BNFL Commercial

British Nuclear Group
Intelligent nuclear clean-up

Chapelcross End State Project

End State Development Report

	Name	Signature
Issued by:	**Mike Travis** **Site Director**	

This report has been prepared by British Nuclear Group, Chapelcross site in response to the NDA Site End State reconciliation process. This report is an additional requirement over and above the SSG managed consultation process and must to be read in conjunction with the final SSG report. It follows the structure issued in NDA guidance notes.

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EXECUTIVE SUMMARY:

- The site fully acknowledges the Site Stakeholder Group (SSG) led process on Site End States.
- The site endorses the findings of the SSG led process on Site End States in all respects and fully supports the concept for early site remediation as a key message coming from this study.
- The site end state identified as Option 5 is consistent with the current Chapelcross site Lifetime Plan (LTP).
- In parallel with the SSG process on Site End States, British Nuclear Group Chapelcross initiated a site end use study involving young people of Annandale and Eskdale. This was managed independently by *Space Unlimited* and based out of a local secondary school – Lockerbie Academy. Over 500 responses were received through this process and this demonstrated that the young people of this area care passionately about the future re-use of the Chapelcross site and the need for the NDA to leave a positive lasting legacy.
- A detailed assessment of technical, environmental and social factors associated with Options 4 and 5 when compared against the current LTP baseline demonstrates that there are no significant concerns/issues should either of these options be adopted.
- The concept of early site remediation (referred to as early *Final Site Clearance* in the site Lifetime Plan) is a real option for the Chapelcross site and hence the SSG recommendation which shows strong support for this across the stakeholders and general public through open consultation is welcomed.
- Should early site remediation become part of the evolving NDA strategy a key consideration is the prioritisation of the sites. Both Chapelcross and Calder Hall have four reactors which are of a much smaller design compared to the other sites. The Chapelcross site also has its indigenous workforce (with embedded knowledge of reactor design/operations) and also the land to develop appropriate R&D facilities on its larger (250 acre) nuclear licensed site. The idea of initiating reactor decommissioning at Chapelcross as a lead site is very much supported and recommended to the NDA as a way to minimise the overall technological risks of early final site clearance across the whole Magnox reactor.
- Early site remediation at Chapelcross is a key enabler in delivering the NDA's socio economic objectives in one of the four geographical priority areas identified by the NDA in its 2006 "Draft NDA Socio Economic Policy" consultation document.
- Outwith the provision of UK national solutions for final waste disposal there are no significant risks or issues which would preclude the adoption of Options 4 or 5 and hence enable early final site clearance and/or site re-use.

1 Details of Review of Site End States/End Uses

1.1 End State

The Nuclear Decommissioning Authority (NDA) has asked that the assumed End States for its sites, including Chapelcross, be reviewed by 31 March 2007. In guidance [NDA, 2006], it has indicated that the Site Stakeholder Group (SSG) should determine its views on the various options that exist and make a recommendation to NDA. The SSG is to be supported by the Site Licence Company (SLC), in the case of Chapelcross, British Nuclear Group (BNG). The roles and responsibilities are shown in Box 1.

Box 1: Roles and Responsibility in the NDA End State Definition Process

Nuclear Decommissioning Agency

- Lead the End State definition process by agreeing the process to be used by the SLCs and ensuring SLCs provide support to the SSG.
- Undertake reconciliation of suggested End States with issues of national strategy.
- Incorporate output of process into NDA Strategy.

Site Licence Company

- Facilitate the process for consultation with the stakeholders.
- Provide technical expertise to define a range of feasible End State solutions.
- Engage stakeholders on End State solutions

Site Stakeholder Groups

- Agree a process for consultation that includes consideration of how to engage with the wider local stakeholder community (i.e. those not already represented within the SSG).
- Review consultation responses and arrive at a hierarchy of Site End Uses that represents the desires of the broad range of local stakeholders.
- Provide NDA with representative feedback on End States presented by the SLCs.

In September 2006, BNG commenced a process to support the SSG. On behalf of the SSG, specialist consultancy support was sought and in October a contract was issued to Quintessa Limited with the approval of the End State subgroup of the SSG.

Initially, proposals were submitted to the subgroup by Quintessa regarding the overall scope of the consultation on End States [Penfold, 2006a] and the stakeholder engagement strategy [Collier, 2006]. These were approved and published on the SSG website at the end of October 2006, and issued to stakeholders as the first stage in the three-month End State consultation.

1.1.1 Scope

The Scope document describes the reasons for reviewing the End State of the site, the process for reviewing the Chapelcross End State, and proposes options to be considered.

The process adopted is consistent with best practice and NDA guidance [NDA, 2006], and at its heart is a 'Best Practicable Environmental Option' (BPEO) approach. Adoption of the BPEO approach ensures that the process is systematic, structured and consultative [RCEP, 1988]. The key stages are shown in Box 2.

Box 2: The BPEO Process

Stage	Description	
1.	Define the Objective	The overall objective is to assist in the identification of the best End State strategy for the Chapelcross nuclear licensed site.
2.	Generate Options	The whole range of possible options is identified at this stage.
3.	Screen out Impracticable Options	Impracticable options are screened out from further consideration using constraints - basic requirements that all options must satisfy.
4.	Identify Key Criteria for Comparing Options	Criteria are relevant factors of interest – e.g. safety performance, environmental issues, social/economic effects, cost.
5.	Score Options for Each Criterion	Each option is assigned a score (or rating) reflecting its performance for each criterion.
6.	Compare Options	Options are then compared, with reference to the scores, to identify the pros and cons of each, with input from stakeholders.
7.	Determine the BPEO	The BPEO is the option that best satisfies the range of the criteria, taking account of stakeholder views.

Seven options were identified, of which two were proposed to be screened out on the basis that they did not meet basic principles of legality and proportionality. The options presented for detailed consideration were:

1 **Minimum Practicable Restoration**: The site is closed with a minimum amount of work to meet commitments to regulators and NDA. Public safety would require

continuing controls on access to the site, together with monitoring and any necessary maintenance.

2 **Deferred Restoration**: The site would be cleaned up to release most land for industrial (and possibly other) uses. However, the reactors and any significantly contaminated land would remain under Care and Maintenance on a controlled part of the site for a century or so whilst radioactive decay reduced the hazard. The removal of all remaining radioactive waste after this time would permit the remainder of the site to be released from nuclear controls.

3 **On-site Disposal of Wastes**: Suitable decommissioning radioactive waste and other hazardous wastes would be disposed of on-site, to minimise transport of hazardous material. The site would be cleaned up to allow the maximum amount of land to be released from nuclear controls, with a small "island" remaining under control, where waste is safely disposed.

4 **Early Restoration for Industrial Use**: The whole site would be cleaned up fit for industrial use on the earliest practicable timescale. Contaminated land would be remediated and all waste would be transferred off-site.

5 **Maximum Practicable Restoration**: The whole site is cleaned up to be safe for unrestricted use. This would involve decommissioning and demolition of all buildings and plant on the site, and movement of the waste off-site. Some contamination would remain, but would meet safety targets.

The scoping document also presented a list of key criteria against which the options could be assessed, based on Environment Agency and SEPA guidance on BPEO [EA and SEPA, 2003].

