Deliverable 2.3: Report on recommendations for the long-term maintenance of critical infrastructure for RWM at the European level: Initial version

Work Package 2 - Knowledge Management

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Executive Summary

This deliverable reports on the work carried out under Sub-task 3.2 of the European Partnership on Radioactive Waste Management (EURAD-2) Work Package (WP) 2 on Knowledge Management (KM), which focuses on European infrastructures for Radioactive Waste Management (RWM). The sub-task has two inter-connected objectives: to maintain and develop the European catalogue of RWM infrastructures, and to examine the long-term sustainability of the infrastructures that Member States regard as critical. Deliverable D2.3 addresses the second objective and presents an initial position reached at the end of Year 2 of the partnership.

During Year 2, a programme of structured stakeholder engagement activities was initiated, in order to establish what the term 'critical infrastructure' is understood to mean in different national and organisational contexts, and to explore where infrastructure needs and gaps are considered to lie. These began with a webinar, which aimed to share information on various infrastructure initiatives of interest to the RWM community, and to gather initial feedback from interested parties. Three polling questions put to webinar participants provided an initial indication of the infrastructure types of greatest interest, the gaps perceived by the community, and the stakeholder groups that should be approached; these responses were used in planning the targeted engagements that followed. Two targeted engagements were then held: with representatives of Waste Management Organisations (WMOs) from Small Inventory Member States (SIMS), referred to as SIMS(WMO), and with Civil Society representatives. Further targeted engagements with other stakeholder groups are planned to take place in Years 3 and 4 of the partnership, and will be reflected in a final report on recommendations for the long-term maintenance of critical infrastructures, which will constitute EURAD-2 Deliverable D2.4.

The principal finding of analysis so far is that assigning an RWM infrastructure as 'critical' cannot be established from the characteristics of the facility alone. Across the two engagement groups, an infrastructure was described as critical for a range of different reasons:

- a national programme depends on it;
- it is approaching the end of its design lifetime or licensing basis;
- the capability it provides exists in few other places and would be difficult to replace;
- its absence would leave a waste management route incomplete;
- the knowledge or data associated with it would be lost; or
- its availability and credibility affect public confidence.

The Civil Society engagement extended the concept further, considering RWM infrastructure to also encompass the organisations and governance arrangements responsible for waste management, especially in relation to legacy sites and the capabilities required to manage them, and to the exposure of infrastructures to hazards that earlier assessments did not consider.

These interpretations are not mutually exclusive, and a working definition of critical RWM infrastructures was developed. However, this should be used with caution: the adoption of a single definition applied uniformly across Europe risks masking the wide range of relevant considerations that has been observed and the necessity for context-specific approaches to respond to particular infrastructure needs.

On this basis, this initial report sets out the areas in which vulnerabilities have been identified so far. These are dominated by the absence or delay of final disposal routes, which dictates storage requirements and links directly with time-dependent limitations such as the ageing, licensing and replacement plans of existing facilities. Other important vulnerabilities include the concentration of specialist capabilities in a small number of European facilities; the completeness and accessibility of data, records and corporate memory; the coverage of the EURAD-2 infrastructure catalogue itself and the voluntary basis on which it is compiled; and the governance and participation arrangements through which decisions about infrastructure are taken and sustained.

Seven initial recommendations have been developed from the evidence gathered so far. They are summarised below. These are not yet offered as final conclusions of the partnership: they draw on the inputs of two stakeholder groups only and are therefore preliminary in both evidence and scope.

- Recommendation 1: Recognise context-dependent interpretations of critical infrastructure. Use a flexible assessment approach that reflects programme maturity, national responsibilities, infrastructure function, lifecycle status, access, knowledge needs and societal expectations rather than imposing a single Europe-wide definition.
- Recommendation 2: Assess disposal-route dependencies and long-term endpoint gaps. Examine whether existing and planned storage and disposal routes provide credible endpoints for current, future and legacy waste streams, and identify the consequences of delay or uncertainty.
- Recommendation 3: Add lifecycle, licensing and replacement indicators to the infrastructure catalogue. Record information such as expected lifetime, licensing status, operational constraints, planned upgrades, future availability, access conditions and programme dependency so that emerging 'cliff edges' can be identified early.
- Recommendation 4: Treat knowledge and data preservation as part of critical infrastructure management. Assess record completeness, data accessibility, organisational memory, knowledge transfer and risks associated with the loss of expertise alongside physical assets and technical capabilities.
- Recommendation 5: Assess where European-level coordination can add value. Distinguish issues best addressed nationally from those that may benefit from shared access, expert networks, mobility, coordinated planning or other forms of European collaboration.
- Recommendation 6: Include governance and participation arrangements in the assessment. Consider responsible organisations, regulatory and institutional arrangements, and mechanisms for Civil Society participation alongside physical infrastructure, capabilities and knowledge systems.
- Recommendation 7: Account for changing vulnerability and external hazards. Reassess the interpretation of what are deemed to be 'critical infrastructures' periodically and consider climate-related hazards, transport dependencies, resilience and redundancy without duplicating existing national assessment requirements.

Each of these recommendations will be reassessed as the EURAD-2 work proceeds. From Year 3 onwards, additional stakeholder groups will be engaged, which are expected to include WMOs from Large Inventory Member States, LIMS(WMO), technical safety and support organisations and regulators, and Research Entities (REs), together with further Civil Society representatives. The inputs from all groups will then be screened to establish which issues are common across groups, which are specific to a particular group or programme type, and which reflect genuine differences of view about what should be regarded as critical. That screening, together with further development of the EURAD-2 infrastructure catalogue, will inform progression of the initial recommendations presented here into final recommendations to be reported in Deliverable D2.4 in Year 5 (2029) of the partnership. Recommendations may be confirmed, modified, merged or set aside as a result of that process.

Accordingly, Deliverable D2.3 should be regarded as an interim position rather than as a final standpoint or a definitive prioritisation of critical infrastructure needs. It records what has been learned from the first two engagements, sets out questions that remain open, and establishes the structured process through which further evidence will be gathered and assessed.

Keywords

Infrastructure, facility, catalogue, knowledge management, mobility, recommendations

Table of content

Executive Summary 4

Keywords 5

Table of content 6

List of figures 8

List of Tables 9

List of acronyms and abbreviations 10

1. Introduction 11

1.1 Purpose of Deliverable D2.3 and link to Deliverable D2.4 11

1.2 EURAD-2 Infrastructure Catalogue 11

1.3 Report structure 13

2. Approach to identify critical infrastructures across Europe 14

2.1 Infrastructure webinar 14

2.2 Stakeholder engagement approach 18

2.3 Stakeholder groups engagement in Year 2 19

3. Understanding critical infrastructure in RWM 20

3.1 What is meant by 'critical infrastructures'? Collected interpretations through stakeholder engagements in Year 2 20

4. Initial recommendations 23

4.1 Recommendation 1: Recognise context-dependent interpretations of critical RWM infrastructure 23

4.2 Recommendation 2: Assess disposal-route dependencies and long-term endpoint gaps .. 24

4.3 Recommendation 3: Introduce lifecycle, licensing and replacement indicators into the catalogue 25

4.4 Recommendation 4: Treat knowledge and data preservation as part of critical infrastructure management 25

4.5 Recommendation 5: Assess where European-level coordination can add value 26

4.6 Recommendation 6: Include governance and participation arrangements in the assessment of critical infrastructure 27

4.7 Recommendation 7: Account for changing vulnerability, including exposure to external hazards 28

5. Conclusion 29

5.1 Summary of work 29

5.2 Roadmap from initial to final recommendations 30

Appendix A. 32

Appendix A1: Questions raised during stakeholder engagements 33

Appendix A2: Record of key discussion points from stakeholder engagement with SIMS (WMO) representatives 36

Appendix A3: Record of key discussion points from stakeholder engagement with Civil Society representatives 37

References 40

List of figures

Figure 2-1: Responses to polling question 1: what types of RWM infrastructures are of particular interest to you? (73 respondents; multiple selections permitted). 15

Figure 2-2: Responses to polling question 2 as captured during the webinar: what gaps are you aware of in relation to RWM infrastructures? (86 responses). 16

Figure 2-3: Themes identified from responses to polling question 2: what gaps are you aware of in relation to RWM infrastructures? (86 responses, grouped into ten themes). 16

Figure 2-4: Responses to polling question 3 as captured during the webinar: which groups of stakeholders should we engage with to explore critical infrastructure needs? (65 responses). 17

Figure 2-5: Stakeholder groups identified from responses to polling question 3: which groups of stakeholders should we engage with to explore critical infrastructure needs? (65 responses, grouped into ten groups). 18

List of Tables

Table 3-1: Collected interpretations of critical infrastructures. 22

Table A 1: *Key feedback collected from the Stakeholder Engagement 1. Reference numbers are used in the report to underpin outcomes and recommendations.* 37

Table A 2: *Key feedback collected from the Stakeholder Engagement 2. Reference numbers are used in the report to underpin outcomes and recommendations.* 39

List of acronyms and abbreviations

Acronym	Definition
DG ENER	Directorate-General for Energy (European Commission)
DGR	Deep Geological Repository
DTMN	Difficult to Measure (radionuclides)
EC	European Commission
EU	European Union
EURAD	European Joint Programme on Radioactive Waste Management (2019-2024)
EURAD-2	European Partnership on Radioactive Waste Management (2024-2029)
GSEU	Geological Services for Europe
JRC	Joint Research Centre
KIT	Karlsruhe Institute of Technology
KM	Knowledge Management
LIMS	Large Inventory Member State
PMO	Project Management Office
R&D	Research and Development
RE	Research Entity
RWM	Radioactive Waste Management
SIMS	Small Inventory Member State
SMR	Small Modular Reactor
TSO	Technical Safety Organisation
WMO	Waste Management Organisation
WP	Work Package

1. Introduction

The EURAD-2 partnership [1] runs for five years from October 2024 through September 2029. The KM WP (WP2) is an integral component of the EURAD-2 work programme, dedicated to developing and maintaining knowledge and competencies vital to realising the RWM goals of European Member States.

