Closure of the Finnish LILW repositories

KYT closure workshop

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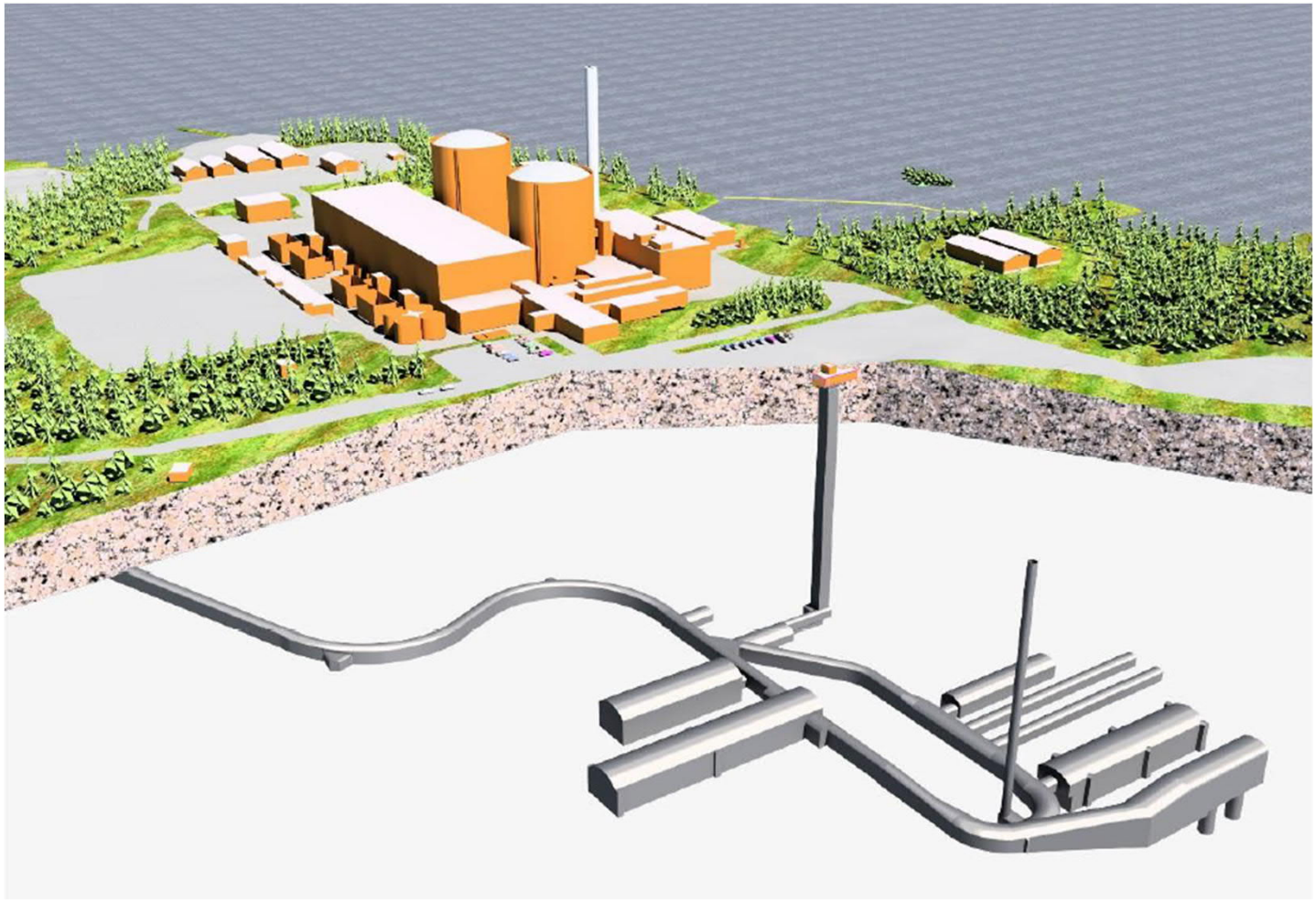
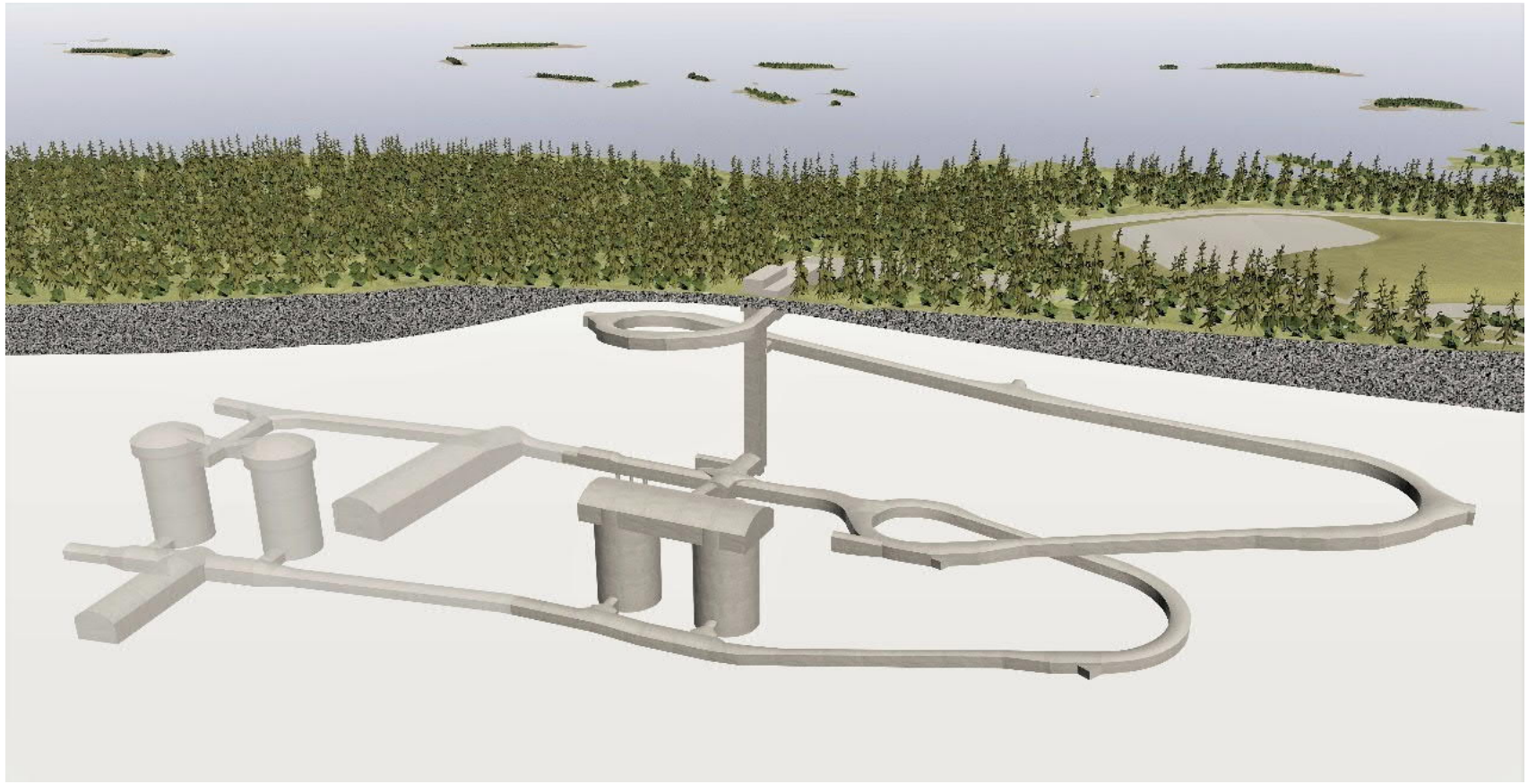
Contents of this presentation