1.1.2 Options Assessment

A systematic assessment of the options was undertaken by a specialist panel on 30 November 2006, with the intention of evaluating the options against a range of key criteria. The workshop followed an approach consistent with that adopted to underpin a BPEO study. Alongside a detailed record of options "scores", its key conclusions were expressed as "pros and cons" of the specific options in relation to the criteria considered. These are presented in Box 3.

The full options assessment, and a summary, was issued for consultation in December 2006.

Box 3: Outcome of the Options Assessment – Pros and Cons of the Options

Option	Pros	Cons
Option 1: Minimum Practicable Restoration	• Quick and easy to implement. • Less waste and transport and lower discharges during decommissioning compared with other options.	• Future generations have to look after substantial amounts of hazardous material. • Risk to humans and the environment in the long term.
Option 2: Deferred Restoration	• Radioactive decay reduces radioactivity concentrations whilst material is safety stored. • Less waste and transport and lower discharges during decommissioning compared with phased de-licensing options (options 3, 4, 5).	• Takes more than a century to reach the End State, during which part of the site must be controlled and maintained. At about 2130 the whole site could be de-licensed.
Option 3: On-site Disposal	• Much lower volume of radioactive (and perhaps hazardous) waste transported from the site than other phased de-licensing options (2, 4, 5). • Less dependence on external agencies to decommission the site.	• Some safely disposed waste would remain in perpetuity at Chapelcross. • Site would need to remain under institutional control until about 2130 when it could be de-licensed.
Option 4: Early Restoration	• An End State permitting a wide range of End Uses is reached as quickly as practicable. • Whole site could be de-licensed as soon as ILW can be transferred to national facilities (about 2040).	• Dismantling reactors in the next few decades means waste with higher levels of radioactivity is generated which might result in increased radiation exposure of workers.
Option 5: Maximum Practicable Restoration	• No planning restrictions or nuclear licence (apart from the area of ILW stores) at the End State, so any End Use would be allowed. • Whole site could be de-licensed as soon as ILW can be transferred to national facilities (about 2040).	• More waste and disruption than other options.

1.1.3 Stakeholder Engagement and Decision-Making

The stakeholder engagement strategy was developed to complement the BPEO process, and extend into the subsequent decision-making stage to be undertaken by the SSG. The main points of the consultation process are as follows.

- Written consultations were accepted between 1 November 2006 and 31 January 2007 on the following information:
  - the scope of the study (including suggested options and criteria), issued for consultation in November 2006; and
  - a systematic assessment of options[1], issued for consultation in December 2006.
- A presentation on the scope, options and criteria was made to the SSG meeting on 1 December 2006.
- Stakeholder workshops, consultation and public events took place in January 2007:
  - two stakeholder workshops were held on 17 January 2007; and
  - a public open day was held on 18 January 2007.

An assessment of the Stakeholder Panels [Collier, 2007a] and consultation responses [Penfold, 2007a] was published in early February 2007. This was included with other documents in an "evidence pack" that formed the basic material to be considered by the SSG in formulating a decision [Penfold, 2007b]. The key elements of the decision-making process were:

- "Decision Conference" in February 2007 to review the evidence and stakeholders views [Collier, 2007b]; and
- Presentation, discussion and final adoption of the End State recommendation at the full SSG meeting on 2 March 2007.

1.1.4 Outcomes

Consultation documents were issued to over 250 stakeholders and made available on the SSG website. Around 60 stakeholders were invited to attend the January 2007 Stakeholder Workshops. SSG meetings are held in public and questions were invited on the End State process.

Stakeholder Panels

Two stakeholder panels were held, one with five participants and one with seven. Each lasted two hours and was independently facilitated. Full details of the panels are presented in the report [Collier, 2007a]. Some of the key points arising are as follows.

- Both Panels considered that all the options were plausible as illustrations of the range of potential End States. None were rejected and no new ones suggested.
- Both Panels agreed that the most important criteria were associated with health & safety and socio-economic issues. Environment and amenity/quality of life criteria

[1] A specialist workshop was held on 30 November 2007 to review the options and assess them against health and safety, environmental, technical, social and economic and cost criteria.

were also considered to be important. Given that health and safety was assured by regulation, socio-economic criteria were the main discriminators. This covers End Use flexibility, jobs before and after End State, and burden on future generations.

- The unanimous conclusion was that – unless a new nuclear reactor was to be sited at Chapelcross – early decommissioning was desirable and that the community needed to argue its case vigorously with the Nuclear Decommissioning Authority (NDA) and other stakeholders.
- Option 5 (Maximum Practicable Restoration) was the ideal but the majority felt that greater flexibility in terms of future use might not justify the additional cost and waste volumes. Option 3 (Onsite Disposal) may be acceptable under some circumstances but it could be a challenge to sell it to the community. Participants were aware of their lack of detailed knowledge but the majority view was that Option 4 (Early Restoration, for industrial use) - was probably the preferred option.

Results of the Wider Consultation

A total of thirteen responses written were received to the wider consultation. The respondents were all people living in the region (Creca, Annan and Lockerbie). Most were individuals, but where they stated an affiliation this was to local schools, the council, a trade union, and a project team at the site.

The main points made were as follows:

- The respondents did not offer any additional options and agreed that options had been screened out from detailed consideration fairly. One person suggested that Option 3 (onsite disposal) should also be screened out because waste would be left on site.
- No-one disagreed with the criteria, and the only additional criterion suggested was on closer inspection covered by criteria that had already been included.
- Nine of the respondents expressed a clear preference:
    - Six respondents preferred Option 5;
    - One respondent preferred Option 4;
    - One respondent preferred Options 2, 3 or 4; and
    - One respondent stated a preference for Option 4 or 5.
- Eleven of the respondents provided specific information on their views of the importance of the main criterion groups, assigning weights of 0 – 100. Generally there was no major distinction in weights although some respondents rated that security and technical performance and practicability as less important than other attributes.
- Combining the stakeholder's weights with option scores provide 'weighted total scores' for each option. These consistently resulted in Option 5 gaining the highest score, although Option 4 was always a very close second.

Decision Conference
The Decision Conference had the status of an SSG End State Sub-group meeting and was not held in public, though the SSG invited stakeholders as observers or participants. It was a working meeting, reviewing the evidence and coming to a provisional conclusion. It took place during the afternoon of 21st February 2007 at Gretna Green and was chaired by the SSG End State Sub-group Chair.

The key steps in the decision-making process were as follows:

1. **Process and Information –** Clarify context within NDA End State programme and output requirements, establish context of event within the overall SSG programme and summarise processes that have contributed evidence
2. **Understand the Decision –** Agree the nature of the decision
3. **Evidence –** Review all the information supplied in the briefing pack
4. **Take the Decision –** Identify and review key issues, summarise option strengths and weaknesses, determine the options deemed unacceptable, 'liveable with' and agree a preferred option, formulate recommendation for full SSG meeting

The results of the parallel Lockerbie Academy 'End Use' opinion poll were not available at the Decision Conference. However, the Academy made a separate presentation to members of the SSG and the project team, and the results were taken into account by the SSG in the final decision.

