Safety review of Tokai L3 burial facility

October 2024

THE JAPAN ATOMIC POWER COMPANY
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1. Status of Tokai decommissioning

Reason for shutdown

Tokai-1 is the sole Magnox NPP in Japan

Tokai-1 is the oldest NPP in Japan

Unit cost became higher than LWRs

Chronology

Jun.1996 Formal announcement for closure

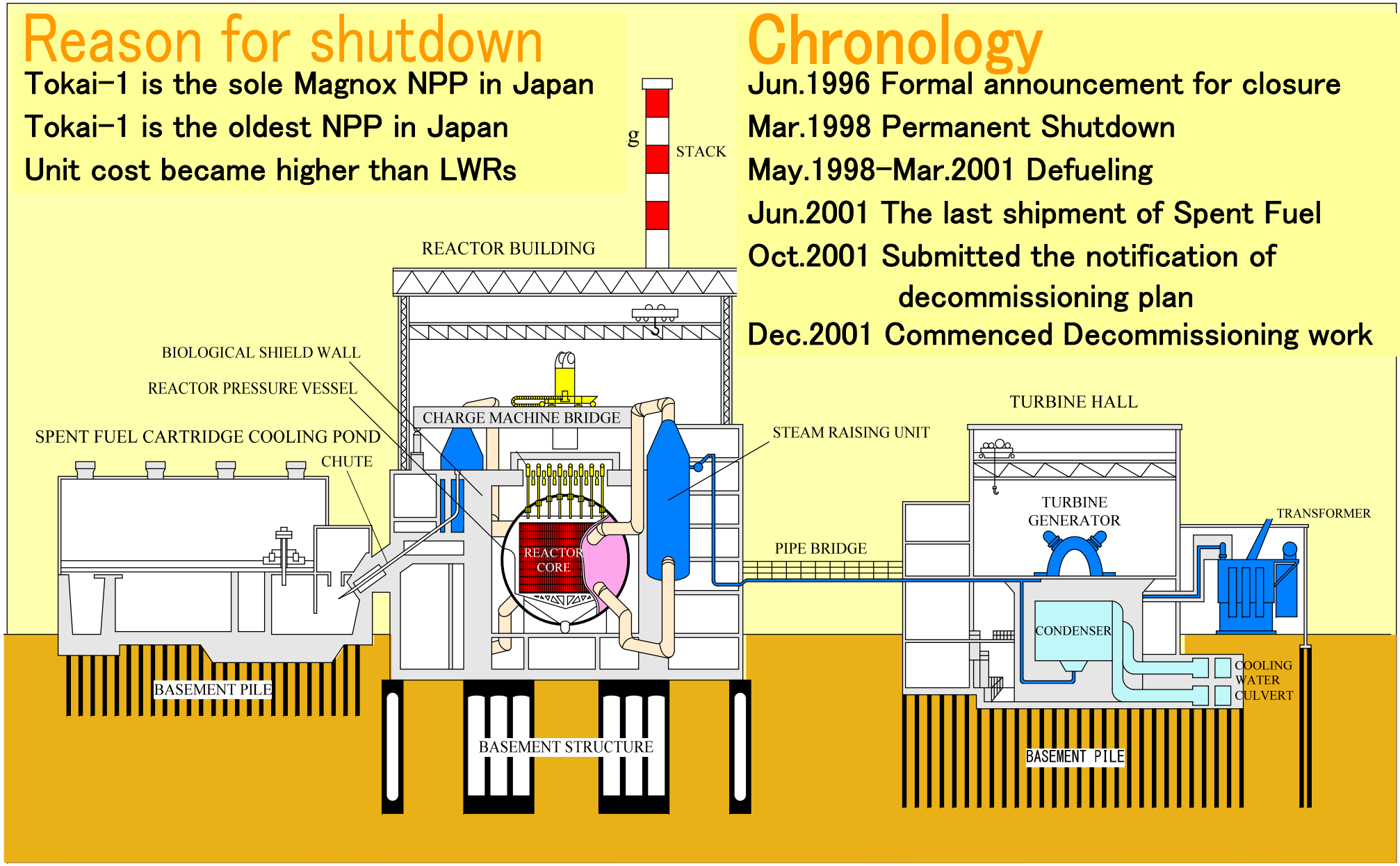
Mar.1998 Permanent Shutdown

May.1998-Mar.2001 Defueling

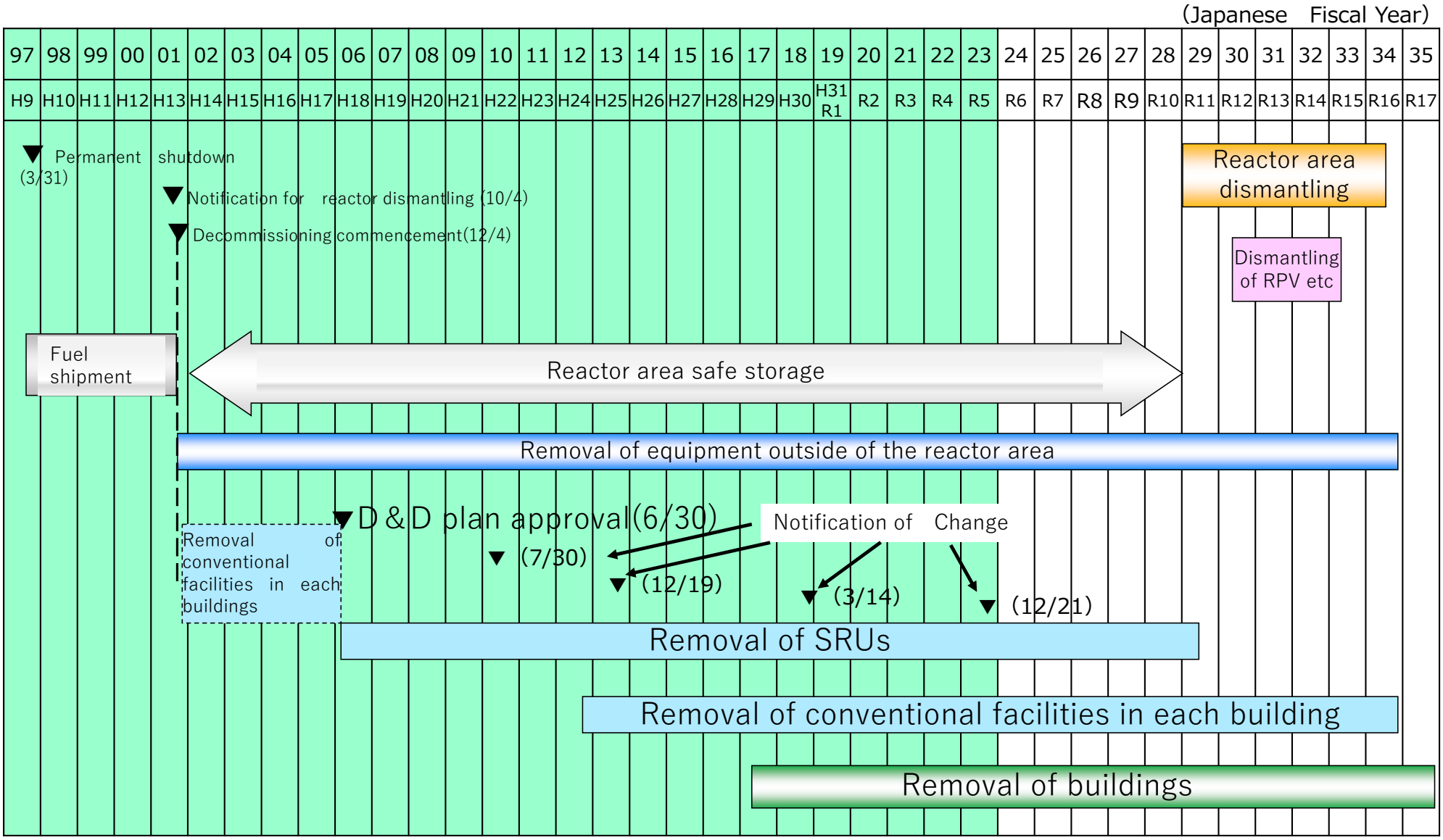
Jun.2001 The last shipment of Spent Fuel

