NDA Strategy

Integrated Impact Assessment Report

Non-Technical Summary

Final

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Contents

1.0 Introduction

The NDA is undertaking its second five-year review of its Strategy, in accordance with the Energy Act 2004. The Strategy reviews the NDA's strategic position, establishing and maintaining its strategic direction on activities across the sites which comprise its estate. The strategies that have been selected are carried out by Site Licence Companies (SLCs), which manage the sites on the NDA's behalf and under its strategic guidance.

The version currently under development is the NDA Strategy (2016) (otherwise referred to as the 'Strategy'). The NDA is committed to ensuring that the development of its Strategy is in accordance with the requirements of the European Union's Strategic Environmental Assessment (SEA) Directive and transposing UK SEA Regulations.

The NDA also wishes to adhere to good practice by conducting an SEA, Health Impact Assessment (HIA) and Socio-economic Impact Assessment (SeIA), and reporting on these three strands in an Integrated Impact Assessment (IIA) that fulfils the requirements of the SEA Regulations.[1]

IIAs are used by plan and policy-makers to inform various options, policies and strategies. They draw together different types of assessment to provide a broad and holistic perspective which can be easily communicated to stakeholders.

This document is the Non-Technical Summary of the IIA Report. The IIA Report is split into three volumes:

- **Volume 1:** consists of an introduction, the project background, descriptions of preferred and credible options, the approach to assessment and methodology, results of the assessment, the measures identified to mitigate risks and enhance opportunities, and conclusions and next steps;
- **Volume 2:** provides the detailed assessment of preferred options and reasonable alternatives; and
- **Volume 3:** consists of a baseline report and review of relevant policy and legislation.

For further information on the IIA please refer to the main report. Where appropriate, references to the main report are provided throughout this document.

2.0 Project background

2.1 The NDA mission

The Nuclear Decommissioning Authority (NDA) is a non-departmental public body established under the Energy Act 2004. The NDA mission is to deliver safe, sustainable and publicly acceptable solutions to the challenge of nuclear clean-up and waste management.

The UK's Nuclear Legacy

The NDA has responsibility to oversee the clean-up and decommissioning of 17 of the UK's civil public sector nuclear sites (see Figure 2-A). These range from Sellafield, a complex operational site, to previously operational nuclear power stations and nuclear research facilities.

Radioactive waste is material that has no further use and is above a certain (very low) level of radioactivity. Over the years the UK has accumulated a substantial legacy of radioactive waste from various civil nuclear and defence programmes. Waste also arises in non-nuclear industries, for example where radioactive materials are used for medical and industrial purposes (NDA, 2015c).

The NDA develops nuclear decommissioning plans and implements them through an estate-wide Strategy. This Strategy sets the pace and priority of decommissioning activities across the estate, and

[1] Note that SEA and IIA both include health and socio-economic assessments, whereas "SEA" in this assessment refers to all other aspects related to environment which are covered under SEA.

ensures the safe management of spent fuels, nuclear materials and radioactive wastes. The Strategy is based on a process of identifying and selecting preferred strategies which balance safety, cost and security with achieving benefits for the environment and society.

2.2 The NDA estate

The NDA estate includes reactors, chemical plants, research and development facilities, fuel fabrication and reprocessing facilities, waste treatment facilities and waste stores. Some plants date from the 1940s and 1950s, including a number of the Legacy Ponds and Silos at Sellafield. These facilities are ageing and contain significant quantities of spent fuel, presenting some of the highest risks and representing some of the NDA's greatest decommissioning challenges.

Some facilities across the estate continue to form an essential part of the nation's nuclear infrastructure, which means they must continue to be operated safely and effectively until they have fulfilled their purpose.

2.3 NDA Strategy (2016)

Under the Energy Act 2004, the NDA is required to publish a Strategy setting out its strategic direction for activities across its estate. This Strategy is subject to periodic review, formal public consultation and approval by ministers. The first Strategy was published in 2006 with an update published in 2011. This document is the Non-Technical Summary of the Integrated Impact Assessment (IIA) that accompanies the NDA Strategy (2016) document. It provides an overview of the Strategy's potential environmental, socio-economic and health effects.

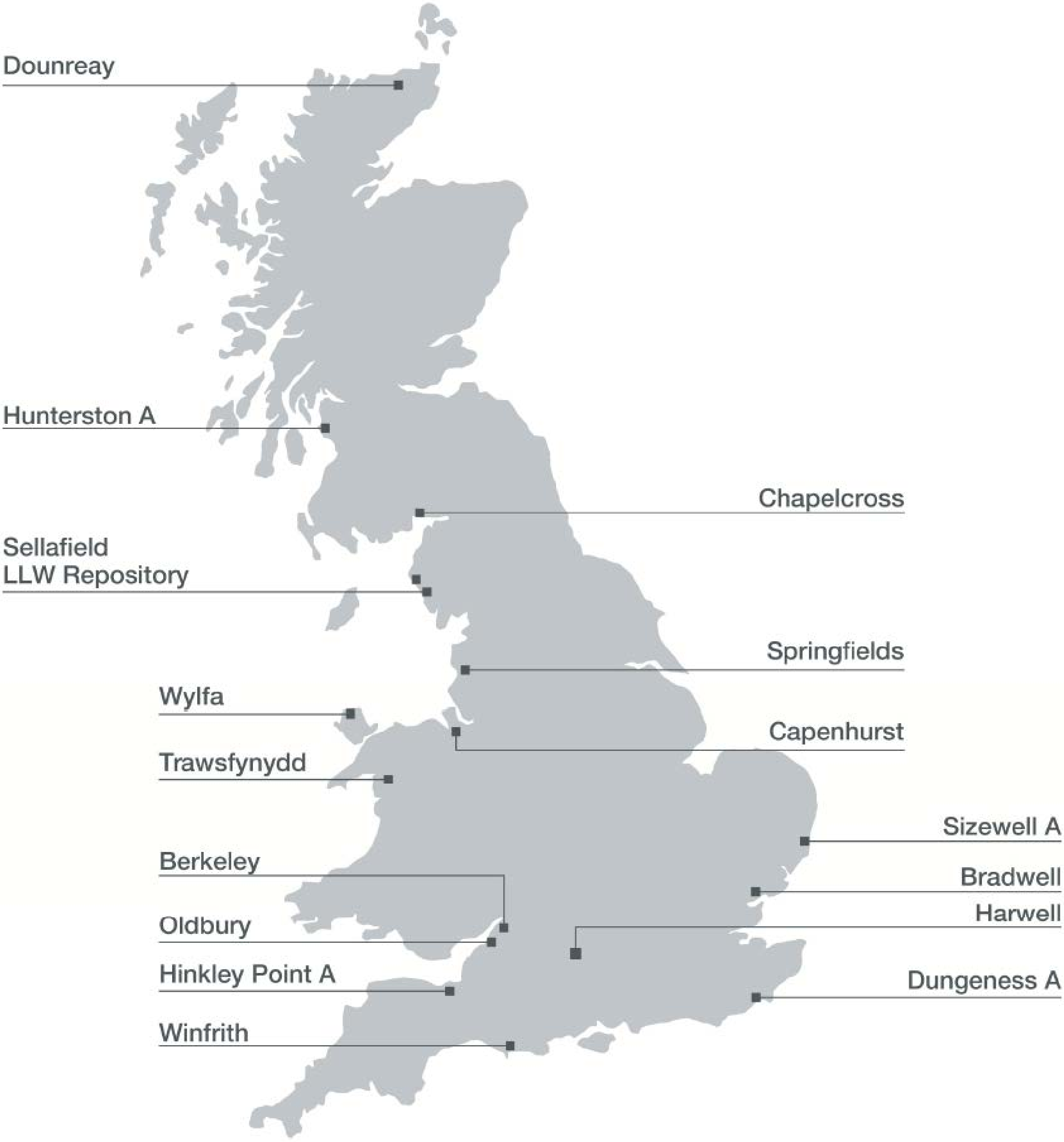

Figure 2-A: The NDA Estate[2]

[2] Source: NDA, 2014d

3.0 Baseline conditions

3.1 Introduction

To inform the assessment, information was collected on the baseline environmental, health and socio-economic conditions at each of the NDA sites. This information includes both existing conditions and future conditions that would be likely to evolve assuming there are no further changes to the NDA Strategy. The results of this exercise are presented in Volume 3 of this IIA Report, which includes a description of the 17 sites comprising the NDA estate.

Understanding the baseline at each of the NDA sites is important, both for determining the nature and extent of potential impacts of the Strategy, and ultimately in identifying options which may positively influence environmental, social and health conditions.

The key issues highlighted by the baseline data gathering exercise are outlined below.

3.2 Environment

From an environmental perspective, some of the main issues at the sites are associated with the use of materials and the generation, storage and treatment of wastes. Substantial volumes of waste (radioactive and especially non-radioactive) are produced as sites undergo decommissioning. Following retrieval, much of the radioactive waste is stored in purpose-built facilities pending treatment or disposal, whilst non-radioactive and some low-level radioactive waste is treated for reuse, where possible, or otherwise transported to authorised disposal sites. This creates a range of additional environmental issues around air quality, noise, landscape, radiological discharges, energy use and carbon emissions.[3]

Due to their industrial nature, many of the NDA sites are prominent features within their respective landscapes and are widely visible across surrounding areas. Most of the sites are in coastal locations, which could put them at risk from changes in the coastal environment. This may include increased rates of erosion, changes in tidal surges or sea level rise. Such changes may be precipitated or accelerated by climate change.

Many of the sites have areas of chemical and radiological land contamination which may require remediation as part of decommissioning activities. The nature, extent and severity of such contamination varies from site to site, and across different parts of a site. Management of such contamination is an important element in moving sites towards their site end state.

Across the sites, there is ongoing management of radiological discharges and wastes. At a number of sites, radiological discharges continue within authorised limits, while others have seen discharges reduce or cease since the end of the operational phase. Decommissioning can cause short-term increased discharges of radioactivity before reducing radiological risks in line with the NDA mission.

During the course of nuclear operations, many of the NDA sites have, and some continue to, draw water from and make discharges to water bodies. Such abstractions and discharges have been made within regulatory limits, and in most cases, have decreased since the operational phase ended. The Sellafield site continues to abstract water to support ongoing operations. Decommissioning activities undertaken at other sites may also continue to affect the water environment through abstraction and discharges.

Energy use and carbon emissions are important issues at the NDA sites. Decommissioning activities such as demolition and operational activities such as reprocessing at Sellafield require energy and generate direct and indirect carbon emissions.

[3] 'Carbon emissions' is a conventional term used in place of greenhouse gas emissions, which are typically measured using units of 'carbon equivalents' (CO_2e). As such, the term 'carbon emissions' refers to all greenhouse gas emissions for the purposes of this assessment.