- Present the closure concept of the Finnish LILW repositories at Loviisa (Fortum) and Olkiluoto (TVO)
- Examples from both Loviisa and Olkiluoto are provided (see the title of each slide)
- Current closure plan: purpose of the closing, details of the plugs, backfilling, closing of the boreholes
- Impact of the closure on the performance of the repository

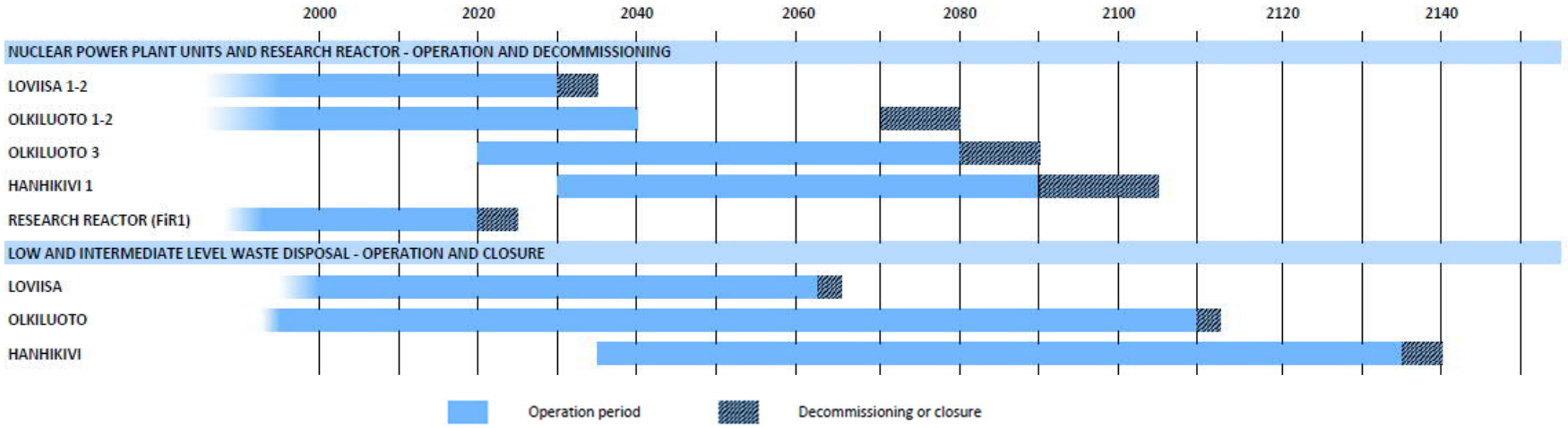
LILW repositories of the Finnish NPPs: Loviisa



LILW repositories of the Finnish NPPs: Olkiluoto



Timeline


2000
2020
2040
2060
2080
2100
2120
2140
NUCLEAR POWER PLANT UNITS AND RESEARCH REACTOR - OPERATION AND DECOMMISSIONING
LOVIISA 1-2
OLKILUOTO 1-2
OLKILUOTO 3
HANHIKIVI 1
RESEARCH REACTOR (FiR1)
LOW AND INTERMEDIATE LEVEL WASTE DISPOSAL - OPERATION AND CLOSURE
LOVIISA
OLKILUOTO
HANHIKIVI
Operation period
Decommissioning or closure

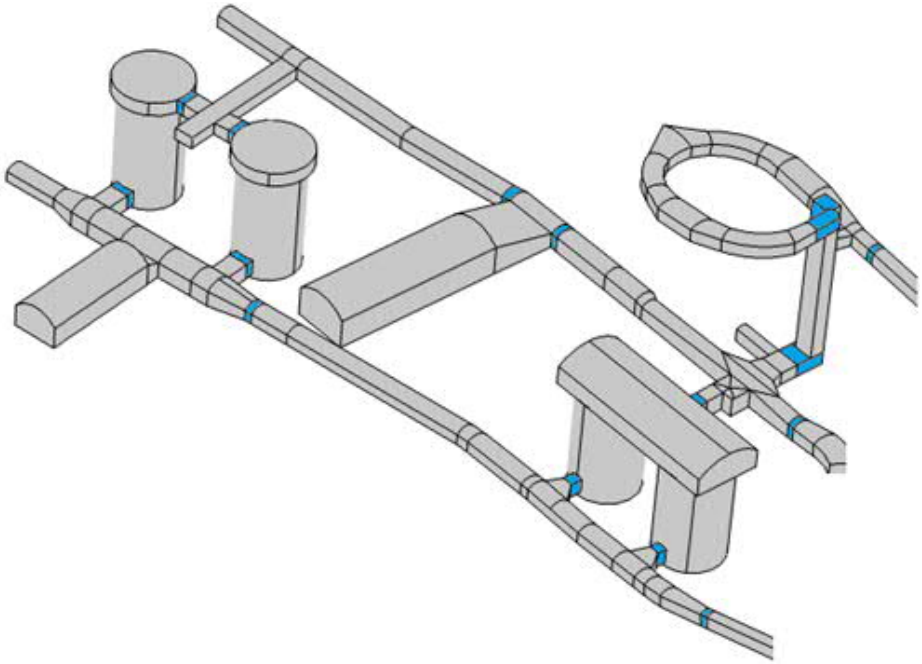
Closure of the Finnish LILW repositories