Oct.2001 Submitted the notification of decommissioning plan

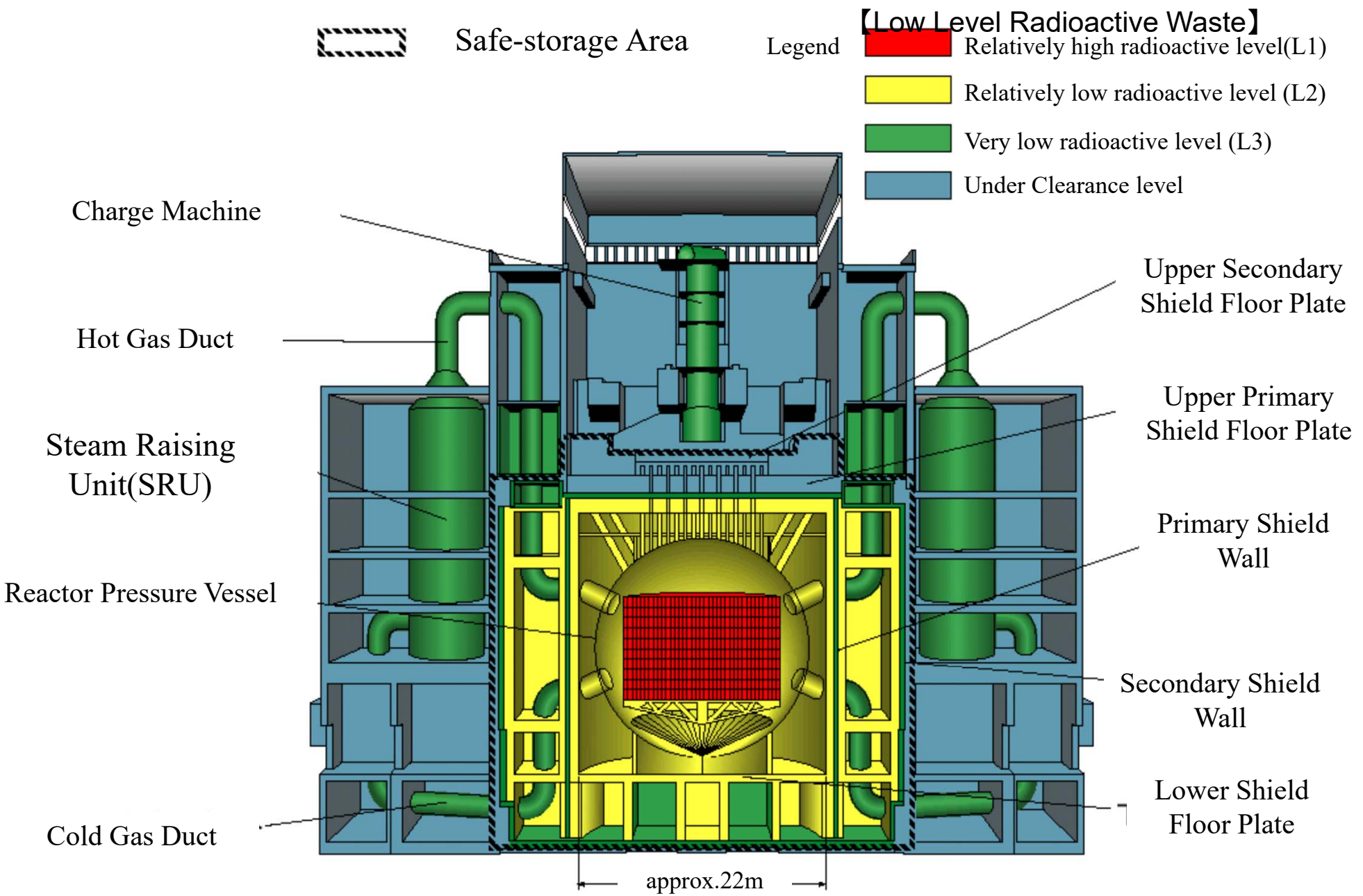
Dec.2001 Commenced Decommissioning work



1. Schedule of Tokai decommissioning



1. Status of Tokai decommissioning



1. Status of Tokai decommissioning

[ton]

		Operational wastes	Decommissioning wastes			Total
			1st Phase	2nd Phase	3rd Phase	
LLW	Relatively high radioactive level (L1 waste)	30	0	0	1,530	1,600
LLW	Relatively low radioactive level (L2 waste)	4,210	340	630	7,900	13,100
LLW	Very low radioactive level (L3 waste)	-	10	1,810	11,260	13,100
No necessity to be dealt as radioactive (Clearance material)		-	1,400	2,840	35,930	40,200
Non-radioactive waste		-	9,160	3,090	116,380	128,700
Total		4,300	11,000	8,400	173,000	196,600

1. Status of Tokai decommissioning

Classification		Regulatory infrastructure	Upper limit Concentration (Bq/ton)	Disposal site
LLW	Relatively high radioactive waste(L1)	Established	C-14:1E+16	**Under investigation**
	Relatively Low radioactive waste(L2)	Established	C-14 : 1E+11 Co-60: 1E+15	[Operational wastes] Rokkasho LLW Disposal Center [Decommissioning wastes] **Under consideration**
	Very low radioactive level waste(L3)	Established	Co-60 :1E+10	[JPDR] JAEA Tokai Research Center [JAPC Tokai-1] **Under safety review**
No necessity to be dealt as radioactive (Clearance material)		Established	C-14 : 1E+6 Co-60: 1E+5	Recycle or disposal an industrial waste

2. Safety review for Tokai L3 burial facility

- 2015.July.：Submitted application
- 2016.Dec.：Revision application (1st time)
- 2018.Jul.：Completed a full explanation of the contents of the revised application form.
- 2019.Dec.：Revision of laws and regulations (1st time)

  ⇒Review of facility structure and reevaluation of radiation dose assessment due to changes in facility structure
- 2021.Oct.：Revision of laws and regulations (2nd time)

  ⇒Changes in conditions for radiation dose evaluation, revaluation

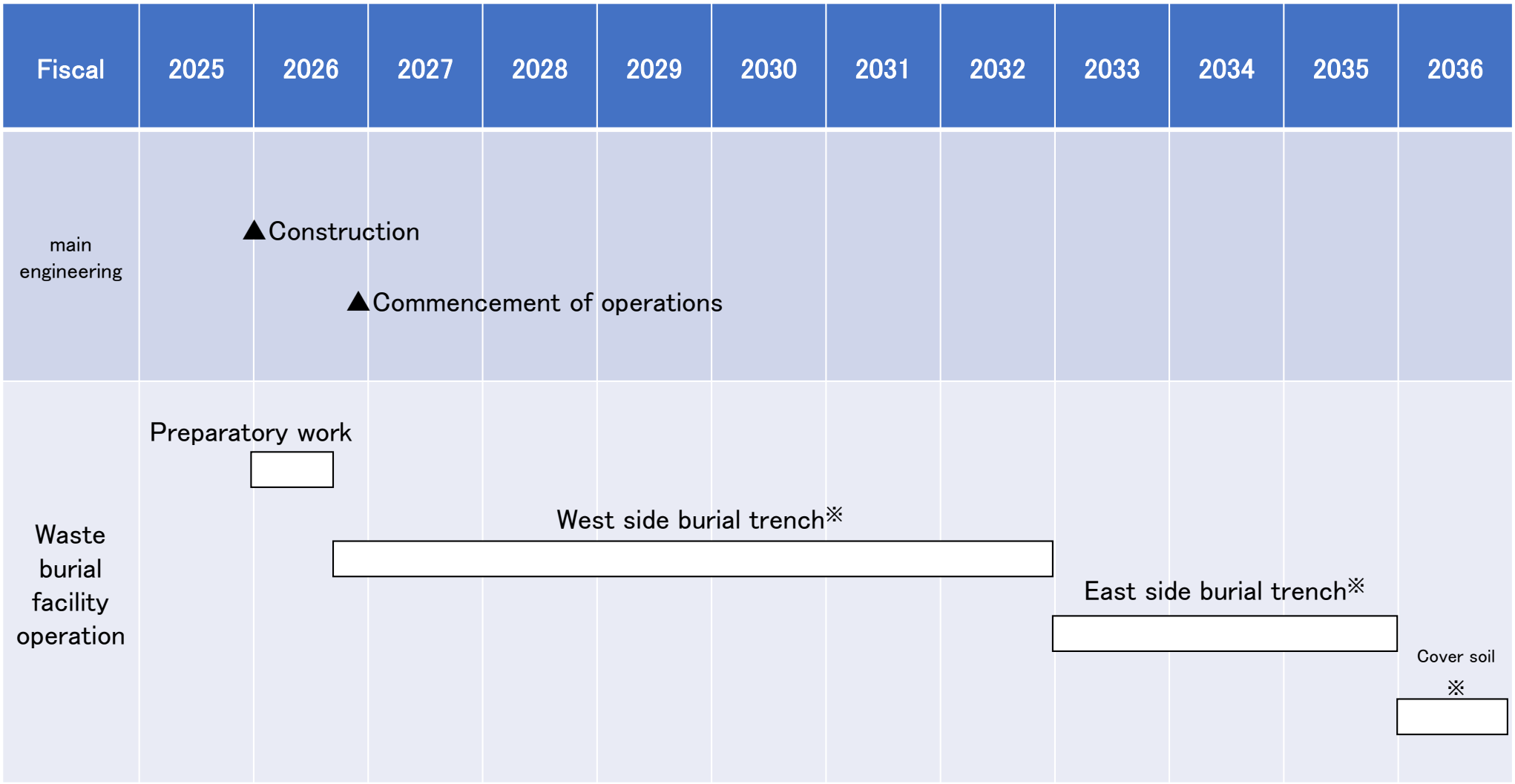
- 2022.Aug.：Submitted documents for review complied with the amended law

  ⇒Resumption of review
- 2023.Sept.：Regulatory comments on the Revision of facility structure

  ⇒Review of facility structure and reevaluation of radiation dose assessment due to changes in facility structure
- 2024.July.：Revision application (2nd time)