3.3 Socio-economics

Due to their remote locations, many of the sites are major employers in the surrounding area or region, and because of the varying nature of nuclear operations ongoing at each of the sites, these jobs range from construction and demolition work to specialist nuclear and civil engineering and managerial positions.

Similarly, some of the sites has been and continue to be a major source of investment into the local and regional economies. This comes not just from employment but also from multiplier effects and activities in the sites' supply chains.

At one time or another, each of the sites in the NDA's estate have been considered a national asset, supplying electricity derived from nuclear power or advancing the nation's nuclear capabilities through experimental research. Some sites such as Sellafield contain facilities which continue to serve as national assets and must be maintained as such until they have fulfilled their purpose. Others continue to undergo decommissioning and may eventually be divested for redevelopment to potentially become a local asset. An example of this is the transfer of some of the research facilities at Berkeley Centre (owned by NDA and adjacent to the Berkeley reactor decommissioning site) to South Gloucestershire and Stroud College, with a view to providing training in the renewable energy and nuclear sectors.

According to the Nuclear Workforce Assessment (NESA, 2014), between 2017 and 2027, peaking in 2021, there will be substantial demand for nuclear engineering, civils and construction workers for work on the UK's nuclear new build projects. This will be in the order of 15,000 Full Time Equivalents (FTE).[4] Current estimates suggest 7,000 - 9,000 professional staff may need to be recruited in the industry to 2020 (1,200 - 1,500 per year) and 6,000 - 8,500 technical staff may need to be recruited to 2022 (750 - 1,000 per year) to meet this demand (NESA, 2014). Whilst these dates may be subject to change, this could potentially impact the NDA mission at any time, as the pool of available qualified nuclear staff will be in increased demand.

3.4 Health

Across the sites, radiological health risks are an important consideration. Whether it is demolishing an office block or management of High Level Waste (HLW) arising from spent fuel reprocessing, radiological safety remains a key priority. This will continue to be the case until the sites have reached their end states. The use of safety cases, minimisation of waste, adherence to 'as low as reasonably achievable' (ALARA) principles and requirements to demonstrate the use of 'best available techniques' (BAT) help to ensure risks to workers, the public and the environment are minimised and kept well within statutory limits.

The main health risks arising from activity at NDA sites come from conventional sources such as construction, demolition and transport. Environmental impacts of construction works can have implications from a health perspective. Changes in air quality can lead to increased risk of cardiovascular and respiratory illness. Increases in noise levels and alterations to the landscape can lead to disturbance and annoyance, while changes in water quality may result in adverse health effects if the water is used for drinking supplies or recreational activities. Increases in traffic due to the movement of materials, plant and workers has the potential to increase the risk of road accidents on routes leading to and from the sites.

Such environmental effects can also affect the attractiveness of local recreational and amenity features, which might lead to declines in levels of physical activity undertaken by the local population.

Mental health and well-being is another important health issue relating to activities across the NDA estate. Increased stress and anxiety can be experienced by those living close to industrial sites which generate noise, dust and other environmental effects. On the other hand, by providing and maintaining employment opportunities and encouraging investment into the local community, sites can also positively influence the mental health and well-being of the local population.

[4] This is the ratio of the total number of paid hours (full-time, part-time, and contracted) by the number of working hours in that period. It provides a measure of employees working full time.

4.0 The Strategy

4.1 Themes, topics and credible options

As set out in the Strategy, there are four driving strategic themes under which the NDA groups its core activities:

- Site Decommissioning and Remediation
- Spent Fuels
- Nuclear Materials
- Integrated Waste Management

These four driving themes are supported by a fifth theme; 'Critical Enablers'. This theme covers other aspects of the NDA's activities such as transport and logistics, public and stakeholder engagement and land and property management, which support the overall delivery of the NDA mission. For the purpose of the assessment, Critical Enablers have been considered, where relevant, under each of the four driving themes.

Within each driving strategic theme, activities may be further broken down into topic strategies. For example, the Spent Fuels strategy is split into three individual topics: Spent Magnox Fuel, Spent Oxide Fuel and Spent Exotic Fuel. These topic strategies form part of the overarching Strategy.

For each strategic theme and topic, a number of credible options have been identified and defined in consultation with the NDA. These options, which are described in papers produced by the NDA and published on its website, are the focus of this IIA.

Note that the intention of the IIA Report is to provide an indicative assessment of current credible options but not to preclude the adoption of other management options in the future. This recognises the fact that some options not currently considered to be credible or preferred on the basis of their level of technical development, may become more credible in the future as the technology matures. Changes in government policy and site-specific considerations can also influence the credibility of strategic options over time.

4.2 Site Decommissioning and Remediation

Site Decommissioning and Remediation outlines the NDA's approach to decommissioning redundant facilities, securing the land required by decommissioning activity and the means by which contamination of ground and groundwater will be managed. Such decisions are made on a case-by-case basis.

This strategic theme is divided into four topics:

4.2.1 Decommissioning

There are two broad credible options for Decommissioning:

1. **Continuous decommissioning** that commences at the end of nuclear operations and continues until final demolition of the facility

2. **Deferred decommissioning** that involves one or more periods when the facility is purposely made safe for a period of quiescence, during which only routine maintenance activities would be carried out

It is planned that most of the nuclear reactors in the NDA estate will be managed using a deferred decommissioning strategy when they are shut down. This means that following the initial stages of decommissioning, these reactors will be kept closed for several decades to allow radiation levels within the reactor to naturally decay, resulting in simpler, safer and more cost-effective decommissioning at a later time. For other facilities at a site, continuous decommissioning may be preferred.

4.2.2 Land Quality Management

Land Quality Management involves managing risks to people and the environment from radioactive and non-radioactive contamination in ground and groundwater. This is done through prevention and remediation (including control and monitoring).

Four credible options have been identified for Land Quality Management. These are:

1. ***In situ* management without intervention** (e.g. monitored natural attenuation or monitored natural decay)
2. ***In situ* management with intervention** (e.g. enhanced bioremediation or physical treatment)
3. ***Ex situ* management for reuse** (this may involve a process such as soil washing to make material suitable for reuse)
4. ***Ex situ* excavation for disposal** (this option involves removing the material from the ground and transferring it to an authorised waste disposal site)

4.2.3 Site Interim and End States

Every NDA site will have an agreed site end state. The site end state sets out the long-term restoration objectives for the site, considering the land's next planned use or probable future uses. For many NDA sites, the end state is not scheduled to be achieved for many decades, so it is important to ensure there is flexibility in the long-term site remediation plans. Over time, the description of the end state becomes more detailed as decommissioning progresses and a clearer picture of the site's characteristics emerges.

A wide range of issues could affect the proposed Site End State, such as changes in policy and regulations, advances in technology and changes in the desires of a community over generations. It may not be realistic or necessary to remediate a site completely (i.e. removing all hazards so that the site may be suitable for any use). For some sites, remediation will focus on preparing the site for a specified beneficial use.

There are three credible options for the Site Interim and End States strategy:

1. **Leave the hazard where it is and prevent use**
2. **Make land suitable for next planned use**
3. **Remove the hazard completely so that the risk does not need to be controlled**

4.2.4 Land Use

Land Use is a new topic identified in the NDA Strategy (2016). It has arisen from a desire on the part of the NDA to apply joined-up thinking to how a site is remediated and ultimately used following final site clearance.

Whilst the Site Interim and End States strategy describes the condition to which designated land and associated structures and infrastructure need to be restored, Land Use is about understanding how sites can be used following the end of decommissioning or during interim periods of decommissioning and remediation activities.

There are three options for Land Use:

1. **Retain land as an NDA asset / liability**
2. **Retain land on behalf of government as a national asset**
3. **Divest the land (leasehold or freehold) for social, environmental or economic benefit**

4.3 Spent Fuels

Within the Spent Fuels theme, there are three individual topic strategies, reflecting the three groups of spent fuels for which the NDA is responsible.

4.3.1 Spent Magnox Fuel

Two credible options were assessed for managing the remaining inventory of spent Magnox fuel:

1. **Manage entire inventory in existing reprocessing facilities** (this was the preferred option identified in the previous Strategy and forms the Baseline Scenario in the assessment)
2. **Curtail reprocessing operations and build storage and immobilisation facilities, disposing of spent fuel to a geological disposal facility (GDF)** (this is a credible alternative option which has been assessed in detail against the Baseline Scenario)

4.3.2 Spent Oxide Fuel

The three credible options available for managing spent oxide fuel are:

1. **Manage in existing reprocessing and storage facilities in line with contractual commitments, with interim storage of unreprocessed spent oxide fuel pending a future decision on whether to declare them as waste for disposal in a GDF** (Baseline Scenario)
2. **Curtail reprocessing operations and build storage and immobilisation facilities, disposing of spent fuel to a GDF** (credible alternative option assessed in detail)
3. **Extend reprocessing capability, building major new support plants** (credible alternative option assessed in detail)

4.3.3 Spent Exotic Fuel

The Spent Exotic Fuel strategy differs considerably from the strategies for Magnox and Oxides. This is primarily due to the unique nature of the inventory, which has mostly been produced from experimental research into nuclear reactor technologies. Within the inventory, there are several different forms of spent fuel.

'DFR Breeder' is spent fuel that has arisen from operation of the experimental fast reactors at Dounreay. It makes up the greatest volume of the exotics inventory.

As the DFR Breeder material shares similar chemical, physical, and radiological properties to Magnox spent fuel, it can be managed using the same facilities (i.e. through reprocessing). Since the last Strategy was published, the decision has been made to incorporate this part of the exotics inventory into the Magnox strategy (see Section 4.3.1).

The remainder of the exotics inventory comprises:

- fuels consisting of plutonium, mixed uranium and plutonium oxide and mixed uranium and plutonium carbide fuels;
- unirradiated high enriched uranium fuels consisting of uranium oxides, uranium metal, uranium alloy, uranium tetrafluoride, uranium hexafluoride and other miscellaneous enriched uranium fuels; and
- irradiated fuels, comprising oxide and carbide fuel consisting mainly of Prototype Fast Reactor (PFR) fuel and the HELIOS material that was irradiated in experimental work (DSRL, 2015).

Unlike the DFR Breeder material, much of this spent fuel cannot be managed through existing facilities. This means that alternative disposition options will need to be implemented.

Work is currently ongoing to identify and develop credible options for the disposition of spent exotic fuels that cannot be managed using existing facilities. This means that at this stage, there are no options under the Exotics strategy to be assessed.

4.4 Nuclear Materials

This strategic theme comprises the two topics of Plutonium and Uranics, which set out the NDA's approach to dealing with the inventory of nuclear materials stored on some of its sites.

