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Trawsfynydd Site:

Supporting statement for NRW Form RSR-C5 application to vary the radioactive substances activity permit to add on-site disposal of solid radioactive waste (Ponds Complex structures and other minor structures)

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PREFACE - INTRODUCTION TO SUPPORTING STATEMENT

Background to this document

Magnox Ltd (hereafter 'Magnox') is developing a proposal for the demolition, infilling, and capping of the Ponds Complex at the Trawsfynydd reactor site – the Ponds Complex Demolition and Disposal (PCDD) Project, as defined in [1]. At the time of submission of this document to Natural Resources Wales (NRW), Magnox

- is the operator of the site and therefore the applicant,
- has (since 31 October 2023) been re-branded as Nuclear Restoration Services (NRS); and
- is a wholly owned subsidiary of the Nuclear Decommissioning Authority (NDA), which owns the site.

The PCDD Project will entail on-site disposal of radioactive waste at the Ponds Complex, both by:

- emplacement of suitable radioactive demolition arisings for the purpose of infilling unwanted voids within the Ponds Complex (termed disposal for a purpose - DfaP), generated through the demolition of concrete and masonry structures located above the demolition cutline (ACL); and
- in-situ disposal (ISD) of redundant radioactive structures located below the demolition cutline (BCL), both within the footprint of the Ponds Complex and in the wider "Disposal Area" (defined below).

Purpose of this document

The purpose of this document is to provide a high-level summary of how the various questions in the relevant application form (RSR C-5) are addressed within the suite of documents prepared by Magnox to support the application, and to sign-post representatives of the environment agencies (and others) to specific documents or parts of documents that address the information required by Form RSR C-5, as elaborated in the "How to Apply" guidance for the form [2].

Relationship of this document to the Waste Management Plan and Site-Wide Environmental Safety Case

As stipulated in Improvement Condition IC1 introduced in the site's revised RSR permit effective from January 2020 [3], Magnox is required to develop and maintain a Waste Management Plan (WMP) and Site-Wide Environmental Safety Case (SWESC) for the site. The WMP and SWESC are site-wide documents, whereas the present application for on-site disposal only concerns the Ponds Complex and adjacent areas (the Disposal Area). The 2023 version of the WMP and SWESC head documents supporting the application for on-site disposal, concern the whole site, but focus on and provide more detail concerning the proposed on-site disposals in the Disposal Area and their potential environmental impacts.

Functional requirements for the PCDD Project

The key functional requirements for the PCDD Project (when completed) are as follows:

- The area of the site where the proposed disposals will be implemented (the Disposal Area) must be capable of being incorporated into the overall end state (including landscaping) at the appropriate time;
- the Disposal Area must be capable of being released from Radioactive Substances Regulation (RSR) within, at most, a few decades after reaching the end state;
- structures within the Disposal Area must have been demolished down to a cutline at or below approximately ground floor slab level;

- ground floor slabs and below-ground structures will have been left in-situ, so far as is reasonably practicable (involving permitted in-situ disposal in the case of radioactive structures);
- below-ground voids have been infilled. So far as is reasonably practicable, this should be with concrete and masonry demolition arisings, including radioactive and/or non-radioactive demolition arisings, rather than imported material;
- all parts of the Ponds Complex where there are infilled voids must have been capped over by a new concrete slab; and
- the implementation of on-site disposals of radioactive waste must have been demonstrated to be (a) optimised and (b) compliant with relevant groundwater protection legislation.

Regulatory requirements for the PCDD Project

Commencement of the PCDD Project will require several regulatory permissions and/or regulatory or self-regulatory processes to be worked through [1, §1.1], principally:

- a variation to the site's RSR permit granted by Natural Resources Wales (NRW) under EPR, to allow on-site disposal of radioactive wastes – the application to be made using NRW's Form RSR-C5, taking into account the relevant NRW "how to apply" guidance document;
- the need to address the principles and requirements of the "Guidance on Requirements for Release from RSR", which is known by its acronym – the "GRR" [4] – when making the permit variation application;
- planning permission for development under the Town and Country Planning Act, with the associated requirement to submit an environmental impact assessment (EIA);
- the parallel requirement to have the consent of the Office for Nuclear Regulation (ONR) (regarding both nuclear safety and environmental impact assessment requirements);
- the parallel requirement to have due regard for the Transboundary Radioactive Contamination (Wales) Direction 2021; and
- the need to take into account the wider stakeholder engagement context, including advice to implement a Health Impact Assessment.

Approach to provision of further information

As this application is the first of its kind in the UK, Magnox has decided to submit it well ahead of when permission from NRW is needed, to allow for a protracted determination period, should that be needed.

The SWESC is therefore based on less information than will be available closer to the time of implementation of the PCDD Project and the associated on-site disposals. Magnox (as NRS) will be able to provide substantial further information to NRW prior to implementation. The extent of such further information provided prior to determination of the application will depend on how much information NRW requires at that stage. Appendix A of the SWESC head document describes the types of further information that Magnox will provide to NRW as it becomes available and includes a list of forward actions identified within the SWESC head document itself.

Further notes to readers

This document is intended to be more than simply a sign-posting document. In order to help the reader understand the rationale for how Magnox has addressed the questions in Form RSR-C5, some aspects of the claims, arguments and evidence presented in the SWESC have been referred to. However, this document is not a summary of the claims, arguments and evidence relevant to the proposed near-term on-site disposals, and readers should not rely on

this document as if it were part of the SWESC, but should read the relevant sections of the SWESC identified herein.

The focus of this document is on the questions in Form RSR-C5, which are almost entirely concerned with the immediate (near-term proposal for on-site disposal of radioactive waste. However, this proposal will be determined by NRW in the context of the totality and full life cycle of the site, which Magnox envisages will lead to an end state that includes further on-site disposals (associated with the reactor buildings), and radioactively contaminated ground and some non-radioactive sub-surface hazards remaining in situ (including the licensed burials of asbestos-containing materials at the northern end of the site). This document provides some information on these other envisaged aspects of the site end state to help put the current proposal for on-site disposal in context, but is not directly relevant to the current proposal and application.

Magnox has identified a number of key documents that support the WMP and the SWESC. These are listed in the Schedule of Documents submitted to NRW in support of this application. These documents include the WMP and SWESC head documents, a non-technical summary of the present application (in Welsh and English versions), the current Site Development Plan for the Trawsfynydd site as a whole, and a Statement of Community Involvement specifically related to the present proposal and the related future planning application. The Statement of Community Involvement includes a compilation of the key matters raised at the Health Impact Assessment workshop with local stakeholders, and Magnox's responses.

RSR-C5 Question 1. About the permit being varied

This application refers to “Trawsfynydd Decommissioning Site”, permit number **EPR/GB3835DE**.

RSR-C5 Question 2. Other applications

Magnox Ltd expects to manage non-radioactive arisings from reactor site decommissioning via on-site recovery as appropriate for void filling, landscaping or other purposes (compliant with the Waste Hierarchy, substitution and the proximity principle). In this respect, Magnox has submitted a draft Waste Recovery Plan to NRW for an opinion on recovery, with the intention to subsequently submit an application to NRW for a Deposit for Recovery permit associated with planned reactor height reduction [5].

RSR-C5 Question 3. About your proposed changes

This application concerns a variation to the radioactive substances activity permit currently held by Magnox for the Trawsfynydd site to allow on-site disposal of solid radioactive waste. The 2023 SWESC [6] and WMP [7] head documents support this application.

3b Changes to disposal of radioactive waste activity

Magnox has ticked the boxes indicating addition of the following activities:

- **In-situ disposal** of one or more structures that are radioactive waste.
- **Disposal for a purpose** involving filling a void or structure with radioactive waste. [In fact, involving filling numerous voids within sub-surface structures.]

3c Provide a technical description of your on-site disposal of radioactive waste

i. Description of the proposed disposal locations

The Trawsfynydd Nuclear Licensed Site is located on the northern shore of Llyn Trawsfynydd in north-west Wales (National Grid Reference: E269000 N338200; Figure 1). It is situated within the Snowdonia National Park, ~3 km north-west of the village of Trawsfynydd and 1.5 km south-east of the village of Gellilydan. The footprint of the main buildings of the former Trawsfynydd Nuclear Power Station occupies an area of approximately 200 m by 250 m within the site. The boundaries of the RSR permitted site and location of the proposed Disposal Area within it are shown in Figure 2. Plans of the locations of the proposed disposals are shown in Figure 3 and Figure 4.

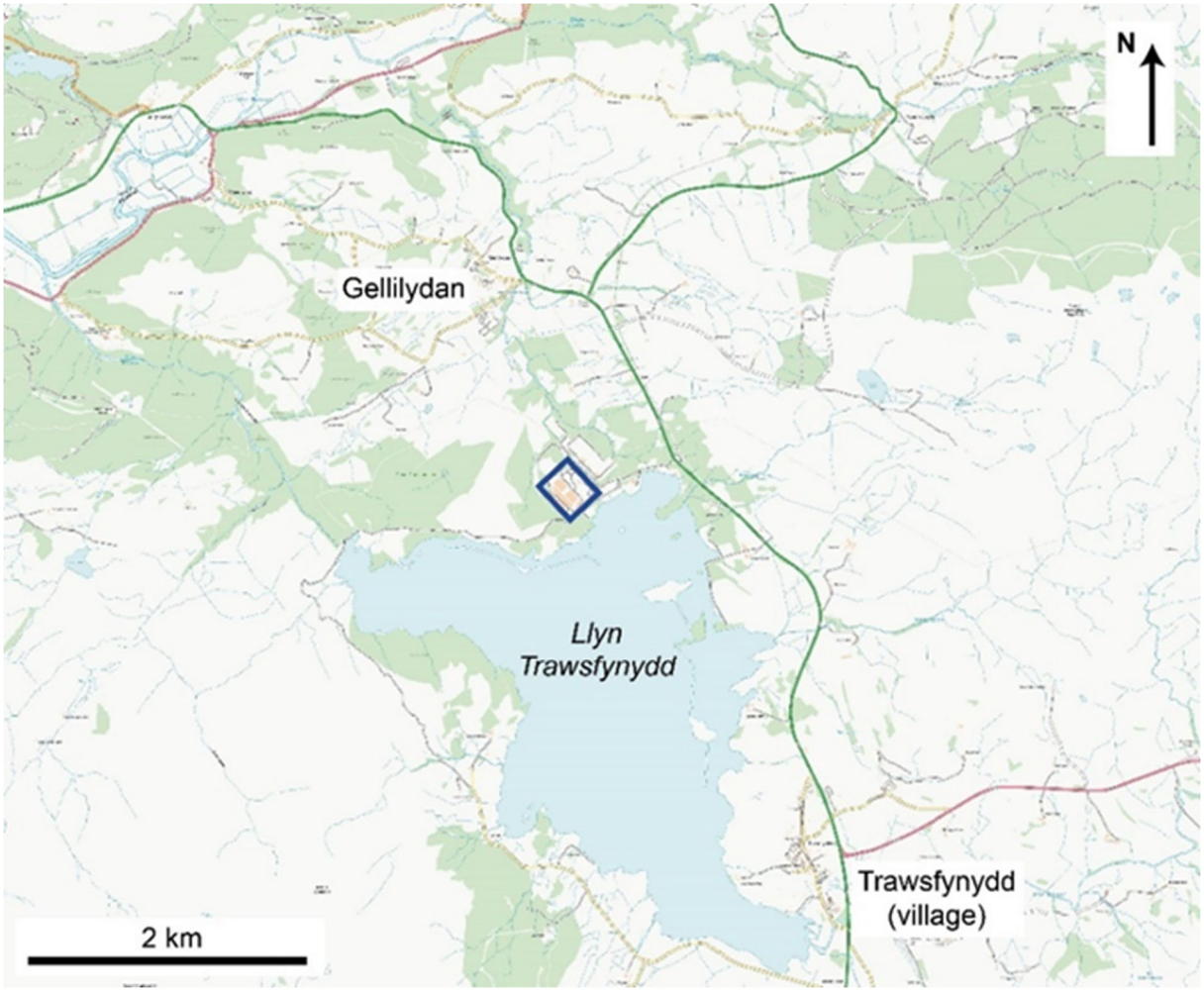

Figure 1: Map of the region surrounding the Trawsfynydd site (developed using OS OpenMap - contains OS data © Crown copyright and database right 2022). The blue square denotes the location of the site. [SWESC Figure 1-1.]

