FORMAL DRAFT - FOR DISCUSSION

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SITE RESTORATION PROGRAMME:
WINFRITH END STATE PROJECT

WASTE RECOVERY PLAN

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EXECUTIVE SUMMARY

This Waste Recovery Plan has been prepared to support a planned Permit Application for a Deposit for Recovery (DfR) activity involving the recovery and re-use of conventional demolition arisings on the Magnox Winfrith site. The recovered waste will include materials with EWC codes 17 01 01, 17 01 02, 17 01 03, 17 01 07 (concrete, brick, tiles and ceramics). The recovery and re-use of such materials will form a key part of site restoration activities.

Magnox is required to undertake decommissioning of experimental nuclear reactors and support facilities and restore the Winfrith site to its End State of Heathland with Public Access, following 60 years of intensive operational use. The Winfrith site will be the first Magnox nuclear site in the UK to complete full site restoration and is a priority project as it is a crucial part of delivering the Nuclear Decommissioning Authority's mission.

To achieve site restoration, multiple permissions are required from the Environment Agency, the Office for Nuclear Regulation and Dorset Council. Magnox works closely with all agencies and local communities to define the optimised approach to delivering the End State of Heathland with Public Access through decommissioning and site restoration activities.

Optimisation assessment in accordance with the Environmental Permit requirements and the EA's GRR guidance (Ref.1) has identified that the best approach to delivering the End State is to leave radioactively contaminated voids on the site, in place. The recovery and re-use of site-derived waste is the best available technique and most sustainable option to backfill voids and ensure the long-term engineering performance of the radioactive waste disposals.

Should the recovery and re-use of site-derived waste not be permitted there would still be a need to backfill the voids to ensure the long-term performance of the radioactive waste disposals. The use of purchased material would result in additional environmental, safety and cost impacts with no identified benefits.

This Waste Recovery Plan demonstrates that the use of site-won material to backfill voids is a valid recovery operation and is the optimised solution for achieving the Winfrith Site End State. Evidence to support the following points is addressed within the document:

- The Energy Act 2004 places the legal obligation on the NDA to define the end state of sites through stakeholder engagement and deliver the next planned use for its nuclear sites. For Winfrith, the NDA has identified the end state through stakeholder engagement as 'Heathland with Public Access'. Magnox is funded by the NDA to deliver decommissioning and the End State, including backfilling voids to deliver 'Heathland with Public Access';
- The works support the NDA mission to deliver safe, sustainable and publicly acceptable solutions to the challenge of nuclear clean-up and waste management;
- There are a number of legal obligations on Magnox to undertake decommissioning, including the Nuclear Installations Act, the Environmental Permitting Regulations and the associated Site Licence and Environmental Permit issued for the Winfrith site. Specifically, the Nuclear Site Licence requires operators to undertake decommissioning;
- The retention of the below ground structures under GRR is essential to the completion of site restoration and the implementation of the Site End State. This has created a defined need to carry out the backfilling of the below ground structures to produce a surface suitable for 'Heathland with public Access'. The work would therefore be completed using a non-waste material if the use of site-derived waste was not permitted;
- The Winfrith site decommissioning operations is a 'Lead and Learn' for nuclear decommissioning and a priority project for the NDA and BEIS. Should additional funds be required for purchasing new materials to backfill voids, Magnox would secure funding via NDA and BEIS to ensure the success of this first of a kind critical project;

- The engineering function for the recovery of site derived waste (or imported material) is to provide a stable surface to allow establishment of heathland and support public access, minimise risk of long term surface subsidence, minimise the risk of human intrusion and ensure the long term environmental performance through minimising leachate generation;
- The engineering concept designs have been produced through a robust, iterative assessment process to national and international engineering standards and with input from key stakeholders to determine the preferred approach;
- No more waste than is required to fulfil the Engineering Concept Designs will be used during the works (to fill the voids to 1 meter below ground level (m bgl));
- The waste is suitable for its intended purpose and will meet the Engineering Functional Requirements and acceptance criteria for the voids;
- The voids would require backfilling using imported non-waste material if the use of site-won waste was not permitted;
- The proposed works are consistent with and supported by the Dorset Council Adopted Waste Plan;
- Restoration of the site will deliver Biodiversity Net Gain and amenity value for local communities;
- Decommissioning, site restoration and recovery of site-derived materials directly support a number of the UK Governments objectives within the 25 year Environment Plan.

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QA Grade – 1

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Glossary

ALES	Active Liquid Effluent System – used for treatment and discharge of radioactive liquid effluent arising's from site operations and decommissioning. The system includes a discharge Pipeline and is in the final stages of use. In addition to the active effluent, the ALES plant also receives foul, process and surface water.
AOD	Above Ordnance Datum
AONB	Area of Outstanding Natural Beauty
BAT	Best Available Techniques – it is a requirement of the Environmental Permit that an operator must use BAT to prevent or minimise emissions and impacts on the environment and to control discharges and disposals of radioactive waste.
BEIS	Department for Business, Energy and Industrial Strategy
DC	Dorset Council – local authority for Winfrith site. Formed in April 2019.
DfR	Deposit for Recovery – a waste recovery activity involving the deposit of waste that is to be used in construction and/or reclamation, restoration or improvement of land; for this document it relates to the use of decommissioning and demolition wastes for the infilling of the SGHWR and Dragon below ground voids.
DIP	Dorset Innovation Park an adjacent local enterprise partnership and commercial development owned and operated by Dorset Council.
Dragon	An experimental high temperature reactor that operated in the 1960s and 1970s, currently in the final stages of decommissioning.
EA	Environment Agency
EAC	Emplacement Acceptance Criteria – site specified limits on material that can remain in place in the reactor voids following decommissioning and material that can be used to backfill. This is summarised as Very Low Level radioactive Waste or Out of Scope Waste, meeting the inert landfill criteria and physical requirements.
EPR	Environmental Permitting Regulations 2016
GRR	Guidance on Requirements for Release from Radioactive Substances Regulation – sets down the requirement for nuclear sites to have a SWESC and WMP and specific requirements in relation to sites in the final stages of decommissioning.
GWDTE	Groundwater Dependent Terrestrial Ecosystem
HGV	Heavy Goods Vehicles
HRA(e)	Habitat Regulations Assessment – a process to determine if proposals may affect the protected features of a habitats site before deciding whether to undertake, permit or authorise it.
HRA(w)	Hydrogeological Risk Assessment – completed for each of the reactor voids to assess the potential release and spread of contaminants from the SGHWR and Dragon disposals
Human intrusion	Any human action without full knowledge of the nature of the disposals that disturbs radioactive substances, or that impairs a barrier or measure providing an environmental safety function.
IEP	Interim End Point – the point in time at which the Winfrith IES is achieved

IES	Interim End State – the condition of the Winfrith site (or part thereof), following all physical decommissioning and clean-up activities required for the next planned use of the site (or part thereof).
In-scope	Waste or material that has a radioactive content above the limits specified in Schedule 23 of EPR, commonly identified as “radioactive”.
In-situ disposal	Leaving radioactively contaminated sub-surface structures in place. A suitable RSR Environmental Permit in accordance with the Environment Agency’s GRR is required prior to disposal commencing. Note that if the structures were non-radioactive, they would be excluded from the Waste Framework Directive and classed as land in-situ.
LLW	Low Level radioactive Waste – meeting the legal definition where specific activity is less than 12 GBq/t of beta / gamma emitting radionuclides and 4 GBq/t of alpha emitting radionuclide contamination.
NDA	Nuclear Decommissioning Authority – Non-Departmental Public Body established under the Energy Act 2004, responsible for the decommissioning, clean up and restoration of former civil nuclear research and power generating sites.
NIA	Nuclear Installations Act 1965 (as amended) – provides regulatory powers for the Office for Nuclear Regulation and details how nuclear sites are regulated.
OECD	Organisation for Economic Cooperation and Development – sponsored the design, build and operation of the Dragon experimental reactor.
ONR	Office for Nuclear Regulation – primary regulator for nuclear licenced sites, such as Winfrith, under the terms of NIA 65.
On-site disposal for a purpose	Disposal on-site of radioactive waste generated elsewhere on the site of origin (i.e. not in its original position) to minimise the import of new materials.
Optimisation	Optimisation – the process of identifying the BAT solution. This is typically a process that compares the safety and environmental performance of options and the costs in terms of time, effort or money. The environment agencies and other bodies have published several guidance documents on this subject.
Out of Scope	Material or waste whose level of radioactivity is below that regulated under Schedule 23 of the Environment Permitting Regulations.
PA	Performance Assessment – assessment of the radiological performance of proposed disposals including detailed modelling of behaviour following disposal and risks to human health and the environment.
RSR	Radioactive Substances Regulation – Regulation under a Permit issued under Schedule 23 of the Environmental Permitting Regulations. Currently, primarily associated with regulation of gaseous and aqueous discharges and solid waste disposal from decommissioning operations (noting ONR responsibility for site management).
Radioactive waste	Radioactive material that is no longer in use.
Radioactive material	Material in which the concentrations of radionuclides are greater than the values specified in Schedule 23 of EPR. This excludes material lawfully disposed of as waste or contaminated ground that remains where it was contaminated.
SAC	Special Area of Conservation
SGHWR	Steam Generating Heavy Water Reactor – an experimental reactor that had an aluminium core, water-cooling system and heavy water moderator. The reactor was operational between 1957 and 1996 and is in now in the final stages of decommissioning.
SLC	Site Licence Company – a site that holds a licence to operate as a nuclear establishment, issued by the ONR under the NIA.

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SPA	Special Protection Area
SQEP	Suitably Qualified and Experienced Persons – as defined in the Magnox management system to meet the requirements of the Nuclear Site Licence and EPR Permit.
SSSI	Site of Special Scientific Interest
SWESC	Site-Wide Environmental Safety Case – a documented set of claims, made by the operator of a nuclear site, to demonstrate achievement by the site as a whole of the required standard of environmental safety. Where relevant, the SWESC includes the environmental safety case for any on-site disposal facility. The SWESC also takes account of contributions to the combined impact on representative persons from adjacent nuclear sites, and from areas of contamination and previously permitted disposals outside the site.
VLLW	Very Low Level radioactive Waste – meeting the definition of radioactive used by commercial VLLW disposal facilities of less than 200 MBq/t total specific activity.
WMP	Waste Management Plan – a documented plan, prepared by the operator of a nuclear site, which provides a comprehensive description of the current intent for dealing with all radioactive substances on or adjacent to the site and demonstrates how waste management has been optimised.
WSSG	Winfrith Site Stakeholder Group
ZEBRA	Zero Energy Breeder Reactor Assembly – A fast breeder reactor assembly designed for studying neutron physics. The reactor has been successfully decommissioned and site restoration is nearing completion.

1 INTRODUCTION

Summary:

The Winfrith Nuclear site in Dorset was a core part of national and international research into reactor technology and radioactive materials from the 1950s until 1996. Having already successfully completed numerous decommissioning operations, the site will be the first Magnox site in the UK to complete the decommissioning mission and deliver its next planned use.

The Winfrith former nuclear research site is operated by Magnox Ltd, a subsidiary of the Nuclear Decommissioning Authority (NDA). Magnox Ltd operates 12 nuclear decommissioning sites across England, Wales and Scotland.

The Winfrith site currently operates under a Nuclear Site Licence from the Office for Nuclear Regulation, as made under the Nuclear Installations Act 1965 (NIA 65), and an Environmental Permit under Schedule 23 of the Environmental Permitting Regulations (EPR) for radioactive substances activities to support operations, decommissioning and site restoration activities.

The requirement to decommission nuclear sites comes from legal obligations under the Energy Act 2004 and the Nuclear Installations Act, enacted through the Nuclear Site Licence. Magnox is required to complete decommissioning and restore the Winfrith site to a state that allows release from regulatory requirements and meets the defined End State and next planned land use. The site Environmental Permit requires Magnox to use the optimised approach to undertake decommissioning and waste management.

The Winfrith site is in the process of decommissioning the remaining facilities and restoring the site to allow removal of nuclear regulatory controls and to meet the agreed end state as part of the NDA's obligations.

To enable the restoration of the site, an Environmental Permit will be required to allow for a Deposit for Recovery (DfR) activity involving the recovery and re-use of conventional demolition arising's.

1.1 Site setting

The Magnox Winfrith site is situated near the south coast of Dorset, approximately 6.3 kilometres (km) inland, and covers an area of 74 hectares (ha) (Appendix A and Appendix B).

