LONG-TERM PERFORMANCE OF WASTE MATRICES (L'OPERA) – WP7

EURAD-2 Kick-off meeting

Thierry Mennecart (SCK CEN, Belgium)
thierry.mennecart@sckcen.be

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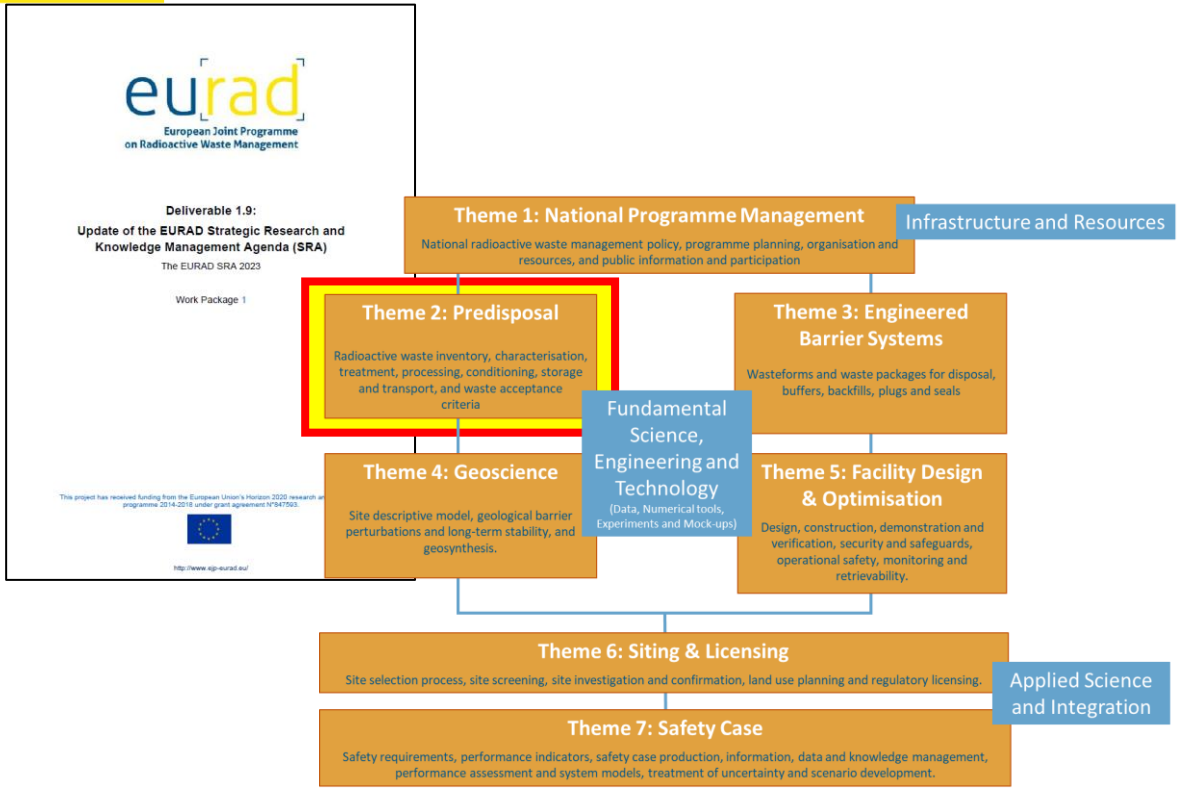
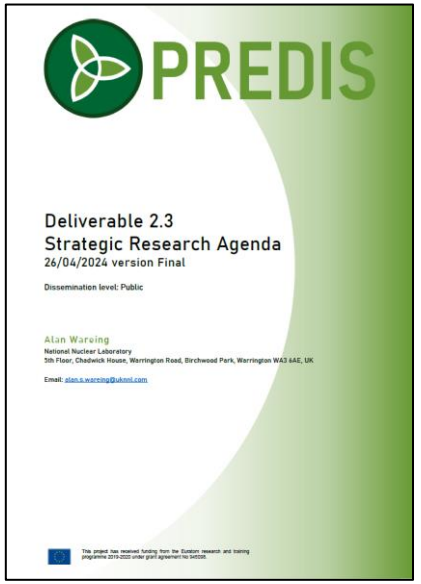
PROJECT INITIATION