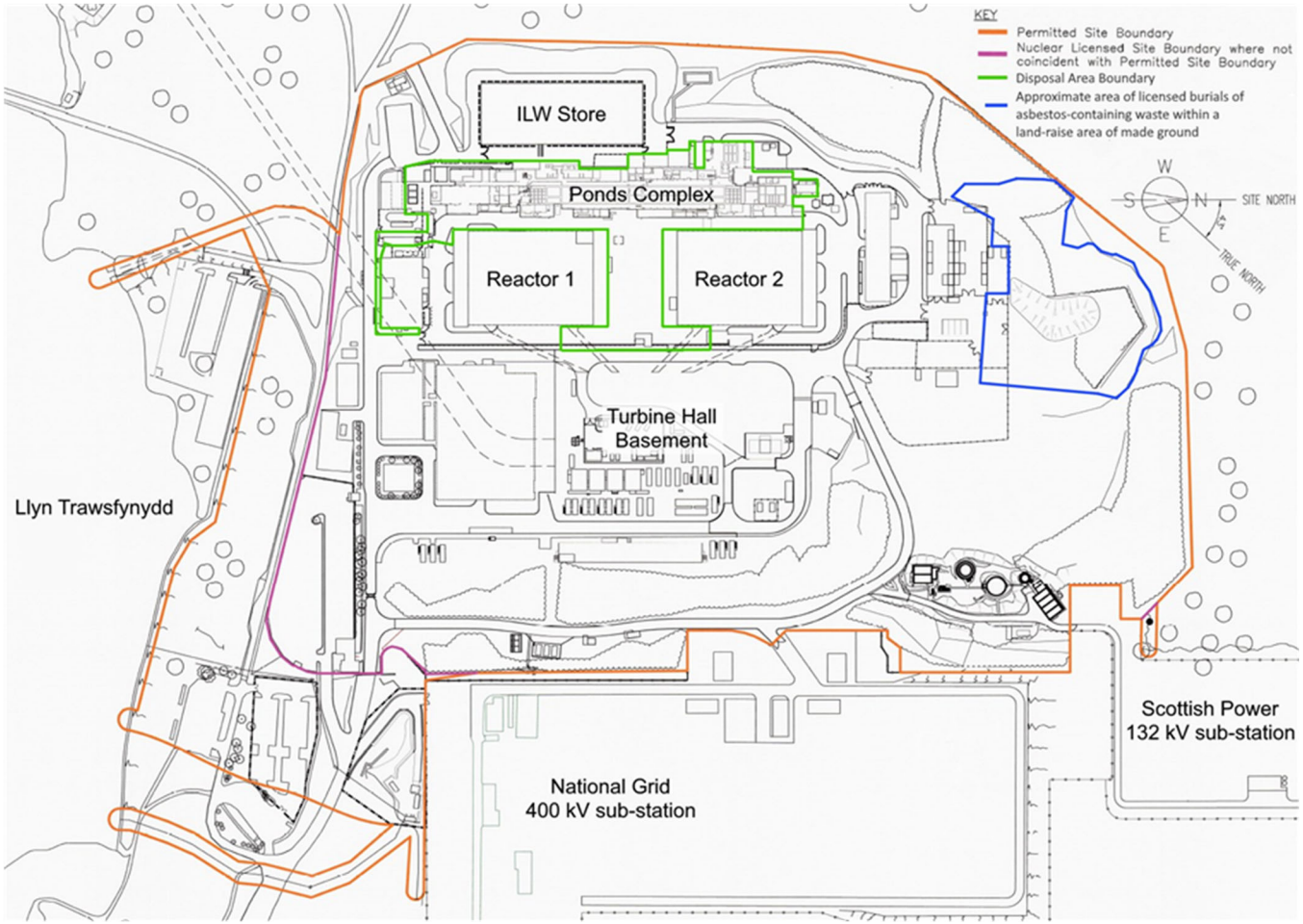

Figure 2: Boundaries of the Trawsfynydd RSR permitted site (orange line) [3] and Nuclear Licensed Site (purple line). The location of the proposed Disposal Area is also shown (green line). [SWESC Figure 1-2.]

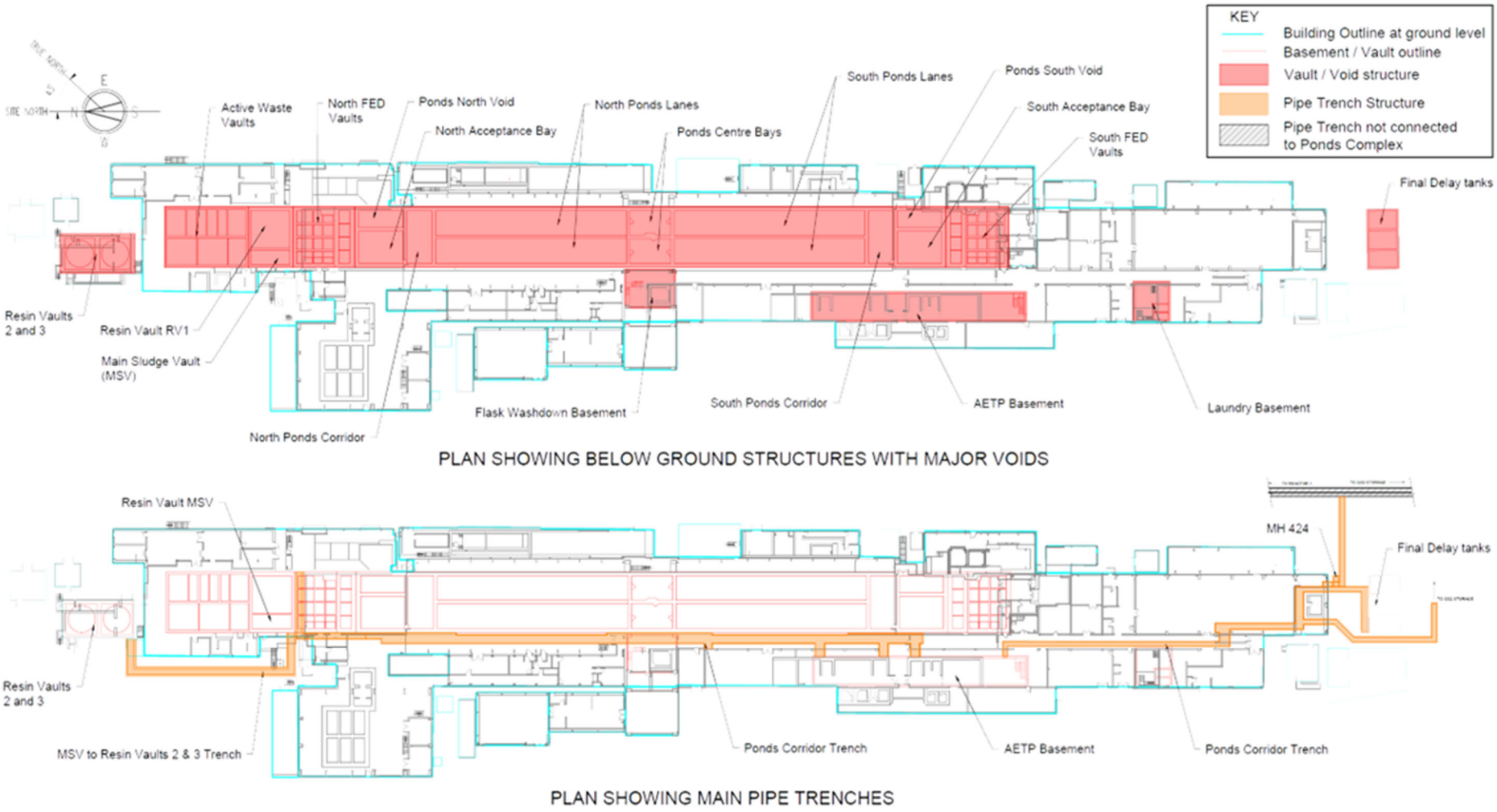

Figure 3: Plans of the location of the proposed on-site disposals within the Ponds Complex, showing the locations of the sub-surface voids and pipe trenches. [SWESC Figure 1-7.]