The preferred option that emerged during the Decision Conference was a combination of Options 4 and 5. The view was that Options 4 and 5 were similar and that a decision could be taken in due course as to the extent to which remaining infrastructure remains (Option 4) or is removed (Option 5). This conclusion was rechecked against the full list of the criterion groups.

The Decision Conference prepared draft recommendations for the SSG to review and endorse or amend at its next meeting, which was held in public and offered everyone an opportunity to hear about the evidence and comment before the final decision was made.

1.2 End Use

1.2.1 Options

NDA End Use Categories
NDA has identified broad categories of End Uses for consideration in the review [NDA, 2006]. These broad categories were considered in the End State Options Assessment process. Each option was compared with the End Use categories to determine whether the option would preclude any of the potential uses of the site. The rationale was then recorded.

Consultation on End Uses – *Space Unlimited* Project

In parallel with the Site End State Consultation process British Nuclear Group were keen to conduct an unconstrained parallel exercise on Site End Use. To do this a local secondary school was selected (Lockerbie Academy) and an educational project vehicle (*Space Unlimited*) was used. This study, conducted over a 12 week period resulted in the a number of re-use options being proposed, a website and discussion blog being set-up and the collation of over 500 option assessment responses from the pupils at Lockerbie and Langholm secondary schools. The SSG members were also invited to participate in the options selection exercise.

The most popular choices were leisure/sport based and this is very much a reflection of the fact that Chapelcross is a large site (over 500 acres) with large tracts of land which could be easily developed for alternative use and is also a site which is close to three small towns with very limited amenities. The majority of those who responded saw the benefit of early restoration but few wanted to see the land returned back to an agricultural state. The SSG responses were more focussed on sustainable job based activities (rather than leisure) and favoured options such as a new nuclear plant and science centre.

1.2.2 Review of End Use and End State

The relationship between End State options and End Uses was explored in the Options Assessment workshop. It was noted that most of the 250 acres that are not licensed could be released relatively quickly. However, it will be at least 20 years before most of the licensed site will be available, maybe much longer. Given that only the restoration of the licensed site could have implications for End Use, only this part was considered when comparing options to End Uses. The conclusions of the workshop are shown in Table 1.

Table 1: End Uses Permitted by the End State Options

End Use / End State	Industrial/ Commercial	Waste management	Research	Recreational/ Nature	Accomm-odation	Agriculture
Option 1: Minimum Practicable Restoration	✓	✓	✓	✘	✘	✘
Option 2: Deferred Restoration*	✓	✓	✓	✓	✓	✘
Option 3: On-site Disposal	✓	✓	✓	✓	✓	✘
Option 4: Early Restoration	✓	✓	✓	✓	✓	✘

Option 5: Maximum Practicable Restoration	✓	✓	✓	✓	✓	✓

Key:

✘ End use is not permitted by the End State on the currently licensed part of the site.

✓ End use permitted on some of the site provided the use benefits from the restrictions imposed by the nuclear license conditions, and is approved by NII.

✓ End use is permitted for the whole of the currently licensed part of the site only after 2130. Prior to this the option would perform like Option 1.

✓ End use is permitted by the End State for the whole of the currently licensed part of the site, with the exception of ILW stores that would remain until 2040 and LLW disposal facility that would remain under control until about 2130.

✓ End use is permitted by the End State for the whole of the currently licensed part of the site, with the exception of ILW stores that would remain until 2040.

A review of End Uses versus End States was also undertaken during stakeholder panels [Collier, 2007a]. There was a general preference for a new nuclear use of the site, or failing that the provision of infrastructure for new industries. There was recognition that either Options 4 or 5 offered an appropriate degree of flexibility in relation to End Use. Similar comments were received in the feedback to the wider consultation [Penfold, 2007a].

The issue of End Uses was also considered in the SSG March 2007 deliberations [Chapelcross Site Stakeholder Group, 2007]. It was noted that there was a preference for any new infrastructure that could provide future jobs and investment, and on that basis early restoration with Option 4 appeared favourable.

2 Statement on Current Approved End State (Baseline)

The current site end state as agreed in the March 2007 issued Lifetime Plan is for deferred restoration – effectively Option 2. The four phases for the Chapelcross Lifetime Plan are described below.

PHASE 1 – Defuelling (2007 - 2010)
This phase focuses on the removal of the remaining spent fuel in the four reactors. The Defuelling Organisation Structure has been fully resourced and is in place.

PHASE 2 – Care & Maintenance Preparations (2010 – 2017)
During this phase Post Operational Clear Out of the site buildings will be completed and preparations to transition into C&M will be completed. It is expected that the workforce will reduce by 150 near the beginning of this phase. Throughout the phase the number of employees will vary dependent on the projects being undertaken, with a significant reduction expected once the Intermediate Level Waste store is constructed and operational and a further significant reduction near the end of the phase. It is anticipated that at the end of the phase approximately 50 employees will be left on site.

PHASE 3 – Care & Maintenance (2018 – 2116)
During this period the site will be maintained in a safe and secure state. The site will have approximately 20 employees, focused mostly on security and monitoring.

PHASE 4 - Final Site Clearance (2116 – 2118)
The numbers of employees deployed during this period is expected to be >100 with significant use of the supply chain to provide the services of specialists. There will be no severance payments at the end of the project as all employees will be assumed to be under contract for the duration of the project only.

Impact of Earlier Site Restoration:
Should earlier site restoration be preferred then the key impacts are with respect to:

a) Workforce transition at the end of Phases 1 and 2 to provide the continuity of workforce and skills required to complete Phase 4. The completion of defuelling is currently scheduled for late 2009/early 2010. The currently assumed severance costs are c. £15m.

b) Waste disposal at the end of Phase 2 where new routes may be required for LLW and final repository solutions will have to be agreed for ILW.

A detailed analysis of these and the other impacts assessed as part of the site end state consultation process is provided in Section 3.

3 Variance Analysis

3.1 Introduction

Given the broad, high-level description of the potential End State options, and the limited information currently available concerning their detailed characteristics (e.g. waste volumes), the preliminary variance analysis that has been undertaken is qualitative in nature and based on the best judgement of BNG specialists. It is should be recognised that many aspects are subject to considerable uncertainty.

Nevertheless, it is recognised that an analysis of the implications of alternative End State options is important input to NDA's review and assessment of End States. The approach adopted, therefore, has been to highlight in broad terms the variation of End State options from the Baseline in terms of a range of key "metrics" considered to be relevant to NDA's assessment. These include:

- Site jobs (up to the Intermediate End Point (IEP), and between the IEP and Final End Point, where relevant).
- Timescales (to the FEP, and IEP if relevant)
- Amount of land delicensed (at the FEP, and IEP if relevant)
- Range of End Uses
- Waste volume (radioactive and non-radioactive)
- Radioactive discharges
- Resource use
- Transport (radioactive waste and other transport)
- Technology Requirements
- Costs (to IEP, IEP-FEP and post-FEP, where relevant)

Note that the metrics broadly map on to a subset of the assessment criteria considered in the End State options assessment [Penfold, 2006b].

3.2 Overview

Figure 1 summarises the variation of End State options from Baseline for the key criteria. Options have been rated as either involving much less, less, about the same, greater, or much greater of the relevant metric than the Baseline. Section 3.3 describes the basis for these assignments.

