</td>
<td>60</td>
<td>0</td>
</tr>
<tr>
<td>Other (mainly transfer of waste to a waste treatment centre, or decay storage then incineration)</td>
<td>145</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total quantities (the data on volume and mass are mutually exclusive)</strong></td>
<td><strong>51,350</strong></td>
<td><strong>54.2</strong></td>
</tr>
</tbody>
</table>

On the basis that the survey included around 20% of all authorisation holders, and that the bulk of the arisings are from one area of the UK that appeared to be well represented in the survey, it is estimated that total UK arisings from the non-nuclear industry are very unlikely to exceed 100,000 m³ per year.

The data is reported in m³ from facilities that predominantly incinerate their waste and thus track waste production volumetrically. The waste reported in tonnes is from facilities that predominantly dispose of waste to landfill and thus make use of the landfill weighbridge to collate waste returns. Note that the volume and weights are independent of each other of each other and additive.

The responses to the survey were dominated by medical and research sectors resulting in a high proportion of the waste dominated by carbon -14, tritium and technetium-99m and other short lived beta emitters, with clinical and laboratory wastes being the most commonly reported physical waste types. Disposal by incineration was the dominant disposal route for the wastes reported by volume with disposal to landfill being the dominant disposal route for wastes reported by mass.

Of the total waste reported, 53m³ and 0.27 tonnes were sent to LLWR for disposal (0.1% of the waste reported by volume and 0.5% of waste reported by mass). LLWR is therefore only a minor route for the non-nuclear industry in terms of volume but is strategically important as a route for waste that does not meet the WAC for other routes.

Except possibly for carbon-14 and tritium, there appears to be no significant anticipated increase in most types of radioactivity in wastes that will require disposal from the non-nuclear sector. Anticipated physical quantities are less than at present.
Table 7 shows that controlled burial of LLW by the non-nuclear sector appears to be very rarely undertaken, despite its inclusion amongst disposal options in the 2007 LLW policy statement. Data on secondary VLLW (i.e. incinerator residues) was very sparse, as few incinerator companies responded.

A previous SNIFFER report\(^{[23]}\) estimated that in 2005 approximately 3,600 tonnes of ‘primary’ VLLW was produced by non-nuclear organisations (excluding the oil and gas industry). The vast majority of the activity (>86%) in primary VLLW was associated with short-lived radionuclides with half-lives less than 30 years. A survey of these VLLW producers indicated that 52% of VLLW was incinerated and 48% sent for landfill. The 2005 report estimated that incineration produces approximately 20,000 tonnes of ‘secondary’ VLLW consisting of ash and off-gas treatment residues which are sent to landfill. The reason for this increase in mass from primary to secondary is thought to be associated with the addition of other non-radioactive wastes for co-incineration.

The estimate of LLW produced from the non-nuclear industry has increased following DECC’s survey of waste producers. There is still uncertainty in the actual volume produced with an estimated range of 52,000 to 100,000\(\text{m}^3\) of waste generated per year. This compares with estimated average waste arisings per year from the nuclear industry of ~40,000\(\text{m}^3/\text{yr}\) over the next 10 years (section 4.4.2). While of a similar size waste stream to that of the nuclear industry, only 53\(\text{m}^3\) and 0.27 tonnes were sent to LLWR for disposal. This shows that alternative waste routes are already available and readily used for disposal. As such it is not expected that this waste stream will significantly impact LLWR operations.

The oil and gas industry is another significant producer in the non-nuclear industry which produces wastes contaminated with Naturally Occurring Radioactive Material (NORM). This is typically in the form of scale within the internals of pipework and equipment used to extract oil. A report commissioned by the NDA in 2008\(^{[24]}\) reviewed NORM waste volumes and the potential impact such volumes may have on the LLWR. Figure 24 shows the approximate volume of oilfield NORM solids forecast to arise in the UK from 2004 up to 2040, beyond which time it is expected that arisings will be minimal. These wastes are generally unsuitable for compaction and therefore disposal volumes could be up to 2 times greater.

**FIGURE 24 – NORM WASTE ARISINGS OVER TIME**

![NORM Waste Arisings Over Time](image)

The figure shows that raw volumes delivered on shore are likely to be less than 200\(\text{m}^3/\text{yr}\) hence these volumes are not significant in volumetric terms for LLWR capacity.

Currently most NORM waste is discharged to sea; however future changes to the regulatory regime may require more of this waste to be disposed to an appropriate solid waste management facility. A ruling from the Scottish Government has concluded that discharge to sea is not the BPEO. Thus, new arrangements...
to manage NORM waste will be required. Although all this waste is presumed to be LLW, between 17% and 47% of the NORM scale waste disposed of at the Scotoil facility in the years 2000-2005 would have been classed as exempt.

Organisations which produce NORM wastes are being dealt with separately from the rest of the non-nuclear industry in the DECC strategy consultation process because their LLW and VLLW are often contaminated with organic material (including hydrocarbons) and contain certain very long half-life radionuclides whose management needs to be considered carefully. Future disposal arrangements of NORM from the oil and gas sectors are uncertain, pending the outcome of an appeal by a waste facility operator (Scotoil) against the regulatory decision by the Scottish Environmental Protection Agency (SEPA) that the BPEO was not being used to manage disposals of radioactive waste. There are also considerable uncertainties over volumes of waste that will arise from decommissioning of oil and gas installations. Some of these industries face imminent difficulties with disposals of radioactive waste containing naturally occurring radioactivity; therefore a further data collection and options assessment to identify feasible management options, including disposal, will be completed and incorporated in the final DECC strategy to promote optimum disposal routes for these wastes.

SITA UK and Nuvia Ltd are currently developing a landfill site at Stoneyhill near Peterhead in Aberdeenshire to treat and dispose of waste contaminated with NORM generated from the oil and gas industry[25]. A broad range of components will be treated including pumps and valves and the more common tubular components.

Waste from the descaling operation will be conditioned by mixing the scale with cement and water. This will then be poured into 220 litre drums, which will be fitted with lids and allowed to cure for at least 7 days before disposal in the landfill. It is estimated that NORM arising from the descaling of contaminated equipment, plus unconditioned NORM scale received directly by the facility, will be up to a maximum of 200 tonnes per annum. All treated items will be sent back to the client for either reuse, recycling or disposal as non hazardous waste.

Options for disposing of solid NORM are currently limited. The management of NORM wastes at LLWR may have significant implications due to the relatively high radium and thorium levels. These nuclides present particular challenges to the LLWR ESC. Current developments of alternative waste routes are expected to divert the majority of this waste stream resulting in minimal impact to LLWR operations.

4.4.11 Inventory Issues

During collation of the information available, several areas of improvement have been identified to better improve the data reporting and further strengthen the baseline data.

LLW inventory information is currently collected and managed in multiple datasets. These include the UKRWI, WIDRAM and bespoke datasets used by site waste teams to underpin the NDA LTPs and IWS submissions. These datasets are not always consistent due to different reporting formats, timescales and underpinning assumptions.

Although recently the WAT and UKRWI datasets have been converging, further work is needed in order to improve and refine the LLW dataset that can be used to improve the accuracy of short and long-term forecasting, liability estimating and strategic planning.

A significant amount of work has recently been completed by the NDA SLCs to improve the accuracy of their radioactive waste inventories, notably work carried out by Magnox North and South on the ‘SMART Inventory’ and Sellafield Ltd on the ‘Decommissioning Mandate’ process (discussed in sections 5.3 and 5.4). As a result of these projects, baselines are in the process of being updated and these results will inform future inventories.

It is also foreseen that further improvements to the reporting of ‘actual’ waste treatment or disposal data by SLCs and the wider industry would greatly assist DECC in measuring the progress of the policy for long term management of solid low level radioactive waste[4]. This would also provide greater accountability and bring focus to issues that affect future strategic decision making.
LLWR are also in the process of developing their waste inventory strategy through the ACCELS project and are looking to implement a National LLW Programme commencing 2011. This will involve site targeted reviews across the NDA and Non-NDA estate, in-depth analysis of inventory data and initiating improvements to existing waste inventory tools such as the WAT, British Radioactive Waste Information Management System (BRIMS) and Short-term forecasting ensuring they remain ‘fit for purpose’.

In addition, the ACCELS project included LLWR working in partnership with SLCs to generate efficiencies across the NDA estate and help align the forecasted waste volumes with associated costs of managing this waste and thus informing the NP.

The review of the activity levels assigned to specific waste streams has identified that over 3.1 million m$^3$ of waste specified as VLLW actually appears to be LLW albeit very close to the VLLW / LLW activity boundary. Conversely over 0.2 million m$^3$ of LLW streams appear to state VLLW activity levels. This highlights a need to improve consistency in the categorisation or characterisation of wastes within the baseline and the possible deployment of specialist equipment to assist sites in achieving this aim.

Better characterisation will enable the SLC’s to estimate disposal costs and identify wastes streams that can be diverted from the LLWR through treatment or alternative disposal.

There are a number of materials that are not currently included in the LLW inventory the most significant of which is potentially contaminated land. A significant amount of further characterisation is necessary across a number of NDA and Non-NDA sites to define the potential size of the challenge. The ultimate quantity declared as LLW or VLLW (potentially up to 13 million m$^3$) and subsequent management strategy will significantly impact on LLW strategy. A report was produced which discusses radioactive materials not included in the 2010 UKRWI in more detail[21].

It is currently unclear what impact the ongoing government EO review will have on the LLW inventory. Government are considering moving towards a system of radionuclide specific limits in line with the European approach. This may result in some material currently classified as LLW becoming exempt, whilst some material currently below the exemption threshold of 0.4Bq/g may fall within LLW.

The move towards an integrated LLW inventory data source containing accurate and appropriate information will give confidence in the data provided and subsequent strategic analysis. This will allow SLC’s to better underpin their site clean up plans and will generate confidence from the supply chain that there is a viable market to further develop treatment and disposal options.

### 4.5 Costs and Liabilities

A LLW management cost baseline for 2008 was established in the first issue of the LLW Strategic Review to inform NDA’s strategic decision-making and formulation of the national LLW strategy. This cost baseline was updated in 2009 and has been comprehensively updated in 2010 to take into account the latest LTP information and the refinements resulting from the ACCELS programme. The cost baseline is used to define a NP which is included within NDA’s ARAC.

The costs and liabilities faced by NDA for LLW management include the full lifecycle costs for management and disposal of solid LLW and VLLW generated by operations and decommissioning of NDA’s sites. This includes the design, construction, operation, decommissioning of any solid LLW management facilities required in addition to the cost of treatment (characterisation, packaging, conditioning, etc), transport and waste disposal. The costs associated with the in-situ management of contaminated land and groundwater remediation have not been included, although the cost associated with the management and disposal of any material treated as LLW are included.

The NDA’s standard Programme Summary Work Breakdown Structure (PSWBS)[12] was used to identify areas where these LLW costs are likely to reside within the LTPs of all NDA sites. The baseline primarily focuses on identifiable solid LLW and VLLW costs residing within every site’s LTP. It is possible, however, that other LLW costs may be embedded elsewhere (e.g. in decommissioning projects) and hence are not currently included in the LLW baseline. In compiling the costs for each site, some judgement has been made to assess the relevance of particular facilities to LLW management (for example, where facilities may have a shared role with other waste types such as exempt, non-hazardous, hazardous, ILW, etc).
Cost data used in this report has been sourced from a number of areas. Magnox, RSRL and Dounreay LTP data for 2010 have been collated directly for use in this baseline. Sellafield are currently in the process of finalising and agreeing a new LTP10 which will act as a contract baseline. Costs for Sellafield have been approved up to 2025. Beyond 2025, provisional Sellafield LTP10 cost data have been used in this assessment. Springfields have recently moved to a new contractual relationship with NDA; however, NDA still retains responsibility for certain liabilities associated with legacy waste management. 2010 Springfields data was not available in time for this assessment; therefore cost data from 2009 has been used. Costs of operating LLWR are not directly included within the baseline as these costs are indirectly represented as offsite disposal costs within other SLC’s plans.

The 2010 cost baseline should therefore be regarded as ‘provisional’ and may be subject to change following finalisation of the Sellafield LTP10 and receipt of Springfields data for 2010. The baseline is described further in the following sections below.

4.5.1  LLW Cost Summary

The undiscounted cost of LLW management across the NDA estate in March 2008 was defined in the LLW Strategic Review at approximately £9.86Bn. This includes the full cost of management and disposal of LLW included within SLC LTPs. In 2010, the total cost has decreased by £0.96Bn to around £8.9Bn. Within this total, several elements have increased and decreased. The reasons for the increases and decreases are discussed further in the relevant sections below. As discussed above, due to the provisional nature of some of the cost data used for Sellafield and Springfields, the 2010 total may be subject to change.

Table D1 in Appendix D shows how this cost is distributed by NDA’s PSWBS across different sites in 2008 and 2010. This is summarised in Figure 25 below.

**Figure 25 – Total 2010 LLW Liability by Cost Category (£m)**

Over 63% of the costs are associated with off-site waste disposal. Costs of operating LLWR (and its successor) are not directly included within the baseline as these costs are indirectly represented as offsite disposal costs within other SLC’s plans. This category has risen significantly from £2.8Bn to £5.6Bn since 2008 due to revised inventory estimates and disposal cost rates assumed by Magnox and Sellafield. A
proportion of metal recycling and thermal treatment costs occurring post-2025 at Sellafield are also included within this category which drive some of the increase.

Around 17% is associated with treatment operations. This category typically includes operational aspects of LLW management including costs for waste characterisation, size-reduction, sorting, segregation, packaging, and volume reduction (e.g. compaction). In reality, some treatment and pre-processing costs for LLW management are also embedded within decommissioning projects which have not been captured. This category has decreased significantly from £4.9Bn to £1.5Bn since 2008 primarily due to the removal of the soil treatment plant and other waste handling/treatment facilities at Sellafield.

Less than 10% of the cost is associated with transport. This category has risen from £0.2Bn to £0.8Bn since 2008 due to revised LLW transport costs during the Magnox FSC phase. It should be noted that whilst some waste transport costs at Sellafield are included within LLW budgets, other transport costs sit within a separate Infrastructure programme which covers movement of LLW and spent fuel by rail and therefore could not be specifically separated out for inclusion in this baseline.

The overall cost associated with new construction projects has decreased from £1.1Bn to £0.4Bn in 2010. Much of this is due to removal of the new treatment facilities at Sellafield (metal recycling, smelter, thermal treatment), although some of these costs have been replaced as treatment costs within the off-site disposal category instead. As a result of the ACCELS programme, the construction costs of Magnox FSC facilities included with the LLW baseline has also been rationalised. It should be noted that the cost of some new facilities have increased, such as the Sellafield sort and segregation facility and Dounreay onsite disposal facility.

### 4.5.2 LLW Cost by SLC

Figure 26 shows how this cost is distributed within NDA sites. Almost 50% (£4.4 billion) of costs are associated with LLW management at Sellafield. This is consistent with Sellafield being the largest producer of waste. A further £3.9 billion (45%) is associated with LLW management at the 10 Magnox sites. Springfields, Dounreay and Research Sites combined account for less than 6% of the total liability.

**Figure 26 – 2010 LLW Costs by SLC (£m)**

<table>
<thead>
<tr>
<th>SLC</th>
<th>Cost (£m)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactor Sites North</td>
<td>2,220</td>
<td>25%</td>
</tr>
<tr>
<td>Reactor Sites South</td>
<td>1,738</td>
<td>20%</td>
</tr>
<tr>
<td>Sellafield</td>
<td>4,457</td>
<td>49%</td>
</tr>
<tr>
<td>Springfields</td>
<td>156</td>
<td>2%</td>
</tr>
<tr>
<td>DSRL</td>
<td>186</td>
<td>2%</td>
</tr>
<tr>
<td>RSRL</td>
<td>141</td>
<td>2%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£8,898m</strong></td>
<td></td>
</tr>
</tbody>
</table>
4.5.3 LLW costs over time

Figure 27 shows the profile of spending per year on LLW management. This yearly profile shows that expenditure on LLW management is due to rise over the next few years from £62 million/year to an average of over £100 million/year at 2020. Much of this increase in LLW costs is associated with a ramp up of Magnox and Sellafield decommissioning activities. The cost profile shows some large peaks of £150-£225 million/year between 2075 and 2100 primarily associated with FSC at Magnox sites.

![Annual LLW Costs](image)

When compared to the 2008 profile, the 2010 near-term costs up to 2070 are broadly similar. Beyond 2070, the cost profile is higher in some years as some of the costs have been brought forward in line with Magnox FSC schedules. LLW management costs now terminate in 2120 instead of 2129, thus saving approximately 10 years in site programme costs.

4.5.4 Analysis of changes from 2008 Baseline

As discussed previously the 2010 baseline has decreased by approximately £1Bn from 2008. Although the overall cost appears to have decreased, some items that were included within the LTP08 baseline have been removed as a result of a rationalisation exercise undertaken as part of the ACCELS programme, while other elements of the original baseline have increased. These significant variations are shown in Figure 28 and Table 8 below.
As shown in Table 8, there have been significant changes in some LLW work programmes. This is particularly important for Magnox and Sellafield. LLWR have worked with each SLC via the ACCELS programme to understand the underlying reasons for these significant changes to the cost baseline.
This has revealed the following issues:

- Many SLCs continue to make very conservative assumptions regarding predicted waste quantities and currently plan for a high degree of ‘self-sufficiency’ at each site.
- Development of the LTPs occurred prior to the development of the UK Nuclear Industry LLW Strategy and many site baselines have not yet been fully updated to reflect the new strategy.
- Most cost baselines do not take into account opportunities with regard to potential categorisation and waste routes (i.e. they assume worst case).

Within the Sellafield LTP10 there have been some significant increases or decreases in costs of specific facilities. The Waste Operating Unit (OU) at Sellafield has recently been reorganised in LTP10, following a Partner, Assess, Innovate, and Sustain (PAIS) team review. The new Sellafield waste programme boundary now reasonably captures the majority of site LLW costs, noting that some Waste OU assets and resources can also be used to manage ILW and Plutonium Contaminated Material (PCM) wastes some of the time. Some costs such as Calder Hall waste management, Capenhurst and Windscale operations, and clearance and characterisation have been removed or reallocated as a result of this reorganisation.

The new LTP10 contract baseline is fully underpinned but ‘non-aspirational’ in nature, with the exception of a few LLW opportunities that are already being incorporated into the LTP10 contract baseline (e.g. substitution of new waste treatment facilities by utilisation of the supply chain post-2020). It is currently envisaged that the other opportunities will be incorporated into Sellafield’s LTP10 Execution/Performance Plan, where appropriate, which aims to improve the cost-effectiveness of the original contract baseline.

Costs of Magnox C&M preps have reduced as a result of improved waste estimating and categorisation assumptions for decommissioning activities. Magnox have systematically reviewed these estimates further in 2009 and 2010 under the Magnox Inventory Improvement Programme which is expected to lead to further reductions in LLW transport and disposal costs for the C&M phase of its sites.

The Magnox FSC LLW costs have increased significantly since March 2008. The original March 2008 estimates were based on a decommissioning plan that can be traced back to 1986 and included a number of inconsistencies and variations across the various Magnox sites. To improve the estimate, Magnox formed a team of internal and external experts to examine and review all FSC phase activities of all of the Magnox North and Magnox South reactor sites. In many cases, costs were re-estimated using an ‘approximate estimating methodology’, using Hinkley Point A as a template. Hinkley costs are then subsequently extrapolated to other Magnox sites on a parametric basis. Although in many areas overall decommissioning costs reduced, a by-product of this process has been some substantial increases in LLW management and disposal costs in the 2009 and 2010 baselines.

As part of the ACCELS programme, LLWR have worked with NDA and SLCs to identify over 40 opportunities to reduce the baseline. LLWR has worked with each SLC to gather the required underpinning data and review the opportunities. Integrated Project Team (IPT) reviews, comprised of LLWR, NDA, and SLC managers, have been formed to review the Sellafield and Magnox opportunities and develop the forward plan for implementation. The process for evaluation of opportunities adopted is consistent with the approach in NDA’s PCP 16 – Opportunity Management[13]. These opportunities are discussed further in Section 5.

### 4.5.5 Non-NDA Nuclear Industry Sites

There are a number of non-NDA sites which produce LLW and VLLW. These include private entities such as GE Healthcare and EDF Energy and government consignors such as Ministry of Defence (MoD). These organisations are responsible for their own LLW liabilities and consequently this baseline analysis currently only includes liabilities associated with NDA-owned sites.

These organisations utilise a number of NDA assets for treatment and disposal of LLW waste on a commercial basis.
4.6 Assets and Infrastructure

This Assets and Infrastructure section of the LLW Strategic Review presents an overview of the UK and international treatment and disposal facilities currently available to manage LLW and VLLW from the UK nuclear industry. It also discusses some of the key facilities which are at the planning and development stage.

From the 1950s to 1988, virtually all LLW from the UK nuclear industry was disposed at the Low Level Waste Repository near Drigg by tumble-tipping into trenches. Vault disposal operations began in 1988 and subsequently high-force compaction was introduced in 1995. This is still the primary means to reduce LLW volumes prior to disposal. Following compaction, the resultant waste pucks are encapsulated in larger containers for disposal in near-surface engineered vaults. Waste that cannot be compacted, such as masonry and large items of equipment, are placed in large containers and encapsulated with a cementitious grout.

In recent years, the focus of waste management has evolved, with many waste producers pursuing improved application of the waste hierarchy in line with the Government Policy and the recently issued UK Nuclear Industry LLW Strategy. Waste producers are responsible for following requirements contained under the RSA93, now subsumed into the Environmental Permitting Regulations 2010, (EP 2010). A key provision of these regulations is for waste producers to use BAT, which constitutes BPEO and BPM to manage their radioactive waste. Appendix A provides an overview of all nuclear licensed sites current waste management strategies and their future plans.

4.6.1 Pre-treatment facilities

The majority of UK nuclear facilities have their own, small-scale facilities which provide varying degrees of scale and capability in waste segregation, size reduction, decontamination, and packaging activities depending on the site’s requirements. At some of the sites, there may be some spare operational capacity that could potentially be used for managing wastes from other sites, subject to planning and regulatory authorisation.

As sites move from operations into the decommissioning phases, many of these facilities will require modification or additional capacity to be provided in new facilities. Some sites, including Chapelcross and Hinkley Point A, have invested in dedicated waste sorting and packaging facilities which have allowed non-compactable wastes to be loaded more efficiently. Cutting devices are used to size reduce items and lay down areas are used to store items to allow more effective packing regimes to be devised. A number of other Magnox sites, who are in the earlier stages of decommissioning or are still operating, have plans for new waste management facilities of varying degrees of complexity, some with decontamination and size reduction facilities and others more simply for the more efficient packing of non-compactable waste into large containers.

Many LLW producers have small-scale shredding or baling equipment and low force compactors to reduce the volume of waste sent for onward processing and disposal. Additionally, sites have also invested in other pre-treatment equipment such as methods for scabbling concrete and decontaminating metal. Other examples include: high pressure water jetting; shot blasting; acid baths; and machining and grinding equipment. Many such facilities are commercially readily available.

4.6.2 Sorting and Segregation

Most sites have the ability to sort and segregate compactable from non-compactable wastes. A number of sites also segregate combustible waste, where they have access to an on-site or off-site incinerator. Sites use a range of characterisation, assay and measurement equipment, underpinned by various procedures, methodologies and IT data management systems. These infrastructures also support the segregation of wastes by activity and fissile content, as required by site and facility requirements.

As more treatment and disposal options are made available, it is expected that sites will improve the amount of segregation undertaken. Sellafield Ltd has a new £108m Sort and Segregation facility which is expected to be operational by 2018. This facility will provide a large-scale sort and segregate service to...
segregate wastes from decommissioning activities by type and activity, before sending the waste to alternative treatment and disposal routes.

4.6.3 High-Force Compaction Facilities

The LLW inventory contains a number of “operational” or “soft” wastes such as paper, plastics, clothing, and small items of metal that are suitable for compaction. This method of treatment has historically been the main volume reduction technology used for LLW in the UK for operational wastes. It should be noted that much of this waste may also be suitable for alternative processes such as incineration, and a recent strategic study has determined that the BPEO for combustible VLLW is incineration. As more sites move into the decommissioning phase, the nature of the waste arisings change towards increasing proportions of less compactable materials such as metal, rubble and soil as buildings and facilities are dismantled.

High Force Compaction (HFC) or “super-compaction” involves compressing metallic drums or boxes with a hydraulic ram using 500 metric tons or more compaction force. Achievable volume reduction efficiencies typically are in the range of 4:1 to 10:1 depending on the wastestream characteristics. The compaction process eliminates void spaces and also increases the mechanical strength of the final package for disposal. The resulting compressed ‘pucks’ are then placed into a larger container such as a HHISO for disposal.

Four super-compaction facilities are currently available in the UK. These include Waste Monitoring and Compaction Facility (WAMAC) at Sellafield and the Waste Receipt Assay Characterisation and Supercompaction facility (WRACS) at Dounreay. In addition, there are two mobile supercompaction services available via the supply chain operated by Inutec based at Winfrith and Studsvik UK based at Lillyhall in Cumbria.

All facilities can compact waste in 200L drums. In addition to drums, the WAMAC facility can receive loose compactable waste in skips from Sellafield plants and external consignors for loading into 1m³ boxes prior to compaction. The WAMAC, Inutec and Studsvik compactors are fully available to other waste producers on a commercial basis whilst the WRACS facility is used exclusively for Dounreay waste. In contrast to WAMAC and WRACS, the Inutec and Studsvik compactors are suitable for compaction of asbestos.

4.6.4 Metal Treatment Facilities

Metal arises at nuclear sites from the dismantling of buildings, equipment and other redundant assets. This metal is often treated on site by size reduction and decontamination techniques either to reduce the volume of waste for further treatment (cutting out hot spots), to alter the geometry to improve packing efficiency; or to reduce the levels of contamination for onward management. Many different techniques exist to support these activities, most of which have been adapted for use in the nuclear industry in order to improve the collection of secondary waste arisings and to reduce dose uptake to operators.

A number of NDA sites operate their own larger-scale decontamination facilities including a “Wheelabrator” facility at Sellafield and the Winfrith Abrasive Cleaning Machine (WACM) at Winfrith. These facilities process ferrous metals, which have relatively low levels of contamination and simple geometries, by grit-blasting the surface of the metal in order to reach exemption levels. The secondary wastes (primarily blasting residues) are then disposed of via the normal LLW route. Currently any material failing to meet the ‘exemption’ criteria after processing is sentenced as LLW to the LLWR.

A new commercial Metal Recycling Facility (MRF) has been constructed by Studsvik at Lillyhall in Cumbria and has been in operation for over a year. This facility utilises sorting and grit blasting techniques to achieve decontamination. It is worth noting that all sites within England and Wales now have access to the MRF as a result of a global variation to authorisations undertaken by the Environment Agency.

Metals that cannot easily be decontaminated by grit blasting alone can be recycled by melting. Metal melting is a well-proven mature technology that has been operated around the world for over 20 years. Metal is melted in an induction or electric-arc furnace where the majority of the radioisotopes concentrate into the floating slag layer which can subsequently be collected and returned to the customer for final disposal as LLW. The homogenised metal is then cast into an ingot which can be easily assayed, handled,
stored and recycled. Such material is appropriate for wider distribution, but is ideally suited to further use in the nuclear industry, as shielding or waste transport and disposal containers. The process of metal melting can allow up to 95% of the original material to be recycled.

Several commercial metal melting facilities are currently operated around the world. These include: Energy Solutions in the USA; Siempelkamp in Germany; Socodei in France, and Studsvik in Sweden. These facilities are all licensed to accept material from international consignors (including UK wastes) and their use is supported by UK Government Policy and the LLW Strategy. Other metal melting treatment facilities are also in operation in Russia; however these are largely limited to domestic wastes only and are not currently commercially available for use by UK waste consignors. A small-scale metal melting facility was operated at Capenhurst for a short period, but this has since been decommissioned. Consequently, there are no metal melting facilities in operation in the UK at present.

LLWR now offers metal treatment services through its consignor support organisation. The metallic waste treatment service was introduced in the Waste Service Contract on 1st April 2010. Several customers have now used this service to reduce waste disposal volumes at LLWR. Under the new framework agreements, LLWR Ltd now offers the following service providers and facilities for the treatment of metallic waste:

1. Energy Solutions, using the following treatment facilities:
   a. Bear Creek (Oak Ridge, Tennessee, USA);
   b. Inutec (Winfrith, UK);
   c. Siempelkamp GmbH (Krefeld, Germany)
2. Nuvia, using the treatment facility at Socodei (Centraco, France);
3. Studsvik using the following facilities:
   a. Metal Recycling Facility (Workington, UK);
   b. Studsvik AB (Nyköping, Sweden)

4.6.5 Incineration Facilities

Incineration is a widely used and well developed waste treatment technology used both internationally and within the UK for radioactive and non-radioactive wastes. Incineration reduces waste volumes by up to 98% by burning combustible solid and liquid wastes and breaking down the reactive compounds and organics to create a stable homogenous waste form for disposal.