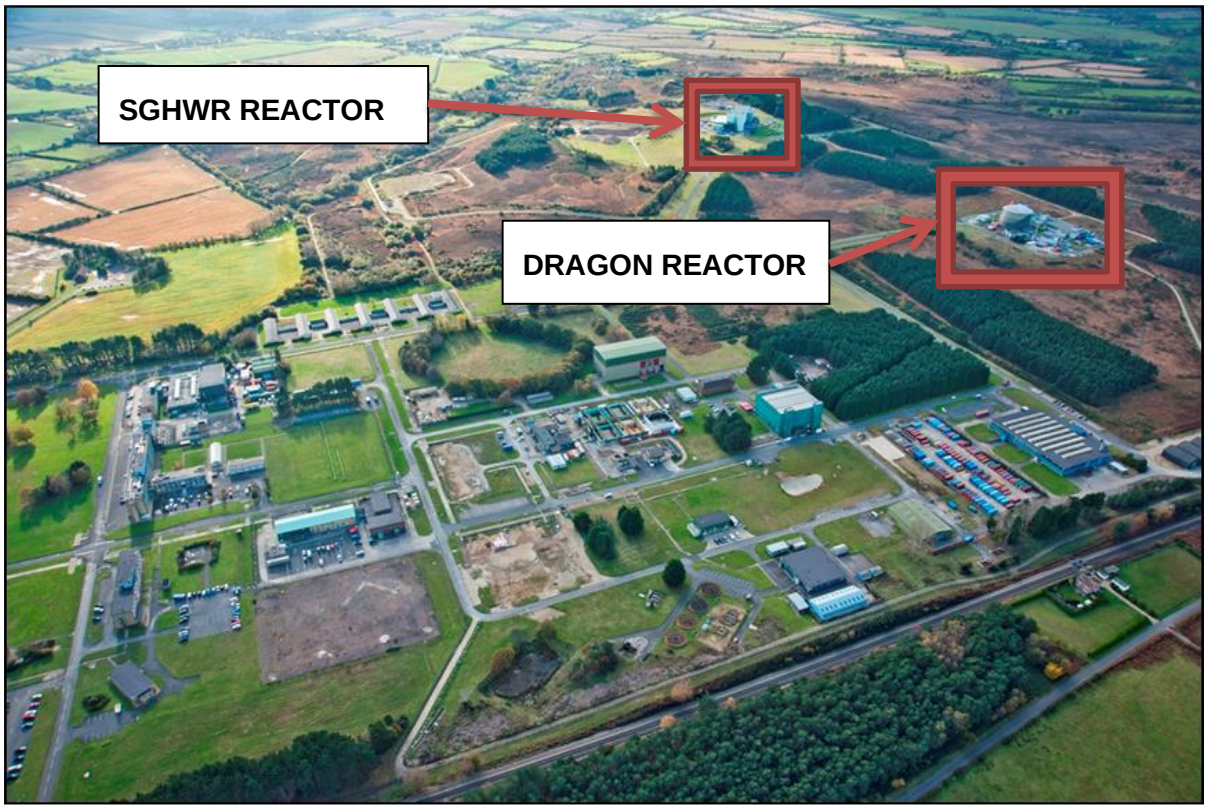
The site entrance is on Gatemore Road, which runs along the western boundary. Directly to the north of the site lies the London – Weymouth Railway Line, a number of wooded areas and agricultural land, as well as an off-site waste water treatment plant. The nearest settlements are located on Blacknoll Lane, approximately 140 metres (m) south of the site boundary. The county town of Dorchester is approximately 11 km west of the site.

To the east of the site is the Dorset Innovation Park (DIP), which previously formed part of the Winfrith nuclear site and has now been released for further use. Beyond this is the town of Wool, surrounded by land used predominantly for agricultural purposes. To the south of the site, a combination of agricultural land, natural acid heathland and residential properties of East Knighton and Winfrith Newburgh are present.

The Dorset Area of Outstanding Natural Beauty (AONB) is situated approximately 750 m to the south of the southern site boundary. To the west of the site the land predominantly comprises natural acid heathland (Winfrith Heath and Tadnoll Nature Reserves) and beyond that the principal land use is for agriculture.

The majority of the site is within the Winfrith Heath Site of Special Scientific Interest (SSSI) and is designated as a Groundwater Dependant Terrestrial Ecosystem (GWDTE). However, the Dragon and SGHWR reactor areas are not included in the area of the SSSI or GWDTE designations (Ref. 2). A map of sensitive local habitats is provided in Appendix A.

Figure 1: Site setting and key features



1.2 Site History

The area occupied by the Winfrith Site was known as Hardy's Heath or Egdon Heath prior to development in the 1950s. The Winfrith nuclear site began development in the 1950s to provide facilities for research into experimental nuclear reactor designs and associated testing. The site housed nine research and prototype reactors through the operational lifetime, as well as laboratories and support facilities. One reactor also provided power to the national grid for 20+ years. The site was operational between 1957 and 1996. During the operational lifetime, Winfrith undertook unique research and experimentation into a variety of nuclear engineering and safety topics for both UK operations and as part of international co-operation agreements.

Once nuclear operations ceased in 1996, decommissioning commenced. Large areas of the site have been successfully decommissioned and released for other uses, such as the neighbouring DIP commercial development. Decommissioning is continuing to allow restoration and final site closure of the remainder of the site.

1.3 Current status

The Site is well progressed in its mission and has successfully decommissioned seven of the previous nine reactors and numerous laboratory and support facilities. The remaining on-site facilities include two former nuclear reactors currently being decommissioned, the active liquid effluent system, solid waste processing areas and numerous offices.

The two remaining reactors are the Steam Generating Heavy Water Reactor (SGHWR) and the Dragon experimental high temperature reactor.

1.3.1 SGHWR

The SGHWR was a prototype reactor design with a core composed of zirconium alloy tubes which passed through vertical tubes in a tank of heavy water moderator. The zirconium tubes contained slightly enriched uranium fuel which was cooled by a flow of light water up the tubes, generating steam. The 100 MWe reactor was connected to the grid in 1967 and ran until 1990.

The SGHWR structure is situated in the south of the Winfrith site. Above ground, it consists of a steel framed building, clad in steel panels with some masonry walls, and houses heavy concrete internal structures. Below ground level, the structure is mainly formed of reinforced concrete. The total void volume is 28,000 m^3. The internal structure is complex and the depth of the building below ground is variable; the basement levels are between 4.2 and 10.7 m bgl in the reactor hall, while the basement levels in the annexes are at higher levels. Ground level is 41.6 m AOD). An aerial layout of SGHWR is shown in Figure 2.

SGHWR ceased generating electricity in 1990 and extensive decommissioning has been undertaken since, with all fuel and the majority of the plant and equipment removed. Over the next few years, the core will be removed and disposed off-site, before final demolition of the building.

Figure 2: Images of the SGHWR Reactor

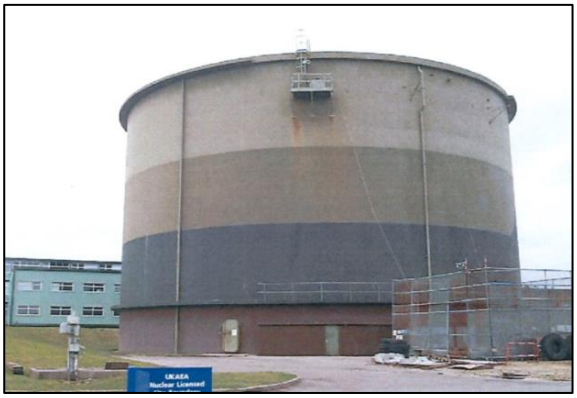
1.3.2 Dragon

Dragon was a unique helium cooled high temperature experimental reactor, which was operational between 1965 and 1976. The one-off design resulted from a project sponsored and managed by the Organisation for Economic Cooperation and Development (OECD).

The reactor building is cylindrical and the external structure forms the outer reactor containment. The reactor building is 26 m high (above ground level) and 35 m in diameter. The 3.7 m thick concrete foundation is 7.6 m bgl. The below ground void is approximately 7000 m^3. The aerial layout of Dragon is shown in Figure 3.

Once research ceased in 1976, limited decommissioning was undertaken and work has continued since that time.

Figure 3: Images of the Dragon Reactor



1.3.3 Other facilities

The Active Liquid Effluent System (ALES) and the associated sea discharge pipeline remain in use to treat and discharge radioactive effluent arising's from decommissioning. In addition, a number of solid waste processing and storage facilities remain in use to allow treatment, assay, packaging and disposal of solid wastes generated during decommissioning.

A number of non-radioactive facilities also remain on-site including offices, support facilities, empty buildings and buildings awaiting demolition.

None of the other remaining structures include sub-surface voids that will require an Environmental Permit for disposal of radioactive waste under GRR or backfilling.

1.4 Site restoration

As facilities are decommissioned and demolished, site restoration activities are undertaken to encourage reinstatement of a heathland habitat consistent with the local area. The site restoration process has been successfully demonstrated with the full restoration of the area housing the Zero Energy Breeder Reactor Assembly (ZEBRA) and former laboratories. These areas are now developing naturally and being colonised by species appropriate for a heathland landscape.

Following decommissioning of the remaining facilities and site restoration, Winfrith will be the first Magnox nuclear site in the United Kingdom to go through full site closure, with the intent of restoring the land area and surrendering regulatory permissions to allow for public access and amenity use.

Figure 4: Previous successful restoration and the ZEBRA reactor and laboratory facilities

Left – Zebra prior to demolition (April 2005) *Right – Zebra site restoration (December 2018)*

The proposed site End State, immediately following site restoration, is presented in Appendix B and the Concept Landscape Masterplan (Ref. 3).

2 SITE END STATE AND RESTORATION STRATEGY

Summary:

The aim of Winfrith site restoration, in line with the NDA's obligations and legal duties under the Energy Act 2004, is to complete decommissioning, allowing removal of nuclear regulatory controls and providing land suitable for its next use. The next planned use for Winfrith was determined through stakeholder consultation and is identified as 'Heathland with Public Access'.

As an operator under the Nuclear Installations Act, Magnox has a legal duty to plan and complete decommissioning in accordance with the site licence conditions.

The End State for Winfrith has been assessed in accordance with the Environment Agency's requirements under the GRR to *define the optimised End State* for sites. The assessment identified that, on balance of benefits and detriments, the optimised approach to site closure includes leaving the SGHWR and Dragon sub-surface structures in place and backfilling the voids with suitable material to meet safety criteria and deliver a surface suitable for 'Heathland with Public Access'.

Magnox will require multiple permissions and approvals to deliver site restoration and closure. As the work is 'first of a kind', Magnox is working closely with regulatory bodies and stakeholders to develop appropriate submissions as the nuclear regulatory framework is updated.

Under the Energy Act the NDA is required to define the next planned land use and to restore sites to meet these requirements. In accordance with their obligations under the Energy Act, the NDA and Magnox have completed two stages of public consultation to define the End State for the Winfrith site.

2.1 Defining the End State

In 2006/2007, the NDA completed public consultation with a range of stakeholders including the Winfrith Site Stakeholder Group (WSSG) to consider possible future uses for the Winfrith Site. All of the options considered involved closure of the Winfrith site to meet the NDA's core mission of decommissioning.

Various options for the 'Management Approach' and 'Landscape Condition' were assessed through the consultation, with the results indicating that the preferred End State consists of "a hybrid landscape supporting habitat and ecology whilst also providing public amenity value through public access across the site."

The recommendation from the public consultation was that the Final End State of the site should be "open heathland with unrestricted public access" with the potential opportunity for additional employment development to the north of the site associated with the railhead.

2.2 Optimisation of the End State

The Winfrith Environmental Permit includes the requirement to identify the optimised approach to delivering decommissioning and waste management for the site, in accordance with the EA's GRR.

Winfrith undertook a detailed staged optimisation assessment in accordance with the EA's GRR that included engagement with local community representatives to determine the best manner to deliver 'Heathland with Public access'.

The optimisation process assessed stakeholder and regulatory views to define the best way to implement the End State whilst maximising environmental benefits through a series of assessments and workshops.

In 2013/14 a series of five workshops involving regulators, the local authority, WSSG and members of the public were completed (Ref. 4). These were followed by significant assessments in 2016/17 to determine the preferred approach to implement the End State (Ref. 5). These workshops reaffirmed the End State of Heathland with Public Access and identified that 'in-situ disposal' and 'disposal for a purpose' of radioactive waste in accordance with the EA's GRR, were preferred for the sub-surface structures of the remaining reactors.

The key arguments supporting the optimised approach are:

- Less environmental impact associated with full excavation in proximity to a sensitive habitats and road transport miles;
- Reduced need for hazardous industrial working by full excavation of the structures;
- Significantly fewer HGV movements to remove waste from site, minimising nuisance and risk to local communities;
- Lower cost both in the near term and across the lifecycle of the project;
- Enabling the NDA to complete its mission and set a positive precedent for the rest of the nuclear industry.

Retaining the sub-surface structures as part of the End State necessitates the backfilling of remaining void space to provide a surface profile similar to the local environs and allow restoration to 'Heathland with Public Access'.

Based on the consultation and technical studies, a conceptual landscape masterplan (Ref. 3) was developed highlighting the key outcomes of Site Restoration. An indicative proposed end state is presented in Appendix B, noting that this may be subject to change during detailed design.

2.3 Regulatory controls for Site Restoration

The site is currently regulated under an Environmental Permit for Radioactive Substances Activities and a Nuclear Site Licence. All current operations are managed under these permissions which place obligations on Magnox to undertake decommissioning in a manner that minimises risks to workers and the public and minimises impact on the environment.

Additional permissions and underpinning technical assessments will be required to allow implementation of final site decommissioning, on-site disposal of radioactive waste, and restoration of the site, to allow eventual surrender of regulatory controls.

2.3.1 Nuclear Site Licence under NIA65

The Nuclear Instillations Act 1965 (NIA65) sets out a system of regulatory control based on the licensing process administered by the Office for Nuclear Regulations (ONR). Under this regime, a site operator is required to have a licence to use the site for specified activities, such as the operation and decommissioning of nuclear sites.

The Nuclear Site Licence requires operators to manage radiological and nuclear safety, in addition to conventional health and safety requirements and also requires operators to appropriately plan for decommissioning of sites and to publish the decommissioning plan. The decommissioning plan must demonstrate how the operator will minimise risks to workers and the public to levels that are As Low As Reasonably Achievable (ALARA).

Winfrith has a published decommissioning plan in accordance with Licence Conditions requirements. This plan includes demolition of the reactors and on-site disposal of radioactive waste and back filling of the associated voids to deliver the next planned use. The decommissioning plan minimises risk to workers through a number of measures including minimising the requirement for large-scale excavations and minimising waste handling operations and off-site disposals and the associated transport safety risks to workers and the public.

Consultations by the Department for Business, Energy & Industrial Strategy (BEIS) in 2016 (Ref. 6) and 2018 (Ref. 7) recognise that the current nuclear site licence process is not a proportionate method for regulating sites in the final stages of decommissioning and clean up, such as the Winfrith site. BEIS is in the process of amending primary and secondary legislation to allow for the transition of the site from nuclear controls to conventional regulatory controls. The Winfrith decommissioning programme is one of the key drivers for amending legislation.

2.3.2 Radioactive Substance Regulations (RSR) Environmental Permit

The site currently holds an Environmental Permit (EPR/PB3898DC), which authorises radioactive substances activities under Schedule 23 of EPR 2016.