- **2.3.2 Optimisation of radioactive waste predisposal activities**
- 3.1.3 Cemented LL-ILW
- 3.1.4 Other Wasteforms

Based on the recommendations from:

- EURAD-1 core group
- 3 Colleges: - Waste Management Organizations (WMO)
  - Research Entities (RE)
  - Technical Support Organizations (TSO)

Public webinar #1 (January 2023)
EURAD-2 WP Focus Funnel (March 2023)
Public webinar #2 (July 2023)

LONG-TERM PERFORMANCE OF WASTE MATRICES (WP7 – L'OPERA)

- **Increase the knowledge and understanding of matrices for the immobilization of Low and Intermediate Level Waste (LILW):**
  - Matrices : geopolymers, alkali-activated materials, magnesian potassium phosphate cements (MKPC), and Nochar
  - LILW: Radioactive Solid Organic Waste (RSOW), Metallics, Radioactive Liquid Organic Waste (RLOW).

- **Evaluation of the long-term performance of matrices:**
  - Increase of the TRL of processes developed within previous European projects (e.g. PREDIS)
  - Investigate final wasteforms coming from innovative processes (collaboration with WP6 – STREAM)

- **Long-term behaviour under disposal conditions:**
  - Degradation behaviour and its consequences on the performance of the wasteforms
  - Extrapolation to a few hundred years for surface disposal and to longer periods for geological disposal

PROJECT OVERVIEW

- **25 partners** from **10 countries**
- **2 Associated partners** from Switzerland
- **5 End Users**

- **Duration:** 5 years

  01.10.2024 – 31.09.2029

- **Budget:** 4 M€ total, of which EC contribution of 2 M€, 529.4 PM
  - First two years are currently secured (EURATOM Call only granted 20 M€ for EURAD-2)

PARTNERS OF WP7 – L'OPERA

TASKS' BREAKDOWN

	Task title	Task leaders	
		Main Task leader	Co Leader
1	Management/coordination of the WP	MENNECART Thierry, SCK CEN (RE)	FREDERICKX Lander, SCK CEN (RE)
2	Knowledge Management	PANCOTTI Federica, SOGIN (WMO)	LO FRANO Rosa, UniPi (RE)
3	Boundary conditions	GU Yushan, VTT (TSO)	OEY Tandré, VTT (TSO)
4	Inventory of the conditioned materials and complete characterisation	TORRES ALVAREZ Elena, CIEMAT (TSO)	
5	Novel Matrices/wasteforms behaviour	RICARD Denise, ANDRA (WMO)	
6	Implementation: Modelling for prediction of durability of materials and multiscale approach	LO FRANO Rosa, UniPi (RE)	

WP7 L'OPERA

Task 2 - Knowledge Management

Stefania Uras, Federica Pancotti, Giorgio Mingrone (SOGIN, Italy)

uras@sogin.it; pancotti@sogin.it; mingrone@sogin.it

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TASK 2 - KNOWLEDGE MANAGEMENT (M1 – M58)

Contribution: All WP7 partners

OBJECTIVE: to **capture knowledge** relevant for the SRA topic of this WP and to contribute to **knowledge transfer** to the EURAD-2 community and beyond through the EURAD-2 KM programme