Incineration is applicable to a broad range of dry solid wastes including paper and other cellulose-based compounds (cloth and other textiles), plastics, rubber, paper, cartridge filters and also liquid waste such as oils. Currently only a very small proportion of the potential combustible waste is actually planned to be incinerated under current site strategies.

A number of Magnox and EDF Energy nuclear power stations operate incineration facilities to treat their own waste and that of the adjacent power stations (where applicable) as shown in Table 9 below.
TABLE 9 – CURRENT AUTHORISED INCINERATORS ON NUCLEAR SITES

<table>
<thead>
<tr>
<th>NDA Sites</th>
<th>Non-NDA Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dungeness A</td>
<td>Hinkley Point B</td>
</tr>
<tr>
<td>Oldbury</td>
<td>Heysham</td>
</tr>
<tr>
<td>Sizewell A</td>
<td>Hartlepool</td>
</tr>
<tr>
<td>Wylfa</td>
<td>Sizewell B</td>
</tr>
</tbody>
</table>

The Capenhurst site also has an incinerator which is currently moth-balled. This facility could potentially process waste from other sites but would require significant investment to bring the facility up to modern emissions standards, and would require re-authorisation to become operational again.

Two commercially operated incinerators (Tradebe near Fawley and Grundons near Colnbrook) currently treat radioactive waste from a number of nuclear and non-nuclear industry sites. There are a number of incinerators across the UK authorised to burn small quantities of radioactive waste, arising primarily from hospitals and other small users. In addition to these, there are several commercial and municipal incinerators that could, subject to authorisation, be capable of processing combustible VLLW. However, such authorisations have thus far not been submitted and these assets are not considered further at this point.

It should be noted that there are significant differences between these different facilities with regard to the quantity, type of radioactivity and physical nature of waste (e.g. solids and/or liquids) that can be accepted. For example, most incinerators in the UK have very strict limits on activity (Tradebe and Grundons) and some prohibit any alpha emitting radionuclides.

LLWR Ltd has introduced a Combustible Waste Treatment Service in December 2010 as part of an amendment to the waste services contract. Under the new framework agreements, LLWR Ltd offers the following service providers and facilities for the treatment of combustible waste:

1. Abbott Nuclear Consulting, using the Tradebe facility (Fawley, UK);
2. Nuvia, using the facility at Socodei (Centraco, France);
3. Energy Solutions, using the following facilities:
   a. Bear Creek (Oak Ridge, Tennessee, USA);
   b. Belgoprocess (Mol-Dressel, Belgium);
   c. Inutec (Winfrith, UK);
   d. Grundon (Colnbrook, UK);
4. Studsvik using the following facilities:
   a. Studsvik AB (Nyköping, Sweden)
   b. Tradebe (Fawley, UK)

4.6.6 Other Treatment Facilities

Drying

Drying processes can be used to treat some LLW wastes that do not meet the LLWR conditions for acceptance due to their high liquid content. In the drying process low temperature heat (typically hot air or steam) is applied to evaporate water from aqueous or non-aqueous liquids, sludges and slurries to leave a dry residue that will typically contain the majority of the radioactivity. In the UK, Inutec operate a mobile drying plant for drummed liquid waste where drums are placed within a container unit and heated to drive off liquid.

NORM treatment and disposal

Historically, the majority of pipe-work and equipment contaminated with NORM from UK oil and gas operations has been decontaminated by Scotoil Services in Aberdeen using high-pressure water jetting to remove NORM. The decontaminated components are typically re-used in the oil and gas industries and the
remaining NORM waste is macerated and then discharged to sea. In 2006, the SEPA undertook a review to establish whether this practice still represented BPEO and was consistent with UK Government policy on minimising discharges of radioactive waste to the environment under the OSPAR convention (Convention for the Protection of the Marine Environment of the North-East Atlantic).

A recent Scottish Government ruling determined that the company must seek alternative treatment and disposal options for the majority of the solid NORM waste resulting from its operations. Subsequently, SITA acquired Stoneyhill Waste Management Ltd and are seeking authorisation from SEPA for disposal of NORM from the North Sea oil and gas industry.

4.6.7 LLW Repository

The majority of LLW generated in UK from both nuclear and non-nuclear industries is currently disposed at the LLWR near Drigg in Cumbria. LLW has been disposed at the LLWR since 1959. LLW may also be disposed to landfill sites or other engineered disposal facilities under ‘controlled burial’ arrangements. This is discussed further in Section 4.6.9 below.

Waste streams are accepted for disposal at the LLWR based on the availability of sufficient volumetric and radiological capacity. LLW arrives at the LLWR in containers of varying sizes, either following processing mainly in the WAMAC facility at Sellafield or directly from the consignors. Containerised wastes are then grouted and placed into the engineered concrete vaults.

The current operational vault at the LLWR, Vault 8, has almost reached capacity and a very small amount of authorised disposal capacity remains. Vault 9 has been constructed and is also operational but is currently authorised for storage of LLW only, pending the acceptance by the Environment Agency of the ESC, expected in 2011.

A further series of vaults were historically planned which would have provided an additional total capacity of 700,000m³ (i.e. in Vaults 9-14), subject to planning authorisation. It should be noted, however, that the current Lifetime Plan for LLWR (LTP10) includes provision for fewer vaults based on a reduction in volumes following rigorous implementation of the waste hierarchy in line with the current UK Government Policy and Strategy.

Once the existing LLWR is full a new facility would be required. The LLW strategy aims to extend the life of the existing site and thereby reduce or eliminate the need for a new LLWR facility. As part of the ESC programme, LLWR are considering a number of options to increase disposal capacity beyond vaults 9-14. This includes proposals for higher stacking of containers and the potential to reuse VLLW within the cap profiling material. These proposals will be progressed further during 2011-2013.
4.6.8 Onsite Disposal (OSD)

In addition to the national facility at LLWR, there have also been some limited historic disposals to pits and trenches on other UK nuclear sites such as Harwell, Dounreay, Springfields and Sellafield. Some of these facilities may require remediation prior to site closure potentially generating LLW, though the current intention on these sites is for final disposal.

Historically Sellafield have disposed of VLLW/HVLA excavated soil to the on-site South Landfill and Calder Landfill. Both facilities are now non-operational. The Calder Landfill Extension Segregated Area (CLESA) which has a capacity of 100,000m³ is currently being used for disposal of inert wastes from decommissioning and site clearance activities. Sellafields LTP10 included £56m for operations and maintenance of the CLESA and a further £4.5m for the construction of a second facility between 2026 and 2031. This facility would not however, be able to accommodate all of Sellafields waste.

Some nuclear licensed sites, such as Harwell and Dounreay have plans for VLLW/HVLA disposal facilities on their sites. A new facility on the Dounreay site, currently under construction, similar to that of the LLWR in Cumbria, is planned to dispose of all remaining LLW at Dounreay. The LTP10 for Dounreay has a budget of £104m identified for the construction and operation of their LLW management facility. RSRL has identified £12m for the construction of a facility for the management of HVLA at Harwell. This facility may also fulfil the requirements of the Winfrith site. This proposal is a contingent facility in case routes to the supply chain do not open up.

Other nuclear licensed sites are also investigating the potential to locate disposal facilities on their sites following appropriate optioneering studies. Magnox South carried out preliminary work to investigate the feasibility of OSD at Hinkley Point A. This proposal is currently on hold.

A summary of the status of OSD proposals within LTPs is shown in Table 10.
**TABLE 10— STATUS OF ONSITE DISPOSAL AT NDA SITES**

<table>
<thead>
<tr>
<th>SLC</th>
<th>Site</th>
<th>On-site Disposal Planned in Site Baseline?</th>
<th>Notes</th>
<th>Costs Allocated in LTP Baseline (£)</th>
<th>Waste Category</th>
<th>Operational dates for OSD facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Sites Restoration Ltd</td>
<td>Harwell</td>
<td>Yes</td>
<td>Baseline option in LTP although may be reconsidered if off-site routes open up</td>
<td>£12m</td>
<td>HVLA</td>
<td>2015-2063</td>
</tr>
<tr>
<td></td>
<td>Winfrith</td>
<td>No: Aim to avoid an on-site disposal route</td>
<td>Winfrith will only consider onsite disposal option for HVLA if offsite routes are not available via Harwell or elsewhere.</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Dounreay Site Restoration Ltd</td>
<td>Dounreay</td>
<td>Yes</td>
<td></td>
<td>£104m</td>
<td>LLW HVLA</td>
</tr>
<tr>
<td>Sellafield Ltd</td>
<td>Sellafield site</td>
<td>Yes: CLESA Operations and maintenance</td>
<td></td>
<td>£51.5m</td>
<td>LLW</td>
<td>2010-2119</td>
</tr>
<tr>
<td></td>
<td>CLESA 2 new construction</td>
<td></td>
<td></td>
<td>£4.5m</td>
<td>LLW</td>
<td>2026-2031</td>
</tr>
<tr>
<td></td>
<td>Windscale</td>
<td>Not specifically on the Windscale site.</td>
<td>Windscale VLLW will go to Sellafield on site landfill.</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Capenhurst site</td>
<td>No:</td>
<td>LLW disposals are planned to continue to Clifton Marsh; VLLW/HVLA disposals are to Clifton Marsh but alternative routes will be assessed when they become available.</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>LLWR Ltd.</td>
<td>LLW Repository</td>
<td>Yes</td>
<td>Considerable work undertaken on feasibility, design and preparation of planning application. Stakeholders have indicated that on-site disposal of VLLW would be acceptable, but that this would require further discussion and consultation.</td>
<td>£1,600m</td>
<td>LLW VLLW</td>
<td>2008-2070</td>
</tr>
<tr>
<td>Springfields Fuels Ltd</td>
<td>Springfields</td>
<td>No: Not currently in LTP</td>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>Project on hold</td>
</tr>
<tr>
<td></td>
<td>Dungeness A</td>
<td>No:</td>
<td>LTP assumes that LLWR will be available throughout the lifecycle and that the conditions for acceptance do not change.</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Magnox South Ltd</td>
<td>Magnox South Generic Issues</td>
<td>Decommissioning Strategy Organisation (DSO) considers OSD as a generic option in IWSs for sites in Magnox South (and North via DSO interface)</td>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>SLC</td>
<td>Site</td>
<td>On-site Disposal Planned in Site Baseline?</td>
<td>Notes</td>
<td>Costs Allocated in LTP Baseline (£)</td>
<td>Waste Category</td>
<td>Operational dates for OSD facilities</td>
</tr>
<tr>
<td>-----</td>
<td>------</td>
<td>------------------------------------------</td>
<td>-------</td>
<td>------------------------------------</td>
<td>----------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Bradwell</td>
<td>No:</td>
<td>LTP assumes that LLWR will be available throughout the lifecycle and that the conditions for acceptance do not change.</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Sizewell A</td>
<td>No:</td>
<td>Sizewell have a decision point on on-site disposal at the end of FY10/11 or start of FY 11/12</td>
<td>Not known</td>
<td>LLW</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Hinkley Point A</td>
<td>Partially: Preliminary work included Change control needed to fund full implementation. Project is listed in IWS as currently frozen</td>
<td>Magnox is investigating alternative routes for VLLW disposal (other than LLWR)</td>
<td>£0.15m</td>
<td>LLW</td>
<td>Project on hold</td>
</tr>
<tr>
<td></td>
<td>Berkeley</td>
<td>No:</td>
<td>It is assumed that LLWR will be available when LLW disposal activities are programmed.</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Magnox North Ltd</td>
<td>No: Considered as a baseline option with a view to securing LLW disposal routes in the longer term, assuming LLWR closure in 2050 approx. Considered in interface with Magnox South DSO only.</td>
<td>The sites will take advantage, where possible, of strategic initiatives looking at other LLW disposal options such as metal melting both in the UK and overseas and on-site disposal of LLW. A Magnox North BPED for VLLW was carried out in 2010 and this investigated the full range of disposal options available.</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Chapelcross</td>
<td>No: R&amp;D reference only in site delicensing topic: Considered in interface with Magnox South DSO only.</td>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Trawsfynydd</td>
<td>No: Research and Development (R&amp;D) reference only in site delicensing topic: Considered in interface with Magnox South DSO only.</td>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Wylfa</td>
<td>No: R&amp;D reference only in site delicensing topic: Considered in interface with Magnox South DSO only.</td>
<td>It is assumed that a national disposal site for LLW will remain available throughout the duration of site decommissioning. Any discontinuity in the availability of a disposal facility may result in a requirement for interim storage of waste, with associated increased costs.</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
As the Scottish Government are currently reviewing their waste management strategies, there is a threat the Scottish Government will change its waste management strategies and it will not possible to dispose of the LLW generated through the current offsite route. The waste would have to be stored on site until the waste management strategy had been finalised and a disposal route was available, with significant cost implications. Development and establishment of (HV) VLLW disposal route is underway.

Oldbury

No: Identified as a future option for the management of LLW.

Feasibility study to validate OSD of LLW. Assumed that borehole examinations for potential OSD for LQM purposes will be carried out concurrent with contaminated land management. Oldbury state the intention to temporarily "dispose" of solid (and liquid) LLW on site (LTP Summary)

<table>
<thead>
<tr>
<th>SLC</th>
<th>Site</th>
<th>On-site Disposal Planned in Site Baseline?</th>
<th>Notes</th>
<th>Costs Allocated in LTP Baseline (£)</th>
<th>Waste Category</th>
<th>Operational dates for OSD facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hunterston A</td>
<td>No: R&amp;D reference only in site delicensing topic: Considered in interface with Magnox South DSO only.</td>
<td>As the Scottish Government are currently reviewing their waste management strategies, there is a threat the Scottish Government will change its waste management strategies and it will not possible to dispose of the LLW generated through the current offsite route. The waste would have to be stored on site until the waste management strategy had been finalised and a disposal route was available, with significant cost implications. Development and establishment of (HV) VLLW disposal route is underway.</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Oldbury</td>
<td>No: Identified as a future option for the management of LLW.</td>
<td>Feasibility study to validate OSD of LLW. Assumed that borehole examinations for potential OSD for LQM purposes will be carried out concurrent with contaminated land management. Oldbury state the intention to temporarily &quot;dispose&quot; of solid (and liquid) LLW on site (LTP Summary)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Key:
- **OSD considered and costs identified in LTP**
- **OSD considered but costs not identified in LTP**
- **OSD not considered or retained as a contingency.**
4.6.9 Other Disposal Options

The 2007 Government Policy and the UK LLW Strategy recognise that previous policies were not designed with the large scale decommissioning of current nuclear facilities in mind. Consequently, the current Policy reflects the lower risks posed by wastes with such low levels of radioactivity as that in, for example, VLLW. Whereas historically most of this material would have been disposed to the LLWR, the Policy introduced a wider range of options for management and disposal of LLW and VLLW that could be considered including disposal to specified landfills.

At present, the most significant disposal site in the UK is the commercial landfill at Clifton Marsh operated by SITA. Springfields and Capenhurst currently have authorisations for disposal of LLW and VLLW to this facility. The site is expected to have a remaining operating life of around 10 years, but this is subject to successful reauthorisation. The facility also offers a specialist asbestos disposal service in purpose-built mono cells. There are other commercial landfills around the UK which currently receive small quantities of VLLW from the nuclear industry (e.g. from Devonport, Harwell and Winfrith) and from health care and other non-nuclear industries.

A number of commercial landfill operators are seeking authorisations under the Environmental Permitting Regulations 2010 for LLW and VLLW disposal ranging from expansion of existing sites to new dedicated facilities. Augean has applied for an authorisation to dispose of LLW at the existing Kings Cliffe landfill site in Northamptonshire. Similarly, Waste Recycling Group has applied for an authorisation to dispose of VLLW at the Lillyhall landfill site in Cumbria. SITA is applying for an authorisation to dispose of LLW to a new facility at Keekle Head in Cumbria. Decisions on environmental permitting and planning permission (where required) are expected during 2011 for these facilities. These proposals would collectively provide several times the capacity needed to accommodate LLW and VLLW arisings over the next 5 years[31].

4.6.10 Packaging

The LLWR WAC currently specifies a number of standard waste packaging requirements for disposal. Common containers used for LLW management include:

- Full height ISO containers – Transport of drummed waste to WAMAC
- Half height ISO containers – Disposal at LLWR
- Third height ISO containers – Disposal of dense material at LLWR
- Nominal 200 litre drums – Compaction or Direct disposal in HHISO
- Reusable IP2 0075 Skips – Transport to WAMAC for compaction
- 1m³ Box – Filled and Compacted at WAMAC

The main container currently used is the HHISO. THISO are also sometimes used to dispose of dense material. The design of the steel containers is based on ISO standards but includes a number of modifications to the top, base and side panels as shown in Figure 29. These modifications to the design were made to:

- Ensure good grout flow during filling
- Minimise voidage associated with the ISO container structure
- Enable the loads in a stack of ISO containers to be distributed through the waste form and container structure, rather than just through the container
- Provide a more uniform load distribution across the base in order to reduce point loads acting on the vault base slab
The licensing of these containers has recently been changed to enable three uses compared to the single use restrictions previously. A range of other transport packages such as re-useable IP 2 ISO 0075 Skips for loose waste, and IP2 Full-Height ISO Container (FHISO) containers for drummed waste are often used to transport waste to WAMAC for compaction.

The majority of the compactable LLW that arises from nuclear sites other than Sellafield is packed in to nominal 200 litre drums. The drums are mostly standard drum with no IP classification designed to the BS standards 15750-1 and 209:2000. There are some drums with IP classification used for transport when no overpack is used. These drums are then sent to WAMAC for compaction.

The 1m³ boxes are used for loose compactable waste originating at Sellafield or consigned in 0075 Skips for compaction of wastes. They are designed to optimise volume to weight ratios in half height ISO containers rather than in drums. The boxes also have the option of using anti springback plates. These are used when material with the potential of springback, such as plastics, are being compacted.

Figure 30 shows the schematic of the drum and box before and after compaction. Compacted pucks are loaded into HHISO containers for disposal.

HHISOs or THISOs are received at LLWR, grouted and placed in an engineered vault for storage. The use of HHISO containers as an IP2 transport and disposal container is relatively costly and inevitably introduces a significant amount of additional voidage that occupies valuable disposal space in the vault.

For example, the internal volume of a HHISO is 15.5m³; however this occupies around 19.5m³ of disposal space in the vault. Historically the packaging efficiency for HHISOs is less than 60%, although recently many consignors have shown significant improvements.

There are several other containers that are often used for the purpose of transporting radioactive materials. The majority of these are based on a 20-ft ISO container and are available in IP1, IP2, IP3 and Type A ratings depending on design and application. Some of theses containers are specially designed for different applications, for example, shipment of large bulky items or containers specially fitted with a rail system for loading pallets.

In addition to the packaging systems described above, LLWR Ltd have developed new packaging systems including bulk bags for the transport of VLLW and re-usable ISO containers for LLW, VLLW, metal waste for recycling and compactable wastes. The re-usable ISO containers developed by LLWR Ltd are modular and are capable of carrying several types of waste. Figure 31 below shows examples of the TC02 packaging system developed, and used for several waste shipments:
In addition to mounting individual items on the removable stillages, there is a range of alternative containers for LLW and VLLW, constructed of metals or plastics that can be transported using the TC02.

4.6.11 Transport

The movement of radioactive waste in the UK is governed by the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2007 (Statutory Instrument 1573)\(^\text{[14]}\) and regulated by the Department for Transport (DfT). These regulations have recently been introduced in the UK to provide a harmonised approach within the European Union (EU) for the safe transport of dangerous goods including radioactive materials.

The UK has an established road and rail infrastructure with annual road freight totalling 150 billion tonne kilometres and rail freight totalling 50 billion tonne kilometres. Moreover, half a million packages of radioactive material are shipped within the UK each year, with the nuclear industry making up only a small proportion of this total.

The LLWR has historically received between 500 and 700 HHISO containers per year in addition to occasional large items for disposal. Most of this waste (~75-80%) is delivered to LLWR by rail from Sellafield. This waste is typically generated at Sellafield or received at Sellafield by road for super-compaction at the WAMAC facility. This is an effective operation with scheduled rail moves accommodating multiple LLW containers per shipment.

In March 2010 LLWR published the draft report of its LLW Transport Hubs Assessment\(^\text{[15]}\), carried out by Entec. This study was undertaken as part of a series of initiatives set within the National LLW Management Plan. The scope of the LLW Transport Hubs Assessment was: to assess the feasibility of using transport hubs in support of multi-modal transport solutions, including available capacity and identification of strategic sites; and to identify measurable savings that can be achieved by using rail in preference to road transport.

The data collation and modelling undertaken in the study showed that national LLW and VLLW transport costs make up typically 5-10% of the total management and disposal cost. The study modelled the use of 12 potential strategic national rail hubs, and concluded that using rail compared to road could result in between 15 and 22% savings in total logistics costs, depending on the contractual model adopted and utilisation of capacity. Figure 32 below summarises the waste arriving at LLWR by road and rail between 2003 and 2009. The values given for 2010 are for the months of March through September.
Virtually all non-Sellafield LLW is transported from the producing site to either Sellafield or LLWR by road. It is estimated that currently around 20-25% of waste shipments are received at LLWR directly by road.

Consignors have historically organised their own transport using services provided by commercial carriers or other SLCs. There are currently only a small number of hauliers licensed to transport Class 7 Dangerous Goods (radioactive material) in the UK. Only two of the ten Magnox sites have facilities for loading or unloading containers directly from road vehicles. This means that the containers normally have to be collected and delivered on side-loading semi trailers. With one exception, all of the 7 EDF Energy and 11 Magnox stations have railheads within 2 km to 25 km of the site however these are principally used for transport of spent fuel only and not for LLW.

The key nuclear rail freight company is Direct Rail Services (DRS) (now owned by NDA) which was established in 1995 to provide BNFL with a strategic rail transport service. Its main focus was handling the specialist transportation of spent nuclear fuel from the UK’s nuclear power stations to the Sellafield reprocessing facility in Cumbria, but it now offers a range of commercial services and is currently the only organisation involved with LLW rail transport. DRS have operating depots at Carlisle, Crewe, Sellafield, in Scotland and in the South-East of England.

It is recognised that transport of waste and bulk materials to LLWR is a significant stakeholder issue, particularly for residents of the surrounding communities. However with the exception of local stakeholder issues at certain sensitive sites, the transportation of LLW is not considered to be a major impact on the UK’s transport infrastructure when considered in the context of other transport activities. It is however noted that the quantity of material to be transported will increase over the next few years as a result of NDA’s decommissioning activities.

Notwithstanding this, the recent completion of Vault 9 demonstrated that a much improved transport approach could be adopted. The transport management plan maximised the use of rail transport and temporary storage at the Port of Workington and a new temporary siding at Millom. 144 trains were used to transport over 90% of the construction materials to the site. This avoided over 15,000 road journeys passing through the Drigg village. This development set the standard for future operations at the site, both for construction activities and waste management operations.
4.6.12 Infrastructure Summary

The UK nuclear industry LLW producers have access to a wide range of treatment and disposal assets. Historically the main volume reduction technology has been supercompaction and some use of incineration. With the changing nature of wastes from decommissioning, many sites are increasingly evaluating the use of more effective volume reduction technologies including incineration, metal decontamination and melting. The LLWR in Cumbria is the main disposal facility for LLW in the UK and is available to most LLW producers with the exception of Dounreay which has plans for its own facilities.

Table 10 below summarises the key infrastructure for management of the UK’s LLW and VLLW, highlighting both commercial facilities that are able to manage waste from many sites and those facilities currently for their own on-site use only. Figure 33 shows the geographical distribution of these assets that currently have authorisations.
<table>
<thead>
<tr>
<th>Organisation</th>
<th>Location</th>
<th>LLW Disposal</th>
<th>VLLW Disposal</th>
<th>Super-</th>
<th>Incinerat</th>
<th>Metal Treatment</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDF Energy</td>
<td>Hartlepool</td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EDF Energy</td>
<td>Heysham 1&amp;2</td>
<td></td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>EDF Energy</td>
<td>Sizewell B</td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EDF Energy</td>
<td>Hinkley Point B</td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnox North</td>
<td>Wylfa</td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnox North</td>
<td>Oldbury</td>
<td>Δ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnox South</td>
<td>Sizewell A</td>
<td>Δ</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Magnox South</td>
<td>Dungeness A</td>
<td>Δ</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Research Sites</td>
<td>Winfrith</td>
<td>Δ</td>
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</tr>
<tr>
<td>Sellafield</td>
<td>Sellafield</td>
<td>Δ</td>
<td>▲</td>
<td>▲</td>
<td>Δ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DSRL</td>
<td>Dounreay</td>
<td>Δ</td>
<td>Δ</td>
<td>Δ</td>
<td>Δ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLWR</td>
<td>LLWR, Cumbria</td>
<td>▲</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Inutec</td>
<td>Winfrith</td>
<td>▲</td>
<td></td>
<td></td>
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<tr>
<td>Studsvik</td>
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<td>Tradebe</td>
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<tr>
<td>Grundons</td>
<td>Colnbrook</td>
<td>▲</td>
<td></td>
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<tr>
<td>SITA</td>
<td>Clifton Marsh</td>
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<tr>
<td>SITA</td>
<td>Stonyhill</td>
<td></td>
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<tr>
<td>Augean</td>
<td>Kings Cliffe</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>WRG</td>
<td>Lillyhall</td>
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<td></td>
<td></td>
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<tr>
<td>Scotoil</td>
<td>Aberdeen</td>
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<td></td>
<td></td>
<td>▲</td>
</tr>
<tr>
<td>Studsvik</td>
<td>Sweden</td>
<td>▲</td>
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<td></td>
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<td>Siempelkamp</td>
<td>Germany</td>
<td></td>
<td></td>
<td>▲</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Socodei</td>
<td>France</td>
<td>▲</td>
<td></td>
<td></td>
<td></td>
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<td>▲</td>
</tr>
<tr>
<td>EnergySolutions</td>
<td>USA</td>
<td>▲</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>▲</td>
</tr>
</tbody>
</table>

▲ Commercial facilities available to all producers
△ Facilities for on-site waste only
◊ Potential facilities - subject to authorisation or planning permission
FIGURE 33 – CURRENT AUTHOURISED WASTE MANAGEMENT ASSETS AND INFRASTRUCTURE
5 Synergies and Opportunities

5.1 UK Nuclear Industry LLW Management Plan

As discussed in Section 2.3, the LLW Management Plan\[^3\] includes detail on 60 initiatives necessary to implement the significant opportunities presented by the UK Nuclear Industry LLW Strategy. These initiatives can be mapped according to the NDA’s strategic objectives for LLW as shown in Figure 34 below.

**Figure 34 – Mapping of NDA Strategic Objectives and LLW Management Plan Initiatives**
The management plan provides further detail on the scope, schedule and approach to delivering each initiative. Collectively these initiatives are expected to provide greater alignment of site strategies with the UK LLW Strategy and, either directly or indirectly, will lead to a significant reduction in the cost baseline.

5.2 ACCELS NP Opportunities

5.2.1 NP Opportunity Identification

The ACCELS programme, described in Section 2.4, identified a number of opportunities to reduce the NP between December 2009 and March 2010. The primary driver for this programme is NDA’s requirement to demonstrate to government that implementation of the UK Nuclear Industry LLW Strategy provides an effective, value for money approach to management of the nation’s LLW. This is extremely challenging since there is currently misalignment between the cost basis of many SLC plans and strategies; the SLC plans and IWS’s often reflecting a non-optimised approach to LLW management. Initial opportunities within the baseline were identified based on three discrete themes:

1. Opportunities to improve inventory and forecasting assumptions
2. Opportunities to use consistent waste routing assumptions and cost estimates
3. Improved efficiency and targeted reductions in capital spend, including:
   • Efficient use of on-site resources, best practices, and fit-for-purpose facilities
   • Evaluating use of supply-chain off-site treatment and disposal routes (make vs. buy)
   • Strategic estate-wide approaches to maximise economies of scale

For Magnox, Springfields, Research Sites, and Dounreay, the LTP08 Rev D (March 2009) baseline was used as a basis to identify opportunities for further study. For Sellafield, opportunities have been evaluated against the LTP10 contract baseline. The new LTP10 contract baseline is fully underpinned but ‘non-aspirational’ in nature, with the exception of a few LLW opportunities that have already been incorporated into the LTP10 contract baseline (e.g. removal of soil treatment plant and substitution of new waste treatment facilities for supply chain costs post-2020). This is shown as part of the analysis of significant changes in Section 4.5.4. It is currently envisaged that the other opportunities will be incorporated into Sellafield’s LTP10 Execution/Performance Plan, where appropriate, which aims to improve the cost-effectiveness of the original contract baseline.