The EA provided Guidance on the Release of Nuclear Sites from the Radioactive Substance Regulations (known as the GRR) in July 2018 (Ref. 8). The requirement to comply with the GRR was incorporated into the site's Environmental Permit in 2020.

The purpose of the GRR is to provide guidance on the process of bringing a nuclear site to a condition suitable to be released from RSR, with a requirement to define the optimised approach to waste management in the final stages of decommissioning.

The GRR also enables operators, subject to engagement with stakeholders, to undertake in-situ disposal and disposal for a purpose of radioactive waste on-site, provided that it can be clearly demonstrated as the optimised approach. The GRR is now reflected in the Winfrith site Environmental Permit. The key requirements on Magnox as an operator are:

- Demonstrate that the waste management approach and site end state is optimised, taking account of environment, safety and socio-economic factors, subject to the constraints provided to in the GRR;
- Provide a Waste Management Plan[1] (WMP) that summarises the optimised management of waste;
- Assess the associated risks against specified criteria through a Site Wide Environmental Safety Case (SWESC).

Optimisation assessment, in accordance with GRR and the site's Environmental Permit, has been completed (Section 2.2) and identified the preferred option of in-situ disposal of the below ground structures (voids) of the SGHWR and Dragon reactors and disposal for a purpose of radioactive waste into those voids, where it can be demonstrated to meet specified criteria. Any remaining voids not filled with radioactive waste will need to be backfilled to produce a safe waste disposal and a surface suitable for the next planned use.

An application to vary the current site Environmental Permit will be required for the in-situ disposals and disposal for a purpose of radioactive waste, subject to them being demonstrated as compliant with all other requirements of the GRR. The application will need to demonstrate that the structures, backfill and engineered systems will meet the engineering and performance requirements to demonstrate long-term safety. The variation to the current RSR Permit will be in addition to the proposed Permit for Deposit for Recovery.

Once the appropriate permissions have been received, the structure will be prepared, the building demolished and the voids will be back-filled to at least 1 m bgl in accordance with the engineering design. An engineered cap will be emplaced over the disposal locations and the final surface will be finished in a way that promotes the development of an ecological community consistent with the wider site. The site will meet the restoration objective of 'Heathland with Public Access' around this time.

The disposals will remain permitted as a radioactive waste disposal whilst Magnox undertakes validation monitoring for a period, perhaps for several decades. When suitable validation monitoring is complete Magnox will apply to surrender the RSR Permit (and any other controls) to demonstrate the site has met the requirements objectives of site

1 Draft versions of these documents were completed as part of the Lead and Learn exercise carried out in 2017.

restoration and thereafter the land will be subject to normal controls such as the Town & Country Planning regime.

2.3.3 Deposit for Recovery Environmental Permit

In-situ disposal of the reactor sub-surface structures will require the remaining voids to be backfilled to about 1 m bgl to allow for site restoration and establishment of heathland. The re-use of non-radioactive (i.e. out of scope of RSR) material and wastes for the purpose of backfilling the voids will require a Deposit for Recovery Permit. This Waste Recovery Plan will demonstrate that emplacement of waste into the voids is a recovery operation and is consistent with NDA strategy, the Dorset Council Adopted Waste Plan and wider government objectives on sustainability and obligations to complete decommissioning of legacy nuclear sites. Evidence to support the following points will be provided within the document:

- There is a specific need to carry out the work;
- The work is subject to an ongoing design process that will continue in line with national and international standards and the company management procedure for design (Ref. 9) and in accordance with the nuclear site licence and environmental permit requirements;
- No more waste than is required to fulfil the Engineering Design will be used during the works;
- The waste is suitable for its intended purpose and will not cause pollution or harm to the environment;
- The work would have to be carried out using a non-waste material if the use of waste was not permitted;
- The waste used is a direct replacement for a non-waste material;
- Magnox has obligations to complete the work.

2.3.4 Town and Country Planning Act and Environmental Impact Assessment regulations

As the disposal of radioactive waste constitutes a waste activity under National Planning Policy Framework, an application for planning permission will be made to Dorset Council. An Environmental Impact Assessment (EIA) and Habitat Regulations Assessment (HRA(e)) are being undertaken to determine the likely effects of the proposals. A scoping report has been provided to the local authority and a scoping opinion provided (Ref. 10, 11 and 12). The planning application will be accompanied by a number of supporting documents including an Environmental Statement and a Restoration Management Plan presenting the final landscape plan. These are currently in preparation.

The Winfrith site and its decommissioning and site restoration programme has been included as a planning policy within the adopted Waste Plan (Ref. 13). The EIA and planning application will be submitted several months after the Deposit for Recovery and Radioactive Substances Permit applications. Consultation, review and approval of the Planning and Permit applications will be in parallel as all plans and permissions need to be consistent.

3 WHY THE WORK IS REQUIRED

Summary:

The requirement to undertake decommissioning and restore sites is a core obligation on the NDA and Magnox as its subsidiary under the Energy Act. The NDA consulted stakeholders over a number of years to define the End State for Winfrith as Heathland with Public Access.

Magnox is required to decommission the site under the conditions of the Nuclear Installations Act.

Magnox is required under the Environmental Permit and EAs GRR to define the optimised approach to decommissioning and waste management. The assessments completed between 2012 and 2016 identified the preferred option of retaining sub-surface structures at SGHWR and Dragon.

The sub-surface structures must be backfilled to provide a surface suitable for 'Heathland with Public Access' in accordance with the NDA mission and to ensure the long term safety and environmental performance of the radioactive waste disposal.

The obligations and duties on the NDA under the Energy Act 2004 are required to complete the mission of decommissioning legacy nuclear facilities safely, securely, cost effectively and in ways that protect people and the environment.

Magnox, as a wholly owned subsidiary of the NDA, is responsible for undertaking decommissioning operations to fulfil the NDA mission and in accordance with regulatory requirements. For Winfrith, completing the NDA's duty under the Energy Act includes decommissioning the site to deliver the End State of 'Heathland with Public Access'.

The Nuclear Site Licence places a duty on Magnox as the operator to undertake decommissioning in a manner that minimises risks to workers and the public to levels that are ALARA.

The Environmental Permitting Regulations and the GRR require Magnox to define the optimised approach to decommissioning and waste management for its sites. Assessments for the Winfrith site have shown that the optimised approach is to retain the sub-surface structures at SGHWR and Dragon as radioactive waste disposals as the most sustainable approach to decommissioning and preferred by stakeholders.

The retention of these sub-surface structures necessitates the backfilling of remaining void space to provide a surface profile similar to the local environs and to allow restoration of 'Heathland with Public Access.

This approach of retaining the below ground structures at SGHWR and Dragon and backfilling the remaining void space will:

- Deliver the NDA mission for decommissioning sites to achieve their end state;
- Meet the requirements of the Nuclear Site Licence conditions through minimising risk to workers and the public in selection of the decommissioning plan;
- Meet requirements of the Environmental Permit by defining and delivering the optimised end state for the site with engagement from local communities.

The voids will need to be backfilled, capped and covered in accordance with the Concept Engineering Designs to:

- Ensure that the End State is inherently safe for public access by filling the large voids;

- Form an integral part of the local heathland landscape, by ensuring that the cap finish uses locally derived soils suitable for the immediate area (cap and soils are not part of the scope for recovery);
- Ensure the long-term performance of the radioactive waste disposal, through minimising the risk of subsidence by using a combination of large concrete blocks and material of a suitable grade in backfilling;
- Reduce the likelihood of human intrusion through the use of barriers including the engineered cap, with concrete being resistant to human intrusion;
- Minimise the risk to the environment, through using large blocks of concrete (low surface area, low permeability and low pore capacity) in areas that will be in contact with groundwater.

Outlines of the Dragon and SGHWR below ground voids and above ground structures are provided in Appendix C and Appendix D.

4 HOW THE WORK WILL BE CARRIED OUT

Summary:

The purpose of the recovery operations will be to fill remaining voids created by the radioactive waste disposal of the sub-surface structures, prevent later subsidence, minimise the risk of human intrusion and provide a surface finish level suitable to deliver 'Heathland with Public Access'.

The proposals are subject to detailed technical and safety assessment under the requirements of GRR. The design, engineering and implementation are managed in accordance with the Nuclear Site Licence Conditions.

The voids will be prepared for backfilling by removing some walls and floors. Localised grouting will be used where necessary to stabilise the void structure. Large blocks will then be cut from the above ground structure and placed into the deepest voids to minimise risk of subsidence and leachate generation. Remaining void space will be backfilled with suitable material, in accordance with the design process to around 1 m below ground level.

An engineered cap will then be placed over the backfill and topped with a layer of locally derived soil to provide a finished surface for the site which meets the End State of 'Heathland with Public Access.'

All assessments are undertaken by SQEP persons and in accordance with national and international guidance and regulatory requirements.

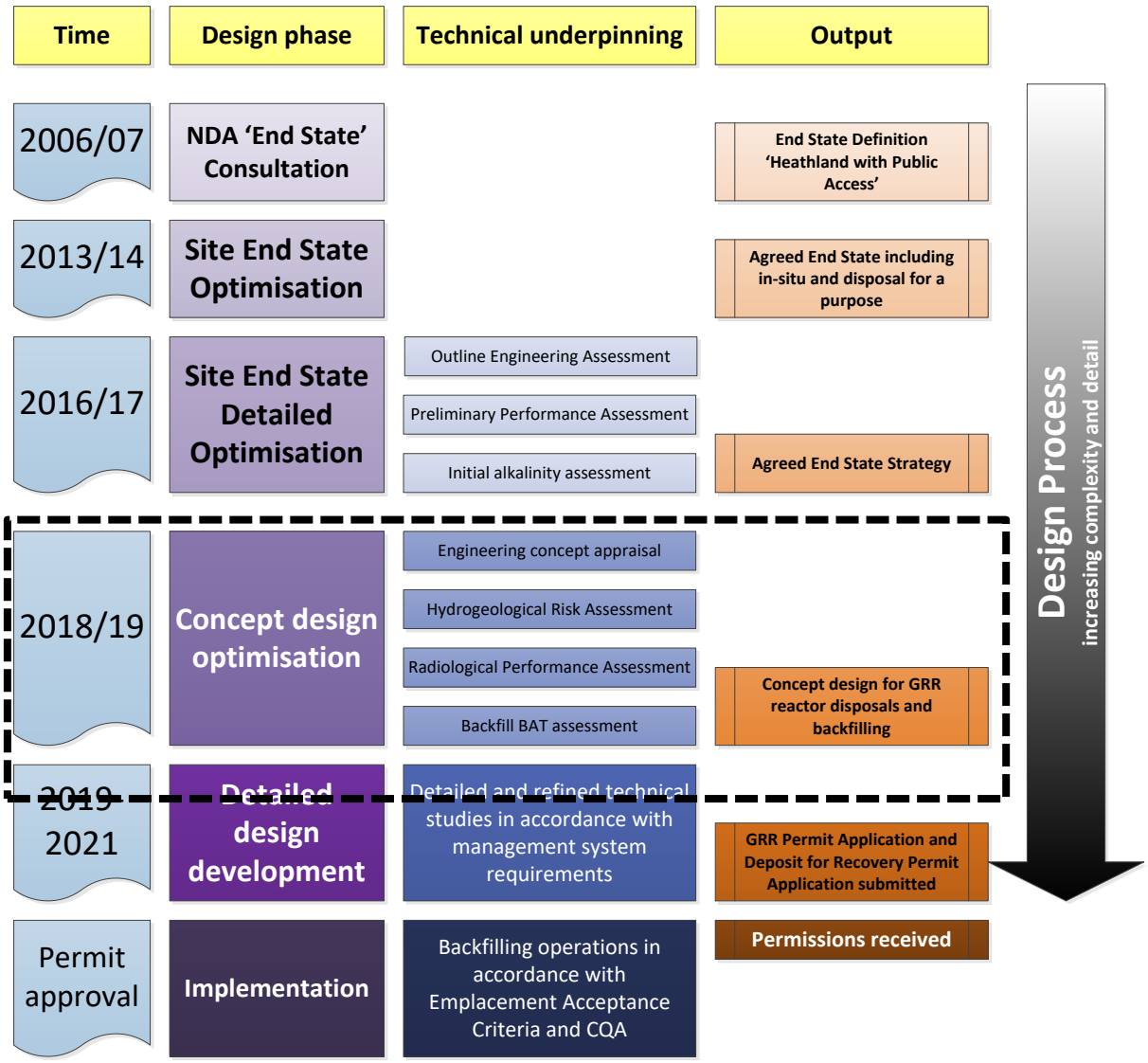
The agreed optimised End State to be delivered for the site includes:

1. All above ground structures (reactors, offices, other structures) to be demolished to around 1 m bgl to provide surface suitable for Heathland with Public Access;
2. SGHWR and Dragon sub-surface structures to remain in place as in-situ disposals of radioactive waste, identified as the optimised approach for site end state, subject to engineering safety and design requirements;
3. SGHWR and Dragon sub-surface voids will be prepared through localised cutting and reinforcing work and then backfilled with blocks at lower levels, to ensure subsidence is tolerable, with additional crushed material added to stabilise the structure and in-fill remaining small voids, thereby providing a safe final landform;
4. An engineered capping layer will be installed to minimise the likelihood of human intrusion and water ingress into the radioactive disposals (outside the scope of recovery operation);
5. Suitable, locally derived cap cover material will be placed over the engineered cap to allow for habitat development consistent with the planned heathland environment (outside the scope of recovery operation);
6. Appropriate below ground drainage will be installed, if required.

Design of the on-site disposals of radioactive waste, and any associated backfilling, has commenced. The design process requires a structured and phased approach, in accordance with the Magnox management system requirements, national and international standards, industry best practice and the GRR, to ensure compliance with Nuclear Site Licence conditions and requirements associated with the Environmental Permit.