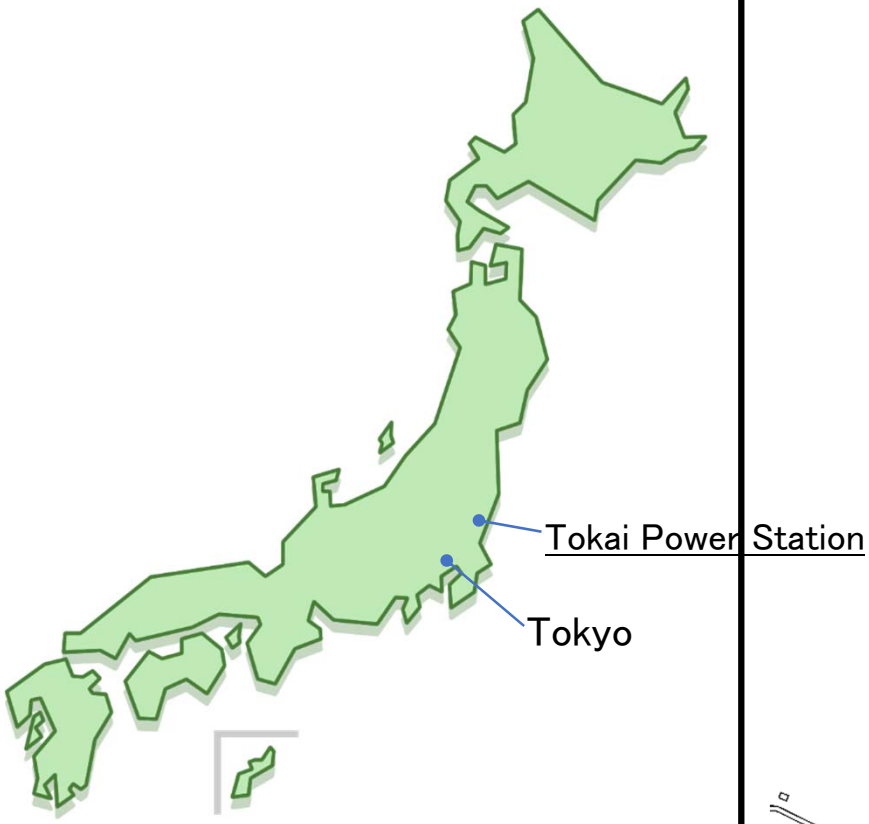
  ⇒Resumption of examination

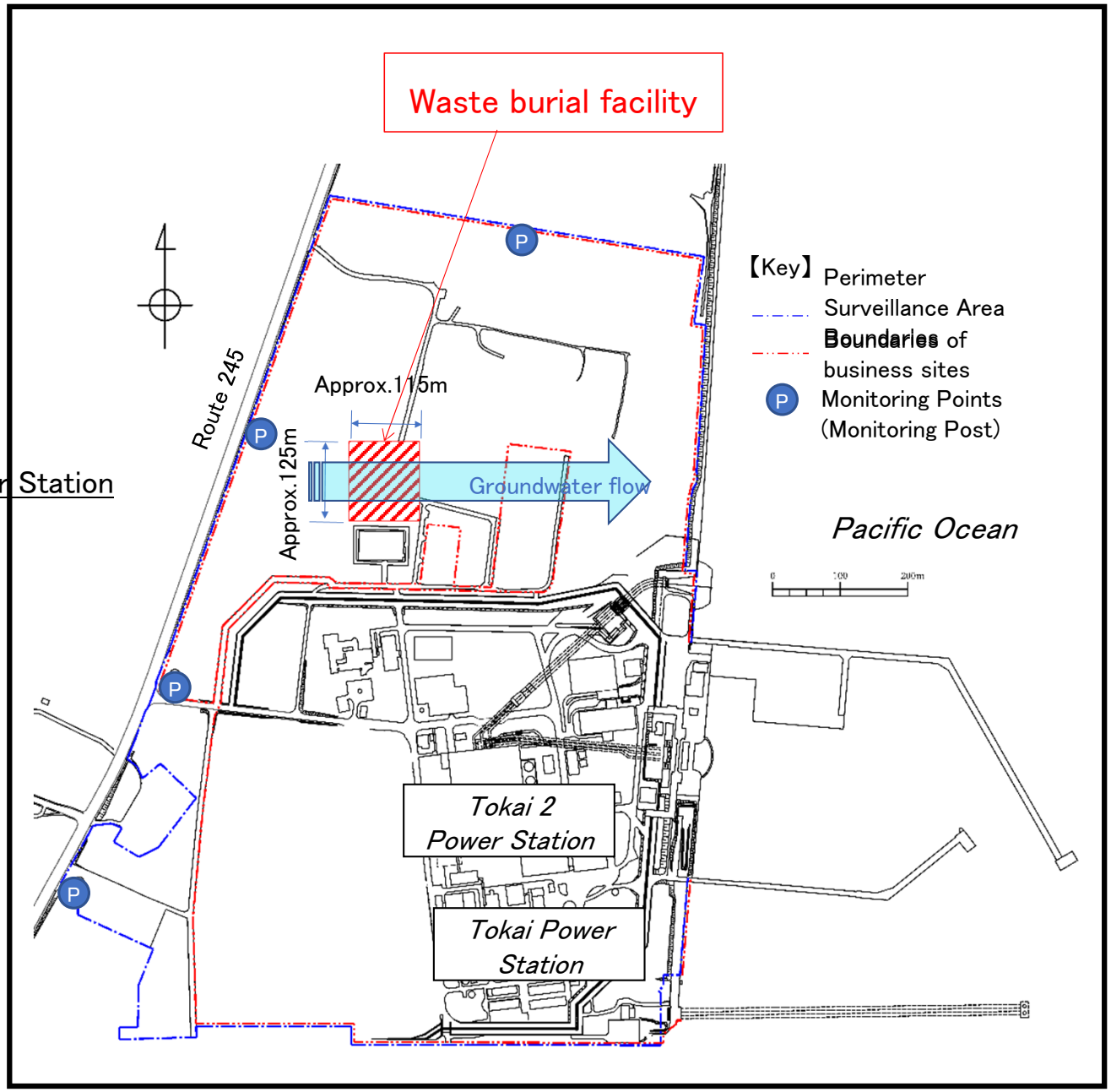
3. Operation plan of Tokai L3 burial facility (Tentative)



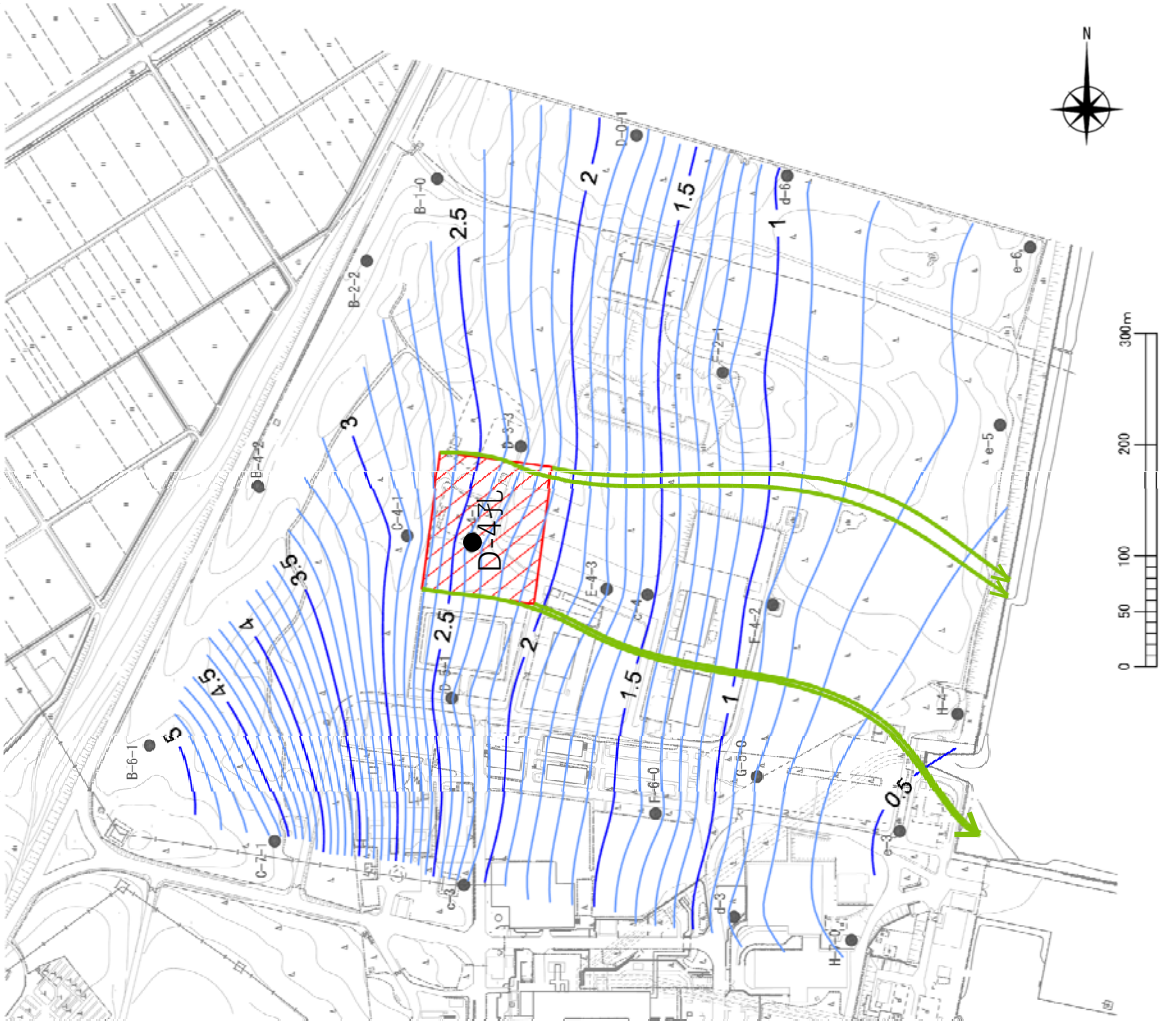
※Carried out according to the decommissioning process

3. Location of Tokai L3 burial facility





3. Groundwater level contour map



- Groundwater level at the survey target site
- Ground surface at study site: elevation 8.4m

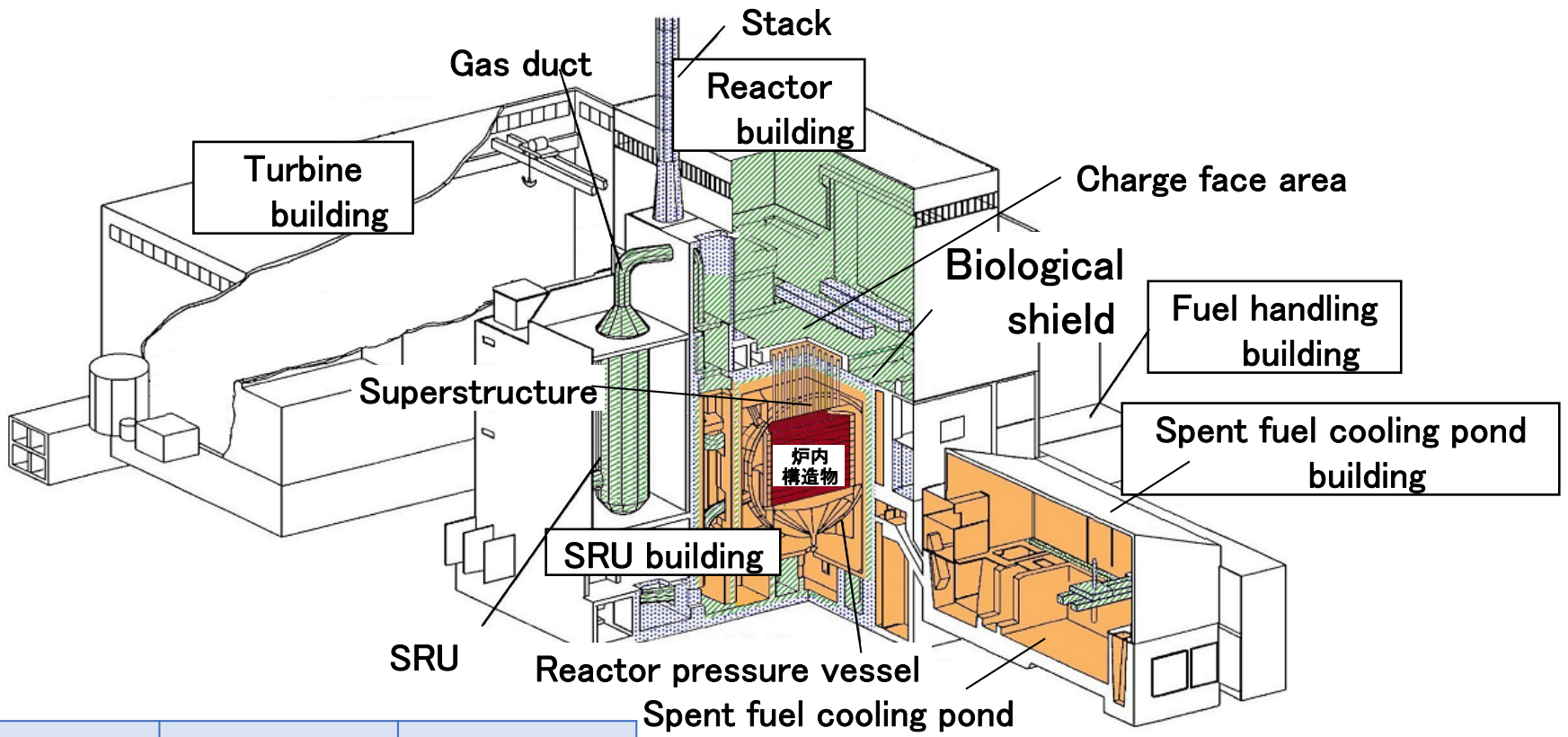
  Groundwater level at the same point [D-4 hole] : T.P. 1.4～ 2.6m