LLWR has worked with each SLC to gather the required underpinning data and review the opportunities. IPT reviews, comprising of LLWR, NDA, and SLC managers, have been formed to review the Sellafield and Magnox opportunities and develop the forward plan for implementation. The process for evaluation of opportunities adopted is consistent with the approach in NDA’s Programme Control Procedure (PCP) 16 – Opportunity Management. The opportunities identified to date are summarised in Table 11 below.
<table>
<thead>
<tr>
<th>Ref.</th>
<th>SLC</th>
<th>Facility</th>
<th>Opportunity</th>
<th>Delivery mechanism</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL1</td>
<td>Sellafield</td>
<td>Soil Decontamination Plant</td>
<td>Re-allocate facility to Land Quality Programme budget or eliminate project</td>
<td>Scope of this OU (previously soil decontamination and disposal of contaminated land at Sellafield in vaults) is currently under review. It is now planned that the land will be largely managed in-situ.</td>
<td>Complete</td>
</tr>
<tr>
<td>SL2</td>
<td>Sellafield</td>
<td>Calder Hall Waste Management</td>
<td>Re-allocate facility to Decommissioning Programme budget</td>
<td>Scope of this OU overlaps with other waste types and decommissioning activities</td>
<td>Complete</td>
</tr>
<tr>
<td>SL3</td>
<td>Sellafield</td>
<td>Clearance &amp; Characterisation</td>
<td>Re-allocate facility to Decommissioning Programme budget</td>
<td>Scope of this OU overlaps with other waste types and decommissioning activities</td>
<td>Complete</td>
</tr>
<tr>
<td>SL4</td>
<td>Sellafield</td>
<td>LLW Metals Melt &amp; Smelt Facility</td>
<td>Use supply chain for metal recycling</td>
<td>Shift to supply chain provision of metal recycling services</td>
<td>Complete</td>
</tr>
<tr>
<td>SL5</td>
<td>Sellafield</td>
<td>LLW Thermal Destruction Facility</td>
<td>Use supply chain for thermal treatment</td>
<td>Shift to supply chain provision of thermal treatment services</td>
<td>Complete</td>
</tr>
<tr>
<td>SL6</td>
<td>Sellafield</td>
<td>Waste Monitoring &amp; Compaction Plant</td>
<td>Modify pricing norms to more closely reflect LLWR market experience</td>
<td>LLWR to provide pricing norms for treatment and disposal to Sellafield based on new market knowledge</td>
<td>Complete</td>
</tr>
<tr>
<td>SL7</td>
<td>Sellafield</td>
<td>Waste Monitoring &amp; Compaction Plant</td>
<td>Challenge baseline assumptions for volume reduction</td>
<td>LLWR to provide data to Sellafield based on experience and market knowledge</td>
<td>Complete</td>
</tr>
<tr>
<td>SL8</td>
<td>Sellafield</td>
<td>Waste Monitoring &amp; Compaction Plant</td>
<td>Challenge VLLW and Exempt quantities in baseline</td>
<td>Evaluate the current inventory estimate of “Potentially exempt LLW/VLLW” for the most cost effective disposal route.</td>
<td>Complete</td>
</tr>
<tr>
<td>SL9</td>
<td>Sellafield</td>
<td></td>
<td>Share inventory best practice</td>
<td>Share best practice from Sellafield decommissioning mandates and Magnox SMART inventory process</td>
<td>Complete</td>
</tr>
<tr>
<td>SL10</td>
<td>Sellafield</td>
<td></td>
<td>Use re-usable HHISOs</td>
<td>Use the forthcoming LLWR re-usable HHISOs for treatment</td>
<td>Ongoing</td>
</tr>
<tr>
<td>SL11</td>
<td>Sellafield</td>
<td></td>
<td>Alternative Plans for WAMAC</td>
<td>Switch to thermal treatment/supply chain compaction earlier than 2020</td>
<td>Trial of combustible service during Financial Year (FY) 11/12</td>
</tr>
<tr>
<td>SL12</td>
<td>Sellafield</td>
<td>Waste Monitoring &amp; Compaction Plant</td>
<td></td>
<td>Expand use of WAMAC for sort/seg and size reduction</td>
<td>Planned for FY 11/12</td>
</tr>
<tr>
<td>SL13</td>
<td>Sellafield</td>
<td>Alternative Plans for WAMAC</td>
<td></td>
<td>Eliminate Level 2 monitoring regime</td>
<td>Planned for FY 11/12</td>
</tr>
<tr>
<td>SL14</td>
<td>Sellafield</td>
<td></td>
<td></td>
<td>Evaluate use of WAMAC for lower-end ILW compaction</td>
<td>Planned for FY 11/12</td>
</tr>
<tr>
<td>SL15</td>
<td>Sellafield</td>
<td></td>
<td></td>
<td>Evaluate use of WAMAC for PCM crate breakdown</td>
<td>On hold</td>
</tr>
<tr>
<td>SL16</td>
<td>Sellafield</td>
<td></td>
<td></td>
<td>Delay decommissioning for WAMAC</td>
<td>Dependent on the above opportunities</td>
</tr>
<tr>
<td>SL17</td>
<td>Sellafield</td>
<td>92700 Metals Recycling</td>
<td>Alternative Plans for Sellafield MRF</td>
<td>Process Separation Area metal within B927 - eliminate Separation Area wheelabrator</td>
<td>Complete</td>
</tr>
<tr>
<td>SL18</td>
<td>Sellafield</td>
<td></td>
<td></td>
<td>Shift to supply chain provision of metal recycling services</td>
<td>Ongoing – Future Decision point on B927 operation in 2013</td>
</tr>
<tr>
<td>SL19</td>
<td>Sellafield</td>
<td>LLW Sort Segregate &amp; Size Reduction Facility</td>
<td>Alternative Approach to Sort, Segregation and Size Reduction</td>
<td>Evaluate options for sorting and size reduction (e.g. use of WAMAC, MRF, temporary buildings, etc)</td>
<td>Planned for FY 11/12</td>
</tr>
<tr>
<td>Ref.</td>
<td>SLC</td>
<td>Facility</td>
<td>Opportunity</td>
<td>Delivery mechanism</td>
<td>Status</td>
</tr>
<tr>
<td>------</td>
<td>-----</td>
<td>----------</td>
<td>-------------</td>
<td>--------------------</td>
<td>--------</td>
</tr>
<tr>
<td>SL20</td>
<td></td>
<td>Sellafield</td>
<td>Integrate requirements with decommissioning projects</td>
<td>Ensure all needs, including ILW are met or coordinated</td>
<td>Planned for FY 11/12</td>
</tr>
<tr>
<td>SL21</td>
<td>SLC</td>
<td>Building 259 Decontamination</td>
<td>Evaluate expanding existing capability and capacity</td>
<td>Evaluate use of B259 to provide more aggressive decontamination approach for ILW to LLW</td>
<td>Unlikely to be technically feasible</td>
</tr>
<tr>
<td>SL22</td>
<td>Sellafield</td>
<td>LLW Transport</td>
<td>Use Sellafield as road/rail hub</td>
<td>Expand use of Sellafield south yard for rail shipments to LLWR</td>
<td>LLWR transport procurement</td>
</tr>
<tr>
<td>SL23</td>
<td>Sellafield</td>
<td>LLW Transport</td>
<td>Utilise LLWR transport services</td>
<td>Utilise LLWR transport services for off-site treatment and disposal shipments</td>
<td>Trial planned for FY 11/12</td>
</tr>
<tr>
<td>SL24</td>
<td>Sellafield</td>
<td>LLW Packaging</td>
<td>Deliver optimal UK transport model</td>
<td>Implement results of LLWR integrated transport study using existing Sellafield resources</td>
<td>Ongoing</td>
</tr>
<tr>
<td>SL25</td>
<td>Sellafield</td>
<td>LLW Packaging</td>
<td>Expanded use of reusable 0075 ISO containers</td>
<td>Expand use of 0075s for compactable waste to WAMAC and for LLWR combustible waste services</td>
<td>In progress</td>
</tr>
<tr>
<td>SL26</td>
<td>Sellafield</td>
<td>LLW Packaging</td>
<td>Utilise LLWR packaging services</td>
<td>Evaluate impact of LLWR service on SLC resource requirements</td>
<td>In progress</td>
</tr>
<tr>
<td>SL27</td>
<td>Sellafield</td>
<td>Waste OU Resources</td>
<td>Integration of Sellafield and LLWR resources</td>
<td>Integration of existing LLWR consignor support resources and staffing of new Sellafield waste OU</td>
<td>To be considered further during FY 11/12</td>
</tr>
<tr>
<td>SL28</td>
<td>Sellafield</td>
<td>Waste OU Resources</td>
<td>Combining Sellafield and LLWR resources</td>
<td>Offer combined LLWR/ Sellafield resources as part of service offering</td>
<td>To be considered further during FY 11/12</td>
</tr>
<tr>
<td>SL29</td>
<td>Sellafield</td>
<td>Waste Tracking</td>
<td>Improve waste tracking process</td>
<td>Combine LLWR and Sellafield requirements and resources for procurement of waste tracking system</td>
<td>To be considered further during FY 11/12</td>
</tr>
<tr>
<td>DR1</td>
<td>DSRL</td>
<td>New LLW Facilities</td>
<td>Implement waste hierarchy</td>
<td>Reduce volumes requiring disposal within the new on-site LLW disposal facility</td>
<td>Planned for FY 11/12</td>
</tr>
<tr>
<td>DR2</td>
<td>DSRL</td>
<td>LLW Packaging</td>
<td>Utilise cheaper disposal containers/liners</td>
<td>Utilise new disposal liner developed by LLWR for onsite disposal at Dounreay</td>
<td>Planned for FY 11/12</td>
</tr>
<tr>
<td>RS1</td>
<td>RSRL</td>
<td>HVLA Waste Disposal Facility</td>
<td>Use supply chain for HVLA/VLLW disposal</td>
<td>Use supply chain provision of HVLA/VLLW disposal services</td>
<td>Planned for FY 11/12</td>
</tr>
<tr>
<td>RS2</td>
<td>RSRL</td>
<td>Solid Waste Operations</td>
<td>Use supply chain for metal recycling</td>
<td>Shift to supply chain provision of metal recycling services</td>
<td>Planned for FY 11/12</td>
</tr>
<tr>
<td>MX1</td>
<td>Magnox</td>
<td>FSC</td>
<td>Revise assumptions on VLLW and Exempt quantities</td>
<td>Expand Magnox Smart Inventory project or extrapolate results to FSC</td>
<td>To be considered further during FY 11/12</td>
</tr>
<tr>
<td>MX2</td>
<td>Magnox</td>
<td>FSC LLW Management Facility</td>
<td>Construction of fit-for-purpose facilities</td>
<td>Investigate current scope and estimate. Evaluate potential to use temporary facilities (e.g. Rubb tents) instead of fixed facilities</td>
<td>To be considered further during FY 11/12</td>
</tr>
<tr>
<td>MX3</td>
<td>Magnox</td>
<td>C&amp;M Preps LLW Management Facility Construction</td>
<td>Construction of fit-for-purpose facilities</td>
<td>Investigate current scope and estimate. Evaluate potential to use temporary facilities (e.g. Rubb tents) instead of fixed facilities</td>
<td>To be considered further during FY 11/12</td>
</tr>
<tr>
<td>MX4</td>
<td>Magnox</td>
<td>C&amp;M Preps LLW Management</td>
<td>Revise assumptions on VLLW and Exempt quantities</td>
<td>Finalise Magnox Smart Inventory project</td>
<td>Inventory Review Complete. Change control of cost savings due in June 2011</td>
</tr>
<tr>
<td>MX5</td>
<td></td>
<td></td>
<td>Maxime use of off-site routes: Metal Incineration Compaction VLLW</td>
<td>Focus on accelerating use of off-site routes</td>
<td>Ongoing</td>
</tr>
</tbody>
</table>
Sellafied Phase 1 Summary

Of the 29 initiatives identified, six were completed by March 2010 and were incorporated into the LTP10 baseline. As a result of the initiatives, several components of the original LLW NP have already been removed from LTP10 or re-allocated from the LLW programme to other directorates (e.g. decommissioning). This includes the scope associated with construction and operation of new smelting and incineration facilities in 2020 and the Soil Decontamination Plant. Collectively this has removed around £3.9Bn from the 2010 LLW estimate. The corresponding costs for use of the supply chain for treatment are now included in the off-site disposal budget post-2020 which has lead to an increase in this element.

As discussed in Section 4.5.4 the net result of these changes are a reduction of £1.8Bn. It should be noted that the LTP10 values are currently ‘provisional values’ and may be subject to change during the Sellafield LTP10 approval process. The final approved LTP10 will form the basis of any subsequent NP savings from ACCELS initiatives.

A path forward for each remaining initiative was agreed between the parties to further evaluate and quantify the potential benefits. The status of these actions is reported to NDA on a monthly basis.

Magnox Phase 1 Summary

For Magnox, nine initiatives have been identified and reviewed. These include opportunities for both C&M Preps and FSC phases based on the outcome of current ongoing work programmes such as the SMART inventory and accelerated decommissioning.

Several opportunities relate to the revision of key underpinning waste volume, cost, and routing assumptions to remove some of the conservatism from the current plans. Others relate to more effective use of waste management resources and use of fit-for-purpose facilities. As a result of improved understanding of the underpinning ‘Basis of Estimates’ for FSC, the construction costs for new LLW and ILW management facilities can now be separated out for NP purposes within the LTP10 baseline.

A path forward for each remaining initiative was agreed between the parties to further evaluate and quantify the potential benefits.

Dounreay and Research Sites Summary

Both Dounreay and the Research sites are relatively well advanced in implementing the waste hierarchy concepts into their LTPs. The current plans therefore already reflect this development of diverse, cost-effective waste management routes. Two opportunities have been identified for RSRL, and one for Dounreay, around further use of the supply chain to implement the hierarchy. In both cases this could reduce or eliminate the capital costs of constructing onsite disposal capacity. An additional opportunity has been added for Dounreay associated with use of LLWR’s disposal liners. A path forward for each initiative was agreed between the parties to further evaluate the potential benefits.
5.3 ACCELS Phase 2

The ultimate goal of the programme is to see opportunities formally reflected within modified LTP’s. However, NDA can consider whether sufficient confidence exists in the validity of an opportunity to make an adjustment to the annual LLW NP ARAC estimate in advance of any formal change to the SLC baselines. This may be advantageous as it often takes significant time to translate such opportunities into baseline scope within an LTP via the formal change-control or contract re-baselining processes.

A forward path for each of the 42 opportunities was defined at a high level and an owner assigned from the respective SLC(s) involved in delivery. The timeline for SLC completion of Phase 2 was as follows:

1. Evaluation of underpinning waste estimates and potential sub-categorisation into LLW, VLLW and exempt fractions by 30th November 2010.
2. Evaluation of cost assumptions and opportunities compared to current baseline by 31st January 2011
3. Incorporation into NDA ARAC process by 31st March 2011

Going forward, opportunities that have not been completed as part of the ACCELS project will be combined with the initiatives from the LLW management plan to be progressed as a National LLW Programme. The National LLW Programme will allow the NDA to further develop the management of LLW in the UK and will align all the opportunities into a series of work streams.

5.4 Anticipated Impact of ACCELS Phase 2 – Inventory

Phase 2 of the ACCELS programme involved the implementation of opportunities identified during phase 1 and the formal revision of site plans to reflect the integration and savings in LLW management. These opportunities will also be incorporated into the NDA’s ARAC.

Several of the opportunities identified in Table 11 were combined into 2 projects, one delivered by Sellafield and one by Magnox, to enable the benefits to be realised. These projects sought to re-evaluate the underpinning waste estimates and activities to produce a more accurate picture of the expected waste volumes and costs. Summaries of the projects are given below along with anticipated cost and inventory impacts.

5.4.1 Evaluation of Magnox Ltd Phase 2 Opportunities

Magnox Ltd (formerly Magnox North and Magnox South) assembled a small project team including representatives of the LLWR to conduct a review of the volumes of LLW to be disposed of across the Magnox sites as part of the Parent Body Organisation’s (PBO) “Taking Magnox Forward” business improvement plan and in response to the ACCELS programme of work.

The aim of the review was to obtain an improved understanding of the types and quantities of LLW expected to arise at sites from on-going operations and during the Care and Maintenance Preparations (C&MP) phase of decommissioning which typically ends around 2030 for the Magnox fleet. Types of information gathering exercises included plant walk downs, to identify materials and volumes as well as desk studies to assess radiological contamination, plant drawings and size correction factors.

The review included the identification of a number of LLW opportunities such as the disposal of certain wastes as VLLW or via controlled burial for future consideration should the routes become commercially available. Where appropriate, these opportunities will be developed through the Magnox opportunities management process and, in conjunction with NDA and LLWR, delivered through the site decommissioning programmes.

The output of the inventory review is the production of a new, improved dataset, named the “SMART Inventory”[28]. This provides an item-by-item inventory assessment approach with the identification of opportunities for diversion of LLW from the LLWR.
Across the 10 Magnox sites, the SMART Inventory programme has lead to a significant improvement in the understanding of LLW volumes at sites and helps NDA’s LLW NP to be accurately re-assessed and better underpinned.

The impact of these volume reductions on the cumulative raw arisings of UK LLW and VLLW until 2030 is described in Figure 35 below based on the reported volume savings from the SMART inventory review \cite{28}. This saving has been assumed to be constant across the Magnox C&MP phase for the purposes of this report (i.e. an annual ~45% decrease on each waste stream during C&MP). This dataset is considered the most likely representation of future arisings although it is recognised that there may be further scope to reduce volumes through improved characterisation, segregation, and treatment prior to disposal.

**FIGURE 35 – SMART INVENTORY IMPACT ON THE CUMULATIVE RAW ARISINGS OF UK LLW AND VLLW (2010-2030)**

This graph shows that a significant quantity (49,000m$^3$) of Magnox’s LLW in the UKRWI 2010 is likely to be either VLLW or exempt. In order to put the SMART inventory volumes into context, Figure 35 only shows projected UK LLW and VLLW arisings until 2030. However, the overall impact of SMART inventory on the cumulative raw arisings of UK LLW and VLLW over 10 years is described further in Figure 36 and Table 12 below:
FIGURE 36 – SMART INVENTORY IMPACT ON THE CUMULATIVE RAW ARISINGS OF UK LLW AND VLLW (2010-2120)

TABLE 12 – SMART INVENTORY IMPACT ON THE CUMULATIVE RAW ARISINGS OF UK LLW AND VLLW (2010-2120)

<table>
<thead>
<tr>
<th>Source</th>
<th>Total Raw LLW Volume</th>
<th>Total Raw VLLW Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>UKRWI 2010</td>
<td>1,092,110m$^3$</td>
<td>3,335,476m$^3$</td>
</tr>
<tr>
<td>UKRWI 2010 Including SMART Inventory Reduced Volumes</td>
<td>1,043,110m$^3$</td>
<td>3,322,520m$^3$</td>
</tr>
<tr>
<td>- 49,000m$^3$</td>
<td>-12,956m$^3$</td>
<td></td>
</tr>
</tbody>
</table>

Whilst the volume reductions appear relatively small when compared to the total cumulative raw arisings of UK LLW and VLLW, there is significant scope for further reductions by applying the same methodology to all waste generated by the Magnox fleet up until the end of FSC, when the largest volumes of waste are due to be generated.

Magnox currently have a programme of work to re-estimate the cost of these reductions during 2011 and incorporate the savings in to their LTP.
5.4.2 Evaluation of Sellafield Ltd Phase 2 Opportunities

Sellafield Ltd and LLWR have been working together on a series of tasks aimed at evaluating identified opportunities and developing alternative cost-effective approaches to LLW management. One task undertaken has been to jointly review the Sellafield Ltd waste inventory estimates, assess the degree of uncertainty associated with the estimates and refine them where possible.[29]

Sellafield Ltd undertook work on three aspects of the future inventory: Potential re-categorisation of PCM as LLW, potential exemption of HVVLLW from broad front decommissioning and the potential impact of proposed changes to UK exemption criteria.

In regards to the potential re-categorisation of PCM as LLW, Sellafield Ltd concluded that up to 10% of the current PCM 200 litre drum stocks could be potential candidates, equating to a minimum of 500m³. However, should the commissioning of new instrumentation prove successful this may enable greater than 10%. According to their baseline schedule, Sellafield Ltd forecast that transfer of this waste to LLWR would commence in 2017, with the assumption that transfers would occur linearly over the period 2017 – 2025 at a rate of about 55m³ per year.

In regards to the potential exemption of HVVLLW from broad front decommissioning, Sellafield Ltd carried out a detailed review of the waste generated from decommissioning as part of its decommissioning mandate process. Waste stream 2D148 is the largest wastestream in the UKRWI 2010 representing 3.3 million m³ (75%) of the overall waste. This stream captures all site decommissioning activities associated with HVVLLW and potentially exemptible wastes. This waste stream is made up of estimates from Preliminary Decommissioning Plans (PDP) of the 27 major facilities on the Sellafield site. The 27 facilities represent roughly 75% of the cost and hazard associated with the site and roughly 45% of the 2D148 waste stream. The PDP's have been generated through detailed assessment of the primary waste within the buildings as well as secondary waste generated during decommissioning. This was completed using similar methods to the Magnox SMART inventory process (i.e. desk studies, site walk-overs etc…).

The remaining facilities were assessed using a three stage process. The first stage was the re-assessment of the original waste evaluation which predated the Sellafield Ltd 2007 LTP. The second stage involved an uncertainty assessment using a ‘Monte Carlo’ type probability evaluation. The final stage involved converting the estimate using the updated assumptions from the site decommissioning strategy and the revised PDP’s which were proposed for the 2010 LTP. Sellafield Ltd concluded that

“Based on current decommissioning experiences it is considered realistic that 70% of the waste in wastestream 2D148 could be considered very likely to be exempt material”[29].

However, they also noted that there are large uncertainties associated with potentially exempt waste.

In terms of the potential impact of proposed changes to UK exemption criteria, Sellafield Ltd highlighted that there will be some benefits should the UK exemption criteria proposals come into force. At this stage however, they were unable to quantify their overall position without carrying out a comprehensive review on a wastestream by wastestream basis.

Sellafield Ltd did however conclude that when examining wastestream 2D148 in light of the new exemption criteria proposals, the results were consistent with their earlier conclusions that 70% of this wastestream should be considered very likely to be justified as exempt waste.

Figure 37 demonstrates the impact of reducing wastestream 2D148 by the proposed 70% in terms of the UKRWI 2010.
5.4.3 Combined impact of Magnox and Sellafield Ltd on 2010 UK Radioactive Waste Inventory

The anticipated impact of both the Magnox and Sellafield Ltd opportunities are shown in Figure 38 in terms of the effect on cumulative raw arisings of LLW and VLLW between 2010 and 2120. The figure shows a revised total raw volume of around 2.3 million m$^3$ of LLW and VLLW. This demonstrates an overall reduction of around 2.1 million m$^3$ of LLW and VLLW when compared to the total of 4.4 million m$^3$ declared in the 2010 UKRWI.
In terms of how the remaining 2.3 million m$^3$ of LLW and VLLW is apportioned, Figure 39 shows the collective raw volume and percentage share of UK LLW and VLLW by waste producer:

**FIGURE 39 – RAW WASTE ARISINGS OF ACCELS LLW AND VLLW BY WASTE PRODUCER (m$^3$)**

The individual raw volumes and percentage share of both ACCELS LLW and VLLW by waste producer is described in Figures 40 and 41 below:
**FIGURE 41 – RAW WASTE ARISINGS OF ACCELS UK VLLW BY WASTE PRODUCER (m³)**

- **Sellafield Ltd**, 924,243, 70%
- **Westinghouse**, 238,575, 18%
- **GE Healthcare Ltd**, 7,300, 1%
- **Magnox South**, 4,682, 0%
- **Magnox North**, 20,444, 2%
- **RSRL**, 82,938, 6%
- **Ministry of Defence**, 21,362, 2%
- **URENCO**, 2,686, 0%
- **DSRL**, 35,351, 1%
- **Total** = 1,317,580 m³

Figure 42 shows how the ACCELS LLW and VLLW volumes compare against previous inventories including the 2010 UKRWI.

**FIGURE 42 – OVERVIEW OF RADIOACTIVE WASTE INVENTORIES INCLUDING ACCELS REDUCTIONS**

This chart shows that a large fraction of the UKRWI 2010 is likely to be exempt with a corresponding reduction in VLLW and LLW volumes.
5.5 Anticipated Impact of ACCELS Phase 2 - Cost

Following this re-assessment of the SLC inventories, the cost implications have also been assessed. Magnox are currently in the process of generating an anticipated saving from the SMART inventory review. This will be included within future Magnox LTP baselines and the next strategic review. As part of the SMART inventory process, Magnox highlighted several additional areas for improvement that could show further cost reductions. These will be considered further as part of the National LLW Programme.

5.5.1 Evaluation of Sellafield Ltd Opportunities - Cost

The revised Sellafield waste profile as described in section 5.4.3 has been reviewed further as follows in order to refine the cost re-estimating process:

- Reduction of the revised profile to accommodate known conservatisms and improvements in Sellafield LLW management practices from operational plants. An average 30% reduction factor has been applied. A reduction has not been applied beyond 2025 as the vast majority of subsequent arisings will derive from decommissioning activities and the efficiencies for processing operational wastes would not be applicable.
- Determination of the remaining 30% HVVLLW component that would be suitable for disposal at CLESA 1 and CLESA 2.
- Determination of the revised waste profile LLW material volumes that would be suitable for combustion or smelting, post 2020.
- Determination of the revised waste profile suitable for wheelabrator post closure of the replacement wheelabrator facility in 2043.

When fully revised, the waste inventory was then used to re-assess the cost for disposal. Revised cost factors, supplied by the NDA[26], were used to allow sites to standardise their expected waste management costs from the use of supply chain treatment routes.

This re-assessment of the total lifetime cost has delivered an estimated reduction in the NP of £1.5Bn resulting in a new total NP of £7.4Bn. The major contributors to this reduction are shown in Table 13 below.

<table>
<thead>
<tr>
<th>TABLE 13 – MAJOR CONTRIBUTING FACTORS TO ACCELS COST REDUCTION.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost saving initiative</td>
</tr>
<tr>
<td>Re-assessment of the expected activity of waste stream 2D148 (HVVLLW) resulting in 70% of the waste stream re-assigned as exempt. The exempt material is now priced to be disposed of at landfill.</td>
</tr>
<tr>
<td>Revised waste generation profile following the re-assessment of the expected waste to be generated from 27 key facilities on the Sellafield site. This resulted in a better understanding of the waste to be generated resulting in a saving in disposal by burial costs.</td>
</tr>
<tr>
<td>Reduction in the cost of treatment for combustible and metal melting wastes from a better understanding of supply chain capabilities and use of NDA supplied cost factors.</td>
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</table>
Sellafield are in the process of incorporating these reductions into their LTP during 2011. The impact of this work on the NP can be seen in Figure 43 and 44.

**FIGURE 43 – TOTAL NP INCORPORATING ACCELS PHASE 2 STUDY REVISIONS TO THE 2010 BASELINE.**

Total = £7,398m
5.5.2 Summary of ACCELS phase 2 impacts

The ACCELS project has shown several important benefits that improve the NP for LLW. This programme has also highlighted further areas of work to generate greater potential savings. A summary of the ACCELS benefits is given below:

- Revised NP of £7.4 billion.
- Reductions in the inventory at Sellafield have resulted in a reduction of £1.5 billion of the revised baseline cost. This is more than 15% reduction when compared to the 2010 NP and a 25% reduction from the original 2008 baseline cost of £9.8 billion.
- This constitutes a significant saving to the NDA from reconsidering previous LTP assumptions and applying best practice approaches.
- There are still a number of opportunities to reduce the NP which will be considered further through the National LLW Programme.
6 Conclusions

This LLW Strategic Review has established a 2010 LLW baseline in terms of LLW strategies, costs, and the available assets and infrastructure (existing and planned) for LLW management. This updates the previous 2008 baseline within the first LLW Strategic Review. Since January 2009 when the first LLW Strategic Review was published, a range of activities have been undertaken by NDA and LLWR to support the development and implementation of the UK Nuclear Industry LLW Strategy and associated LLW Management Plan.