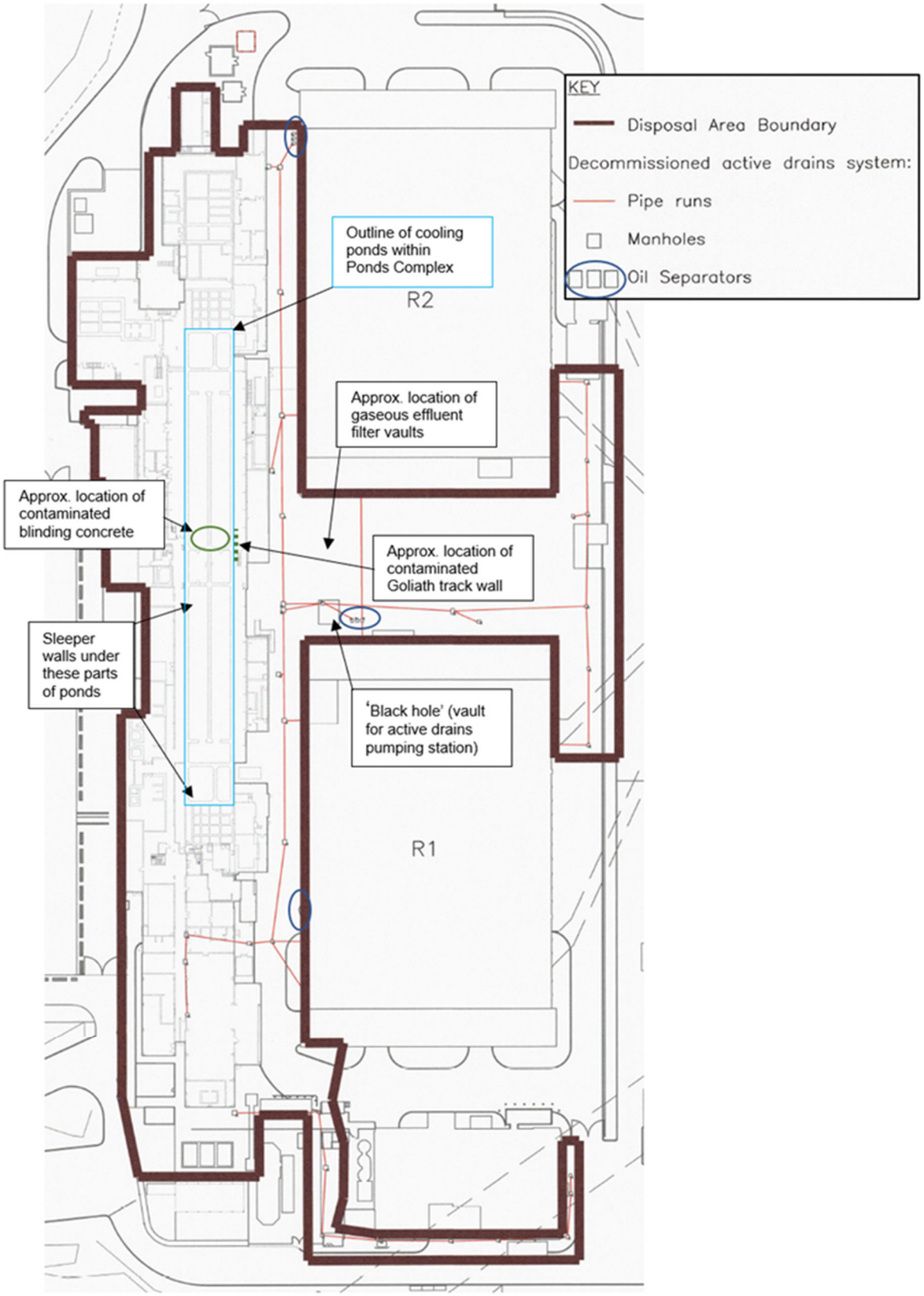

Figure 4: Plan showing the extent of the Disposal Area and indicative locations of minor subsurface radioactive structures associated with the Ponds Complex. [Figure 1-13 of the SWESC].

The site characteristics summary report [8] provides detailed information supporting the Magnox response to Question 3c (i) of the application form, including descriptions of the geology, hydrogeology, surface water hydrology and local environment of the site. This information is summarised in Section 3.1.5 of the SWESC [6].

ii. Design of the proposed disposals

The proposed physical configuration of the disposals (also termed the proposed Disposal Area Interim State, DAIS[1]) is summarised in Section 3.3.2.1 of the SWESC [6] and in a supporting technical note summarising the Application Design [9].

The Application Design has been developed from a base case configuration for the DAIS, through a process of optimisation described in the parts of the SWESC referred to in the response to Question 4 below. Table 1 provides a summary of the outcomes of this process and reproduces the content of Table 3-10 of the SWESC and the first two columns of Table 1 of the Application Design technical note [9].

Table 1: Summary of the Application Design, presented as a development from the base case through optimisation.

Explanation of outcome colour-coding	Base Case Retained
	Improvement on Base Case, as a result of optimisation
	Optimisation to be determined post-permit application.

Aspect	Base Case Configuration	Outcome of optimisation
Main Aspects of the Disposals		
Radioactive demolition waste requiring off-site disposal	Minimise the off-site disposal of radioactive wastes suitable for disposal within the Disposal Area, meaning redundant structures and demolition wastes (largely in the form of concrete and masonry). This means, so far as is reasonably practicable: • radioactive ground floor slabs and below-ground structures left in situ, (ISD); and • below-ground voids infilled with radioactive demolition arisings (DfaP).	Retain base case
Demolition cutline	Structures within the Disposal Area demolished down to a cutline at or below approximately ground floor slab level, so as to avoid there being protrusions above the local surface of the subsequently emplaced capping slab.	Retain base case
Segregation of OoS concrete and masonry demolition arisings	Limit segregation of OoS concrete & masonry demolition arisings from radioactive demolition arisings to that required to form a sub-base layer beneath the new concrete slab, and to ensure that all the radioactive arisings will fit into the voids (without crushing).	Retain base case (anticipated)
Processing of demolition arisings for use as bulk infill to voids	No crushing (processing) of radioactive DfaP wastes, and minimal crushing (processing) of non-radioactive demolition arisings.	Retain base case (anticipated)
	Where the deployed demolition techniques enable segregating steel rebar (e.g., use of munchers) they will be used to remove as much rebar as practicable from concrete demolition arisings.	Retain base case
Configuration of redundant radioactively contaminated structures with no associated DfaP	Contaminated floor slabs	Retain base case
	Active drains system structures outside Ponds Complex	
	Contaminated parts of the Western Goliath Track Wall	
	Contaminated below-ground parts of the external faces of the Cooling Ponds	
	Contaminated parts of the blinding concrete beneath the Cooling Ponds	
	Contaminated lower parts of the concrete Sleeper Walls	

[1] The DAIS is termed an “interim state” because several decades will elapse between its implementation and the site as a whole reaching an end state that can become the site reference state (as defined in the GRR), enabling release from RSR. See also the response to Question 3c(iv).

Aspect	Base Case Configuration	Outcome of optimisation
	Gaseous Effluent Filter Vaults	
High-level overflow from infilled voids	A high-level overflow installed near the top of the cut-line wall of each void to avoid "bathtubbing": i.e. where structures could fill up with infiltrating water such that leachate reaches the ground surface[2].	Retain base case
Forms of Infill		
Form of bulk infill of main Ponds Complex voids (i.e. excluding pipe trenches)	No conditioning of bulk infill to mitigate generation of, or impacts from, leachate.	Targeted monolithic infill in parts of voids below water table
Means of implementing targeted monolithic infill	Not specified.	To be determined post-permit application
Infilling of pipe trenches	Not specified.	To be determined post-permit application
Pre-deposition processing of radioactive demolition arisings	See the "Main aspects of the Disposals" part of this table.	
Capping Slab		
Capping slab: lateral extent	All parts of the Ponds Complex where there are infilled voids and where disposals of radioactive waste are implemented (including ISD of ground-level slabs) capped over by a new (steel reinforced) concrete slab.	Retain base case
Capping slab: minimum thickness	Not specified, but assumed to be 150 mm in the March 2023 base case radiological assessments.	Improvement on Base Case (generally 225 mm thick)
Capping slab: design features	Reinforced concrete slab only.	Retain base case
Pre-Disposal Clean-Out		
Porous concrete	Porous concrete on the floors of the North and South FED Vaults removed. Pipework and sumps underlying the FED Vaults porous concrete (embedded in the structural concrete) cleaned out.	Retain base case
	Porous concrete on the floor of the MSV removed.	Retain base case
	Porous concrete on the floor of the AWVs to remain.	To be determined post-permit application
Contaminated dust in Ponds Lanes	Areas that were previously scabbled (Ponds Lanes and associated bays) vacuumed to remove radioactive dust and the dust disposed offsite.	Retain base case

[2] This overflow will not compromise the "prevent and limit" groundwater protection requirement and would mean that leachate leaving the voids via this route would always enter the unsaturated zone and must travel through it before reaching the saturated zone.

Aspect	Base Case Configuration	Outcome of optimisation
Inventory Management		
Targeted pre-demolition radioactive inventory removal	No requirement for further pre-demolition radioactive inventory removal, over and above that set out above (Pre-Disposal Clean-Out part of this table).	To be determined post-permit application
Sumps and Sampling Drains		
Sump access shafts	Vertical access shafts to catchpots and sumps immediately adjacent to external below cutline walls of some structures (FDTs, Cooling Ponds, AWVs, RV2&3) infilled with grout or imported fresh concrete prior to construction of the cap.	Retain base case
Configuration of sampling drains under ponds	No requirement for removal or grouting of sampling drains beneath the ponds. Note that the loose contents of one drain (drain 7) has previously been removed and replaced with fresh concrete. Subsequent to the definition of the DAIS base case, to address groundwater protection legislation, a decision has been taken to remove the loose contents (porous concrete pipes and surrounding gravel) of the four sampling drains which are currently interacting with groundwater (drains 1, 2, 8 and 9), and to backfill the remaining concrete trenches of these drains with concrete. This is to be implemented independently of the PCDD works. Note that this planned work is cautiously ignored when assessing the DAIS base case in the radiological impact assessments.	Improvement on Base Case – some drains grouted, some drains removed
Sampling drain under FDT 2	No requirement for removal or grouting of sampling drain beneath Final Delay Tank 2.	To be determined post-permit application
Structural Matters		
Sub-base for concrete capping slab	A limited volume of segregated OoS concrete/masonry demolition arisings crushed and deposited at the top of the voids infill as a sub-base for the new concrete cap in a layer up to a maximum of 300 mm thick.	Retain base case
South Ponds Lanes floor	A thin (< 0.25 m) concrete screed on the floor of the South Ponds Lanes to restore protection to exposed reinforcing from corrosion.	Retain base case
AETP Basement floor	To be determined. Additional mitigation may be needed to guard against the potential for failure of the AETP Basement floor slab when loaded by infill, given that this relatively thin floor slab spans between concrete sleeper walls[3].	Retain base case
AETP Basement infilling	About 1.5 m of monolithic infill in the bottom of the AETP Basement[4]. Required to counteract the potential for the relatively thin walls of the basement to fail inwards when the propping effect of the ground floor slab is removed.	Retain base case

iii. Statement concerning co-disposal of directive waste

No on-site co-disposal of directive (controlled) waste is proposed, but proposed deposits of recovered non-radioactive demolition arisings for engineering purposes are included within the scope of the SWESC and associated environmental risk assessments.

iv. Expected timeframes over which disposal of radioactive waste may occur

There have been no previous on-site disposals of radioactive waste at the Trawsfynydd site.

[3] It is assumed that any such additional mitigation will not have a significant effect on the radioactive inventory associated with the base case and used for radiological assessment modelling.
[4] It is assumed that such monolithic infill would be formed using radiologically-clean fresh concrete, which would have a small effect on the volume of demolition arisings emplaced in this void.

The proposed near term on-site disposals are expected to take place over a period not exceeding two years, during the implementation of the PCDD Project, commencing around 2030.