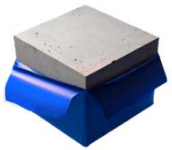
  (Annual fluctuation range1.2m)

- Since the groundwater level contour line of the site is generally parallel to the coastline and lowers in the direction of the sea, groundwater might flow steadily toward the sea side.

Location of waste
contour (0.5m)
contour (0.1m)
streamline

3. Waste buried at Tokai L3 burial facility



Types of waste	Metal	Concrete waste	Concrete block
Buried form	Iron box	Iron box	Plastic sheet packing
size	1.4m × 1.4m × 0.9m	1.4m × 1.4m × 0.9m	0.9m × 0.9m × 0.7m
Storage Container image			
Storage status image			

- Relatively high level waste (L1)
- Relatively low level waste (L2)
- Very low level waste (L3)

: 14%

- Not necessary to be dealt with as radioactive (CL) : 21%
- Non-radioactive waste (including general waste) : 65%

Total amount : 200,000t

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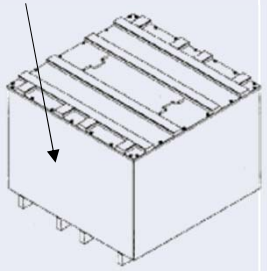
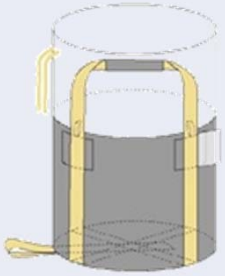
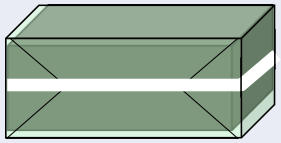
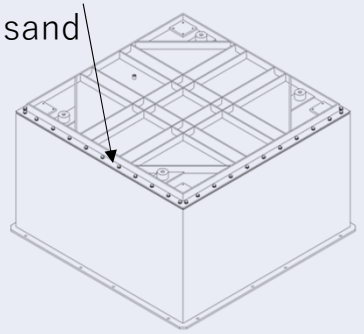
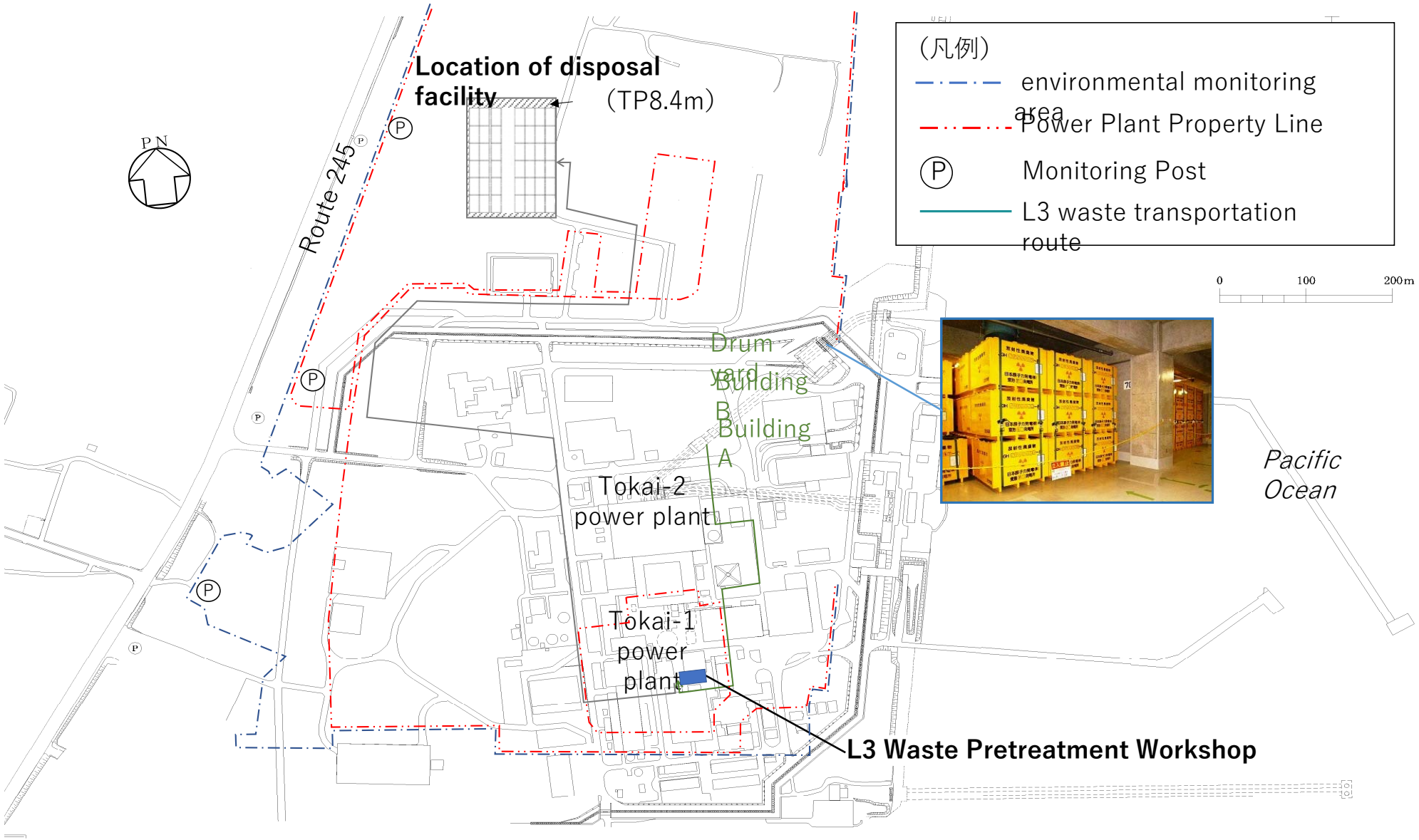
3. Waste buried at Tokai L3 burial facility

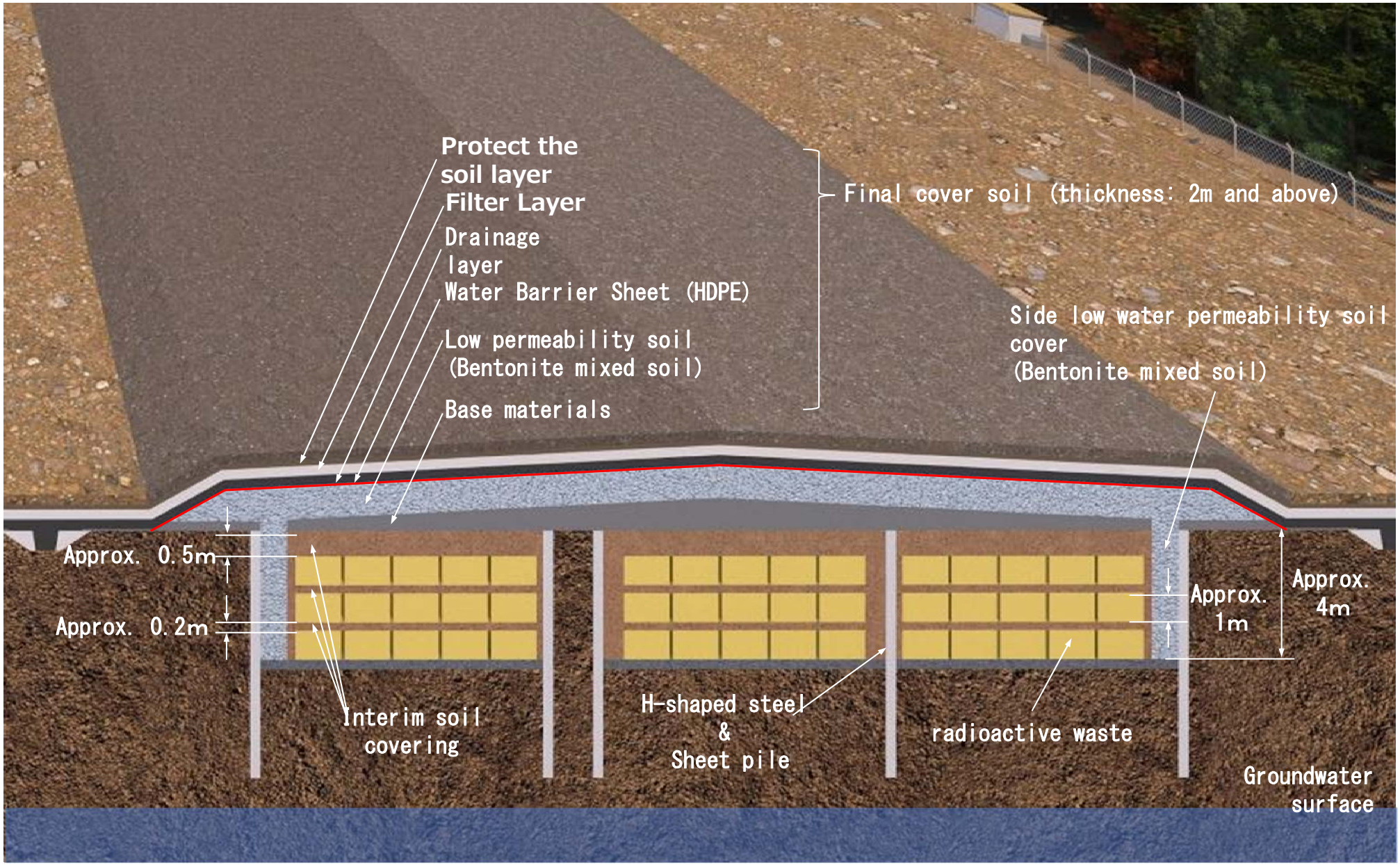
In order to prevent damage due to depression of bentonite mixed soil used for part of the upper cover of the waste burial site and to efficiently store waste, the disposal container has been changed to container without a fork base with improved load-bearing performance.