FORMAL DRAFT - FOR DISCUSSION

Figure 5: Timeline for development of Winfrith site restoration proposals



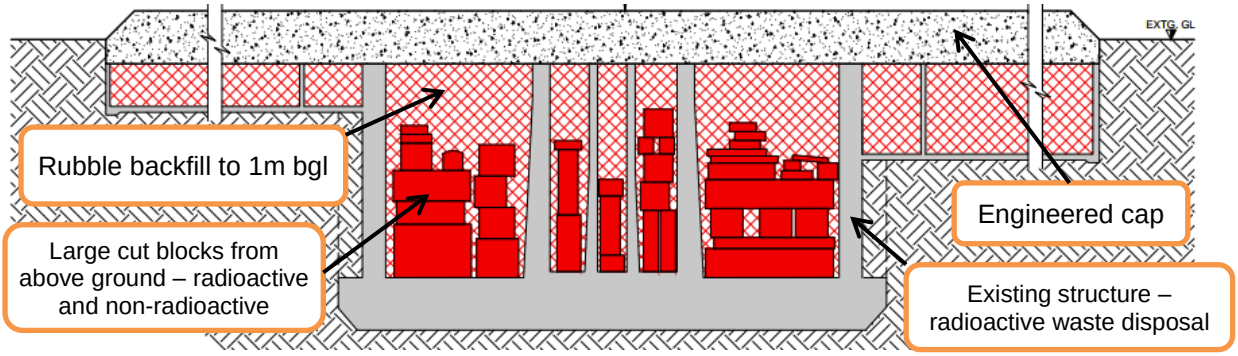
In developing the concept designs for the in-situ disposal of the structure (radioactive waste) and any backfill material (radioactive and 'out of scope' waste), the long-term safety and environmental performance is demonstrated through three core assessments:

- Engineering Concept Appraisal assessing a number of potential design options to determine whether they would meet engineering performance requirements, such as minimising the risk to workers from implementation and minimising the risk of later subsidence;
- Hydrogeological Risk Assessment (HRAw) determining the potential risk from non-radiological contaminants and pH associated with the in-situ disposal and use of backfill in the voids (assessments of current conditions and a number of climate change scenarios have been addressed and modelling shows that, under anticipated conditions, environmental compliance thresholds are met);
- Radiological Performance Assessment (PA) assessing the radiological content of the structures and potential radioactive backfill and modelling contaminant transport to assess potential risks and doses to humans and non-human biota in a variety of scenarios, including human intrusion, water abstraction, fishing and agricultural development.

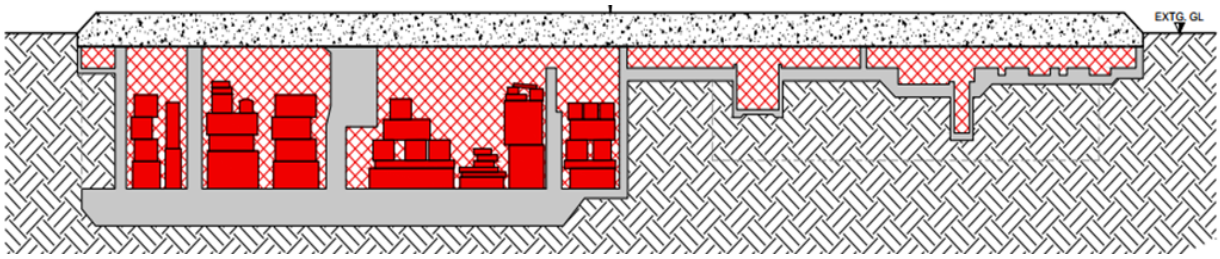
The conclusions and recommendations from these technical assessments inform the backfilling methodology and the limits and conditions on material retained in the voids and used for backfilling. Figure 6 shows an outline of the proposed end state for a reactor building, indicating proposed material type, physical condition and permission routes.

Figure 6: Outline diagram of SGHWR in-situ disposal, disposal for a purpose and deposit for recovery

View East through the facility basements



View South through the facility basements



Note that it is not proposed that backfill materials will be used above 1 m below current ground level; waste recovery therefore would not affect surface levels.

Detailed engineering diagrams of surface finish levels, relative to ordnance datum are provided separately to this document.

4.1 Backfill requirements from engineering design, HRA(w) and PA

The current Engineering Concept Designs, HRA(w) and PA have assessed the requirements for the backfill material against a range of criteria including Settlement, Processing options, Backfill sequence, Compaction requirements, leachate generation and Grouting.

The following conclusions have been drawn from the appraisal:

- Site derived block and crush material will meet engineering and performance requirements for use in backfilling both the SGHWR and Dragon sub-surface voids (FR1, FR7, FR8, FR10 and FR11);
- Settlement of the backfill using a combination of site-derived blocks and crush will not affect the performance of the cap, thus ensuring long term performance;
- Crushing of the demolition arisings, or use of imported engineered crush, is of little benefit to engineering performance and is likely to increase the risk of alkaline leachate being generated;
- Preliminary results of the hydrogeological risk assessment show that larger particles of concrete reduce the potential for generation of alkaline leachate. Therefore, as a principle, large blocks of site-derived concrete and larger particles of rubble are preferable to graded material;

- Grout may be required in some isolated locations to stabilise the structure during demolition or to fill voids not accessible for backfilling with crush. This requirement would apply whether using site-derived or imported material;
- Large scale grouting does not provide significant engineering benefits to offset the environmental impacts (e.g. transport, carbon footprint, etc).

Review of the backfill requirements shows that using a combination of site-derived blocks and crushed material has performance and engineering advantages over purchased or new material.

4.2 Demolition & backfilling methodology

Conventional demolition will be used for the Dragon and SGHWR reactor buildings, this methodology is significantly safer than the other proposed methods (dismantling, deconstruction) as it eliminates many of the hazards which are present in the other methodologies. Backfilling will be undertaken as suitable demolition material becomes available and this is therefore treated here as a single step. The methods will include:

- Existing below ground penetrations will be sealed prior to demolition and backfilling ;
- Where there are internal floors within the voids, the lower floors will be backfilled before demolition operations have the potential to cause a collapse. If necessary, internal floors may be removed prior to backfilling or demolition activities;
- Some internal walls may require being propped up until sufficient backfill is in place;
- Backfilling with blocks in the deeper parts of the building, followed by backfilling with suitable material to ensure structural stability of the disposal.

4.3 Capping the radioactive waste disposals

The capping of the in-situ disposals and disposals for a purpose is a requirement of the GRR; a suitable cap must be put in place to minimise and delay the entry of water into the disposal and reduce the likelihood of inadvertent human intrusion.

The final design of the cap will be determined, based on the outputs of the final Engineering Concept Appraisal, Hydrogeological Risk Assessment and the radiological Performance Assessment modelling at the detailed design stage.

The engineered cap will be covered with locally derived soil to profile the area in keeping local contours and to encourage habitat development. Site contouring design has yet to be finalised, however it will be consistent with local topography and outlined in the concept Landscape Masterplan (Appendix B).

4.4 Drainage and Surface Water Management

The engineering assessment identified that the performance of the Dragon and SGHWR End States are not sensitive to the choice of drainage solution used to drain the caps. The use of conventional, natural drainage solutions will require no long-term maintenance and will be incorporated into the wider site restoration water management design.

4.5 Suitably Qualified and Experienced Persons

The Nuclear Site Licence and Environmental Permit for Winfrith require all operations, design, assessment and delivery to be undertaken by Suitably Qualified and Experienced Persons (SQEP). The regulatory requirements are reflected in the Magnox management system, most notably through, Process Document (PD) 008: Control of Work, PD-012: Environmental Management and PD-018: Design and Modification and Company Standard S-035: Training and Competence Requirements.

SQEP specialist contractors have been engaged by Magnox to develop the technical assessments and design. Contractors have been selected based on their skills, knowledge and experience.

FORMAL DRAFT - FOR DISCUSSION

The designs and risk assessments have been prepared by a number of specialist contractors on behalf of Magnox, in accordance with national and international standards, with input from the EA (Wessex, NWAT, NRG), the ONR and key stakeholders to ensure they are suitable and sufficient.

The designs and technical assessments will contribute to a detailed design that develops the concept design to include details such as the demolition sequence, the load / weight capacity in key areas etc. The detailed design will be prepared by specialist contractors in accordance with relevant standards and the Magnox management system.

A Construction Quality Assurance Plan (CQAP) will be developed and submitted with the GRR and Deposit for Recovery Permit Applications. The CQAP will include details of how the structure and any backfill will be assessed for both radiological and non-radiological contamination, how the demolition and backfilling will be controlled and the appropriate standards for construction and capping.

5 MATERIAL BALANCE AND VOID VOLUMES

Summary:

The Winfrith site will produce a significant amount of concrete and brick from decommissioning and demolition and has some material stockpiled. The volumes have been assessed in the Site Wide Material Management Plan (SWMMP) (Ref.13).

The volumes of material available from site activities will exceed the void space that requires filling. Only the material required by the engineering design will be used to backfill the voids. Surplus material will be managed in accordance with the waste hierarchy.

The table below shows that the combined void space associated with SGHWR and Dragon structures is estimated to be 35,000 m^3. When taking into account the material contained within the existing on-site stockpiles and material arising from future demolitions there will be a surplus of material available on-site. The surplus material will be managed under the Site Wide Materials Management Plan (SWMMP) (Ref.14) and in accordance with Magnox company arrangements for off-site waste disposal (Ref.15).

Table 1: Below ground void volumes SGHWR and Dragon

Location	Description	Approximate void volume (m^3)	Min. depth of void (m below ground level (m bgl))	Max. depth of void (m bgl)
SGHWR	Includes the Reactor Hall, Turbine Hall, North Annex and South Annex	28,000	4	10.7
Dragon	Including the Reactor Building, Service Duct and Vehicle Airlock	7,000	7	7.6
TOTAL		35,000		

Source: Winfrith Material Balance and Cost Estimates *(Ref. 16)*Figures rounded to the nearest thousand.

Previous demolition works on site have led to the production of stockpiled demolition material; these stockpiles are currently stored and managed to the south east of the SGHWR complex. The current volume of waste retained within these stockpiles is estimated to be 22,000 m^3(35,200 t approx.)

Table 2: Stockpiled Material Estimates

Stockpile ID	Type(s) of material	Bulked volume (m^3)	Weight (t)*	Available for reuse?
D6 Rubble Stockpile North	Crushed concrete and brick.	2,000	3,200	Yes
D6 Rubble Stockpile South	Crushed concrete and brick	15,000	24,000	Yes
A51 and A52 Demolition Rubble Stockpile	Crushed concrete and brick	4,000	6,400	Yes
SGHWR Cooling Tower Basin Rubble Stockpile	Crushed concrete	1,000	1,600	Yes
TOTAL		22,000	35,200	

Source : Winfrith Site Wide Material Management Plan (Ref.13). The 'bulked volume' does not assess volumes retained as blocks Figures rounded *to the nearest thousand. * based on 1,600 kg per m^3 rubble*

In addition to the existing stockpiled material, future demolition works of the SGHWR and Dragon reactor buildings and structures will generate further demolition material. The combined material volume to be produced is estimated to be 23,000 m^3.

Table 3: Future demolition arisings to be generated from SGHWR and Dragon

Source ID	Description	In-situ concrete volume (m^3)	Weight (t)*	Bulked volume (m^3)	Available for reuse?
SGHWR Reactor Complex – above ground	Includes the Reactor Hall, Turbine Hall, North Annex and South Annex	11,000	26,400	15,000	Yes
Dragon Reactor Complex – above ground	Includes the Reactor Building, B71 and B78	5,000	12,000	7,000	Yes
TOTAL		16,000	38,400	23,000	

*Source: Winfrith void and Backfill Estimates (Ref. 16). Figures rounded to the nearest thousand*based on 2400 kg per m3 of in-situ concrete*

The backfilling of the voids will be achieved using the minimum amount of material required to remain compliant with the final Engineering Appraisal. Settlement calculations carried out as part of the HRA(w) (Ref.17) have indicated that there is no significant benefit to be gained from the compaction of the material. The material used in backfilling will therefore not be compacted, therefore minimising the volume of material used. Compaction of the backfill would lead to an estimated increase of material required for filling voids in the region of 10,000 m^3.

The voids will only be backfilled to 1 m bgl, in accordance with the Engineering Concept Designs, and therefore will not influence the final site landscaping and site contours. Final contours will be determined through the detailed design of the cap and cap cover specification.

5.1 Management of surplus / unsuitable waste or material

Material to be used in backfilling voids will be assessed to demonstrate it meets the Emplacement Acceptance Criteria (EAC), prior to being used to backfill voids. Any material that does not meet the EAC will be disposed off-site in accordance with the company management procedure for waste (Ref. 18).

Surplus material from the existing stockpiles, demolition works, landscaping activities will also be disposed off-site waste in accordance with the waste hierarchy and the company management procedure for waste, as defined in the Site Wide Material Management Plan (Ref. 14). As with all waste management operations, the waste hierarchy and proximity principle will be considered when identifying off-site disposal routes.

6 WASTE MATERIAL DIRECTLY REPLACES A NON-WASTE

Summary:

The Winfrith site must be decommissioned to meet obligations on the NDA and Magnox under the Energy Act and Nuclear Site Licence.

The Winfrith site is a priority project for the NDA as part of its mission to demonstrate the completion of decommissioning of nuclear sites. The Winfrith site decommissioning programme has also been a key driver for BEIS to update the nuclear regulatory controls. The Waste Local Plan also supports the completion of decommissioning and Site Restoration.

The below ground concrete structures at SGHWR and Dragon are to be retained in accordance with the findings of the assessments completed under the requirements of the site Environmental Permit. Retaining the below ground structures at SGHWR and Dragon requires filling the large below ground voids, to deliver a safe and stable surface suitable for 'Heathland with public access'.

Completing the NDA decommissioning mission, delivering Heathland with Public and Access and backfilling of the voids must take place regardless whether it is using site-derived waste or imported material that meets the constraints of the engineering designs.