Figure 1: Variance Analysis – Overview of Variation of End State Options from Baseline for Key Criteria

Metric	Option A	Option 1	Option 2 (Baseline)	Option 3	Option 4	Option 5	Option Z
Site Jobs to IEP	-	-	3	4	-	-	-
Site Jobs IEP-FEP	1	3	3	4	4	4	5
Time to IEP	-	-	3	4	-	-	-
Time to FEP	1	1	3	3	1	1	1
Amount of Land Delicensed at IEP	-	-	3	3	-	-	-
Amount of Land Delicensed at FEP	1	1	3	3	3	3	3
Range of End Uses	1	1	3	2	3	5	5
Radioactive Waste Volume	1	2	3	4	4	4	4
Non-rad Waste Volume	1	2	3	3	3	4	5
Radioactive Discharges	4	4	3	4	4	4	4
Resource Use	1	2	3	4	4	5	5
Transport (Radioactive)	1	2	3	1	4	4	4
Transport (Other)	1	2	3	3	3	5	5
Technology Requirements	2	3	3	4	4	4	4
Cost (to IEP)	-	-	3	2	-	-	-
Cost (to FEP)	1	2	3	4	4	4	5
Cost (post-FEP)	5	5	3	3	3	2	1

Key:

- \- No Intermediate End Point (IEP) for the option
- 5 Much Greater than existing End State strategy
- 4 Greater than existing End State strategy
- 3 No significant change from existing End State strategy
- 2 Less than existing End State strategy
- 1 Much less than existing End State strategy

3.3 Discussion of Option Variance

3.3.1 Jobs

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
❶	❸	❸	❹	❹	❹	❺

❶ Much less than Baseline....................... ❸ Same as Baseline .... ❺ Much Greater than Baseline

Option A presumes that the site would be closed very rapidly with a minimum of additional decommissioning work, and therefore would involve a rapid and imminent loss of employment. Although some jobs would remain after the closure of the site, these would only be a few tens at most.

Options 1 and 2 (the Baseline) involve continued employment at current, perhaps greater, levels for a decade or more until the initial period of decommissioning is completed. Thereafter, a skeleton workforce would manage the site under a Care and Maintenance regime – in the case of Option 1, for an indefinite period, and in the case of Option 2 for a hundred years or so. The employment associated with final site clearance for Option 2 might be significant for a period of several years, however the workforce may well come from outside the region.

Options 3, 4 and 5 will all involve an extended period of employment for the current workforce compared with the Baseline strategy in connection with the activities to fully decommission the site on an earlier timescale (see next subsection). It is anticipated that the work would continue for an additional decade or so. Option 3 and 5 might require additional employment in relation to the development of a disposal facility and additional site restoration, respectively. However, Option Z would require substantially greater work to excavate to depth with the aim of removing all traces of the site.

3.3.2 Timescales

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
❶	❶	❸	❸	❶	❶	❶

❶ Much less than Baseline....................... ❸ Same as Baseline .... ❺ Much Greater than Baseline

The End State options all presume estimated timescales to reach the final End State. Some options include interim stages that have been referred to as Interim End States, with associated timescales (Interim End Point).

Option A would involve no further work and so the Final End State is reached essentially immediately, although there would be a need for an indefinite site presence for care and maintenance of the existing structures.

The existing Baseline strategy (Option 2) presumes an initial period of decommissioning to be completed by 2017 (Interim End Point). The reactor cores, and potentially some other more highly active structures, would then be maintained under Care and Maintenance for a period of about 100 years whilst radioactive decay reduces concentrations. A final campaign of decommissioning and restoration would then be undertaken, complete some time around 2130.

Option 1 would follow the same strategy up to 2017, but then no further work would be planned and the site would be maintained in Care and Maintenance for an indefinite period. The Final End Point in this case would therefore be 2017.

Options 3, 4, 5 and Z all assume that all reactor structures are decommissioned promptly, including the cores. This is assumed to take until about 2020 or so although there is some uncertainty concerning the timescales for the reactor core dismantlement. Options 3, 5 and Z would take longer to reach the final End State due to the additional work to manage wastes and clean up land. These would reach final End State around 2030.

It is assumed Options 4, 5 and Z would still require some ongoing control of a small "island" housing ILW stores. It would clearly be advantageous if ILW could be transported off-site earlier.

Option 3 is assumed to require a period of ongoing surveillance before the disposal facility is released from control. Based on existing assumptions for the LLWR at Drigg, this would be about 100 years (i.e. to 2130).

3.3.3 Amount of Land Delicensed

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
❶	❶	❸	❸	❸	❸	❸

❶ Much less than Baseline........................ ❸ Same as Baseline .... ❺ Much Greater than Baseline

The amount of land de-licensed at various points in time is summarised in Table 2 for each option.

Those options that consider an indefinite control of the site (Option A and Option 1) will always require a portion of the land to remain under the nuclear site licence. Consequently, these options will result in much less land being de-licensed, although it is recognised that potentially substantial areas of the licensed site could be de-licensed if there was an economic justification to do so.

All other options have as their objective a degree of restoration that would permit all the land under the existing nuclear site licence to be de-licensed by the Final End Point. However, this would occur at different times. Option 2 requires the reactor cores to be licensed for about 100 years after completion of the first phase of decommissioning. Options 3, 4, 5 and Z would require the nuclear site licence to remain in place around the ILW store until ILW was transferred to a UK facility (assumed to be in about 2040). In addition, Option 3 would require access controls and monitoring of the disposal facility, probably for about a century.

Table 2: Amount of Land De-licensed for Each Option

Option	Amount of Land Delicensed at	
A*	**now:** None	**Indefinitely:** None~
1	**2017:** None~	**Indefinitely:** None~
2	**2017:** None~	**2130:** Whole site
3	**2030:** All but LLW and ILW store	**2130:** Whole site
4	**2020:** All but ILW store	**2040:** Whole site
5	**2030:** All but ILW store	**2040:** Whole site
Z*	**2040:** Whole site	

Note:
* Screened from detailed consideration.
~ Except if economically justified.

3.3.4 Range of End Uses

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
❶	❶	❸	❷	❸	❺	❺

❶ Much less than Baseline........................ ❸ Same as Baseline .... ❺ Much Greater than Baseline

Those options considering indefinite control of some of the site (Option A and Option 1) would have significant limitations to the range of End Uses for the site. Option 2 would also have limited scope for End Use until around 2130 or so owing to the on-site storage of reactor cores. However, thereafter the land would be available for industrial re-use (remaining infrastructure, e.g. roads, are assumed to preclude agricultural use).

Options 3 and 4 would provide a considerable amount of land for industrial use on a much earlier timescale. It should be noted that some land would remain unavailable for use for a period, however. The ILW stores are assumed to remain until 2040 in both options, and in Option 3, the LLW facility is assumed to remain under control until about 2130 and would also be likely to limit the scope of re-use of its specific site thereafter.

Option 5 and Option Z both have the objective of completely restoring the land, to the extent of removing residual infrastructure (e.g. roads). These would provide land that could be used for any purpose, including agriculture – with the caveat that a portion of the land would need to remain under control until ILW stores were removed.