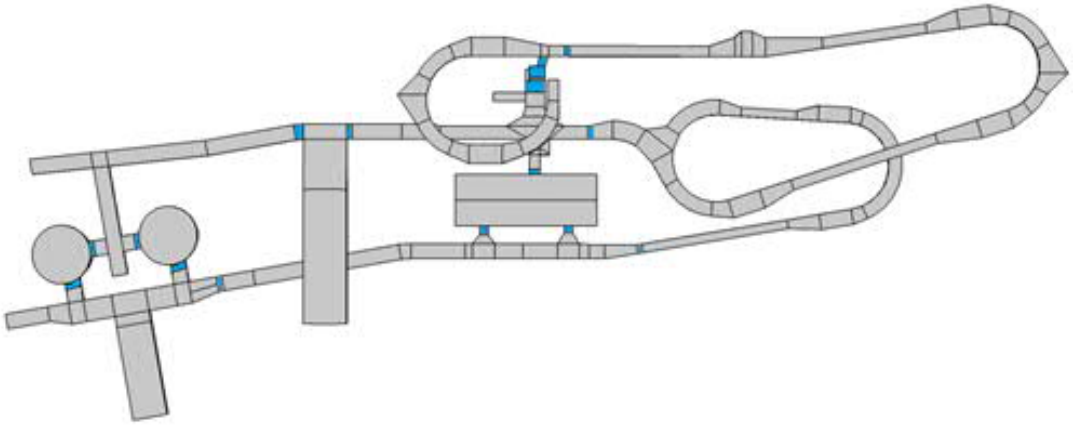
- The closure concept of the repositories is defined in the decommissioning reports:
  - Kaisanlahti et al. “Decommissioning plan of Loviisa NPP” (2018) and
  - Leikola et al. “Olkiluodon ydinvoimalaitoksen käytöstäpoistosuunnitelma” (2020)
- The safety is evaluated in the safety cases:
  - Nummi “Loviisa safety case main report” (2019) and
  - Nummi “TVO safety case main report” (2021)

Closure of the Finnish LILW repositories

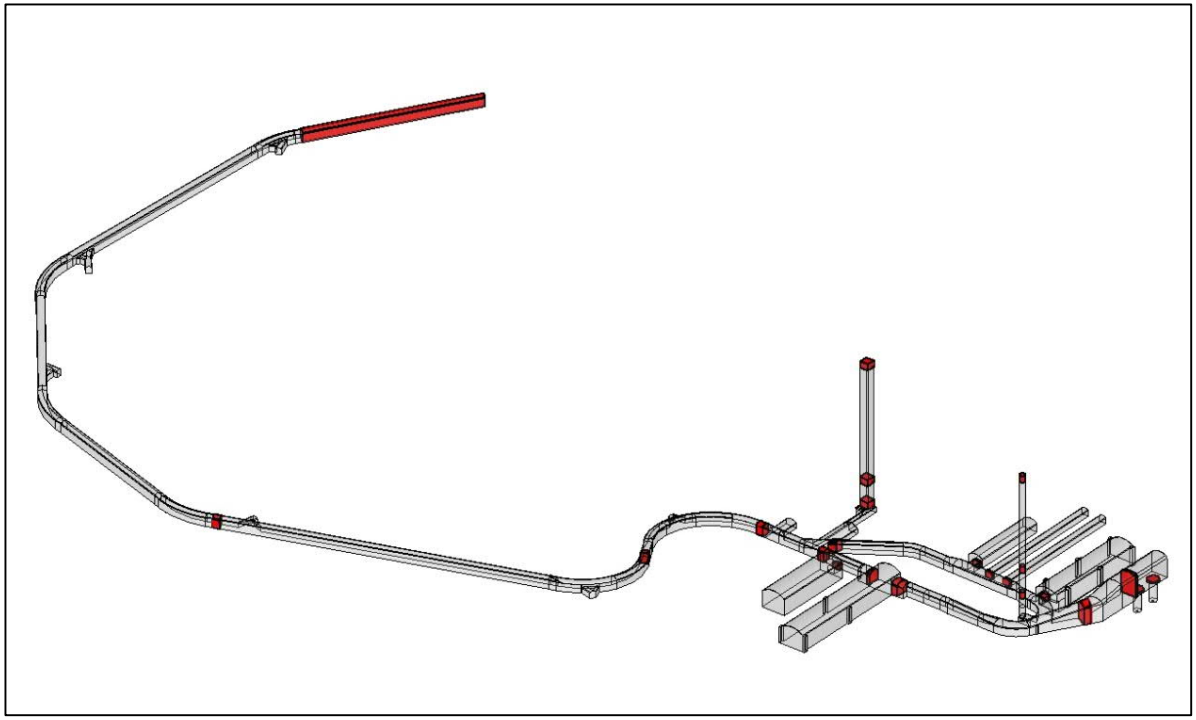
- Closure is done in order to
  - Limit the groundwater flow to increase the longevity of the engineered barriers and to lower the radioactive releases
  - To prevent future human intrusion to the repository
  - To mechanically support the bedrock
- In the current designs, the closure is done using cast concrete plugs and by backfilling the tunnels and waste caverns with crushed rock or concrete