	Before			After		
waste	metal	Concrete debris	Concrete blocks	metal	Concrete debris	Concrete blocks
shape	the steel box is filled with sand  Steel box	 Flexible container	 Plastic Sheet	the steel box is filled with sand  Disposal containers		No change
material	Carbon Steel	Polyethylene Polypropylene, etc.	Polyethylene, etc.	Carbon Steel		No change
size	1.4×1.4×1.1m	Φ1.3×0.8	0.7×0.9×0.9m	1.4×1.4×0.9m		No change

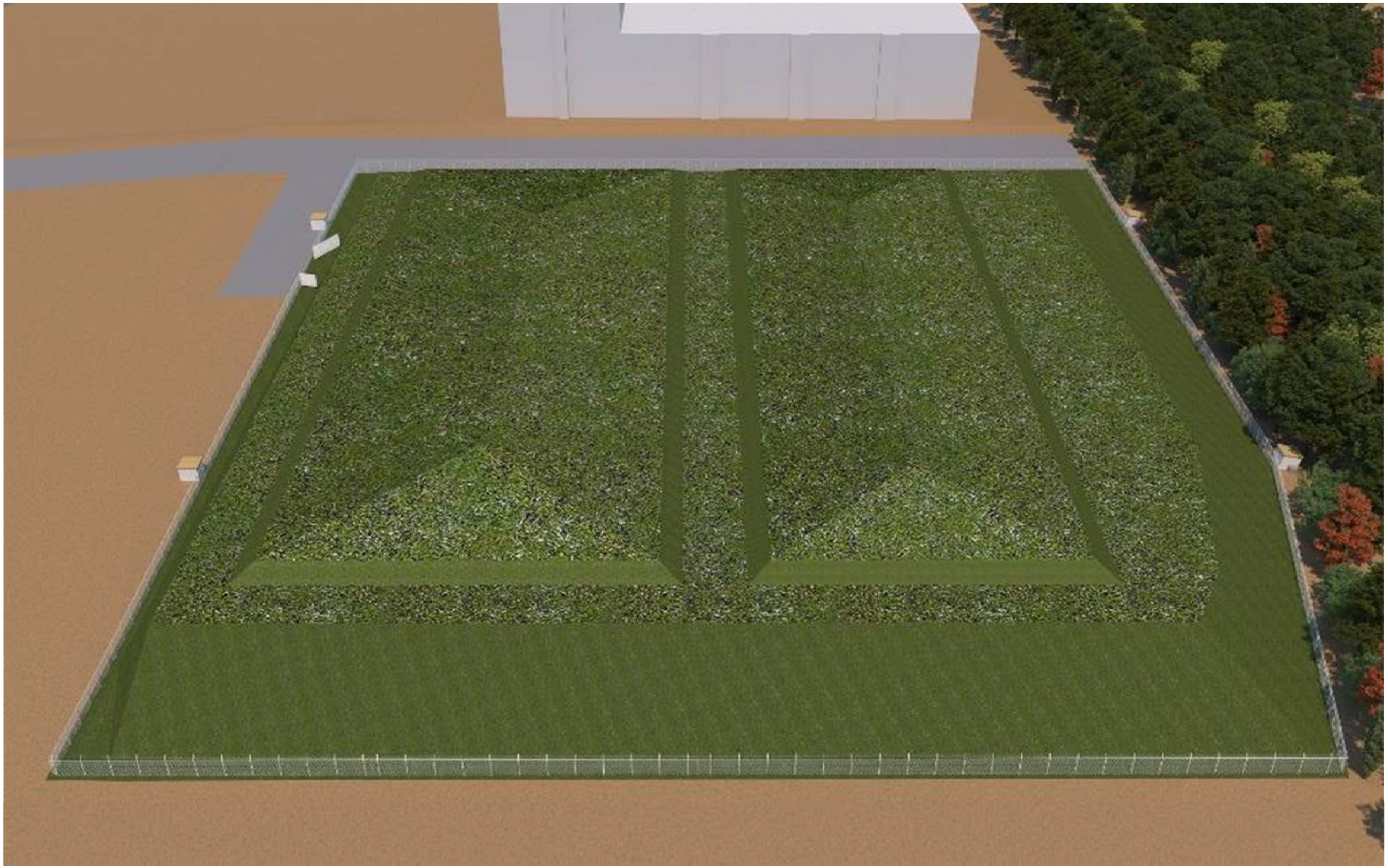
3. Overall logistics



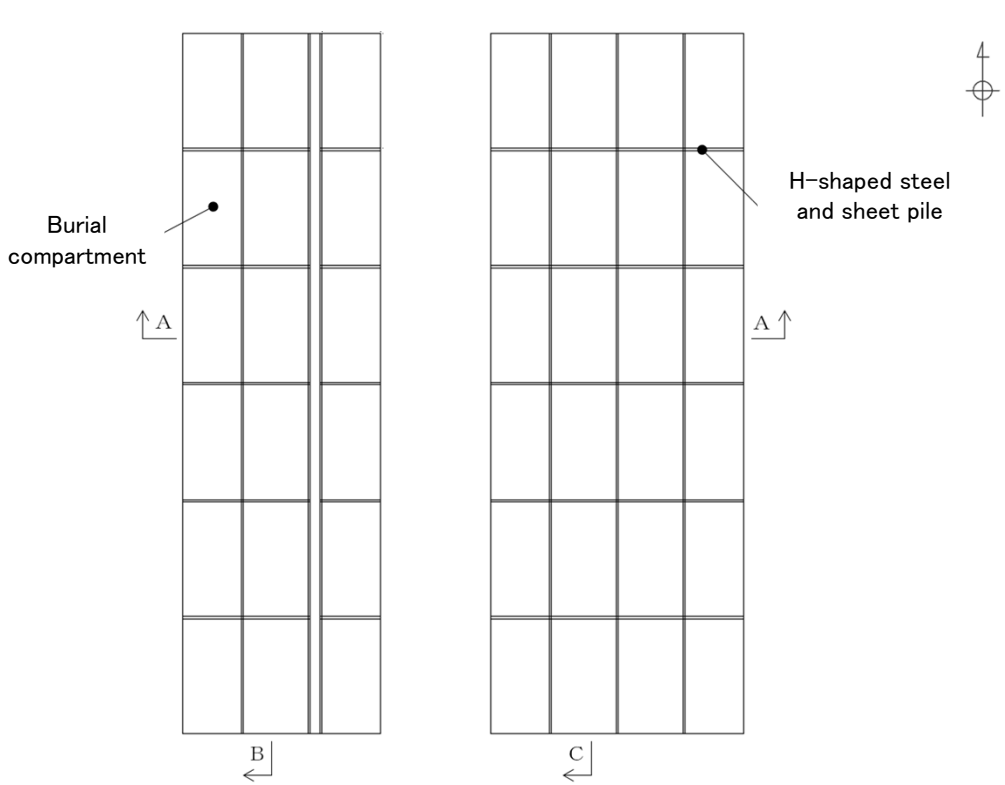
3. Structure of Tokai L3 burial facility



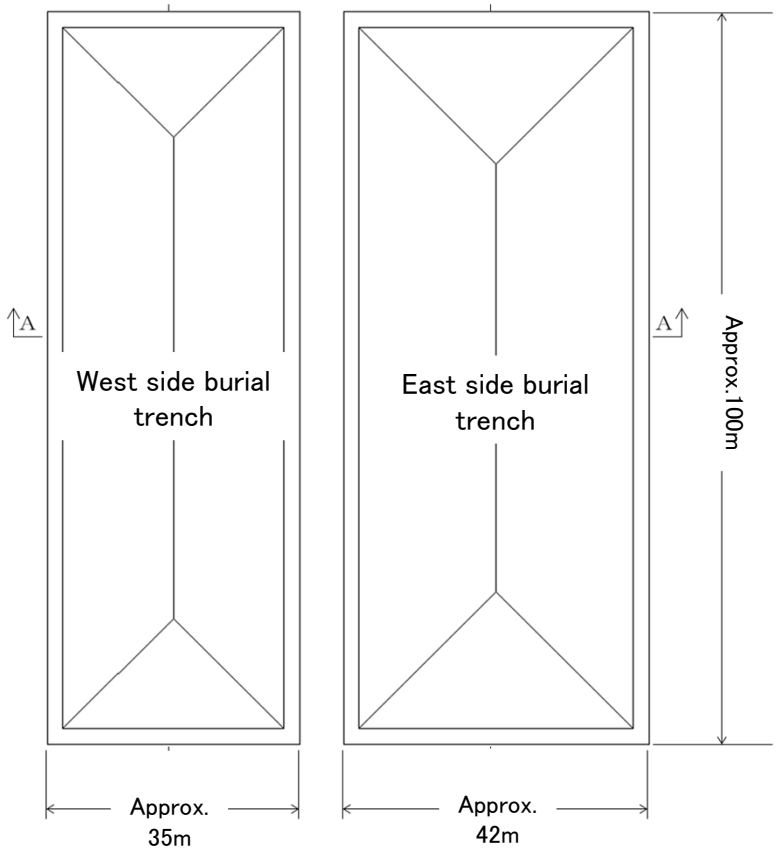
3. Structure of Tokai L3 burial facility (top view)