The goals of EURAD-2 KM are to continue, and build upon, the KM programme established during EURAD of 2019-2024 [2], and for KM activities to become self-sustaining in the next 10 to 20 years. EURAD-2 KM activities support the transfer of RWM knowledge between organisations and generations, by establishing an inclusive, collaborative framework linked to the EURAD Roadmap [3].

Task 3 of the EURAD-2 KM WP, entitled “Knowledge application & know-how development” is aimed at providing guidance on best practices and available technologies, through the production and signposting of documentation reporting successful practices for RWM (sub-task 3.1), as well as through the analysis of available RWM infrastructures within European Member States (sub-task 3.2). These infrastructures include, for example, laboratories, computing clusters, facilities for treatment, storage and/or disposal of radioactive waste, and training facilities.

The overall goal of sub-task 3.2, which this deliverable concerns, is to initiate a reflection and possible initiative to maintain on the long term the most critical infrastructures (typically present now within more advanced and/or larger national programmes) for RWM on a European level, by allowing them to be shared between different national programmes, but also by examining possible ways to maintain and develop them at the state-of-the-art.

There are two parts to the task objectives:

- Firstly, to maintain a list of available RWM infrastructures, identifying where there is potential to host mobility actions over the course of EURAD-2. Recent activities to maintain and develop the EURAD-2 infrastructures ‘catalogue’ are summarised in Section 1.2.
- Secondly, to use this list to support analysis and engagement of the long-term sustainability of critical infrastructures, considering RWM infrastructure requirements across the EU and the extent to which these are expected to be met based on existing and currently planned facilities.

1.1 Purpose of Deliverable D2.3 and link to Deliverable D2.4

This report (Deliverable D2.3) provides a set of initial recommendations for the long-term maintenance of critical infrastructures for RWM at the European level, drawing on stakeholder engagement conducted during Year 2 of the partnership. It provides an overview of the inputs received from the stakeholder groups engaged with so far, as well as outlining a structure for the definition and assessment of the most critical RWM infrastructures. It also proposes initial actions to support long-term maintenance, access to, and preservation of, critical infrastructures.

Deliverable D2.3 does not reflect a final position; it should be regarded as an interim update, reporting on analysis conducted so far, and designed to promote discussion and aid forward planning. As such, it does not provide a set of final recommendations, but rather, a first set of inputs on existing needs and gaps, which will then be considered alongside other stakeholder groups’ inputs from engagements to be conducted in Years 3 and 4. Taken together, these will underpin a set of finalised recommendations, which will be presented in an updated version of this report, as Deliverable D2.4, to be produced towards the end of EURAD-2 in Year 5 (2029). The preliminary findings and recommendations presented here will be validated, refined and expanded through further stakeholder engagement, catalogue updates and analysis before the final recommendations are documented in Deliverable D2.4.

1.2 EURAD-2 Infrastructure Catalogue

The scope of infrastructures considered as a starting point for the stakeholder engagement discussions and analysis reported in this deliverable is mostly based on the existing EURAD/EURAD-2 catalogue of

RWM infrastructures [4]. This catalogue was initially developed within EURAD WP13 on Training and Mobility to identify infrastructures available to support mobility actions and knowledge exchange within the EURAD community. The emphasis of the EURAD-2 infrastructures catalogue is on physical infrastructures supporting radioactive waste management activities, thereby complementing other available catalogues of facilities (such as the catalogue produced by the OFFERR project which focuses on nuclear research facilities). Such facilities include:

- Disposal sites
- Storage facilities
- Waste treatment facilities
- Education and research laboratories
- Underground laboratories
- Research laboratories
- Research reactors
- Modelling facilities
- Testing facilities

The EURAD-2 infrastructure catalogue builds upon initial work conducted in EURAD through updates (conducted approximately annually) that are implemented in response to reviewing existing entries, adding new infrastructures and collecting additional information from EURAD-2 partners, end users and stakeholders. Recent updates are reported elsewhere in EURAD-2 Milestone 23 [5] and summarised below. Future updates will also highlight complementary information available in other, related infrastructure tools, reports and catalogues, and will enhance the functionality available for exploring information in the catalogue.

Catalogue updates in 2025 were determined through a survey distributed to EURAD-2 partners, end users and stakeholders. An updated version was compiled using information from the previous EURAD School infrastructure list [4], survey responses and direct contact with respondents where clarification was required. The updated catalogue identified 36 new infrastructures that were not included in the previous list and updated 12 existing entries, following responses from 39 organisations. The updated list of 99 infrastructures in total was published on the EURAD School website at https://euradschool.eu/infrastructures/ [4], including descriptions of each infrastructure and additional information regarding the possibility of mobility actions.

The catalogue includes information on a broad range of infrastructure types relevant to RWM activities. The updated EURAD-2 list contains infrastructures belonging to REs, WMOs and Technical Safety Organisations (TSOs), covering different stages of radioactive waste management [5]. The research, development and demonstration priorities that these infrastructures support are set out in the EURAD Strategic Research Agenda [7], and a purpose of the catalogue is to make visible the facilities on which delivery of that agenda depends.

The types of infrastructures currently represented include:

- Underground laboratories and underground research facilities, supporting research related to geological disposal, underground experiments and demonstration activities;
- Research laboratories and specialist experimental facilities, including analytical and radioanalytical laboratories, research and testing facilities, and specialised laboratories supporting RWM-related activities;
- Waste treatment and conditioning facilities, supporting activities such as radioactive waste characterisation, treatment, conditioning and preparation for storage or disposal;
- Storage and disposal facilities;
- Modelling, simulation and computational capabilities, including modelling laboratories and high-performance computing facilities supporting numerical simulations and safety assessment activities;

- Training and education infrastructures, supporting the development of RWM competencies and knowledge transfer.

The information collected for each infrastructure entry includes:

- infrastructure name;
- host organisation;
- organisation type;
- infrastructure type;
- country;
- contact information (if available);
- possibility for mobility actions.

Contact information is held and published in the catalogue only where the individual or organisation concerned has given consent for it to be shared, in line with the data protection requirements of the General Data Protection Regulation (GDPR) and the EURAD-2 Data Management Plan.

1.3 Report structure

The rest of this report has the following structure:

- Section 2 summarises the approach followed to explore critical infrastructure needs through structured engagement with different stakeholder groups, including the engagement method, the groups consulted in Year 2 and the groups planned for subsequent years. This includes the infrastructure webinar held in March 2026, which was the first engagement activity undertaken and which informed the planning of the targeted engagements that followed.
- Section 3 examines how the phrase ‘critical infrastructure’ is understood in the context of RWM and brings together the interpretations collected through the Year 2 stakeholder engagements.
- Section 4 presents seven initial recommendations for the long-term maintenance of critical RWM infrastructure, setting out for each the issue identified, supporting evidence, potential contributors and the expected output for Deliverable D2.4.
- Section 5 concludes the report by summarising the work completed and describing the roadmap for developing the initial findings and recommendations into the final recommendations to be reported in Deliverable D2.4.
- Appendix A1 reproduces the questions and supporting material used during the stakeholder engagements. Appendix A2 records the key discussion points from the engagement with SIMS(WMO) representatives, while Appendix A3 records those from the engagement with Civil Society representatives.
- The report closes with a list of references.

2. Approach to identify critical infrastructures across Europe

Identification of critical RWM infrastructures across Europe requires information that the infrastructure catalogue alone cannot provide. The catalogue records what exists and, following the 2025 update, whether an infrastructure is available to support mobility actions. It does not record why a given infrastructure matters to a national programme, how long it is expected to remain available, or what would follow from its loss. That information is held by the organisations and communities that depend on the infrastructure concerned.

The approach to examine these aspects is therefore based on structured engagement with identified stakeholder groups. Each engagement serves three purposes: to collect the interpretations of what critical infrastructures constitute within a given stakeholder context; to screen current and anticipated infrastructure needs and the gaps associated with them; and to formulate preliminary recommendations to address infrastructure gaps. Since different stakeholder groups are expected to bring differing perspectives on critical infrastructures, infrastructure needs and potential gaps, the engagements are conducted separately by group rather than as a combined exercise. This makes the discussions more manageable, enables a wider range of stakeholders to contribute, and ensures that group-specific perspectives are recorded before commonalities and differences are screened across groups.

2.1 Infrastructure webinar

The first activity in this engagement programme was an open (public) webinar on European infrastructure needs for radioactive waste management, held online on 9 March 2026. The webinar was addressed to the wider EURAD-2 community and other interested parties, and had three purposes: to introduce the infrastructure activities carried out under Sub-task 3.2, including the updated EURAD-2 RWM infrastructure catalogue; to present a number of related European infrastructure initiatives; and to gather initial input from participants on infrastructure interests, perceived gaps, and the stakeholder groups that should be involved in the work that followed.

Presentations were given on four initiatives of relevance to RWM infrastructure: Geological Services for Europe (GSEU), presented by EuroGeoSurveys; radionuclide speciation and analytics capabilities at the Karlsruhe Institute of Technology (KIT); the policy perspective of the European Commission Directorate-General for Energy (DG ENER); and related work undertaken at the Joint Research Centre (JRC). These contributions illustrated the range of initiatives already operating at European level and the scope for connecting them to the work of Sub-task 3.2.

The final part of the webinar was an interactive session built around three live polling questions. As was noted at the time, RWM infrastructure is a broad and complex subject, and the polls were intended to gather early information to assist planning and to maximise the value of the analysis that would follow. The responses from participants (who took part on a voluntary basis) are summarised below.

The first question asked participants which types of RWM infrastructures were of particular interest to them, offering ten categories from which multiple selections could be made. It should be noted that this question was not explicitly linked to the concept of which RWM infrastructures are considered to be most critical (as discussed later in this report). Rather, it aimed to identify which facilities were of greatest interest to the audience, which could help inform future updates to the EURAD infrastructure catalogue. The responses are presented in *Figure 2-1*. Disposal facilities were selected most frequently, by 52% of the 73 respondents, followed by research laboratories (38%) and underground laboratories (33%). Pre-treatment and treatment facilities (32%), conditioning facilities (27%) and storage facilities (27%) also attracted substantial interest. Test and pilot facilities and educational and training facilities were each selected by 22% of respondents, data management facilities by 18% and high-performance computing facilities by 12%. Interest was therefore distributed across the full waste management lifecycle rather than concentrated on a single category of facility, and extended beyond physical waste management facilities to capabilities supporting training, data management and modelling.

