NIRAS ONDRAF

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Accounting for Climate in the Belgian Surface Disposal Programme

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Disposal Site

How is climate (change) addressed ?

- **Design**
  - Design requirement *"Withstand design climate loads"*
  - Design calculations (flooding, settlements,...)
- **Safety assessment**
  - Scenarios
  - Near-field models
  - Hydrogeological models
  - Biosphere models

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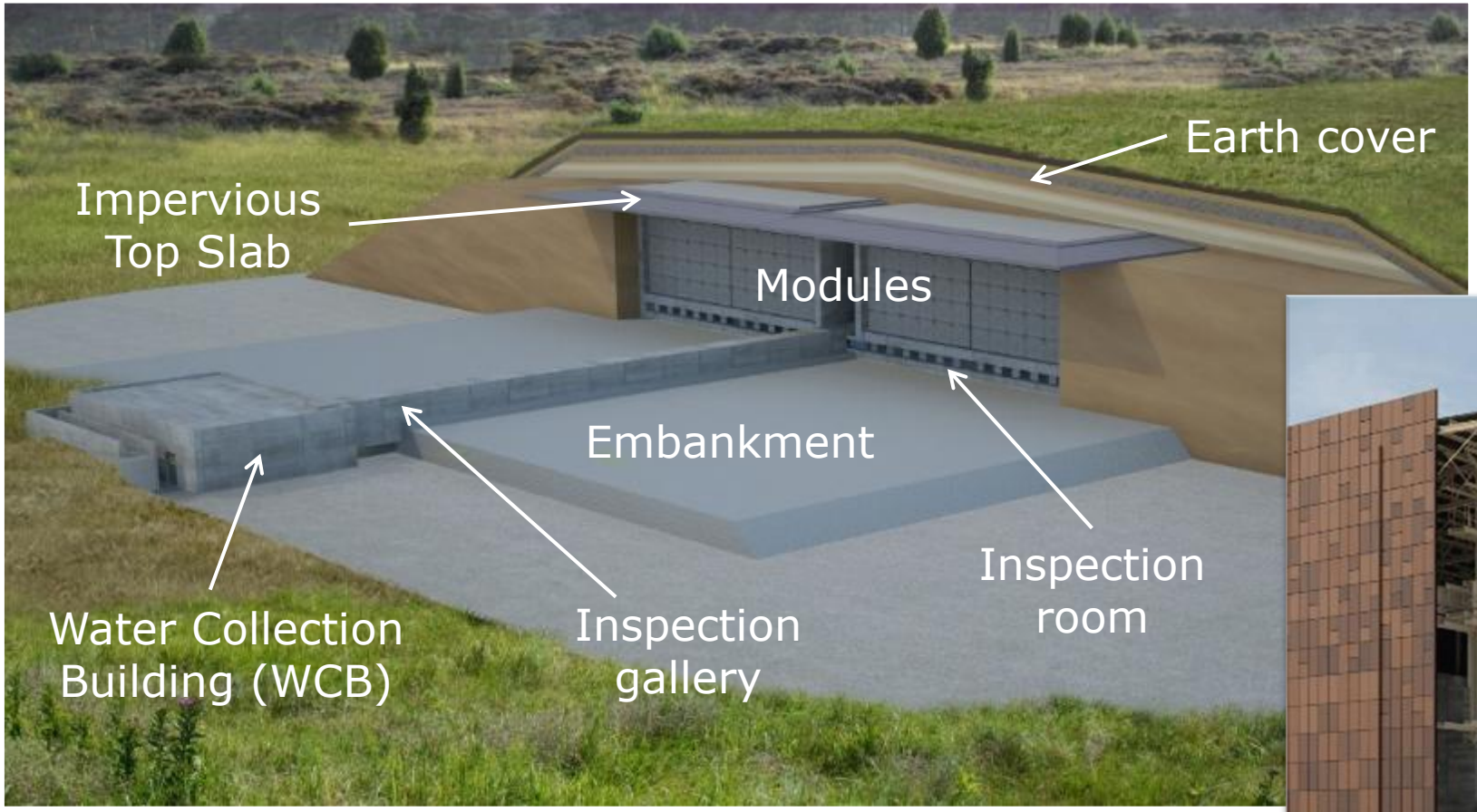
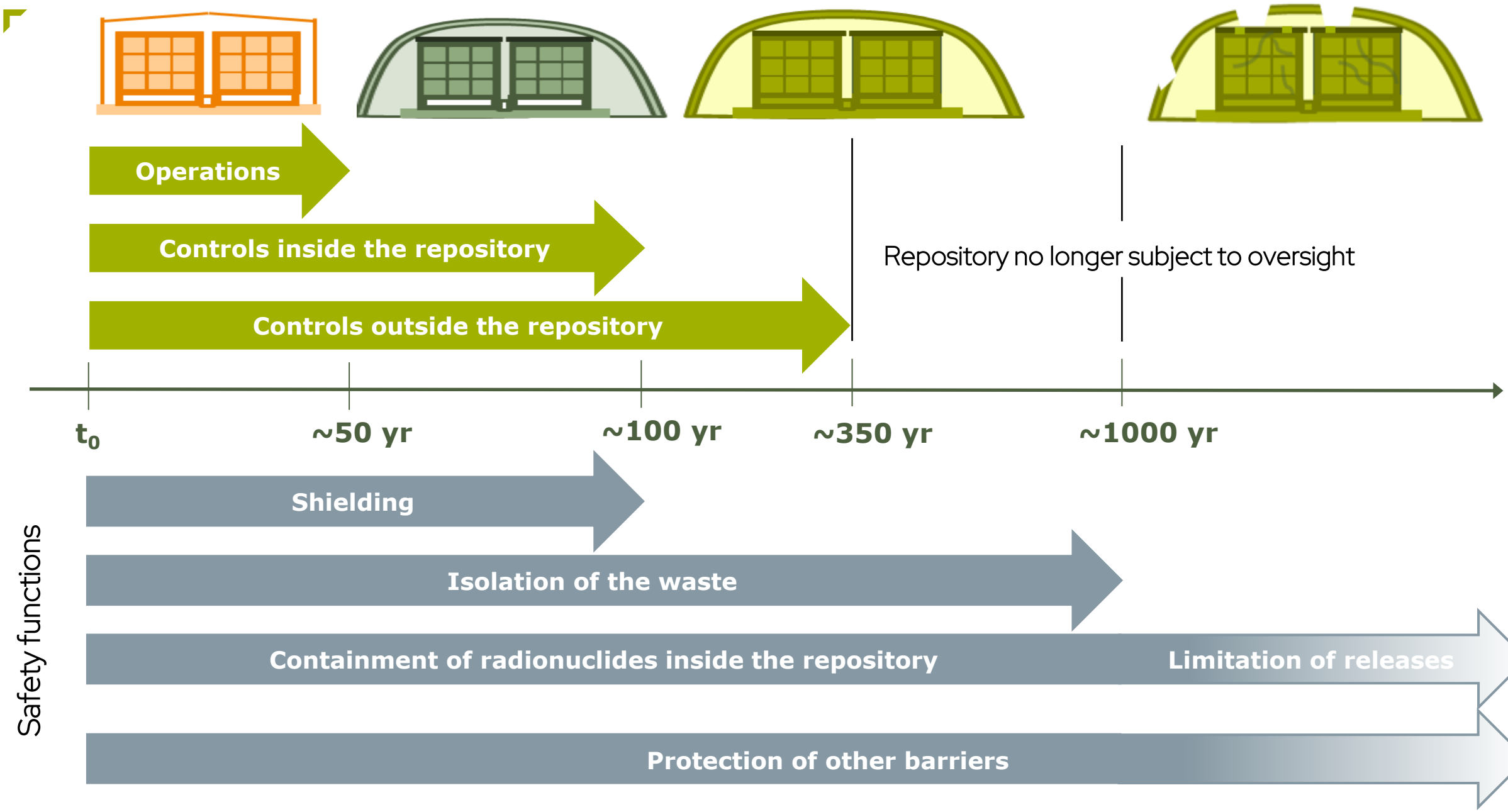
Engineered Barriers