Considering the longer term, a site-wide reference configuration, which encompasses the features within and outside the scope of the proposed near-term on-site disposals, has been defined for assessment purposes, based on the outcome of strategic optimisation of waste management options for the site, and on cautious assumptions regarding the Trawsfynydd end state. The main assumption is that where there is potential for leaving radioactivity on-site, on-site disposal will be implemented and that no unnecessary removal of radioactivity for off-site disposal will take place. The configuration includes in situ disposal of radioactive below-ground structures of the reactors and disposal of the above-ground radioactive components of the reactor bioshields via disposal for a purpose to fill basement voids. It also involves leaving existing sub-surface contaminated ground in situ. This configuration is described in Section 3.2.2.2 of the SWESC [6].

As of November 2023, it is envisaged in the Magnox ‘Management Schedule Summary’ (MSS) that on-site disposals associated with the reactor buildings will be complete by 2055 and that final site clearance activities will all be complete by 2070 (Section 1.1.3 of the SWESC [6]). Release of the site from RSR is envisaged to be some time after that.

RSR-C5 Question 4. Operating techniques

4a Describe how you manage the on-site disposal of solid radioactive waste to protect the environment and to optimise the protection of members of the public

The Magnox methodology for management of on-site disposal of solid radioactive waste to protect the environment and to optimise the protection of the public is summarised in Sections 2.4.2, 2.4.3 and 2.4.4 of the SWESC. Magnox has applied this methodology to define a provisionally optimised Disposal Area Interim State (DAIS) through the identification of appropriate engineering measures considering any proportionate mitigation of radiological impacts.

As of the date of submission of this application, the outcome of this process is a provisionally optimised "Application Design" for the configuration of the proposed disposals (termed the provisionally optimised DAIS) as set out in [9], and in Table 1 of this document.

The maximum amounts of radioactivity content and of individual radionuclides to be disposed of within the proposed DAIS are given below in response to Questions 5a(iii) and 5a(vii), respectively and these in turn determine the proposed limits on disposed radioactivity given in response to Question 5b.

The way in which the proposed limits on disposed radioactivity have been arrived at has involved an incremental and iterative process, key steps in which have been as follows:

- Findings from a previous iteration[5] of developing an inventory of credible candidate features for on-site disposal (and subsequent radiological assessments) were used to inform the development of a new "bounding inventory" of candidate features for on-site disposal, within the Ponds Complex and within the associated redundant infrastructure (active drains, etc.) [11, 12]. This inventory was "bounding" in the sense that it included all potentially radioactive features and components of the physical types considered as credible candidates for on-site disposal (i.e., mainly concrete or masonry).
- Subsequent to compiling the "bounding inventory", the following components were screened out as not suitable for on-site disposal:
    - The porous concrete on the bases of the fuel element debris (FED) vaults were excluded because a decision was made to retrieve this material as part of the post-operational clean-out of the vaults following retrieval of bulk FED. This was partly because some of the porous concrete was being scraped out in the process of FED retrieval and partly because it was recognised that the porous concrete would likely be partly impregnated by loose particulate waste derived from FED (making it borderline higher activity waste) and potentially containing small particles of irradiated uranium fuel.
    - The porous concrete on the base of the Miscellaneous Sludge Vault (MSV) was excluded because some preliminary characterisation work revealed the presence of oily residues on top of and impregnating the porous concrete, in addition to the expected presence of Magnox sludge (not yet well-quantified) which has a relatively high proportion of long-lived actinide radionuclides.
    - The radioactive dust loosely adhering to the previously scabbled walls and floors of the cooling ponds was excluded because a decision was taken to commit to remove the loose dust (by vacuum cleaning) prior to demolition, chiefly to assist radiological control of the demolition works.

[5] This previous iteration resulted in an "Interim SWESC" produced in 2019 and amended in 2020, which is referenced from the 2023 SWESC that supports this application.

- The exclusion of the above three components led to a “base case” inventory, associated with a base case or reference case[6] configuration for the DAIS, which was used as a starting point for structured optimisation, informed by radiological assessments (see Section 3.3.2 of the SWESC). It is this base case radioactive inventory that is given as the basis of the responses below to Question 5a(iii), 5a(vii) and 5b. The base case inventory is set out in Table 3 under the response to Question 5a(vii) below.
- A further development was the recognition that a small number of radioactive components of the Ponds Complex (specifically four of the under-ponds sampling drains shown in Figure 1-12 of the SWESC) could currently be giving rise to “direct discharges” of radionuclides into groundwater, which would be contrary to groundwater protection legislation, regardless of the assessed radiological impacts on people and the environment. Magnox therefore has committed to remove the contaminated loose contents of these four under-ponds sampling drains (for off-site disposal) and infill the remaining contaminated concrete channels with fresh concrete. This will be done in advance of and independently from the implementation of the PCDD works. Therefore, the large majority of the radioactive inventory of those four sampling drains, which is included in the base case inventory referred to above, will not in fact be included in the proposed on-site disposals. As discussed in Section 3.3.3 of the SWESC, the exclusion of this small part of the base case inventory contributes to a slight beneficial effect on assessed dose to some representative persons (RPs) but not the most exposed RP (“Resident”) and has no effect on assessed doses through human intrusion or site occupancy. Hence, this application relies on the extensive suite of radiological assessments for the base case configuration and inventory of the DAIS (see Section 3.2 of the SWESC), in addition to the more limited assessments undertaken for the provisionally optimised DAIS (see Section 3.3.3 of the SWESC). Defining the activity limits from the base case inventory (see response to Question 5b) means that the base case radiological assessments are “at the proposed limits for the disposal(s)”, as required for the responses to Questions 7a and 7b.

Demonstration of environmental protection and optimisation is summarised in Sections 3.3.2, 3.3.3 and 3.3.4 of the SWESC as follows:

- Section 3.3.2.1 describes how Magnox will manage releases of leachate from infill within voids.
- Section 3.3.2.2 describes how Magnox may manage the radioactive inventory for disposal through measures such as targeted inventory removal, subject to future characterisation.
- Section 3.3.2.3 describes how Magnox will manage in-situ disposal of the under-ponds sampling drains.
- Section 3.3.2.4 describes how Magnox will implement a cap that will be installed above the on-site disposals within the Ponds Complex footprint, including all disposals for the purpose of infilling voids.
- Section 3.3.2.5 describes various other miscellaneous aspects of optimisation including pipe trenches within the Ponds Complex footprint and contaminated Disposal Area infrastructure with no associated disposal for a purpose.
- Section 3.3.2.6 presents the provisionally optimised Application Deisgn.

[6] The “reference case” configuration for the DAIS is a development of the base case to enable natural evolution assessments,

The provisionally optimised DAIS configuration has been considered in relation to the radiological impact of natural evolution, human intrusion and site occupancy, with results presented in Section 3.3.3 of the SWESC.

Radiological characterisation will continue throughout decommissioning and appropriate removal of radioactivity will be undertaken after deplanting to ensure that the remaining inventory is consistent with the estimates assumed for the optimised end state.

Magnox has considered how the DAIS may impact on or constrain optimisation of the final configuration of the whole site and has assessed the impacts of an assumed optimised end state configuration (Section 3.3.4 of the SWESC). Site-wide optimisation has been considered in less detail than optimisation of the DAIS, recognising current uncertainty over the strategic approach to future reactor decommissioning and waste management, and the consequent site end state. Because the inventory of the reactor bioshields contains different radionuclides to that of the Disposal Area, the radiological impacts from the bioshields, which across the site contain most of the radioactivity for potential future on-site disposal, tend not to overlap the impacts from the Disposal Area. Therefore, optimisation of these features can be considered independently as discussed in the Section 3.3.4 of the SWESC.

Magnox has identified optimisation decisions that are to be deferred until after submission of the 2023 permit variation application, due to uncertainty in current data (e.g., radiological inventory) or the need to involve additional expertise (e.g., the future appointed demolition contractor). These will be undertaken in due course and Magnox has set out its strategy for future optimisation (Section 3.3.5 of the SWESC).

4b Describe how you manage the on-site disposal of solid radioactive waste to protect members of the public and the environment from any non-radiological hazards of the radioactive waste

A sufficiently detailed and cautious description of "*nature, magnitude and distribution of… non-radiological hazards associated with, or potentially interacting with, the radiological hazards*" [GRR para. A4.14] has been developed to support both the demonstration of environmental safety, and optimisation of the proposed disposals, described in Section 3.3.5 of the SWESC.

Magnox describes its management of non-radiological hazards in Section 3.2.12 of the SWESC. Magnox has assessed, and will continue to review, the risks posed by non-radiological hazards present on the Trawsfynydd site such that people and the environment are protected during the period of, and after release from, RSR. This is undertaken by showing consistency with the level of protection provided by relevant national standards.

For the Disposal Area, qualitative arguments and quantitative assessment are used to confirm the acceptability of risks from current and future non-radiological hazards, including but not limited to those associated with the features within the scope of the proposed near-term on-site disposals. This includes the undertaking of a hydrogeological risk assessment [10], considering potential impacts to groundwater, and associated receptors. Following regulatory guidance on groundwater risk assessment, a tiered approach to risk assessment has been employed. Utilising understanding of the non-radiological hazards Section 3.1.3.2 of the SWESC, it is found that most potential pollutants can be screened out at Tier 1, due to the very low risk they pose. For the three specific non radiological hazards where a more detailed Tier 2 assessment is required (chromium (VI), alkalinity and residual solvent compounds), this assessment finds that the risks posed to groundwater and its associated receptors are acceptable.

Assessment of the sub-surface non-radiological hazards present outside the Disposal Area suggests that the risks posed are currently acceptable, other than for the non-aqueous phase liquid migration of hydrocarbons associated with the former Turbine Hall. In relation to this single unacceptable risk, near-term remediation works agreed with NRW are planned to ensure protection of people and the environment.

As decommissioning of the Trawsfynydd site continues, future decommissioning activities will be planned such that the risks posed by non-radiological hazards, present either in the sub-surface or associated with future on-site disposals, are consistent with the requirements of relevant national standards and that the potential for impacts from across the site to combine in a problematic way is minimised.

RSR-C5 Question 5. Disposal of radioactive waste

5a Provide a description and quantitative estimates of the radioactive waste to be disposed of on-site

Table 2 provides the information requested in RSR-C5 Question 5a in the guidance document relating to disposals of radioactive waste, with Roman numerals added for the ten bullet points in the guidance.

Table 2: Information relating to disposals of radioactive waste requested under RSR-C5 Question 5a.