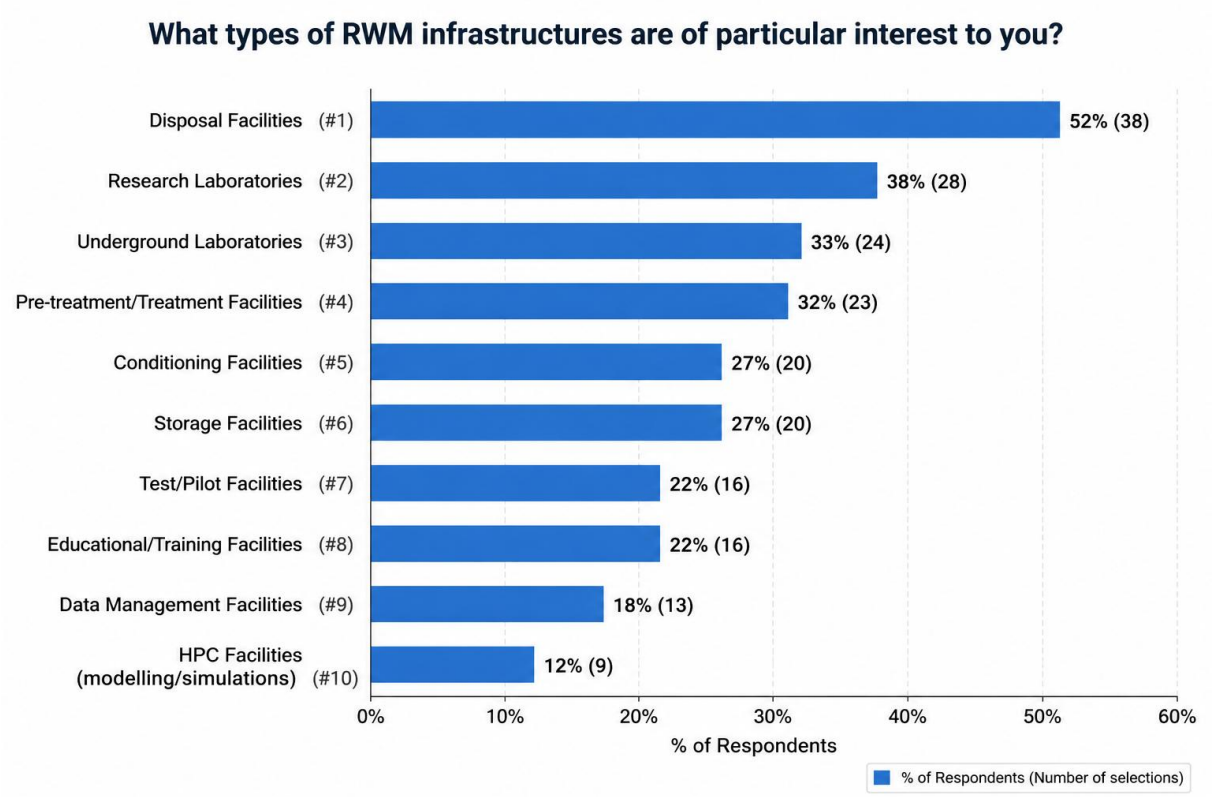


Figure 2-1: Responses to polling question 1: what types of RWM infrastructures are of particular interest to you? (73 respondents; multiple selections permitted).

The second question asked participants what gaps they were aware of in relation to RWM infrastructures. This was an open question, and the responses were displayed to participants as a word cloud during the session, reproduced in *Figure 2-2*. The 86 responses received were subsequently grouped by the task team into ten themes, shown in *Figure 2-3*. The frequency with which each theme was mentioned indicates its relative prominence among the responses received, rather than providing an objective measure of its importance or of which infrastructures are considered most critical. The development of geological disposal facilities was the most frequently cited gap, followed by strategic planning and governance, and data management and information sharing, which attracted a comparable number of responses to one another. Ageing infrastructure and the loss of experienced staff, and waste packages and characterisation, were also prominent. Pilot and scale-up facilities, research and development infrastructure, legacy and novel waste streams, networking and transnational access, and public acceptance and financing completed the set. A notable feature of these responses is that several of the most frequently raised gaps concern governance, data and workforce rather than physical facilities alone.



Figure 2-2: Responses to polling question 2 as captured during the webinar: what gaps are you aware of in relation to RWM infrastructures? (86 responses).

RWM Infrastructure Gap Themes

Gap Theme	Response Count	Representative Examples
1. Geological Disposal & DGR* Development	12	• Lack of operational DGRs; DGR development gaps; • deep borehole data; underground laboratories
2. Strategic Planning & Governance	9	• Strategic plans missing; governance gaps; • long political decision processes; inappropriate government involvement
3. Data Management & Information Sharing	9	• Missing/open-access data; common databases; data management facilities; geological data; track & trace
4. Ageing Infrastructure & Workforce	7	• Ageing lab infrastructures; ageing interim storage; shortage of trained staff; expert retirement
5. Waste Packages & Characterisation	7	• Waste packages; DTMN measurements; waste streams; classification of radioactive waste; legacy wastes
6. Pilot/Scale-up Facilities	6	• Pilot plants; scale-up/pilot plant; test/pilot scale facilities; synchrotron access
7. R&D Infrastructure	6	• Spent fuel laboratory; research reactors; irradiation facilities; modern engineering services
8. Legacy Waste & Novel Streams	5	• Legacy wastes; SMR and novel waste streams; resins; thermal treatment; problematic conditioned waste
9. Networking & Transnational Access	5	• Network building; transnational access to RWM facilities; RWM infrastructure and regulation; common framework
10. Public Acceptance & Financing	4	• Public concern on sites; long-term operation financing; uncertainty in cost estimates; host community engagement

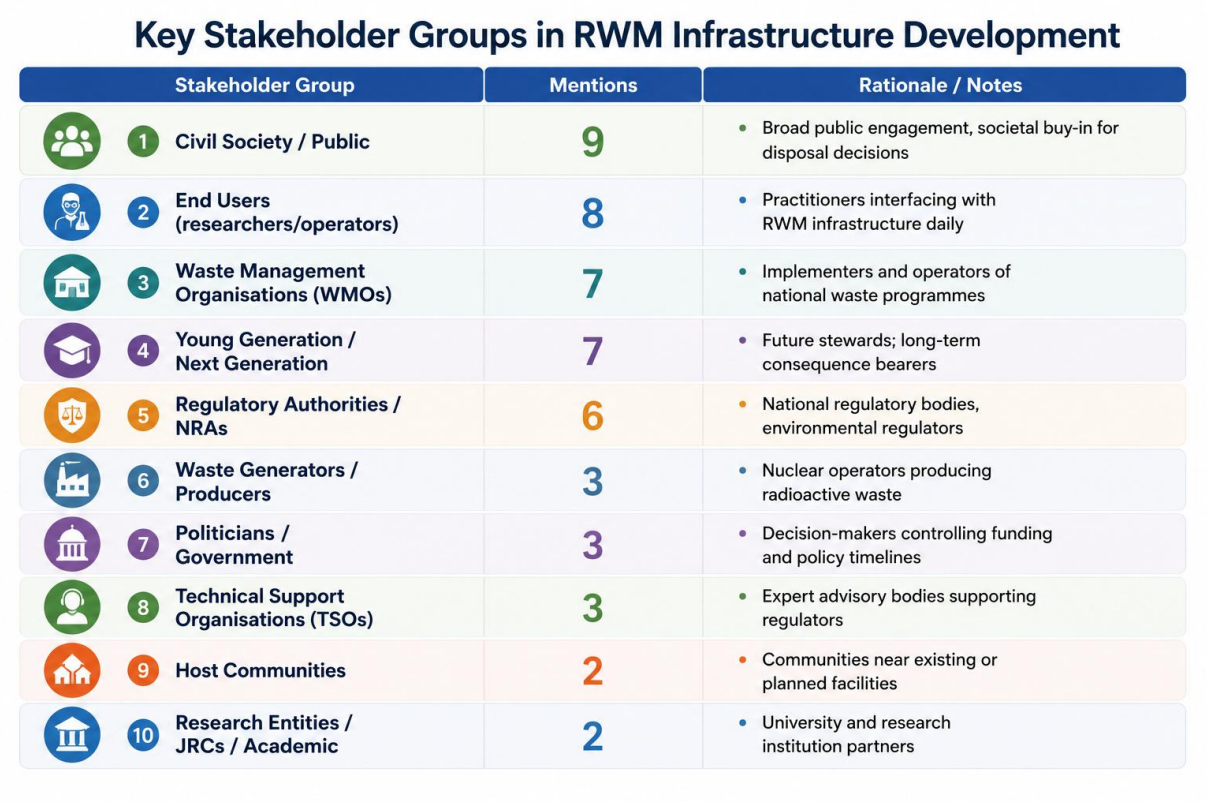
**DGR – Deep Geological Repository*

Figure 2-3: Themes identified from responses to polling question 2: what gaps are you aware of in relation to RWM infrastructures? (86 responses, grouped into ten themes).

The third question asked which groups of stakeholders should be engaged in exploring critical infrastructure needs. The responses as displayed during the session are reproduced in *Figure 2-4*. The 65 responses received were subsequently grouped by the task team into ten stakeholder groups, shown in *Figure 2-5*. Civil Society and the public were mentioned most often, followed by end users such as researchers and operators, waste management organisations, and the young generation. Regulatory authorities, waste generators, politicians and government, technical safety organisations, host communities and research entities were also identified. The stakeholder group labels shown in Figure 2.1-5 reproduce the terms used by webinar participants; elsewhere in this report TSO is expanded as Technical Safety Organisation, following SITEX usage.