Key conclusions from the review are as follows:

- The review of site IWS indicates that, with few exceptions, the IWS documents largely meet the expectations established by NDA, as described in ENG-01. However, it is also evident that documents are often complex and whilst there is evidence of good practice (e.g. Sellafield’s articulation of LLW strategy) and recognising the role of the main overarching documents, IWS rarely provide a clear statement for site LLW strategy. Waste disposal to LLWR is often the default strategy, and this may be reflective of the immaturity of alternative waste routes. This is an area that is being developed by LLWR and sites, and perhaps as new waste routes become established, waste disposal will cease to be the default strategy and implementation of the waste hierarchy will be substituted in site strategies.

- A review of the UK’s LLW inventory shows that information on the sites LLW is developing to better identify waste streams and to incorporate new waste disposal routes. The total forecast LLW volume is 4.4 million m$^3$ which arises during 2010 to 2120. This consists of 3.3 million m$^3$ of VLLW and 1.1 million m$^3$ of LLW. Sellafield is the dominant LLW waste generator for the UK, producing roughly 3.3 million m$^3$ of waste (LLW and VLLW) accounting for 76% of the UK’s total waste. Volumes are dominated by VLLW wastes with soil and rubble identified as the dominant waste stream.

- Comparison with previous inventories shows that sites are re-characterising wastes as VLLW leading to a reduction of 0.4 million m$^3$ of LLW between the WIDRAM 2008 and UKRWI 2010 inventory figures. Volumes of VLLW have however, increased significantly compared to previous inventories. The inventory review has also highlighted several areas of improvement that would greatly improve the information generated and allow for a better understanding of the future LLW waste arisings. These areas include consistency of waste reporting tools, reporting of actual waste treatment and disposal routes and improved consistency in characterisation practices.

- The review of cost information shows that the provisional 2010 costs baseline is around £8.9Bn. This has decreased by £0.96Bn from the previous 2008 baseline of £9.86Bn. It should be noted that the 2010 baseline may be subject to change following finalisation of the Sellafield LTP10 and receipt of Springfields data for 2010. Within the total, there have been increases and decreases in the cost of individual elements reflecting changes in scope, unit rate assumptions, and underpinning inventory numbers. There remain several areas where site baselines are not fully aligned with the UK LLW strategy or utilise very conservative assumptions regarding waste volumes and categorisation.

- The review of assets and infrastructure highlights that there have been some changes to the facilities that are available to nuclear sites. The Studsvik MRF has now been successfully operating for over a year and has treated waste from a number of nuclear sites. LLWR have introduced segregated waste services for metallic and combustible waste which will expand options available to waste producers. A number of commercial landfill operators are seeking authorisations under the Environmental Permitting Regulations 2010 for LLW and VLLW disposal ranging from expansion of existing sites to new dedicated facilities. To facilitate implementation of the waste hierarchy, LLWR are in the process of developing a suite of new packages which are more cost effective and provide more flexibility for treatment purposes.

- The ACCELS project has identified numerous opportunities to further reduce the UK’s LLW cost and inventory. Work done by Sellafield and Magnox to re-assess the underpinning waste data and
the assumptions used to develop the 2010 baseline has identified additional reductions. The ACCELS programme has identified that up to 2.1 million m$^3$ of waste currently classified as LLW or VLLW may be exempt leading to a cost saving of £1.5Bn on top of the revised baseline. The new total NP would then be £7.4Bn following incorporation of the savings in to the NDA’s ARAC. This represents a £2.5 billion reduction (25%) from the 2008 baseline.

The revised baseline shows real progress towards understanding the expected impacts of LLW management in the UK. The work done to better substantiate the waste data has led to a significant reduction in the NP and identified numerous areas where the same processes can be further applied. The remaining opportunities identified through the ACCELS project and the LLW Management Plan will be combined to form the National LLW Programme. This programme will be used to track and deliver the ongoing work which aims to minimise the cost and impact of LLW generation in the UK.
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7. ACCELS – Transition results and Recommended Forward Programme, LLW Repository Ltd, March 2010
8. Revised Proposals for a Future Exemptions Regime Under the Radioactive Substances Act 1993 and the Environmental Permitting Regulations 2011 Consultation, DECC, August 2010
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19. Waste Inventory Disposition Route Assessment Model (WIDRAM) database, National Nuclear Laboratory, NDA02790/06/11/06, September 2008
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Clarification. Rev 1 September 2010.

27. Development of the Derived Inventory for ILW & LLW Based on the 2007 UK Radioactive Waste 
Inventory. Nuclear Decommissioning Authority, Pöyry Energy Limited. 390685/12. 15th November 
2010


November 2010.


31. ‘Near Term’ Analysis of Very Low Level Waste. Low Level Waste Repository 
RP/3400737/PROJ/00004/A. November 2010.
Appendix A – Site IWS Summaries

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<thead>
<tr>
<th>MAGNOX NORTH</th>
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<tr>
<td><strong>Summary of LLW Strategy</strong></td>
<td><strong>Issue 3 March 2010</strong></td>
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<tr>
<td>The baseline strategy for non-combustible solid LLW is disposal to the LLWR. An on-site LLW management team will sort waste and exclude items not permitted under the LLWR Conditions for Acceptance. The strategy notes that facilities are available at some sites to size-reduce and decontaminate LLW to minimise volumes transferred to LLWR.</td>
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<tr>
<td>Magnox North utilises strategic options studies and BPM to identify and develop waste management strategy, and are cognisant of Government and National Strategies for LLW.</td>
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**Status**
Magnox North is responsible for 5 sites relevant to this review at different lifecycle stages:
- Hunterston A; ceased generation, POCO (Post-Operational Clean-Out) completed, fuel removal and C&M preps underway
- Trawsfynydd; ceased generation, POCO completed, fuel removal and C&M preps underway
- Chapelcross; ceased generation, POCO completed, de-fuelling and decommissioning underway
- Oldbury; operational station
- Wylfa; operational station

**Waste Volumes**
Total raw LLW arisings through each lifecycle phase are predicted to be approximately 0.29 million m$^3$
Magnox North IWS predicts the following volumes of LLW:
- C&M Preps – 113,766 m$^3$
- C&M – 632 m$^3$
- FSC – 172,265 m$^3$
- Total – 286,664 m$^3$

**Origin of Waste**
LLW primarily arises from operational and decommissioning activities. The IWS notes that C&M Preps produces the greatest volume of waste of non-hazardous and inert wastes, whilst the greatest volume of LLW is produced in FSC.

**Current Waste Routes**
The IWS provides an overview of processing and disposal routes
The IWS (page 91), recognising the finite capacity of disposal to LLWR (the technical baseline for disposal of non-compactable LLW) also notes alternative strategies for the management of LLW:
- Onsite disposal / controlled burial
- Metal melting
- Disposal of VLLW to conventional landfill

**Organisation and Management**
Waste management is the responsibility of the Projects, Waste and Decommissioning Strategy Director (page 38). This organisation reports to the Managing Director and is supported by a Waste Innovation Manager and Waste and Decommissioning Strategy Manager (with responsibility for ILW, LLW and Conventional Waste Strategy and Decommissioning strategy).

The IWS identifies generic roles and waste management responsibilities (page 39)
The management system, organisation structure, responsibilities, authorities and interfaces for managing work at each
**MAGNOX NORTH**

**MAIN REPORT**

**Issue 3 March 2010**

Magnox North site is detailed in a site document:

- Operational Quality Assurance Programme (OQAP) for Oldbury and Wylfa
- Decommissioning Quality Assurance Programme (DQAP) for Chapelcross, Hunterston A and Trawsfynydd

The IWS notes that each site operates an integrated management system meeting Magnox North requirements as well as those of the NDA (specifically meeting International Standards (page 39)). Each site must operate in accordance with EHS policies referenced in the Magnox North Company Manual (page 40)

The Magnox North management system incorporates the following document levels (page 41):

- High level management arrangements including Management Control Procedures (MCP; MCP16 addresses Waste), Departmental Manuals, post profiles, Interface agreements etc.
- Working level management arrangements including departmental instructions, work instructions, quality plans etc.

**Changes from 2009 IWS**

The IWS identifies the following changes related to LLW management since the previous IWS:

- Further progress in establishing alternative disposition routes for LLW and in particular VLLW
- Establishment of a more effective waste management organisation
- Progress in re-evaluating Magnox North radioactive waste inventory
- Progress on establishing a more efficient and consistent approach to radioactive waste characterisation
- More detail on BPEO studies and gaps.

**Opportunities to Improve**

The IWS identifies the following actions related to the management of LLW (page 108):

- Development and implementation of the Magnox North VLLW strategy
- Delivery of a characterisation improvement project to introduce a common process to improve consistency and coordination
- Finalise and implement common standards for clearance and exemption across the Magnox North estate
- Develop and deliver a programme to improve inventory estimates and disposition routes
- Work with the LLWR and sites to implement a new contract arrangements to ensure value for the NDA
- To review the benefits of a SLC wide waste tracking software system

The Magnox North IWS identifies the following opportunities specifically related to LLW management (page 63):

- Melting and reuse of pond skips following decontamination to LLW
- Decay storage of desiccant to LLW
- Various LLW routes including, recovery, reuse and treatment of materials, disposal of VLLW to specified landfill sites, controlled burial of LLW, on-site disposal of LLW, decay storage of short lived LLW and incineration as a disposal / treatment option for combustible LLW.

A comprehensive summary of opportunities is provided in Appendix C of the IWS (page 121)

**Principal LLW Issues**

The Magnox North IWS identifies the following risks specifically related to the management of LLW:

- Uncertainty regarding LLWR ability to accommodate all decommissioning waste, specifically early closure date and vault availability
- Uncertainty regarding Cumbria County Councils core strategy prohibiting disposal of Magnox North LLW to LLWR
- Uncertainty regarding LLWR conditions for acceptance resulting in the requirement for additional work to ensure compliance
- Waste volume and activity predictions less than actual
### Alignment to Principles Identified in LLW Strategy

|   | The Magnox North key objectives for decommissioning and waste management include (page 19):
|---|---|
|   | • Ensure continued safety of the public, the workforce and the protection of the environment  
|   | • Deliver a systematic and progressive hazard reduction  
| A | Underpinning the strategy are a number of principals including (page 33):
|   | • The safety of the public and workforce, together with the protection of the environment are of paramount importance and will be considered ahead of all other factors  
|   | In addition to options studies and BPM Magnox North employs the NDA SED process which seeks to understand chemical and radiological hazard potential to further prioritise options (page 53).
| B | The Magnox North strategy is underpinned by the following principles related to application of the waste hierarchy and minimising waste generation (page 33):
|   | • Strategies will be compliant with legislation, be in accordance with Government and Company policy, take account of stakeholder views and regulatory and industry guidance  
|   | • The quantities of radioactive waste and otherwise hazardous waste arising during the course of decommissioning will be minimised as far as reasonably practicable.
|   | The Magnox North Business Improvement Plan 2009 includes the following delivery targets (page 19):
|   | • Introduce improvements in LLW/VLLW management to reduce lifetime plan costs and optimise use of waste hierarchy / disposal facilities  
|   | The IWS notes the waste hierarchy and commits to 'reduce its environmental impact as a result of its waste management activities and is committed to following EU and UK Government’s waste hierarchy policy' (page 35).
|   | The Magnox North LLW processing and disposal routes process clearing incorporates the waste management hierarchy (page 91), and expects a variant of the waste hierarchy to be applied on all Magnox North Sites.
| C | Characterisation is identified as a key element of the Magnox North LLW processing and disposal process (page 91) and noted as 'essential in defining a strategy for retrieval, conditioning and disposal of LLW (page 92)'.
|   | The Magnox North IWS presents a Waste Characterisation Strategy (page 77) and is presented as an integral part of waste strategy as well as essential to demonstrate BPM and produce reliable characterisation data. Magnox North has developed a Waste Characterisation Strategy to create a more consistent approach to waste characterisation. Figure 14 of the IWS presents the Magnox North Characterisations Process (page 78).
| D | Authorised site waste routers are identified in the individual site IWSs.
| E | Magnox North has considered alternative LLW disposal strategies including onsite disposal / controlled burial, metal treatment and VLLW disposal to conventional landfill.
|   | Magnox North takes a planned structured approach to stakeholder engagement and the IWS confirms that stakeholder views are essential to the development of the IWS. The IWS identifies the following interactions:
|   | • NDA consultation with stakeholders in vicinity of sites on preferred end-states  
|   | • Site engagement with local stakeholders providing a formal mechanism for consultation on decommissioning and waste management strategies  
|   | • Informal contact with various stakeholders including responding to public requests, providing
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<tr>
<th>MAGNOX NORTH</th>
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<tr>
<td>an opportunity to engage the public on the site's waste strategy</td>
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<tr>
<td>- The IWS forms the basis for discussion between Magnox and its regulators. Key stakeholders are identified in the IWS.</td>
<td></td>
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<tr>
<td><strong>F</strong></td>
<td>The Magnox North IWS identifies alternative waste strategies (page 64) to pursue decommissioning</td>
</tr>
<tr>
<td><strong>G</strong></td>
<td>The Magnox strategy is underpinned by the following principles related to application of the waste hierarchy and minimising waste generation (page 33):</td>
</tr>
<tr>
<td>- Strategies will be compliant with legislation, be in accordance with Government and Company policy, take account of stakeholder views and regulatory and industry guidance</td>
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<tr>
<td><strong>H</strong></td>
<td>The IWS notes the importance of Strategic Options studies in planning decision-making for waste management (page 51). The IWS further states that prior to detailed planning each site is required to complete a BPEO optioneering process to inform its radioactive waste management decision making. BPM is also utilised to support waste decision making (page 51)/</td>
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<tr>
<td>In addition sites are required to utilise the NDA SED process to assist in project prioritisation (page 53).</td>
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<tr>
<td>The IWSs include no specific reference to business case development but notes that BPEO may consider cost (page 51).</td>
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### MAGNOX NORTH

#### Summary of LLW Strategy

The Hunterston A strategy is aligned with Magnox North strategy. Section 4 of the IWS provides the Hunterston A Waste strategy. The strategy is underpinned by waste characterisation specifically in developing strategic options for waste as well as demonstrating BPM. Hunterston A identifies the re-categorisation of LLW metal as a key strategic objective achieved through the removal of surface decontamination by sponge-jetting.

#### Status

Hunterston A ceased generation in 1990, POCO is complete and all fuel removed. Care and maintenance preparation has commenced.

#### Waste Volumes

The Hunterston A life time plan identifies that 16% of all waste arising during the full lifecycle is LLW with approximately 600 m³ generated during decommissioning. Predicted waste volumes arising in the following phases:

- C&M Preps – 7,723 m³
- C&M – 128 m³
- FSC – 14,574 m³
- Total -22,425 m³

#### Origin of Wastes

LLW will arise from operational and decommissioning activities, with the station currently preparing for care and maintenance. The waste is comprised of both solid and liquids and includes:

- Mild steel and ferrous
- Stainless steel
- Contaminated soils
- Concrete
- Graphite, and,
- Others

#### Current Waste Routes

Whilst opportunities to meet the waste hierarchy are identified in the IWS, the principal thrust of the Hunterston A strategy is articulated as disposal (whether conventional or radioactive). The Hunterston A IWS identifies the following waste routes:

- Solid LLW to LLWR via WAMAC if compactable.
- Insulation (Asbestos) in decay storage prior to disposal at an approved hazardous waste site
- Sludges and FED have been categorised and the site will continue with activities to understand further LLW sludge liabilities
- Operational waste is disposed of at LLWR. Lightly-contaminated work ware is laundered and returned to site for re-use
- Combustible LLW, consisting of contaminated oils and other liquid hydrocarbons is currently stored on site but potential off-site commercial incineration is currently being investigated

#### Organisation and Management

The site has established an organisation to manage waste arisings on the site, including a dedicated and Suitably Qualified and Experienced Person (SQEP) low level waste team.

The site has established an integrated management system which underpins the management of waste. Hunterston A has implemented MCP 16 which addresses control and disposal of decommissioning waste (page 13)

#### Changes from 2009 IWS

Hunterston A has appointed a Waste Manager and established a Waste Management Department. The IWS notes
further developments principally related to ILW. However, the IWS does indicate the development and establishment of a VLLW disposal route are underway (page 8)

**Opportunities for Improvement**

The Hunterston A action plan details the following actions for 2010 related to the management of LLW:

- Optimisation of waste management organisation and arrangements
- LLW minimisation including improvements in packing efficiency, use of incineration routes and optimisation of clearance and exemption and assay techniques
- Review of BPEO / BPM arrangements
- Development of stringent sentencing regime to improve waste segregation

The Hunterston A IWS identifies a number of research and development opportunities related to the management of LLW. These include:

- Examination of whether it is possible to clean oil contaminated pipework prior to retrieval and conditioning
- Review of the process for collection, characterisation and segregation of oils with the aim of re-categorising oil as exempt
- Characterisation of sewage sludge to determine whether it is LLW or HVLLW

The IWS identifies the following Magnox North opportunities relevant to Hunterston A (page 28):

- Increased use of supercompaction to reduce disposal volumes
- Melting of contaminated metals to segregate out heavier radionuclides and free release the remaining metal
- Improved segregation of LLW from ILW

The IWS identifies the following site specific opportunities (page 29):

- Utilisation of HVLLW disposal routes
- Increased use of super-compaction to reduce disposal volumes

**Principal LLW Issues for the Site**

The IWS does not identify specific risks related to the management of LLW, but the following LLW issues were identified:

- Re-categorisation of LLW to reduce disposal volumes
- Increase in packing factors of ISO containers
- Land Quality Management including stakeholder engagement in relation to VLLW pits

**Alignment to Principles Identified in LLW Strategy**

<p>| A | Hunterston A’s primary objective as stated in the IWS is to ‘decommission the site in a prompt, safe and effective manager designed to reduce chemical and radiological hazards on site’. SED for each waste item have been evaluated and lifetime SED profile created. SED is utilised to prioritise work. | ✓ |
| B | The requirement to minimise waste generation is a site aim. The requirement to ‘avoid producing waste if possible is identified. The IWS recognises further action is required to ‘drive home the principles of the waste hierarchy’ as well as ‘minimising LLW, increasing recycling and lessening site reliance on expensive landfill’. A key strategic aim is to reduce LLW metal disposal through re-categorisation following surface decontamination where applicable. | ✓ |</p>
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<th><strong>MAGNOX NORTH</strong></th>
<th><strong>HUNTERSTON A</strong></th>
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<td><strong>C</strong> The strategy notes that the site ‘endeavours to re-categorise as much LLW by segregation of LLW components of packages by increased assurance monitoring. A number of characterisation focussed research and development requirements have been identified, although waste characterisation is not explicitly described in the Hunterston A IWS. The site recognises that there is an opportunity to improve LLW assay techniques and characterisation (page 64).</td>
<td>✓</td>
</tr>
<tr>
<td><strong>D</strong> Hunterston A notes the availability of several alternative routes to disposal at LLWR. These include oils to Studsvik facility in Sweden or Tradebe at Fawley, metal treatment, compaction. The IWS identifies the following authorised LLW routes:</td>
<td>✓</td>
</tr>
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</table>
| • LLW to LLWR  
• LLW metal to Sweden. | ✓ |
| **E** The Hunterston IWS identifies key stakeholders and the IWS provides evidence of stakeholder engagement on specific waste management issues (page 29) | ✓ |
| **F** The Hunterston IWS recognises that a variety of waste management routes are essential to support hazard reduction and decommissioning. The IWS recognises a number of waste routes for LLW and notes the sites RSA multimedia application includes a new route; transfer of High Volume Very Low Level Waste (HVVLLW) to a suitably licensed landfill. | ✓ |
| **G** Hunterston A explicitly states that the site has an integrated system for waste management. The IWS addresses both radioactive and non-radioactive wastes. The Hunterston A IWS notes alignment with National and Regional policy and strategy (page 9) including: | ✓ |
| • North Ayrshire Local Plan  
• Scottish Waste Policy | ✓ |
| **H** Hunterston A adopts the Magnox North approach to options studies to support waste management decision making. In addition, Hunterston A also applies the NDA SED process (page 18). The IWS does not reference the NDA Business Case Methodology nor indicates application. | ✓ |
### Summary of LLW Strategy

The Trawsfynydd strategy aligns with the Magnox North Strategy. No explicit site strategy is articulated in the IWS. However, site aims to develop an integrated strategy for LLW management in alignment with Government Consultations and the UK LLW strategy. UK LLW strategy emphasises the importance of the waste management hierarchy. The Trawsfynydd IWS refer to the Magnox North IWS.

The Magnox North default strategy for LLW is to dispose non-compactable LLW to LLWR.

### Status

Trawsfynydd ceased generation in 1993, POCO is complete and all fuel removed. Care and maintenance preparation has commenced.

### Waste Volumes

Table 23 in Annex 1 of the Trawsfynydd IWS provides data on LLW waste arisings. 58,389 m³ of raw waste and 61,100 m³ of packaged waste is predicted with 50% confidence.

### Origin of Wastes

The Trawsfynydd IWS states that LLW arises during project specific work related to de-planting and decommissioning and during more general operational activities. The majority of this waste is predicted to be generated during Final Site Clearance. The IWS notes that solid LLW is generated during the care and maintenance preparations phase but this is likely to be restricted to forms of plastic sheeting and protective clothing (page 69).

The following types of LLW are identified in the Trawsfynydd IWS:

- Metal
- Glass
- Plastic
- Rubber
- Contaminated sludges
- Other materials

### Current Waste Routes

The Trawsfynydd site IWS notes the following principal LLW routes (page 54):

- Liquid Organic LLW to the Fawley Hazardous Waste Incinerator
- Solid LLW to the LLWR
- Compactable waste to WAMAC then to LLWR

Trawsfynydd notes that LLW is processed and sized-reduced at the location where it is produced or at a dedicated on-site waste management facility.

### Organisation and Management

Trawsfynydd has established an organisation for waste management with responsibilities, authorities, and interfaces clearly established. These are established in the sites Decommissioning Quality Assurance Programme.

A waste manager was appointed in 2009 in accordance with Magnox North arrangements.

Trawsfynydd has established an integrated system for the management of waste underpinned by Magnox North
### Standards (page 26):
- MCP 14 Decommissioning and Radioactive Waste Management
- MCP 16 Management of Solid, Liquid and Gaseous Waste
- MCP 17 Environmental Management

### Changes from 2009 IWS

A waste manager was appointed during 2009 (page 26).

The IWS identifies a number of other significant changes since the 2009 IWS. However, it is difficult to assign changes specifically to LLW management. The IWS does note that waste in the Active Waste Vaults have been characterised and this has resulted in a significant portion of waste being re-categorised as LLW (which has already been consigned to LLWR). The IWS also notes that orphan LLW oils are progressing through an assay and segregation programme with a disposal route identified.

### Opportunities for Improvement

The following actions are identified in the Trawsfynydd IWS:

- Optimisation of waste management arrangements
- Improvements in LLW minimisation including maximising packing efficiency of disposal containers
- Use of new incineration and other routes identified in the UK LLW strategy
- Continue to optimise current authorised LLW routes

The IWS identifies the following opportunities (page 45):

- Increased use of super compaction to reduce disposal volumes
- Melting of contaminated metal to segregate out heavier radionuclide contaminants and free release of the remaining metal
- Improved segregation of LLW from ILW
- Utilise Wylfa on-site disposal facility for LLW

### Principal LLW Issues for the Site

The IWS identifies the following Magnox North generic risk that could directly affect Trawsfynydd (page 43):

- Insufficient capacity for LLW at LLWR

### Alignment to Principles Identified in LLW Strategy

| A | The primary aim of the site is 'to decommission the site in a prompt, safe, and effective manner and substantially reduce the radiological and chemical hazards on site'. A further site aim is to develop an integrated strategy for LLW management as proposed in current Government Consultation and by LLW strategy. Furthermore, Trawsfynydd utilises Safety and Environment Detriment scores, project benefit scores and external modifiers to prioritise projects (page 33). | ✔ |
| B | The IWS notes that site standard requires application of Best Practicable Means and the 'use of the waste hierarchy for radioactive waste management work is planned and undertaken' (page 29). | ✔ |
| C | The IWS recognises the importance of and alignment with the Magnox North IWS (which emphasises the importance of waste characterisation). The Trawsfynydd IWS does not specifically reference the importance of characterisation explicitly, but it is evident implicitly throughout the IWS. A key challenge identified (page 101) is to 'improve waste characterisation to improve confidence in volume and physical, chemical and radiological characteristics of the waste'. | ✗ |
### MAGNOX NORTH

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| **D** | The IWS identifies the following authorised transfer routes (page 96):  
   - Solid non compactable LLW to LLWR  
   - Solid compactable LLW to WAMAC prior to disposal at LLWR  
   The site does not utilise a Transfrontier Authorisation to permit metal recycling overseas. |
| **E** | The IWS provides examples of waste management stakeholder engagement (although no specific LLW examples are provided). These include:  
   - Waste management issues discussed at every Site Stakeholder Group (SSG) meeting  
   - The IWS (and other waste management issues) are reviewed by a technical sub-group of the SSG |
| **F** | Trawsfynydd has a limited number of authorised LLW routes. However the IWS notes the availability of potential waste routes in the LLW strategy and indeed concludes (page 102) that key challenges during 2010 is to optimise LLW management through consideration of alternative LLW disposal options. |
| **G** | The Trawsfynydd IWS confirms that the site has established an integrated system for the management of waste. The structure of the system is outlined in the site’s Decommissioning Quality Assurance Programme (page 26).  
   The IWS recognises the importance of and notes alignment with the National and regional policy and strategy including (page 20):  
| **H** | Trawsfynydd adopts the Magnox North approach to options studies to support waste management decision making. In addition Trawsfynydd also applies the NDA SED process (page 33).  
   The IWS does not reference the development of business case methodology to support LLW decisions. However the IWS does note the potential application of a business case to an ILW project (page 43). |
### Summary of LLW Strategy

The current Wylfa decommissioning strategy is based on hazard reduction taking into account the process of natural radioactive decay (page 35). The site will progress site specific BPEO’s for individual waste streams for the site lifecycle.

### Status

The site is currently generating electricity. The IWS indicates that this will continue until 2011 with de-fuelling initiated through 2015, and C&M Preps to 2025. The IWS notes that the site is pursuing opportunities to reduce hazards during this period.

### Waste Volumes

The site predicts the following volumes of LLW:

- C&M Preps – 6,030 m³
- C&M – 142 m³
- FSC – 40,842 m³
- Total – 47,013 m³

### Origins of Wastes

The IWS notes that the following LLW streams will be generated during generation and de-fuelling phases:

- Miscellaneous material from the pile cap, dry fuel store, and associated areas
- Operational waste, miscellaneous waste, redundant equipment and PPE from the flask handling area and Active Effluent Treatment Plant.
- Incinerator ash arising from operation of the on-site incinerator

Seven decommissioning projects have been identified as generating over 99% of the Wylfa site C&M Preps phase:

- Reactor building asbestos removal
- Dry stores 1, 2, & 3 and fuel handling areas decommissioning
- Desiccant retrieval and processing
- Wet LLW retrieval and processing
- CW pump house and associated building decommissioning and demolition
- R1 and R2 reactor building and equipment building decontamination and deplanting
- Dry store 4, & 5 and deplanting, decommissioning and demolition

Wylfa predicts that the dry store 4 and 5 project will account for over 90% of the LLW arisings during C&M Preps, with minimal LLW anticipated during C&M. The majority of the LLW will be generated during FSC. The site predicts that it is anticipated that the majority of waste during these periods will be steel and rubble, classified as VLLW and HVLA.

The IWS predicts relatively small volumes of LLW will be generated during electricity generation and de-fuelling.

### Current Waste Routes

The authorised disposal routes for Wylfa are:

- Solid non-compactable LLW to LLWR
- Solid compactable LLW to WAMAC prior to disposal at LLWR
- Solid LLW to on-site incinerator
The site does not currently have a Transfrontier Authorisation for the overseas treatment of metal.

Wylfa has the following facilities relevant to LLW management:

- A LLW treatment and assay facility
- LLW store
- LLW ISO container hard standing and loading area

Organisation and Management

The Site has established a comprehensive organisation to manage waste but this recognises that the station continues to generate electricity. The IWS notes that as the site moves towards the de-fuelling and decommissioning phases, waste management will become more important. The IWS references a waste management team responsible for waste management reporting to the Waste and Decommissioning Manager and a Waste section (established in 2007).