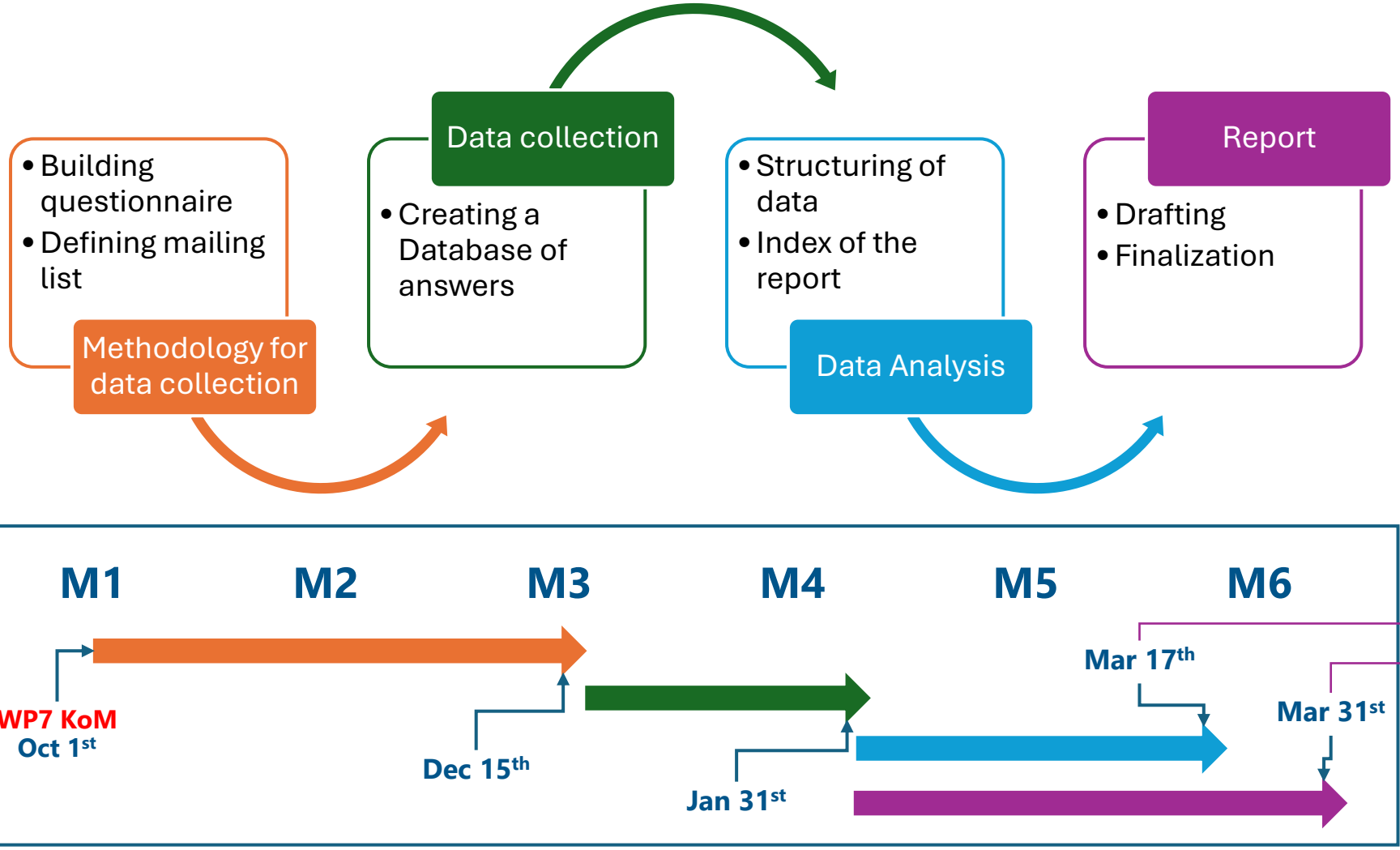
TASK 2: KNOWLEDGE MANAGEMENT

- **Subtask 2.1: Knowledge capture -** SOGIN, CNRS, Polimi, SURAO and UJV
  - Capture Knowledge relevant to the WP, gained prior to EURAD-2 and extended during this WPs progress
    - D7.1 "State of the Art on novel matrices for LILW immobilization" (M6) – **March 2025**

