Dose Estimation for Treatment of Contamination Wastes Generated from Fukushima Daiichi Nuclear Power Station Accident

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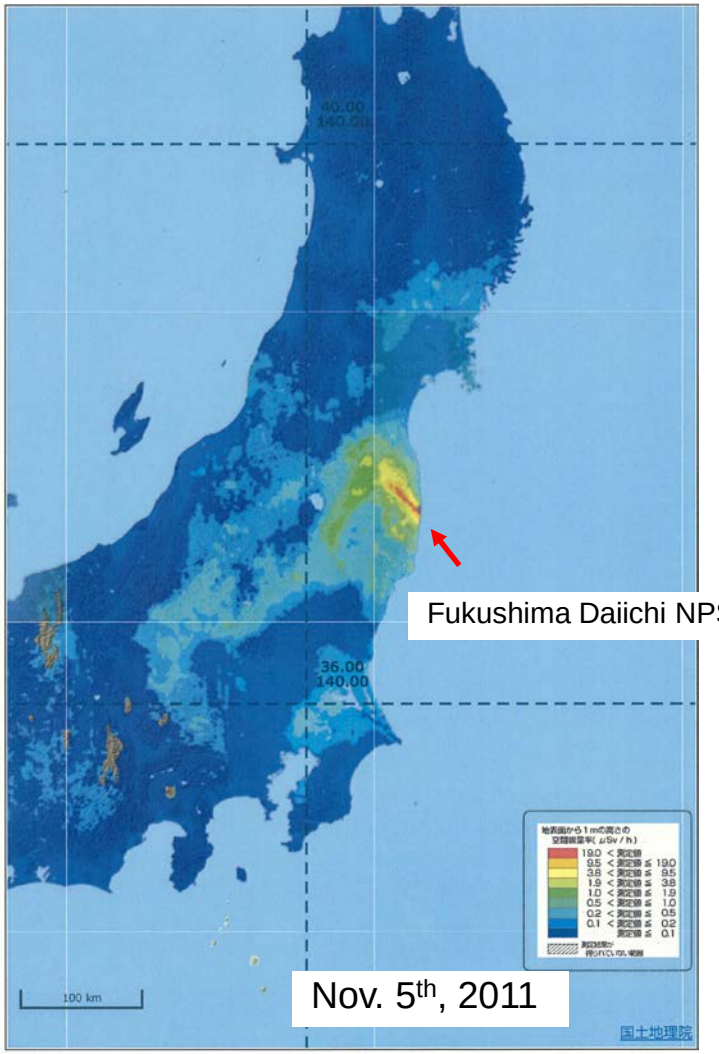
Background （1/2）



Air dose rate by aircraft monitoring

(https://ramap.jmc.or.jp/map)

- The Fukushima Daiichi NPS accident resulted in the release of radionuclides to the environment, which were deposited onto eastern area in Japan.
- The radionuclides deposition caused many kinds of contaminations in living environment.
- New regulatory system was needed to set up for radiation safety to the treatment of them.

First topic

Dose estimation for making a criterion to distinguish between regular treatment and radioactive waste management in a recovery phase

Background （2/2）

Decontamination Activities

Interim storage facilities

Restricted recycle

Final disposal (outside Fukushima Pref.)

- Large volume of decontamination wastes in Fukushima : 22 million m^3
  - Decontamination soil: 90 %
  - Waste such as incineration ash : 10%
- MOE policy for decontamination wastes
  - be stored in interim storage facilities
  - be disposed of outside Fukushima finally
  - reduce disposal volume by using low-level decontamination soil as recycled materials
  - restricted recycle to civil engineering structures in public projects

Second topic

Dose estimation to make the criteria for ensuring the safety of restricted recycle of decontamination soil

Ministry of the Environment HP (http://josen.env.go.jp/archive/)