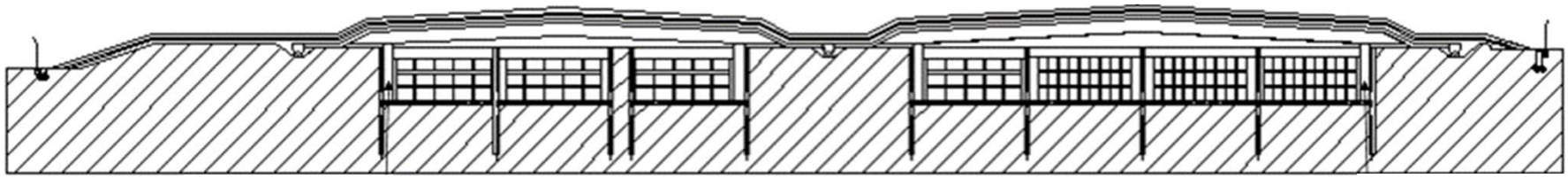
3. Structure of Tokai L3 burial facility



Burial compartment floor plan



Final cover soil plan

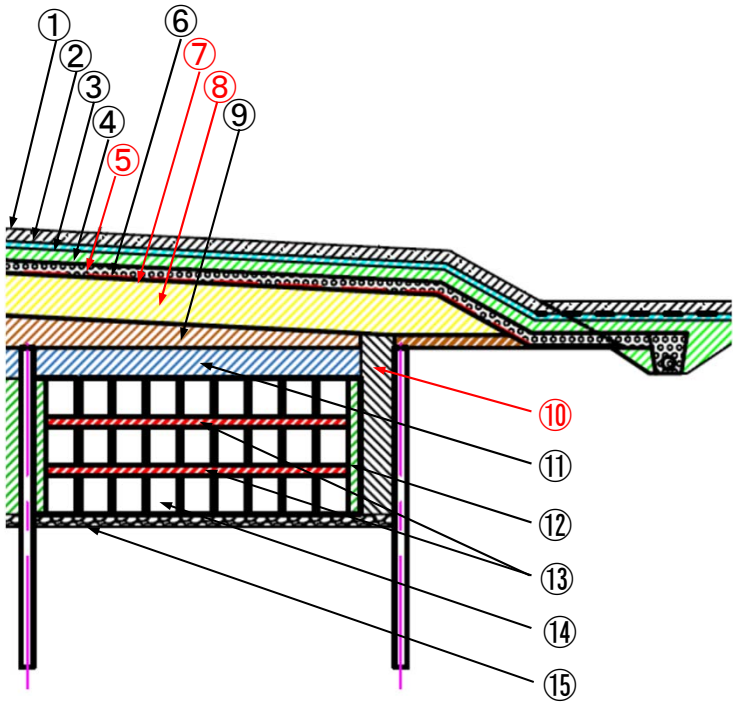


West side burial trench

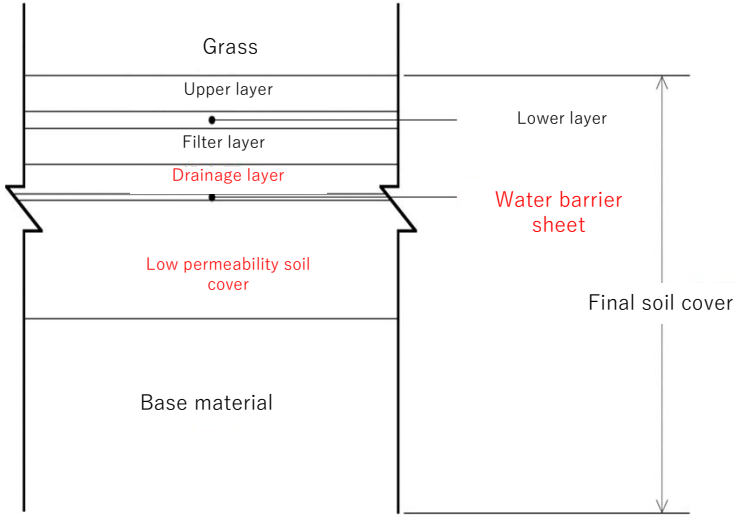
East side burial trench

A-A cross-sectional view

3. Structure of Tokai L3 burial facility



Cross-sectional view of a waste burial facility



Position		Role
①Grass		Drain surface water from rainfall and protect the soil cover surface from erosion by surface water
Final soil cover	②Protective soil layer (Upper layer)	It has erosion resistance, water retention, and fertilizer retention properties to grow grass
	③Protective soil layer (Lower layer)	Prevents the outflow of fine particles from the upper layer to the filter layer and ensures appropriate drainage
	④Filter layer	Prevents the outflow of fine particles from the upper layer to the drainage layer and ensures appropriate drainage
	⑤Drainage layer	Lateral drainage and water saturation time are shortened to minimize erosion and improve slope stability.
	⑥Protective layers & Mats	It mitigates the impact of the filter layer during construction and prevents the water barrier sheet from damage
Waste Disposal Sites	**⑦Water barrier sheet (HDPE)**	Suppress the infiltration of rainwater and other waste layers from the top. In addition, the water barrier sheet plays a role in assisting in reducing water seepage into the facility and controlling the outflow of bentonite.
	⑧Low permeability soil cover (Bentonite mixed soil)	
	⑨Base materials	Solid foundation for compaction of the upper layer, ensure sufficient bearing capacity
	⑩Side low permeability soil cover (Bentonite mixed soil)	Suppress the infiltration of rainwater and other waste layers from the side
	⑪Soil cover in the middle i	Shielding radiation from waste layers
	⑫Fill with sand	Reduction of air in waste landfills / absorption of photogenic materials
	⑬Soil cover in the middle ii	Shielding radiation from waste layers / absorption of radioactive materials
	⑭Filled sand (in the iron box)	Reduction of voids in the steel box / absorption of radioactive materials
	⑮Base materials	Solid substrate for compaction of side low permeability soil cover, ensure sufficient bearing capacity

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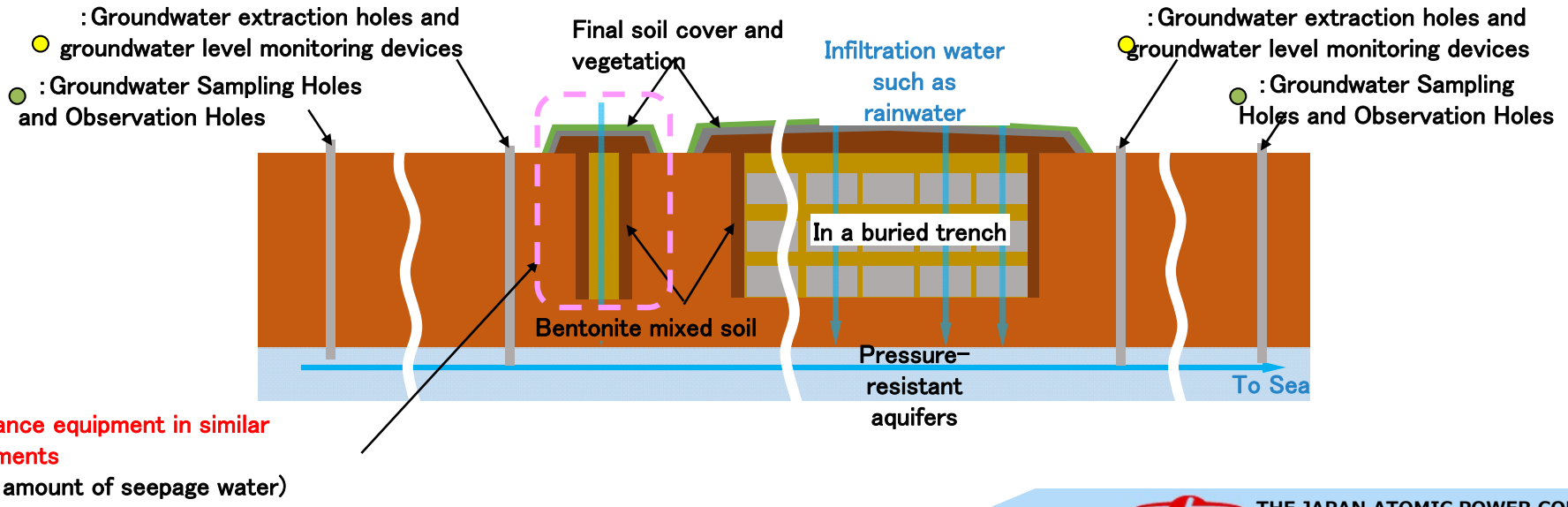
3. Structure of Tokai L3 burial facility

- Surveillance measurements during the operation period

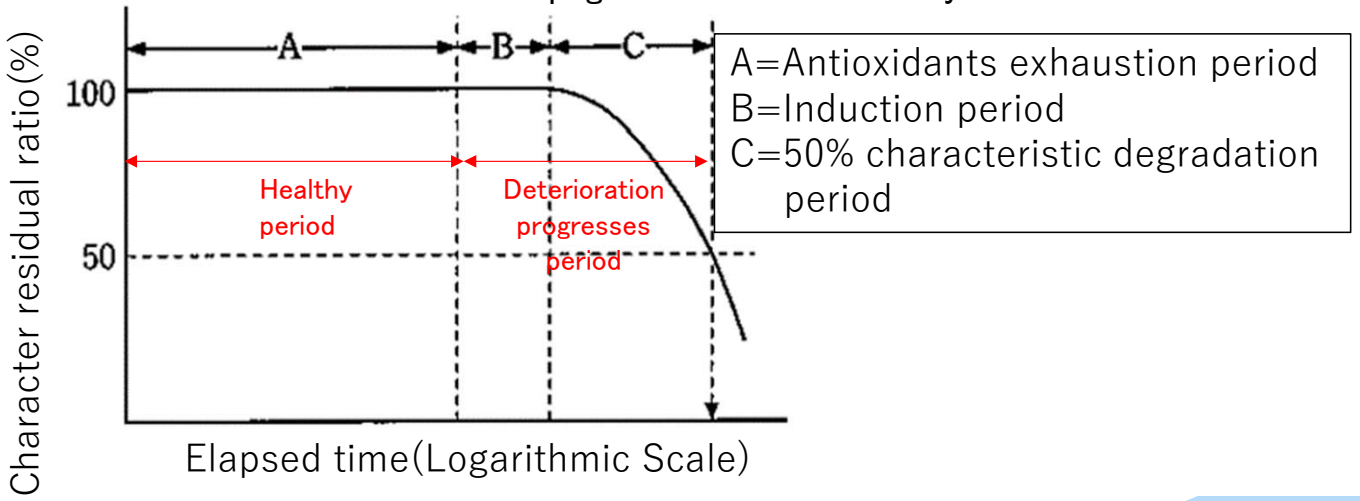
  - Monitoring will continue for about 50 years after the completion of soil covering.
  - The monitoring target can be confirmed to meet the technical requirements, as shown in the table below.
  - As for the condition of the soil cover, a similar environment is created to prevent destruction, and data is obtained from it