6.1 Funding

Magnox is funded by the NDA, who in turn are funded by BEIS. The annual funding for the NDA programme is set each year by the Department for Business, Energy and Industrial Strategy and HM treasury, and is a combination of government funding and income from the NDA commercial assets. As part of this budget, Magnox Ltd as a wholly owned subsidiary of the NDA is allocated a portion of the funding. This funding is based on the proposed decommissioning programme, that as a minimum must meet legal requirements and support the NDA mission.

The NDA and Government view Winfrith decommissioning and site restoration as a critical infrastructure project to demonstrate UK capability in nuclear decommissioning and proportionate regulation of nuclear sites in the final stages of decommissioning. The importance of the Winfrith decommissioning programme has been identified in a number of BEIS consultations (Ref.5, Ref.6).

The costs of the Winfrith Decommissioning Programme are detailed in a Life Time Plan approved by the NDA. The Lifetime Plan also includes contingency costs to cover identified risks. The potential risk of additional costs associated with using a non-waste material are included in the Lifetime Plan. In the event that funding were required for removal of site derived material and import of new non-waste material, Magnox would apply to the NDA to access the contingency funding by preparing a business case in accordance with the NDA Strategy Management System and HM Treasury Green Book.

As a critical demonstration project for the NDA and BEIS, it is anticipated that the required additional funds would be made available due to the importance of achieving Winfrith Site End state and restoration in compliance with the overall NDA mission to return there sites to their next planned use.

6.2 Local Waste Policy

The Dorset Local Waste Plan (Ref. 13) recognises the importance of restoration of the Winfrith site to the local community. The recovery of site-derived material is supported within

the Waste Plan to aid in delivering sustainable site restoration, application of the waste hierarchy and can the activity can be demonstrated as safe.

The policies in relation to the Winfrith site emphasise the importance of the site restoration. If necessary, imported material could be used in place of site-derived material to support site restoration activities, although it would not be consistent with the waste hierarchy.

The policies within the Dorset Local Waste Plan in relation to site restoration supports the case for securing the additional funding, should it be required, for the use of non-waste material if the use of waste were not permitted.

6.3 Material to be used in Backfilling

The engineering appraisal and concept designs (Ref.19) out the functional requirements for materials to be used in backfilling operations to ensure later subsidence is avoided and provide a surface suitable for the next planned land use.

Emplacement Acceptance Criteria (EAC) have been established for the voids (Ref. 19) that set out the intended acceptance criteria which backfill material must meet. The EAC will be updated as the site specific risk assessments are completed.

Detailed assessments have shown that recovery of site-derived material will meet both the functional specification and EAC. Imported material that meets the engineering functional requirements and the EAC could replace site-derived material in backfilling voids, if required.

If the recovery and reuse of historical and future site-won demolition arisings are not permitted then the operation would be completed in the same manner but would require the importation of approximately 35,000 m^3 of virgin material to be placed into the SGHWR and Dragon voids and associated export of demolition arisings. Imported material would be assessed to demonstrate it meets the engineering requirements and EAC.

7 GENERAL OBLIGATIONS

Summary:

General obligations to undertake decommissioning, site restoration and the backfilling of voids are identified from a number of sources:

- The Energy Act 2004 and NDA Strategy place an obligation on Magnox to decommission the site and deliver the agreed end state;
- The Nuclear Installations Act, and associated Site Licence Conditions requires Magnox to undertake decommissioning;
- Health and Safety legislation and obligations on construction projects require decommissioning in the safest manner achievable. Retaining sub-surface structures as waste disposals minimises operations, working hours and risk. Recovery of site-derived material also minimises worker risk;
- The Dorset Local Waste Plan supports the optimised approach to decommissioning, including on-site radioactive waste disposals at the SGHWR and Dragon and recovery of site derived wastes to backfill voids to deliver sustainable site restoration and complete the NDA mission at Winfrith;
- The decommissioning approach demonstrates application of the waste hierarchy and the proximity principle as part of maximising the environmental benefits of the work and ensuring that there are no unacceptable adverse impacts;
- Site restoration activities will deliver biodiversity net gain;
- Use of site-derived materials will minimise overall impact in delivering the IES;
- The NDA and Magnox, as wholly owned Government subsidiaries, are required to support the Governments 25 year environmental targets. Decommissioning, site restoration and reuse of site derived material supports a number of these targets;
- Magnox and the NDA are financially accountable to the Government and required to deliver value for money to the taxpayer. Use of site-won material is the most cost-effective manner to support site closure as well as minimising environmental impacts.

Stakeholder engagement, technical studies and engineering design process that have identified that the best approach to delivering Heathland with Public access is through in-site disposal and backfilling large voids with site-derived material to provide an inherently safe End State that will maximise biodiversity gain, whilst minimising risk to workers and the public and impacts on the environment.

7.1 The Energy Act 2004 and NDA Strategy

The Energy Act (2004) established the Nuclear Decommissioning Authority (NDA) as a Non-Departmental Public Body. The Energy Act places a legal duty on the NDA, and its subsidiaries, to complete decommissioning of legacy nuclear facilities safely, securely, cost effectively and in ways that protect people and the environment. The ultimate mission for the NDA is to complete decommissioning of all of its sites and deliver the Site End States.

The Energy Act also requires the NDA to review and publish its strategy for decommissioning management to meet the agreed Site End States every 5 years. The NDA's current strategy is to maximise the progressive and cost effective reduction of risks and hazards at their sites to make them suitable for their next planned use. In the case of Winfrith, this represents the Site achieving its defined End State.

The NDA strategy directly supports the retention of sub-surface structures and reuse of materials on-site, where it supports achieving decommissioning objectives. Key details from the 2016 NDA strategy relating to Site Interim End States can be seen in Appendix I and the following extract should also be noted:

> *"Our mission will be complete when we release our designated sites for other uses. We aim to complete this mission as soon as reasonably practicable with a progressive reduction of risk and hazard.*
>
> *Defining the objective of decommissioning and remediation requires a site-specific assessment of the benefits and detriments of clean up. This recognises that, in some cases, removing all traces of a site's industrial use will do more harm than good.*
>
> *Furthermore we believe that there are opportunities for the beneficial reuse of waste on site, for example, using decommissioning rubble for landscaping and void filling. In these cases, it is our strategic preference to undertake enough remediation to enable the beneficial reuse of a site. Accordingly, our strategy is to be proactive in promoting beneficial reuse of our sites."*

Decommissioning and site restoration including in-situ disposal of below ground structures and backfilling to create a surface suitable for 'Heathland with Public Access' at Winfrith meets the NDA obligations to deliver the site decommissioning and site restoration and is consistent with NDA strategy.

As a critical demonstration project for the NDA mission, there is a high-level commitment to both decommissioning and to site restoration. Should the use of site-derived waste not be permitted, the use of a non-waste material for backfilling the voids would be required to satisfy site restoration and end use criteria.

Key details form the 2016 NDA strategy relating to Site Interim End States can be seen in Appendix I.

7.2 Nuclear Installations Act and associated Site Licence Conditions

The Winfrith site operates under a Nuclear Site Licence, granted by the Office for Nuclear Regulation, under the Nuclear Installations Act 1965 (as amended). The Site Licence Conditions require operators to undertake planning and control for operations, including decommissioning to ensure the safety and security of staff and members of the public. The licence condition relevant to the obligation to undertake decommissioning of the site is Licence Condition 35, and specifically clauses:

- '1. *The Licensee will make and implement adequate arrangements for the decommissioning of any plant of process which may affect safety.*' This places a statutory duty on operators to undertake decommissioning.
- '2. *The Licensee shall make arrangements for the production and implementation of decommissioning programmes for each plant*.' This requires operators to document the decommissioning plans for the plant and site. Subsequent conditions can allow the regulator to inspect plans, and requires the operator to seek approval for any alternations to the plans.

Other licence conditions (13, 14, 15, 19, 26 and 36) require licensees to undertake operations in a manner that reduces safety risk to operators and members of the public. This requirement includes how operations (including decommissioning) are designed and implemented.

The Licence conditions are a legal obligation on Magnox to undertake decommissioning in the safest manner possible. The optimisation process assessed the operator and public safety of each of the options for decommissioning and restoration. Leaving the sub-surface structures in-situ (in-situ disposal and using site-derived material in backfilling) is the safest operation as it minimises worker operations and transport of waste, therefore minimising hazards from decommissioning and restoration.

The preferred end state for the site (in-situ disposal of the structures and backfilling with site-derived material) has been incorporated into the decommissioning plan for the site under LC35.

7.2.1 Health and Safety

The principles of prevention given in the Construction (Design and Management) (CDM) Regulations (2015) require designers to eliminate hazards from their design where it is reasonably practicable to do so. Magnox is subject to obligations under these regulations to eliminate foreseeable health and safety risks to anyone who may be affected by the project and to take steps to reduce or control any risks that cannot be eliminated.

Health and Safety obligations were assessed through the optimisation process and in developing the Engineering Concept Designs. In-situ disposals of the sub-surface structures, conventional demolition techniques and infilling the below ground voids with suitable site-won waste material at SGHWR and Dragon significantly reduces the overall risk to operatives and members of the public by:

- Reducing the volume of traffic associated with the transport of waste and material to fill voids left by removal of sub-surface structures
- Reducing the risk of accidents to workers while excavating waste
- Reducing to a minimum the time spent by operatives working in high hazard activities / areas.
- Minimising excavation areas
- Reducing the need to double handle waste materials associated with the demolition process
- Reducing the hazards associated with the creation of large below ground voids by the application of the backfilling process

7.3 Requirements from the Environmental Permit and GRR

The Site operates under an Environmental Permit (EPR/PB3898DC) which requires Magnox to use the Best Available Techniques (BAT) to minimise the production and disposal of radioactive waste, the quantity of waste disposed of and impacts on members of the public and the environment.

The EA's GRR have been incorporated into Site Environmental Permits and Magnox must also comply with the requirements when defining decommissioning and waste management plans, specifically requirements to:

- Ensure the application of optimisation when managing radioactive waste from decommissioning and clean-up at their sites;
- Minimise environmental effects through the effective application of the waste hierarchy;
- Use resources effectively and efficiently.

Under the Permit requirements, Magnox has optimised the Winfrith End State, in accordance with the requirements of the GRR including input from local stakeholders and regulators.

The optimised End State requires retaining the large sub-surface structures at SGHWR and Dragon as in-situ disposals of radioactive waste as it is the most sustainable option. The optimised end state strategy of in-situ disposals necessitates backfilling of remaining void space to allow for restoration to 'heathland with public access' and to ensure the site is brought to a condition at which it can be released from RSR. Magnox has identified that Best Available Technique (BAT) approach to backfilling voids is through use of site-derived material as it offers numerous performance benefits, in comparison to imported material, and minimises impact on local communities and carbon footprint.

7.4 Planning obligations

An application for planning permission to demolish the SGHWR and Dragon reactor building structures, complete in-situ disposal of radioactive waste and undertake site restoration works will be made to Dorset Council in parallel with required Environmental Permit applications.

Section 11 of the Dorset Council Adopted Waste Plan (Ref.20) specifically to Winfrith and sub sections 11.39 and 11.40 (see below) in particular commit to minimising the amount of waste requiring off-site disposal through recovery on-site.

> ***11.39*** *The Waste Plan is committed to moving waste up the waste hierarchy in accordance with national policy for radioactive waste management. This involves minimising the amount of waste that needs to be disposed of, including LLW that is capable of recovery in the first instance. Any residual waste that requires disposal should, where it is practicable to do so, adhere to the waste hierarchy and proximity principle. In this respect Magnox has set out its intention in its programme of works to consider where necessary the retention in-situ of certain sub-surface structures where disturbance would not deliver any practical environmental benefits. This may also include the back-filling of some sub-surface voids with waste arising on site.*
>
> ***11.40*** *In-situ retention and on-site recovery or disposal of waste could help to support the overarching waste management principles of the Plan, but should not compromise the restoration of the site to a condition to achieve IES or FES. The disposal of waste arising from the decommissioning of Winfrith on site should be restoration-led, enabling the land to be used more effectively for another use, and should use the minimum amount of waste to achieve the stated purpose. Consequently, waste that is not classified as inert would be expected to be managed off-site at a suitable licensed facility where this is the most practicable way of achieving IES or FES, unless recovery or disposal on site is demonstrated to support the waste hierarchy and proximity principle; it would not compromise the intended site restoration and after use and would not lead to unacceptable adverse impacts on the environment and amenity.*

The Waste Plan supports both in-situ disposal of radioactive waste and the recovery of Out of Scope inert waste material on site to be used for infilling of sub-surface voids. This is reflected in Policy 10A as illustrated below.

Policy 10 Decommissioning and Restoration of Winfrith Nuclear Licensed Site (Ref.13)

> *The Waste Planning Authority will work constructively with the site license holder, the Local planning authority, statutory regulatory bodies and the local community to support the decommissioning of the former Winfrith nuclear research and development facility and restoration to open heathland with public access. In determining planning applications for waste management development at the former Winfrith nuclear research and development facility, the Waste Planning Authority will have regard of the following.*
>
> *a) The on-site recovery or disposal of waste originating from the decommissioning of the Winfrith facility will be permitted where it would demonstrably support the sites restoration to open heathland with public access, be in conformity with the waste hierarchy and the proximity principle and would not cause unacceptable adverse impacts on the environment and amenity.*

Given the proposed scheme for waste disposals and site restoration, an Environmental Impact Assessment and Habitats Regulations Assessment are required. A scoping report (Ref. 8) has been submitted detailing the likely scope of the EIA and a Scoping Opinion (Ref. 9) received in response.

7.5 Biodiversity, habitat and ecology net gain

The design process reviewed the potential impacts on nearby protected habitats (SSSI, SAC, SPA) for the available End State options. The preferred approach of in-situ disposal of the below ground structures at SGHWR and Dragon does not require large-scale excavation of the building footprint, and therefore has less potential to impact on the surrounding protected habitats. The alternative option (full excavation of building footprint) would create significant disruption through extensive excavations, noise and dust generation, on-site

management of the excavated materials, transport and disposal elsewhere of the waste arisings.