The IWS notes that Wylfa has an integrated system for the management of waste, recognising Regulatory Requirements and Government Policy as well as the need to integrate with project teams. The integrated system is implemented through MCP 16 (Management of Solid, Liquid and Gaseous Waste), in accordance with Magnox North requirements.

Changes from 2009 IWS

The following changes from the 2009 version of the IWS specifically related and identifiable to LLW are noted:

- Waste coordinators established
- Routine use of 0075 skips for certain LLW materials established
- BPEO for VLLW issued

Improvement Opportunities

The IWS identified the following opportunities specifically related to LLW management:

- Optimisation of the waste management organisation following on-going operation feedback as well as optimisation of waste management arrangements (recognising that current arrangements support a electricity generating site) to ensure the agreed strategy can be delivered
- Further opportunities to optimise LLW minimisation including segregation of waste for appropriate disposal routes, use of incineration, metal segregation and smelting, VLLW route, and improvements in clearance and exemption
- Optimisation of LLW assay techniques

The IWS identifies the following potential opportunities:

- FED characterisation may result in the opportunity for early disposal of FED off-site as LLW depending on the outcome of the Magnox South FED dissolution process being investigated
- The investment in sampling and waste characterisation techniques and capabilities may result in improvements in waste characterisation and sentencing decisions

The Wylfa IWS identifies the following potential opportunities specifically related to LLW management:

- Use of the Wylfa incinerator as a regional facility for other NDA sites
- Investigate a range of decontamination technologies that will reduce the total volumes of radioactive waste for disposal
- Investigation into options for the disposal of VLLW, supported by a BPEO study
# Principal LLW Issues for the Site

The Wylfa IWS does not identify specific risks.

## Alignment to Principles Identified in LLW Strategy

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>A</strong></td>
<td>Wylfa objectives include ‘decommissioning the site in a prompt, safe, and efficient and effective manner to reduce the chemical and radiological hazards on site in accordance with the waste hierarchy’ (page 11). The IWS notes that Wylfa utilises an optioneering process to inform decision making and applies the NDA SED procedure to assist prioritisation. A SED score for each waste item have been evaluated based on form and location (page 23). The Waste Section has the remit to ‘safely, efficiently and effectively manage waste arisings throughout the remaining site lifecycle (page 16).</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>The IWS notes that Waste Minimisation is a requirement for all staff, with standards established to minimise the creation of radioactive waste through application of BPM (page 20). Wylfa objectives include (page 11):</td>
</tr>
<tr>
<td></td>
<td>- ‘To decommission the site in a prompt, safe, and efficient and effective manner to reduce the chemical and radiological hazards on site in accordance with the waste hierarchy'</td>
</tr>
<tr>
<td></td>
<td>- Minimise unnecessary LLW and secondary LLW arisings and maximise packing efficiency</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>The IWS notes that characterisation of waste in terms of its physical, chemical, radiological properties, and volume forms an integral part of the strategic assessment of waste management options (page 35). The site recognises the importance of characterisation in being able to demonstrate BPM.</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>Annex 2 of the Wylfa IWS identifies the site’s current authorised waste routes (page 70):</td>
</tr>
<tr>
<td></td>
<td>- Disposal of solid LLW by incineration on premises</td>
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<td></td>
<td>- Disposal of solid by transfer to LLWR</td>
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<tr>
<td></td>
<td>- Disposal of solid LLW by transfer to LLWR via WAMAC</td>
</tr>
<tr>
<td><strong>E</strong></td>
<td>The IWS notes that work is currently underway to estimate volumes in VLLW category with plans to segregate this waste stream for alternative disposal (page 42). Wylfa is currently leading a BPEO for VLLW (page 42). Wylfa has engaged stakeholders on the following waste management issues with relevance to LLW:</td>
</tr>
<tr>
<td></td>
<td>- Consultation with the Site Stakeholder Group on preferred site end state.</td>
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<td></td>
<td>- Engagement with the consultation on the Policy for the Long Term Management of Solid Low Level Radioactive Waste in the UK.</td>
</tr>
<tr>
<td><strong>F</strong></td>
<td>The Wylfa IWS notes that Magnox North is considering strategic initiatives to optimise the management of radioactive waste that could lead to the establishment of additional transfer routes for waste (page 61). The IWS notes the opportunity to utilise new contract arrangements with LLWR to divert LLW metal from disposal (page 43).</td>
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<tr>
<td>MAGNOX NORTH</td>
<td>WYLFA Issue 3 February 2010</td>
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<tr>
<td><strong>G</strong></td>
<td>The IWS notes that wastes are routed to a waste sorting and assay facility for sorting into non-radioactive, incinerable, compactable and non-compactable waste streams. Waste is placed in dedicated skips and drums depending on waste stream (page 42). This indicates an integrated approach to waste management.</td>
</tr>
<tr>
<td></td>
<td>The IWS states (page 7) that the ‘IWS relates to all waste and materials that could become waste both radioactive and non-radioactive arising from past, present, and future generation, de-fuelling and decommissioning operations at Wylfa.</td>
</tr>
<tr>
<td></td>
<td>The IWS recognises and confirms consistency with the following local and National Policy and associated documents:</td>
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<tr>
<td></td>
<td>• Isle of Anglesey Local plan which recognises the waste hierarchy, BPEO concept to assess waste options and the proximity principal.</td>
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<td></td>
<td>• Welsh Waste Vision which promotes the concepts of sustainability and the proximity principle.</td>
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<tr>
<td><strong>H</strong></td>
<td>Wylfa adopts the Magnox North approach to options studies to support waste management decision making. In addition Wylfa also applies the NDA SED process (page 18).</td>
</tr>
<tr>
<td></td>
<td>The IWS does not reference the NDA Business Case Methodology nor indicates application.</td>
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</tbody>
</table>
**Summary of LLW Strategy**

The objective of the Chapelcross site is to ‘decommission the site in a prompt, safe and effective manner to reduce chemical and radiological hazards’ (page 10). Options assessments are utilised to identify the most appropriate waste strategy. Throughout the IWS, reference is made to application of the waste management hierarchy as well as the importance of waste characterisation.

A single waste route is identified in the IWS; the default LLW strategy is disposal to LLWR (perhaps prior to super compaction at WAMAC). The IWS does, however, note additional potential waste routes.

**Status**

Chapelcross ceased generating in 2004 and is currently in a C&M Prep phase predicted to be completed in 2022.

<table>
<thead>
<tr>
<th>Waste Volumes</th>
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<tbody>
<tr>
<td>The site predicts the following volumes of LLW:</td>
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</table>

The IWS predicts that 23% of all waste arisings will be LLW.

**Origin of Wastes**

Current and future LLW arisings will arise from deplanting and decommissioning activities across the Life Cycle Base Line. The site team is responsible for categorising LLW into the following types:

- Compactable LLW
- Non-compactable LLW
- Asbestos LLW
- Mobile LLW
- Tritiated LLW.

LLW generated on-site can be processed at the on-site process facility. The waste is then temporarily stored prior to disposal off-site. Significant arisings are anticipated during FSC. It is proposed that the majority of arisings during decommissioning will be managed in a new LLW handling facility.

Historic LLW is present on the Chapelcross site, generated during its operational life.

**Current Waste Routes**

The IWS identifies a single waste route as disposal to LLWR via WAMAC if compaction is required. However, the IWS notes aspirations to establish an incineration route to Fawley.

**Organisation and Management**

The management system, organisation structure, responsibilities, authorities, and interfaces for those managing waste at Chapelcross are established in the Site’s Operational Quality Assurance Programme document. A Waste and Land Quality Manager, supported by a Waste Technical Manager and End State and Characterisation Manager reports to the Deputy Site Director. The IWS notes that the operation of waste routes requires close interactions with project teams, departments, subcontractors, and regulators.
The site has implemented the Magnox standard for Decommissioning and Radioactive waste management

The waste manager has allocated responsibility for the IWS.

**Changes from 2009 IWS**

The Chapelcross IWS identifies the following changes specifically related to LLW since the 2009 version of the report:

- Re-characterised asbestos from three exchange main bodies from LLW to exempt
- Began engagement with LLWR on segregated waste routes
- Initiated variation to site RSA authorisation with regard to VLLW submitted to SEPA

**Opportunities to Improve**

The IWS identified the following actions for 2010 specifically related to LLW management:

- Optimisation of the waste management organisation following on-going operational feedback as well as optimisation of waste management arrangements (recognising that current arrangements support an electricity generating site) to ensure the agreed strategy can be delivered
- Develop further opportunities to optimise LLW minimisation including use of incineration routes, improvements in clearance and exemption, and packing efficiency of disposal containers.
- Optimisation of LLW assay techniques
- Increase certainty in waste volumes through improvements in characterisation of surface and sub-surface

The following opportunities are identified in the IWS:

- Application of the characterisation and clearance process
- Use of the Studsvik Sweden incinerator for contaminated oils with ash repatriated to UK for disposal at LLWR
- Increased use of the super compactor to reduce disposal volumes
- Melting of contaminated metals to facilitate exemption
- Improved segregation of LLW from ILW

**Principle LLW Issues for the Site**

The IWS identifies the following risks relevant to the management of LLW:

- Inadequate characterisation and sampling
- Not all waste identified

**Alignment to Principles Identified in LLW Strategy**

<table>
<thead>
<tr>
<th></th>
<th>The objectives of the Chapelcross site are to ‘decommission the site in a prompt, safe, and effective manner to reduce chemical and radiological hazards’ (page 10).</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>The Chapelcross IWS notes the application of optioneering / BPEO type approach to prioritisation as well as applying the NDA SED process to each waste item.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Chapelcross aims to (page 10) minimise unnecessary LLW and secondary waste arisings and maximise packing rates.</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>The IWS notes that all wastes are minimised at source where practicable and unavoidable wastes are segregated to reduce volumes, re-used or recycled; application of the waste hierarchy.</td>
</tr>
<tr>
<td></td>
<td>The IWS notes that minimisation of waste is a requirement for all staff with the EHS&amp;Q team establishing standards for waste management and application of BPM to achieve this.</td>
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### MAGNOX NORTH

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<tr>
<td>C</td>
<td>The IWS notes that characterisation of waste in terms of its physical, chemical, radiological properties, and volume is an integral part of the strategic assessment of waste management options (page 31). The IWS notes that waste characterisation is essential to demonstrate BPM (page 32). The conclusions to the IWS note the importance of ‘waste characterisation, including improvement in confidence in the waste volume and physical chemical and radiological characterisation’ (page 58).</td>
</tr>
<tr>
<td>D</td>
<td>The IWS identifies a single waste route as disposal via LLWR. THE IWS notes that changes to the RSA may establish super compaction at Winfrith as a treatment option.</td>
</tr>
<tr>
<td>E</td>
<td>The IWS notes that Chapelcross adopts the approach stakeholder engagement established by Magnox North in their Stakeholder Engagement Plan. The IWS identifies key Chapelcross stakeholders and notes that monthly meetings are in place with SEPA and the NII. The IWS does not identify any specific regulatory engagement related to solid LLW but notes that the local authority is consulted with and advised biannually on ongoing work to address contaminated land (page 29).</td>
</tr>
<tr>
<td>F</td>
<td>The IWS notes opportunities to establish new waste routes to support decommissioning. These include metal melting and VLLW disposal.</td>
</tr>
<tr>
<td>G</td>
<td>The IWS notes that the IWS relates to all waste and materials that could become waste, both radioactive and non-radioactive arising from past, present, and future generation and decommissioning operations at Chapelcross (page 5). The IWS notes alignment with the following National and Local policy requirements: * Waste Plan for Ayrshire, Dumfries and Galloway * Scottish waste policy requirement to implement the waste hierarchy</td>
</tr>
<tr>
<td>H</td>
<td>Chapelcross adopts the Magnox North approach to options studies to support waste management decision making. In addition Chapelcross also applies the NDA SED process (page 20). The IWS does not reference the NDA Business Case Methodology nor indicates application.</td>
</tr>
</tbody>
</table>
Summary of LLW Strategy

The Oldbury IWS states that the overall strategy for handling and conditioning waste follows the principles of the waste hierarchy as well as accounting for Magnox Corporate, National and Local Government Policy, NDA objectives, and regulatory requirements.

Oldbury seeks to reclassify active materials into less active (or cleared) waste through improved segregation, assay, and/or decontamination. The IWS summaries the overall processing / waste handling strategy as follows:

- Optimisation of segregation of wastes into activity category
- Decontamination of solid wastes and size reduction of large items where practicable
- Early retrieval and packaging of stored ILW
- LLW to be packaged in drums or HHISO containers for disposal to LLWR

The IWS summarises the storage / disposal strategy:

- Recycling / reuse of materials where possible
- Use of bulk, inert, non-active material for infill where required during decommissioning
- Default assumption for LLW is disposal to LLWR
- ILW to be stored on site until ILW disposal route is available (or until re-categorised as LLW)

Status

The Oldbury Nuclear Power Station continues to generate electricity. Decommissioning is at the planning stage only.

Waste Volumes

Oldbury estimate that total LLW arisings will be 24,720m³ representing 9% of all waste through the facility lifecycle.

Origin of Wastes

The IWS notes that primary and secondary LLW arises from ongoing operations. The site anticipates significantly increased waste volumes during decommissioning phases with wastes dominated by building materials. The IWS identifies 6 decommissioning projects that will generate over 99% of the LLW at the facility during the C&M phases:

- Reactor building C&M Preps
- Conventional decommissioning
- Ponds C&M Preps
- LLW facility decommissioning
- Radiological Controlled Area (RCA) decommissioning
- TILWSP/TRSDU decommissioning

The facility operates a LLW handling facility incorporating shredding, low force compaction, sorting, assay, and container filling operations. An incinerator is also available for active oils and other combustible LLW.

The IWS notes that Oldbury will generate a significant volume of LLW concrete and steel rebar due to the concrete pressure vessel construction.
The IWS identify current waste routes as well as potential future waste routes. The default strategy is disposal at LLWR but the IWS does identify comprehensive waste routes. Solid LLW has two waste routes:

- Non-combustible LLW (including incinerator ash), and,
- Combustible LLW (including active oils)

Solid LLW is transferred to LLWR. WAMAC is utilised where appropriate. All wastes are disposed of in accordance with the site RSA 1993 authorisation.

A comprehensive organisation has been established to manage waste at Oldbury. Management of radioactive waste is completed by Oldbury employees. Technical advice relating to radioactive waste is provided by the health physics department. Waste prediction and planning for waste arisings during decommissions is carried out by the Decommissions Strategy team. Oldbury plan to establish a waste management department led by a waste manager approximately 2 years before the commencement of C&M preps.

Oldbury has established an integrated system for the management of waste.

The Oldbury IWS identifies several developments since 2009. Those related to LLW include:

- Direct pour of 25m³ of sludge into 1/3 height ISO containers for consignment to LLWR (previously such waste was consigned in 220l drums). It is estimated that this approach resulted in a 59% disposal volume reduction.
- Opportunities to increase the commercial use of VLLW disposal routes were applicable in accordance with changes to UK policy.

Proposals are identified to convert the current Mechanical Maintenance Workshop to a LLW handling facility (page 8) during C&M Preps and Decommission Milestones indicate that construction of a LLW facility will commence in 2014 and operate until decommissioning is completed in 2027.

Further optimisation for LLW minimisation

Optimisation of LLW assay techniques

Liaison with other sites actively developing alternative LLW strategies

The Oldbury site objectives are to continue power generation until June 2011 and then to de-fuel and decommission the site in a prompt, safe, and effective manner designed to reduce chemical and radiological hazards on site.

The Oldbury IWS emphasises the importance of optioneering / BPEO type approach to prioritisation. Oldbury has completed BPEO studies for all predicted decommissioning waste arisings to assist in the formulation of the integrated waste management strategy. In completing the BPEO, Oldbury has considered the waste hierarchy.

Oldbury has also utilised the NDA SED process to assist prioritisation.
<table>
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<tr>
<th>MAGNOX NORTH</th>
<th>OLDBURY</th>
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<tr>
<td>March 2010</td>
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<tbody>
<tr>
<td>B</td>
<td>Oldbury state that the overall strategy for handling and conditioning waste follows the principles of the waste hierarchy. The Oldbury processing / waste handling and storage / disposal strategies include elements of the waste hierarchy. The IWS clearly articulates the importance of waste prevention.</td>
<td>✓</td>
</tr>
<tr>
<td>C</td>
<td>The IWS (page 40) states that Oldbury seeks to reclassify active materials into less active (or cleared) waste through improved segregation assay and / or decontamination. This is aligned with UK LLW strategy. The IWS also notes that characterisation of waste in terms of physical, chemical, and radiological properties and volume is an integral part of the strategic assessment of waste management options. The IWS also notes that waste characterisation is essential to being able to demonstrate BPM.</td>
<td>✓</td>
</tr>
<tr>
<td>D</td>
<td>The Oldbury IWS clearly identifies diverse waste routes and recognises that development in waste disposal will increase site flexibility. In particular Oldbury recognises recent changes to LLW policy may offer opportunities to reduce consignments to LLWR.</td>
<td>✓</td>
</tr>
<tr>
<td>E</td>
<td>Oldbury note their approach to stakeholder engagement is aligned with the Magnox North Stakeholder engagement plan.</td>
<td>✓</td>
</tr>
<tr>
<td>F</td>
<td>The Oldbury IWS recognises that waste route flexibility is likely to improve with, in particular, changes to UK policy. The site also recognises that alternative strategies may be available; for example, metals melting and opportunities to improve decontamination practices.</td>
<td>✓</td>
</tr>
<tr>
<td>G</td>
<td>The Oldbury IWS notes that it ‘relates to all waste and materials that could become waste, both radioactive and non-radioactive arisings from past, present, and future generation and decommissioning operations at Oldbury’. The Oldbury waste management arrangements (MCP16) cover active and non-active wastes (page 17). Appendix 1 provides data for active, hazardous, and non-hazardous wastes.</td>
<td>✓</td>
</tr>
<tr>
<td>H</td>
<td>Oldbury adopts the Magnox North approach to options studies to support waste management decision making. In addition Oldbury also applies the NDA SED process (page 23). The IWS does not reference the NDA Business Case Methodology nor indicates application.</td>
<td>-</td>
</tr>
</tbody>
</table>
Summary of LLW Strategy

The key objective for each Magnox South site is to ‘Safely deliver decommissioning and clean up to restore the Magnox South sites to a final end-state as agreed with the customer, the Nuclear Decommissioning Authority. This must be achieved safely, compliantly and at the best value to the tax payer, with environment and socio-economic needs in mind’.

The current strategy for decommissioning at all sites is based upon hazard reduction taking advantage of the natural process of radioactive decay to reduce levels of radioactivity achieved in the following phases:

- De-fuelling
- C&M Preps
- C&M
- FSC

The baseline strategy for non-combustible solid LLW will be disposal to authorised disposal routes (page 75). A new category of LLW, VLLW is currently under review which will alleviate some burden on vault capacity at LLWR.

The IWS confirms that the current baseline for solid non-combustible LLW produced during C&M Preps is disposal to LLWR (page 96).

Status

Magnox South is responsible for 5 sites relevant to this review and they are each at different lifecycle stages:

- Sizewell A; in the process of removing fuel from reactors with C&M Preps being completed in parallel
- Dungeness; in the process of removing fuel from reactors with C&M Preps being completed in parallel
- Hinkley Point A; de-fuelled and current in C&M Preps phase
- Bradwell; fuel has been removed from the reactor and despatched to Sellafield
- Berkeley; de-fuelled and currently in C&M Preps phase

Waste Volumes

Magnox South predicts a the following volumes of LLW for each phase:

- C&M Preps – 21,183 m³
- C&M – 622 m³
- FSC – 142,317 m³
- Total – 164,122 m³

The IWS estimates that approximately 20% of waste arising from decommissioning activities will be LLW.

Origin of Waste

Waste will arise from progression of each individual sites’ decommissioning plans. Each individual site report provides an estimate of waste at each stage.
Current Waste Routes

The IWS identifies the following LLW Routes:

- Transfer to LLW for disposal
- Transfer to WAMAC or Winfrith for super compaction prior to disposal at LLWR
- Transfer to authorised facilities for incineration (Fawley or internal resource)
- Overseas metal recycling is being utilised by Hinkley Point A and Sizewell A

The IWS notes that facilities are available at sites for segregation, size reduction and decontamination of LLW to minimise waste volumes transferred to LLWR (page 96).

Organisation and Management

Magnox South will establish a new waste function with a dedicated Waste Director. The following functions will report to the Waste Director:

- Waste Strategy
- Waste Programme
- Waste Routes
- Integration and delivery

The Management system, organisation structure, responsibilities, authorities and interfaces for managing work at each Magnox South site is detailed in site documents:

- OQAP for Sizewell A, Hinkley A and Dungeness A
- DQAP for Berkeley and Bradwell

The IWS identifies generic roles and waste management responsibilities (page 38)

The IWS notes that each site operates an integrated management system meeting Magnox South requirements as well as those of the NDA specifically meeting International Standards (page 39). Each site must operate in accordance with QEHS policies referenced in the Magnox South Company Manual (page 40)

The Magnox South management system incorporates the following document levels (page 41):

- High level management arrangements including MCP; MCP16 addresses Waste, Departmental Manuals, post profiles, Interface agreements etc.
- Working level management arrangements including departmental instructions, work instructions, quality plans etc.

Changes from 2009 IWS

The current IWS identifies the following changes in the previous IWS specifically related to LLW management:

- Completion of a comprehensive review of site radioactive waste volumes presenting opportunities to improve the accuracy of the inventory and reduce volumes significantly
- An early closure plan to take Bradwell site into care and maintenance in fours years
- Development of a data base for generic and site specific BPEO studies
- Implementation by Bradwell (the designated lead site) of a waste tracking system that will generate all disposal paperwork and provide full radioactive and non-radioactive waste tracking
- Reconfiguration of the Management Control Procedure 16 (The Management of Radioactive and Non-Radioactive Solid, Liquid, and Gaseous wastes)
- Introduction for new company standards for site waste management plans and project waste management plans
## Opportunities to Improve

The IWS identifies the following areas for action specifically related to LLW management:

- Waste characterisation – assessment of data and additional sampling, testing, analysis and modelling may be required to improve confidence in underlying data, specifically with regard to volumes. Appropriate governance and guidance is being developed as part of the waste characterisation project.
- Optimisation of waste management organisation and arrangements, specifically related to the waste department structure so that it can deliver the agreed strategy for both radioactive and non-radioactive waste.
- LLW minimisation through optimisation of clearance and exemption and utilisation of VLLW disposal routes.
- Improvements to the stakeholder engagement plan.

The IWS identifies the following opportunities specifically related to LLW Management:

- Study considering Intermodal Transport of LLW Containers which concluded that there were no practical or logistical reasons why LLW cannot be moved by rail. However, from an economic perspective use of rail services is not viable.
- Disposal options for LLW across 5 sites are being examined, supported by work on waste treatment, characterisation, monitoring, sampling techniques, storage etc. Work is progressing in liaison with LLWR and to ensure alignment with LLW strategy.

## Principal LLW Issues

The IWS identifies the following risks related to the management of LLW:

- New regulatory requirements may result in rework or a change in project focus.
- Changes to LLWR conditions for acceptance may require additional work to ensure compliance resulting in cost increases and schedule overruns.
- Volume and activity levels could increase as a result of not being able to accurately predict such levels.

## Alignment to Principles Identified in LLW Strategy

**A**  
The key objective for each Magnox South site is to ‘Safely deliver decommissioning and clean up to restore the Magnox South sites to a final end-state as agreed with the customer, the Nuclear Decommissioning Authority. This must be achieved safely, compliantly and at the best value to the tax payer, with environment and socio-economic needs in mind’.

The IWS further notes that the process for work to be performed is categorised and includes (page 16):

- Maintain safety and environmental performance.
- Hazard reduction.

The IWS notes that NDA SED process is used to inform and prioritise decommissioning strategies (page 53).

The Magnox Decommissioning and Radioactive Waste Management Strategy has the following objective (page 31):

- To ensure the continued safety of the public, workforce and the protection of the environment.

The IWS identifies further objectives that provide a clear framework for the development of a decommissioning and waste strategy (page 31):

- ‘The safety for the public and the workforce together with the protection of the environment are of paramount focus and will be considered ahead of all other factors.’
The IWS states that implementation of the Magnox South waste strategy (page 75) is dependent upon individual site safety case (once again emphasising the importance of high standards of safety and environmental protection).

B The IWS identifies objectives that provide a clear framework for the development of a decommissioning and waste strategy (page 31):

- ‘The quantities of radioactive and otherwise hazardous waste arising during the course of decommissioning will be minimised as far as reasonably practicable’.

The IWS recognises the importance of the waste hierarchy (page 32) and notes that all sites have made a commitment to avoid waste generation (page 33).

Sites are expected to apply BPEO and BPM (BAT) to minimise releases of radioactivity to the environment (page 51).

The IWS recognises the NDA business plan the principal objective to (page 30):

- Implement the waste hierarchy by planning for effective disposal solutions.

C The IWS notes (page 81) that the characterisation of waste is an integral part of the strategic assessment of waste management options. The IWS also confirms that waste characterisation is an essential element of BPM demonstration. The IWS states that a Waste Characterisation Group has been established to provide governance to the characterisation programme. Bradwell is identified as the lead site for waste characterisation and has developed a Site Characterisation Plan, comprehensive in both waste scope and strategy (page 81) and notes that the plan has three phases:

- Characterisation to underpin waste volume estimates
- Characterisation to allow decommissioning to process in a safe and compliant manner
- Characterisation for materials and waste disposal

The IWS notes that the purpose of the Integrated Waste Characterisation Strategy is to provide guidelines for accurate and consistent identification of actual and potential waste categories in materials generated by decommissioning activities. The IWS provides an overview of the strategy (reproduced opposite):

The IWS notes that facilities are available at sites for segregation, size reduction and decontamination of LLW to minimise waste volumes transferred to LLWR (page 96).

D The IWS provides information on all Magnox South authorised waste routes (page 115)
### MAGNOX SOUTH

#### Issue 1 March 2010

| E | The IWS notes that alternative strategies considered by Magnox South for the management of LLW including (page 97):
|   | - OSD
|   | - Disposal of VLLW to Conventional Landfill

Magnox South has developed a comprehensive stakeholder engagement programme which takes a planned, structured approach with the aim of generating confidence, preserving good relationships and improving stakeholder trust.

The IWS provides a comprehensive list of key Magnox South Stakeholders (page 70) and notes arrangements for regulatory engagement (page 72).

The IWS notes that the following stakeholder views have been considered in the development of the IWS:

- NDA consultation in the vicinity of sites with regard to strategy development
- Site engagement through Site Stakeholder Groups
- Informal site contact with various stakeholders
- Inter-SLC sharing of IWS documentation
- Routine engagement with the Regulator
- Sharing of baseline decommissioning strategy with regulators and other stakeholders.

| F | The IWS recognises the prevailing and developing LLW strategy and opportunities to consider alternative waste routes for metal, VLLW and HVLA waste (page 75, 98). These are noted in site specific IWS documents. The IWS also notes that where there is no disposal route available, radioactive waste will be placed into a passively safe state (page 32) and ‘strategies will maintain a flexible approach so as not to prematurely foreclose options’ (page 32).

| G | The Magnox South IWS considers both radioactive and non-radioactive wastes (page 108) and the decommissioning and waste strategy (page 75) makes reference to the approach to ensure integration.

The IWS provide an overview of all relevant National Strategy and Government policy relevant to the IWS (page 23). This is utilised and referenced by the site specific IWSs.

| H | Magnox South utilises principally BPEO / BPM options studies to support waste management decision making and also applies the NDA SED process (page 50).

The Magnox South IWS recognises the NDA principles which underpin waste strategy (page 25); ‘To decide how to manage waste on the basis of a business case’.

The IWS also notes that SED process is supported by a business case requirement (page 53).

The IWS comments that the on-site disposal of LLW project has been on hold following an instruction from NDA to review the business case (page 68). A draft business case has been completed (page 125).
### Summary of LLW Strategy

The statement of strategy or waste policy is not articulated but the IWS aligns with the waste hierarchy. Several existing waste routes are identified and the IWS identifies potential future routes to meet changes in Government policy and the requirements of decommissioning. Waste strategy is determined for each waste stream by application of optioneering which also assists the site to demonstrate BPM. The IWS recognises the importance of diverse waste management routes to meet the requirements of the waste hierarchy.