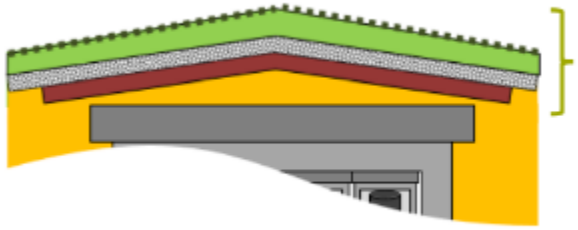

Operations
Controls inside the repository
Controls outside the repository
Repository no longer subject to oversight
t0
~50 yr
~100 yr
~350 yr
~1000 yr
Safety functions
Shielding
Isolation of the waste
Containment of radionuclides inside the repository
Limitation of releases
Protection of other barriers

Up to ~50 years

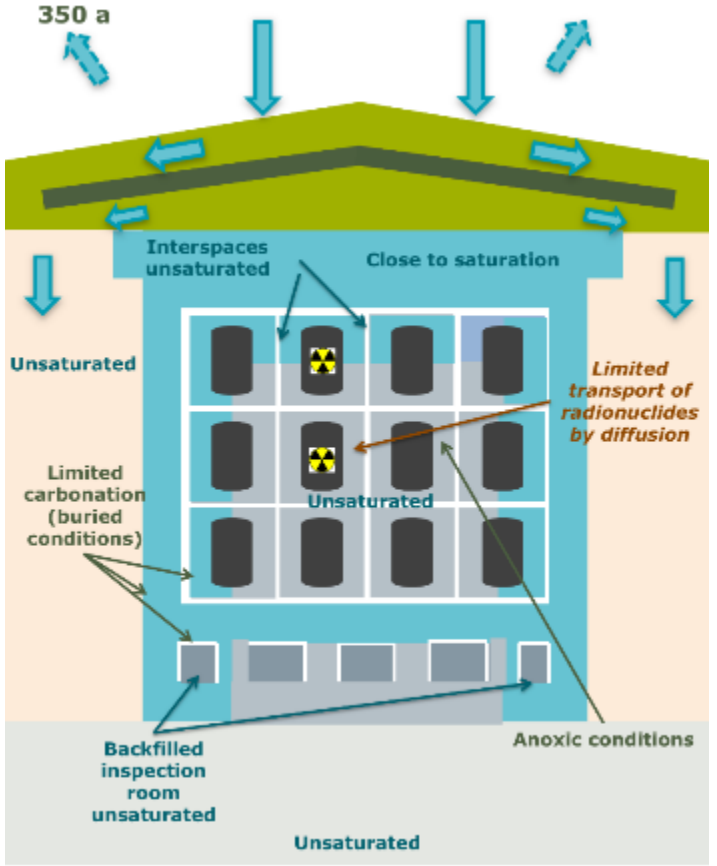
Design requirement *"Withstand design climate loads"* applies a.o. to:

- Trolley:
  - Protects monoliths against rain
  - Extreme temperatures
  - Wind load
- Steel roof
  - Snow, wind & tornado loads
  - Temperature differences

From ~50 to ~ 1000 years

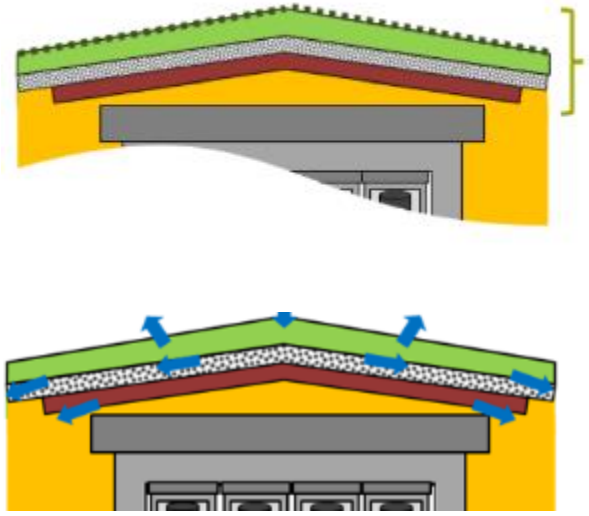


- **Impervious top slab** has a key role in limiting water infiltration towards the modules
  - Water percolating through the earth cover slowly resaturates underlying concrete components
- **Carbonation** = main degradation mechanism of concrete components
  - Virtually halted (very low rates) in presence of the earth cover (buried conditions)