Figure 2-4: Responses to polling question 3 as captured during the webinar: which groups of stakeholders should we engage with to explore critical infrastructure needs? (65 responses).



Key Stakeholder Groups in RWM Infrastructure Development

Stakeholder Group	Mentions	Rationale / Notes
1 Civil Society / Public	9	Broad public engagement, societal buy-in for disposal decisions
2 End Users (researchers/operators)	8	Practitioners interfacing with RWM infrastructure daily
3 Waste Management Organisations (WMOs)	7	Implementers and operators of national waste programmes
4 Young Generation / Next Generation	7	Future stewards; long-term consequence bearers
5 Regulatory Authorities / NRAs	6	National regulatory bodies, environmental regulators
6 Waste Generators / Producers	3	Nuclear operators producing radioactive waste
7 Politicians / Government	3	Decision-makers controlling funding and policy timelines
8 Technical Support Organisations (TSOs)	3	Expert advisory bodies supporting regulators
9 Host Communities	2	Communities near existing or planned facilities
10 Research Entities / JRCs / Academic	2	University and research institution partners

Figure 2-5: Stakeholder groups identified from responses to polling question 3: which groups of stakeholders should we engage with to explore critical infrastructure needs? (65 responses, grouped into ten groups).

The outcomes of the webinar informed the work reported in this deliverable in three ways. First, the breadth of infrastructure types identified in response to the first question supported the broad interpretation of infrastructure adopted for the subsequent engagements, discussed in Section 3. Second, the gap themes identified in response to the second question informed the topics covered by the structured interview question pack described in Subsection 2.2. Third, the stakeholder groups identified in response to the third question were used in selecting the groups approached for the Year 2 engagements, described in Subsection 2.3: Civil Society and waste management organisations were respectively the first and third most frequently mentioned groups. The webinar therefore served as the starting point for the engagement programme, providing a broad initial indication of priorities which the targeted engagements then examined in greater depth with specific stakeholder groups.

2.2 Stakeholder engagement approach

Each engagement (of which two have been held so far) takes the form of a structured interview of 90 minutes, chaired by the sub-task 3.2 team and held online. A slide pack setting out the topics for discussion is circulated to participants in advance, together with the context of the sub-task and its link to written deliverables. The slide pack is organised into six thematic parts, the last of which is optional. This provides structure to the engagement and facilitates pre-preparation, while allowing the discussion itself to move between topics according to the priorities of the participants.

The topics addressed in the slide pack cover the following areas:

- general perspectives on what makes an RWM infrastructure critical, and on the interpretations that apply in the context of the participant;
- the current status of RWM infrastructures relevant to the programme or role of the participant, including those which are relied upon and which are vulnerable, ageing or difficult to access;

- future needs, including whether existing and planned storage and disposal routes are sufficient for anticipated waste streams, and whether legacy issues are adequately covered by current infrastructure;
- recommendations, including which needs could be addressed through sharing, mobility, expert networks, co-investment or European-level coordination;
- other aspects considered relevant by participants but not covered by the preceding topics;
- the infrastructures of the participating organisation, including any information that should be added to the European infrastructure catalogue to support planning and access. This part is optional.

The slide pack used for the Year 2 engagements is reproduced in Appendix A1.

Inputs are collected in two ways. The primary input is the discussion during the session, which is documented by the sub-task team. Sessions are recorded for internal reference only, with the consent of participants, so that notes taken can be checked against what was said. Participants may also submit written responses against the questions in the slide pack, either before or after the session. All inputs are anonymised in reporting, and participants are invited to review the draft deliverable to confirm that their contributions have been represented accurately.

2.3 Stakeholder groups engagement in Year 2

Two engagements were held during EURAD-2 Year 2:

- **SIMS(WMO), held on 7 July 2026**. Four participants were drawn from waste management organisations and national bodies in four Member States with comparatively small radioactive waste inventories (Austria, Estonia, Italy and Portugal). The reference notes from this engagement are provided in Appendix A2.
- **Civil Society, held on 13 July 2026**. Six participants were drawn from Civil Society organisations active in radioactive waste management in four Member States as well as the United Kingdom (UK), including representatives of a European Civil Society network, national environmental organisations, a local community organisation and an elected local representative from a community hosting waste management facilities. Four representatives were based in countries with large radioactive waste inventories (Bulgaria, France and the UK); two were based in SIMS countries (Austria and Denmark). The reference notes from this engagement are provided in Appendix A3.

The first two engagements were set up with Civil Society representatives and WMOs in response to the feedback received during the March 2026 webinar. In response to the question on which stakeholder groups should be engaged, the most mentions were given to Civil Society and the public, to end users (which encompasses several groups) and to WMOs, WMOs being a subset of end users. WMO engagement is being further subdivided into SIMS(WMO) and LIMS(WMO), recognising the very different contexts for national waste management practices as a function of the size of their inventories. SIMS(WMO) representatives were engaged in Year 2 and engagement with LIMS(WMO) representatives is expected to follow in Year 3. Engaging Civil Society and SIMS(WMO) representatives separately provided an early indication of the range of interpretations that the assessment framework will need to accommodate: SIMS(WMO) representatives approach infrastructure primarily from the position of delivering a national programme with limited resources, while Civil Society representatives approach it from the position of transparency, participation and long-term societal responsibility.

The remaining stakeholder groups will be engaged from Year 3 onwards. These are expected to include LIMS(WMO), technical safety and support organisations and regulators, and research entities, together with any further Civil Society representatives identified through the engagements already held. The composition and sequencing of these engagements is discussed in Section 5.

3. Understanding critical infrastructure in RWM

In the context of RWM across Europe, the concept of critical infrastructure needs to be interpreted more broadly than the continued availability of individual physical assets. The first stakeholder engagement with representatives from smaller inventory Member State programmes showed that what is meant by 'critical' is not consistently interpreted across national contexts, and that the term can have different meanings depending on the maturity, scale and institutional setting of each programme. In some contexts, an infrastructure may be considered critical because it is essential to implementing a national programme; in others, because it is approaching the end of its design lifetime, is no longer state-of-the-art, is difficult to access, or because its absence would create a gap in a future waste management route.

Engagements so far have confirmed that 'critical' should not be regarded only as an engineering attribute. It should also be understood in relation to programme delivery, licensing and regulatory continuity, knowledge preservation, stakeholder confidence, societal expectations and intergenerational responsibility. This broader interpretation is important because, in RWM, the consequences of losing access to an infrastructure or capability may extend beyond immediate technical performance. They may affect the ability of a national programme to progress, to maintain a credible safety and licensing basis, to preserve essential knowledge, to demonstrate transparency and progress in waste management to stakeholders, and to avoid transferring unresolved responsibilities to future generations.

3.1 What is meant by 'critical infrastructures'? Collected interpretations through stakeholder engagements in Year 2

Working definition of critical RWM infrastructure:

Based on initial stakeholder engagement, **critical RWM infrastructure can be understood as any physical asset, specialist capability, knowledge or data system, access mechanism, storage or disposal pathway, or institutional arrangement whose loss, degradation, obsolescence or inaccessibility would create significant consequences for the safe, timely and credible implementation of radioactive waste management.**

This definition deliberately covers several dimensions, because the same infrastructure may be critical for different reasons in different national programmes.

The collected interpretations from discussions with stakeholders thus far are grouped and presented in Table 3-1. It is worth noting that many of these interpretations are relevant to the consideration of critical infrastructures in other fields, not only in relation to radioactive waste management.

Interpretation of critical infrastructure	Description
Programme-critical infrastructure	Facilities, capabilities or institutional arrangements that are necessary to implement national radioactive waste management programmes, including treatment, conditioning, storage, disposal, research, assessment and training functions. The Civil Society engagement extended this to the organisations responsible for delivering national programmes, noting that where no organisation has yet been designated, its absence may itself constrain the progress of a programme.
Time-critical infrastructure	Facilities approaching the end of their design lifetime, licensing period or safe operating envelope, including assets that may require extension, replacement, relicensing or major safety reassessment within the coming decades. Where a capability exists at only a small number of European facilities, the projected lifetimes of those facilities may also need to be compared, so that a capability is not lost across Europe at the same time (a so-called 'cliff edge' effect).
Capability-critical infrastructure	Specialist laboratories, technical expertise, modelling capabilities, safety assessment competence, regulatory support functions and other capabilities that are difficult to replace if lost. Specialised analytical equipment available at only two or three facilities across Europe, and subject to recurrent funding decisions, was given as an example of a capability that would be at risk, and difficult to replace.
Route-critical infrastructure	Storage and disposal pathways, including interim storage and final disposal routes, whose absence or delay prevents a complete waste management solution from being implemented. Uncertainty over the timing of disposal availability was identified as a particular constraint, since the number of storage facilities required, and the period for which they are required, cannot be determined until a disposal endpoint is established.
Knowledge-critical infrastructure	Data, records, historical waste information, knowledge management systems and organisational memory needed to support safety cases, licensing, waste characterisation and strategic decisions. Particular emphasis was placed on preserving knowledge and memory about facilities and sites, including whether they have been identified as critical, and on the arrangements required once institutional control ceases.
Societally critical infrastructure	Infrastructures, decisions or arrangements whose availability and credibility affect stakeholder confidence, social acceptance, transparency and trust in long-term RWM decisions. Access to education and information for both current and future generations was identified as an enabling condition for wider community involvement in decisions about radioactive waste management.
Governance-critical infrastructure	Regulatory, institutional and decision-making arrangements, including the organisations responsible for radioactive waste management and the mechanisms through which Civil Society participates in decisions. Where such mechanisms are embedded in law, they were considered to support the continuity, transparency and long-term funding of national programmes.