### Status

Sizewell A ceased generation in December 2006. During 2009 the site began removing spent nuclear fuel from the reactors to ponds. The fuel will be held until it is dispatched from the site in flasks. The IWS notes that alongside this activity other areas of decommissioning are being completed. The site expected de-fuelling to continue until 2013 and C&M preps to be completed in 2034.

The site is currently in C&M Preps phase of decommissioning.

### Waste Volumes

The site predicts a the following volumes of LLW:

- C&M Preps – 4,901 m³
- C&M – 116 m³
- FSC – 24,866 m³
- Total – 29,883 m³

### Origin of Waste

The Sizewell A IWS identifies LLW as originating:

- From Routine operations and maintenance of the plant inside the RCA. It is treated as it arises using conventional methods in existing facilities. It is sorted into waste streams
- During the decommissioning lifecycle, large quantities of contaminated building and plant materials are expected

### Current Waste Routes

The IWS identifies the following authorised radioactive waste routes:

- Solid non-compactable waste to LLWR
- Solid compactable waste to LLWR via WAMAC
- Solid compactable waste to LLWR via Winfrith

### Organisation and Management

Sizewell A has established a comprehensive waste management organisation, including a dedicated Waste Department led by a Waste Manager. The Department is partitioned into two areas: delivery and strategy.

Sizewell operates an integrated system for the management of waste (page 17) with a top tier MCP for waste management established in accordance with Magnox South requirements. The Management System, organisation structure, responsibilities, authorities and interfaces for managing, performing and assessing work at Sizewell A are detailed in the Sites Quality Assurance Programme document. Sizewell has allocated waste coordinators to projects to
facilitate effective management.

The Waste Department is responsible for producing the site’s IWS and ensuring adequate arrangements are in place for safe, compliant disposal of solid waste from site.

### Changes from 2009 IWS

The Sizewell A IWS notes the following significant changes from the 2009 IWS pertaining to LLW:

- The site has implemented a Site Waste Management Plan detailing waste arisings and disposals. Project Waste Management Plans are also required for major projects.
- The site has opened an alternative route for the recycling of contaminated metal.

### Opportunities to Improve

The IWS identified the following opportunities specifically related to LLW management:

- Optimisation of the waste management organisation following on-going operational feedback as well as optimisation of waste management arrangements (recognising that current arrangements support an electricity generating site) to ensure the agreed strategy can be delivered.
- Further opportunities to optimise LLW minimisation include: segregation of waste for appropriate disposal routes, use of incineration and other treatment where possible, improvements in clearance and exemption, identification of HVLLW for authorised landfill disposal.
- Optimisation of LLW assay techniques.
- Prepare and submit an application for a change to the RSA authorisation to permit disposal of large volumes of LLW to an alternative landfill to LLWR.
- Investigate requirements for the renewal of the Transfrontier Shipment Authorisation (TFS) to support metal disposal.

The IWS identifies the following potential opportunities:

- FED characterisation may result in the opportunity for early disposal of FED off-site as LLW depending on the outcome of the Magnox South FED dissolution process being investigated.
- The investment in sampling and waste characterisation techniques and capabilities may result in improvements in waste characterisation and sentencing decisions.

### Principal LLW Issues for the Site

The site identifies the following risk related to LLW management:

- Unavailability of LLWR at the time required by Sizewell decommissioning strategy.

Mitigation is detailed in the IWS.

### Alignment to Principles Identified in LLW Strategy

<table>
<thead>
<tr>
<th>A</th>
<th>Sizewell uses optioneering to inform decision making (page 20) and has applied the NDA prioritisation process (SED score) to prioritise project work at site. The IWS notes that processes established for decommissioning will be designed to minimise hazard arising from these wastes before packaging and disposal (page 40)</th>
</tr>
</thead>
</table>
Furthermore the Sizewell IWS notes a commitment to Health, Safety and Environmental best practice:

- The waste department's responsibility for ensuring arrangements are in place for the safe disposal of all solid waste on-site (page 15)
- Identifies the Health and Safety Executive (HSE) Safety Assessment Principles (page 14)
- That processes established for decommissioning will be designed to minimise hazard arising from these wastes before packaging and disposal (page 40)
- The hazard associated with a waste stream determines the handover point the team generating the waste to the waste management team (page 17)

The IWS notes that the minimisation of waste is a requirement placed on all staff, utilising standards, including BPM, to minimise the creation and disposal of radioactive waste (page 18). The IWS confirms that the site has implemented Site Waste Management Plans and Project Specific Waste Management Plans (page 18).

The IWS notes that characterisation of waste in terms of its physical, chemical, radiological properties and volume is an integral component of the strategic assessment of waste management options (page 32). The report proposes that the Sizewell Characterisation Programme for Sizewell A should enable the site to have 80% confidence in its inventory volume data. The IWS also notes that waste characterisation is essential to demonstrate BPM.

Annex 3 of the IWS identifies the following authorised solid LLW routes (page 85):

- Incineration at Sizewell
- Transfer to LLWR for final disposal
- Transfer to WAMAC for treatment prior to final disposal at LLWR
- Transfer to Winfrith for treatment prior to final disposal at LLWR

The site also operates a TFS to treat contaminated steel (expires December 2010).

The site recognises the need to develop new waste routes including (page 64):

- Additional activity allocation for potential FED disposal to LLWR
- Application for disposal of VLLW to local landfill sites

The IWS notes that stakeholder engagement adopted by the site is in accordance with the Magnox South Stakeholder Engagement Plan (page 29). The IWS identifies key stakeholders and notes that the site also maintains a Regulator Engagement Plan. The IWS identifies the following specific stakeholder engagement completed on waste management issues (page 30):

- Engagement with local licensed landfill site operators and Suffolk County Council regarding changes to UK Government Policy for the management of LLW
- Engagement with Suffolk County Council regarding their waste Resources and Issues Consultation (as part of Waste Core Strategy Review).

The Sizewell A IWS notes several current and potential waste management routes and recognises that flexibility is requirement throughout the decommissioning lifecycle. For example the site has established a TFS for the overseas treatment of metal and notes the requirement to re-establish this for 2010. The site has consulted with landfill providers and the local authority on VLLW disposal.
The Sizewell Waste Department has responsibility for ILW, LLW and non-radioactive waste (Figure 3).

The IWS confirms awareness of National Policies etc. detailed in the Magnox South IWS and identifies the following local and regional waste management plans (recognising their impact on Sizewell A):

- Suffolk Waste Local plan
- East of England Regional Waste Vision
  - Implement BPEO for each waste stream
  - Minimise environmental impact
  - Seek to reduce the generation of waste

Sizewell A adopts the Magnox South approach to options studies to support waste management decision making. In addition Sizewell also applies the NDA SED process (page 20).

The Sizewell A IWS does not reference the NDA Business Case Methodology nor indicates application.
**Summary of LLW Strategy**

The Berkeley IWS provides an integrated waste strategy (radioactive and non-radioactive wastes). The site waste management policy is consistent with the waste hierarchy with the most appropriate strategy for each waste item being determined by options assessment. This also assists the site to demonstrate BPM. The IWS recognises the importance of diverse waste management routes to meet the requirements of the waste hierarchy.

**Status**

Berkeley Power Station ceased generation in 1989. Fuel removal from the reactors commenced in 1989 and was completed in 1992. The IWS states that approximately 70% of site has now been decommissioned with 4 key plant areas awaiting removal prior to the start of the Care and Maintenance phase.

The site is currently in the C&M Preps phase and this is predicted to be completed by 2026.

**Waste Volumes**

The site predicts the following volumes of raw LLW:

- C&M Preps – 1,796 m³
- C&M – 124 m³
- FSC – 20,757 m³
- Total – 20,757 m³

**Origin of Wastes**

LLW primarily arises from de-planting and decommissioning activities across the LTP, but will also include high volume low activity operational LLW arisings.

The majority of LLW will arise from the demolition of the reactor buildings during FSC.

**Current Waste Routes**

The Berkeley site IWS provides a comprehensive overview of waste disposal and transfer routes (figure 10, page 39):

- Direct consignment of LLW metal to the Studsvik facility at Workington
- Direct consignment of LLW to the LLWR
- Consignment of incinerable waste to the Fawley, Southampton incinerator
- Super compaction at WAMAC prior to disposal at LLWR.

**Organisation and Management**

The site has established an organisation meeting the requirements of the Magnox South IWS; a waste management team comprising a programme and an execution team led by Head of Waste. The IWS notes that the waste management organisation is under development.

The IWS indicates that the Operations Manager has responsibility for development of the IWS and the development and delivery of all waste management aspects of the site LTP. The IWS notes that at present these responsibilities are delegated to the Head of Waste (who has responsibility for the Waste Management Team).
The Site operates an integrated quality management system outlined in the Site Quality Plan. Management arrangements have been developed in accordance with Magnox South requirements.

It is expected that LLW arisings generated through C&M Preps will be managed at the site LLW complex whilst LLW generated during FSC will be managed through a purpose-built LLW facility.

Changes from 2009 IWS

The IWS identifies the following changes relevant to LLW from the 2009 version:

- New approaches to the classification and treatment of existing LLW streams are being considered, with the possibility that a portion of these could be disposed of as exempt waste, or High Volume LLW (HVLLW).
- A new RSA 1993 authorisation has been issued for the site which allows offsite disposal and treatment of LLW at other facilities in the UK and overseas as well as potential to dispose of HVLLW

Opportunities to Improve

The IWS identified the following opportunities specifically related to LLW management:

- Optimisation of the waste management organisation following on-going operation feedback to ensure the agreed strategy can be delivered
- Further opportunities to optimise LLW minimisation, including segregation of waste for appropriate disposal routes, use of incineration and other treatment where possible, improvements in clearance and exemption, identification of HVLLW for authorised landfill disposal
- Optimisation of LLW assay techniques
- Production of guidelines for the characterisation of waste including LLW
- Production of a waste characterisation plan to improve waste confidence levels

Principal LLW Issues for the Site

The Berkeley IWS identifies the following risks relevant to the management of solid LLW:

- EA restricts the disposal of LLW at the LLWR through refusal of an authorisation variation
- LLWR costs rise above NDA escalation costs
- Funding restriction result in a deferral of key projects

The IWS identifies mitigation.

Alignment to Principles Identified in LLW Strategy

A Berkeley uses the optioneering process to inform its decision making. The site has also utilised the NDA SED process for prioritisation. SED scores have been calculated for each waste stream (page 26). The site endorses the Health and Safety Executives’ Safety Assessment Principles (page 18).

B The Berkeley IWS provides a statement of site policy and procedures. This states that ‘the sites waste management policy is based on the principle that the preferred priority of action is consistent with the waste hierarchy’ (page 19). The IWS further states that the core principles of waste management at Berkeley include reduce/avoid, reuse and recycle. The Berkeley IWS recognises the importance of waste prevention and the waste hierarchy:

- Application of BPM to minimise the volume of waste transferred to LLWR
- Segregation of wastes prior to disposal to LLWR
- Treatment to promote reuse and recycling
- The site Action Plan identifies several areas, including: proposals to optimise LLW minimisation, opportunities from a waste minimisation focus group, optimisation of assay techniques and waste management organisation and arrangements.

The IWS identifies a number of new and potential waste treatment routes that meet the requirements of the waste hierarchy.
### MAGNOX SOUTH

#### C
The Berkeley IWS (page 38) notes that characterisation of waste in terms of its physical, chemical, radiological properties and volume forms, not only an integral part of the strategic assessment of waste management options, but also being able to demonstrate BPM.

The IWS also references proposals to develop an Integrated Characterisation Strategy Plan to underpin the site’s IWS. The site recognises the importance of characterisation to optimise waste management options and project delivery.

#### D
The Berkeley IWS identified the following regulated waste routes (Annex 3):

- Solid LLW – incineration at Fawley Southampton
- Solid LLW – direct transfer to LLWR
- Solid LLW – transfer to WAMAC prior to disposal at LLWR
- Metallic LLW – transfer to Studsvik UK, Workington

The IWS notes that further innovative waste routes will be required to sustain decommissioning, and the site is actively engaged with the Regulator to develop these.

#### E
The IWS recognises the need for new waste routes or approaches and notes the requirement to complete further segregation of LLW prior to disposal to LLWR (page 48) to treat and reclassify the following waste prior to disposal:

- Metallic LLW
- Combustible LLW
- Super compactable LLW
- Other LLW
- High Volume LLW

#### F
The Berkeley IWS notes several current and potential waste management routes and recognises that flexibility is a requirement throughout the decommissioning lifecycle. For example the IWS notes that during C&M Preps and FSC, contaminated soil may be directly disposed as infill for HHISO containers or reclassified as HVLLW (page 49).

#### G
Section 4 of the Berkeley IWS clearly states that it provides a summary of the waste management strategy for radioactive and non-radioactive waste types.

#### H
Berkeley adopts the Magnox South approach to options studies to support waste management decision making. In addition Berkeley also applies the NDA SED process (page 26).

The Berkeley IWS does not reference the NDA Business Case Methodology nor indicates application.
<table>
<thead>
<tr>
<th>MAGNOX SOUTH</th>
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<tbody>
<tr>
<td><strong>Summary of LLW Strategy</strong></td>
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<tr>
<td>Whilst the Bradwell IWS does not articulate a site specific summary strategy it does note full alignment with the Magnox South objectives and aims. The requirements of strategy development including optioneering, BPEO, BPM and SED are clearly articulated in the Bradwell IWS.</td>
<td></td>
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<tr>
<td>The Bradwell strategy follows the standard approach of C&amp;M Preps, C&amp;M and FSC. The IWS also notes alignment with local and regional waste management plans including:</td>
<td></td>
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<tr>
<td>- Managing waste in a manner consistent with the waste hierarchy and ALARP principles</td>
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<tr>
<td>- Use of the nearest appropriate location for the disposal of waste</td>
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<tr>
<td>- Management of waste at the point of arising</td>
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<tr>
<td><strong>Status</strong></td>
<td></td>
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<tr>
<td>The Bradwell site ceased electricity generation in 2002, and is currently decommissioning. Fuel removal from the reactors was completed in December 2005 and from the ponds and site before October 2006. The site is currently in C&amp;M Preps phase predicted to continue until 2027.</td>
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<tr>
<td><strong>Waste Volumes</strong></td>
<td></td>
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<tr>
<td>The site predicts a the following volumes of raw LLW:</td>
<td></td>
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<tr>
<td>- C&amp;M Preps – 4,432 m$^3$</td>
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<tr>
<td>- C&amp;M – 112 m$^3$</td>
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<tr>
<td>- FSC – 35,006 m$^3$</td>
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<tr>
<td>- Total – 39,550 m$^3$</td>
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<tr>
<td><strong>Origin of Wastes</strong></td>
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<tr>
<td>The IWS notes that 5 decommissioning projects have been identified as generating over 80% of the LLW for the C&amp;M phase:</td>
<td></td>
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<tr>
<td>- Fuel transfer ponds decommissioning</td>
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<td>- Reactor building clearances</td>
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<tr>
<td>- Pond water treatment plant decommissioning</td>
<td></td>
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<tr>
<td>- Pile cap mobile equipment</td>
<td></td>
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<tr>
<td>- Circulator hall de-plant</td>
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<tr>
<td>It is anticipated that the greatest volume of LLW will be concrete generated during FSC. Larger volumes of contaminated soil, mild steel, other metals and secondary waste will also be generated during this phase. FSC will generate approximately 89% of total LLW throughout the decommissioning lifecycle.</td>
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<tr>
<td>The IWS notes that whilst there is not LLW pond sludge at present this may change as characterisation data becomes available.</td>
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</tbody>
</table>
Current Waste Routes

Bradwell currently operates the following facilities for solid Low Level Waste Management (note: this has been extracted from the IWS and reflects facilities with a clear LLW management function):

- Low Level Waste Management Facility, which was designed to receive, process, analyse, provide interim storage and dispatch compactable and non-compactable LLW.
- An Active Waste Handling Building (AWHB) for the receipt, processing, storage and dispatch of compactable and higher activity Low Level Waste
- Temporary staging area which has been used for LLW HHISO containers containing pond skips, prior to further processing and / or packaging disposal

The IWS details current and potential waste routes. At present Bradwell identifies disposal at LLWR (perhaps via the Winfrith super compactor) and on-site disposal as the principle route for solid non-combustible LLW.

However the IWS also notes the following approaches for other types of waste:

- Metal – where practicable metal LLW will be decontaminated to exempt levels to enable recycling. Overseas recycling will be utilised if this is not possible in the UK.
- Primary circuit components – in line with base line state will be recycled, with boilers laid down and stored.
- Pond Skips will be decontaminated suitable for recycling at a metal melting facility
- Combustible LLW incinerated via the authorised disposal route to Fawley Southampton.

Bradwell is considering strategic options to transfer waste to other Magnox South Sites.

Organisation and Management

Bradwell has established an organisation for waste management, with the waste manager a member of the Site Lead Team, responsible for waste characterisation, on-site waste management activities, monitoring release and sentencing of all wastes and off-site transportation and waste disposal. The Waste Manager is also responsible for the development of the site IWS and waste management aspects of the LTP.

The sites decommissioning Quality Assurance Programme document details the management system, organisation structure, authorities and interfaces for those responsible for waste management. A waste management department manual has been issued, with all operations controlled by documented systems of work. A waste programme and waste execution team report to the Waste Manager to develop and deliver the waste strategy.

Project Waste Management Plans are required for all projects where waste may be generated and these must be in place prior to waste generation.

Changes from 2009 IWS

The Bradwell IWS notes a number of changes specifically related to LLW from the 2009 version of the IWS:

- Inactive and active commissioning and handover to the waste department of a LLW Management Facility
- A TFS Authorisation issued for recycling contaminated and activated metal to Energy Solutions’ Bear Creek facility
- Introduction of a new company standard requiring that Project Waste Management Plans are prepared for all projects generating waste
- Trials to decontaminate ILW pond fuel skips. Baskets and liners to determine a more effective technique to decontaminate to LLW levels suitable for metal melting
- Requirement for variation to RSA authorisation submitted to increase the site activity allocation for disposal of solid waste to LLWR
Opportunities to Improve

The IWS identified the following opportunities specifically related to LLW management:

- Use of rail as an alternative to using road for the transport of HHISO containers, which may result in reducing overall transport costs for dispatching LLW to the LLWR
- The development of a Low Level Waste Management Facility offers opportunities to minimise waste transfers to the LLWR by enhancing the sites capabilities for decontamination and size reduction operations. Increased packing efficiencies are expected
- Review of radioactive waste inventory to identify the volume of VLLW that potentially could be sent for disposal at landfills other than LLWR
- Further opportunities to minimise LLW including improvements in packing efficiency, use of the incineration route and improvements in clearance and exemption to allow disposal as exempt waste
- Opportunities to improve waste processing efficiency to enhance waste assay techniques

Principle LLW Issues for the Site

The IWS identifies the following risks relevant to LLW:

- Waste Characterisation – waste monitoring protocols cannot be developed to satisfy the Regulator and potentially high throughputs of waste arisings requiring off-site disposal
- Waste Characterisation – Inadequate physical characterisation of waste prevents designed retrieval processes from functioning correctly
- Waste Characterisation - Unexpected rogue debris found in Active Waste Vaults
- Land Quality - Additional land contamination is discovered within or external to the site boundary or existing land contamination starts to migrate

Mitigation measures are identified for all the above site issues.

Alignment to Principles Identified in LLW Strategy

A The Bradwell IWS identifies local and National policy requirements (page 14) and notes the relevance of managing waste in a manner consistent with ALARP principles

The Bradwell IWS notes that it should be read in conjunction with the Magnox South IWS. This states quite clearly that a key objective of the strategy is to (page 31 Magnox South IWS):

- Ensure the continued safety of the public, the workforce and the protection of the environment
- To deliver a systematic and progressive reduction of hazard at each site.

Bradwell has employed the NDA prioritisation process for each waste item as well as considering external modifiers and project interdependencies. The IWS also notes that the site also uses the optioneering process for decision making and prioritisation, including BPEO/BPM.

The Bradwell IWS notes the requirements of the HSE Safety Assessment Principles.

B The Bradwell IWS identifies local and national policy requirements (page 14) and notes the relevance of managing waste in a manner consistent with the waste hierarchy

The IWS notes that the IWS has been written to avoid repetition and duplication, and Magnox South Corporate policies, strategies and standard management arrangements are applicable ( page 3). In this context the Magnox South IWS notes that the core waste management objectives at all sites must account for the principles of the waste hierarchy.
<table>
<thead>
<tr>
<th>MAGNOX SOUTH</th>
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<tbody>
<tr>
<td>C</td>
<td>The IWS notes that characterisation of waste in terms of its physical, chemical and radiological properties and volume forms an integral part of the strategic assessment of waste management options. The IWS notes that Bradwell has established a Characterisation plan/programme and this should enable the site to have 80% confidence in its inventory volume. The IWS notes that Bradwell considers effective characterisation essential to demonstrate BPM (page 33) Bradwell is the lead site for waste characterisation for Magnox South (Magnox South IWS, Issue 1, 2010)</td>
</tr>
</tbody>
</table>
| D | The Bradwell IWS notes the core waste management routes as:  
- Disposal of solid LLW to LLWR  
- Incineration of combustible LLW at Fawley Southampton  
- Super compaction of compactable LLW at Winfrith or WAMAC prior to disposal at LLWR  
The IWS identifies a number of opportunities to increase flexibility of waste disposal routes. These include metal melting, interim storage and overseas recycling. The IWS notes the opportunities of improvement in characterisation to enable waste to be exempt as well as ability to utilise alternative landfills to LLWR. |
| E | Bradwell approach stakeholder engagement in accordance with the Magnox South Stakeholder Engagement Plan. The IWS identifies key National and International stakeholders. The IWS identifies the following waste management stakeholder engagements applicable to LLW management:  
- Discussions with LLWR to permit the consignment of Vault 6B sludge  
- TFS authorisation in place for transfer of metals to Energy Solutions facility in USA. A new TFS application has been drafted to consign metals to Siempelkamp Germany. |
| F | The Bradwell IWS notes a number of waste routes. Implicit is the need to support waste types of differing hazard. For example the IWS notes the preference to dispose of VLLW to landfills other than LLWR. |
| G | Section 4 of the Bradwell waste strategy clearly states that the strategy provides for radioactive and non-radioactive waste types and confirms alignment to National and Regional policy and strategy. |
| H | Bradwell adopts the Magnox South approach to options studies to support waste management decision making. In addition Bradwell also applies the NDA SED process (page 26). The Bradwell IWS does not reference the NDA Business Case Methodology nor indicates application. |
Summary of LLW Strategy

Whilst the Hinkley Point A site does not articulate a site specific summary strategy it does note that strategy development including optioneering, BPEO, BPM and SED have been utilised to develop strategy.

The Hinkley Point A strategy follows the standard approach of C&M Preps, C&M and FSC. The IWS also notes alignment with local and regional waste management plans including:

- Managing waste in a manner consistent with the waste hierarchy and Safety Assessment Principles
- Use of the nearest appropriate location for the disposal of waste
- Management of waste at the point of arising

Status

Hinkley Point A ceased generation in 1999. Removal of fuel from the reactors was completed in November 2004. Fuel-free verification has yet to be confirmed. The site is currently in the C&M Preps phase which is predicted to continue until 2032.

Waste Volumes

The site predicts the following volumes of raw LLW:

- C&M Preps – 5,337 m³
- C&M – 100 m³
- FSC – 38,326 m³
- Total – 43,763 m³

The site estimates that approximately 24% of the total waste arising during decommissioning.

Origin of Wastes

Solid LLW will arise through the decommissioning lifecycle; however it is FSC where the majority is generated (with this being largely concrete). The Hinkley Point A IWS identifies three decommissioning projects as generating over 75% of the LLW for the C&M Phase:

- Pond decommissioning
- Reactor building clearances
- Pond water/active effluent treatment plant decommissioning

Operational solid LLW will continue to be generated throughout.

Current Waste Routes

The IWS identifies the following authorised waste routes:

- Organic solid LLW to the incinerator at Fawley Southampton
- Solid LLW to LLWR
- Solid compactable LLW to WAMAC prior to disposal at LLWR
- Shipment of radioactively contaminated pond skips and contaminated metals to USA for recycling

The IWS notes that the incineration contract with Hinkley Point B has been terminated.
Organisation and Management

The site has established a comprehensive organisation to manage waste (page 15). A waste manager, who is also a member of the site Lead Team, has been appointed to lead the waste management department. The waste team is divided into a Waste Processing Team, Waste Process Strategy Team and waste delivery engineers. The Waste Department is structured to manage waste routes and develop and implement waste strategy.

Hinkley Point A has an integrated system for the management of waste. The management system, organisation structure, responsibilities and authorities for those managing waste are established in the Site’s Quality Assurance Programme document. The site has developed a waste management manual that details the waste management arrangements.

Changes from 2009 IWS

The IWS identifies no significant changes from the 2009 version.

Opportunities to Improve

The Hinkley Point A IWS Action plan identifies the following opportunities to improvement LLW management:

- Optimisation of waste management organisation and waste management arrangements
- Opportunities to optimise LLW minimisation through improvements in packing efficiency, use of the incineration route, changes to clearance and exemption and exploitation of VLLW
- Optimisation of LLW assay techniques
- Identification of alternative options for VLLW disposal
- Maximise recycling opportunities for metal and minimise waste disposals to LLWR
- Implementation of the electronic waste tracking system

Principal LLW Issues for the Site

The Hinkley Point IWS identifies the following risk specifically related to LLW:

- Uncertainty regarding LLW disposal at the LLWR; closing date, future vaults, location, capacity and availability

Mitigation is identified in the IWS

Alignment to Principles Identified in LLW Strategy

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| A | Hinkley Point A uses the optioneering process to inform its decision making. The site has applied the NDA SED process to assist prioritisation and notes that at Hinkley Point A the waste stream is the building block for the prioritisation process contributing to the overall SED score for the host facility (page 23).

The conclusions to the IWS note that application of the radioactive waste management principles compliant with the Health and Safety Executive’s Safety Assessment Principles are integrated into future site plans. |

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| B | The IWS provides a statement of site Policy (page 14) This states that ‘the site waste management policy is based on the principle that the preferred priority action is consistent with the waste hierarchy’. The IWS further notes that the core principles at Hinkley Point A include:

- Reduce/Avoid
- Reuse
- Recycle

The conclusions to the Hinkley Point A IWS note that application of the waste hierarchy, sustainable waste management and consideration of environmental impact are built into future site plans (page 82). Certainly examples of application of treatment options (for example reuse of pond skips) indicated this to be the case (page 44). |
C The IWS notes that characterisation of waste in terms of its physical, chemical and radiological properties and volume is an integral part of the strategic assessment of waste management options (page 39). Hinkley Point A notes that characterisation is essential to demonstrate BPM. The site has also developed an integrated characterisation strategy plan to underpin the IWS. This indicated the importance attached to characterisation by the site. The 2009 and 2010 Action Plan includes opportunities to improve site characterisation practices.

The IWS indicates the significant current and potential waste segregation. The Site Waste Management Principles include: ‘Radioactive Waste shall be characterised and segregated in order to facilitate safe and effective management, transport and disposal’ (page 15).

D The Hinkley Point A IWS identified the following regulated waste routes (Annex 3):

- Solid LLW – transfer to Hinkley Point B for incineration
- Solid LLW direct transfer to LLWR
- Solid LLW – transfer to WAMAC prior to disposal at LLWR
- Metallic LLW – transfer to Winfrith for super compaction

The IWS notes that further innovative waste routes will be required to sustain decommissioning and the site is actively engaged with the Regulator to develop these.

E The Hinkley Point A IWS includes details of arrangements for both radioactive and non-radioactive waste. The site notes that Hinkley Point A is aligned with Magnox South and recognises Local and Regional Waste Management Plans:

- Somerset Waste Local Plan
- South West Region Waste Vision
- Somerset and Exmoor National Park Joint Structure Plan

F The IWS identifies a number of current regulated and potential waste routes for solid LLW, and notes the application of BPEO, BPM and optioneering to determine such routes. The IWS notes opportunities to utilise changes in Government policy to facilitate disposal of VLLW as well as the option to establish on-site disposal for concrete and building rubble (in cooperation with Somerset County Council) (page 52).

G The IWS incorporates both radioactive and non-radioactive waste management strategies. In referencing UK and Regional policy and strategy the IWS indicates alignment. The following Regional Waste Management Plans are noted:

- Somerset Waste Local Plan
- South West Regional Waste Vision

H Hinkley Point A adopts the Magnox South approach to options studies to support waste management decision making. In addition Hinkley Point A also applies the NDA SED process (page 23).