The potential biodiversity net gain from undertaking restoration of the Winfrith site will be quantified through the Environmental Impact Assessment process in accordance with the requirements of Dorset Council (Ref. 20) and the Natural England biodiversity metric (Ref. 21) once habitat surveys have been completed and the proposed ecological restoration measures have been defined.

At this early stage it is possible to define that the environmental benefits will include an increase in land area available for habitat of around 15-20 ha (18% approx.) through removal of building slabs, roads and car parks on the site.

Although not currently quantified, biodiversity net gain can be anticipated through:

- Enhancement of the condition of the more developed areas of the site through removal of artificial drainage and reinstatement of a more natural hydrograph (i.e. moving land areas from poor to moderate, or from moderate to good condition);
- Benefits in the zone of influence, most notably through holding and slowing water on-site to reduce rate of discharge to the River Frome to the north of the site;
- Greater landscape and ecological connectivity with neighbouring heathlands to the east and west of the site, through eventual removal of the fence, supporting coherent ecological networks across the characteristic heathland habitat.

A possible final site configuration, including the backfilled SGHWR and Dragon reactor voids is outlined in Appendix V from the Concept Landscape Masterplan. The concept landscape masterplan has defined the site layout after completion of decommissioning and implementation of the IES, including proposed disposals at the SGHWR and Dragon reactor, with minimal local profiling and surface cover providing a landscape in keeping with local surroundings and capable of delivering mosaic heathland habitats. The Concept Landscape Masterplan has been reviewed by local stakeholders. Comments from stakeholders are being incorporated to develop a Restoration Management Plan that will develop the design further and provide details of how habitats will be managed to encourage biodiversity.

Magnox have selected a preferred End State that minimises impact on protected habitats during the implementation stage, whilst delivering biodiversity net gain as part of site restoration.

7.6 UK Government 25 year Environmental Targets

The UK Government has made a number of commitments under the 25 year Environment Plan to support core sustainability targets. As a non-departmental Government body, the NDA has obligations to fulfil Government Policies. As a wholly owned subsidiary of the NDA, Magnox supports delivery of these policies and commitments.

Key policies relevant to Winfrith include:

- Using and managing land sustainably – decommissioning and site restoration will allow release of land that has previously been unavailable, supporting local environmental enhancement and demonstrating biodiversity net gain;
- Recovering nature and enhancing landscapes – decommissioning and site restoration will reinstate the landscape character at the Winfrith site and enhance the area and quality of biodiversity;
- Connecting people with the environment – the next planned use is heathland with public access with amenity value;
- Increasing resource efficiency – in-situ disposal of below ground structures and recovery of site derived material minimises the requirement for the use of new materials in backfilling thereby minimising the use of resources and energy;

- Reducing pollution – retaining the below ground structures and backfilling with site derived material minimises pollution from transport and greenhouse gas emissions.

The decommissioning of the site, including in-situ disposal of below ground structures and backfilling using site derived material and the eventual delivery of the next planned use for the site directly supports Government and company sustainability objectives through:

- Minimising disruption to protected habitats and impact on local communities through minimising excavations;
- Minimising road transports and carbon footprint by minimising off-site waste disposals and import of new materials (approximately 2000 road moves avoided);
- Increasing biodiversity, habitat connectivity and amenity value through delivery of the next planned land use.

7.7 Value for Money to UK taxpayer

A key principal of the NDA strategy requires the use of cost effective working practices whilst reducing the risks associated with sites, to enable a site's next planned use.

The recovery and re-use of site-won material provides a significant cost saving when compared with exporting site derived demolition arisings and importation of new infill material. If imported material were required to support site restoration, Magnox would require additional funds from BEIS via the NDA. Although it is likely that this additional funding would be available if required, the recovery and re-use of site-derived material is considered to be most in keeping with the NDA's commitment in terms cost effective and sustainable working practices. The costs associated with both re-use and export / import have been estimated in Table 4.

Table 4: Summary of costs comparison for imported material and site won material

Location	Cost associated with imported material (£)	Cost associated with site won material (£)	Cost saving from use of site won material
SGHWR	2,240,000	910,000	£1,290,000
DRAGON	780,000	431,000	£332,000
Rubble stockpile	2,180,000	1,519,000	£621,000
Surplus material Disposal	N/A	325,000	-£325,000
Total	5,200,000	3,185,00	**£2,015,000**

NOTE: the above estimates are based on the use of large concrete sections within the reactor voids for site won materials (that includes significant health and safety and long term environmental benefits). Imported material is assumed to be crush aggregate, which is widely available. Cost estimates include waste disposal, characterisation (both site won and imported), labour, machinery, transport. export and disposal costs included within estimates

Full cost breakdowns and underpinning assumptions are provided in Appendix G.

7.8 Financial net gain

The Winfrith site is owned by the NDA, a subsidiary of the UK government. Once the site has been decommissioned and restored to Heathland with public access, there is no near-term intention to sell the land associated. The land will continue to be permitted as a radioactive waste disposal site for a period of several decades while validation monitoring is undertaken.

The original purchase of the land for the majority of site (circa 1956) was subject to compulsory purchase, therefore, once the Permit has been surrendered the majority of the land is likely to be offered back to the original landowner under the Crichel Down rules. Any proceeds from a sale of land will be returned to the Government.

As the site currently has several designated and protected habitats, and the decommissioning and restoration will encourage habitat reinstatement, it is unlikely the land will have any significant financial value at the point it is released to the original landowner. There would therefore be no financial net gain, whether waste or non-waste is used for backfilling of the voids.

8 CONCLUSION

The main aim of Magnox and the NDA is to safely and cost effectively reduce the risks associated with Winfrith Site to a level that satisfies all regulatory conditions and meets the requirement of the agreed site End State of "open heathland with unrestricted public access".

The Winfrith site End State has been determined by the NDA through stakeholder engagement. Delivering the End State will allow the Site to be released from nuclear regulatory controls and to achieve its next planned use. Winfrith will be the first Magnox site to be closed and achieve full site restoration.

The site will seek to recover 35,000 m^3 Out of Scope demolition arisings (EWC 17-01-01,17 01 02, 17 01 03, 17 01 07 ,) produced on the site to support backfilling reactor voids to 1 m bgl, in accordance with the engineering designs. This will allow full site restoration and will achieve the End State for the site of 'Heathland with public access.'

The need to undertake a Deposit for Recovery operation arises from:

- The legal duty to complete decommissioning is identified in the Nuclear Installations Act 1965 (as amended), under Site Licence Condition 35, and the NDA responsibility to decommission legacy sites under the Energy Act 2004;
- The requirement to apply the optimised approach to waste management in the final stages of decommissioning is implemented through the site Environmental Permit, in accordance with the EA's GRR;
- The requirement to retain below ground structures at SGHWR and Dragon has been demonstrated as the optimised approach under the GRR for the Site; it poses the lowest Health and Safety risk to workers and meets the expectations of the Dorset Council Waste Plan and local planning policies;
- The need to backfill the voids is established through the NDA's duty and mission to define and deliver the End States for legacy nuclear sites in consultation with local stakeholders. For Winfrith, consultation identified the End State of 'Heathland with Public access', necessitating the backfilling of voids optimised under GRR to provide a suitable surface finish for the defined End State.
- Backfilling voids will also support delivery of biodiversity net gain as part of the wider site restoration.

If the re-use of site-derived waste as a DfR were not permitted, then the work will be completed in the same way using a non-waste material. This will entail increased environmental impacts at the Winfrith site and elsewhere as a result of the need to transport and dispose of the material that would otherwise have been used to backfill the below ground voids. There will also be increased costs and increased risks to workers and the public. No benefits to using non-waste materials for backfilling have been identified.

This waste recovery plan demonstrates that:

- There is an obligation to undertake the backfilling operation as part of Site Restoration to meet the requirements of the Winfrith End State and the NDA Strategy and obligations under the Energy Act 2004 and to deliver the optimised End State under the EA's GRR;
- The waste to be used in backfilling voids will meet the Engineering Functional Requirements and Acceptance criteria for the voids that have been developed based on technical assessments;
- Only the amount of material required by the Engineering Concept Designs, to fill the voids to 1 m bgl, will be used, with any potential excess material being disposed as waste;

- The proposed approach to site restoration as a whole offers significant environmental and ecological enhancement including Biodiversity Net Gain;
- The same operation would be completed with a non-waste material if the use of site-derived waste was not permitted, although the optimised end state strategy would need to be reviewed with stakeholders and additional engineering would potentially be required;
- The identified use of waste in backfilling voids is consistent with local planning policy;
- The use of site won material will result in significant cost saving to government;
- The proposed recovery operation will be adequately assessed and managed through the permit application process, Environmental Impact Assessment, a Construction Quality Assurance Plan and site controls.

9 REFERENCES

1 Management of radioactive waste from decommissioning of nuclear sites: Guidance on Requirements for Release from Radioactive Substances Regulation, July 2018

2 MAGIC website 1 accessed on 26/02/2018.

3 Concept Landscape Masterplan: Winfrith Nuclear Site. Arcadis. September 2017.

4 Defining the Winfrith End State. Issue 1. ES(13)P015. 29/08/2013

5 Winfrith Interim End State Stage B Strategy paper. ES(17) P154. Issue 2. January 2018.

6 BEIS Discussion paper on: Regulation of nuclear sites in the final stages of decommissioning and clean up. November 2016. https://www.gov.uk/government/consultations/the-regulation-of-nuclear-sites-in-the-final-stages-of-decommissioning-and-clean-up

7 BEIS Consultation response Impact Assessment. May 2018. https://www.gov.uk/government/consultations/the-regulation-of-nuclear-sites-in-the-final-stages-of-decommissioning-and-clean-up

8 Management of radioactive waste from decommissioning of nuclear sites: Guidance on Requirements for Release from Radioactive Substances Regulation. Version 1. July 2018.

9 Company Management System. Design and Modifications. Process Document PD-018. Issue 2. 2017.

10 Winfrith Decommissioning EIA Scoping Report. Planning Application PL\2398\19\SO. February 2019.

11 Magnox Winfrith Scoping Opinion of Dorset Council, Main Site restoration 17/04/2019. https://plan.dorsetcc.gov.uk/Planning/Display?applicationNumber=PL%5C2398%5C19%5CSO

12 Winfrith main Site Restoration Habitat Regulation Assessment (HRA) February 2019. https://plan.dorsetcc.gov.uk/Planning/Display?applicationNumber=PL%5C2398%5C19%5CSO

13 Bournemouth, Christchurch, Poole and Dorset Waste Plan. December 2019. https://www.dorsetcouncil.gov.uk/planning-buildings-land/planning-policy/dorset-county-council/waste-planning-policy/new-waste-plan.aspx

14 Site Wide Materials Management Plan (SWMMP). ES(19)P324. Issue 2. September 2020.

15 Company Management System. Process Document PD-026: Waste Management. Issue 7. 2018

16 Winfrith Material Balance and Cost Estimates ES(19)SS05 ISSUE 1 January 2020

17 Winfrith Hydrogeological Risk Assessment Scoping Report ISSUE 3. 17.12.2018

18 Company Management System. Process Document PD-026: Waste Management. Issue 7. 2018.

19 Emplacement Acceptance Criteria. ES(18)P191. Issue 1. February 2018

20 Dorset Council: Dorset Biodiversity Appraisal Protocol and Dorset Biodiversity Compensation Framework. PL/EN/3. https://www.dorsetcouncil.gov.uk/countryside-coast-parks/countrysidemanagement/biodiversity/biodiversity-appraisal-in-dorset.aspx

21 Natural England. The Biodiversity Metric 2.0 (JP029). July 2019. http://publications.naturalengland.org.uk/publication/5850908674228224

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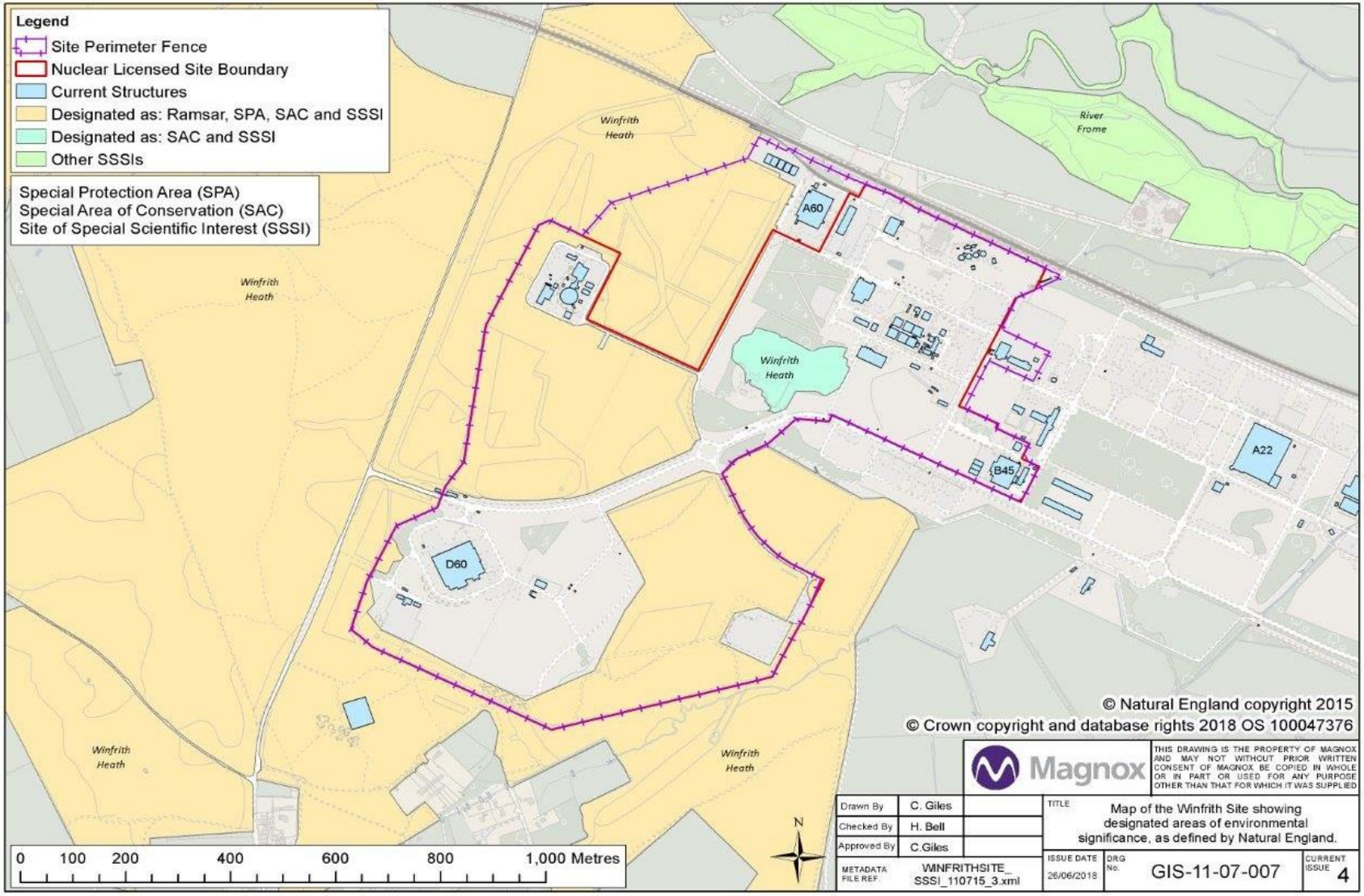
Appendix A: Site map showing areas of environmental significance