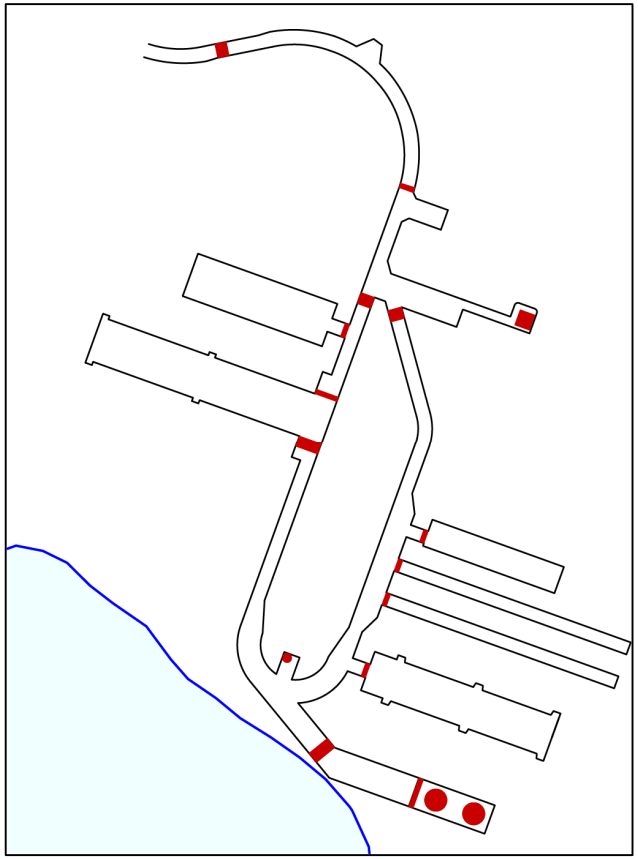
Location of the plugs (TVO)