The Hinkley Point A IWS notes that a business case to support the viability of on-site disposal of LLW at Hinkley Point A is under development (page 34).
Summary of LLW Strategy

Dungeness A is currently de-fuelling reactors with some C&M Preps being completed in parallel.

Dungeness A note that the strategy for decommissioning is hazard reduction based, taking advantage, where necessary of the process of natural decay to reduce levels of radioactivity.

The IWS notes that the overall Dungeness site strategy is aligned with Government policy and regulatory requirements and demonstrates application of the waste hierarchy:

- Ensure waste is appropriately sorted and characterised
- Reuse of concrete to infill voids on site
- Reuse/recycle free release steel

The IWS notes that a component of the strategy is to increase in size and capability of the existing LLW handling building before 2014 to enable the site to meet increasing waste management agreement requirements during decommissioning.

Status

Dungeness A ceased power generation in December 2006. The site is in the process of de-fuelling the reactors and dispatching spent fuel to Sellafield. The IWS notes that many parts of the site are not in operation and are steadily being dismantled to reduce hazard. C&M Preps is forecast to continue until 2034.

Waste Volumes

The site predicts a the following volumes of raw LLW (page 34):

- C&M Preps – 4,717 m³
- C&M – 170 m³
- FSC – 23,362 m³
- Total – 28,249 m³

The site estimates that 28% of all waste arisings during decommissioning will be LLW.

Origin of Wastes

The IWS notes that the majority of LLW will be generated during FSC resulting form the demolition of reactor buildings, the majority will be concrete, mild steel and secondary wastes. The current state for FSC concrete is to disposal at LLWR. The IWS notes that the activation profile and presence of Tritium has the potential to increase significantly this volume.

Waste will also arise from C&M Preps and C&M but this is a small proportion of the total.

Current Waste Routes

The IWS notes the following authorised waste disposal routes for solid LLW:

- Solid (compactable and non-compactable) LLW to the LLWR (where appropriate via WAMAC)
- Compactable waste to the super compactor at Winfrith
- Combustible solid LLW incinerated at on-site facilities
Waste management agreements are in place with LLWR for disposal and/or LLW treatments for recycling or waste minimisation, the WAMAC prior to disposal and the super compactor at Winfrith.

The IWS notes that the current strategy for solid non-combustible waste is to transfer to LLWR for disposal; this applies to contaminated land (soil), insulation (asbestos), LLW sludge, ion exchange materials, and general compactable and non-compactable wastes. Waste is sorted at the Low Level Active Waste Facility.

The IWS notes that the baseline for combustible LLW is to incinerate in authorised facilities on-site. It is anticipated that this practice will continue.

The IWS notes that there are no other transfer routes in the near term (page 60) but notes that Magnox South are seeking to optimise the management of certain radioactive wastes (primarily) metals which could lead to new transfer routes for radioactive waste.

**Organisation and Management**

Dungeness A has established a waste management organisation (page 15). The management system, organisation structure, responsibilities authorities and interfaces for those managing, performing and assessing work at Dungeness A are established in the site's Operational Quality Assurance document.

Dungeness A established a dedicated waste management department recognising the challenges faced by a decommissioning site. The waste manager heads the waste team and is a member of the site lead team. The waste manager and team are responsible for:

- Developing the waste management team to meet present and future needs
- Developing and implementing the Dungeness A IWS and supporting documentation
- Recruiting, training and overseeing waste management staff assigned to various waste management facilities

Dungeness A has an integrated system for the management of waste established in accordance with Magnox South requirements.

**Changes from 2009 IWS**

The IWS identifies the following changes related to the management of LLW:

- Consultation commenced with the EA to pursue the development of a formal VLLW disposal route
- Introduction of company standard requiring that a site waste management plan is produced for all new projects

**Opportunities for Improvements**

The following potential improvements are identified in the Dungeness A IWS:

- Development of the existing Low Level Active Waste to permit great flexibility with respect to decontamination of LLW as well as improved ISO container loading arrangements
- Further opportunities to optimise LLW minimisation including improved packing efficiency, greater use of incineration route and improvements in clearance and exemption facilities
- Optimisation of LLW assay techniques/equipment
- Utilise the new LLWR metal recycling service

**Principal LLW Issues for the Site**

The Dungeness A IWS identifies the following risks related to LLW management:

- Uncertainty regarding the continued availability of LLWR; specifically closure date, future vaults, location, capacity and availability
- Encapsulation of FED in its raw state would take up unnecessary amounts of space in LLW
## Alignment to Principles Identified in LLW Strategy

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| A | The IWS states that the current strategy for decommissioning is hazard reduction based. Dungeness A uses the optioneering process to inform its decision making. The IWS notes the following factors have been utilise to assess prioritisation (page 21):  
  - SED measures for each waste item has been evaluated based on form and location  
  - Consideration of external modifiers                                                                                                                                                                                               |
| B | The IWS notes that Dungeness A uses BPM to minimise the volumes of waste transferred to disposal facilities. The IWS action plan (page 65) notes the following activities that during 2010 Dungeness A aligned with waste hierarchy:  
  - Improvements in decontamination performance to increase material removed from LLW and VLLW categories  
  - Establish a plan to remove waste from site applying the waste hierarchy.                                                                                                                                                        |
| C | The IWS (page 34) notes that characterisation of waste in terms of its physical, chemical, radiological properties and volume is an integral part of the strategic assessment of waste management options. The IWS Action Plan for 2010 (page 64) notes that Dungeness A is seeking to complete a full site-wide characterisation survey to remove uncertainty regarding both the classification and volumes of waste. |
| D | The IWS notes the available waste routes and also recognises that recent and future changes have the potential to open further waste management routes for the site.                                                                             |
| E | The IWS identifies the key site stakeholders and provides examples of stakeholder engagement on specific waste management issues (page 31):  
  - Waste disposal practices – visit from local MP for Hastings & Bexhill to witness site practices and fact finding on local issues regarding waste management and other areas of interest.  
  - Stakeholder presentation – biannual meetings where the site presents to local stakeholder groups including NGO’s and local groups to demonstrate arrangements established to manage the impact of the decommissioning process. |
| F | The IWS Action Plan for 2010 (page 64) notes that Dungeness A is seeking to utilise the LLWR metals recycling and VLLW disposal routes as they become available, recognising the need for flexibility in waste management routes.                                      |
| G | Section 4 of the Dungeness A IWS provides a summary of the waste management strategy for both radioactive and non-radioactive wastes. The IWS provides an overview of relevant local and regional waste management plans as well as noting alignment with the Magnox South IWS. |
| H | Dungeness A adopts the Magnox South approach to options studies to support waste management decision making. In addition Dungeness A also applies the NDA SED process (page 21). The Dungeness A IWS does not reference the NDA business case process nor provide examples of application. |
Summary of LLW Strategy

Sellafield articulate a comprehensive Low Level Waste Strategy in the Sellafield IWS Principles document (and published in the LLW Management Strategy, December 2008). For clarity this has been reproduced below.

Sellafield provides a prediction of the impact of strategy on waste volumes (page 31)

Status

Sellafield is an operational site with decommissioning works, principally to reduce site hazard, being completed in parallel

Waste Volumes

The June 2009 IWS predicts that approximately 756,000 m³ of packaged LLW (excluding contaminated Land LLW and VLLW) will be generated during the facility lifetime.

Origin of Wastes

LLW at Sellafield arises from operational and decommissioning activities. Operational LLW is generated during routine monitoring and maintenance work and comprises paper, plastic clothing, wood and miscellaneous metallic items. Decommissioning waste consisting of building rubble, soils, metal plant, and equipment (page 11, Sellafield IWS Principles)

Current Waste Routes

The IWS does not provide a clear overview of current waste. However the following routes are identified:

- Disposal to LLWR
- Super compaction at WAMAC prior to disposal at LLWR
- Treatment at the Sellafield Metals Recycling Facility
 Organisation and Management

The 2009 IWS does not discuss organisation and management. However, the IWS does note the IWS structure, and identifies the creation of the Waste and Effluent Directorate to improve coordination, integration and optimisation of wastes at Sellafield.

Changes from 2008 IWS

The Sellafield 2009 IWS identifies numerous changes and improvements. Those of particular importance to LLW management include:

- Review of LLW disposal practices including the onsite metals recycling facility has resulted in a reduction in the number of containers consigned to LLWR.
- Provide an extensive BPM case to justify the disposal of Calder Hall heat exchanger asbestos to landfill rather than LLWR.
- Commissioning monitoring equipment to improve exemption of waste
- The metal facility exceeded production targets for processing and recycling

Sellafield confirms that there has been no change in LLW strategy (page 4) and provides a supporting figure to illustrate this (reproduced below as an example of best practice).
Opportunities to Improve

Sellafield recognise the benefits of LLW treatment and high level analysis indicates a potential saving of approximately 20,000 ISO Freight containers if the following processes are developed:

- Waste sorting and segregation capability
- Thermal treatment capability
- Metal decontamination capability
- Specified landfill capability

In addition the IWS recognises potential benefits to LLW management from Windscale and Sellafield synergy.

The 2009 IWS does not provide a 2009/2010 action plan

Principle LLW Issues for the Site

The Sellafield 2009 IWS identifies the following risks applicable to the management of LLW:

- Uncertainty surrounding the LLWR regarding potential changes to waste acceptance criteria, future capacity and potential disposal cost increases
- The Sellafield IWS may not be aligned with the National Waste Strategy

Mitigation measures are established in the 2009 IWS.

The Sellafield IWS comprises a number of component strategies (HLW, ILW, PCM, LLW, Aqueous and Gaseous waste). The Sellafield IWS Principles document (page 9) identifies 3 principal high level risks associated with the IWS:

- Component waste strategies at Sellafield
- Site-wide internal risks
- Uncertainties due to decisions that are external and outside the control of Sellafield

Alignment to Principles Identified in LLW Strategy

The Sellafield vision for their IWS is focused on sustainability and defines sustainability in the following terms: ‘where sustainability is waste in a form that requires ideally nil, but probably minimal management to safely protect people and environment including remediation of historical impacts’ (Sellafield IWS Principles, page 4). The 2009 IWS (page 3) reproduces this statement.

The Sellafield IWS Principles document (page 6) notes that a fundamental principle for the IWS ‘is that all strategic decisions related to waste management on the Sellafield site should be consistent with the NDA’s Business Case Guidance and therefore BAT and ALARP’. The Principles document confirms that a fundamental requirement of the site licence is to ensure risks to the workforce and members of the public are mitigated to a level that is As Low As is Reasonably Practicable (page 5)

Sellafield has articulated an adjusted vision the waste hierarchy which includes ‘safety and risk reduction’ at the very top of the triangle indicating the primacy of this activity (Sellafield IWS Principles, page 7)

The Sellafield IWS Principles document states that an IWS seeks to ‘Reduce risk
The 2009 IWS (page 3) notes that the rate of progress in implementing the IWS is influenced by the need to be consistent with the higher strategic driver for the site of ‘hazard and environmental risk reduction’; once again emphasising the importance of high standards of health, safety and environmental protection.

Sellafield applies the SED process to understand priorities (page 26, Sellafield IWS 2009)

### B The Sellafield waste management principles incorporated into the IWS include ‘the waste hierarchy’. (Sellafield IWS Principles, page 4)

The Sellafield IWS Principles document states that an IWS seeks to ‘avoid the generation of waste’ (page 8)

The IWS (2009, page 3) supports the site IWS vision by:

- Providing a methodology for the practical application of the Waste Hierarchy

### C Characterisation (sort, segregate, size, reduce) forms a central element of the Sellafield LLW strategy. Characterisation provides the basis for subsequent waste processing, storage or disposal (page 12).

The Sellafield IWS proposes an integrated approach to the implementation of process and treatment capabilities where a central hub would sort, segregate, size reduce and characterise LLW (page 13)

### D The IWS does not provide a clear overview of current waste. However the following routes are identified:

- Disposal to LLWR
- Super compaction at WAMAC
- Treatment at the Sellafield MRF

It is recommended that the 2010 iteration of the IWS details current regulated waste routes.
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| **E** | The Sellafield IWS Principles document (page 8) introduces the concept of Engineered Destinations for waste focussed on minimising the pathways to the environment and with the aim of minimising the generation of radioactive waste and ensuring exempt waste can be reused or recycled. This approach provides a good basis for developing new waste routes.  

The Sellafield IWS Principles document provides a comprehensive list of external bodies impacting Sellafield Ltd policy  

The Sellafield Low Level Waste Strategy (page 24) details a comprehensive stakeholder engagement supporting a series of BPEOs completed for the following waste streams:  

- Oils  
- Process wastes  
- Ferrous metals  
- Lead  
- Mercury  
- Asbestos |
| ✔️ |   |
| **F** | The IWS supports the development of flexible waste routes and LLW strategy has been developed to deliver this. The IWS identifies WAMAC, Thermal Treatment, Low Force Compaction, Metal decontamination and treatment and disposal as waste routes (page 31, Sellafield IWS 2009) |
| ✔️ |   |
| **G** | The 2009 IWS recognises applicable national, regional and local waste strategies including the UK Discharge Strategy and National LLW strategy.  

A risk identified in the 2009 IWS is that the IWS may not be aligned with the National Waste Strategy. A mitigation measure to develop and implement a communication plan has been established. |
| ✔️ |   |
| **H** | The IWS notes the key strategic priority is focussed on site hazard reduction, with high level objectives required by the NDA (page 26). The IWS notes several factors considered in prioritisation including SED, stakeholder concerns, cost, revenue, fault mechanisms etc.  

The LLW Principles document notes the requirement to complete a business case to support all strategic decisions related to waste (page 6). |
| ✔️ |   |
**Summary of LLW Strategy**

The overall strategy for handling and conditioning waste is to:

- Minimise waste arisings wherever practicable in line with the waste hierarchy
- Segregate wastes (VLLW/LLW and hazardous/non-hazardous) as far as practicable to reduce volumes of more restrictive categories
- Package solid LLW appropriately for disposal

The site strategy also provides for the delivery of a LLW course to all operational employees and managers to include waste hierarchy, disposal site conditions for acceptance and considerations governing the choice of the most appropriate disposal routes.

Capenhurst IWS specifically notes that the site seeks to actively participate in the National LLW Strategy.

In addition, the site has strategic objectives to complete decommissioning of the diffusion plant and to remove all plant and infrastructure not required to deliver cost effective uranium storage operations by 2010.

The site operates an integrated waste and environment decision making process (Figure 6, page 36) incorporating the BPEO process that clearly incorporates the waste hierarchy.

**Status**

The site commenced decommissioning in 1982 and this is significantly advanced. The continuing activities address the more difficult residue materials, contaminated waste components and demolition of redundant buildings. The site currently stores 40,000 te of uranic materials and is in the process of commissioning a building for washing empty uranium hexafluoride containers.

**Waste Volumes**

The site estimates that the total LLW inventory is 21,000 m³, 14,320 m³ and 2,935m³ has already been disposed of to Clifton Marsh and LLWR to respectively.

**Origin of Waste**

LLW will arise from de-planting and decommissioning activities throughout the site lifetime. The IWS notes that the treatment and disposal of remaining contaminated wastes from the diffusion plant decommissioning will involve the removal of 150 te of metal and 50 te of concrete waste associated with the retrieval, processing and packaging of legacy LLW that are not presently in a passive state, as well as de-planting of site services no longer required. (page 11). The IWS indicates that this will be characterised and disposed of to Clifton Marsh or LLWR.

**Current Waste Routes**

Capenhurst offers the following radioactive waste and disposal routes:

- Soft combustible waste is being consigned to Clifton Marsh
- Tritiated spoil and metal arte being stored to allow decay of activity prior to disposal at Clifton Marsh
- Non combustible solids are being sorted, assayed, reduced in volume (if practicable) packaged in drums/placed directly into ISO containers for disposal at either Clifton Marsh or the LLWR.
- Alternative disposal routes are being sought for oil
The IWS notes that the following disposal routes are currently authorised by the Environment Agency:

- Incineration of active oils and combustible LLW
- Transfer of solid (non-combustible) LLW to LLWR
- Transfer of sold high volume low activity LLW for controlled burial at Clifton Marsh

### Organisation and Management

The Capenhurst site has established a comprehensive organisation to manage waste arisings. The Head of Operations with support from the Head of Quality, Environment, Health and Safety has responsibility for the management of site wastes.

A documented integrated management system has been established to manage waste arisings and disposals.

### Changes from 2008 IWS

The Capenhurst IWS notes the following changes material to LLW management since the 2008 IWS:

- The incinerator has been taken out of active use.
- recommenced disposals at Clifton Marsh site against a new multimedia authorisation
- Modification of strategy for tritiated waste currently stored in Bay 'I' to dispose of as LLW to Clifton Marsh

### Opportunities for Improvement

Opportunities for improvement specifically identifiable to LLW management include:

- Opportunity for controlled burial of LLW at sites other than Clifton Marsh
- Trials to confirm appropriate disposal route for high uranic incinerator ash and confirm disposal to LLWR

### Principal LLW Issues for the Site

The Capenhurst IWS does not note risks specifically identifiable to LLW management.

### Alignment to Principles Identified in LLW Strategy

| A | The Capenhurst IWS states that the site Integrated Decommissioning Programme was established with the aim of 'undertaking decommissioning as soon as practicable, reducing hazards in a systematic and progressive way, focussing on the most active and potentially mobile radioactivity and achieving a condition of passive safety'.

  The Capenhurst IWS presents a comprehensive waste and environmental decision making framework aimed in part at identifying BPEO and BPM but also considering aspects of the waste hierarchy, constraints and hazard and risk to members of the public (page 37)

  The IWS also notes that the site recognises various policy and guidance documents issued by stakeholders including Sellafield Ltd. and the NII.

  The Capenhurst IWS notes that the site has not utilised the NDA SED process to prioritise decommissioning but also states that this is under review. The IWS does however note that early remediation of land is considered a priority to reduce the hazard potentially associated with the site (page 37). |
|---|---|
| B | The waste hierarchy as it applies to LLW is articulated in the IWS, specifically:

  - Re-use and recycle materials wherever practicable
  - Dispose of solid non-combustible LLW to Clifton Marsh or if necessary to Low Level Waste Repository under Multimedia RSA 93 authorisation
  - Incinerate combustible LLW (and oils if appropriate) at the on-site facility where a BPEO study justifies this or use alternative commercial routes |
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The IWS confirms the importance of waste prevention and the application of the waste hierarchy. An aim of the site Integrated Management System is to ensure ‘the production of waste is minimised and the reuse and recycling of materials shall be promoted. All waste shall be disposed of (or stored) in a safe manner’.

C The IWS notes that the site waste management strategy includes provision for the development of waste fingerprinting and characterisation processes. Reference to characterisation as an essential component of LLW strategy is not explicit.

D The IWS notes uncertainty with regard to LLW routes including the continued operation of Clifton Marsh beyond 2012. The IWS does however recognise that revised government policy may ensure that other disposal options become available. Alternative routes for recycling are not identified in this version of the IWS.

E The IWS (page 43) identifies a comprehensive list of stakeholders and notes that the site has engaged in BPEOs for land and waste management. It notes no known local stakeholder issues regarding off-site transport of waste.

F The IWS notes a number of disposal routes. These include:

- Soft combustible waste is being consigned to Clifton Marsh
- Tritiated spoil and metal are being stored to allow decay of activity prior to disposal at Clifton Marsh
- Non combustible solids are being sorted, assayed, reduced in volume (if practicable) packaged in drums/placed directly into ISO containers for disposal at either Clifton Marsh or the LLWR.

Alternative disposal routes are being sought for oil and projects have been initiated for incineration ash management.

G The Capenhurst IWS aims to address all wastes (and materials that could become waste), both radioactive and non-radioactive, arising from past, present and future operations. The IWS includes reference to non-radioactive wastes.

The Capenhurst IWS recognises the constraints and implications placed on site waste management practices by national and regional policy. A site objective is to actively participate in National LLW Strategy.

H Capenhurst provides a summary of the sites Waste and Environmental Decision Making framework which integrates the requirements of the waste hierarchy and BPEO optioneering as well as prioritisation into a single approach (page 36). This provides the site with a robust waste decision making tool.

The Capenhurst IWS provide no reference to the NDA business case requirements or implementation of a business case to support waste management decision making.
**Summary of LLW Strategy**

RSRL objective is to maintain high standards of safety, security and environment performance whilst eliminating the nuclear liabilities at the lowest lifetime cost (page 15).

The overall strategy for waste is to:

- Sort the waste into the lowest hazard or activity category
- Make full use of available waste disposal routes and make the waste passively safe for long term storage where disposal routes are not currently available (page 15)

The default strategy appears to be disposal at LLWR (page 3).

**Harwell**

The Harwell strategy is to minimise product of LLW by application of the waste hierarchy (page 60). A comprehensive summary of site strategy is provided in Figure 9 (page 63).

RSRL objective is to maintain high standards of safety, security and environment performance whilst eliminating the nuclear liabilities at the lowest lifetime cost (page 15).

The overall strategy for waste is to:

- Sort the waste into the lowest hazard or activity category
- Make full use of available waste disposal routes and make the waste passively safe for long term storage where disposal routes are not currently available (page 15)

The default strategy appears to be disposal at LLWR (page 3).

**Status**

Research Sites Restoration Ltd. was formed, as a wholly owned subsidiary of UKAEA to manage Harwell and Winfrith sites for the NDA in February 2009. In October 2009 RSRL moved into the private sector upon completion of the sale of UKAEA Ltd. to Babcock International Group plc.

**HARWELL AND WINFRITH**

Issue 2 March 2010

**Harwell**

The Harwell strategy is to minimise production of LLW by application of the waste hierarchy (page 60). A comprehensive summary of the site strategy is provided in Figure 9 (page 63).

**Winfirth**

A site BPEO identified the four categories of waste; solid non-combustible LLW, solid combustible LLW, solid VLLW and HVLA wastes. Whilst the current strategy is to consign both combustible and non-combustible LLW to LLWR four categories were identified to further examine potential treatment / disposal options for all wastes. A comprehensive site strategy is presented in Figure 13 (page 80).
Harwell have been progressing a programme of work to decommission and dismantle redundant facilities since the 1990’s. It is predicted that the Harwell site will reach an interim end state by 2031 when all the ILW including reactor decommission arisings have been packaged for final disposal. A final end state, when all ILW has been transferred to the Geological Disposal Facility (GDF) and the site de-licensed is anticipated in 2064.

Winfrith

The site decommissioning programme commenced in the 1990’s with the last operational reactor closing in 1995. The site is now processing legacy waste and maintaining the reactors and other facilities in care and maintenance until funding becomes available to complete restoration. The site predicts a final end state in 2064 when all higher activity wastes are transferred to the GDF.

### Waste Volumes

#### Harwell

The following (packaged) volumes of LLW are predicted:

- Operational LLW – 905 m$^3$
- Decommissioning LLW – 16,976 m$^3$
- High Volume Low Activity Waste – 83,793 m$^3$

#### Winfrith

The following volumes of LLW are predicted:

- LLW solid – 8,996 m$^3$ + 25 m$^3$ Sodium
- LLW Sludge – 534 m$^3$
- VLLW – 3,372 m$^3$

### Origin of Waste

Both sites note that waste arises from historic waste and fuel operations as well as future decommissioning operations.

Harwell states that LLW arisings consists of:

- Solid waste routinely consigned to LLWR
- Waste consigned off-site for incineration
- High volume low activity waste

Winfrith notes that solid LLW is generated on the Winfrith site from routine operations, the decommissioning of redundant nuclear facilities and removal of contaminated land.

### Current Waste Routes

The IWS identifies the following waste routes for both Harwell and Winfrith:

- Compactable and non-compactable LLW from Harwell and Winfrith to LLWR
- Compactable LLW from Harwell and Winfrith to WAMAC prior to disposal at LLWR
Combustible LLW to incinerator at Fawley Southampton

The IWS identifies the following additional routes for waste from Harwell:

- LLW metal for treatment in WACM
- Compactable LLW to the Inutec super compactor at Winfrith prior to disposal at LLWR

Winfresh operates a super compactor and waste originating from their activities is treated in this facility.

Organisation and Management

RSRL has established a comprehensive waste management organisation; comprising a management team reporting to the RSRL Managing Director (page 22). The RSRL Operations Director has overall responsibility for the strategic development, implementation and operation of waste processes. A Waste Strategy Manager, Solid Waste Complex Manager and Waste Compliance Manager are direct reports (page 22).

RSRL has established a RSRL Waste Strategy Group chaired by the Waste Strategy Manager as a forum for developing waste management strategy and document review (e.g. the IWS, BPEO’s etc.) (page 23).

RSRL has a comprehensive management system designed to support various processes undertaken by the sites, including waste management. The Waste Management process describes how RSRL manages radioactive, non-radioactive waste and nuclear materials destined to be waste (page 24). Two RSRL standards address waste:

- STD 0022 manages generation, treatment and storage of waste
- STD 0034 manages disposal; all wastes; both radioactive and non-radioactive

The IWS confirms that there are separate arrangements at each site to account for the differing authorisation requirements (page 27):

- Harwell – Quality Programme for the disposal of solid radioactive waste and waste generated in Areas with the Potential for Radioactive Contamination
- Winfrith – Management of Waste at Winfrith

Changes from 2009 IWS

RSRL identifies the following change since the 2009 version specifically related to the management of LLW:

- Strategic review to assess LTP logic in order to ensure that highest hazard work is prioritised in the programme

Harwell identifies the following change since the 2009 version specifically related to the management of LLW:

- Legacy sludges have been re-characterised and re-categorised as LLW and will be processed and consigned to LLWR

Winfresh identifies the following change since the 2009 version specifically related to the management of LLW:

- The expansion of the existing VLLW disposal route for Winfrith waste including soil and concrete rubble was achieved.

Opportunities to Improve

The IWS does not provide a 2010 Action Plan.

The IWS identifies the following RSRL opportunities specifically related to the management of LLW:

- Reduction in LLW disposal volumes through potential recycling routes with Studsvik

Harwell
The IWS identifies the following Harwell opportunity specifically related to the management of LLW:

- Identification of a low cost off-site waste route for the controlled burial of minimally contaminated waste

**Winfrith**

The IWS identifies the following Winfrith opportunities specifically related to the management of LLW:

- Increase the annual authorised VLLW disposal volume allowance

**Principal LLW issues for RSRL and their sites**

The IWS identifies the following RSRL risk specifically related to the management of LLW:

- LLWR is not available to accept LLW from RSRL

**Harwell**

The IWS identifies the following risk specifically associated with the management of LLW at Harwell:

- An on-site disposal route is not available before 2025
- A disposal route for High Volume Low Activity Waste is not available

**Winfrith**

The IWS identifies the following risk specifically associated with the management of LLW at Winfrith:

- A disposal route for High Volume Low Activity Waste is not available

Mitigation is established for all identified risks.

**Alignment to Principles Identified in LLW Strategy**

<table>
<thead>
<tr>
<th>A</th>
<th>RSRL objective is to maintain high standards of safety, security and environment performance whilst eliminating the nuclear liabilities at the lowest lifetime cost (page 15).</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The IWS details RSRL’s principles of Waste Management (page 17). They recognise the NDA requirement give priority to reducing risk and protect safety, security and the environment.</td>
</tr>
<tr>
<td>B</td>
<td>A key element of the IWS includes ‘the use of the waste hierarchy and BPM to minimise the volume of waste arising’ (page 2).</td>
</tr>
<tr>
<td></td>
<td>RSRL note that the IWS is based on the waste hierarchy, and aims to minimise waste generation and encourage recycling and reuse as part of the disposal process (page 14).</td>
</tr>
<tr>
<td></td>
<td>The IWS details RSRL’s principles of Waste Management (page 17). They recognise the NDA requirement to apply the waste hierarchy.</td>
</tr>
<tr>
<td></td>
<td>RSRL ensures that waste production is minimised (page 18). RSRL acknowledge the NDA Requirement to apply the principles of the Waste Hierarchy (page 18).</td>
</tr>
<tr>
<td></td>
<td>RSRL confirm that the IWS is compliant with the Waste Hierarchy, Best Available Technique and Best Practicable Means (page 46).</td>
</tr>
<tr>
<td>C</td>
<td>The IWS identifies the key elements of the Integrated Waste Strategy including ‘waste is segregated into the lowest possible radiological and non-radiological categories for disposal or long term storage’ (page 2).</td>
</tr>
<tr>
<td></td>
<td>Winfrith notes that in developing its LLW management strategy the site has considered the Industry Code of Practice on Clearance and exemption and where possible segregates and decontaminates</td>
</tr>
</tbody>
</table>
LLW to allow part to be treated as exempt waste (page 78).