      Initial version of the SotA summarizing the **available information about the long-term durability and stability of the conditioned matrices investigated in this WP**
    - D7.6 "State of the Art on novel matrices for LILW immobilization (Update)" (M57) – **June 2029**

      Updated SotA report, integrating the key findings of the tasks in this WP and relevant findings from other WPs.
- **Subtask 2.2: Knowledge transfer –** SOGIN, all WP7 Partners
  - Deliver, in cooperation with KM WP/(s), specific activities to transfer knowledge to interested parties (e.g. online training, face-to face-training, e-learning materials, workshops, posts for social media, summary sheets, videos, guidance…)

SUBTASK 2.1: KNOWLEDGE CAPTURE - BASELINE PLAN



WP7 L'OPERA

Task 3 - Boundary conditions

Yushan GU (VTT, Finland)

yushan.gu@vtt.fi

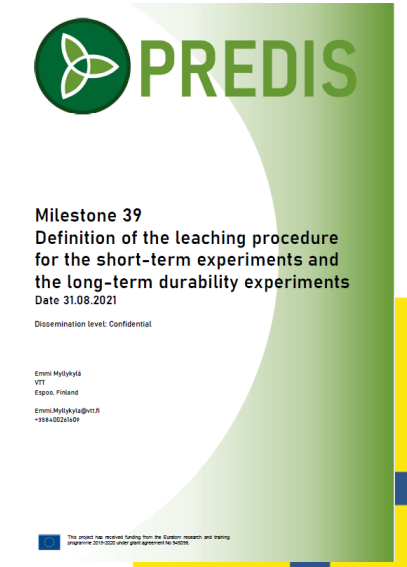
Co-funded by the European Union under Grant Agreement n° 101166718

TASK 3 - BOUNDARY CONDITIONS (M1 – M9)

Contributions: ANDRA, CIEMAT, ENEA, NRG, SIIEG NASU, UJV, Unipi, UniRoma, SCK CEN, Orano, VTT, SURAO, ENRESA

OBJECTIVES:

- **Determine and characterise the key parameters influencing the durability and the stability of the different waste matrices in a function of their application and expected roles/issues;**
  - Determination of key parameters:
    Water composition, pH, Salinity, Redox, Hydrology;
  - Identification of the requirement/specification of waste forms regarding:
    Chemical, Physical and Mechanical properties;
- **Determine the expected long-term conditions prevailing in disposal facilities and the irradiation characteristics;**
  - Definition of the long-term conditions considering the interaction between the waste package and the environment:
    Temperature, Irradiation levels such as dose and cumulative integrated dose;
  - Common exposure conditions (A reference protocol);
  - National disposal conditions and irradiation characteristics.



WP7 - L'OPERA

Task 4. Inventory of the conditioned materials and complete characterisation

Elena Torres Álvarez (CIEMAT, Spain)

elena.torres@ciemat.es

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TASK 4 - INVENTORY OF THE CONDITIONED MATERIALS AND COMPLETE CHARACTERIZATION (M1-M48)

Contribution: CTU/UJV/SURAO, CTU, CVRez, INCT, SIIEG NASU, ENEA, POLIMI, UniRoma, ANDRA/PIMM, CEA, CIEMAT/CSIC/UAM, SCK CEN & VTT

Objective: Provide a complete and descriptive inventory of the matrices and wasteforms investigated in WP7 L'OPERA

- **Detailed information about:**
  - Nature of the matrices and immobilized waste
  - Physical and chemical composition of the conditioned materials
  - Interactions between the waste and matrices
- **First results on short-term evolution**

COLLABORATION WITH WP6-STREAM

Delivery of samples for durability tests (CVRez, SCK CEN & VTT)

Systems to be studied:

- Matrices : Geopolymer & Alkali-activated materials, Nochar, MKPC
- Wastes: RLOW (oils), RSOW (IERs), metallic materials

COMMON CHARACTERIZATION PROTOCOL

- **Need of standardization of results: screening of robustness of waste forms**
- **Minimum characterization protocol common to all partners for task 4 according to type of waste form – need of an updated inventory of waste forms**
  - **Joint protocol for Task 4 and 5:** pre- and post-mortem characterization
- **Basic characterization is NOT OPTIONAL**
- **Minimum requirements: additional techniques up to each partner**

WP7 - L'OPERA

Task 5 - Wasteforms durability and stability testing

Denise Ricard (Andra, France)

denise.ricard@andra.fr

Co-funded by the European Union under Grant Agreement n° 101166718

TASK 5 - WASTEFORMS DURABILITY AND STABILITY TESTING (M6 – M55)

Contribution: CTU/UJV/SURAO, CTU, CVRez, INCT, SIIEG NASU, ENEA, POLIMI, UniRoma, ANDRA/PIMM, CEA, CIEMAT/CSIC/UAM, SCK CEN & VTT, PSI, EMPA/IRSN

Objectives:

- **Determine the key parameters influencing the durability and the stability of the conditioned waste**
- **Characterize the long-term evolution of the conditioned materials under as representative as possible of disposal conditions.**
  - Evolution of the materials regarding the effect of:
    - Irradiation (radiolysis or radiooxydation): associated to the radionuclide contamination
    - Presence of water: associated to the presence of water in disposal or in the wasteforms
    - Temperature: associated to temperature changes in the wastes/disposal
    - Mechanical ageing
  - Definition of accelerated ageing to acquire long-term performance data
    - Particular attention on conditions: results should be extrapolable to disposal conditions
  - Definition of relevant tracers at chemical and/or physical scales will be followed to determine degradation mechanisms and some cases acquisition of kinetic parameters

SUBTASKS

- **Subtask 5.1: Material evolution after artificial degradation**
  - Studies of evolution of materials regarding
    - Irradiation, thermal ageing and thermal cycling, mechanical ageing

- **Subtask 5.2: Long-term leaching**
  - Studies of long-term leaching of matrices and wasteforms:
    - Including Pre-aged systems (task 5.1)
    - Real scale experiments with inactive geopolymers

WP7 – L'OPERA

Task 6 – Implementation

Rosa Lo Frano (UniPi, Italy)

rosa.lo.frano@unipi.it

Co-funded by the European Union under Grant Agreement n° 101166718

TASK 6 – IMPLEMENTATION (M30-M56)

Contribution: UniPi, ANDRA/PIMM, UDC/CIEMAT/CSIC, ORANO, SCK CEN, VTT, PSI, EMPA

Objective: Predict the long-term performance of conditioned matrices

- Modelling approaches are based on:
  - Extrapolated data by using kinetic model
  - Multiscale relationship tracers/uses properties/criteria
  - Reactive transport codes to perform the THC models
  - *Multiscale modelling of porous media performance*
  - Sublattice solid solution models - thermodynamic modelling approaches
  - Numerical description of the chemical reactions driving the microstructure evolution