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Appendix B: Map of proposed Interim End State highlighting site restoration proposals

FORMAL DRAFT - FOR DISCUSSION

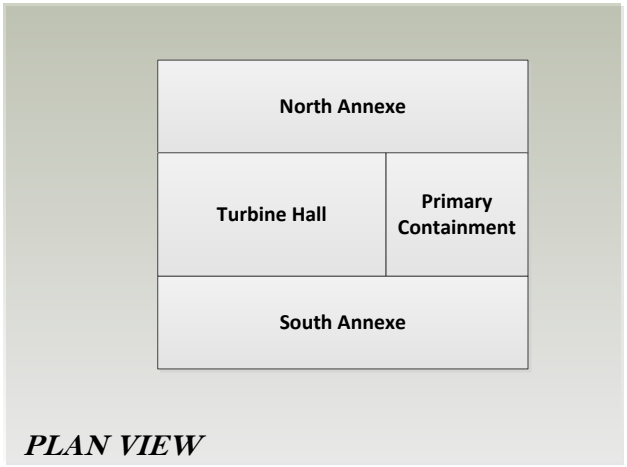
Appendix C: SGHWR below ground void dimensions

Above Ground Structure

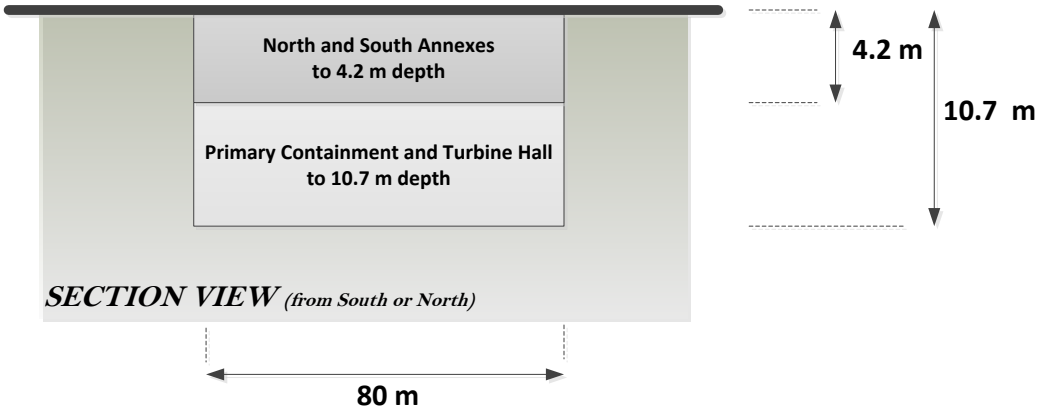
Below Ground Void

SGHWR Below Ground Void Dimensions:

Width, Depth and Volume



Total SGHWR below ground void volume = 28,100 m3



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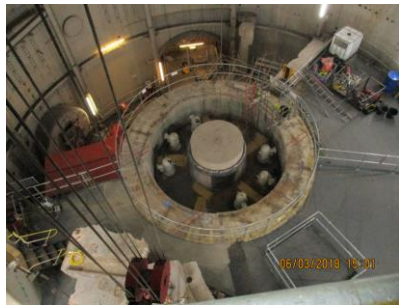
Appendix D: Dragon below ground void dimensions

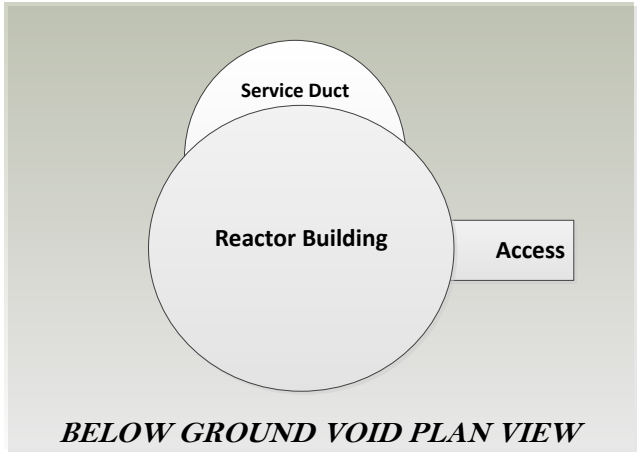
Above Ground Structure



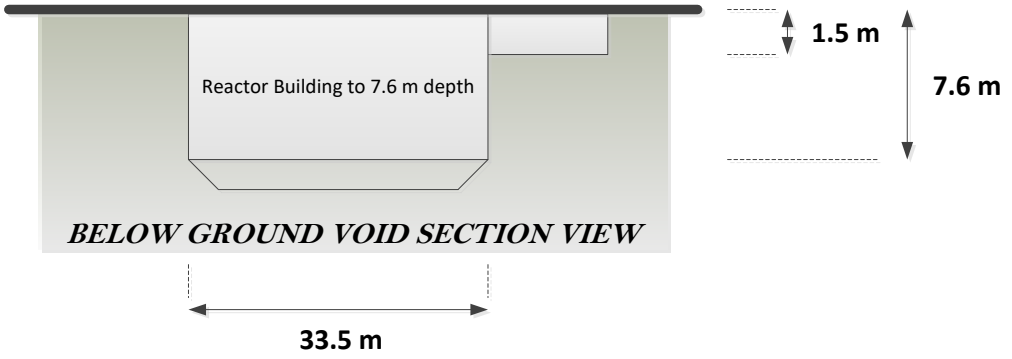
Below Ground Void

Dragon Reactor Below Ground Void Dimensions:

Width, Depth and Volume



Total Dragon Reactor below ground void volume = 6544 m3



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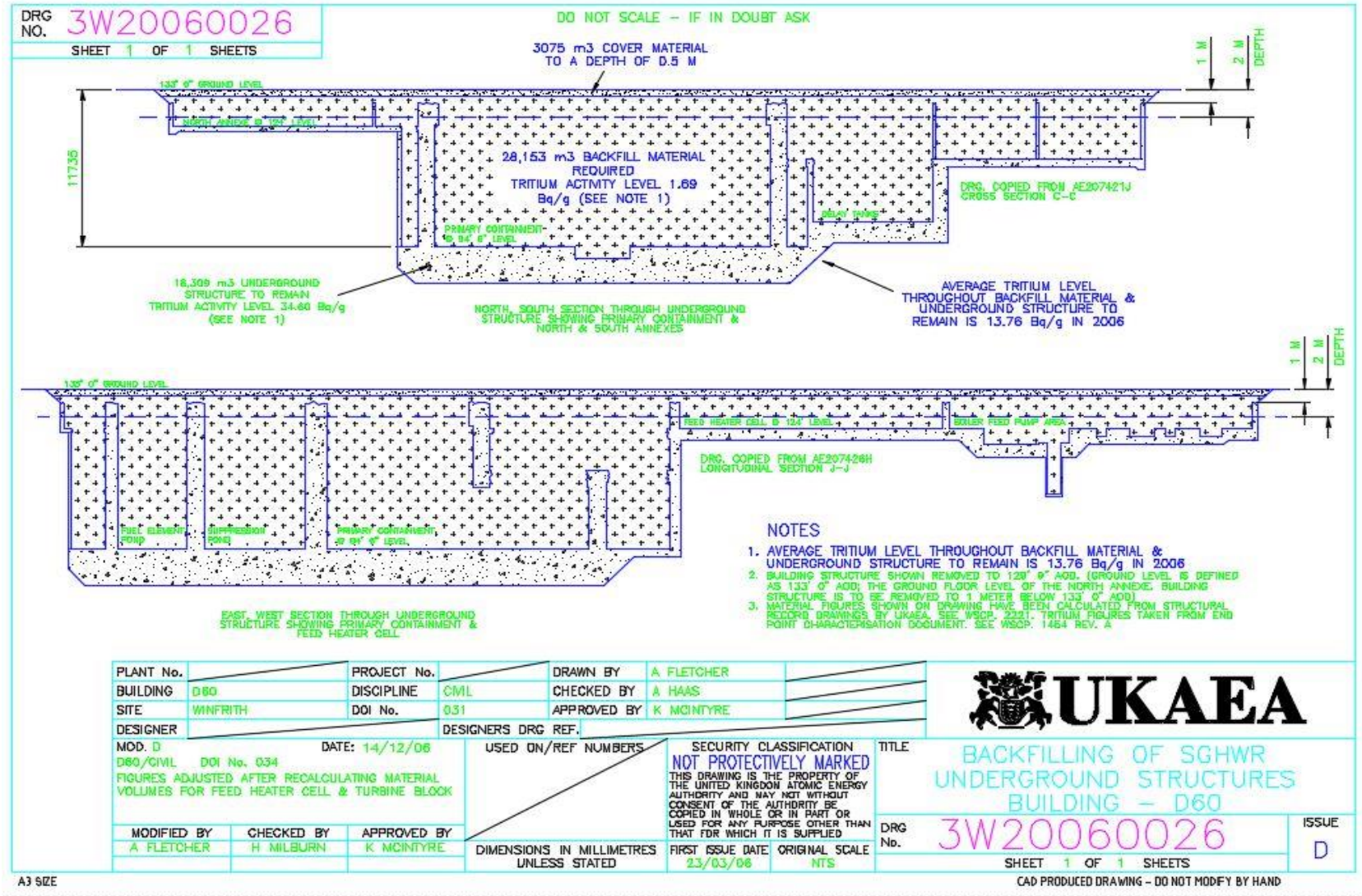
Appendix E: SGHWR Void Volume Drawing



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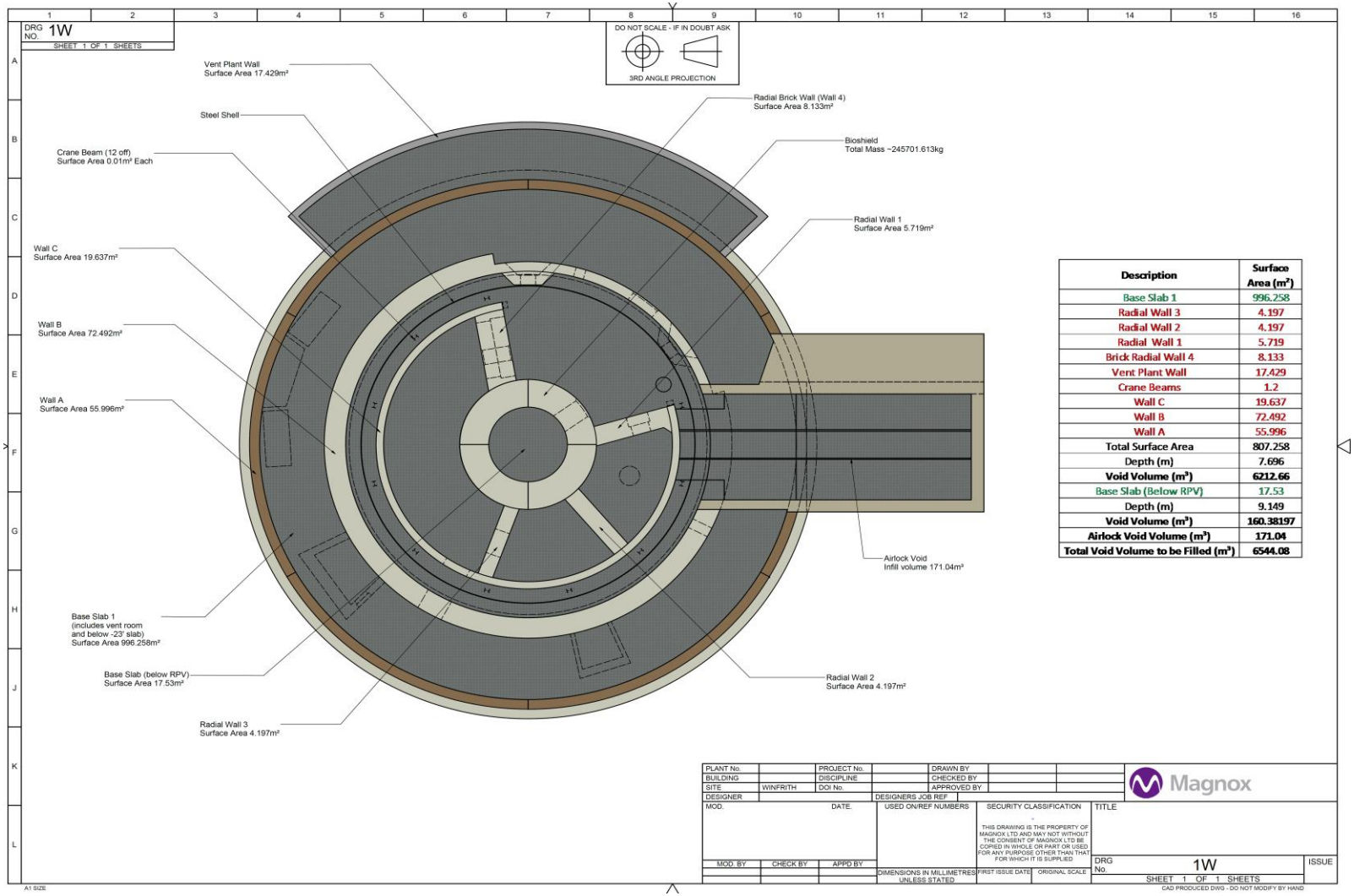
Appendix F: Dragon Void Volume Drawing