3.3.5 Waste Volume

With the exception of Option A, all Options presume the same extent of decommissioning work as Option 2. Differences in waste volume therefore primarily arise for two reasons:

- Differences in the amount of contaminated land that is remediated; and
- The greater quantity of waste that arises when final site clearance work is undertaken without the benefit of an approximately 100 year period of radioactive decay.

Detailed estimates of waste volume arisings for alternative End State options are not presently available, therefore the following sections describe the broad consequences of an alternative strategy.

Radioactive Waste Volumes

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
1	2	3	4	4	4	4

1 Much less than Baseline........................ 3 Same as Baseline .... 5 Much Greater than Baseline

Option A will result (at least initially) in much less radioactive waste as decommissioning activities are presumed to cease. However, it can be anticipated that in the future, degradation of the structures and plant would ultimately result in significant volumes of waste. Option 1 would also result in less waste than Option 2. Whilst the initial phase of decommissioning is the same (up to 2017), subsequent work to clear the site would not take place and therefore these wastes would not arise. As with Option A, however, in the long-term waste may arise in any case as structures degrade.

Options 3, 4, 5 and Z are assumed to broadly result in a greater quantity of waste than the Baseline. The additional volume would be associated with:

- the greater concentrations of radionuclides encountered in materials arising from he dismantling structures such as the reactor cores without the benefit of a period of radioactive decay; and
- the greater volume of soil contaminated with radioactivity which must be excavated for de-licensing targets to be met about 100 years sooner than necessary for Option 2.

Non-Radioactive Waste Volumes

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
1	2	3	3	3	4	5

❶ Much less than Baseline....................... ❸ Same as Baseline .... ❺ Much Greater than Baseline

Options 5 and Z would result in increased volumes of non-radioactive waste compared with that anticipated for the Baseline, associated with the extensive excavation of made ground and infrastructure.

Option 3 would also result in generating large volumes of spoil as a result of the excavation for the LLW disposal facility. However, most – if not all – could be re-used as a “cap” for the vaults and to landscape the facility and there can be assumed to be no net increase of waste for export. Option 4 would be expected to be broadly similar in terms of the quantity of waste generated to that anticipated for the existing Baseline, although marginally more waste may arise as a result of the efforts to clean up the site much earlier than assumed in the Baseline. Overall, Options 2, 3 and 4 are considered to result in similar amounts of waste.

Option 1 would be expected to result in less radioactive waste as work would not be required to excavate contaminated land and some structures (e.g. reactor buildings) would remain. Option A would result in much less waste as all the structures are assumed to remain.

3.3.6 Radioactive Discharges

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
❹	❹	❸	❹	❹	❹	❹

❶ Much less than Baseline....................... ❸ Same as Baseline .... ❺ Much Greater than Baseline

Options 3, 4, 5 and Z are considered likely to involve greater discharges of radionuclides to air and water primarily as a result of the work needed to dismantle the reactor core when greater levels of radioactivity are present than in the Baseline strategy. Whilst there will be careful control of the decommissioning work, some increase discharges is inevitable (e.g. of gaseous radionuclides, and in liquid arising from decontamination activities). It is also noted that in the very long term some radioactivity will be released from the LLW disposal facility considered in Option 3, however the rate of discharge will be very low and will be controlled by engineered features. Therefore, the discharges associated with this option are not considered to be significantly different from 4, 5 and Z.

Options A and 1 are also considered to involve greater discharges than Option 2 (the Baseline). These are related to ongoing releases resulting from the maintenance of the remaining structures – which is assumed to continue essentially indefinitely.

3.3.7 Resource Use

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z

❶	❷	❸	❹	❹	❺	❺

❶ Much less than Baseline........................ ❸ Same as Baseline .... ❺ Much Greater than Baseline

Options 3 and 4 are considered to involve increased resource use compared with Option 2, the Baseline. Option 3 will require material for the engineering associated with the repository, although it has the potential benefit of permitting the excavated material to be re-used in the repository engineering. Option 4 also requires greater import of material associated with restoration of the radioactively contaminated land it is assumed to be necessary to excavate to permit early de-licensing.

Options 5 and Z involve extensive excavation of the site in order to restore it to a quality that is consistent with unrestricted agricultural use. This is expected to require the import of very large amounts of material (e.g. soil for landscaping).

Option 1 will require much less in terms of resources owing to the continued licensed status of the site; however some resources will be needed associated with the demolition of redundant buildings and maintenance of others. Option A, however, will require very little, with the only resources required being associated with building maintenance.

3.3.8 Transport

Radioactive Waste Transport

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
❶	❷	❸	❶	❹	❹	❹

❶ Much less than Baseline........................ ❸ Same as Baseline .... ❺ Much Greater than Baseline

Both Options A and Option 3 will require very much less transport of radioactive waste. Option A will not result in the generation of much radioactive waste owing to the strategy of permanent storage of the site facilities. Option 3 will result in much the same volume of radioactive waste as the Baseline (Option 2) – however most of the volume will be disposed of on-site.

For other options the transport of radioactive waste is directly correlated with the volume generated. Therefore Option 1 will result in less transport of radioactive waste than the Baseline strategy, whilst Options 4, 5 and Z will result in more.

Other Transport

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
❶	❷	❸	❸	❸	❺	❺

❶ Much less than Baseline........................ ❸ Same as Baseline .... ❺ Much Greater than Baseline

The other transport to and from the site is assumed to comprise personnel, equipment and construction/landscaping materials (of relevant) and the export of non-radioactive waste.

The greatest amounts of transport are considered to be associated with Options 5 and Z which are considered to require very large quantities of landscaping material to be imported, and also generate large quantities of non-radioactive waste (the excess, compared with the Baseline, being associated with the excavation of made ground).

Options 3 and 4 are considered to have similar requirements for transport to Option 2 (the Baseline), although it is noted that personnel transport to and from the site would not persist for as long (due to early de-licensing) although traffic would potentially be greater for a period. Option 3 is also noted to require some additional import of material for the construction of the repository however this could be balanced by the re-use of other materials on site.

Option 1 would involve similar amounts of transport to Option 2 over the first decade or so, but then would only require that associated with site Care and Maintenance indefinitely, as final site clearance, and the associated transport requirements, would not occur. Option A would require the least transport as the site would effectively enter a Care and Maintenance regime immediately.

3.3.9 Technology Requirements

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
2	3	3	4	4	4	4

1 Much less than Baseline........................ 3 Same as Baseline .... 5 Much Greater than Baseline

Compared with the Baseline, Options 3, 4, 5 and Z require additional technology in relation to the need to dismantle the reactor cores more rapidly than the Baseline. Such work has been demonstrated on other reactors, however it would require upscaling for application to power reactors such as at Chapelcross.

Option 1 would require much the same technology requirements as Option 2, as the initial phase of decommissioning would be undertaken in a similar manner. Because the final site clearance assumed for the Baseline takes place more than 100 years after decommissioning, and does not involve any complex technology, there is not considered to be a significant distinction between technology requirements for Options 1 and 2. Option A has limited technology requirements as very limited decommissioning is assumed. However, it is noted that in the future technologies for stabilising structures and reducing degradation may be required to maintain the safety of the site.

3.3.10 Costs

As has been noted, cost estimates are highly uncertain given the broad description of the options that are currently under consideration. The NDA is also currently in the process of evaluating the impact of early site restoration and developing the business case. It is not considered appropriate to pre-judge the output of this process at this time.