Interpretation of critical infrastructure	Description
Legacy-related infrastructure	Legacy sites and legacy waste, together with the tools, networks and capabilities required to characterise, assess and manage them. Management needs associated with legacy infrastructure often require a degree of retrospective 'backfitting' to offset a lack of up-front planning, or adjustments to account for longer-than-planned operational lifetimes. They may remain latent and then become urgent at short notice, and views differ on whether the term 'critical infrastructure' attaches to the sites themselves or to the means of managing them.
Resilience-critical infrastructure	Infrastructures whose exposure to external hazards, including climate-related hazards and disruption to transport routes, may not have been identified in earlier assessments. This interpretation implies that critical infrastructure and vulnerability require periodic reassessment rather than a single determination.

Table 3-1: Collected interpretations of critical infrastructures.

4. Initial recommendations

The recommendations presented in this section are preliminary and derive from initial stakeholder engagement with SIMS(WMO) representatives and with representatives of Civil Society. These recommendations do not constitute final recommendations for EURAD-2; rather, they provide an initial framework for discussion, validation and refinement through subsequent stakeholder engagements. Each recommendation is linked, where possible, to an identified issue, the evidence base recorded in Appendices A2 and A3, the actors who may contribute to follow-up, and the action expected before the final recommendations are consolidated in Deliverable D2.4 in Year 5 (2029).

4.1 Recommendation 1: Recognise context-dependent interpretations of critical RWM infrastructure

Issue identified	Stakeholder engagement showed that the term 'critical infrastructure' is understood in multiple ways across stakeholder groups and national RWM contexts. These interpretations may relate to programme dependency, ageing facilities, loss of state-of-the-art capability, gaps in future waste management routes, knowledge and data vulnerabilities, institutional arrangements, or social acceptance concerns. The Civil Society engagement broadened this further, associating the term 'critical infrastructure' with safety and a shared safety culture, with the organisations and governance arrangements responsible for waste management, and with national policy requirements such as long-term retrievability obligations. A narrower interpretation, focused on the specialised equipment required for particular analyses or research, was also expressed.
Reference	Appendix A2, Ref. 1; Appendix A3, Ref. 1, 2, 3 and 4; Section 3.
Preliminary recommendation	A working definition of critical RWM infrastructure was presented in Section 3.1. This explicitly recognises the range of possible interpretations of the term 'critical RWM infrastructure', including those relating to programme maturity, national responsibilities, infrastructure function, lifecycle status and timescales, access conditions, knowledge preservation needs and societal expectations. The working definition therefore provides a common starting point to develop a flexible approach to assess and manage critical RWM infrastructures, without imposing a uniform interpretation of what is critical across different national programmes and stakeholder groups. However, the definition should be used with caution, noting that adoption of a single definition across Europe could risk masking the wide range of relevant considerations that has been observed and the necessity for context-specific approaches to respond to particular infrastructure needs. Infrastructure management strategies should aim to distinguish between issues that are properly addressed at a national level and those that require a pan-European perspective.
Actors/contributors to follow-up	KM WP / Subtask 3.2 team; SIMS(WMO) representatives; LIMS(WMO) representatives; TSOs and regulators; REs; Civil Society representatives; EURAD-2 Colleges and end-user groups contributing to the interpretation and validation of context-dependent criteria.
Expected output for Deliverable D2.4	A structured, context-sensitive assessment framework and shared terminology that make the different forms of critical infrastructure aspects explicit, comparable and transparent across the European RWM community, without reducing them to a single generic definition.

4.2 Recommendation 2: Assess disposal-route dependencies and long-term endpoint gaps

Issue identified	Final disposal solutions, particularly geological disposal facilities, may be absent, delayed or uncertain in national programmes. Waste streams, including those arising from research reactors or legacy facilities, may not have been sufficiently anticipated in national planning and this continues to be a risk for future arisings. Civil Society representatives identified uncertainty over the timing of disposal availability as the principal constraint on infrastructure planning, since the number of storage facilities required, and the period for which they are required, cannot be determined until a disposal endpoint is defined. Legacy sites and legacy waste were also raised as a distinct category whose management needs may become urgent at short notice.
Reference	Appendix A2, Ref. 2 and Ref. 3; Appendix A3, Ref. 7 and Ref. 11.
Preliminary recommendation	The assessment of critical infrastructure should explicitly examine dependencies on storage and disposal routes, including whether existing or planned routes provide a credible long-term endpoint for current, future and legacy waste streams. The findings should be explored further through continued discussion with SIMS(WMO) representatives and relevant storage, disposal and other facility operators, and through planned engagement with LIMS(WMO), technical safety organisations, regulators and Civil Society stakeholders. These discussions should recognise that many RWM infrastructures may remain critical until all applicable wastes can be transferred safely to the next stage of the waste lifecycle. The assessment should also consider legacy sites and legacy waste, including whether the interpretation of 'critical infrastructure' attaches to the sites themselves or to the capabilities required to characterise and manage them.
Actors/contributors to follow-up	SIMS(WMO) and LIMS(WMO) representatives; national waste owners and programme owners; disposal and storage facility operators; TSOs and regulators; REs with expertise in waste inventory forecasting, disposal concepts and legacy or research reactor waste streams; Civil Society representatives for societal acceptability and long-term endpoint considerations.
Expected output for Deliverable D2.4	A clearer distinction between infrastructure gaps that are linked to physical capacity, programme planning, and the absence or inaccessibility of final disposal routes.

4.3 Recommendation 3: Introduce lifecycle, licensing and replacement indicators into the catalogue

Issue identified	The current EURAD-2 RWM infrastructure catalogue is useful for visibility, information exchange and promoting mobility actions, but does not yet provide enough information to assess long-term availability, licensing risks, replacement needs or gaps. The Civil Society engagement additionally identified limitations in the coverage of the catalogue and in the basis on which entries are collected. Reliance on voluntary inputs, and the original purpose of supporting mobility actions, were considered to have left certain categories of site under-represented in some countries.
Reference	Appendix A2, Ref. 4 and Ref. 6; Appendix A3, Ref. 5 and Ref. 6.
Preliminary recommendation	Future catalogue updates should consider adding fields on expected infrastructure lifetime, licensing status, operational constraints, planned upgrades or extensions, safety reassessment requirements, future availability, access conditions, programme dependency, potential for sharing, and the status of associated knowledge and data systems. Consideration should also be given to whether entries could be informed by inputs from national regulators, given the close link between availability of critical infrastructures and safety, with the resulting information reviewed by other national actors, and to whether exposure to external hazards should be recorded.
Actors/contributors to follow-up	Catalogue owners and KM WP / Subtask 3.2 team; infrastructure host organisations; WMOs, TSOs and REs providing facility-level data; facility operators and technical managers; regulators or licensing authorities where relevant; EURAD-2 mobility and training contributors to ensure catalogue fields remain compatible with access and knowledge-transfer objectives.
Expected output for Deliverable D2.4	An enhanced catalogue structure that can help identify potential 'cliff edges' in availability or licensing before they become programme constraints.

4.4 Recommendation 4: Treat knowledge and data preservation as part of critical infrastructure management

Issue identified	Critical gaps are not limited to physical infrastructure, and two distinct types of record are relevant. The first is waste characterisation records, which are needed to support robust safety, licensing and strategic decision-making and which are often incomplete, particularly for historical waste streams. The second is the wider body of records relating to facilities and sites, which may be important while a facility is operating or being decommissioned but which are not necessarily required over the long term. Civil Society representatives placed particular emphasis on preserving knowledge and memory about facilities and sites, and on the period after institutional control ceases, when communities may no longer have access to the information or resources required for long-term monitoring. The relevance of independent long-term monitoring of disposal facilities, both during and after the period of institutional control, was highlighted as an important tool for building and maintaining stakeholder confidence.

Reference	Appendix A2, Ref. 5; Appendix A3, Ref. 13.
Preliminary recommendation	Management of critical infrastructures should encompass knowledge preservation, data availability and organisational memory alongside physical assets and technical capabilities. Future catalogue updates or stakeholder questionnaires should seek information on record completeness, data accessibility, knowledge transfer arrangements and risks linked to loss of expertise. Aspects relating to preserving expertise and knowledge transfer when a specialist facility closes, or when staff leave/retire may also be relevant grounds for mobility applications under Task 4 of EURAD-2 KM. The level of detail that can realistically be captured in the catalogue will vary: facility-specific information may be constrained by confidentiality or by difficulty in identifying the appropriate contacts, so this should be pursued at the level of national programmes in the first instance, with facility-level detail sought only where it is readily available. Consideration should also be given to the arrangements required to maintain knowledge and monitoring capability beyond the period of active institutional control.
Actors/contributors to follow-up	KM WP / Subtask 3.2 team; knowledge management leads within WMOs, TSOs and REs; waste inventory and records managers; safety case and licensing specialists; data management and digital preservation experts; training and mobility coordinators; Civil Society representatives where transparency, accessibility and trust in preserved knowledge are relevant.
Expected output for Deliverable D2.4	A broader assessment framework recognising data and knowledge management systems as enabling conditions for infrastructure to remain usable, licensable and credible over time.

4.5 Recommendation 5: Assess where European-level coordination can add value

Issue identified	Some vulnerabilities may not be fully resolvable by individual programmes acting alone. Greater visibility, forward planning and dialogue across stakeholder groups may be needed to identify shared gaps and possible European-level responses. Civil Society representatives noted that shared solutions had not featured in the discussion of critical infrastructures despite their importance for programmes lacking funding, capacity or knowledge, and pointed to existing collaborative arrangements between national programmes as a possible reference point. It was also suggested that a European legal framework setting out how Member States with small inventories could cooperate might provide a basis for such arrangements. Separately, the European Commission has a continuing role beyond establishing the legislative framework, in pursuing implementation of and compliance with Member State obligations under Council Directive 2011/70/Euratom. This was reinforced during the Year 2 engagements, where a SIMS(WMO) representative highlighted the role the EU could play in addressing waste management challenges within their national programme.
Reference	Appendix A2, Ref. 6 and Ref. 7; Appendix A3, Ref. 8.