Target	Technical Requirements	Monitoring & Measurement Items	Monitoring and measuring equipment
Artificial and Natural Barriers (Entire waste burial facility)	absorption, Low water permeability	Concentration of radioactive materials	Groundwater Sampling Holes
		Groundwater level (groundwater flow field, hydraulic gradient, whether buried radioactive waste is directly immersed in groundwater, aquifer thickness)	Groundwater level monitoring device, Observation Holes
Artificial barriers (Surface water barrier, water barrier sheet, low permeability soil cover and side low water permeability soil cover)	Low water permeability	Annual infiltration water volume	Periodic inspections, in-situ tests in similar environments, Laboratory tests to complement it if necessary



3. Structure of Tokai L3 burial facility

- Concepts for Reducing Leakage of Radioactive Materials
  - Soil cover is carried out using natural materials that are stable for a long time.
  - Soil cover surfaces are covered with grass to reduce erosion.
  - A drainage layer is provided to drain rainwater that has seeped into the soil cover.
  - Bentonite mixed soils and water barrier sheets reduce contact between waste and rainwater
  - A bentonite mixed soil layer is provided to reduce the infiltration of seepage water from the side of the waste burial site.
  - Reduce the transfer of radioactive materials into groundwater by placing waste in a location that does not come into contact with groundwater.
- Target hydraulic conductivity of bentonite mixed soils.
  - Set up so that the dose of exposure to the public can be reduced as much as possible.
  - The hydraulic conductivity is set at 1.0×10 to 10 m/s.
- Effect of water barrier sheets to reduce seepage water
  - Use HDPE as a water barrier sheet
  - Since it is not a natural material, it is necessary to set a functional maintenance period due to deterioration. The most serious deterioration of HDPE is ultraviolet degradation and high-temperature deterioration, but this does not apply to the Tokai L3 burial facility
  - Therefore, the main deterioration is set as oxidative degradation of the polymer, and the period that contributes to the reduction of seepage water is set to 150 years.



4. Evaluation of public dose from Tokai L3 burial facility

Period	purpose	Target	Criteria(mSv/y)	Note
Operation	Operation Management	Normal	1	
	Validation of Design	Normal	0.05	ALARA
		Accident/abnormal	5	
After institutional control	Validation of Design	Likely scenario	0.01	
		Less likely scenario	0.3	
		Human intrusion	0.3	“1” if drilling resistance can be assumed such as concrete pit

4. Evaluation of public dose from Tokai L3 burial facility

Regulations for the burial of low-level radioactive waste are as follows:

- L1 Burial Facility
  - Waste is buried more than 70 meters underground from the surface of the earth.
  - The evaluation scenarios are "natural event scenario (Standard value: 300 μSv/y)" and "boring scenario (Standard value: 20 mSv/y)"
- L2 Burial Facility
  - Waste is buried underground less than 70 meters from the surface
  - The radionuclides whose concentrations are capped in the regulations are C-14, Co-60, Ni-63, Sr-90, Tc-99, Cs-137, α nuclides.
  - The evaluation scenario is, 「Natural Event Scenarios (Standard value : 10 μSv／y, 300 μSv／y)」, 「Anthropogenic Scenarios (Standard value : 1mSv／y)」
- L3 Burial Facility
  - Waste is buried underground less than 70 meters from the surface
  - The radionuclides whose concentrations are set in the regulations are Co-60, Sr-90, and Cs-137
  - The evaluation scenario is, 「Natural Event Scenarios (Standard value : 10 μSv／y, 300 μSv／y)」, 「Anthropogenic Scenarios (Standard value : 300 μSv／y)」

Nuclides	L1 Burial Facility Concentration upper limit	L2 Burial Facility Concentration upper limit	L3 Burial Facility Concentration upper limit
C-14	Not set	1.0×10^{5}Bq／g	－
Co-60		1.0×10^{9}Bq／g	1.0×10^{4}Bq／g
Ni-63		1.0×10^{7}Bq／g	－
Sr-90		1.0×10^{7}Bq／g	1.0×10^{1}Bq／g
Tc-99		1.0×10^{3}Bq／g	－
Cs-137		1.0×10^{8}Bq／g	1.0×10^{2}Bq／g
α		1.0×10^{4}Bq／g	－

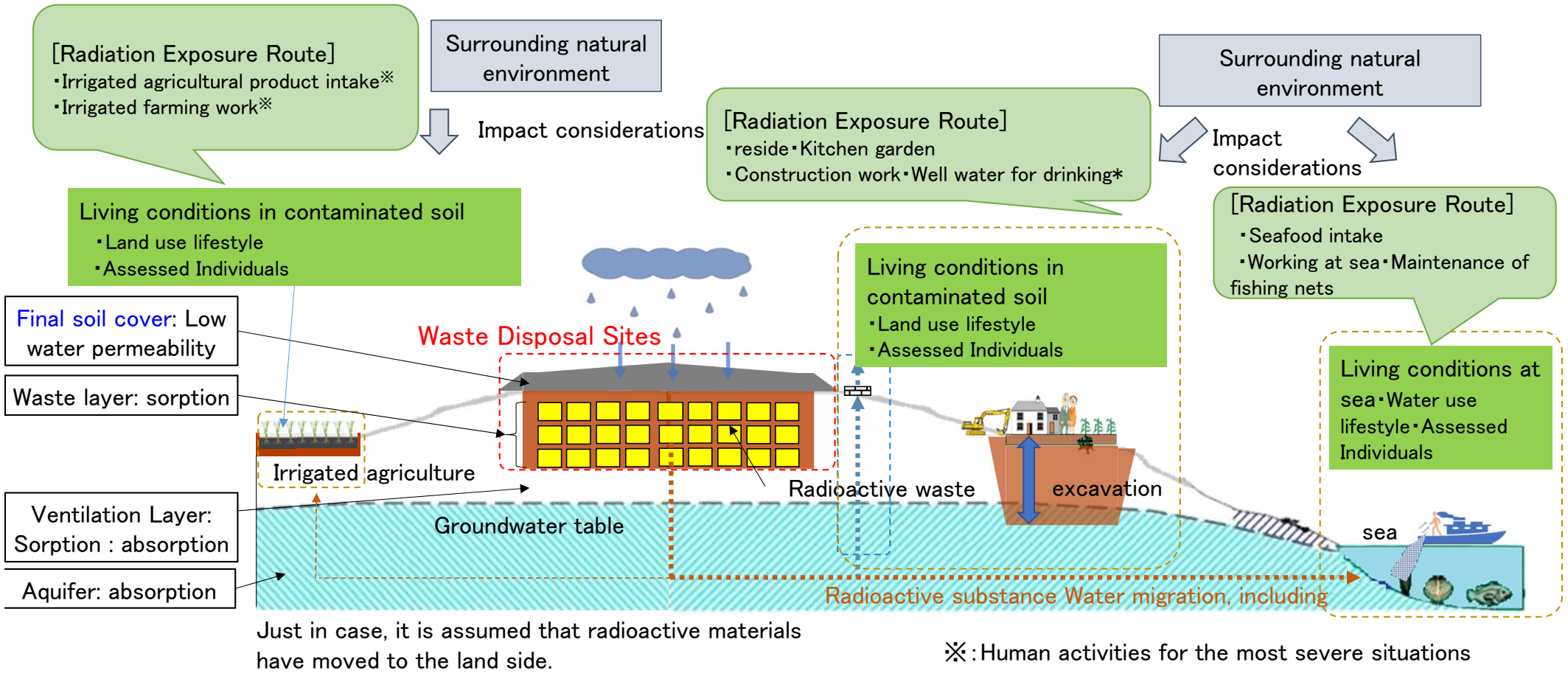
4. Evaluation of public dose from Tokai L3 burial facility

scenario	Standard value	Assessed Individuals	Routes of exposure
Natural Event Scenarios	10 μ Sv／y	Resident	Residence
			Kitchen garden
			Seafood intake
	300 μ Sv／y	Fishermen	Seafood intake
			Working out at sea
			Maintenance of fishing nets
		Farmers	Seafood intake
			Residence
			Kitchen garden
			Well water drinking
			Irrigated agricultural product intake
			Irrigated farming work
		Construction Workers	Seafood intake
			Residence
			Kitchen garden
			Well water drinking
			Irrigated agricultural product intake
			Construction
		Resident	Seafood intake
			Residence
			Kitchen garden
			Well water drinking
			Irrigated agricultural product intake

Exposure routes in which the radiation dose is most abundant due to the influence of Cl-36