4.4.1 Plutonium

Three credible options exist for managing the NDA inventory of civil plutonium:

1. **Continued safe and secure storage, renovating and replacing stores as required** (Baseline Scenario)
2. **Build facilities to immobilise plutonium, interim store the product and dispose of to a GDF** (credible alternative option assessed in detail)
3. **Build facilities to reuse plutonium in nuclear fuel** (credible alternative option assessed in detail)

4.4.2 Uranics

The credible options for managing the uranics inventory are broadly similar to those for plutonium. These are:

1. **Continued safe and secure storage, holding the material as a nil value asset and renovating and replacing stores as required** (Baseline Scenario)
2. **Build facilities to immobilise uranics and dispose to a suitable facility**
3. **Sell the uranics inventory, treating any uranics for which treatment is cost-effective in order to enhance saleability**

4.5 Integrated Waste Management

Integrated Waste Management considers how the NDA manages all forms of waste arising from operation and decommissioning of its sites. The strategy is broken down into: Radioactive Waste, Liquid and Gaseous Discharges and Non-radioactive Waste.

4.5.1 Radioactive Waste

In the UK, radioactive wastes are classified according to the type and quantity of radioactivity they contain and how much heat this radioactivity produces (ONR, 2013).

The NDA Strategy for radioactive waste management covers two categories of radioactive waste: Higher Activity Waste and Solid Low Level Waste.

Higher Activity Waste (HAW)

HAW includes High Level Waste (HLW), Intermediate Level Waste (ILW) and a relatively small volume of Low Level Waste (LLW) that is unsuitable for management under the *UK Strategy for Management of Solid LLW from the Nuclear Industry* (NDA, 2010a), in most cases because of the nature of the radionuclides contained in the waste.

In England and Wales, the government policy is for HAW to be disposed of in a GDF and using alternative disposal systems. The Scottish government policy is that the management of higher activity radioactive waste should be in near-surface facilities. As the NDA's strategy is selected to meet the requirements of these policies, in effect there is no strategic decision for the NDA to make (although the NDA works closely with government to identify and develop solutions). In other words, the NDA's strategic position is to comply with and deliver government policy regarding the management of HAW.

As the initial stage of the HAW management route is fixed (i.e. retrieve the waste from the sites) and the end stage is also fixed (i.e. geological disposal or alternative systems in England and Wales and near-surface in Scotland), the intermediary stage must involve some form of treatment, conditioning and / or packaging to make the waste suitable for disposal. From an NDA perspective, it is during this stage that there is the greatest scope for strategic decision-making.

Credible management options available during this stage revolve around two issues:

- where the waste is stored; and
- where the waste is treated.

NDA Strategy

The assessment has considered the treatment and storage of HAW, for which there are three credible options:

1. **Storage / treatment at local (on or near site) facilities**
2. **Storage / treatment at regional facilities**
3. **Treatment at national facilities***

* Storage of wastes in a single national facility is not considered to be credible owing to the existence of numerous suitable storage facilities across the country.

Solid Low Level Waste (LLW)

The NDA strategy for managing solid LLW, which includes VLLW, is consistent with the UK Nuclear Industry LLW Strategy (NDA, 2010a and 2015c). Therefore, from an NDA perspective, there are no strategic decisions to make and no credible options require assessment.

4.5.2 Liquid and Gaseous Discharges

In June 2009, the UK government published its revised UK Strategy for Radioactive Discharges to inform decision-making by industry and regulators (DECC, 2009). This sets out how the UK will implement its obligations in respect of the OSPAR Radioactive Substances Strategy 2020 intermediate objective (OSPAR Commission, 2010). As the NDA has a significant role in its development and implementation, a separate strategy for the NDA estate is not required.

4.5.3 Non-radioactive Waste

The UK has a well-established, comprehensive and prescriptive regulatory regime for the management of non-radioactive waste. The NDA adheres to this regime and implements it across its estate. As a result, there are no strategic decisions for the NDA to make and no credible options require assessment.

5.0 Approach to assessment and methodology

5.1 Introduction

The Integrated Impact Assessment (IIA) of NDA Strategy (2016) comprises the combined assessment results of a Strategic Environmental Assessment (SEA) [1], Health Impact Assessment (HIA) and Socio-economic Impact Assessment (SeIA). Each assessment has been completed by relevant specialists, with ongoing dialogue to ensure consistency and effective information sharing across them. The results of both the environmental and socio-economic assessments have been used to inform the HIA.

5.2 Requirements of SEA, SeIA and HIA

Strategic Environmental Assessment (SEA)

The NDA is committed to ensuring that the development of its Strategy is in accordance with the requirements of the European Union's SEA Directive and transposing UK Regulations.

SEA became a statutory requirement following the adoption of European Directive 2001/42/EC (the SEA Directive) "on the assessment of the effects of certain plans and programmes on the environment". The SEA Directive was transposed into UK legislation on the 20 July 2004 as Statutory Instrument No. 1633 – The Environmental Assessment of Plans and Programmes Regulations 2004 ("the SEA Regulations").

Health Impact Assessment (HIA)

The NDA Strategy (2016), which covers activities at each of the 17 sites that make up the NDA estate, could have potential effects upon public health. In order to understand the potential risks for health effects associated with the Strategy, a HIA has been undertaken.

By incorporating HIA into the assessment, the NDA is aiming to demonstrate good practice and integrate HIA into its strategic decision-making.

Socio-economic Impact Assessment (SeIA)

Employees at NDA sites generally number in the hundreds. Given their largely remote locations, this makes many of the sites important providers of employment and contributors to the local and, in some cases, regional economy. Changes at the sites as they move through their respective decommissioning programmes therefore have the potential to affect the socio-economic characteristics of local communities, particularly by affecting those directly employed at the sites and organisations in the sites' supply chains.

The potential for the NDA Strategy to have socio-economic implications is a key consideration in its development, as underlined by a requirement in the Energy Act (2004). By incorporating SeIA into the assessment, the NDA is aiming both to demonstrate good practice in giving due regard to socio-economic considerations, and to integrate SeIA into its strategic decision-making.

5.3 Geographic scope

The geographic scope of the assessment covers the UK, as the 17 sites which comprise the NDA estate are spread across these countries with the exception of Northern Ireland.

Where the policy of the UK government or the Scottish or Welsh devolved administrations may influence the geographic scope of a particular option, the assessment follows the Strategy in adhering to government policy. Anything beyond the geographic scope set out in policy has been considered beyond the scope of the assessment, for example, the storage and disposal of Higher Activity Waste (HAW) using international facilities.

The Baseline Report (contained in Volume 3 of the IIA Report) has been developed using a geographic boundary of between 100 m and 5,000 m around each site for topics deemed appropriate for consideration at a local scale.

5.4 Temporal scope

The temporal scope of the assessment reflects the period of time for which the Strategy applies. It is therefore assumed that the Strategy will be in operation until the final site in the NDA estate achieves its stated end state. This is anticipated to be Sellafield in the year 2120. However, it is also assumed that the Strategy will be reviewed and updated on a 5-year cycle within this period.

It is important to note that in reality such dates are not fixed, as new technologies may be developed which speed up decommissioning programmes. Similarly, unforeseen circumstances may extend decommissioning timescales.

The exact timescales over which impacts will occur is uncertain. Results outlined in the assessment should therefore be viewed as indicative and not absolute from a temporal perspective.

5.5 Key assessment steps

A set of key steps was developed and applied during the assessment. These were:

1. Identify the risks of (or opportunities for) effects of the strategic options identified in the Strategy, and how they might occur;
2. Identify any existing legislative requirements and forms of mitigation which may already address the risks;
3. Where the risk of (or opportunity for) an effect remains, assess the potential significance (based on the magnitude of the effect and the sensitivity of receptors), where possible taking into account uncertainties and factors which may cause the significance to vary;
4. Recommend further mitigation and enhancement measures; and

5. Recommend monitoring and response mechanisms.

For some options, insufficient information was available to conduct step 3 as above. Instead, the assessment of these options focused on identifying and discussing environmental, socio-economic and health effects and their management and mitigation, as well as opportunities for potential benefits.

5.6 Proposed assessment framework and guide questions

In order to support the IIA, a number of guiding assessment questions were developed to cover the range of environmental, health and socio-economic issues relevant to the assessment of the Strategy. These questions have evolved from the Sustainability Objectives and accompanying assessment guide questions provided in the SEA of the last Strategy (2011).

The updated assessment guide questions used in the IIA can be found in IIA Report: Volume 1 – Appendix B.

5.7 Assumptions and uncertainties

To support the assessment and ensure transparency and robustness, a set of assumptions and uncertainties have been documented in a register.

The register is presented in IIA Report: Volume 1 - Appendix A.

5.8 Response to scoping consultation

In line with requirements of SEA, a Scoping Workshop was held in March 2015 with representatives of Statutory Consultees and other relevant key stakeholders with an interest in the NDA Strategy.

The purpose of the workshop was to inform attendees of the proposed methodology for the IIA, including the ways in which it differed from the SEA conducted for the previous Strategy (2011). Feedback was then sought regarding the approach, with particular focus on the assessment guiding questions which were subsequently used to frame the assessment.

Following the Scoping Workshop, organisations in attendance and those unable to attend on the day were given a two-week period in which to provide additional responses or to raise any further issues regarding the approach to the assessment. As no further responses were received, it was assumed that attendees were broadly satisfied with the assessment approach, and that no additional consultation was required at that time.

The formal Scoping Workshop and two-week post-workshop consultation period were used in the place of a full Scoping Report.

6.0 Integrated Impact Assessment of the NDA Strategy (2016)

6.1 Introduction

This chapter presents the findings of the IIA in the form of risks and opportunities for environmental, socio-economic and health effects associated with the NDA Strategy (2016). It is split by theme and topic.

6.2 Site Decommissioning and Remediation

6.2.1 Decommissioning

Decommissioning involves decontamination and full or partial dismantling of facilities following the end of operations and the removal of operational material and waste (sometimes known as Post

Operational Clean Out). The approach to decommissioning is developed on a case-by-case basis, reflecting the specific nature of the facility in question. The NDA estate includes reactors, chemical plants, research facilities, waste management facilities, fuel fabrication and reprocessing plants, all of which present different decommissioning challenges.

Strategy (Preferred Option)

The NDA strategy is to decommission its sites as soon as reasonably practicable, taking account of lifecycle risks to people and the environment and other relevant factors. There are two broad credible options for implementing this strategy, with each option being preferred under specific conditions. Generally, the NDA preference is for continuous decommissioning, except where there are clear benefits to be had from deferring work. Where deferred decommissioning is preferred, there needs to be a clear and well-documented case for this.

Potential Effects

Environmental risks and opportunities

Continuous decommissioning offers an environmental opportunity in terms of reducing the hazard and risks associated with land and facilities more quickly; allowing access to subsurface contamination, which can then be managed more efficiently. This can lead to short and medium-term improvements to the landscape and air and water quality. Additionally, continuous decommissioning can make use of existing infrastructure which might otherwise need to be maintained or upgraded if decommissioning is deferred.