4 Technical Considerations

4.1 Introduction

This section provides a preliminary assessment of the feasibility and practicality of End State options in relation to technical issues.

Given the broad, high-level description of the potential End State options, the preliminary assessment that adopted a qualitative approach, based on the best judgement of BNG specialists and as such are subject to considerable uncertainty.

Technical issues are categorised as:

- Feasibility with current technology;
- Practicality of technology development; and
- Compatibility with regulations.

The latter has been added to recognise that, whilst all options are subject to a screening criterion that requires them to be consistent with regulations, in some important areas there remains some degree of uncertainty and scope for interpretation. It is considered important that this aspect is recognised in the assessment of feasibility and practicality.

For each set of issues, a distinction is made between those relating to:

- decommissioning;
- contaminated land/de-licensing; and
- waste management.

Figure 2 summarises the assessment of End State options in terms of feasibility and practicality. A simple scale is adopted in which 1 indicates complete infeasibility, and 5 indicates complete feasibility. Section 4.2 describes further the basis for the assigned ratings.

One thing that should not go without notice is that fact that Chapelcross has four reactors which are of a much smaller design compared to the other sites and a significant land area in which to develop R&D activities. The assessment of the current baseline versus earlier restoration demonstrates a very small increase in technical risk hence the real issue is more about where to start rather than when to start.

Figure 2: Assessment of Feasibility of End State Options

Aspect	Option A	Option 1	Option 2 (Baseline)	Option 3	Option 4	Option 5	Option Z
Feasibility with Current Technology							
Decommissioning	5	4	4	3	3	3	3
Contaminated Land	5	5	5	5	5	5	1
Waste Management	5	5	5	4	5	5	5
Practicality of Technology Development							
Decommissioning	5	4	4	3	3	3	3
Contaminated Land	5	5	5	5	5	5	1
Waste Management	5	5	5	4	5	5	5
Compatibility with Regulations							
Decommissioning	1	5	5	5	5	5	5
Contaminated Land/De-licensing	2	2	5	3	5	5	2
Waste Management	5	5	5	3	5	5	3

Key:

5 Feasible, practical and/or compatible with the issue in question.

:

1 Completely infeasible, impractical or incompatible with the issue in question

4.2 *Feasibility with Current Technology*

4.2.1 Decommissioning

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
❺	❹	❹	❸	❸	❸	❸

❶ Completely infeasible .... ❺ Completely feasible

The key issue in relation to the feasibility of options with current technology for decommissioning relates to the management of highly radioactive materials that have in many cases aged significantly over the plant's lifetime. The most challenging issue is the dismantlement of the reactor cores. The existing Baseline assumes that this takes place in over a century's time, when relatively simple existing technology is required. However, this option, and Option 1, still require a substantial amount of decommissioning work to be undertaken over the next decade or so, some of which will require some development to upscale techniques for application to a power reactor, or transfer technologies from other reactor types. Options 3, 4, 5 and Z would therefore present challenges if only existing technology were available, in particular due to the objective of complete dismantlement and decommissioning within a few decades. The development of new technologies is considered in the next section.

Option A is assumed to involve only very limited decommissioning and therefore no issues are envisaged.

4.2.2 Contaminated Land

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
❺	❺	❺	❺	❺	❺	❶
❺	❺	❺	❹	❺	❺	❺
❺	❹	❹	❸	❸	❸	❸
❺	❺	❺	❺	❺	❺	❶
❺	❺	❺	❹	❺	❺	❺
❶	❺	❺	❺	❺	❺	❺
❷	❷	❺	❸	❺	❺	❷
❺	❺	❺	❸	❺	❺	❸

❶ Completely infeasible .... ❺ Completely feasible

The remediation of contaminated land to the anticipated End State is considered to be feasible with current technology for all options with the exception of Option Z.

Options A and 1 would primarily involve the maintenance of the current regime. Options 3, 4 and 5 would require a degree of in-situ remediation and/or excavation for disposal (depending on the location and character of the contamination), and a wide range of technologies are available for this purpose. Option 2 will involve a combination of an in-situ regime followed by some limited remediation as necessary, in around 100 years' time.

Option Z requires all traces of the site to and associated contamination to be removed. It is considered that current technology does not exist to remove every trace of the site. The key issue is in relation to limits in detection capability for contaminants in very large quantities of soil.

4.2.3 Waste

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
5	5	5	4	5	5	5

❶ Completely infeasible .... ❺ Completely feasible

All options would adopt a common approach to the handling and packaging of wastes that would follow current accepted practice. Some additional work would be required (e.g. to package ILW in a manner consistent with Nirex specifications, and obtain relevant Letters of Compliance) however the wastes involved are not unusual and such issues have been considered in decommissioning plans.

All options except Option 3 would involve the transfer of waste off-site for disposal in national facilities. Once again, this practice is well established in respect of LLW. National plans will determine the management strategy for ILW.

Option 3 will involve the development of an on-site facility for the LLW. The design would be required to be optimised to take account of the site conditions, but in general terms LLW repository design principles are well established, and no novel technologies are required.

4.3 Practicality of Technology Development

4.3.1 Decommissioning

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
5	4	4	3	3	3	3

❶ Completely infeasible .... ❺ Completely feasible

As noted in Section 4.2, the key issue relates to the development of technologies for the dismantlement of the reactor cores in the next few decades, as envisaged by Options 3, 4, 5 and Z. Such an approach would require the use of remote methods and robotics to deal with core components and structures in the presence of high dose rates. Such technologies have been developed and applied, but not to heavily irradiated reactors the size of those at Chapelcross. It is considered that the challenges are primarily in relation to "upscaling" and refining of existing technologies – rather than development from scratch. Therefore, the approach is not considered to be a major challenge.

It has also been noted that all options requiring decommissioning will require some degree of technology development, and only Option A would not require any.

4.3.2 Contaminated Land

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
5	5	5	5	5	5	1

1 Completely infeasible .... 5 Completely feasible

The management and/or remediation of contaminated land to a state consistent with the End State can be undertaken with current techniques and technologies for all options with the exception of Option Z. As noted, Option Z would require the capability to remove all traces of the site's presence and this is not considered to be fully practicable with current technologies – primarily in relation to limits on the ability to detect low amounts of radioactivity in very large amounts of soil and rock.

4.3.3 Waste

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
5	5	5	4	5	5	5

1 Completely infeasible .... 5 Completely feasible

Only Option 3 would require a measure of technology development in relation to waste management. In this case, it would be necessary to develop and refine a repository design that is suitable to the Chapelcross site. Modern LLW repository designs generally follow well established principles in relation to the location, construction and operation. No aspects require any technologies other than standard civil engineering practice. However, it is appreciated that the design would have to be carefully developed and shown to be optimised in relation to long-term safety and environmental performance.

4.4 Consistency with Policy and Regulations

4.4.1 Decommissioning

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
1	5	5	5	5	5	5

1 Completely infeasible .... 5 Completely feasible

Option A is not consistent and regulations as it would not demonstrate progressive reduction of hazards on site (indeed, the option was screened from detailed consideration on this basis). All other options are intended to comply with decommissioning policy in respect of progressive hazard reduction.