The IWS presents comprehensive LLW site strategy summarises for both Harwell and Winfrith (pages 63 and 81 respectively). Whilst the importance of characterisation and segregation is implicit throughout the IWS it is not explicit in these site summaries.

D Harwell operates the following authorised LLW routes (Annex 2, page 1):
- Transfer to LLW site operator
- Transfer to Sellafield site operator prior to disposal at LLWR
- Transfer to Winfrith
- Transfer to incinerator at Fawley Southampton

Winfrith operates the following authorised LLW routes (Annex 2, page 2):
- Transfer to LLW site operator
- Transfer to Sellafield site operator prior to disposal at LLWR
- Transfer to incinerator at Fawley Southampton
- VLLW disposal to landfill

E Harwell recognise the following opportunities to develop new waste routes:
- Smelting metallic LLW – discussions have commenced with Studsvik to progress this (page 60)
- The impact of the UK LLW strategy on operations at Harwell

Winfrith recognise the following opportunities to develop new waste routes (page 79):
- Incineration of combustible LLW on or off-site
- Direct disposal of VLLW to landfill
- Alternative disposal routes for HVLA waste

The IWS identifies the RSRL approach to Stakeholder Engagement and notes that the strategy is based on openness (page 44):
- Stakeholders will be identified and plan put in place to communicate with them
- Significant projects and major operational activities will produce stakeholder communication plans
- Development of stakeholder management skills in staff will be encouraged

The IWS states that stakeholder engagement on site specific waste issues is largely achieved through public participation in the BPEO process and notes that the completion of site waste BPEOs for both Harwell and Winfrith were developed with full consultation of internal and external stakeholders.

F The strategy recognises the need for additional waste management routes. A key element of the IWS is to consider alternative disposal options; this may include off-site alternatives for the disposal of HVLA wastes as well as recycling opportunities for LLW metal. The default strategy remains disposal (page 3). The IWS notes that the baseline strategy for HVLA waste at Harwell is disposal in on-site facilities whilst Winfrith operates metal decontamination and LLW super compaction; again demonstrating an understanding of the requirement for flexible disposal routes.

G The IWS confirms the current strategy applies to all the ‘radioactive, non-radioactive solid, liquid and gaseous waste identified as being in existence or due to arise on either Harwell or Winfrith sites’ (page 2).

RSRL Waste Management process describes how RSRL manages radioactive, non-radioactive waste and nuclear materials destined to be waste (page 24).

Section 3 of the IWS provides an overview of the applicable regulatory and policy framework (page 17).
The RSRL IWS notes that the IWS is based on a comprehensive and transparent decision making process, supported by site waste BPEO’s. RSRL confirms that strategic options studies are completed to develop and implement waste management strategy (page 30). RSRL also employs the NDA SED process to assist prioritisation.

The RSRL IWS notes the requirement to complete business case to support all strategic decisions related to waste (page 6), but an example is not provided in the IWS.
### Summary of LLW Strategy

The IWS provides an overview of the LLWR Integrated Waste Strategy.

The IWS notes that the LLWR waste management strategy is to process operational and historic airings in the most efficient manner, taking into account current and future treatment and disposal options whilst adhering to Government Policy, NDA objectives and regulatory requirements (page 11).

The IWS summarises the overall strategy for the handling and conditioning waste as:

- Minimise waste arising where practicable in line with the waste hierarchy
- Segregate wastes as far as practicable to reduce volumes of more restrictive categories
- Package solid LLW in ISO containers for disposal

### Status

The LLWR is an operational site with some decommissioning completed in parallel. It is predicted that the site will reach its capacity in 2070.

PCM Magazine Decommissioning has commenced and LLW will be generated.

### Waste Volumes

The IWS notes that arisings are approximately 20 m³ annual and predicts 5,110 m³ of conditioned waste generated prior to site closure in 2059. There is an expectation that decommissioning of the PCM facilities will generate an additional 435 m³ of conditioned LLW between 2008 and 2010.

### Origin of Waste

Annex 1 of the IWS notes that the majority of LLW arises from the processing wastes from the maintenance of plant and equipment. However the IWS does identify decommissioning wastes including metal, building materials asbestos and others as contributing to LLW arisings.

### Current Waste Routes

Solid LLW is sorted, assayed, reduced in volume and where practicable placed directly into ISO containers for disposal at LLWR. Further conditioning may be completed at WAMAC prior to disposal at LLWR.

The IWS notes that the implication of government policy with regard to VLLW and HVLLW is currently under investigation (page 13).

### Organisation and Management

The site has established an organisation to manage waste. The Head of Programme Delivery and Head of Projects are responsible for ensuring that waste is managed in accordance with all relevant requirements including optimisation of waste management (included as part of the safety documentation) supported by the Site Movements Liaison Officer and the Dangerous Goods Dispatch Officer. Governance is provided by the Head of Safety, Regulatory Liaison and Governance (page 7).

### Changes from 2007 IWS

First LLWR IWS produced in 2008 following contract award.
### Opportunities to Improve

The IWS identifies two specific actions relevant to the management of LLW generated at LLWR:

- Review, revision and submission of the Environmental Safety Case
- Exclusion from vault disposal and development of separate storage / disposal provision for VLLW

### Principal LLW Issues for the Site

Risks not identified in the IWS but reference is made to the 2008 LTP:

- Environmental safety Case does not receive regulatory approval

### Alignment to Principles Identified in LLW Strategy

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>LLWR does not apply the NDA prioritisation process. However the IWS notes that the strategy is developed to meet NDA policy guidance. LLWR policy requirements and NII Safety Assessment Principles. The IWS also notes that small quantities of secondary PCM waste is addressed in the Hazard Baseline and Reduction programme indicating a commitment to safety and hazard reduction. The IWS also recognises the application of BPEO and BPM to ensure doses are ALARA.</td>
</tr>
<tr>
<td>B</td>
<td>The IWS notes that the site waste management policy is to apply the waste management hierarchy in order as far as is reasonably practicable to maximise the generation of waste materials (page 5). The IWS makes a clear commitment to the waste hierarchy but examples of LLWR utilising treatment routes for their own waste are not clear. The Executive summary emphasises that the provision of facilities to meet the requirements of the waste hierarchy applies equally to waste generated by the LLWR (page 4).</td>
</tr>
<tr>
<td>C</td>
<td>The importance of characterisation is implicit throughout the IWS but not explicit.</td>
</tr>
<tr>
<td>D</td>
<td>Waste routes are identified in the IWS; direct disposal or disposal post conditioning at WAMAC.</td>
</tr>
</tbody>
</table>
| E | The IWS notes the following stakeholder engagement activities specifically related to the management of LLW and in accordance with the site Stakeholder Engagement Strategy:
  - Working with the regulator to plan and assist the regulatory inspection schedules and project activities (formal and informal communications)
  - Regulator meetings with employees
  - Consultation correspondence with Local Authorities, Planning Departments. Regional Development Agencies
  - Operation of local liaison groups
The IWS notes that the general public, Public Bodies and Regulatory Authorities have been involved in consultation regarding the planning approval of vault 9. |
| F | The IWS identified the proposed innovation for LLW management and notes that the application of the waste management hierarchy applies to LLWR generated wastes. |
| G | The IWS notes that the LLWR waste management strategy is to process operational and historic airings in the most efficient manner, taking into account current and future treatment and disposal options whilst adhering to Government Policy, NDA objectives and regulatory requirements (page 11). The IWS clearly states that the document provides a strategy for all radioactive and non-radioactive waste streams (page 4). |
| H | The LLWR supports waste management decisions with BPEO / BPM optioneering approach (page 8) There is no reference to the NDA requirement for waste management decisions to be supported by neither a business case nor an example of such a case. However, the LLW has completed business cases to support its strategic initiatives, for example the segregated waste service. |
Summary of LLW Strategy

The principal aims of the Integrated Waste Strategy are to:

- Improve demonstrable compliance with legislation
- Improve efficiency and effectiveness of AWE waste services
- Support the development of a culture that promotes waste minimisation as well as maximising the reuse, recycling and energy recovery of any waste of which, production cannot be avoided.

The IWS supports the company’s wider Corporate Social Responsibility Agenda.

The IWS does not articulate an overarching strategy for the management of wastes but the document embodies all the required elements: mission, vision, objectives, adherence to the Waste Hierarchy, importance of characterisation, importance of new waste routes and minimising use of LLWR.

The original IWS established 6 objectives and a series of commitments to achieve these.

Status

AWE is an operational facility.

Waste Volumes

Figure 4 in Section 4.3 of the AWE’s IWS provides an indication of LLW arisings:

- Legacy (Pre 2010) – approx. 200m³
- Operational (2010 – 2038) – approx. 5500m³
- Decommissioning (2010 -2060) – approx. 8000m³

(Note: waste volumes are indicate and taken from bar chart)

Origin of Wastes

Radioactive waste arises from historic and current site operations. Legacy wastes from historic operations are also accumulated onsite. The IWS notes that increased waste volumes are expected during decommissioning.

Current Waste Routes

Section 4.8.1 identifies current VLLW / LLW routes. Such routes are aligned with the waste hierarchy

Organisation and Management

Section 3 of the IWS provides organisation structure for the Waste Services Group, the department responsible for the delivery waste services to the company. An overview of roles and responsibilities is also provided. Overall responsibility for delivering the Waste Strategy rests with the Director of Infrastructure.

A Head of Waste (HoW), responsible for operating the integrated model for waste across the company was appointed in 2008. The HoW principal responsibility is to implement the IWS with the cooperation of the Waste Management Steering
Atomic Weapons Establishment (AWE)  

Issue 1 July 2010

Committee (page 4)

The IWS notes that Facility, Project and Department Manager continue to have the principal duty to control waste generated by their activities.

Company Safety Instructions (CSI) establish further roles and responsibilities including CSI 1602; Radioactive Waste

Changes from 2009 IWS

The IWS does not provide a concise update. However the IWS does summarise the key elements and achievements of the Waste Services (page 8). The Executive summary details progress made since 2007 including:

- Establishment of a waste service desk which has received over 12,000 calls
- The diversion of 58% of all solid waste from landfill (between April 2009 and March 2010)
- Trialling recycling routes for metallic LLW

Opportunities for Improvement

The IWS identifies the following priorities for 2010/2011:

- The implementation of an AWE strategy for the Management and Disposal of Low Activity Solid Wastes. This strategy will feature radioactive waste metal off-site treatment, introduction of a new bag monitor and the introduction of disposal routes for high volume very low level waste (page 57)
- Development of waste process maps and guidance notes to support decommissioning and project managed waste (page 57)
- Implementation of the management model for decommissioning and project management wastes

Principal LLW Issues for the Site

- The generation of construction, demolition and excavation waste

Alignment to Principles Identified in LLW Strategy

<table>
<thead>
<tr>
<th>A</th>
<th>The principal aim of the IWS is to improve demonstrable compliance with legislation (page 3). The IWS notes that AWE’s overriding objective is ‘to ensure that none of our activities harms our employees, the environment or the public’ (page 8). Furthermore the IWS will support this by protecting human health and the environment by minimising the amount of waste disposed from AWE sites by actively seeking to reduce the amount sent to landfill’. AWE has established a Corporate Sustainability Plan with four key theme areas; the IWS is an important tool in delivering Key Sustainability Theme 2: Waste Management (page 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>The IWS states that AWE’s vision is to ‘implement a targeted drive towards zero waste’ (page 8). Section 1.4.1 (page 9) notes that ‘AWE strives to reduce its environmental impact by preventing waste wherever possible and making more sustainable use of the by-product material that is produced by invoking the principles of the waste hierarchy’. The document clearly demonstrates integration of the waste hierarchy into waste management. The document notes the development of a strategy by AWE for Low Activity Solid Wastes (page 12) which focuses on waste avoidance, minimisation and provision of measures to make use of alternative disposal facilities for High Volume Very Low Level Waste.</td>
</tr>
</tbody>
</table>
| C | The IWS recognises that a programme of characterisation is underway utilising a recently commissioned neutron and gamma (ILW/LLW) assay system in conjunction with real-time radiography (will identify any drums that can be re-classified as LLW) (page 24) AWE has identified a series of staged targets to ensure that the business achieves its aspiration of being a sustainable business. These include reference to the importance of characterisation:  

- To improve radioactive waste characterisation and ensure it is embedded into AWE working |
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>practices</strong></td>
<td></td>
</tr>
</tbody>
</table>
|   | - AWE has a culture where it is second nature to prevent and minimise the production of radioactive waste and ensure that where production cannot be avoided the wastes are appropriately characterised and managed in line with BAT.  
   - Several objectives which include reference to improving characterisation training and awareness.  
   The IWS does not specifically note the primacy of characterisation in AWE’s waste strategy.  |
| **D**  |   |
|   | - Section 4.8 (page 38) provides an overview of AWE’s preferred waste routes for wastes frequently produced by the company. The IWS notes that the destinations have been identified by waste stream specific strategies that consider the Waste Hierarchy. Tables are available for VLLW and LLW (Section 4.8.1).  
   - The IWS also recognises the need to develop alternative waste route (objectives established, page 53 – 56)  
   An improvement action has been identified to ensure the most appropriate waste route is identified (page 24).  |
| **E**  |   |
|   | - The IWS notes that the majority of operational LLW can be diverted away from LLWR (page 25). AWE has established two specific objectives focussed on developing waste routes:  
   - Objective to minimise waste production and increase segregation, reuse and recycling (page 54) - a key commitment supporting this initiative is to investigate alternative waste minimisation, reuse and recycling opportunities (page 54). The IWS identifies several opportunities including; smelting of metals, soil, construction and demolition arisings, Uranium contaminated oils (page 54).  
   - Objective to manage residual wastes in sustainable way (limit disposal to landfill) (page 55) – commitments include a review of landfill wastes that would permit diversion from LLWR and an investigation into alternative treatment options for residual wastes (including shot blasting steel work, chemical decontamination, gasification, pyrolysis and mechanical biological treatment) (page 55).  
   Section 1.4.2 (page 10) notes that the strategy has been developed with due regard for the requirements of stakeholders (internal and external). Two objectives related to stakeholder engagement have been established (page 43):  
   - To improve AWE employee and contractor waste awareness and behaviours supported by a commitment to promote the IWS, establish a waste awareness programme and waste training programme.  
   - To improve communication and provide easily accessible technical support and advice supported by commitments to establish a waste intranet site and technical help line, a waste focus newsletter, waste legislation guidance and technical guidance notes.  |
| **F**  |   |
|   | - The IWS recognises current waste routes and identifies the need for additional waste routes to meet UK LLW policy and site operational and decommissioning requirements.  |
| **G**  |   |
|   | - The IWS details strategy for both radioactive and non-radioactive wastes. The IWS notes that the ‘document addresses the management of all wastes produced by the company’.  
   Section 2 (page 15) provides an overview of Policy and Legislation. Section 1.4.2 (page 10) notes Government requirements in the ‘Sustainable operations on the Government Estate: targets’. The IWS presents established targets.  
   The IWS evaluates the requirements of strategy and policy. For example (page 19) the main elements of the Waste Strategy for England 2007 have been evaluated and those relevant to AWE IWS identified.  |
<p>| <strong>H</strong>  |   |
|   | - The IWS does not reference specifically the requirement for a business case. However the IWS does indicate that waste performance is very much integrated into business performance, including:  |</p>
<table>
<thead>
<tr>
<th>Atomic Weapons Establishment (AWE)</th>
<th>Issue 1 July 2010</th>
</tr>
</thead>
</table>

- Development of an IWS will have obvious business benefits
- A Waste Management Steering Committee is in place to ensure that AWE manages all wastes in a consistent and efficient way that meets the need of business
Appendix B – Process for Compiling the 2010 UK Radioactive Waste Inventory

Data collection and Processing
Preparation of the 2010 UK Radioactive Waste Inventory by DECC has involved the collation of detailed numerical and descriptive data for 655 radioactive waste streams designated LLW by waste producers in the UK.

The number of waste streams is about 20 more than in the previous 2007 UK Radioactive Waste Inventory. This is the result of better waste characterisation. Most notably there have been increases at some Magnox sites undergoing decommissioning, where low volume wastes are being identified as separate streams for management purposes. This is also the case at, and at Sellafield.

Information on these wastes was gathered by requesting the data in a standard form for each waste stream. Some sites, accounting for the majority of waste streams, independently compiled an update of their inventory data. For the remaining sites, preliminary 2010 Inventory information was estimated by extrapolating from data in the 2007 Inventory. This information was sent to the waste producing sites for endorsement or amendment.

In summary, the 2010 Inventory data comprises a full update of waste stream volumes, and a partial update of waste stream material compositions and radionuclide activities. Over 200 persons across all waste producing sites were involved in providing the 2010 Inventory data.

Data assessment
Data has been analysed by POYRY on behalf of DECC. The authors independently assessed all information supplied for each waste stream. The assessment included:

- Checking for internal consistency and completeness;
- Comparison of the information with that in the 2007 Inventory;
- Evaluation of the adequacy and validity of the information.

Feedback was provided, as a result of which some revisions to data were made by waste producers.

The Inventory database
Following the completion of data assessment, the information for each waste stream was transferred into a database. This information was then processed to produce summary and detailed outputs for the 2010 Inventory documents. The data providers have approved the publication of their data in the 2010 Inventory reports.

Figure B1 presents the process in which data was gathered and submitted as part of the 2010 UK Radioactive Waste Inventory for the majority of waste producers.
FIGURE B1 – PROCESS FLOW OF INVENTORY DATA FOR THE 2010 UK RADIOACTIVE WASTE INVENTORY

Waste Inventory
### Appendix C – LLW and VLLW Raw Volumes by UK County Council Area

Tables C1 and C2 identify the LLW and VLLW raw volumes by UK County Council area during the periods 2010-2020 and 2010-2120.

**Table C1 – 10 Year LLW and VLLW Raw Waste Volumes for Stock and Future Arisings by UK County (m³)**

<table>
<thead>
<tr>
<th>UK Region</th>
<th>UK County</th>
<th>LLW Volume</th>
<th>VLLW Volume</th>
<th>Total Waste Volume</th>
<th>Percentage of the total Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>North West</td>
<td>Cheshire</td>
<td>468</td>
<td>3,406</td>
<td>3,874</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>Cumbria</td>
<td>116,825</td>
<td>41,039</td>
<td>157,864</td>
<td>32%</td>
</tr>
<tr>
<td></td>
<td>Lancashire</td>
<td>7,883</td>
<td>47,148</td>
<td>55,031</td>
<td>11%</td>
</tr>
<tr>
<td>North East</td>
<td>County Durham</td>
<td>7,103</td>
<td>-</td>
<td>7,103</td>
<td>1%</td>
</tr>
<tr>
<td>West Midlands</td>
<td>Shropshire</td>
<td>62</td>
<td>-</td>
<td>62</td>
<td>0%</td>
</tr>
<tr>
<td>East Midlands</td>
<td>Derbyshire</td>
<td>730</td>
<td>-</td>
<td>730</td>
<td>0%</td>
</tr>
<tr>
<td>East</td>
<td>Essex</td>
<td>3,062</td>
<td>-</td>
<td>3,062</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>Suffolk</td>
<td>3,538</td>
<td>-</td>
<td>3,538</td>
<td>1%</td>
</tr>
<tr>
<td>South West</td>
<td>Devon</td>
<td>643</td>
<td>9,020</td>
<td>9,663</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Dorset</td>
<td>604</td>
<td>355</td>
<td>959</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Gloucestershire</td>
<td>6,028</td>
<td>-</td>
<td>6,028</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>Somerset</td>
<td>8,122</td>
<td>-</td>
<td>8,122</td>
<td>2%</td>
</tr>
<tr>
<td>South East</td>
<td>Berkshire</td>
<td>9,096</td>
<td>1,026</td>
<td>10,122</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Buckinghamshire</td>
<td>5,057</td>
<td>-</td>
<td>5,057</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>Hampshire</td>
<td>17</td>
<td>-</td>
<td>17</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Kent</td>
<td>7,678</td>
<td>-</td>
<td>7,678</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Oxfordshire</td>
<td>13,928</td>
<td>57,013</td>
<td>70,941</td>
<td>14%</td>
</tr>
<tr>
<td>Wales</td>
<td>Anglesey</td>
<td>3,673</td>
<td>-</td>
<td>3,673</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>Glamorgan</td>
<td>1,210</td>
<td>2,677</td>
<td>3,887</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>Gwynedd</td>
<td>1,052</td>
<td>-</td>
<td>1,052</td>
<td>0%</td>
</tr>
<tr>
<td>Scotland</td>
<td>Argyll and Bute</td>
<td>75</td>
<td>-</td>
<td>75</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Ayrshire</td>
<td>10,304</td>
<td>-</td>
<td>10,304</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Caithness</td>
<td>33,021</td>
<td>8,528</td>
<td>41,549</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>Dumfriesshire</td>
<td>59,083</td>
<td>27,700</td>
<td>86,783</td>
<td>17%</td>
</tr>
<tr>
<td></td>
<td>East Lothian</td>
<td>612</td>
<td>-</td>
<td>612</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Fife</td>
<td>942</td>
<td>-</td>
<td>942</td>
<td>0%</td>
</tr>
<tr>
<td>Other</td>
<td>Minor Waste Producers</td>
<td>1,632</td>
<td>-</td>
<td>1,632</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Flasks and Flatrols</td>
<td>43</td>
<td>-</td>
<td>43</td>
<td>0%</td>
</tr>
</tbody>
</table>

|                   |                   | 302,488    | 197,912     | 500,400             |
### Table C2 – 110 Year LLW and VLLW Raw Waste Volumes for Stock and Future Arisings by UK County (M³)

<table>
<thead>
<tr>
<th>UK Region</th>
<th>UK County</th>
<th>LLW Volume</th>
<th>VLLW Volume</th>
<th>Total Waste Volume</th>
<th>Percentage of the total Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>North West</td>
<td>Cheshire</td>
<td>2,150</td>
<td>4,486</td>
<td>6,636</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Cumbria</td>
<td>403,396</td>
<td>2,927,382</td>
<td>3,330,778</td>
<td>75%</td>
</tr>
<tr>
<td></td>
<td>Lancashire</td>
<td>33,718</td>
<td>238,575</td>
<td>272,293</td>
<td>6%</td>
</tr>
<tr>
<td>North East</td>
<td>County Durham</td>
<td>14,051</td>
<td>-</td>
<td>14,051</td>
<td>0%</td>
</tr>
<tr>
<td>West Midlands</td>
<td>Shropshire</td>
<td>100</td>
<td>-</td>
<td>100</td>
<td>0%</td>
</tr>
<tr>
<td>East Midlands</td>
<td>Derbyshire</td>
<td>730</td>
<td>-</td>
<td>730</td>
<td>0%</td>
</tr>
<tr>
<td>East</td>
<td>Essex</td>
<td>36,821</td>
<td>2,684</td>
<td>39,505</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>Suffolk</td>
<td>46,345</td>
<td>308</td>
<td>46,653</td>
<td>1%</td>
</tr>
<tr>
<td>South West</td>
<td>Devon</td>
<td>1,090</td>
<td>15,979</td>
<td>17,069</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Dorset</td>
<td>8,830</td>
<td>465</td>
<td>9,295</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Gloucestershire</td>
<td>49,424</td>
<td>1,050</td>
<td>50,474</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>Somerset</td>
<td>57,255</td>
<td>710</td>
<td>57,965</td>
<td>1%</td>
</tr>
<tr>
<td>South East</td>
<td>Berkshire</td>
<td>25,728</td>
<td>5,383</td>
<td>31,111</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>Buckinghamshire</td>
<td>13,390</td>
<td>-</td>
<td>13,390</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Hampshire</td>
<td>24</td>
<td>-</td>
<td>24</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Kent</td>
<td>44,736</td>
<td>930</td>
<td>45,666</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>Oxfordshire</td>
<td>18,107</td>
<td>82,473</td>
<td>100,580</td>
<td>2%</td>
</tr>
<tr>
<td>Wales</td>
<td>Anglesey</td>
<td>46,796</td>
<td>-</td>
<td>46,796</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>Glamorgan</td>
<td>3,300</td>
<td>7,300</td>
<td>10,600</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Gwynedd</td>
<td>45,531</td>
<td>3,200</td>
<td>48,731</td>
<td>1%</td>
</tr>
<tr>
<td>Scotland</td>
<td>Argyll and Bute</td>
<td>558</td>
<td>-</td>
<td>558</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Ayrshire</td>
<td>61,037</td>
<td>-</td>
<td>61,037</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>Caithness</td>
<td>57,933</td>
<td>15,351</td>
<td>73,284</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Dumfriesshire</td>
<td>92,250</td>
<td>29,200</td>
<td>121,450</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td>East Lothian</td>
<td>18,568</td>
<td>-</td>
<td>18,568</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Fife</td>
<td>2,401</td>
<td>-</td>
<td>2,401</td>
<td>0%</td>
</tr>
<tr>
<td>Other</td>
<td>Minor Waste Producers</td>
<td>7,414</td>
<td>-</td>
<td>7,414</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Flasks and Flatrols</td>
<td>427</td>
<td>-</td>
<td>427</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1,092,110</strong></td>
<td><strong>3,335,476</strong></td>
<td><strong>4,427,586</strong></td>
<td></td>
</tr>
</tbody>
</table>
### Appendix D – LLW Cost Summary Table

**Table D1 – LTP Cost Comparison per Site**

<table>
<thead>
<tr>
<th>Category</th>
<th>Dounreay</th>
<th>Magnox North</th>
<th>Magnox South</th>
<th>Research Sites</th>
<th>Sellafield</th>
<th>Springfields</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LTP08</td>
<td>LTP10</td>
<td>LTP08</td>
<td>LTP10</td>
<td>LTP08</td>
<td>LTP10</td>
<td>LTP08</td>
</tr>
<tr>
<td>New Construction Projects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Operations</td>
<td>£40.4m</td>
<td>£48.8m</td>
<td>£470.8m</td>
<td>£451.1m</td>
<td>£253.3m</td>
<td>£370.3m</td>
<td>£36.9m</td>
</tr>
<tr>
<td>Storage Operations</td>
<td>£2.9m</td>
<td>£3.6m</td>
<td>£14.9m</td>
<td>£16.8m</td>
<td>£0m</td>
<td>£0m</td>
<td>£3.5m</td>
</tr>
<tr>
<td>Maintenance</td>
<td>£6m</td>
<td>£7.0m</td>
<td>£5.4m</td>
<td>£44.5m</td>
<td>£3.3m</td>
<td>£14.7m</td>
<td>£2.7m</td>
</tr>
<tr>
<td>Plant Enhancement</td>
<td>£11.1m</td>
<td>£14.4m</td>
<td>£28.4m</td>
<td>£19.2m</td>
<td>£0.8m</td>
<td>£0.7m</td>
<td>£0.0m</td>
</tr>
<tr>
<td>Transport</td>
<td>£4.9m</td>
<td>£4.2m</td>
<td>£86m</td>
<td>£443.9m</td>
<td>£56.8m</td>
<td>£4.7m</td>
<td>£4.3m</td>
</tr>
<tr>
<td>On-Site Disposal</td>
<td>£16.6m</td>
<td>£14.8m</td>
<td>£0m</td>
<td>£0.2m</td>
<td>£0.1m</td>
<td>£3.7m</td>
<td>£7.9m</td>
</tr>
<tr>
<td>Off-site Disposal</td>
<td>£0m</td>
<td>£0m</td>
<td>£626.6m</td>
<td>£1,124.3m</td>
<td>£734.5m</td>
<td>£85.0m</td>
<td>£87.1m</td>
</tr>
<tr>
<td>Waste &amp; Nuclear Materials Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decommissioning &amp; Termination</td>
<td>£81.7m</td>
<td>£90.7m</td>
<td>£1,232.1m</td>
<td>£2,099.8m</td>
<td>£1,049m</td>
<td>£1,641.9m</td>
<td>£148.4m</td>
</tr>
<tr>
<td>Site Support</td>
<td>£0m</td>
<td>£0m</td>
<td>£0m</td>
<td>£0m</td>
<td>£0m</td>
<td>£74.2m</td>
<td>£34.7m</td>
</tr>
<tr>
<td>Total</td>
<td>£167m</td>
<td>£186m</td>
<td>£1,748m</td>
<td>£2,220m</td>
<td>£1,420m</td>
<td>£1,738m</td>
<td>£156m</td>
</tr>
</tbody>
</table>

**Notes:**
- Sellafield data represents ‘provisional’ LTP10 data post-2025
- Springfields data is based on LTP09
- LLWR operational costs not included (included within off-site disposal costs)