In some cases, deferring decommissioning can provide an opportunity to allow natural decay, which reduces the radiological risk to the public and the environment during decommissioning and may reduce the level of physical activity needed to clean up a site or facility. This reduction in activity may reduce environmental impacts such as noise and vibration, air and water pollution. If there are short-lived radionuclides, then deferred decommissioning may reduce the waste management burden, with potential knock-on implications in terms of reduced transport.

The use of deferred decommissioning is highly dependent on site-specific considerations, such as the nature of the contamination and the facilities being decommissioned. It may not always be suitable, in which case such opportunities may not be realised.

Continuous decommissioning can put strain on waste management facilities, as greater volumes of waste may be generated in the short to medium-term. In contrast, deferred decommissioning may allow more time to plan appropriate management routes for waste generated, as well as allowing transport movements to be spread out over time. However, there may be a trade-off in terms of extended duration of impacts on land use and the landscape.

Socio-economic risks and opportunities

Continuous decommissioning offers opportunities in terms of maintaining a skilled workforce and jobs in the supply chain. It can also mean that land becomes available for alternative uses more quickly. Such uses may include supporting new facilities or providing some other form of socio-economic or environmental benefit (see Section 6.2.4).

A key socio-economic risk associated with continuous decommissioning is the potential for skills and the workforce to be 'locked up' on a particular site or area of a site. This may prevent other sites or areas receiving attention, which could have further implications from an environmental and health perspective.

The main socio-economic opportunities associated with deferred decommissioning are the potential maintenance of jobs over a longer time frame (though these would decline significantly and could be lost during quiet periods), and the possible reuse of facilities during the deferral period.

Health risks and opportunities

Under the continuous decommissioning option, it is likely that more intensive activity would be required to clean up the site or facility. This could lead to higher-magnitude environmental impacts in the short to medium-term, which may have implications for health. Intensive demolition or excavation works, for example, could result in changes in air quality which might lead to slightly increased risks of cardiovascular and respiratory illness amongst the local population.

Deferred decommissioning may provide opportunities to spread out environmental impacts (and associated health impacts) over time, but at the risk of incurring negative effects on mental health and well-being due to extended impacts on the landscape and land use.

Maintenance of jobs over a longer period of time under the deferred option could offer mental health and well-being benefits (although there would be a decline in jobs during periods of deferral) and may enable attention (in terms of resources, skills and workforce) to be diverted to sites and facilities where health risks are higher. This could be considered an additional health opportunity of deferred decommissioning.

Alternatives

As both continuous and deferred decommissioning are considered to be preferred options under certain conditions, there are no alternative credible options requiring assessment.

6.2.2 Land Quality Management

Land quality management involves managing risks to people and the environment from radioactive and non-radioactive contamination in ground and groundwater. This is done through prevention and remediation (including control and monitoring).

Decisions over how remediation is carried out, including whether contaminated land is treated *in situ* or *ex situ*, are made on a case-by-case basis taking into account a range of relevant factors. Such factors include the nature of the contamination, the risks to people and the environment and the Site Interim and End States (see Section 6.2.2).

Strategy (Preferred Option)

Risk to people and the environment is the NDA's primary and enduring consideration in deciding how to manage land contamination. This risk is determined in part by the nature, extent and likely behaviour of any contamination.

The NDA strategy is to employ early risk-based decision-making to ensure remediation is proportionate to the level of risk. At higher levels of risk, there is less flexibility in the way land quality is managed. Often the decision is driven by the need to reduce risk. Action will be taken as soon as reasonably practicable to minimise the time at risk. As levels of risk decrease, the strategy is to take account of sustainable development to promote socio-economic opportunities and maximise environmental protection.

Due to decisions being taken on a case-by-case basis, there is no single preferred option for this strategy. Instead, there are four credible options which may each be preferred under certain conditions;

- *In situ* management without intervention
- *In situ* management with intervention
- *Ex situ* management for reuse
- *Ex situ* excavation for disposal

Potential Effects

Environmental risks and opportunities

In situ management without intervention, due to the minimal activities required, has very few environmental risks; providing it has first been established that the contamination is not spreading or getting worse. As the contaminated land would be left where it is to allow natural attenuation to take place, there would be very small energy use requirements, waste generation, vehicle movements and impacts in terms of pollution. However, use of the option is highly dependent on the nature of the contamination being correctly understood and whether potential pathways exist which might lead to effects on receptors. As such, it may not always be suitable.

In the event that the contaminant does not attenuate naturally and remains in a relatively unchanged form for an extended period of time, there would be very few long-term environmental opportunities offered by this option in terms of improving land quality.

In situ management with intervention offers opportunities in terms of improving land quality, and avoids many of the adverse environmental effects such as air and noise emissions associated with options that include excavation. Such opportunities may come with a trade-off in terms of environmental risks in the short and medium-term. For example, intervention could involve processes which use energy and generate pollutant emissions. Intervention also involves disturbing contaminants and may increase the risk of contaminants spreading or additional releases of contaminants.

Ex situ excavation for reuse would have short-term impacts associated with excavation activities. This may include transport of plant and equipment, energy use and emissions of air pollutants. Energy may also be used in treating excavated material.

The main environmental opportunity offered by the *ex situ* for reuse option is the avoidance of waste, which under the disposal option would require transport to an authorised site. Reusing existing material may also help to reduce material requirements for other developments at a site. This could have environmental implications in terms of avoiding transport movements and carbon emissions.

Excavating contaminated land for disposal is the option with the greatest environmental risk, as there would be short-term impacts from changes in air quality, noise and vibration and landscape from the excavation activities, followed by longer-term impacts of transporting wastes to suitable disposal facilities.

Socio-economic risks and opportunities

From a socio-economic perspective, *in situ* management without intervention offers the fewest socio-economic opportunities, as employment would largely be restricted to monitoring activities. There would also be few opportunities to enhance knowledge and skills or provide education and training.

In contrast, *in situ* management with intervention would provide a range of opportunities to enhance knowledge and develop skills, although the extent of these opportunities would largely depend on the intervention technology used. There may also be opportunities for education, training and employment.

In situ management with intervention gives greater control over timescales than management without intervention, which can help free up land for alternative uses more quickly.

Ex situ excavation for reuse and *ex situ* excavation for disposal would each create employment and may lead to economic investment, but would be unlikely to create many opportunities in terms of enhancing knowledge and skills or education and training.

Finally, removing contaminated material from the ground can provide greater control over timescales, allowing the land to be freed up for alternative uses more quickly (see Section 6.2.4).

Health risks and opportunities

All options would offer health opportunities as the hazard would be removed or reduced. Intervention and excavation potentially offer the most opportunities from a health perspective, as the time ‘at risk’ is reduced. However, there is a trade-off in terms of short-term environmental impacts which may influence health. For example, works to excavate contaminated material and transport it off-site could lead to changes in air quality which might influence the risk of cardiovascular and respiratory illnesses, while increased traffic might influence the risk of road accidents on the local transport network.

Alternatives

The four credible options outlined above may each be considered preferred under specific conditions, and could all be used to implement the NDA strategy. Therefore, there are no other options requiring assessment.

6.2.3 Site Interim and End States

The NDA owns significant quantities of land, of which around one quarter is designated land that has been assigned by the government for decommissioning and remediation. As part of its responsibilities to government, the NDA is required to propose the end state for the designated land at each of its sites. The site end state describes the condition to which the site (land, structures and infrastructure) will be taken and, where necessary, should be accompanied by a description of the controls required to protect people and the environment from any residual hazards.

Site interim and end states together define objectives for the ongoing management of structures, infrastructure and land quality. They also have implications for the management of spent fuels, nuclear materials and waste arising from operational and decommissioning activities.

Strategy (Preferred Option)

The NDA strategy is to employ pragmatic, risk-based remediation objectives that enable beneficial reuse of sites wherever possible. This recognises that there may be both risks and opportunities associated with decommissioning and remediation activities. In some cases, there may be a tipping point beyond which remediation does more harm than good.

As a site gets closer to the end of its decommissioning journey, its end state will need to be defined in increasing levels of detail. As far as possible, this should be informed by a clear view of the future land use to ensure the safety of future users, and maximise beneficial reuse of structures, infrastructure and land (see Section 6.2.4).

The NDA's preferred option to achieve this strategy is to put each of its sites, on a site-by-site basis, into a condition suitable for the next planned use (in line with relevant planning requirements) or for probable future use(s) where remediation occurs before the next use is planned.

Potential Effects

The next planned use option ensures that the level of intervention (taking into account the cost, energy use and risk to workers) and the volume of waste generated are appropriate (no more or less than required) to meet the requirements of the next planned use. Whilst this can help to ensure that environmental, health and socio-economic risks are minimised, the exact nature and extent of risks (and therefore impacts) will be dependent on the next planned use and the activities needed to make the land suitable for it.

Environmental risks and opportunities

Activities required to make land suitable for a next planned use are likely to generate a range of short to long-term environmental impacts, from changes in air, water and soil quality to the generation of carbon emissions and wastes. The extent of such impacts would depend on the next planned use and the current state of the land. For example, in order to make the land suitable for use as a car park, the extent of physical activity (and thus the magnitude of associated environmental impacts) may be reduced when compared to making the land suitable for use as a residential development.

In addition to the range of environmental risks associated with this option, there would also be various environmental opportunities, including opportunities to remove contamination, improve long-term air, water and soil quality at the site and remove structures or facilities which have adverse landscape and visual impacts.

Socio-economic risks and opportunities

Under the preferred option, there would be opportunities to enhance knowledge and develop skills. Regardless of the next planned use for a site, a degree of remediation may need to take place to make the site safe. Generally speaking, the greater the extent of intervention required, the greater the opportunities may be for developing knowledge and skills and promoting education and training, though this is not always the case. Such intervention would generate employment.

A further socio-economic opportunity associated with this option is the potential for reuse or divestment of the land which, following remediation, may become a local or national asset.

Health risks and opportunities

The main health opportunity associated with taking sites to a condition suitable for their next planned use is the removal of hazards which may affect land, water and air quality. Removal of such hazards may also free the land up for alternative uses, which could include amenity or recreational features. Creation of such features could positively impact levels of physical activity undertaken by the local population, thereby providing health benefits.

Remediation of a site to a condition suitable for its next planned use has the potential to generate adverse environmental impacts in the short to medium-term, though these would be reduced compared to making a site suitable for any foreseeable use. Such impacts could have adverse implications for health. For example, an increase in air pollutant emissions can influence the risk of cardiovascular and respiratory illnesses amongst the local population.

Making land suitable for its next planned use may offer further opportunities to facilitate dialogue with stakeholders, which can have a positive effect on community cohesion and may lead to mental health and well-being benefits.

Alternatives

Leave the hazard where it is and prevent use

This option would not involve physical activity to improve the condition of the site, but may involve minimal activity to maintain, stabilise it or prevent further contamination. For the most part, it would rely on controls (legal or administrative tools or actions such as restrictions on land use, environmental monitoring requirements, and site access and security measures) to manage risks to people and the environment.