Description	Surface Area (m²)
Base Slab 1	996.258
Radial Wall 3	4.197
Radial Wall 2	4.197
Radial Wall 1	5.719
Brick Radial Wall 4	8.133
Vent Plant Wall	17.429
Crane Beams	1.2
Wall C	19.637
Wall B	72.492
Wall A	55.996
Total Surface Area	807.258
Depth (m)	7.696
Void Volume (m³)	6212.66
Base Slab (Below RPV)	17.53
Depth (m)	9.149
Void Volume (m³)	160.38197
Airlock Void Volume (m³)	171.04
Total Void Volume to be Filled (m³)	6544.08

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Appendix G: Breakdown of costs for use of imported material and use of site-won material

ESTIMATED COST FOR IMPORTATION OF INFILL MATERIAL

Location	Volume Required (m3)	Import Cost(£)*
SGHWR	28,000	600,000
DRAGON	7,000	130,000
Total	35,000	730,000

**Based on £21/m3 current local estimate*

ESTIMATED COST FOR CHARACTERISATION (SGHWR, DRAGON AND EXISTING RUBBLE STOCKPILES)

Location	Bulked Rubble Characterisation (£)	Block Characterisation (£)	TOTAL (£)*
SGHWR	470,000	440,000	900,000
DRAGON	400,000	25,000	400,000
Rubble stockpile	22,000	1,500,000	1,500,000
Total			2,800,000

**Estimate Based on Current Magnox Characterisation of Rubble Stock Pile Estimate (£70/m3)*

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Summary costs for exporting site won material and importing backfill

Location	Characterisation (£)	Import(£)	Transport / Disposal(£)	Total(£)
SGHWR	900,000	600,000	740,000	2,250,000
DRAGON	400,000	135,000	200,000	775,000
Rubble Stock Piles	1,500,000	N/A	620,000	2,000,000
TOTAL	2,800,000	735,000	1,500,000	5,025,000

Summary costs associated with using site won material to backfill voids

Location	Characterisation(£)	Surplus material Disposal (£)
SGHWR	900,000	Not known
DRAGON	400,000	Not known
Rubble stockpile	1,500,000	Not known
Total	2,800,000	325,000

Note: Assumes the use of large concrete blocks in the reactor disposals.

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Appendix H: Summary of benefits and detriments for backfill options

Option	Description	Summary of benefits	Summary of detriments
1	Clean non-cementitious material from site spoil mounds. Site spoil mounds were produced in the 1950/60s from construction operations and have since become a site feature (i.e. excavation of reactors / labs). Spoil mounds are primarily sub-soil made ground.	Non-cementitious therefore lowest risk from leachate generation in voids.	Spoil mounds are now site features and habitats. Planning permission would be required for excavation. Habitat designations are in place across several spoil mounds (SSSI) therefore excavation may not be permitted due to loss of habitat. Would require re-location of substation and infrastructure resulting in disruption to local community / businesses. Requires large numbers of HGVs due to the export of on-site building demolition material/waste. Significant Health and Safety risks due to requirement for large excavations and vehicle movements.
2	Cementitious backfill - blocks from above ground reactor structures and crush from rubble stockpile. This comprises large cut blocks and building demolition rubble that will arise from future demolitions and crush stored on-site following previous demolition operations.	Use of blocks minimises potential for leachate generation in void in comparison to new cementitious material. Minimises road moves. Lowest cost. Satisfies Stakeholder agreement. Reduced Health and Safety risk due to fewer vehicle movements and conventional demolition techniques.	Cementitious material (weathered and blocks) still has some potential to generate alkaline leachate. This would be appropriately assessed and managed through HRA(w), engineering design and EAC.

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Option	Description	Summary of benefits	Summary of detriments
3	Out of scope stockpiled rubble combined with in-scope and out of scope new demolition arisings *(Note, this option would need to be permitted under a variation to the site RSR permit under the GRR guidance).*	Use of blocks minimises potential for leachate generation in void in comparison to new cementitious material. Radiological performance assessment indicates that use of in-scope material would meet regulatory requirements (GRR). Minimises road moves. Lower cost. Satisfies Stakeholder agreement. Reduced Health and Safety risk due to fewer vehicle movements and conventional demolition techniques.	Cementitious blocks still have some potential to generate alkaline leachate.
4	Material purchased and imported for purpose of backfilling voids. Material would be sourced from local suppliers so far as possible. Use of imported material would require off-site disposal of site derived material.	Material can be specified in line with EAC.	Highest number of road moves for both material import and waste export. Highest potential for environmental impacts associated with import of materials and export and disposal of wastes. Highest cost due to purchase of new material and disposal of site derived material.

FORMAL DRAFT - FOR DISCUSSION

Appendix I: NDA Strategy

3.3 Site Interim and End States

Objective:

To define credible objectives for the decommissioning and remediation of each site (or part of a site).

The NDA owns significant quantities of land, of which around one quarter is designated, i.e. land that has been assigned by UK government to us for decommissioning and remediation. As part of our responsibilities to government, we are required to propose the end state for the designated land at each of our 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.

For many of our sites, the site end state is not scheduled to be achieved for many decades. For these sites, it is difficult to define the site end state in detail without ruling out credible options prematurely.

To support the development of plans and maintain clarity of the decommissioning journey, our previous Strategy introduced an aspiration to make better use of interim states as natural milestones and decision points on the way to the site end state. An interim state is typically a stable state that marks a stepped reduction in risk or hazard.

Site interim and end states together define objectives for ongoing management of structures, infrastructure and land quality as well as having implications for the management of spent fuels, nuclear materials and waste arising from operations, decommissioning and remediation.

Our Strategy

Our strategy remains to employ pragmatic, risk informed remediation objectives for our sites that balance the benefits and detriments of site decommissioning and remediation. This recognises that, in some cases, removing all traces of a site's industrial use does more harm than good and does not represent sustainable development. It is our strategic preference to undertake enough remediation to enable the beneficial reuse of a site, and, if needed, use institutional controls (e.g. land use restrictions) to protect people and the environment from residual hazards.

In other words, our preference is to decommission and remediate our sites to a condition suitable for their next planned use. This is consistent with conventional land development and with controls implemented routinely under the UK land use planning regimes.

It is essential that we keep appropriate records of the site end state and associated controls. This ensures that land will be used safely and sustainably in the future.

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

In cases where the site end state will not be achieved for many decades, fixing a site end state now could rule out options currently not envisaged or risk pursuing an unsuitable end state. It also presupposes what society may desire for a site at the time it will be remediated. Instead, it is more appropriate to develop an overarching vision for the site. Without this overarching vision, there is a risk of inadvertently foreclosing options for an end state. Furthermore, it is difficult to set objectives for ongoing decommissioning and remediation projects.

As important as the vision is a clear articulation of the next interim state. No matter how broad the definition of the site end state, there will be work that is common to all potential decommissioning journeys. Once this work is complete, a decision will be required as to the next step. At this point, the number of potential decommissioning options reduce, and so the cycle continues. In some cases, the next step might rule out an end state option, for example deciding to decommission infrastructure or demolish a building removes the opportunity for its reuse. If an end state option is being ruled out then this must be a conscious decision with appropriate underpinning and justification.

Identifying an interim state does not necessarily imply a period of quiescence. An interim state can be followed by continuous or deferred decommissioning, i.e. a decision may be taken to work towards the next interim state or to pause. Given that an interim state is typically a stable state, it is important that the route to the next interim state is clear before starting to work towards it. Furthermore, in all but exceptional circumstances, facilities should not move away from a stable interim state until it is clear how waste arising will be managed.

Interim states are a good communication tool to align expectations, increase motivation and secure commitment to decommissioning plans for internal and external stakeholders. They allow SLCs to plan more effectively and can also be used as contract milestones.

In accordance with our strategy of taking sites to a condition suitable for their next planned use, we do not anticipate the preservation of our facilities for the benefit of national industrial heritage. However, the preservation of facilities for this purpose will be subject to case-specific assessment in line with planning policy. Furthermore, one of the objectives of the NDA Archive (see NDA Archive) is to preserve the history of the UK nuclear industry.

Strategy Development

We will prepare guidance for SLCs on the optimisation of site end states. We are sharing our draft guidance with a subgroup of the Nuclear Energy Agency's Working Party for Decommissioning and Dismantling, which is tasked with recommending approaches for the development of remediation plans to enable timely delivery of interim and end states.

We will continue to work with the regulators to explore options for more proportionate regulatory control of sites as they progress towards their end state. We want to ensure that the regulatory regime is flexible enough to accommodate a range of end states and that residual controls do not restrict future use of the land unnecessarily, deter developers or impair local amenity. On behalf of government, the NDA and regulators are exploring alternative approaches that will afford the same level of protection for people and the environment and enable beneficial reuse sooner rather than later, for example making better use of our well-established land use planning regimes.

We will prepare guidance for SLCs on the role of interim states in describing and enabling delivery of the longer-term mission.

We will work with key stakeholders to agree the information that should be recorded by our SLCs about interim and end states to ensure that assets are used appropriately and safely by current and future users. Records will play an important role in ensuring the control of risks to people and the environment from residual hazards.

We will work with local authorities to ensure that site end states and statements on the next planned use of sites are consistent with local waste and development plans.

Delivery

The NDA has issued a new specification for the Winfrith site that moves the end of physical decommissioning and remediation from 2048 to the early 2020s, thereby accelerating the opportunity for beneficial reuse as publically accessible heathland by over 20 years. Consequently, the site end state needs to be defined in more detail in consultation with

stakeholders. This gives the SLC an opportunity to ensure the right balance between removing hazards and controlling risks to people and the environment.(see Case Study: Winfrith).

At many other sites, the focus is on developing appropriate interim states. For example, Sellafield Limited is reviewing its decommissioning strategy and proposes to describe options in terms of interim states, which will aid stakeholder engagement in due course. Magnox Limited is working with the NDA and regulators to determine the level of decommissioning and remediation that is required to make each site safe for decades of quiescence (see Optimum timing and sequencing of Magnox reactor dismantling).

Site interim and end states have the potential to affect the local community and local authority development plans, for example in terms of employment and skills retention. This emphasises the need for ongoing stakeholder engagement which is covered in our Public and Stakeholder Engagement Strategy and People Strategy.

Case Study

Winfrith

Located near the Dorset coast, Winfrith was opened in 1961 to provide additional space for the UK's civil nuclear research programme.

The Winfrith site hosted a number of experimental reactors and other fuel cycle research facilities. A substantial amount of decommissioning has already taken place and a significant proportion of radioactive waste has already been removed from the site. The remaining facilities include the DRAGON reactor and a prototype steam-generating heavy water reactor (SGHWR), which ceased generating electricity in 1990.

Our plan for the Winfrith site is to complete all physical decommissioning and remediation work in the near term. Our current target is to achieve this within the next 10 years. We refer to this target as an interim end state and it represents an interim state in which no further physical work is planned.

The reference to physical work is important because after the physical work, natural processes will continue to work towards reaching the conditions required to deliver the site end state. We are working with Magnox Limited to understand where there are opportunities to reduce the amount of physical work now, which may include leaving some residual contamination in situ to take advantage of radioactive decay and natural degradation of contaminants. This could also have the benefit of reducing the amount of material that will need to be imported to the site to bring about the interim end state.

These decisions will be subject to demonstrating that conditions at the interim end state are safe for people and the environment and will be supported by continuing the useful discussions that have already taken place with stakeholders.

Our plans for the Winfrith site are therefore different to the Magnox reactor sites where the near-term target is an interim state after which there will be a period of quiescence (for some decades) followed by further physical decommissioning and remediation required to deliver the site end state.

Once the interim end state has been achieved, it is likely that the Winfrith site will still be subject to regulation, particularly in areas where residual contamination is being managed. It will also remain designated to the NDA under the Energy Act (2004), despite there no longer being any facilities on the surface. However, it is our aspiration that, even with these regulatory controls, we will be able to deliver the site to its next planned use as heathland open to the public for recreational purposes.

The management of the site once the interim end state has been achieved will be an important area of work over this strategy period and in particular will require close working with regulators to ensure that their expectations are met and that the management of the site is compliant with

the relevant regulations. Within the NDA estate there are examples of licenced land where there is public access, however, it is recognised that reaching this state for a whole site will be a first for the UK.

Winfrith will be the first reactor site in the NDA estate to be “cleared” and provides an important opportunity for the NDA and Magnox Limited to demonstrate that we can clear sites and make a whole site available for its next planned use. This is important to us because it has the potential to set a precedent for the future remediation of other sites in the NDA estate.

Following the commencement of the new contract for the Magnox sites (including Winfrith and Harwell) the lifetime plans are currently under review. As a consequence the milestone dates indicated against these sites are subject to change as the plans are further optimised.