4. Evaluation of public dose from Tokai L3 burial facility

○Exposure routes to be evaluated in natural event scenarios

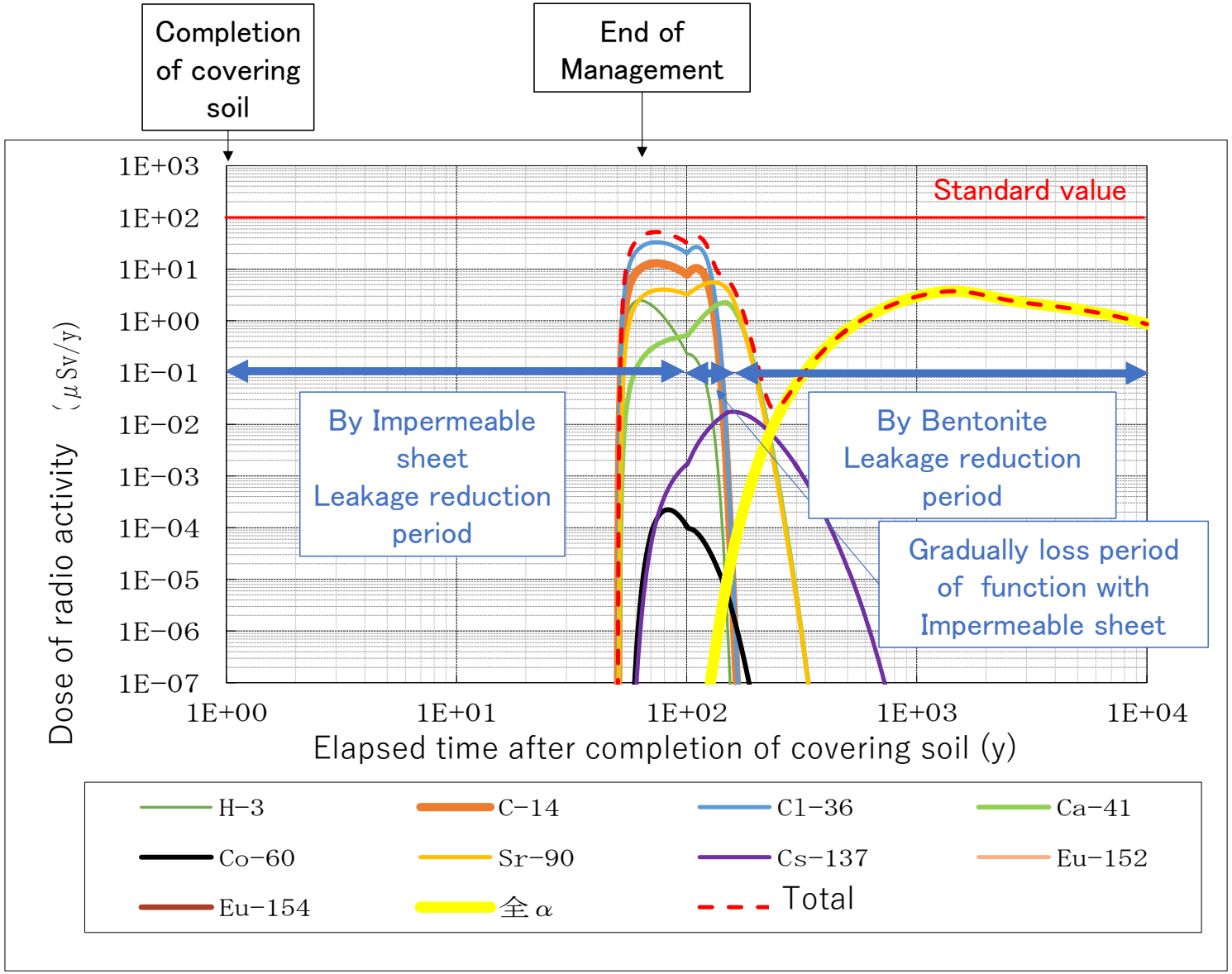


Just in case, it is assumed that radioactive materials have moved to the land side.

※:Human activities for the most severe situations

4. Evaluation of public dose from Tokai L3 burial facility

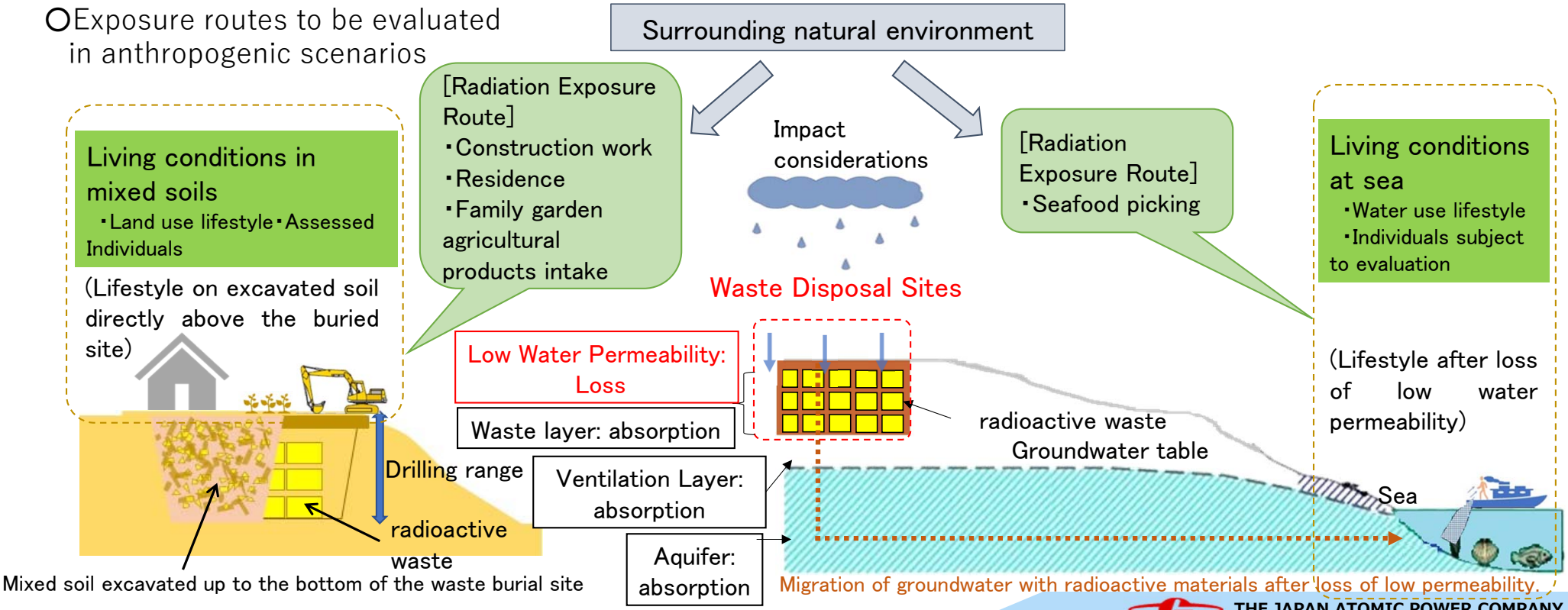
○Evaluation Results of Farmers



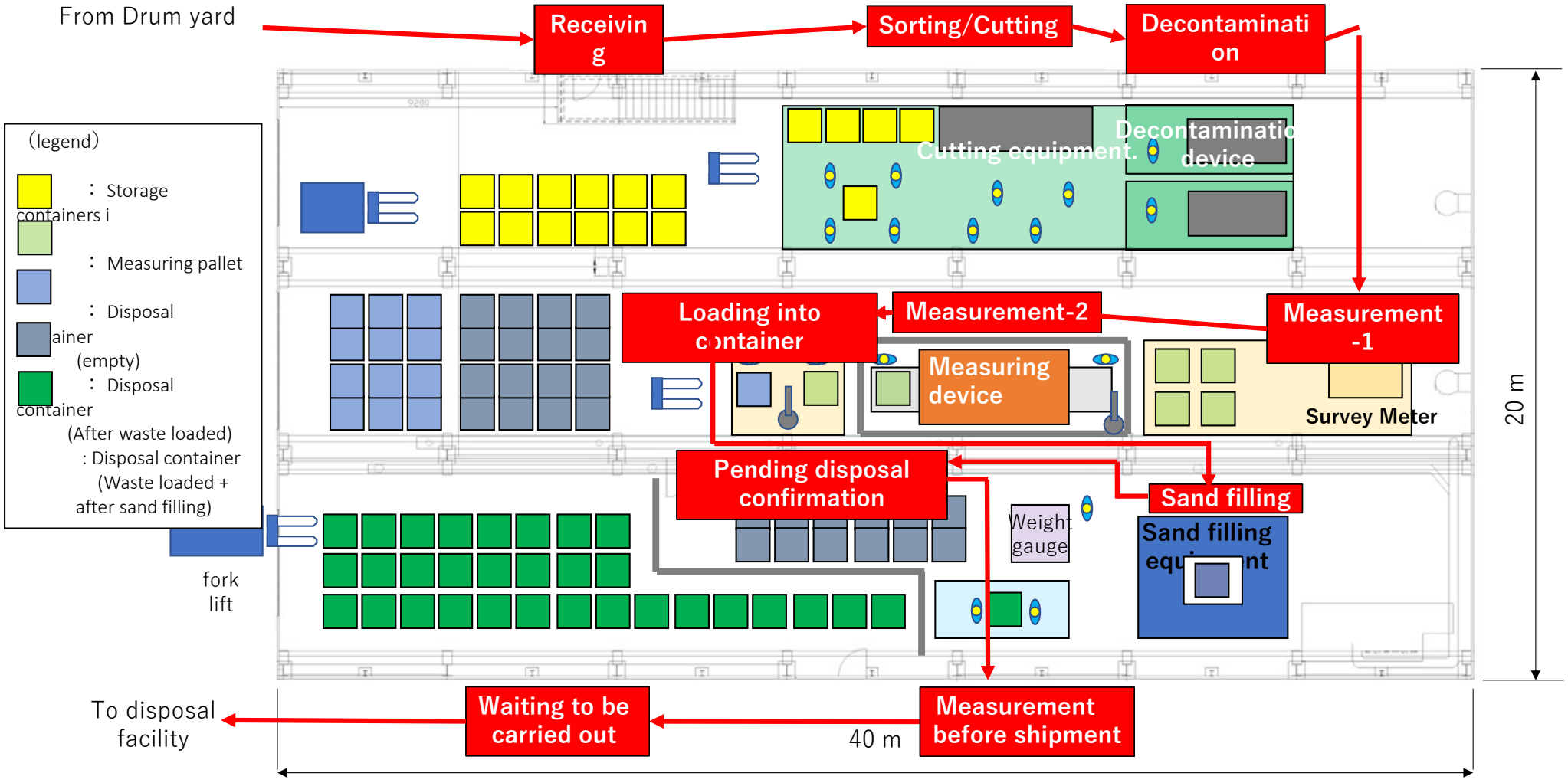
4. Evaluation of public dose from Tokai L3 burial facility

Scenario	Standard value	Assessed Individuals	Routes of exposure
Anthropogenic Scenarios	300 μ Sv／y	Those who are involved in the construction industry (Metal bias)	Construction work (uneven distribution of metals)
		Construction Workers (Uneven distribution of concrete)	Construction work (uneven distribution of concrete)
		inhabitant (Metal bias)	Residence (metal bias)
			Family garden (metal bias)
			Seafood intake
		resident (Uneven distribution of concrete)	Residential (uneven distribution of concrete)
			Kitchen garden (concrete unevenly distributed)
			Seafood intake

○Exposure routes to be evaluated in anthropogenic scenarios



VLL waste pretreatment flow



Thank you for your attention !
御静聴有難うございました。