GENERAL ORGANIZATION

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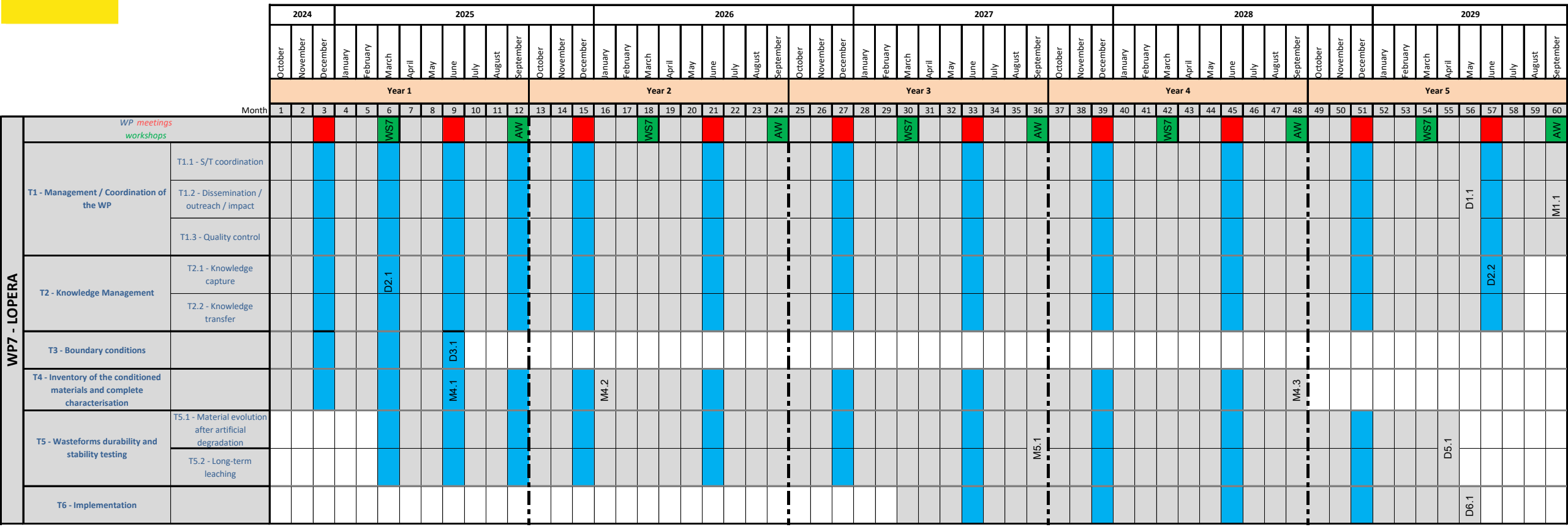
PLANNING



WP7 Kick-off meeting
14 Oct. 2024 (on-line)

- Training
- WP board Meeting
- WP workshop (AW: Annual Workshop, WS: Biannual WP workshop)
- Task workshop
- WP's duration

DELIVERABLES

Number	Deliverable name	Lead participant	Type	Delivery date (in months)
1	D 2.1 – State of the Art on novel matrices for LILW immobilisation	SOGIN	Report [Pu]	6
2	D 3.1 – Representative conditions of disposal facilities for the long-term management of LILW	VTT	Report [Pu]	9
3	D 5.1 – Matrices long-term performance assessment for conditioned LILW	ANDRA	Report [Pu]	55
4	D 1.1 – Outcome/impacts report to Member States and End Users	SCK CEN	Report [Pu]	56
5	D 6.1 – Modelling approaches for the long-term behaviour of conditioned LILW	UniPi	Report [Pu]	56
6	D 2.2 – State of the Art on novel matrices for LILW immobilisation	SOGIN	Report [Pu]	57