4.4.2 Contaminated Land and De-licensing

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
2	2	5	3	5	5	2

1 Completely infeasible .... 5 Completely feasible

Decommissioning policy indicates that a site need not be de-licensed provided it can be shown that the strategy represents the BPEO. On this basis, the strategy to maintain the nuclear licensed site indefinitely (Options A and 1) is consistent with policy. However, such a strategy would require very strong argumentation as it is questionable in relation to NDA's overarching objectives for dealing with the nuclear legacy in the UK.

In a similar respect, the extent of remediation necessary for Option Z would also be expected to be questioned as to its appropriateness.

It is also presently unclear as to the mechanism and scope for de-licensing land occupied by a repository for radioactive waste, therefore there are potential issues regarding Option 3 although other repositories currently exist for LLW in the UK and therefore the issue would be expected to be resolved.

4.4.3 Waste

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
5	5	5	3	5	5	3

1 Completely infeasible .... 5 Completely feasible

With the exception of Option 3, all options envisage waste management to involve final disposal to an off-site facility or facilities. For Options A, 1, 2, 4 and 5 no issues are anticipated, as the waste management approach would follow existing established practices. However, Option Z is anticipated to generate very much more waste than other options. Disposal of a volume of waste might be problematic.

Option 3 involves the establishment of an on-site facility for dealing with the LLW arising from decommissioning. Existing practice in the UK has generally involved consignment of wastes to a central national facility (although there are some exceptions). However, it is noted that forthcoming policy on LLW management may indicate that alternative regional or local facilities can be considered. Nevertheless, this is indicated as an area of uncertainty.

5 Environmental and Social Factors

5.1 Introduction

An assessment of the effect of End State options on environmental and social factors has been undertaken. The approach has been to make a simple qualitative assessment, based on the best judgement of BNG specialists. No more detailed assessment can be undertaken at the present time owing the very general description of all options (with the exception of the Baseline).

NDA guidance has defined the factors to be considered as:

- air quality;
- water quality;
- land quality;
- climatic factors;
- material assets;
- biodiversity, fauna and flora;
- cultural heritage and landscape;
- population; and
- human health.

The outcome of the assessment is a rating of 1-5 for each option in relation to each factor listed above. A rating of 1 indicates that the option is likely to have very significant negative effects (or a major risk very significant negative effects) whilst a rating of 5 indicates no significant negative effects are believed to arise.

Figure 3 summarises the results of the assessment which is described further in Section 5.2.

Figure 3: Assessment of Environmental and Social Impacts of End State Options

Aspect	Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
Air Quality	2	4	5	5	5	5	5
Water Quality	2	3	5	4	5	5	5
Land Quality	2	3	4	3	4	5	2
Climatic Factors	2	3	5	5	5	5	5
Material Assets	5	5	5	5	5	4	1
Biodiversity, Fauna and Flora	5	5	5	5	5	5	5
Cultural Heritage and Landscape	1	2	4	3	4	4	2
Population	1	2	2	3	3	3	3
Human Health	1	2	4	5	5	5	4

Key:

5 End State has no significant negative effects.

:

1 End State has very significant negative effects (or a major risk very significant negative effects).

5.2 Discussion of Key Factors

5.2.1 Air Quality

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
2	4	5	5	5	5	5

1 (Risk of) Very significant negative effects .... 5 No significant negative effects

Options A and 1 have a potential for air quality impacts associated with the risk that, in the long-term, remaining building structures could become unstable and fail, leading to a release. However, it is noted that the majority of the most hazardous material would be removed in the Option 1 End State – only Option A has the potential for a significant release of radioactivity if this situation arose. In both cases non-radioactive releases (e.g. dust) would occur but would be limited and transient.

None of the other options are considered to result in significant releases of radioactivity or other air quality impacts, with the exception of Option Z. In this case, the very extensive excavation of soil and rock could generate considerable amounts of dust. Whilst other options involve demolition and other activities to restore the site, these are considered to be relatively straightforward to control within acceptable levels of impact on air.

5.2.2 Water Quality

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
2	3	5	4	5	5	5

1 (Risk of) Very significant negative effects .... 5 No significant negative effects

As noted in relation to air quality, Options A and Option 1 have the potential that building structures could ultimately fail. This could lead to contamination of groundwater from any contamination that was exposed and could be leached by rainfall. As noted previously, the hazard is significant for Option A as some highly active material will remain on site. For Option 1, the remaining materials would be of much more limited hazard.

Other options are not expected to have any significant effect on water quality, although it is noted that Option 3 could, in the long-term result in some releases of residual radioactivity if the engineered vaults degraded. However, any such release would be expected to be very limited and gradual. Options 2, 4, 5 and Z all ultimately involve an End State in which any significant contamination is removed from the site – therefore there is no potential for effects on groundwater.

5.2.3 Land Quality

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
②	③	④	③	④	❺	②

❶ (Risk of) Very significant negative effects .... ❺ No significant negative effects

The objective of Options 5 and Z is to undertake considerable restoration to provide high quality land. However, it is noted that the strategy considered in Option Z would, in the process of restoring the land, involve extensive disruption and damage to the land.

Option A is also regarded as having a major negative impact on land quality, however this is associated with the potential failure of the engineered structures in the long-term. Such an event could result in the release of hazardous materials that would result in land contamination. Also, Options A and Option 1 involve the in-situ management of land contamination rather than its remediation.

Whilst the disposal facility considered in Option 3 would be subject to strict authorisation conditions that would ensure its long-term safety, it would nevertheless have a notable impact on land quality – for example, it is likely that the facility would need to be covered with a profiled "cap" to minimise the potential for disturbance when it was closed. Furthermore, Options 2, 3 and 4 would both restore the land in relation to the radioactive contamination, but it would remain in a "brownfield" state in which roads and areas of hardstanding would remain.

5.2.4 Climatic Factors

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
❺	❺	❺	❺	❺	❺	❺

❶ (Risk of) Very significant negative effects .... ❺ No significant negative effects

The Chapelcross site is located at sufficient elevation, and sufficiently inland, that changes in sea level and associated coastal erosion would not affect the site. However, it is noted that any residual structures could be vulnerable to climate change effects in the medium and long term. For example, buildings that might remain in Option A and Option 1 could be damaged by infrequent but violent storms. There would be limited risks associated with other options as complete decommissioning would be undertaken, and completed more quickly. Residual waste stored on-site in Option 3 would be located in a vault that would not be vulnerable to climate, except in the very distant future (many tens or hundreds of thousands of years) when glaciation could disturb any activity remaining in the vault.

No option has the potential to result in a significant impact on climate.

5.2.5 Material Assets

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
5	5	5	5	5	4	1

1 (Risk of) Very significant negative effects .... 5 No significant negative effects

Option Z clearly has the potential to make major demands on material assets, as the large quantities of imported material would be required to restore the site after the extensive clean up. To a far lesser degree, Option 5 would also require a degree of imported material (e.g. clean soil) for the purposes of landscaping remediated contaminated soil, and to provide good quality conditions should the land be used for agriculture.

Although there will be some requirements for other options, these are not considered to be significant and could be fulfilled to a considerable degree by re-using materials arising from decommissioning (e.g. rubble). Notably, such re-use would be an important component of the development of a disposal facility in Option 3.