Ref. No.	Required information	Response	Document reference(s)
5a(i)	Where on your site the waste will come from.	All the solid radioactive waste within the scope of this application will come from within the delineated Disposal Area. This inventory is described in the DAIS bounding inventory report [11] and spreadsheet [12], but note that a small number of components of the bounding inventory are excluded from the proposed on-site disposals; they will be removed from the Ponds Complex prior to demolition (see Section 3.3.3 of the SWESC for details). All the radioactive waste proposed for disposal for the purpose of infilling voids in the Disposal Area will come from demolition of concrete and masonry structures of the Ponds Complex.	SWESC [6] Section 3.1.2 [11], [12]
5a(ii)	Its category (for example, Low Level Waste (LLW), High Volume Very Low Level Waste (HV-VLLW) etc).	Almost all of the solid radioactive waste within the scope of this application would be Low Level Waste (LLW) if sent for off-site disposal; much of it would be potentially suitable for disposal to a permitted landfill as low activity LLW.	SWESC Section 3.1.2 [11], [12]
5a(iii)	How much of it (mass or volume and radioactivity content) you will dispose of and over what period - you should specify the maximum amount (mass or volume and radioactivity content) you want to dispose of.	The total volume of material for on-site disposal is ~9000 m^3. The volume of structural material (mainly concrete) for in situ disposal is ~3500 m^3. The maximum ex situ volume of material for DfaP is equal to the BCL void volume, ~5500 m^3. The maximum inventory (in 2022) proposed for on-site disposal is 130 GBq (rounded up). Further details, including amounts of specific radionuclides, are given in response to 5a(vii) below in this table. The expected timeframe over which the proposed disposal of radioactive waste may occur is discussed in section 3c (iv) of this document.	SWESC Section 3.1.2 [11], [12]

Ref. No.	Required information	Response	Document reference(s)
5a(iv)	Its nature and form (for example, packaged/bagged/loose; blocks/crushed etc).	The nature and form of the arisings for DfaP under this application will depend upon the methods used to demolish ACL features. These methods will be agreed between Magnox and the demolition contractor once appointed. However, demolition arisings are expected to be a combination of broken concrete and masonry, cut concrete blocks and intact precast concrete elements. No attempt is made at the present stage of the PCDD Project to estimate the relative proportions of different types of demolition arisings. It is expected that the segregation of OoS concrete and masonry demolition arisings from radioactive demolition arisings will be limited to that required to form a non-active sub base layer beneath the new concrete slab, and to ensure that all the radioactive arisings will fit into the voids in the form that it arises. As regards processing (crushing) of demolition arisings for use as bulk infill to voids, it is expected that there will be no crushing of radioactive arisings, and minimal crushing of OoS arisings, principally to provide material for the sub-base layer for the cap.	SWESC Section 3.3.5.3
5a(v)	For structures being disposed of in situ, a description of the structure, its dimensions, location and degree of radioactive contamination etc.	All structures being disposed of in situ under this application are described and their locations and degrees of contamination are given in the Disposal Area bounding inventory documentation. [11], [12]	SWESC [6] Section 3.1.1 and 3.1.2 [11], [12]
5a(vi)	If applicable, how you will treat or store it prior to disposal.	No crushing (processing) of radioactive DfaP wastes, and minimal crushing (processing) of non-radioactive demolition arisings are proposed. Where the deployed demolition techniques enable segregating steel rebar (e.g., use of munchers) they will be used to remove as much rebar as practicable from concrete demolition arisings, so that it can be recycled. There is no intent for long term storage of ex situ radioactive waste prior to DfaP.	SWESC [6] Section 3.2.2

Ref. No.	Required information	Response	Document reference(s)
5a(vii)	The radionuclides present in the wastes and the total activity (in becquerels) and activity concentrations of each radionuclide (or group of radionuclides) over the lifetime of the disposal. Where your figures relate to groups of radionuclides, a statement should be provided justifying the grouping as appropriate to use in the dose assessment.	The maximum total quantities (activities) of individual radionuclides in the proposed near-term on-site disposals are taken from the "base case" inventory as described in the response to Question 4a and are given in Table 3, with separate values given for the ACL inventory for disposal for a purpose (DfaP) and for the BCL inventory for in situ disposal (ISD). Table 3 also gives average specific activities, obtained by dividing respectively by the estimated total mass of ACL concrete/masonry and by the estimated total mass of BCL concrete/masonry and pipework.	SWESC [6] Section 3.1.2 [11], [12]
5a(viii)	Which radionuclides are likely to contribute significantly to the outcome of the radiological impact assessment (these are likely to vary depending upon the pathway).	Based on the radiological assessments for the base case DAIS, the significant dose-contributing radionuclides are as follows: For the groundwater pathway: Sr-90, Cs-137, Am-241 and Pu nuclides (Disposal Area). For human intrusion after release from RSR: Sr-90, Cs-137, Am-241 and Pu nuclides For site occupancy after release from RSR: Cs-137 There is no significant radiological impact from gaseous release. [Based on the radiological assessments for the reference case site-wide end state, the significant dose-contributing radionuclides for the contaminated ground and reactor building features are Cs-137, Sr-90, Eu-152 and C-14.]	SWESC [6] Sections 3.2.3, 3.2.4, 3.2.5 [13], [14], [15], [16], [17], [18]
5a(ix)	The conventional properties of the radioactive waste (for example, its physical and chemical properties and any non-radiological hazards presented by the waste).	Most of the radioactive waste comprises concrete and masonry containing steel rebar. Most of the rebar from ACL demolition arisings will be removed for recycling. Small quantities of paint, asbestos, and building finishing materials such as bitumen and ceramic may also be present. Concrete, especially when broken, can give rise to highly alkaline leachate, which may also contain appreciable concentrations of chromium (VI). The proposed in situ disposals include the cast iron containment pipes of the former active drains system, now internally grouted. These have been screened out at Tier 1 of the groundwater risk assessment mentioned in Section 4b of this document.	SWESC [6] Sections 3.1.2, 3.1.3 Non-radiological hazards are discussed in SWESC section 3.1.3.1

Ref. No.	Required information	Response	Document reference(s)
5a(x)	Any relevant limitations imposed by the conditions of an EPR permit for directive waste that applies to the same disposal.	Not applicable.	Not applicable

Table 3: Maximum quantities (activities in 2022) of radionuclides in the proposed on-site disposals (ACL, BCL and combined) and associated average specific activities. See text for explanation of grey shading.

Radionuclide	Activity ACL (MBq)	Activity BCL (MBq)	Combined Activity ACL and BCL (MBq)	Average Specific Activity ACL (Bq/g)	Average Specific Activity BCL (Bq/g
H-3	2.8E+02	2.3E+03	2.6E+03	3.3E-02	2.8E-01
C-14	4.9E+01	2.3E+02	2.8E+02	5.8E-03	2.7E-02
Cl-36	5.1E+00	1.2E+01	1.7E+01	6.0E-04	1.4E-03
Fe-55	2.2E+01	2.1E+02	2.3E+02	2.6E-03	2.5E-02
Ni-59	1.6E-02	3.7E+00	3.8E+00	1.9E-06	4.5E-04
Co-60	1.1E+02	1.9E+02	3.0E+02	1.3E-02	2.2E-02
Ni-63	7.7E+01	3.8E+02	4.6E+02	9.0E-03	4.5E-02
Sr-90	1.3E+04	2.3E+04	3.6E+04	1.5E+00	2.8E+00
Nb-94	3.2E-01	2.9E+00	3.2E+00	3.8E-05	3.5E-04
Tc-99	5.0E+00	6.4E+00	1.1E+01	5.9E-04	7.6E-04
Ru-106	1.3E-05	1.6E-05	2.9E-05	1.6E-09	1.9E-09
Ag-108m	6.3E-02	1.1E+00	1.2E+00	7.5E-06	1.4E-04
Sb-125	4.9E-02	1.0E-01	1.5E-01	5.8E-06	1.2E-05
Ba-133	7.9E-02	8.3E-01	9.1E-01	9.3E-06	9.9E-05
Cs-134	5.6E-01	1.5E+00	2.0E+00	6.6E-05	1.7E-04
Cs-137	1.7E+04	4.7E+04	6.4E+04	2.0E+00	5.6E+00
Pm-147	1.9E+00	3.3E+00	5.2E+00	2.2E-04	4.0E-04
Sm-151	1.4E+02	1.9E+02	3.3E+02	1.6E-02	2.2E-02
Eu-152	4.8E-01	1.8E+00	2.3E+00	5.6E-05	2.1E-04
Eu-154	6.8E+01	9.0E+01	1.6E+02	8.0E-03	1.1E-02
Eu-155	5.8E+00	8.9E+00	1.5E+01	6.8E-04	1.1E-03
U-233	7.8E-07	6.9E-03	6.9E-03	9.2E-11	8.2E-07
U-234	6.1E-01	7.9E-01	1.4E+00	7.1E-05	9.4E-05
U-235	5.2E-02	3.1E-02	8.3E-02	6.1E-06	3.7E-06
U-238	7.3E-01	9.6E-01	1.7E+00	8.6E-05	1.1E-04
Pu-238	2.5E+02	3.6E+02	6.1E+02	3.0E-02	4.3E-02
Pu-239	7.8E+02	9.0E+02	1.7E+03	9.2E-02	1.1E-01
Pu-240	4.8E+02	4.5E+02	9.3E+02	5.6E-02	5.4E-02
Pu-241	6.5E+03	7.6E+03	1.4E+04	7.6E-01	9.1E-01
Am-241	2.1E+03	2.6E+03	4.6E+03	2.4E-01	3.1E-01
Cm-242	1.6E-13	2.0E-13	3.6E-13	1.9E-17	2.4E-17

Radionuclide	Activity ACL (MBq)	Activity BCL (MBq)	Combined Activity ACL and BCL (MBq)	Average Specific Activity ACL (Bq/g)	Average Specific Activity BCL (Bq/g
Cm-243	6.6E+00	1.5E+01	2.1E+01	7.8E-04	1.8E-03
Cm-244	1.2E+00	1.2E+01	1.3E+01	1.5E-04	1.4E-03
Total	**4.1E+04**	**8.6E+04**	**1.3E+05**	**4.8E+00**	**1.0E+01**

Some of the radionuclides included in the inventory for the proposed on-site disposals have extremely low total and specific activities. This reflects the presence in certain Trawsfynydd waste fingerprints, primarily 9G106 (general LLW) and the MSV sludge inventory, of radionuclides that have a negligible dose impact in the assessments but, for completeness, have been assessed because they are included in the relevant inventory fingerprints.

In terms of the specific activity reported in Table 3, (total activity divided by the total volume of ACL and BCL disposals), many radionuclides have concentrations that would be below the RSR out of scope (OoS) levels by many orders of magnitude. It is acknowledged that these radionuclides could be encountered at higher specific activity within localised concentrations or contaminated layers of specific features. However, in order to avoid establishing disposal limits for radionuclides having negligible influence on the radiological impacts of the proposed on-site disposals, all radionuclides having a specific activity more than two orders of magnitude below the relevant OoS (shaded grey in Table 3) level are excluded from the limits proposed below in response to Question 5b. Note that, except for Co-60 and Eu-154, this excludes all but the radionuclides specified in Section 5a(viii) of Table 2 as being the ones likely to contribute significantly to radiological impacts from the proposed on-site disposals. The half-lives of Co-60 and Eu-154 are only 6 and 9 years respectively. Therefore, these two radionuclides, that are present in some of the 2022 fingerprints, will have decayed to negligible levels by the time(s) of the site end state and site reference state and are therefore also excluded.