This option is only suitable in extreme cases where remediation is very difficult and turning the site into a disposal site (that needs to be managed by preventing use) is preferable to attempting extensive and costly remediation in order to create a new facility or alternative land use.

Managing the risk using controls could offer some opportunities from an environmental perspective in terms of reducing the physical activity needed in the short and medium-term (and therefore the magnitude of impacts). This might include avoiding pollution-generating activities such as excavation, vehicle movements and energy use.

Under this option no environmental opportunities would be realised in terms of improving water and soil quality at the site in the long-term. The hazard would also still exist in a relatively unaltered form (although monitoring would be used to ensure risks did not increase). This could have potential health implications.

Preventing the site from being reused would limit socio-economic opportunities, but may lead to some employment to undertake monitoring activities.

Remove the hazard completely so that the risk does not need to be controlled

Under this option, the site would be restored to a condition where it can be used for any foreseeable use without the need for additional remediation or management controls. The level of intervention required to achieve this would likely exceed that required under the other two credible options.

This may mean that environmental impacts (both adverse and beneficial) associated with intervention activities are greater. For example, removing the hazard completely would likely lead to high-magnitude adverse impacts in terms of air quality, noise and vibration, carbon emissions, energy use and waste in the short to medium-term, but may result in long-term improvements in air, water and soil quality, as well as positive landscape and visual impacts. It is also likely that greater volumes of waste would be generated which may then need to be removed from the site.

Due to the increased level of intervention required to make the land suitable for any foreseeable use, there may be a range of socio-economic opportunities provided, including employment, development of skills and opportunities for education and training. This could have positive health effects in terms of mental health and well-being. On the other hand, removing the hazard completely would likely take longer, and thus the land would not be made available for reuse as early as it would be under the next planned use option. This could limit the attainment of socio-economic opportunities such as investment into the local economy and jobs.

From a health perspective, removing the hazard completely would likely offer greater long-term health opportunities than the two other credible options. However, in the short to medium-term, the greater level of intervention required may increase health risks as environmental impacts would likely be of higher magnitude.

6.2.4 Land Use

The NDA's Site Interim and End States strategy describes the condition to which designated land and associated structures and infrastructure need to be restored. In support of this, its Land Use strategy explores how land can be used either following completion of decommissioning and remediation activities or on an interim basis prior to achieving the site end state.

Strategy (Preferred Option)

The NDA strategy is to identify credible uses for its land either when decommissioning and remediation is complete or on an interim basis prior to achieving the site end state. Part of this commitment is an aspiration to encourage the reuse of brownfield land over greenfield land, in line with government policy.

The NDA is committed to investigating reuse opportunities, recognising that there is a need to balance the cost of achieving an end state against the socio-economic and/ or environmental value the next use will bring.

Whilst the NDA's preferred option is to divest the land for some benefit, it is recognised that there may be situations in which the land may need to be retained as a government asset or as an NDA liability.

Potential Effects

Environmental opportunities

Decommissioning and clean-up of sites may facilitate development of new nuclear build. This could offer a number of environmental opportunities, including the avoidance of environmental impacts associated with development of new sites. Such development at existing sites would also offer opportunities by providing a low carbon form of power generation, which could have a positive impact from a climate change perspective.

Environmental opportunities may be provided if all or part of some sites are developed into nature conservation sites or habitats. This could help to promote biodiversity and improve local landscapes.

Socio-economic opportunities

Clean-up and closure of the NDA sites may provide socio-economic opportunities if a community service or facility can be established. This might include a business park or some other facility which provides benefits to the local economy. Such development would likely support employment and could lead to opportunities to enhance knowledge and skills.

Development of a college or research establishment could promote opportunities for education and training. An example of this is the transfer of some of the research facilities at Berkeley Centre (owned by NDA and adjacent to the Berkeley reactor decommissioning site) to South Gloucestershire and Stroud College with a view to providing training in the renewable energy and nuclear sectors.

If land is used to support the new generation of nuclear build this could provide an opportunity to create a national asset, providing jobs and economic investment into the community or region.

Health opportunities

Creation of recreational or amenity space or some other form of community facility could lead to health opportunities from improvements in mental health and well-being, as well as having positive physical health implications if it leads to increased levels of physical activity.

In addition, the actual process of determining a future land use in itself may offer health opportunities if it promotes community cohesion through an effective stakeholder consultation process.

Alternatives

The alternative credible options to divesting the land for some socio-economic or environmental benefit are to either retain the land as a government asset or to retain the land as an NDA liability. Such options would offer little in the way of opportunities, and would only be preferred in the event that a more suitable use could not be identified.

6.3 Spent Fuels

6.3.1 Spent Magnox Fuel

The Magnox reactors were the first generation of commercial nuclear power stations to operate in the UK. All of these twenty six reactors have now been shut down. The last remaining operating reactor at Wylfa ceased generating in December 2015.

The NDA has the responsibility to defuel and decommission all of these Magnox reactors. Prior to decommissioning, spent fuel is removed from reactor cores and sent to Sellafield for reprocessing.

Reprocessing was identified as the preferred option for managing Magnox spent fuel as the fuel and alloy in which it is encased are both susceptible to corrosion in water over time. Reprocessing allows the spent fuel to be broken down into its components of uranium, plutonium and waste.

Strategy (Preferred Option)

The NDA strategy is to reprocess all Magnox fuel in line with the Magnox Operating Programme (MOP 9) (NDA, 2012).

The MOP outlines the timeframes and targets for activities at Magnox sites. Detailed co-ordination of all activities ensures a smooth sequence of transport movements and efficient operation of the reprocessing facilities at Sellafield.

Reprocessing of spent Magnox fuel has been the UK's historic strategic position for over 50 years and remains the current preferred option.

Potential Effects

Environmental risks and opportunities

One of the main environmental risks associated with Magnox reprocessing is the potential for liquid and aerial discharges. These are managed in line with government targets as set out in the UK Strategy for Radioactive Discharges (DECC, 2009).

There are a number of other environmental impacts associated with continuing to reprocess the Magnox inventory. These include the ongoing use of energy and generation of carbon emissions associated with equipment and the movement of workers, and the landscape and visual impacts of the plant and stores. These impacts are short-term as the plant is scheduled to be shut down around the year 2020.

Reprocessing spent Magnox fuel produces plutonium, uranium and Highly Active Liquor (HAL), all of which are radioactive and require careful management. Although there are appropriate management routes in place to deal with these products (see Sections 6.4.1 and 6.4.2), this could be considered an environmental risk from a radiological perspective.

There are also risks associated with the use of aqueous processes and solvents during the extraction of plutonium and uranium. The use of such processes can lead to risks of hazardous releases to water bodies. Given the extensive controls that are put in place to avoid, minimise and monitor releases of contamination to the water environment, any residual risks are small.

Such risks may also be offset somewhat by the opportunities that come from converting the spent fuel into a form less susceptible to corrosion. Long-term interim wet storage of spent Magnox fuel can lead to contamination and degradation of interim storage facilities. Such facilities would need to be maintained or replaced whilst an alternative management option to reprocessing was implemented (see 'Alternatives' Section). Reprocessing using existing facilities may therefore offer some environmental opportunities by avoiding construction and maintenance activities. Should the existing reprocessing facilities fail, it may be necessary to replace the current wet fuel interim stores with appropriate spent fuel dry storage containers and facilities.

One of the main opportunities associated with continued reprocessing is the avoidance of construction that would be needed to implement an alternative management route, i.e. disposal of the inventory (see 'Alternatives' Section). Such construction would have a range of short, medium and long-term environmental impacts, including changes in air quality, noise and vibration, landscape and visual impacts, material and energy use and contamination to soil and the water environment. Avoidance of such impacts can be considered a major opportunity.

Socio-economic risks and opportunities

Reprocessing spent Magnox fuel at Sellafield has and continues to bring economic investment into the local and regional economy. This may be both directly and through supporting employment which in turn has multiplier effects. Such economic opportunities would continue under this option until 2020, and perhaps for some time after this as the facilities are decommissioned, but would eventually decline.

From an employment perspective, continuing to reprocess the Magnox inventory through existing facilities will maintain jobs over the next four years. These jobs are associated with operation of the plant and stores, in addition to managerial and administrative positions that may be required to support reprocessing activities.

Once the Magnox inventory has been reprocessed and the facilities are shut down in preparation for decommissioning, these jobs will be lost. Some opportunities for job creation may exist to undertake decommissioning, which could help to offset some of these losses, as could the potential transfer of jobs to other facilities. Such employment changes may affect the nature of local communities and the local economy.

Continued reprocessing offers limited opportunities to develop new skills or knowledge, with the possible exception of techniques to extend the life of interim stores. Such knowledge and skills would likely be enhanced further if an alternative management option was implemented due to the lead time required to construct alternative facilities.

A final socio-economic opportunity associated with this option relates to the recovery of plutonium and uranium through reprocessing of spent fuel. Such materials are not considered wastes and may have commercial value or potential for reuse in the fabrication of new nuclear fuel.

Health risks and opportunities

The main opportunity provided by this option from a health perspective is the conversion of spent fuel into a form less susceptible to corrosion in storage. (Such corrosion can lead to land and water contamination which could have adverse health implications if not managed appropriately.) However, as reprocessing generates HAL, a highly radioactive waste which requires careful management, overall there may be an adverse effect on radiological safety from continued reprocessing, though risks remain well within acceptable limits.

If an alternative management route were implemented to deal with the Magnox inventory it is likely there would be a requirement to prolong the storage of the spent fuel in existing dry and wet storage facilities or replace them with new ones. This could generate a range of health risks relating to construction, in addition to increased risks of hazardous releases and contamination, although the new facilities would be engineered to higher, more modern standards, potentially reducing the risk. Implementation of a non-reprocessing management route would also avoid the production of HAL. Continued reprocessing using existing facilities avoids some of the environment-related health risks such as changes in air quality, noise and traffic that would be associated with construction of a new facility to manage the spent fuel.

Finally, the maintenance of jobs to operate the plant and stores over the next four years may have a positive impact in terms of mental health and well-being. Whilst the interim stores could continue to be managed after this time, closure of the plant may lead to stress, anxiety and other mental health-related effects.

Alternatives

There is one credible alternative option to reprocessing the Magnox inventory through existing facilities. That would be to curtail reprocessing operations, interim store the spent fuel until a conditioning facility could be constructed, condition the fuel (in an engineered container) and dispose of it to a GDF when one becomes available. The potential environmental, socio-economic and health risks associated with this alternative option are assessed in IIA Report: Volume 2 – Section 3.1.

6.3.2 Spent Oxide Fuel

Oxide fuel is used in Advanced Gas-Cooled Reactors (AGR) operated by EDF Energy (EDFE) in the UK, and in Light Water Reactors (LWR) operated by numerous utilities throughout the world. Spent oxide fuel has historically been reprocessed in the Thermal Oxide Reprocessing Plant (THORP) at Sellafield which started operation in 1994.