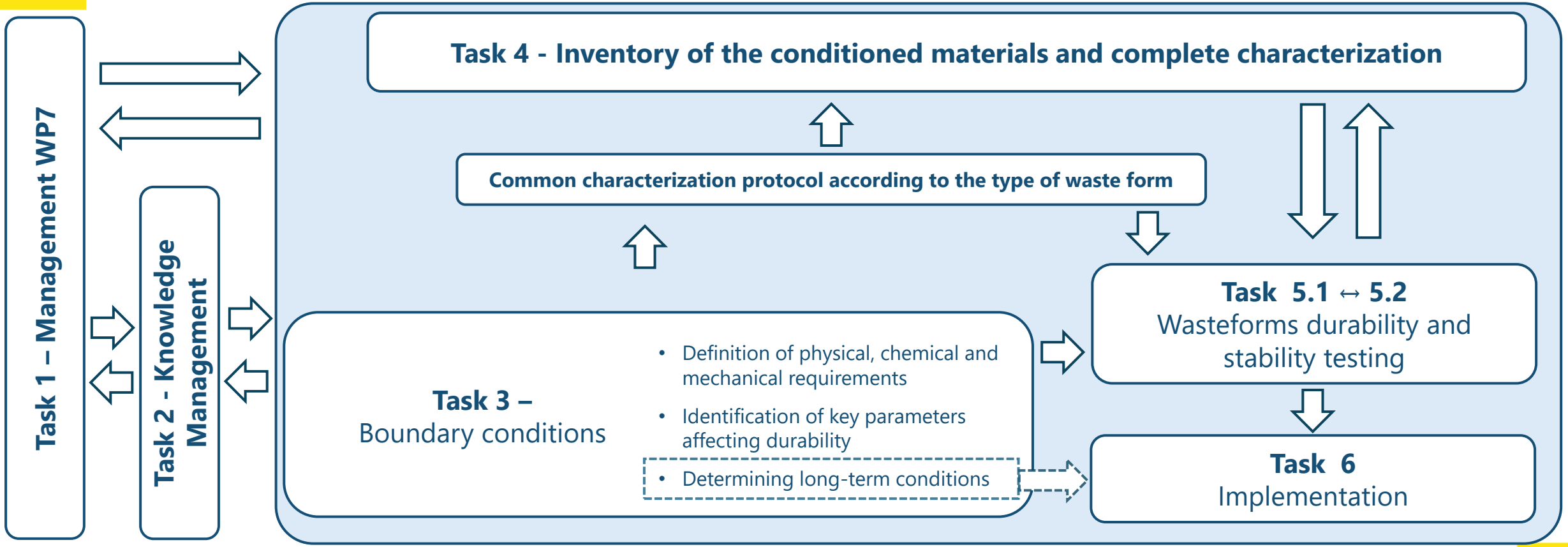
MILESTONES

Number	Milestone name	Lead participant	Delivery date (in months)
1	M4.1 – Delivery campaign of samples	CIEMAT	9
2	M4.2 – Intermediate report on characterisation	CIEMAT	16
3	M5.1 – Intermediate report on durability and stability tests	ANDRA	36
4	M4.3 – Inventory of the conditioned matrices in WP7	CIEMAT	48
5	M1.1 – Submission in scientific journals of at least 5 papers about the WP7 activities	SCK CEN	60

KEY PERFORMANCE INDICATORS

EURATOM Call objective	SRA Drivers	KPI at the WP level	Target by end of Y2 (number)	Target by end of Y5 (number)
Support radioactive waste management innovation and optimisation	Innovation for Optimisation	Change of TRL		1
		Improvement of a process or a method statement (written document)		1
Contribute to addressing scientific/technical challenges	Scientific Insight	Number of State-of-the-Arts published	1	2
		Number of open access publications accepted		5
		Number of presentations at scientific conferences done	2	20
Boost knowledge transfer to early-stage programmes	Tailored solutions	Number of KM documents produced		1

INTERACTIONS WITH OTHER WP7 TASKS



Collaborative approach:

- Encourage sharing materials, samples, techniques, previous experiences, collaboration with other partners
- Open to discussion: protocols, results, techniques

INTERACTION WITH THE OTHER WPs:

- WP5 – ICARUS: Methodologies developed in WP5 can be used to analyze drum(s) or large-scale sample(s) investigate in WP7.
- WP6 – STREAM: WP6 aims to optimize of GP formulations of which the most promising samples will be tested (stability and durability) in WP7, according the standard protocol established in the course of the project.
- WP16 – SUDOKU: Inputs / feedbacks from WP16 related to the disposal facilities specifications in the development of the boundary conditions (task 3)

Thank you for your attention!