5b Provide your proposed limits for the disposal of radioactive waste

The proposed limits for near-term on-site disposal of radioactive waste are as follows:

The “types, volume and properties” of wastes for ISD will be as found.

The “types, volume and properties” of wastes for DfaP will be “limited” as follows:

- types limited to being >99% concrete and masonry, with discrete, asbestos-containing items excluded
- volume limited by the volume of voids to be infilled
- properties as determined by demolition methods

The proposed limits on quantities (Bq) of radionuclides in the proposed disposals are as follows (using 2022 as the decay date):

- For total activity (summed over all radionuclides) (see 5a(iii)): 130 GBq in total (rounded up)

For specific radionuclides, the totals given in

Table 4.

No activity concentration limits are proposed, but activity concentrations will be included in disposal acceptance criteria (see response to Question 9a), and average specific activity values are provided, for information, in Table 3 for ACL and BCL components.

Table 4: Proposed radionuclide limits for the combined ACL and BCL activity totals (in 2022).

Radionuclide	Combined Activity ACL and BCL (MBq)
Sr-90	3.6E+04
Cs-137	6.4E+04
Pu alphas	3.2E+03
Pu-241	1.4E+04
Am-241	4.6E+03
Total (rounded up)	**1.3E+05**

RSR-C5 Question 6. Monitoring

6a Provide a description of the sampling arrangements, techniques and systems for measurement and assessment of discharges of radioactive and other substances from the disposal

6b Provide a description of your environmental monitoring programme

The guidance notes for Question 6a are framed for a landfill-like situation where monitoring would be conducted within the disposal(s). Given the nature of the proposed disposals, Magnox does not propose “in waste” monitoring during the post-works phase and does not intend to monitor landfill gas, or leachate level or quality. As such, section 6a has few requirements applicable to this on-site disposal application. The response to Question 6 has therefore not been separated between Questions 6a and 6b.

The proposed monitoring programme has been designed to ensure that the works phase and post-works sampling arrangements are suitable to detect:

- any unexpected escape of radiological or non-radiological contaminants from the disposal; and
- the migration and spread of such contamination, to enable assessment of potential adverse impacts.

The monitoring programme before disposal implementation works start has been designed to ensure sufficiently robust baseline data is collected to detect significant deviations from baseline during the post-works and works phases. Signposting of proposals for monitoring specific to the proposed on-site disposals during the various phases is given below.

The “post-closure phase” of the disposals

The post-closure (post-implementation / post-works) phase monitoring plan is detailed in [19], which is referenced and discussed briefly in Section 3.1.6.2 of the SWESC. It covers monitoring procedures for sampling, trigger levels, and action planning and refers to supporting documents that describe the applicable monitoring techniques.

The “operational phase” of the disposals

The monitoring that will be conducted during the operational phase (works phase) is being detailed in a works phase environmental monitoring plan. The works phase monitoring plan will be submitted as part of the planning application, and Magnox assumes it will be subject to a planning condition. The works phase monitoring plan is in preparation (as of December 2023) and will contain a similar level of detail as the post-implementation monitoring plan. The works phase monitoring programme will include continuation of monitoring conducted during the baseline plus additional higher frequency monitoring designed to detect impact from activities conducted during the works phase.

Establishing an environmental baseline before disposals start

The baseline environmental monitoring programme is designed to ensure that significant deviations from baseline during the post-works and works phases can be detected. It is discussed briefly in Section 3.1.6.3 of the SWESC.

The baseline environmental monitoring will be reviewed and updated if required to reflect amendments to the post implementation monitoring plan. The post implementation monitoring plan may be updated, for example, following the outcome of the further hydrological and hydrogeological characterisation and monitoring discussed in Section 3.1.6.1 of the SWESC.

The baseline environmental monitoring scope is being obtained by incorporation into the Site’s existing land quality groundwater and surface water monitoring programme as discussed in section 3.1.6.3 of the SWESC. Most of the baseline monitoring locations are already regularly

monitored and a discussion of the current quality of groundwater, surface water and associated sediments is provided in Section 3.1.5.9 of the SWESC.

Relationship to Environmental Monitoring Programme

As stated in Section 3.1.6.2 of the SWESC, Magnox will continue to implement its radiological Environmental Monitoring Programme in accordance with the relevant RSR permit requirement. It is envisaged that the scope of the PCDD monitoring plans for the works implementation and post-implementation phases will be incorporated into the Environmental Monitoring Programme at the appropriate time.

RSR-C5 Question 7. Radiological assessment

To support the ongoing process of identifying an optimised site end state (and hence site reference state) incorporating the proposed near-term on-site disposals, methodologies and models have been developed to assess the radiological impacts, from natural evolution, human intrusion and site occupancy, of all the features that are credible candidates for leaving on-site at Trawsfynydd, both prior to and after release from RSR.

7a Provide a prospective dose assessment at the proposed limits for the disposal

As explained in the response to Question 4a, the proposed limits on the radionuclide inventory of the proposed near-term on-site disposals are associated with a "base case" physical configuration and inventory for the relevant radioactive features. Therefore, the responses to Questions 7a and 7b are based to a large extent on radiological assessment of that base case configuration and inventory, presented in Section 3.2 of the SWESC, which also included radiological assessment for a site-wide reference state that incorporates all the credible radioactive end state features. In addition, Section 3.3.3 of the SWESC presents the results of radiological assessment calculations for the "provisionally optimised" configuration and inventory of the proposed near-term on-site disposals, which differ slightly from the DAIS base case, as described in the response to Question 4a.

Dose assessment for natural evolution of the site

As discussed in Section 2.4.2.1 of the SWESC, the DAIS will be achieved prior to the overall site end state, and the natural evolution dose pathway must be assessed starting from the present day and thus considered in relation to both Requirement R9 and R10 (see Sections 1.1.4 and 2.2.1.1 of the SWESC). As such, the radiological criteria for the natural evolution assessments are as follows:

- The source-related dose constraint in Requirement R9 (0.3 mSv/year) applies to the whole site (including but not limited to on-site disposals) until the SRS is reached.
- The GRR Requirement R10 risk guidance level (10^{-6} per year), which applies after release from RSR when the SRS is reached. Note that, as detailed in Section 2.4.2.2a of the SWESC), comparisons are made against the dose rate equivalent[7] of the risk guidance level (~0.017 mSv/year), as this allows for calculated radiological impacts during and after the period of RSR to be presented together as dose rates.

The assessed dose impacts for natural evolution therefore include times before and after the assumed end state date (2083, 61 years after 2022). As noted in the Section 3.2.3.1c of the SWESC, exposure modes differ for some of the assessed representative persons before and after this date.

It is found that the calculated radiological impacts from natural evolution of the candidate end state features within and outside the scope of the proposed near term on-site disposals, respectively in their DAIS base case configuration (The Application Design has been developed from a base case configuration for the DAIS, through a process of optimisation described in the parts of the SWESC referred to in the response to Question 4 below. Table 1 provides a summary of the outcomes of this process and reproduces the content of Table 3-10 of the SWESC and the first two columns of Table 1 of the Application Design technical note [9].

Table 1) and site-wide reference configuration (Section 3.2.2 of the SWESC), are as follows:

- During the period of RSR, releases of radioactivity from the proposed near-term on-site disposals will not be the main source of dose to the public. The combined doses from radioactive discharges from the Trawsfynydd site during the period of RSR, associated with natural evolution of the credible candidates for leaving on-site at Trawsfynydd (Section 3.2.3

[7] Comparison with the dose rate equivalent is possible because it is cautiously assumed that the probability of a dose being received is 1 (i.e., a conditional risk).

of the SWESC), demolition of the Ponds Complex (Section 3.2.8 of the SWESC) and other permitted site discharges, are calculated to be well below the GRR Requirement R9 source-related dose constraint (0.3 mSv/year) (see Section 3.2.9 of the SWESC).

- After release from RSR, doses are found to be below the dose rate equivalent of the risk guidance level in all but two calculations that show minor exceedances. Where these minor exceedances are calculated, they are a result of cautious modelling approaches and cautiously assuming the probability of a dose being received is one.

Note that dose rates are below relevant GRR radiological criteria in scenarios considering the highly unlikely situation of impairment of protective barriers, resulting from natural disruptive processes (see Sections 3.1.5.7 and 3.2.3 of the SWESC).

Details of the above assessment calculations are found in the following assessment reports [13, 18]. Results of assessment calculations for the "provisionally optimised" DAIS configuration and inventory are presented in Section 3.3.3 of the SWESC, with details of these calculations given in Appendix B.3 of the SWESC.

Dose assessment for inadvertent human intrusion

Calculated radiological impacts of inadvertent human intrusion are considered in relation to GRR Requirement R11 radiological criteria. It is found that the calculated radiological impacts from inadvertent human intrusion into the candidate end state features within and outside the scope of the proposed near term on-site disposals, respectively in their DAIS base case configuration and site wide reference configuration (Section 3.2.2 of the SWESC), are below the relevant GRR radiological criteria in all credible scenarios.

Details of human intrusion assessment calculations are found in the following assessment reports [14, 15, 16, 18].

Dose assessment for site occupiers

Although it is not specifically stated in the GRR that direct radiation from a source needs to be considered after release of a site from RSR, assessments have been undertaken to determine potential dose rates to future site occupiers (see Section 2.4.2.1c of the SWESC). Calculated radiological impacts from site occupancy are considered in relation to the risk guidance level (10^{-6} per year), which applies after release from RSR. Note that, as detailed in Section 2.4.2.1a of the SWESC, comparisons are made against the dose rate equivalent of the risk guidance level (~0.017 mSv/year), i.e., assuming occupancy occurs at the assessed location immediately after release from RSR.

It is found that the calculated radiological impacts from site occupancy above a few of the features where the highest specific activity within the Disposal Area is located in proximity to the ground surface, in their DAIS base case configuration (Section 3.2.2.1 of the SWESC), exceed the dose rate equivalent of the risk guidance level. However, this exceedance is for a configuration that cautiously assumes a 0.15 m (minimum) cap thickness. Moreover, such worst-case dose rates would be expected to drop below 0.017 mSv/year after around 100 years beyond the assumed end state date (2083) and the probability of receiving such a dose is expected to be low.

Details of assessment calculations are found in the relevant assessment report [17].

7b Provide a prospective dose assessment for the most exposed members of the public in Member States of the European Union and/or Norway

Question 7b only requires a response if certain radiological criteria set out in NRW guidance to form RSR-C5 [2] are met. These radiological guidance criteria reference the radiological assessments completed in response to GRR Requirements R9 and R10. A transboundary assessment is only needed where such assessments indicate that:

- *the effective dose from the facility to a local representative person during the period of radioactive substances regulation (GRR Requirement R9) is ≥10 microSv per year, or*
- *the assessed radiological risk to the local representative person after release from radioactive substances regulation (GRR Requirement R10) is ≥6 x 10^{-5} per year, or*
- *there are exceptional pathways of exposure to* [European Union] *Member States and/or Norway either during or after the period of regulation, e.g., involving the export of foodstuffs.*

As referenced in the response to Question 7a, the SWESC presents evidence that neither of the first two of the above criteria will apply (Section 3.2.3.4 of the SWESC) and Magnox believes that no exceptional pathways exist and, as such, the third criterion does not apply. Therefore, Magnox does not intend to provide a prospective transboundary dose assessment with its permit variation application.