Preliminary recommendation	For Deliverable D2.4, the role of European-level coordination should be assessed issue by issue. The SIMS feedback should be screened with LIMS(WMO), technical safety organisations and Civil Society to determine which issues are common across groups, which are specific to smaller programmes, and which could be addressed through shared access arrangements, mobility actions, expert networks, coordinated forward planning or structured dialogue. Existing collaborative arrangements between national programmes should be examined to establish what has worked in practice and under what conditions. The assessment should also consider the role of the European Commission in pursuing implementation of, and compliance with, Member State obligations under the Waste Directive, in addition to its role in setting the legislative framework.
Actors/contributors to follow-up	EURAD-2 coordination and KM WP leadership; EURAD-2 Colleges and end-user groups; European Commission and/or programme-level governance bodies where appropriate; SIMS(WMO), LIMS(WMO), TSOs, REs and Civil Society representatives; infrastructure hosts and operators; mobility, training and expert-network coordinators able to identify where shared access, joint planning or European dialogue could add value.
Expected output for Deliverable D2.4	A set of final recommendations distinguishing actions best addressed nationally, actions requiring European coordination, and topics requiring further evidence before specific measures can be proposed.

4.6 Recommendation 6: Include governance and participation arrangements in the assessment of critical infrastructure

Issue identified	The Civil Society engagement identified regulatory, institutional and decision-making arrangements, and the organisations responsible for radioactive waste management, as falling within the scope of critical infrastructure rather than outside it. Moreover, mechanisms for Civil Society participation that are embedded in law were considered to contribute to the continuity, transparency and long-term funding of national programmes. It was also noted that access to education and information for both current and future generations is an enabling condition for wider community involvement in discussion, debate and decision-making, and that Civil Society should be involved in determining what is regarded as critical.
Reference	Appendix A3, Ref. 1, 2, 9 and 10; Section 3.
Preliminary recommendation	The assessment of critical infrastructure should explicitly consider governance and institutional arrangements alongside physical assets, specialist capabilities and knowledge systems. This should include the organisations responsible for delivering national programmes, the mechanisms through which Civil Society participates, and the extent to which such mechanisms are formally established. The scope and treatment of this dimension should be screened with LIMS(WMO), technical safety organisations, regulators and REs before conclusions are drawn, as interpretations are expected to differ between groups.

Actors/contributors to follow-up	KM WP / Subtask 3.2 team; Civil Society representatives; WMOs and programme owners; regulators and technical safety organisations; national bodies responsible for public participation arrangements; EURAD-2 Colleges and end-user groups.
Expected output for Deliverable D2.4	A clear position on whether, and on what basis, governance and participation arrangements are treated as critical infrastructure within the assessment framework, and on how this dimension relates to the physical and capability dimensions.

4.7 Recommendation 7: Account for changing vulnerability, including exposure to external hazards

Issue identified	The Civil Society engagement noted that infrastructures not previously assessed as vulnerable may become so, and that transport routes may be critical to radioactive waste management. Recent wildfires close to a listed research infrastructure were cited as an illustration. The associated observation was that the term 'critical infrastructures' and vulnerability are not fixed, and that what is regarded as critical may evolve over a horizon of five to twenty years.
Reference	Appendix A3, Ref. 8 and 12; Section 3.
Preliminary recommendation	The assessment approach should treat critical infrastructures and vulnerability as subject to periodic reassessment rather than as a single determination. Consideration should be given to whether exposure to external hazards, including climate-related hazards and dependence on transport routes, should be recorded for infrastructures identified as critical, and to the relationship between this work and existing environmental impact assessment and resilience requirements at national level. Redundancy of access and supply arrangements should also be considered.
Actors/contributors to follow-up	KM WP / Subtask 3.2 team; infrastructure hosts and operators; WMOs, TSOs and regulators; REs with relevant expertise in hazard and resilience assessment; Civil Society representatives; transport and logistics specialists where relevant.
Expected output for Deliverable D2.4	An indication of whether exposure to external hazards should be taken into account when infrastructure needs and gaps are discussed with national programmes and, if so, how it would be recorded and periodically reviewed without duplicating existing national assessment requirements. This is not intended to support a comprehensive European assessment ranking individual infrastructures by criticality, which would be both subjective and highly dependent on the time at which it was carried out.

5. Conclusion

5.1 Summary of work

Work under sub-task 3.2 during Year 2 of EURAD-2 has proceeded along two connected lines. The first was the review and update of the European catalogue of RWM infrastructures, reported in Milestone 23 (see Section 1.2), which added 36 infrastructures not previously listed and updated 12 existing entries on the basis of responses from 39 organisations, and which introduced information on whether each infrastructure is available to support mobility actions. The second was the start of the stakeholder engagement programme, intended to establish what is understood by 'critical infrastructure' and where needs and gaps are considered to lie. Two engagements were held: with SIMS(WMO) representatives on 7 July 2026 and with Civil Society representatives on 13 July 2026. The engagement programme began with an open webinar held on 9 March 2026, at which three polling questions were used to obtain an initial view of infrastructure priorities, gaps and the stakeholder groups to be approached.

The principal conclusion from these engagements is that assigning an RWM infrastructure as 'critical' cannot be established from the characteristics of the facility alone. Across the two engagement groups, an infrastructure was described as critical because a national programme depends on it, because it is approaching the end of its design lifetime or licensing basis, because the capability it provides exists in few places and would be difficult to replace, because its absence would leave a waste management route incomplete, because the knowledge or data associated with it would be lost, or because its availability and credibility affect public confidence. The Civil Society engagement extended this further, considering RWM infrastructure to also encompass the organisations and governance arrangements responsible for waste management, especially in relation to legacy sites and the capabilities required to manage them, and to the exposure of infrastructures to hazards that earlier assessments did not consider. In Section 3.1, this report presents a definition of the term 'critical RWM infrastructure' that encompasses the range of interpretations that have been shared. However, imposing a single definition of critical RWM infrastructure across Europe would risk masking context-specific aspects that individual programmes and stakeholder groups regard as decisive.

The areas of vulnerability identified so far can be grouped as follows: the absence or delay of final disposal routes, which dictate storage requirements and which were the constraint most frequently identified; the ageing, licensing and replacement status of existing facilities; the concentration of specialist capabilities in a small number of European facilities; the completeness and accessibility of data, records and organisational memory; the coverage of the infrastructure catalogue itself and the voluntary basis on which it is compiled; and the governance and participation arrangements through which decisions about infrastructure are taken and sustained. These are not of equal significance for every programme, and the engagements conducted to date represent the perspectives of two stakeholder groups only.

Seven preliminary recommendations are set out in Section 4. They are not presented as conclusions because analysis of critical infrastructure needs is still ongoing. Each identifies an issue arising from the engagements held so far, the evidence supporting it, the actors expected to contribute to its resolution, and the output required before final recommendations can be consolidated. Engagements from Year 3 onwards will take the same starting point as those conducted in Year 2, so that the perspective of each group is captured on a comparable and unprejudiced basis. The preliminary recommendations will be tested against the inputs received once those engagements have been completed, rather than being put to participants as propositions at the outset.

5.2 Roadmap from initial to final recommendations

The transition from Deliverable D2.3 to Deliverable D2.4 will involve four activities, running over the course of EURAD-2 Years 3 to 5:

- **Completing the stakeholder engagement programme.** From Year 3 onwards, additional stakeholder groups will be engaged, which are expected to include LIMS(WMO), technical safety and support organisations and regulators, and REs. Further Civil Society representatives identified during the Year 2 engagement will also be approached. The same structured interview format will be used so that inputs remain comparable across groups.
- **Screening inputs across groups.** The reference notes from each engagement will be compared to establish which issues are common to all groups, and which are specific to a particular group or programme type, as well as highlighting infrastructure gaps and risks. This screening is the step that will convert the preliminary recommendations in Section 4 into final recommendations, and it cannot be completed until the remaining groups have been engaged.
- **Developing the EURAD-2 infrastructure catalogue.** Further annual updates are planned over the rest of EURAD-2. Additional fields identified in Recommendation 3, covering expected lifetime, licensing status, dependency, access conditions and the status of associated knowledge and data, will be considered for inclusion, together with the questions raised during the engagements about the coverage of the catalogue and the basis on which entries are collected. Planned functional improvements include a map-based interface. In coordination with Task 5, this activity should also examine arrangements for maintaining the infrastructure catalogue beyond the end of EURAD-2, including potential hosting organisations, responsibility for updating and validating entries, the resources and funding required, and arrangements for continued access and transfer of responsibility. Options for long-term hosting and maintenance, together with any unresolved responsibilities or resource requirements, should be documented in Deliverable D2.4.

Coordination with related European initiatives will continue over the same period. In particular, the task team will maintain contact with the SNETP OFFERR project, and with its planned continuation, so that the EURAD-2 catalogue of RWM infrastructures and the OFFERR catalogue of nuclear research facilities [6] remain complementary rather than overlapping, and so that users of either can be directed to the other where appropriate.

- **Assessing where European-level action is appropriate.** Recommendation 5 will be addressed most effectively by identifying specific avenues of action rather than general aspirations. The distinction between matters that are national decisions and matters that require a European perspective was raised during the Civil Society engagement and will need to be applied consistently in Deliverable D2.4.

Each of the seven preliminary recommendations is taken forward through the activities above. Recommendations 1 and 6, which concern the interpretation of critical infrastructure and the place of governance and participation arrangements within it, are addressed through the completion of the engagement programme and the screening of inputs across groups. Recommendation 2, on disposal-route dependencies, is addressed through continued engagement with WMO and facility operator representatives and through the screening step. Recommendation 3 is addressed through the development of the EURAD-2 infrastructure catalogue. Recommendation 4, on knowledge and data preservation, and Recommendation 7, on changing vulnerability and external hazards, will be pursued both through the additional catalogue fields considered above and through the questions put to stakeholder groups in Years 3 to 5. Recommendation 5 is addressed through the assessment of where European-level action is appropriate. Where elements of these recommendations fall outside the scope of the current KM work programme, this will be stated explicitly in Deliverable D2.4 so that they can be directed to the appropriate part of the partnership.