5.2.6 Biodiversity, Fauna and Flora

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
5	5	5	5	5	5	5

1 (Risk of) Very significant negative effects .... 5 No significant negative effects

Whilst various sensitive areas of ecology lie around the existing nuclear site, the site itself is unremarkable. The End State itself is not expected to have any significant effects on the local biodiversity, fauna and flora. The main effects would be associated with future use. All End States would permit future uses that could substantially improve conditions (e.g. a semi-natural environment) or result in limited change from the present situation (e.g. industrial use).

5.2.7 Cultural Heritage and Landscape

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
1	2	4	3	4	4	2

1 (Risk of) Very significant negative effects .... 5 No significant negative effects

Options 2, 4 and 5 all result in a site restored for future use, with the nuclear legacy permanently removed. It is assumed that, on balance, the restoration of the landscape is preferable to retaining evidence of the site's industrial heritage, and therefore these options are regarded as being positive in respect of this criterion.

Option 3 involves leaving waste on site, and this would serve as a permanent reminder of the activities – although the effect on the landscape would be limited, and the wastes would have been disposed of in a responsible and safe manner. Options A and 1 would, however, involve buildings and facilities remaining on-site and in evidence. Their presence, whilst preserving the heritage of the site, is considered to be an overall negative factor as there would be a perception that decommissioning and restoration had not been completed.

Option Z would ultimately restore the landscape but would involve major disruption and damage in the process.

5.2.8 Population

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
❶	❷	❷	❸	❸	❸	❸

❶ (Risk of) Very significant negative effects .... ❺ No significant negative effects

It is assumed that the primary impact on population is related to the future employment opportunities in the region.
It is noted that all options could lead to negative impacts as a result of the permanent loss of jobs; however, the local and regional employment opportunities are considered to be primarily determined by the regeneration strategy and are therefore outside the scope of this assessment. Nevertheless, it is noted that each option has the potential to provide some degree of employment associated with the restoration of the site.

Option A would involve rapid closure of the site and loss of the vast majority the current employment opportunities associated with decommissioning over a period of a few years. Options 1 and 2 involve a period of decommissioning that that would last for around a decade. Both would then be followed by a period of Care and Maintenance (lasting indefinitely, Option 1, or for about 100 years, Option 2). The Care and Maintenance period would offer limited employment – perhaps a few tens of jobs at most.

Options 3, 4, 5 and Z would offer an extended period of employment at the site as work was undertaken to fully decommission the site more rapidly than the current Baseline. Option 3, 5 and Z would probably offer more employment (in relation to the construction and operation of a repository, or more extensive remediation of contaminated land) than 4, although in the overall regional context this may not be substantial.

5.2.9 Human Health

Option A	Option 1	Option 2	Option 3	Option 4	Option 5	Option Z
❶	❷	❹	❺	❺	❺	❹

❶ (Risk of) Very significant negative effects .... ❺ No significant negative effects

Option A has the potential for a major impact on human health in the future, as the remaining hazards would require careful ongoing maintenance for a very long time (thousands of years) until radioactivity had decayed to levels that could have insignificant effects on human health. Option 1 also has the potential for significant effects on health if the site were not maintained properly for a very long period of time, as this strategy would also involve leaving residual hazards on-site.

Options 4, 5 and 6 all involve remediation of the site such that it could be safely de-licensed on a relatively early timescale. Radioactive and other hazardous material would be removed for disposal elsewhere. Consequently, these options are considered to have no significant effects on human health with the exception of the potential industrial hazards associated with the extensive remediation envisaged in Option Z.

Option 3 would involve wastes remaining on site, however the repository would have to meet demanding human health and safety targets for it to be authorised. These targets would apply to the safety of future generations as well as the present.

Finally, it is noted that, whilst Option 2 would meet the same End State targets as Option 4, the final site clearance would not happen until more than 100 years after the initial phase of decommissioning. There is both a risk that in the intervening period of Care and Maintenance unforeseen events would occur, and/or that when final clearance were undertaken some of the required skills, experience and knowledge would not be readily available.

6 Risks to Strategy Implementation

The risks to early final site clearance are covered by the impact assessments above and are generally shown to be demonstrably low. One of the key show stoppers to early site remediation though is the implementation of the CoRWM recommendations with respect to final disposal of ILW waste streams.

Overall the site has strong local stakeholder support for early final site clearance based on employment and socio economic benefits from early remediation. As such it is clear that notwithstanding ILW final disposal issues, initiation of reactor decommissioning and early final site clearance is a relatively low risk strategy for the Chapelcross site.

7 Schedule Impacts

The key impact would be to reduce the overall timescale for returning the site to its currently planned end state from 2118 to 2018 plus the time it takes to complete early reactor decommissioning, final site clearance and de-licensing – estimated as another 5 years (ie 2023).

8 Impact on Current IWS

The current site Integrated Waste Strategy assumes that an ILW repository will be available by 2040 and that Chapelcross ILW will be transported to that facility during the period from 2043 to 2046. The key consequence of adopting options 4 or 5 is the impact of earlier final site clearance and the consequent need to advance the UK programme on final waste repository solutions.

9 Inputs from others

Regulators, such as OCNS, NII and SEPA have been consulted as part of the wider Site End State consultation process. They have also reviewed the final SSG recommendation as part of their involvement/membership of the Site Stakeholder Group. No regulator has provided written evidence to support, contradict, or otherwise comment on, the outputs or findings of this process.

Scottish Enterprise Dumfries and Galloway (SEDG) have been instrumental in setting up a Special Purpose (investment) Vehicle to support the regeneration of the Gretna, Lockerbie Annan areas post Chapelcross closure. SEDG were an active participant in the SSG run consultation process on Site End State and they very much welcome the Socio Economic opportunities early site remediation brings both through site workforce skills development and economic planning for alternative job creation in the area.

The Lockerbie Academy project team highlighted the availability of the c. 250 acres of non-licensed site. This creates an immediate opportunity to develop site end use options and plan for early final site clearance now. The Gretna, Lockerbie, Annan Corridor Regeneration Steering Group (CoReS) are now actively looking at options to develop an energy park on this land and also welcome the findings of the SSG end state consultation.

10 Recommendations

British Nuclear group supports the recommendation of the Site Stakeholder Group from its Site End State Consultation process and welcomes the debate about the possibility of earlier final site clearance at the Chapelcross site.

With the Chapelcross site having four smaller reactors and an indigenous workforce (with embedded knowledge of reactor design/operations) and the space to develop appropriate R&R facilities on its larger nuclear licensed site, the NDA is invited to consider the strategy to minimise the overall technological and cost risks of early final site clearance across the Magnox reactor fleet by initiating reactor decommissioning at Chapelcross first. The strong support of the key stakeholders in tandem with the output from the Site End State consultation process strengthens the arguments in support of early final site clearance at Chapelcross and in the process creates the opportunity to make Chapelcross a centre of excellence in reactor decommissioning.

Early site remediation at Chapelcross is also seen a key enabler in delivering the NDA's socio economic objectives in one of the four geographical priority areas - Dumfries and Galloway. This geographical priority area was specifically identified in the 2006 "Draft NDA Socio Economic Policy" consultation document.

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