7c Provide an assessment of the impact on the environment at the proposed limits for the disposal

Long-term post-RSR radiological impacts to non-human biota, associated with the natural evolution of the features within the scope of the proposed near-term on-site disposals (in the DAIS base case configuration –Section 3.2.2.1 of the SWESC) and radioactively contaminated ground (in the site wide reference configuration – Section 3.2.2.2 of the SWESC), have been assessed (Section 3.2.7 of the SWESC and [20]). Calculated radiological impacts were considered in relation to a dose rate screening criterion of 10 µGy/h, suggested in the GRR for "*an initial assessment of the dose rates… for populations of non-human organisms in designated conservation sites*" [GRR, para. A4.100].

It was found that the calculated radiological impacts for the features within the scope of the proposed near-term on-site disposals and contaminated ground are below the dose rate screening criterion for:

- All modelled freshwater biota assumed present in Llyn Trawsfynydd.
- All modelled terrestrial biota assumed present on the land directly down-gradient of the site (currently occupied by the sub-station).

The screening criterion was not met for freshwater biota within the uppermost stretch of the Afon Tafarn-helyg. However, as this exceedance is calculated using cautious modelling, is small in terms of the exceedance magnitude and the physical extent it occurs over, and does meet a less cautious screening criterion recognised by NRW [2], it is considered that the environment will be adequately protected, in relation to radioactivity from the features within the scope of the proposed near-term on-site disposals and contaminated ground, both during and after release from RSR.

RSR-C5 Question 8. Non-radiological assessment

Magnox has assessed, and will continue to review, the risks posed by non-radiological hazards present on the Trawsfynydd site such that people and the environment are protected during the period of, and after release from, RSR. This is undertaken by showing consistency with the level of protection provided by relevant national standards.

A sufficiently detailed and cautious description of *"nature, magnitude and distribution of… non-radiological hazards associated with, or potentially interacting with, the radiological hazards"* [GRR, para. A4.14] has been developed to support both the demonstration of environmental safety and the demonstration of optimisation. A table of localised non-radiological hazards within the Disposal Area is provided in Table 3-3 of the SWESC and site-wide sub-surface non-radiological hazards outside the Disposal Area are reviewed in Section 3.1.3.2 of the SWESC.

For the Disposal Area, qualitative arguments and quantitative assessment are used to confirm the acceptability of risks from current and future non-radiological hazards, including, but not limited to, those associated with the features within the scope of the proposed near term on-site disposals. This includes the undertaking of a hydrogeological risk assessment, considering potential impacts to groundwater, and associated receptors. Following regulatory guidance on groundwater risk assessment, a tiered approach has been employed; this is reported in [21, Appendix B; 22, Section 2.2]. Utilising understanding of the non-radiological hazards at Trawsfynydd, associated with the proposed near-term on-site disposals (Section 3.1.3 of the SWESC), it is found that most can be screened out at Tier 1, due to the very low risk they pose. For the three specific non radiological hazards where a more detailed Tier 2 assessment is required (chromium (VI), alkalinity and residual solvent compounds), this assessment finds that the risks posed to groundwater and its associated receptors are acceptable.

Assessment of the sub-surface non-radiological hazards present outside the Disposal Area suggests that the risks posed are currently acceptable, other than for the non-aqueous phase liquid migration of hydrocarbons associated with the former Turbine Hall. In relation to this single unacceptable risk, remediation works are planned to ensure protection of people and the environment.

As decommissioning of the Trawsfynydd site continues, future decommissioning activities will be planned such that the risks posed by non-radiological hazards, present either in the sub-surface or associated with future on-site disposals, are consistent with the requirements of relevant national standards and the potential for impacts from across the site to combine in a problematic way is minimised.

A combined list of potential non-radiological hazards within built structures in the Disposal Area that have the potential to be left on-site has been developed through review of such documents and discussions with subject matter experts at the Trawsfynydd site (Section 3.1.3 of the SWESC). Non-radiological hazards present at the Trawsfynydd site are recorded in a range of documentation:

- The Site Asbestos Register, which records currently known asbestos inventories, mapped to site spatial referencing systems. As noted in Section 1.5 of the SWESC, discrete asbestos containing materials present within the Ponds Complex will be sent for disposal off-site, where practicable [7], [1].
- The Land Quality Register, introduced in Section 2.4.1.1 of the SWESC, which outlines land quality areas of potential concern (APCs).
- Other documentation, such as characterisation reports, construction era reports, construction era drawings (that denote joints, linings and finishings) and construction era photographs.

A summary of the national standards considered for non-radiological hazards present at Trawsfynydd and the approach taken by Magnox to ensure environmental safety is provided in Table 2-4 of the SWESC.

RSR-C5 Question 9. Radioactive waste pre-disposal arrangements

9a Provide details of your arrangements for pre-disposal verification of the waste to ensure control of the disposal of radioactive waste

Section 2 of the WMP [7] gives an overview of the existing Magnox waste, materials and land quality management arrangements for the Trawsfynydd Site.

Characterisation procedures

The Magnox arrangements for characterisation are summarised in the WMP, Section 2.2.2. The approach to future radiological and non-radiological characterisation of the waste for on-site disposal is also discussed in Sections 2.4.1 and 3.1.4 of the SWESC. More detailed characterisation will be undertaken where inventory uncertainties could pose a challenge to demonstrating suitability of features/components for on-site disposal. This approach is judged to be proportionate and enables Magnox to focus further characterisation on those inventories that are considered to be of most significance.

Management of demolition arisings

As regards the management of waste arising from demolition of ACL Ponds Complex structures and its temporary storage pending DfaP, the existing waste control arrangements at Trawsfynydd will be applied. This will include developing a safety case for interim storage of demolition arisings, and specifying appropriate monitoring to identify any migration of radioactivity away from the interim storage location. The safety case and arrangements for monitoring will be developed prior to beginning to execute any demolition work. These are not primarily matters for the WMP or SWESC.

These management arrangements will ensure that any necessary treatment of the demolition arisings has been undertaken, for example, segregation of rebar from broken concrete destined for DfaP, and segregation of wastes and materials for off-site management or disposal, (such as rebar and bituminised roofing materials). Treatment of controlled waste is discussed in the WMP, Section 6.2.

All Ponds Complex demolition activities will be subject to BAT assessment. To date, optimisation has focused on addressing GRR Requirement 13 for on-site disposal (see Section 3.3 of the SWESC). However, there has also been a strategic BAT assessment undertaken for demolition activities [23]. This assessment has identified a need to undertake some demolition within enclosures to avoid contaminating surface runoff water if the work generates dispersible radioactive dust. Optimisation of management of Lower Activity Waste arising from demolition is discussed in the WMP, Section 4.2.

Requirements concerning the physical form of the waste

Alternative physical forms for the waste for DfaP are considered in Section 3.3.2.1 of the SWESC as part of R13 optimisation, and will be subject to further consideration as the design of the demolition work progresses. The provisionally optimised Application Deisgn is presented in Table 3-33 of the SWESC and has the following expectations for the physical form of the waste:

- Demolition arisings for DfaP expected to be a combination of broken concrete and masonry, cut concrete blocks and intact precast concrete elements; and
- Crushing of non-radioactive demolition arisings only where a non-waste product is required.

Requirements concerning the chemical and biological characteristics of the waste

As introduced in Section 2.4.1.2a of the SWESC, a list of potential non-radiological hazards associated with the Disposal Area, that have the potential to be left permanently on site, has been developed. This is reported in two documents (the non-radiological hazard

characterisation approach [21, Appendix B] and the subsequent non-radiological groundwater risk assessment [22, Section 2]).

Magnox will continue to review the risks posed by non-radiological hazards present on the Trawsfynydd site such that people and the environment are protected during the period of, and after release from, RSR (also see response to Question 8). Checks will be made during future characterisation activities to confirm understanding of the non-radiological inventory, and appropriate action will be taken if any previously undetected non-radiological hazards are found.

Quantitative and qualitative acceptance criteria for on-site disposals

The decision process for pre-disposal verification of waste for on-site disposal (as in-situ disposal or disposal for a purpose) is described in the Section 3.5.2 of the SWESC. In the context of environmental safety, systematically derived acceptance criteria will be used to ensure that disposals are undertaken in conformity with the safety case.

For the proposed near-term on-site disposal of radioactive waste in the Disposal Area, a set of quantitative and qualitative disposal acceptance criteria, and a methodology for their application, will be developed. Unlike waste acceptance criteria for disposal facilities (applied to ex situ wastes), the disposal acceptance criteria will be designed to be applied primarily to intact structures, prior to demolition, when many of the radioactive structures proposed for in situ disposal will still be internally accessible, and the structures destined for disposal for a purpose are still standing. The disposal acceptance criteria will therefore build upon the strategic radiological characterisation plan iterative methodology, described in Section 3.5.2 of the SWESC [24]. This methodology aims to confirm that feature-specific characterisation information, once collected, is suitable to support the associated waste management and sentencing decisions.

The overall function of the disposal acceptance criteria will be to confirm that:

- the radioactive and non-radioactive inventories associated with the features within the scope of the proposed near-term on-site disposals are sufficiently understood;
- the assessed dose impacts associated with the radioactive inventories comply with the GRR radiological criteria and will not unduly constrain envisaged future on-site disposals or in-situ retention of radioactively contaminated ground elsewhere on the Trawsfynydd site; and any associated non-radiological hazards align with the claims and arguments presented in this SWESC.

As stated in Section 2.2.1.5 of the SWESC, it is proposed that any non-radioactive demolition arisings permanently deposited in the Disposal Area will first be fully recovered to meet end of waste criteria in accordance with the Waste and Resources Action Programme (WRAP) quality protocol for aggregates from inert waste [25], including pre-deposition quality verification.

Procedures to ensure a criticality event cannot occur

Procedures to mitigate a criticality event are not needed because the inventory for on-site disposal contains sufficiently low quantities of fissionable radionuclides to rule out the possibility of a future criticality event, as demonstrated in Section 3.2.11 of the SWESC.

RSR-C5 Question 10. Waste Management Plan and Site-Wide Environmental Safety Case

10a Provide relevant extracts from your WMP and SWESC to support your application

The two key Management Requirements of the GRR are the production and maintenance of a Site-Wide Environmental Safety Case (SWESC) and a Waste Management Plan (WMP).

The following are extracts from the summaries of the 2023 SWESC and WMP head documents [6], [7].