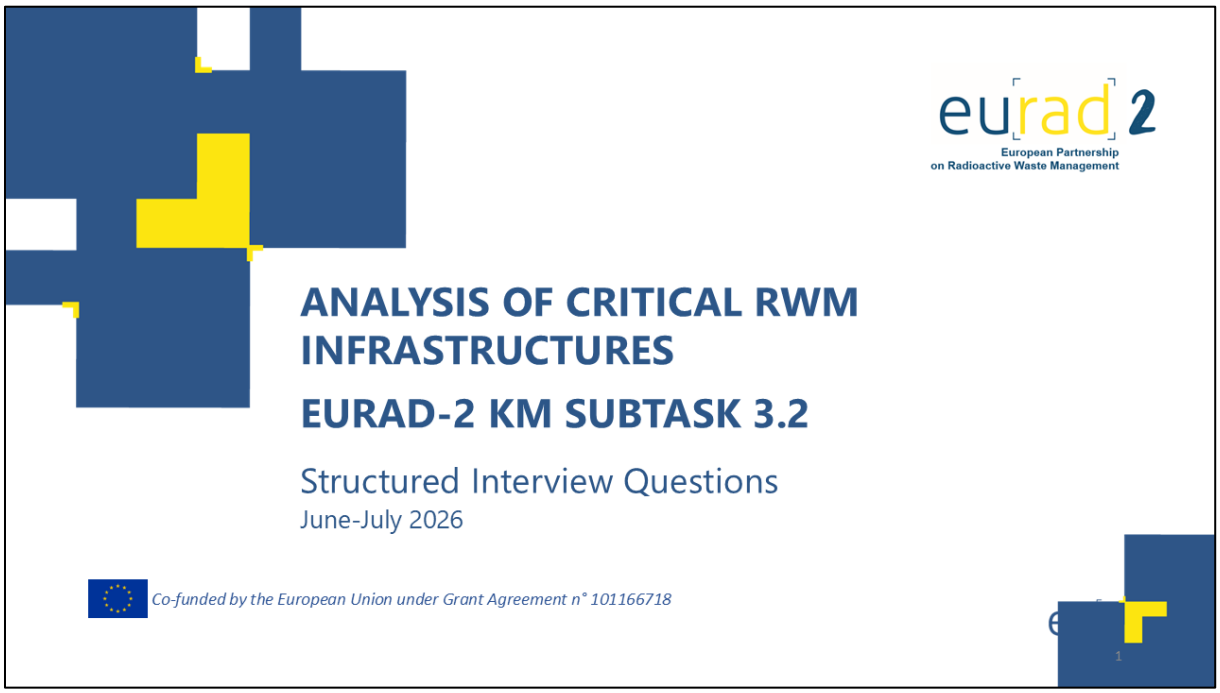
Several evidence gaps are already apparent. The catalogue does not currently record the information needed to identify approaching constraints in availability or licensing. The completeness of the catalogue in certain countries, and for certain categories of site, is variable, and the voluntary basis on which entries are provided limits what can be inferred. No systematic information has yet been collected on the projected lifetimes of specialist capabilities that exist in only a small number of locations. The extent to which governance and participation arrangements should fall within the scope of this work has not yet been tested with groups other than Civil Society.

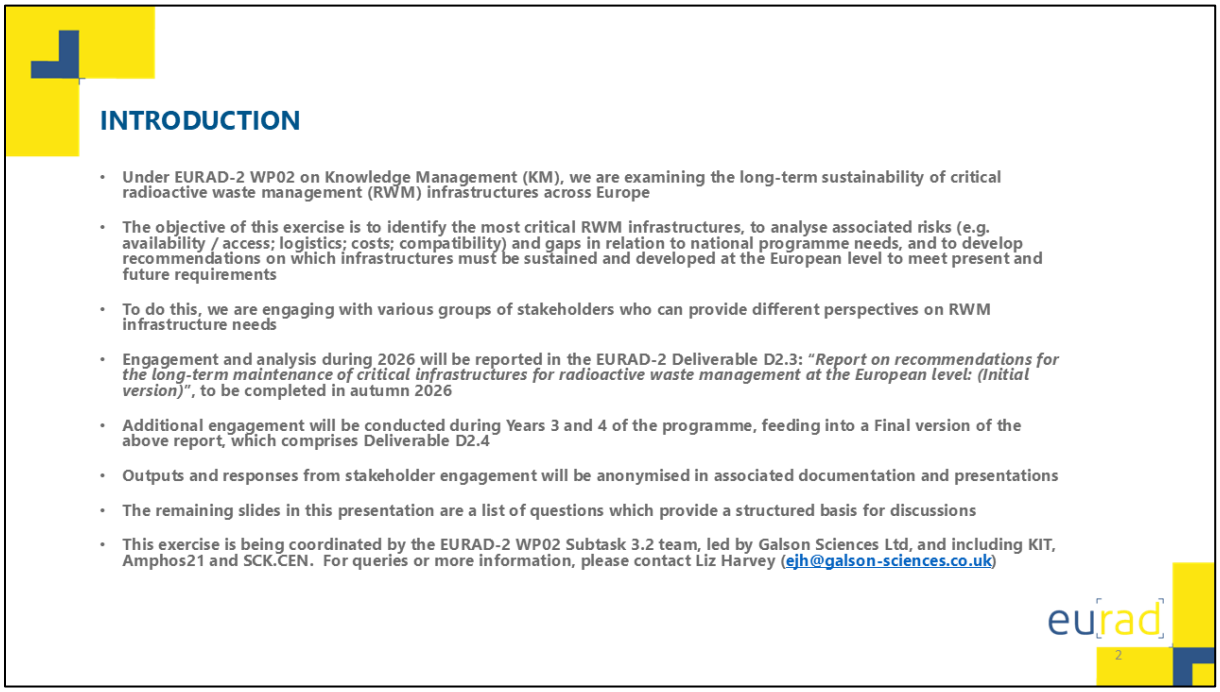
Deliverable D2.4 will consolidate this work into the final report on recommendations for the long-term maintenance of critical infrastructure for RWM at the European level, scheduled for delivery in Year 5 of the partnership.

Appendix A.

This appendix provides the general information used during the stakeholder engagements conducted in Year 2, together with the detailed notes recorded for each individual engagement. Appendix A1 reproduces the slide pack circulated to participants in advance of each session, which sets out the context of sub-task 3.2 and the topics for discussion. Appendix A2 provides the reference notes from the engagement with the SIMS(WMO) group held on 7 July 2026, and Appendix A3 provides the reference notes from the engagement with Civil Society representatives held on 13 July 2026. The reference numbers used in Appendix A2 and Appendix A3 are cited in Section 4 to underpin the preliminary recommendations presented there.

Appendix A1: Questions raised during stakeholder engagements





PART 1 - GENERAL

We want to understand what kinds of RWM infrastructures are regarded as 'critical' within national RWM programmes

a) What do you consider to be 'critical RWM infrastructures?

- These might include laboratories, URLs, characterisation / analysis facilities treatment facilities, conditioning facilities, storage / disposal facilities, computing clusters, data management, modelling capabilities, others,...
- What criteria determine whether RWM infrastructures are 'critical'?

b) Are there any observations — positive or negative — that you would like to share on the state of RWM infrastructures in your country or across Europe?

c) In your view, how 'critical' is the long-term maintenance of RWM infrastructures at the European level — and why?

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3

PART 2 – CURRENT STATUS OF EUROPEAN RWM INFRASTRUCTURES

We want to explore whether currently available RWM infrastructures are sufficient to address RWM requirements at present, and in the next 5-10 years

a) What infrastructures are required to address priorities within your country's national waste management plans?

- Focus areas for national RWM programmes against Directive 2011/70/Euratom?
- Recent developments? E.g. priority wastes, new facilities, particular treatment approaches?

b) What RWM infrastructure capabilities does your national programme currently rely on — domestically and through European access?

- Facilities associated with particular lifecycle stages? Those applicable to particular wastes?
- Do these capabilities meet national programme needs? If not, where do gaps exist and why do they arise?

c) Are there specific infrastructure types or capabilities your programme needs but cannot currently access?

- Please describe the gap and its impact
- What risks are posed by any RWM infrastructure gaps you identified? When would these risks be realised?
- Are plans in place to mitigate these risks? E.g. new facility planning, shared use of facilities

d) Does your organisation have RWM infrastructures that are not currently being utilised to their full extent? How to raise awareness and make them more available?

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4

PART 3 – FUTURE INFRASTRUCTURE NEEDS & GAPS

We are looking to identify emerging RWM infrastructure needs that are expected to arise in the next 10-50 years, particularly those where gaps in provision are anticipated

a) **Are you aware of current RWM infrastructures that are ageing or reaching the end of their operating lifetime and for which there is an ongoing need?**
- Are there infrastructures you are concerned may not be sustained long-term?
- What would be the consequences of losing access to them?

b) **Are you aware of emerging RWM infrastructure requirements for which there is currently no confirmed provision?**
- These might be linked to anticipated new waste arisings (e.g. novel wastes associated with SMR programmes)

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PART 4 – DEVELOPING RECOMMENDATIONS

We want to develop meaningful and actionable recommendations on ensuring sustainable provisions of RWM infrastructures across Europe

a) **Our 2026 analysis will compare available RWM capabilities against current and future national programme needs. What data or evidence from your national programme should inform this?**
- ....

b) **Are there mechanisms such as shared access agreements, joint funding, EU-level coordination that your organisation would support in order to sustain critical infrastructures?**
- ....

c) **What actions should be taken to ensure the long-term maintenance of critical RWM infrastructures at the European level?**
- What could be taken forward in future phases of EURAD?
- What types of facilities should be prioritised for long-term European support and why?