The NDA is contractually committed to receive and manage all of the spent fuel arising from the seven currently operating EDFE AGR power stations in England and Scotland. EDFE has publically declared its intention to operate these stations for as long as it is safe and economic to do so and to seek significant life extensions to its AGR reactors. About half of this AGR spent fuel is under contract for reprocessing in THORP and for the remainder the NDA plans to place this fuel into interim storage pending a future decision over its long-term management.

Strategy (Preferred Option)

In the previous Strategy the NDA committed to undertake a study to determine how much spent fuel should be reprocessed in THORP and how any remaining fuels including future arisings of AGR spent fuel should be managed.

Options were set out in a Credible Options paper for oxide fuels, and assessed against a number of criteria (NDA, 2011c). The conclusion reached through this assessment was that the delivery of the current strategy – to reprocess the contracted amount of spent fuel in THORP – remains the most viable and cost-effective option. The NDA confirmed its position in 2012.

In delivering the current strategy the NDA will have created sufficient space to receive and manage all the AGR fuel from EDFE power stations, which avoids having to build additional storage capacity for AGR fuel. If reprocessing was extended, many of the plants that support THORP's operations would need to be gradually replaced, at great expense. This would potentially divert resources from the NDA's core mission of nuclear clean-up and waste management.

After the closure of THORP the plan for the remaining AGR and other spent oxide fuels is interim storage, pending a future decision on whether to declare them as waste for disposal in a geological disposal facility (GDF). Placing spent fuel in interim storage will not foreclose future options for its management, including the options to dispose of in a GDF or reprocess.

Potential Effects

Environmental risks and opportunities

Managing part of the oxides inventory through existing reprocessing and storage facilities, in line with contractual commitments, avoids some but not all of the short, medium and long-term environmental impacts associated with constructing and operating a new facility to manage the entire inventory. This may include emissions of air pollutants, noise and vibration, landscape and visual impacts and energy use. Some construction may still be required to maintain or replace existing stores and would be required to build a packaging plant (assumed for the purpose of the assessment to be around the year 2065) to enable disposal of any unreprocessed spent fuel if a decision was taken to declare it as waste. Although this facility would be of a smaller scale than one constructed to dispose of the entire inventory, construction would still lead to a range of environmental impacts.

Operation of the packaging plant (which is required for all options but would likely take less time under this option) could generate a number of environmental impacts, particularly from a materials and waste perspective, as several thousand tonnes of spent oxide fuel would be packaged to produce a waste product.

There would also be a number of short-term risks associated with maintaining THORP over the next few years. This might include energy use, emissions of carbon dioxide and landscape and visual impacts.

Production of plutonium, uranium and HAL as part of reprocessing operations can be considered a major environmental risk; however, there are well-established management routes in place to deal with these products.

There may be additional risks from corrosion of spent fuel in storage, which could lead to releases to the ground or water environment. Such risks would need to be carefully managed, which may involve ongoing construction to replace and maintain stores until the packaging plant becomes operational.

This option may provide an environmental opportunity in terms of avoiding generation of some waste. If the entire current and future oxides inventory (estimated to be around 7,500 tonnes in total) was designated for disposal this could put slight but manageable pressure on waste management facilities such as the GDF. Under the preferred option, only part of this inventory (around 4,500 tonnes) may be disposed of so this pressure would be reduced.

Socio-economic risks and opportunities

Under this option, jobs at THORP would be maintained until 2018, which would constitute a minor benefit. After this time there would likely be job losses within the facility and potential decay or loss of reprocessing knowledge and skills. Some jobs would be retained to manage the High Level Waste canisters produced from treatment of HAL and for undertaking plant Post Operational Clean Out (POCO). As POCO has not previously been undertaken for a reprocessing plant this will lead to development of new knowledge and skills.

Considerable employment would be generated through construction of a packaging plant and maintenance or replacement of interim stores to manage any spent oxide fuel not intended for reprocessing. This would range from lower-skilled construction jobs to highly specialist engineering and managerial skills.

Management of the spent oxide fuels using existing facilities offers limited opportunities for developing new knowledge and skills, with the exception of the knowledge and skills that might be gained from implementing techniques to prolong the life of existing interim stores. This might lead to some minor opportunities for education and training.

Development of a packaging plant offers some minor opportunities to enhance knowledge and skills in the conditioning of radioactive wastes. Construction of the facility may also offer socio-economic opportunities by creating a national asset that could be used to manage other waste streams.

Closure of THORP, regarded by some as a national asset, could mean that national reprocessing capability is lost for the future unless significant investment is undertaken to maintain or re-establish it.

Finally, continued operation of THORP and supporting infrastructure might maintain investment into the local economy in the short-term, but such investment would be reduced following closure of the plant. Opportunities for investment may be provided by construction and operation of the packaging plant and interim stores, in which case economic losses from the closure of THORP may be reduced or offset, though this would not be realised for many years.

Health risks and opportunities

In terms of health risks, construction activities required to develop a packaging plant and interim store(s) could lead to short-term adverse changes in air quality, which might influence the risk of respiratory and cardiovascular conditions amongst the local population. Noise and vibration could possibly lead to annoyance and anxiety, while construction traffic could increase the risk of accidents on the local road network. There is also a risk of releases of non-radioactive contaminants to the ground and water environment, which could have further health implications, though these could be controlled through implementation of a construction environmental management plan.

This option may offer some health opportunities by avoiding or reducing adverse environment-related health effects through managing part of the inventory using existing facilities. These health effects would likely be of greater magnitude under alternative management routes, as the facilities needed to manage the entire oxides inventory would likely be larger in scale.

Production of plutonium, uranium and HAL carries some health risks, but as there are extensive controls in place to manage these products of spent fuel reprocessing, such risks to health are small under normal conditions.

A final health risk associated with this option comes from the ongoing storage of spent oxide fuel, which can corrode leading to degradation of storage facilities. This has the potential to lead to contamination via releases to water and the ground. Such risks are strictly controlled and are generally very small. These risks would apply to any option implemented to manage the oxides inventory.

Alternatives

There are two credible alternative options to managing the oxides inventory using existing facilities. One would be to curtail reprocessing operations, interim store the fuel before conditioning and disposing to a GDF. The other option would be to build major new multi-billion pound infrastructure to reprocess the spent fuel through new facilities. The potential environmental, socio-economic and health impacts of these options are considered in detailed assessments in IIA Report: Volume 2 – Section 3.2.

6.3.3 Spent Exotic Fuel

In addition to bulk Magnox and oxide fuels, the NDA also manages a smaller inventory of non-standard fuels, commonly referred to as "exotics". These fuels include metallic, oxide and carbide materials that have come from earlier nuclear industry activities such as the development of research, experimental and prototype fuels and reactors.

Some, but not all, of these fuels share common characteristics with bulk Magnox and oxide fuels, and can be managed in the same way, for example through reprocessing. Some, however, present their own particular management challenges due to their diverse and sometimes unique properties. In some cases, specifically-tailored solutions for long-term management and disposition may be required.

Strategy (Preferred Option)

Where the properties of the exotic fuels share common characteristics with bulk fuels such as Magnox and oxides, it may be practicable and economic to manage them using the same facilities. The NDA has therefore identified that its preferred option is to continue managing the exotic inventory using existing facilities, reprocessing the spent exotic fuels, where possible, alongside bulk fuels.

Any part of the inventory which cannot be reprocessed alongside bulk fuels will be stored pending development of suitable disposition options. This work is ongoing, and not currently at a stage where options can be assessed.

Potential Effects

Where part of the exotics inventory is suitable for management alongside bulk fuels such as Magnox and spent oxide fuels, potential effects are covered under the assessments of those strategies (see Sections 6.3.1 and 6.3.2).

For exotic spent fuels which cannot be reprocessed and remain following closure of the reprocessing plants, suitable disposition options will need to be implemented. As work to identify and develop credible options is currently ongoing, at this stage there are no options to be assessed.

6.4 Nuclear Materials

6.4.1 Plutonium

On completion of reprocessing operations at Sellafield, there will be around 140 tonnes of separated plutonium from civil sources in the UK. This inventory will need to be managed in a way that puts the vast majority of UK plutonium beyond reach, in line with UK government priorities.

NDA Strategy

Strategy (Preferred Option)

In 2011, informed by NDA strategic options work, the UK government proposed a preliminary policy view to pursue reuse of plutonium, by converting the vast majority of the UK civil separated plutonium into fuel for use in civil nuclear reactors. Any remaining plutonium whose condition is such that it could not be converted into fuel would be immobilised and treated as waste for disposal.

Whilst reuse of plutonium is the preferred policy position, there is currently an insufficient understanding of the options to confidently move into implementation. In the meantime, the NDA's strategy for plutonium stocks is to continue to safely and securely store them on its sites in suitable facilities in line with regulatory requirements.

The NDA continues to work with the UK government in developing strategic options for the implementation of its policy to put plutonium beyond reach by undertaking further strategic work on its behalf. This work covers both reuse and disposal options.

Potential Effects

Environmental risks and opportunities

There are a number of environmental risks associated with maintaining the baseline scenario of continued safe and secure storage. These include the major landscape and visual impacts that come from the presence of the stores at the site and the relatively minor air, noise and water quality impacts resulting from activities to repackage the material and replace the stores. It should be noted that such impacts are spread out over time, as the plutonium requires repackaging around every 30 years or so and the stores are built to a 100-year design life.

There would be some ongoing energy use and carbon emissions associated with this option, though this would be limited mainly to maintenance and monitoring activities and ongoing vehicle movements to transport plutonium to the stores. Impacts from flooding are a further environmental risk with continued storage, as the potential for flooding is regarded as an ongoing issue for Sellafield. This risk may become more prevalent over time due to the anticipated effects of climate change.

From a radiological risk perspective, plutonium decay in storage gives rise to neutron and gamma radiation which can be hazardous and requires careful management. This would be a major environmental risk of storing the plutonium on a continuous basis, although it can potentially be mitigated by regular maintenance, monitoring and treatment activities.

Socio-economic risks and opportunities

Whilst continued safe and secure storage of the plutonium inventory prevents the land the stores are built on from being used for alternative purposes, maintenance and repackaging activities do support ongoing employment. This includes construction jobs, monitoring and management positions.

In terms of knowledge and skills, continued storage offers little in the way of opportunities. There are also limited opportunities to provide education and training.

A case could be made that the existing plutonium storage facilities constitute a national asset, providing a means to store the UK's civil plutonium stocks safely and securely. Storing the materials on a continuous basis would therefore preserve a national asset which could be used to store future arisings of plutonium.

Health risks and opportunities

Due to the build-up of neutron and gamma radiation over time, storing the plutonium on a continuous basis could be seen to have a negative impact in terms of radiological safety-related health risks. However, there are strict controls in place to monitor any changes in radiation levels, and any impacts would be appropriately mitigated to minimise radiological risks to people and the environment.