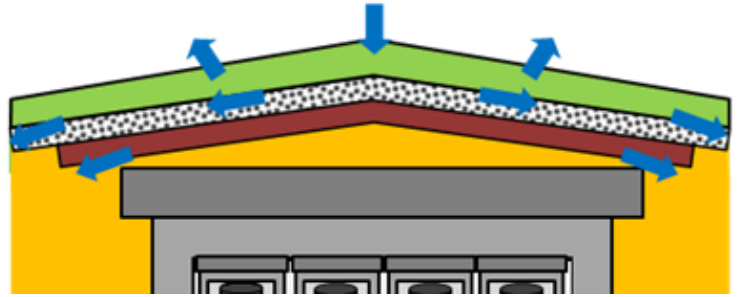
From ~50 to ~ 1000 years

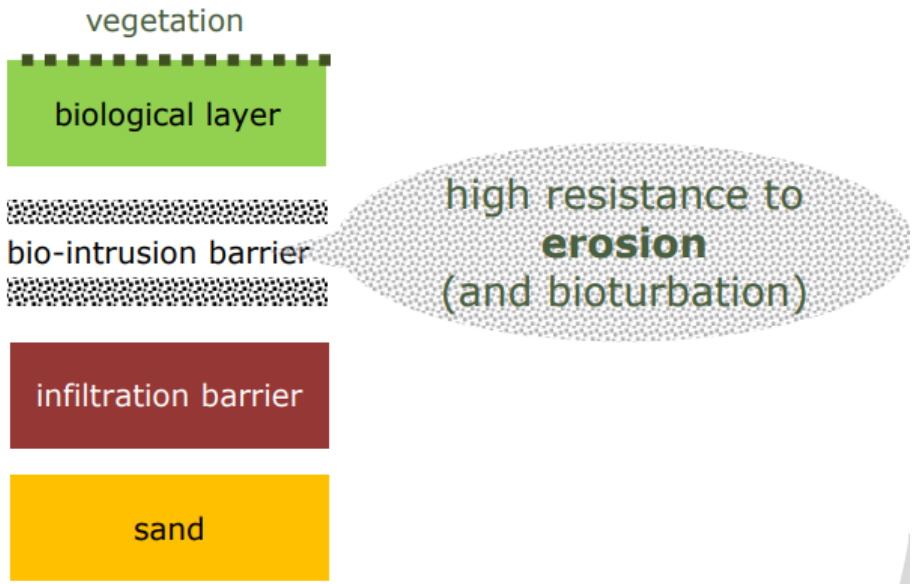
- Safety functions of **earth cover:**
  - Protect concrete barriers
  - Limit water infiltration
  - Isolate the waste
- Controls and repairs (if needed) up to 350 years
- Design requirement *"Withstand design climate loads"* applies to the earth cover