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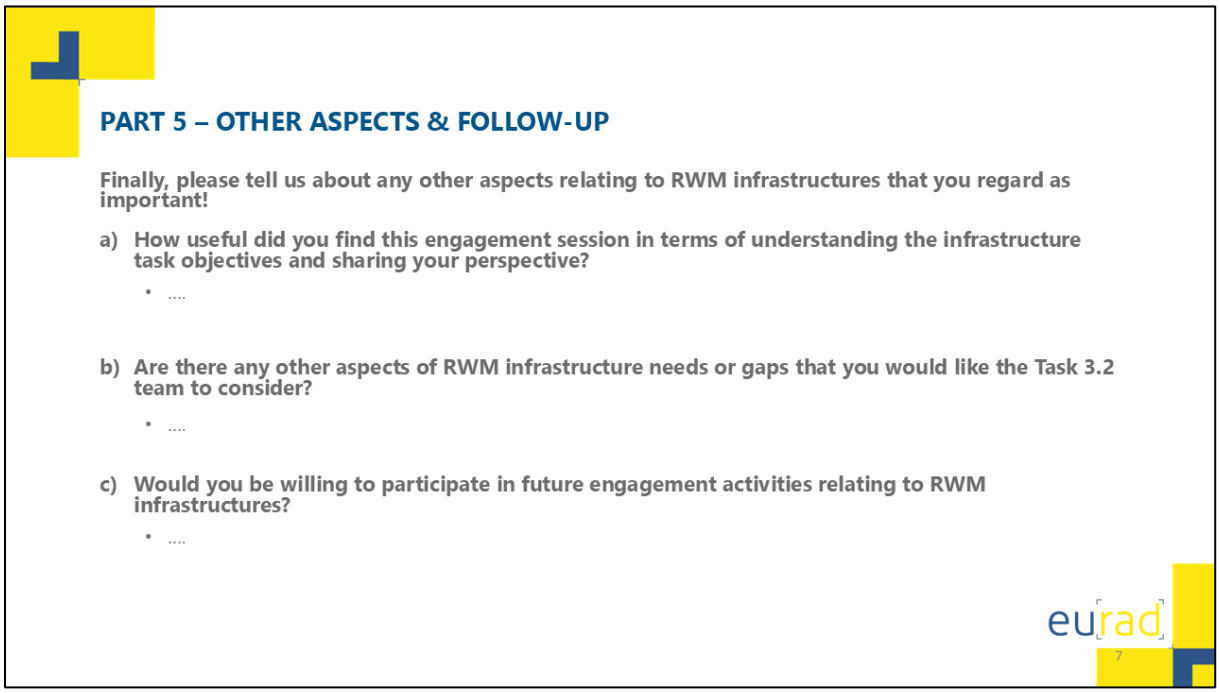

Appendix A2: Record of key discussion points from stakeholder engagement with SIMS (WMO) representatives

Discussion point	Note
1	It was pointed out that the notion of 'critical' infrastructure is not consistently defined across smaller national radioactive waste management programmes. Participants associated 'critical' with several overlapping dimensions, including infrastructures that are essential for implementing national programmes, facilities that are approaching the end of their design lifetime, assets that are no longer state-of-the-art, gaps in the availability of future waste management routes, and issues linked to social acceptance.
2	The absence, delay or uncertainty of final disposal solutions in smaller programmes (particularly, geological disposal facilities), was seen as a major structural gap because long-term storage alone does not provide a complete end point for radioactive waste management.
3	National programmes may not always sufficiently anticipate specific future waste streams, such as those arising from research reactors or other legacy facilities.
4	Some existing facilities may need extension, replacement, relicensing or major safety reassessment within the coming decades.
5	Data and knowledge management were identified as other vulnerabilities. Missing historical data, incomplete records, and unclear information about past waste streams can limit the ability of organisations to make robust safety, licensing and strategic decisions.
6	It was suggested that EURAD-2 and the European Commission could help create pressure, visibility and structure around identified gaps,

	particularly by encouraging earlier identification of critical needs, clearer forward planning, and dialogue between the various stakeholder groups, including Civil Society.
7	European coordination may help compare perspectives across waste management organisations, technical safety organisations, larger and smaller national programmes, and Civil Society stakeholders.

Table A 1: *Key feedback collected from the Stakeholder Engagement 1. Reference numbers are used in the report to underpin outcomes and recommendations.*

Appendix A3: Record of key discussion points from stakeholder engagement with Civil Society representatives

Discussion point	Note
1	The scope of the term 'infrastructure' was raised at the outset of the engagement. Participants asked whether governance arrangements fall within the concept, noting that the term is broad and that the governance structures associated with facilities provide the route through which Civil Society is able to interact with radioactive waste management decisions. It was proposed that determination of 'critical infrastructures' should be anchored in safety and in a shared safety culture, and that on this basis governance arrangements fall within scope alongside physical facilities.
2	It was proposed that the organisations responsible for managing radioactive waste, and not only the facilities themselves, should be treated as critical infrastructure. Reference was made to an official definition applied at municipal level in Austria, under which critical infrastructure covers the systems, facilities and organisations essential to the functioning of society, the economy and government. On this basis it was argued that identifying infrastructures as being 'critical' follows from the consequences of a function becoming unavailable, and is therefore not a matter for individual organisations to elect into.
3	Participants noted that what is considered critical depends on national policy. The example given was a national requirement for disposed waste to remain retrievable for a defined period after closure, which imposes specific and long-lasting requirements on the engineered barrier system and on the resources needed to comply with it. Different policy choices therefore generate different infrastructure and resource requirements between Member States.
4	A narrower and more technical interpretation was also expressed, in which critical infrastructure is understood as the specialised equipment required to perform particular analyses or research. It was noted that certain advanced analytical capabilities exist at only a small number of facilities across Europe, each with a limited operating lifetime and subject to recurrent funding decisions, and that comparing projected lifetimes across Europe would help to avoid the simultaneous loss of a capability. It was further observed that some of the issues raised are national decisions while others are properly addressed at European level, and that this distinction may need to be reflected in the recommendations.

Discussion point	Note
5	The coverage of the existing infrastructure catalogue was considered incomplete. In one national case it was noted that uranium mining and mill tailings sites, storage facilities and historical sites are substantially under-represented, and that a considerably larger number of sites could be identified. It was noted in response that the catalogue relies on voluntary inputs from partners, that some organisations declined to be listed or to have information published, and that the original purpose of supporting mobility actions has shaped the types of facility recorded.
6	It was proposed that catalogue entries could be sourced initially from national regulators, on the basis that critical infrastructures are closely linked to safety, with the resulting draft then reviewed and amended by other national actors. It was also suggested that the catalogue could reflect the balance between the EURAD colleges, and could make explicit which infrastructures are critical in terms of decision-making, so that stakeholders are able to identify where they can interact. It was noted that some regulators and technical safety organisations are members of the EURAD-2 consortium and could be approached directly, while others would need to be invited to contribute on an in-kind basis.
7	The absence of disposal facilities, and uncertainty over the timing of their availability, was identified as the principal constraint on infrastructure planning. Until a disposal endpoint is defined it is not possible to determine how many storage facilities are required, or for how long, and delay translates directly into additional storage capacity being required.
8	It was noted that shared solutions had not featured in the discussion of critical infrastructures, despite being potentially important for Member States that lack the funding, capacity or knowledge to manage their waste independently. Climate change and military conflicts could provide further drivers for waste consolidation and shared onward management, in support of reducing vulnerabilities across Europe. Existing collaborative arrangements between national programmes were suggested as a reference point. It was further proposed that a European legal framework setting out how Member States with small inventories could cooperate might provide a basis for such arrangements, while recognising that the practical difficulties of international cooperation, including acceptance of waste from other countries, remain significant.
9	Institutional mechanisms for Civil Society involvement, where these are embedded in law, were proposed as critical infrastructure in their own right. A national contact forum for radioactive waste management, in operation for eight years and bringing waste management organisations, the regulator, the relevant municipalities and Civil Society organisations together, was cited as an arrangement that has moved national discussion from a confrontational to a collaborative basis and that helps to sustain public interest and, in the longer term, adequate funding. It was also stated that Civil Society should be involved in determining what constitutes critical infrastructure, and that a long-term process perspective is required given the timescales involved.

Discussion point	Note
10	Access to education and information for current and future generations was identified as an enabling condition for wider community involvement. Experience of a national volunteerism process for geological disposal was described, in which few communities came forward and engagement has remained concentrated where nuclear knowledge already exists. It was noted that engagement funding alone did not build lasting community knowledge, and that outcomes have frequently been determined by political rather than technical considerations. A differing view was expressed that local Civil Society organisations have been excluded from the formal community partnership structure, and that relevant Civil Society capacity exists outside it.
11	Legacy sites and legacy waste were raised as a distinct category. It was noted that management needs associated with legacy infrastructure can remain latent and then become urgent at short notice, particularly following an incident. Views differed on whether a legacy site is itself critical infrastructure, or whether this term attaches instead to the tools, networks and capabilities required to assess and manage it. It was suggested that this judgement is best made by the regulator, taking account of the full set of constraints, and that legacy sites may also provide opportunities for field observation of relevance to other sites.
12	Climate change was identified as a factor capable of exposing vulnerabilities in infrastructures not previously assessed as vulnerable, which may not have been anticipated at the time of construction. Transport routes and safe operation were noted as potentially critical for radioactive waste management in this regard. Recent wildfires in proximity to a listed underground research laboratory were cited as one example; another is the dependence of some interim storage facilities (e.g. storage ponds for spent nuclear fuel) on local water supplies, which are increasingly susceptible to disruption during periods of drought. The impacts of falling water levels in the river Danube observed over the summer of 2026 on operation of dependent nuclear power plants such as Paks in Hungary were cited as evidence of such susceptibility [8]. The associated point was that vulnerability requires periodic reassessment, since what is regarded as critical and vulnerable at present will differ over a horizon of five to twenty years. It was proposed that climate adaptation of infrastructures be addressed within environmental impact assessment, and that redundancy and resilience also be assessed.
13	The preservation of knowledge and memory about all facilities and sites, including whether they have been identified as critical, was identified as important for long-term safety. It was further noted that institutional control will eventually cease, and that communities hosting facilities will require assurance that resources will be available for long-term monitoring beyond that point, without which there is limited basis for a community to agree to host a facility.

Table A 2: *Key feedback collected from the Stakeholder Engagement 2. Reference numbers are used in the report to underpin outcomes and recommendations.*

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