A number of health risks associated with this option are linked to environmental effects that would result from activities to maintain and replace the facilities. This might include changes in air quality which can influence the risk of respiratory and cardiovascular illnesses amongst the local population, as well as noise and vibration which can cause disturbance. As these effects would be spread out over time and would be relatively minor, any potential residual health risks would likely be minor or negligible.

Continued safe and secure storage offers very little in the way of health opportunities. Arguably the maintenance of jobs could be considered a minor benefit in terms of mental health and wellbeing, though this may be offset by negative impacts from the ongoing presence of facilities and hazardous material on the site.

Alternatives

Reuse

Although there is currently insufficient understanding of options to enable the preferred policy position of reuse to be implemented, the NDA continues to work closely with technology suppliers, developers and the UK government in order to establish how the reuse option could be secured and implemented.

For the purpose of this assessment, an assumption has been made that a fabrication facility would be required to convert the plutonium stocks into new nuclear fuel. As part of this facility, some form of treatment plant may also be required along with one or more interim stores. The new nuclear fuel would then be transported to the reactors in which it is to be used.

The potential environmental, socio-economic and health effects of implementing the reuse option are considered in the IIA Report: Volume 2 – Section 4.1.

Disposal

An alternative credible option to continuing to store, or reusing the plutonium as fuel, is to construct a suitable treatment facility or multiple facilities to convert the material into a safe form for disposal in a geological facility. This would also require construction of one or more suitable interim storage facilities.

The potential environmental, socio-economic and health effects of implementing the disposal option are considered in IIA Report: Volume 2 – Section 4.1.

6.4.2 Uranics

Uranics are materials containing uranium which have been produced from fuel cycle operations such as enrichment, fuel fabrication and reprocessing since the 1950s. Uranium is a nuclear material, and is not usually classed as a waste as all uranics have the potential to be reused in nuclear fuel to generate electricity.

The two main types of uranics, by inventory mass, considered in the assessment, which are owned and strategically managed by the NDA, are Uranium Hexafluoride (UF_6), also known as “Hex” or “Tails”, and Magnox Depleted Uranium (MDU), a product of spent fuel reprocessing. Both UF_6 and MDU are defined as forms of depleted uranium.

Other types of uranics include High Enriched Uranium (HEU) which is covered in the Exotics strategy and THORP-product Uranium (TPU), which is not owned by the NDA, so decisions regarding its management are not strategic decisions for the NDA to make.

Strategy (Preferred Option)

Owing to the diverse nature of the uranics material owned by NDA, there is no single preferred management option for the whole inventory. The preferred option therefore needs to be determined on a group-by-group basis.

There are three broad credible management options which might be chosen to manage a particular group of the uranic materials. These are:

- continued safe and secure storage
- sale to a third party for recycling and reuse
- conditioning to an appropriate form for disposal

The NDA continues to manage its uranics material in line with contractual obligations and UK government policy.

Potential Effects

Environmental risks and opportunities

There are a number of environmental risks associated with the baseline scenario of continued safe and secure storage, which include landscape and visual impacts of the existing stores and any pollution generated from maintenance activities required to repackage the material or replace the stores.

Material and waste impacts would be considerable for the disposal option, as this option would involve construction of multiple facilities, in addition to classifying approximately 50,000 tonnes of depleted uranium as waste.

Construction impacts may include short-term changes in air and water quality and landscape and visual impacts. Noise may also be generated from vehicle movements and the use of plant which would require energy and could generate carbon emissions.

Environmental impacts associated with construction would be avoided under the sell option. This option would also offer opportunities in terms of landscape and visual impacts by facilitating closure of existing facilities.

It is important to note that the sell option is highly dependent on market conditions and external factors such as the availability of technologies to use the uranic material. Therefore, any landscape and visual and land use opportunities may not be realised for many years, during which time there would be ongoing environmental impacts associated with continued storage, including repackaging and replacing the stores.

Socio-economic risks and opportunities

Whilst storage of the uranics inventory on a continuous basis would prevent the land the stores are built on from being reused, maintenance and repackaging activities support ongoing employment. This includes construction jobs, monitoring and management positions.

Such jobs may be lost under the disposal option, but could to some extent be offset by operational jobs created to manage a conditioning facility and interim stores. In addition, there would be short-term employment opportunities created during construction of the new facilities.

Under the sell option, jobs involved in managing and maintaining existing stores would be lost when the stores closed, with no new employment created. Depending on the timescales over which the uranic material is sold, there may be an opportunity to transfer some of these jobs to other areas of the NDA’s operations.

In terms of knowledge and skills, continued safe and secure storage offers little in the way of opportunities. Disposal on the other hand may offer opportunities to enhance knowledge and skills in the area of uranium conditioning, which could then be applied to the management of other radioactive materials.

The sell option would not directly lead to development of knowledge and skills but may facilitate indirect advances in the area of uranium reuse in fuel.

Health risks and opportunities

From a health perspective, under all three credible options the Hex inventory would be deconverted in URENCO’s purpose-built facility at Capenhurst. This would help to convert the uranium into a more stable and less hazardous form, thereby reducing radiological health risks. In particular, risks associated with cardiovascular and respiratory illness may be reduced, as canisters used to store Hex can leak if they are not actively maintained.

Short-term construction impacts associated with the disposal option, such as changes in air quality and noise and vibration, could have health impacts by slightly increasing the risk of cardiovascular and respiratory illness amongst the local population. Construction traffic may also put pressure on the local transport network which could increase the risk of road accidents and lead to increased driver stress.

Long-term, the disposal option could have some health risks because the long half-life of Uranium-238 and the radiological hazard associated with its daughter products have the potential to lead to risks in the very far future. This will be evaluated using a suitable methodology once a disposal site has been determined.

In contrast, selling the uranics inventory may offer health opportunities, as risks associated with the build-up of hazardous daughter products of uranium can be more appropriately managed in the course of treatment prior to fabrication into fuel. It should be noted that these risks are generally very small and dependent on the type of uranium involved. Closure of existing stores may also offer landscape, visual and land use opportunities, which could lead to positive effects on mental health and well-being.

The creation of employment associated with disposal could lead to positive effects on mental health and well-being. The opposite would be true for the sell option, where employment associated with maintaining stores and repackaging the uranium would be lost.

Alternatives

As any of the three credible options identified above might be preferred for dealing with a particular group of uranic material, there are no other alternative credible options requiring assessment.

6.5 Integrated Waste Management

6.5.1 Radioactive Waste – Higher Activity Waste

Waste management is not a straightforward process of retrieval and disposal. It includes a series of steps: pursuing opportunities for waste minimisation, reuse and recycling, waste processing, packaging, storage, records management, transport and then, where applicable, final disposal.

Following retrieval, radioactive wastes often undergo some form of treatment to make them suitable for disposal. The technologies used to treat the wastes will vary depending on their specific characteristics, the availability of appropriate facilities, time constraints and other relevant factors. Such decisions are made on a case-by-case basis.

The Radioactive Waste strategy is divided into two topics: Higher Activity Waste (HAW) and Low Level Waste (LLW).

HAW comprises High Level Waste (HLW), Intermediate Level Waste (ILW) and a relatively small volume of LLW that is unsuitable for disposal at the LLW Repository in Cumbria or the LLW facility at Dounreay.

As outlined in Section 4.5, the assessment has focused on the management of HAW. Solid LLW management is covered by the UK Strategy for the Management of Solid Low Level Waste in the nuclear industry (2015), Liquid and Gaseous Discharges are covered by the UK Strategy for Radioactive Discharges (2009) and non-radioactive waste is managed according to an established, comprehensive and prescriptive regulatory regime.

From a strategic perspective, the key decisions that need to be made regarding HAW relate to:

1. Where the waste is treated

2. Where the waste is stored (either prior to treatment, following treatment or both)

Strategy (Preferred Option)

The NDA's overarching strategy is to treat and package HAW into a form that can be safely and securely stored for many decades. The current planning assumptions are that, at the appropriate time, the stored waste in England and Wales will be transported to and disposed of in a GDF. For HAW arising in Scotland, long-term management will be in near-surface facilities. The NDA HAW strategy supports policy development and implementation.

There are three broad credible options for implementing this strategy of relevance to this assessment; treatment and storage of HAW locally (at or close to the sites where it arises), treatment and storage at regional hubs and treatment at a national facility. Each option may be preferred under certain conditions. Storage of HAW at a national facility is not considered to be credible owing to the number of suitable facilities that already exist across the UK.

Potential Effects

Environmental risks and opportunities

From an environmental perspective, the main risks are associated with transport of the wastes to facilities and the footprint of the facilities themselves (including the extent of construction activities involved).

Treatment and storage of wastes locally would involve fewer transport movements than using regional or national facilities. This could provide environmental opportunities in terms of reduced air quality and noise and vibration impacts. Use of regional treatment and storage hubs would likely involve more movements than local facilities but less than the national option.

In terms of the facility footprint, the use of numerous local facilities may involve the greatest material requirements. The regional and national options therefore offer opportunities for achieving economies of scale, which has environmental implications in terms of materials, energy use and carbon emissions.

On the other hand, creation of a single national facility would have the largest physical environment footprint. This includes landscape and visual impacts, and may include releases of pollutants to air, water and the ground. Risks of impacts to biodiversity, wildlife and cultural heritage features may also be greater than under the local and regional options, although this is highly dependent on the final location of such a facility.

A degree of packaging and treatment may have to take place prior to transfer of wastes to regional or national facilities, in which case this may result in duplication of efforts and associated environmental risks relating to materials and energy. Avoiding these activities would be an environmental opportunity of using local facilities.

Risks of radiological discharges would be managed through the use of extensive controls such as the ‘as low as reasonably achievable’ (ALARA) principles and best available techniques (BAT), and are therefore considered unlikely to vary significantly between the options.

Socio-economic risks and opportunities

In terms of socio-economic opportunities, the use of local treatment and storage facilities may allow socio-economic benefits such as jobs and investment to be spread amongst a number of communities. In contrast, consolidation of waste at a single national facility could lead to job losses and may require some specialist workers to relocate. It would also mean socio-economic benefits are confined to one particular area.

The main opportunity offered by a single national facility or a number of regional facilities is the freeing up of land at other sites, thereby allowing them to undergo decommissioning and closure. This is less likely to be possible under the local option, meaning that opportunities to reuse the land or divest it for some socio-economic or environmental benefit may not be realised (see Section 6.2.4).

Local facilities may be more complex to design, owing to the need for them to manage a range of different waste types, rather than having a single national or potentially regional facility to manage all wastes of a particular type. This could be seen as an opportunity in terms of advancing knowledge, skills, education and training, or as a risk if it locked-up skills and resources which could be better directed elsewhere. In such a situation, creation of a single specialised facility to manage a particular waste stream may offer socio-economic opportunities, however these would be confined to one spatial area.