From ~50 to ~ 1000 years

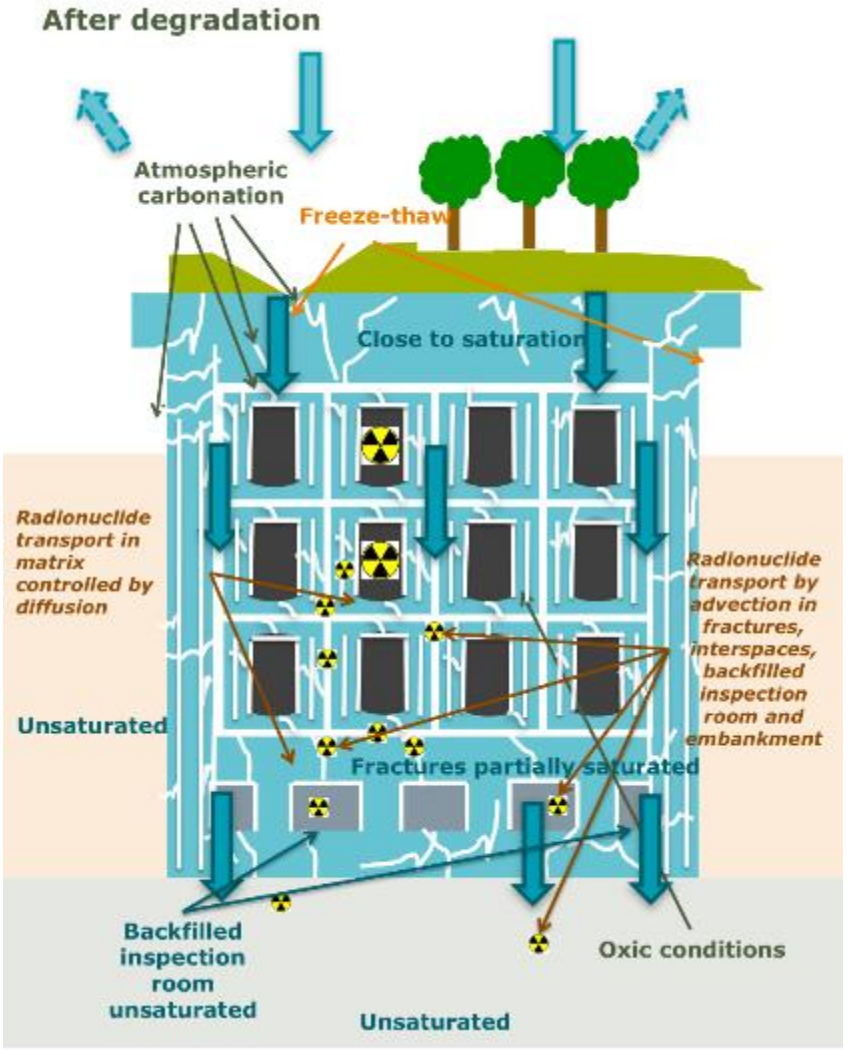
- Earth cover designed to:
  - Withstand erosion
    - Climate change taken into account in the design (e.g. higher rainfall intensity)
  - Avoid drying out of:
    - Biological layer
    - Infiltration (clay) barrier
- Uncertainty regarding future climate treated in the SA through:
  - Alternative scenarios considering accelerated / extreme erosion