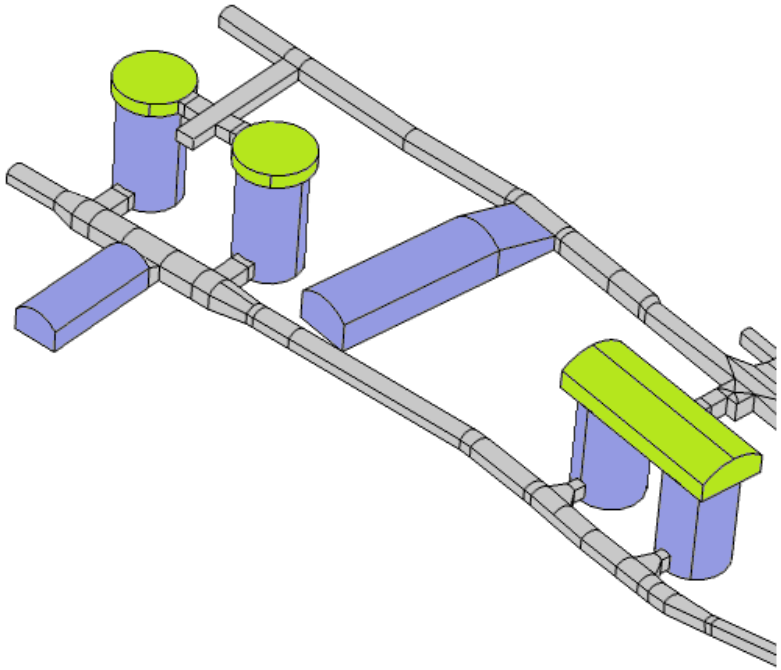


Location of the plugs (Loviisa)

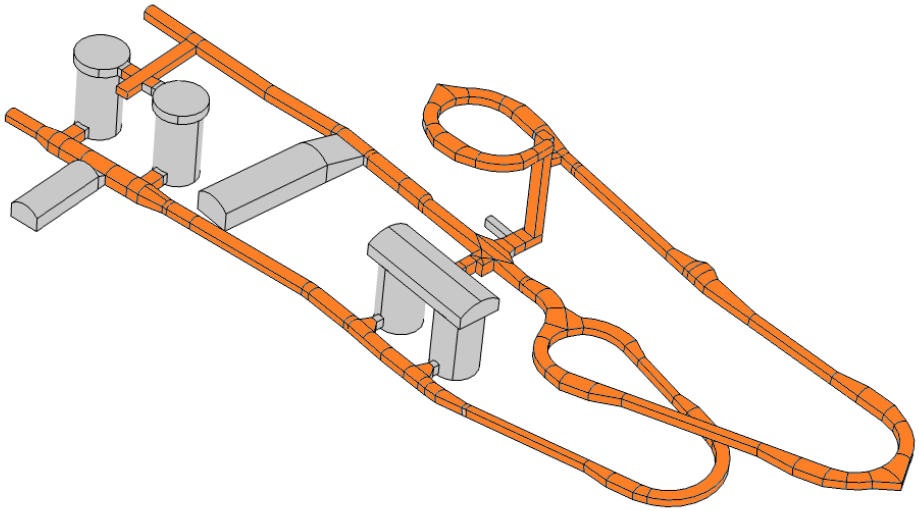




Backfilling (TVO)



Backfilling of the waste caverns with crushed concrete (blue) and crushed rock (green)



Backfilling of the tunnels with crushed concrete

The plug design

- A simple reinforced concrete block is currently proposed + shotcrete or injection grout at the rock-concrete interface
- A detailed design of the plug have not been done since the closure is (at least) some 20 years away
- The behavior and degradation of the block is analysed with a concrete leaching model

The plug design

- A more detailed plug design in proposed by SKB:

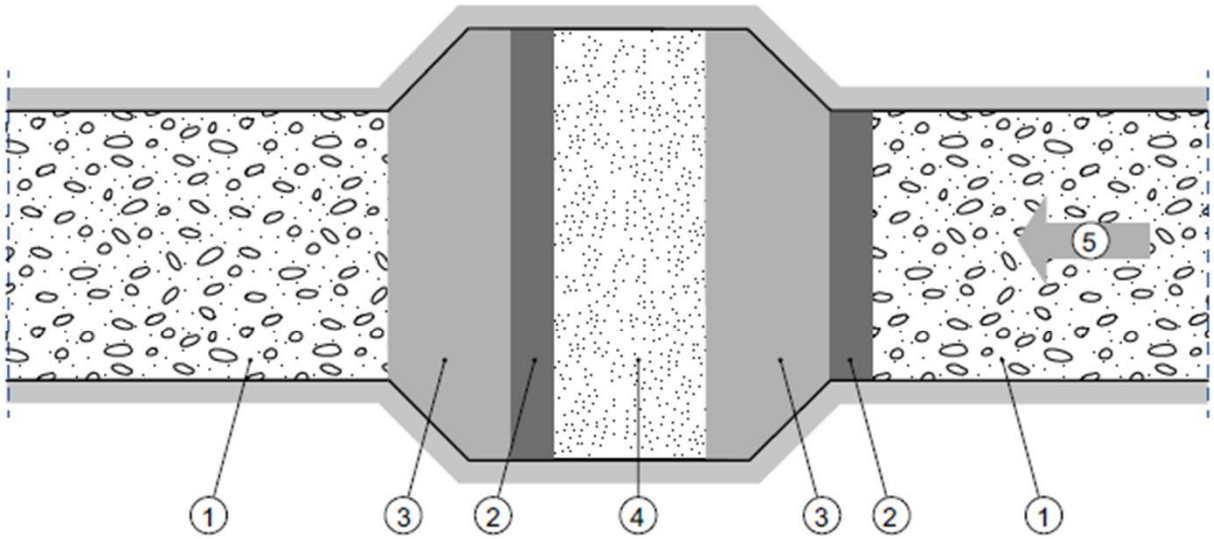
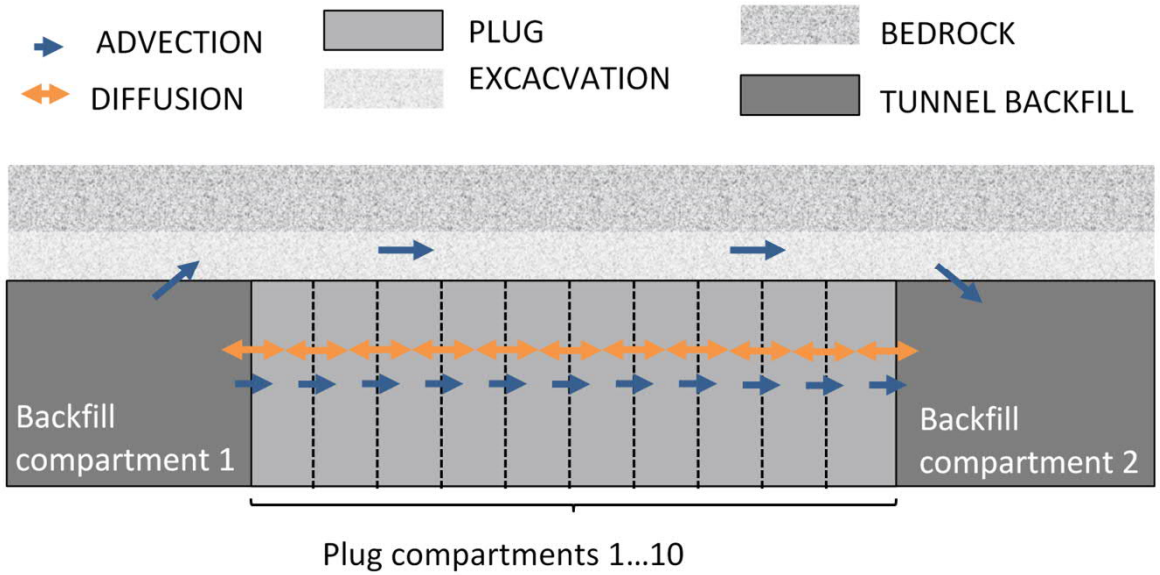


Figure 4-9. Schematic design of a sealing plug (Luterkort et al. 2014). Legend: 1) Backfill of crushed rock or similar. 2) Retaining concrete walls. 3) Cast concrete. 4) Bentonite. 5) Backfill direction (from the waste vault and out). 6) Backfill material.