Health risks and opportunities

One of the main health opportunities offered by the local treatment and storage option is the avoidance of risk associated with transport movements. This includes the risk of traffic accidents and changes in air quality that can influence the risk of cardiovascular and respiratory illness amongst the local population. Treatment at or close to sites may also reduce health risks by ensuring that wastes are converted to a safe and secure form more quickly.

Whilst it is likely that wastes would need to be treated and packaged under the regional and national options to facilitate transport, this could create a logistical challenge which extends the timescale over which wastes are managed. Alternatively, there is a chance that the need to construct multiple local facilities may result in some construction being deferred for funding reasons.

Development of regional or national facilities and subsequent transport of wastes to such facilities may enable decommissioning and remediation to take place at other sites across the estate. This could have positive mental health and well-being effects. On the other hand, loss of or relocation of jobs under a regional or national option could adversely affect the mental health and wellbeing of a local community. This could be seen as a health opportunity under the local option.

Alternatives

As treatment and storage of HAW locally and regionally, and treatment of HAW nationally could all be considered preferred options under certain conditions, there are no alternative credible options requiring assessment.

6.6 Cumulative effects

6.6.1 Types of cumulative effects

'Cumulative effects' are those which arise from two or more impacts occurring simultaneously, whereby an impact that may not have a significant effect on its own may combine with another to produce a cumulative effect that is significant. There are two main types of cumulative effect relevant to the Strategy. These are:

- **intra-strategy effects:** effects which could result from preferred strategic options being taken forward, whereby the timing of option implementation either overlaps to change the severity of an effect (whether to increase or reduce it), or follows sequentially to prolong an effect; and
- **inter-plan effects:** effects of other strategies, plans or programmes acting in combination with the NDA's Strategy.

6.6.2 Intra-Strategy effects

The four driving strategic themes of the Strategy do not operate in isolation at each of the NDA's sites. Instead, all four themes interact with one another and with a fifth theme covering 'Critical Enablers'. The potential environmental, health and socio-economic effects of implementing the Strategy may therefore be altered (increased or decreased) if preferred options under different themes result in development or changes in transport and other infrastructure over similar timescales (including in sequence, which may extend the duration of an effect), or in overlapping geographies.

For most of the sites in the NDA estate, the two strategic themes with the highest level of interaction, and thus most probability for cumulative effects are Site Decommissioning and Remediation and Integrated Waste Management. The Spent Fuels and Nuclear Materials themes may also interact at certain sites.

Interaction between Site Decommissioning and Remediation and Integrated Waste Management

Successful site clean-up depends on the availability of suitable waste management routes and facilities, and as such, these two themes are inextricably linked. The two credible options for the Decommissioning strategy are 'continuous' and 'deferred' (see Section 6.2.1 for descriptions). As stated in Section 6.2.1, continuous decommissioning could possibly put a strain on existing waste management facilities, as greater volumes of waste may be generated in the short to medium-term. As such, continuous decommissioning may not only accelerate the effects identified for the Integrated Waste Management options (see Section 6.5), but potentially increase them, unless new facilities are built or additional capacity is identified within the current system. The extent to which such effects are increased would depend on the number of sites or facilities undergoing continuous decommissioning compared to deferred.

Deferred decommissioning may allow more time to plan appropriate management routes for waste generated, as well as allowing transport movements to be spread out over time. However, there may be a trade-off in terms of extended duration of impacts on land use and the landscape, as the sites will not be remediated as quickly.

The interactions identified above, and the choice between continuous and deferred decommissioning in particular, can impact on the timing of achieving site end states, and therefore the timescales over which environmental, health and socio-economic effects occur (see Section 6.2.3).

As with the Decommissioning strategy, there is a potential interaction between the Land Quality Management strategy and Integrated Waste Management. Depending on the specific conditions of the site and nature of contaminants involved, there is potential for *ex situ* remediation options (which involve excavation) to generate waste materials requiring management under the Integrated Waste Management theme. This may require the provision or expansion of waste management facilities.

Spent Fuels and Nuclear Materials: Additional Cumulative Effects

Management of spent fuels and nuclear materials is an important consideration in the decommissioning and clean-up of a site and has further links to the Integrated Waste Management theme. The timing for defueling of sites, for example, may affect decisions on whether to apply continuous or deferred decommissioning, and can also influence Integrated Waste Management and Land Quality Management decisions (e.g. continued operation of facilities can restrict access to areas of contamination or limit space for *in situ* remediation activities to be used).

Magnox fuels exist primarily at Sellafield, and also at NDA's Oldbury and Wylfa sites which still await completion of defueling.[5] Spent oxide fuels are also mainly present at Sellafield, with additional inventory being transferred to the NDA via contract with EDF Energy from its seven AGR power stations in England and Scotland. Exotic fuels are present mainly at Dounreay and Sellafield.

In terms of nuclear materials, the UK stocks of civil plutonium are primarily located at Sellafield, with a very small amount stored safely at Dounreay. The NDA owns uranic material held at Sellafield, Capenhurst and Springfields.

As such, only four of the 17 NDA sites are affected by this potential cumulative effects issue, but seven non-NDA sites could be affected in terms of their future decommissioning programmes. It is not currently envisaged that implementation of any credible option set out in the Strategy would pose a risk to delivery of these contractual commitments.

6.6.3 Inter-plan effects

The NDA's remit is focused on historic issues, as per its mission to ensure that civil public sector nuclear legacy sites are decommissioned safely, securely, cost effectively and in ways that protect the environment. However, there remains some influence from other government policies and plans on how the NDA's Strategy is ultimately implemented. These include:

- **The UK Strategy for the Management of Solid Low Level Radioactive Waste (LLW) in the nuclear industry:** the NDA published, on behalf of UK government and addressing the entire UK nuclear industry, the final Strategy in February 2016.[6] The timing and capacity of LLW management may theoretically influence selection and implementation of Site Decommissioning and Remediation and Integrated Waste Management strategies;
- **The Ministry of Defence's Submarine Dismantling Project (SDP):** the reactor cores of disused submarines form Intermediate Level Waste (ILW), for which options are currently being considered for

[5] For information from Magnox Ltd. on the status of current and former sites holding Magnox fuels, see http://www.magnoxsites.co.uk/what-we-do/sites/.

[6] Website for LLW Strategy consultation: https://www.gov.uk/government/consultations/consultation-on-an-update-of-the-uk-strategy-for-the-management-of-solid-low-level-radioactive-waste-from-the-nuclear-industry

the siting of interim storage prior to disposal to a GDF (among sites being considered are the NDA sites of Sellafield and Chapelcross, as well as the non-NDA component of the nuclear-licensed site at Capenhurst (noting still a potential interaction in terms of potential cumulative effects)[7]; and

- **The Department of Energy and Climate Change (DECC) National Policy Statement (NPS EN-6) for Nuclear Power Generation ('New Nuclear Programme'):** the government has identified the following sites as potentially suitable for the development of new nuclear power stations in England and Wales before the end of 2025: Bradwell; Hartlepool; Heysham; Hinkley Point; Oldbury; Sizewell; Sellafield; and Wylfa. [8]

For the MoD's SDP and DECC's New Nuclear Programme, issues around potential cumulative effects involve the potential for simultaneous construction or intensive decommissioning and remediation activities, which could generate higher than expected transport requirements, demand for nuclear skills and qualified personnel, or lead to timing issues and constraints on options requiring facilities within existing nuclear-licensed site boundaries. The timing of implementation (design, construction and operation) of such developments relative to implementation of the NDA Strategy is uncertain, making it difficult to accurately predict potential cumulative effects. It is crucial that SLCs and the NDA liaise with, and are informed by, relevant parties during future options development and decision-making at the site level.

6.7 Mitigation

Many of the potential adverse environmental impacts from construction identified in the assessment could be reduced if joint treatment or storage facilities were constructed to manage different types of materials and waste, or if existing facilities are reused wherever possible. Some of the adverse socio-economic impacts associated with closing facilities may be mitigated by transferring staff to alternative facilities or sites.

As there is considerable uncertainty regarding how strategic options will be implemented at a future time and at the site level, the results of the assessment should be viewed as being indicative of potential impacts of the Strategy but not absolute or certain. The nature and significance of identified impacts should be validated in the course of future assessment work when more detailed information is available. Such work would enable appropriate mitigation measures to be determined and applied. The results of the IIA should be used to inform this work, as well as future decision-making made by the NDA and the Site Licence Companies which operate its sites.

7.0 Conclusion and next steps

This Integrated Impact Assessment (IIA) aims to inform, but not drive, future NDA strategic decision-making. As such, there are a number of general conclusions that can be drawn from the IIA of the NDA Strategy (2016). These are listed below, along with potential next steps moving forward.

7.1.1 General conclusions

- For most of the Site Decommissioning and Remediation and Integrated Waste Management strategies the preferred option varies, and is selected on a case-by-case basis.
- Development of new and modification of existing facilities will be needed for some of the preferred strategic options. This generally involves a range of environmental and health risks and socio-economic opportunities.
- Implementation of a number of the preferred options may put pressure on the existing nuclear skills base. This pressure will be increased due to demand from the UK's new nuclear build programme.
- Health risks associated with options are linked to environmental and socio-economic changes.

[7] See: https://www.gov.uk/government/collections/submarine-dismantling-project
[8] See: https://www.gov.uk/government/publications/national-policy-statements-for-energy-infrastructure

- Many adverse impacts of construction can be mitigated by reusing existing facilities.
- Some of the adverse socio-economic impacts associated with closing facilities may be mitigated by transferring staff to alternative facilities or sites.
- Adverse environmental impacts from construction could be reduced if joint treatment or storage facilities are constructed to manage different types of materials and wastes. For example, one packaging plant could be constructed to manage spent Magnox, oxide and exotic fuels that are not reprocessed.
- There is considerable uncertainty regarding how options will be implemented at a future time and at the site level. The results of the assessment should therefore be viewed as being indicative of potential impacts but not absolute or certain.
- The results of the IIA should be used to inform future, more detailed assessments, to help select strategic options, as well as inform future decision-making made by the NDA and the Site Licence Companies which operate its sites.
- Specific impacts upon particular receptors may be more appropriately assessed as part of a project-level Environmental Impact Assessment.

7.1.2 Next steps

- Use of the IIA assessment results as part of the context for future strategic decision-making alongside other important aspects such as cost, feasibility, security and site-specific factors.
- Incorporation of the IIA topics into the NDA’s Value Framework as relevant factors in the identification and selection of credible and preferred options.
- Use of the assessment methodology in future assessment work.
- Consultation with statutory consultees, key stakeholders and the general public to obtain feedback on the IIA and identify potential improvements.

This Non-Technical Summary was published for public consultation alongside the main IIA Report and the NDA Strategy (2016) in January 2016. The outcomes of the consultation and its influence on development of the Strategy and the IIA are documented in an IIA Post-Adoption Statement, available on the NDA website.

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