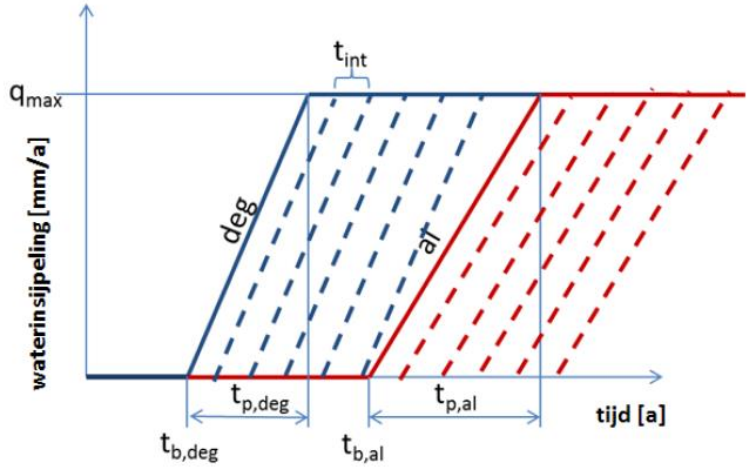
After ~ 1000 years

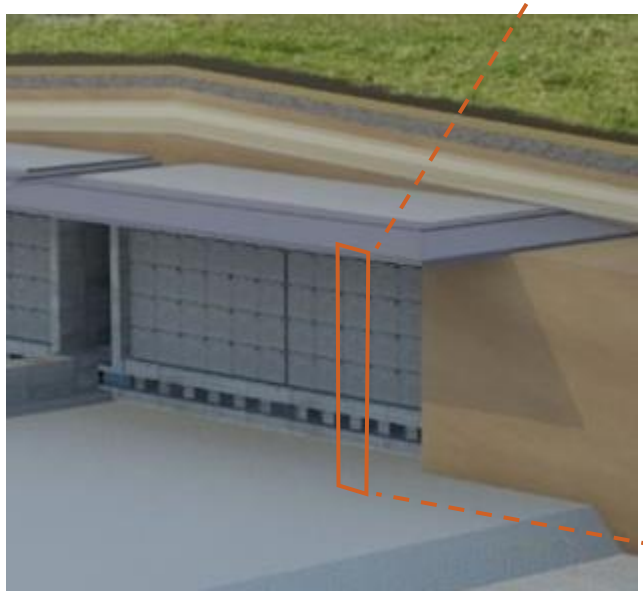
- **Earth cover degradation** → buried conditions no longer guaranteed
  - Enhanced carbonation rates
  - Exposure to freeze-thaw cycles
- Gradual development of **fractures** in impervious top slab, modules and monoliths
  - Preferential pathways for water flow and radionuclide transport

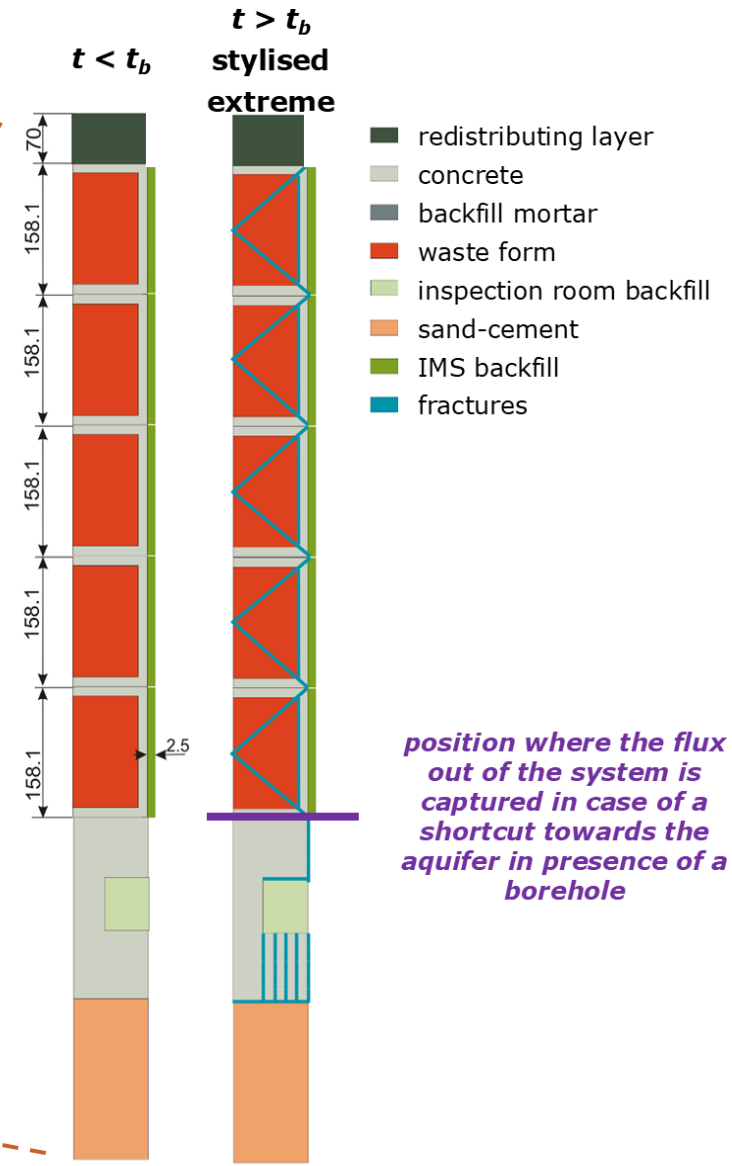


After ~ 1000 years

- **Near-field models:**
  - Uncertainty regarding future climate is treated by choosing a **conservative infiltration rate** (boundary condition)
  - No "bathtub effect" by design
  - Assumption that concrete barriers are already degraded (fractures & carbonation) when water infiltration starts







position where the flux out of the system is captured in case of a shortcut towards the aquifer in presence of a borehole

Timeframes, repository configurations, safety functions & uncertainties determine how climate is addressed !