SWESC

In order to demonstrate compliance with the internationally accepted principles of radioactive waste management, Magnox has developed a strategic approach to demonstrating the safety of the site, including on-site disposal, set out in Section 2 of the Trawsfynydd SWESC, based on the principle that safety is central to all processes and activities. In this context, the term "safety" can be regarded as representing the achievement of appropriate conditions so as to provide an adequate and optimised level of protection to workers, members of the public and the environment from hazards. "Safety" thus encompasses the concept of "environmental safety" as developed in the GRR and to be demonstrated in a SWESC. The approach is based on implementing five key processes and/or activities, in part derived from the five main principles (P1 to P5) set out in the GRR. These are:

1. Disposal System Understanding – Develop an adequate understanding of the disposal system (i.e., the wastes, the adjacent structures and their surroundings).
   - An estimate of the radiological and non-radiological inventory of the wastes proposed (near-term) or envisaged (longer-term) for OSD will be produced.
   - Available data related to geological and hydrological properties and processes, sensitive ecosystems and human activities in the environs of the site will be gathered and summarised.
   - A forward characterisation approach will be developed with the aim of furthering the understanding of the disposal system (to the extent necessary to adequately demonstrate optimised safety), supported by a structured "GRR Uncertainties Management Methodology" (see process / activity 5 below).
2. Demonstrating Environmental Safety – Confirm that the public and environment are protected against radiological and non-radiological hazards (covering Principles P1, P3 and P4).
   - Radiological and non-radiological impact assessments, including, but not limited to, the required assessments set out in the GRR, will be carried out based on the understanding of the disposal system.
   - Assessments will consider impacts during decommissioning, during works to implement OSD and in the long term, with no reliance on human action in the long term.
   - Radiological impact assessments will be carried out to demonstrate that the potential radiological impacts of proposed or envisaged OSDs comply with the quantitative dose and risk criteria set out in GRR Requirements R9, R10, R11 and R12.
   - Non-radiological impact assessments, where required, will be carried out to demonstrate that a level of protection is in place that is consistent with that delivered by current standards for protection of the environment (including groundwater) and for disposal of controlled (non-radioactive) waste.
   - Carrying out assessments is an iterative process; assessments will be updated based on the outcomes of the optimisation process and availability of significant new data.

3. Optimisation – Identify optimised configurations for OSD (covering Principle P2).
   - Optimisation will be carried out to ensure that radiation exposures to people are kept as low as reasonably achievable (ALARA), taking account of economic and social factors.
   - While the main focus of optimisation in the GRR is on radiological protection, Magnox recognises the need to ensure that OSD will not have unacceptable non-radiological impacts. Magnox will demonstrate that such potential unacceptable impacts have been recognised and will be avoided. Such potential impacts may in fact drive the need for mitigation measures to a greater degree than radiological optimisation.
   - An envisaged optimised end state configuration (including a provisionally optimised configuration for the proposed near-term OSDs in the Disposal Area) will be identified, using the Magnox standard procedure established to ensure a consistent and proportionate approach to optimisation (S-391). The procedure is supported by a Magnox guidance note, which provides advice on selection of options analysis methods and on selection of attributes if using “simplified” or “full” multi-attribute decision analysis.
   - Optimisation is an iterative process extending into the future; acquisition of new data will result in review and updating of relevant radiological and options assessments.
4. Undertaking Dialogue – Work in an open and inclusive manner (covering Principle P5).
   - Magnox will continue to engage in an open and inclusive manner with regulators, local communities and any other relevant stakeholders to ensure consistent expectations for the site end state and its implementation.
5. Sound Management – Operate within a sound management framework and a positive environmental safety culture.
   - Relevant aspects of the Magnox management system are in place to ensure:
     · A structured, transparent and traceable implementation of the above processes.
     · The proposed near-term OSDs will be implemented as per future permit conditions, including the development of radiological and non-radiological disposal acceptance criteria.
     · Effective leadership, effective arrangements for policy and decision making, having sufficient resources, a commitment to continuous learning, and effective arrangements for succession planning and knowledge management.
   - Specifically, for GRR-related work, a bespoke uncertainty management methodology has been developed, termed the “GRR Uncertainties Management Methodology”, that provides a structured approach to managing uncertainties relevant to GRR-related activities and documentation.

It is a GRR requirement that the SWESC should consider the environmental safety of the entire site. On the other hand, the PCDD Project and the current RSR application focus on the proposed near-term OSDs within the Disposal Area only, and the safety case for the Disposal Area has therefore been developed to a higher level of detail than the SWESC as a whole. Owing to the staged approach to achieving the Trawsfynydd site end state, with decommissioning of the Ponds Complex some decades ahead of full decommissioning of the reactor buildings, the SWESC demonstrates how the proposed near-term OSDs have been optimised, and how they will later be incorporated into an envisaged optimised end state for the whole site, and whether they could impact future site-wide optimisation decisions.

The GRR highlights the environment agencies’ expectations for the presentation of a SWESC: *“The SWESC should include the claims, arguments and evidence needed to support an application for release from RSR.”* [GRR, Para 4.3.1]

The SWESC for the Trawsfynydd application is therefore structured around a set of claims and arguments regarding arriving at a safe, optimised end state, followed by a summary of the evidence, with reference to more detail in the supporting reports. The five claims (set out below)

and the supporting arguments (set out in Table S.1 of the SWESC) have been formulated through consideration of:

- The Magnox strategic approach to ensuring environmental safety (summarised above) and associated Trawsfynydd site safety strategy.
- Claims and arguments made in the environmental safety cases of UK low level waste near surface disposal facilities, such as the Low Level Waste Repository in Cumbria and the Dounreay Low Level Waste Disposal Facilities. Such considerations need to account for the differences between the GRR and the equivalent guidance on requirements for authorisation of near-surface disposal facilities.

The five claims are:

Disposal System Understanding: At this point in the life cycle of the Trawsfynydd site, the wastes proposed for near-term OSD or envisaged for OSD in the longer term, the adjacent structures and their surroundings (geosphere and biosphere) have been or will be characterised sufficiently, and their future evolution sufficiently understood, for the purpose of assessing and demonstrating environmental safety.

Demonstration of Environmental Safety: Methodologies have been developed to assess the radiological and environmental impacts of radioactive and non-radioactive sub-surface hazards, both during and after release of the site from RSR, in a cautious and proportionate manner. These assessments show that potential radiological and environmental impacts, in combination with impacts from other sources on the site, are appropriately low and consistent with GRR requirements, including quantitative criteria.

Optimisation: A strategic options assessment has demonstrated the credibility of leaving man-made radioactivity on the Trawsfynydd site as part of the site reference state. Magnox has considered specific waste management and design options for interim and final configurations of the Disposal Area and has defined a provisionally optimised Disposal Area Interim State (DAIS) configuration. This provisionally optimised configuration has been defined through the identification of appropriate engineering measures and disposition routes for radioactive and controlled (directive) wastes, and through appropriate mitigation of radiological impacts. Magnox has also considered how the DAIS may impact on or constrain optimisation of the final configuration of the whole site and has assessed the impacts of an assumed optimised end state configuration.

Undertaking Dialogue: During the development of this SWESC and its precursors, Magnox has positively engaged with regulators, local communities and other relevant stakeholders in an open and inclusive manner.

Sound Management: All Magnox operations are, and will continue to be, undertaken within a sound management framework and a firm safety culture, including work contributing to this SWESC.

The SWESC will be a living document and will be updated systematically as more information (such as characterisation data, and more detailed planning for demolition) becomes available.

WMP

The WMP is defined in the GRR as a practical plan to manage the programme of disposals of radioactive waste arising from a site. The WMP is implemented until work involving radioactive substances is completed to achieve the site reference state. It has three principal aims:

- To show that radioactive waste management is optimised;
- To describe how the site will be brought to a condition that meets regulatory requirements for release from RSR; and
- To support the arguments and claims presented in the SWESC.

For a decommissioning site such as Trawsfynydd, where the decommissioning programme is expected to extend over the next several decades, it is appropriate for the WMP (including supporting documentation) to provide a comprehensive description of the current intent for dealing with all radioactive substances[8] on the site, including all radioactive wastes anticipated to arise until the site has reached its envisaged "end state". The WMP should also demonstrate (at appropriate levels of detail) how radioactive waste management has been or will be optimised. The overall purpose of the SWESC is to demonstrate that the required standards of environmental safety will be met throughout the remaining life-cycle of the site and beyond. Development of the WMP and SWESC is expected to be an iterative process up until the point at which release of the site from RSR is secured. In due course the scope of the WMP will reduce as wastes and materials achieve their final dispositions, whether off-site or on-site.

This WMP (and accompanying SWESC) submitted as part of the permit application reflects the final dispositions envisaged (as of December 2023) for all radioactive wastes arising over the remaining life-cycle of the Trawsfynydd Site. To ensure an integrated approach, the WMP also addresses a range of non-radioactive wastes and non-waste solid materials, as encouraged in the GRR.

Depending on the type of waste/material, potential final disposition routes include (but are not limited to):

- discharge of gaseous effluent;
- discharge of aqueous effluent;
- transfer of solid waste for recycling or recovery off-site;
- transfer of solid and liquid waste for incineration off-site;
- transfer of solid and liquid waste for disposal off-site (with or without prior treatment and/or storage on site);
- on-site disposal of solid waste (including disposal by deposit and/or disposal in situ);
- deposit of solid non-waste material on site (following any necessary treatment/recovery operation to achieve end of waste); and
- permanent in-situ retention of non-waste features such as contaminated ground.

For some categories of waste (e.g., gaseous and aqueous radioactive wastes and higher activity radioactive wastes), the WMP incorporates existing arrangements and plans, including the Radioactive Waste Management Case, and hence this head document takes a signposting approach. For other categories of waste (and some non-wastes), a bottom-up approach has been taken to identifying relevant wastes and materials on the Trawsfynydd site.

The various categories and types of radioactive wastes and contaminated ground have been compiled in a spreadsheet workbook accompanying this WMP head document. Where currently

[8] In this context, in accordance with the definition given in the GRR, "radioactive substances" include radioactive wastes, radioactive materials (some of which may become radioactive wastes) and radioactive contamination of the ground/groundwater (which are not wastes).

envisaged final disposition routes are considered to be optimised, the basis of demonstration of such optimisation is signposted from the spreadsheet workbook. Claims, arguments and evidence relating to the envisaged optimised end state of the site are summarised in the accompanying SWESC head document.

Magnox Ltd is developing a proposal for the demolition, infilling, and capping of the Ponds Complex at the Trawsfynydd site. This will entail on-site disposal of radioactive waste at the Ponds Complex, both by emplacement of suitable radioactive demolition arisings (disposal for a purpose - i.e., infilling unwanted below-ground voids within the Ponds Complex) - and by in situ disposal of redundant below-ground radioactive structures. In situ disposal will also be proposed for various components of redundant radioactively contaminated infrastructure outside the footprint of the Ponds Complex (termed “associated infrastructure”), with the area encompassing the proposed on-site radioactive waste disposals termed the “Disposal Area”. This iteration of the WMP is considered to be suitable to be put forward to support the formal application by Magnox Ltd to vary the Trawsfynydd RSR permit to include on-site disposal within the Disposal Area.

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