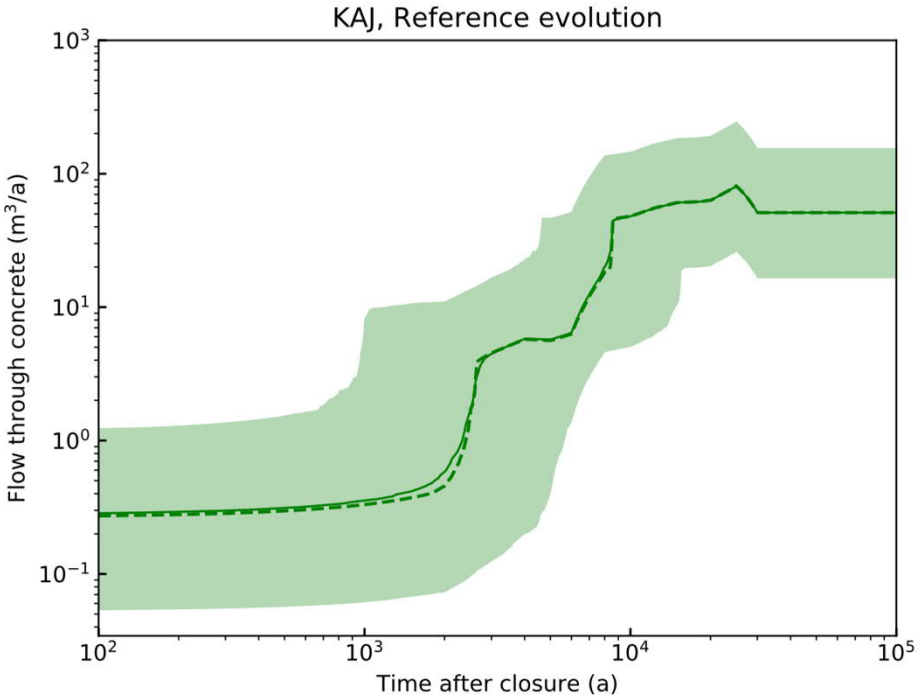
Modelling the degradation of the plugs (TVO)

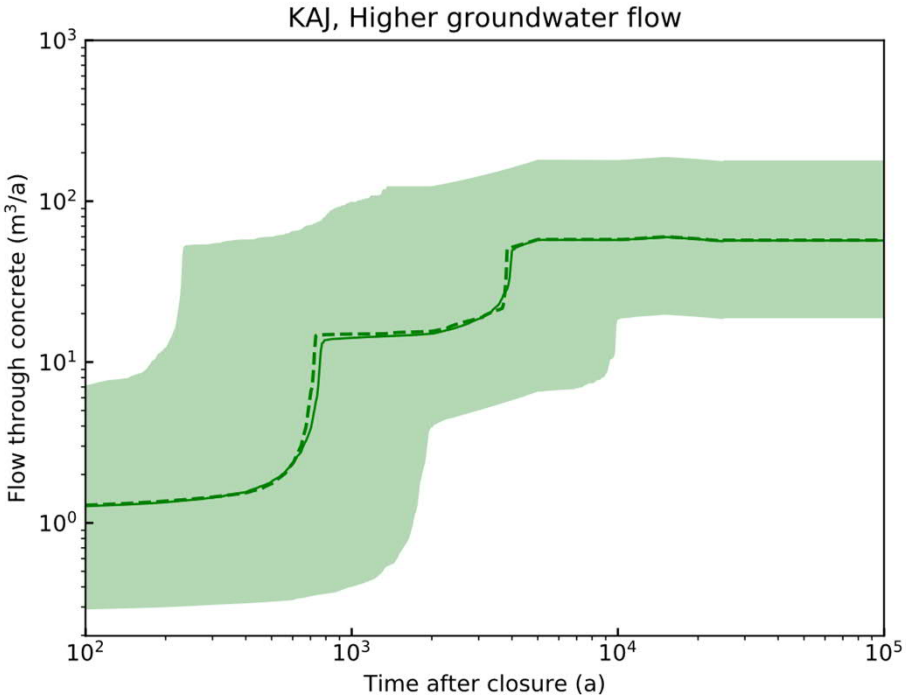


- Degradation of the concrete plugs have been modelled with a compartment model (using Ecolego software), where both advective and diffusive leaching is considered
- Connection between groundwater flow modelling (Comsol) by calculating the flow rate into the waste caverns as a function of the hydraulic conductivity of the different plugs
- Naturally, simplifications have to be done as the total number of plugs and thus the number of permutations is high

Impact of the plugs on the groundwater flow (TVO, KAJ silo)

- The performance of the concrete plug has a large impact on the groundwater flow rate (and thus on the concrete degradation and radionuclide transport)





Conclusions

- The closure of the Finnish LILW repositories was presented: plugs, backfilling, closing of the boreholes
- Also, the impact of the closure on the repository evolution (estimate) was shown
- The exact technical details of the implementation of the closure has not been designed, as the closure at least 20 years (or more) away
- The performance of the closure has been assessed as part of the safety cases

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