1. Dose estimation for making a criterion to distinguish between regular treatment and radioactive waste management

Contamination wastes

Disaster wastes

Wastes generated by tsunami

Dismantling a damaged house

Wastes through environment and life cycle

Dehydrated sludge

Incinerated ash

Rice straw

Decontamination wastes

Temporary storage

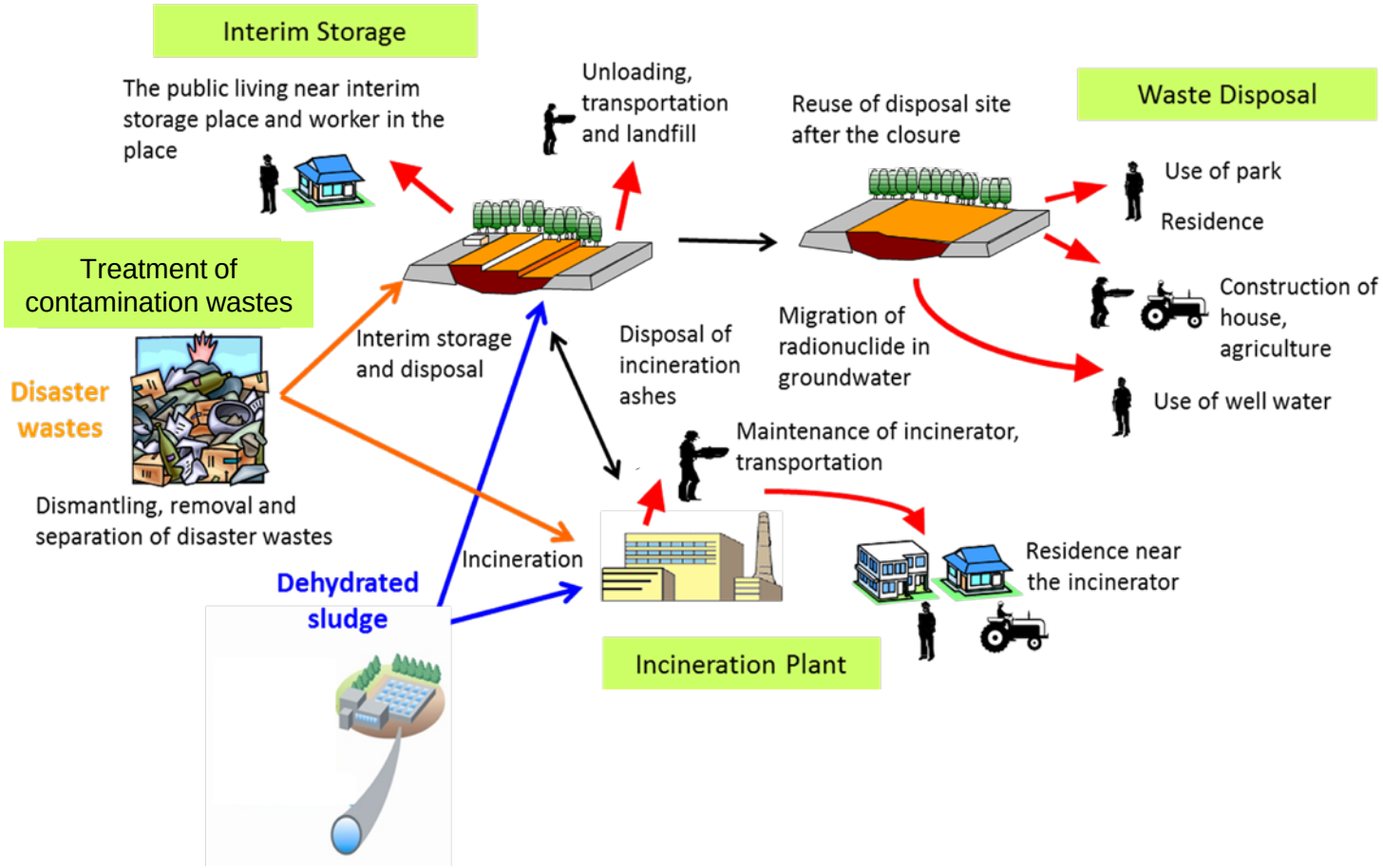
- Radioactive Cs in some wastes was detected over 100,000Bq/kg.

- put highly contamination wastes under the regulatory control
- treat low-level contaminated wastes safely and promptly
- make the criterion to distinguish between regular treatment and radioactive waste management in a recovery phase after emergency situation

Ministry of the Environment HP (http://shiteihaiki.env.go.jp/radiological_contaminated_waste/regional_measures/)
(http://shiteihaiki.env.go.jp/radiological_contaminated_waste/designated_waste/)

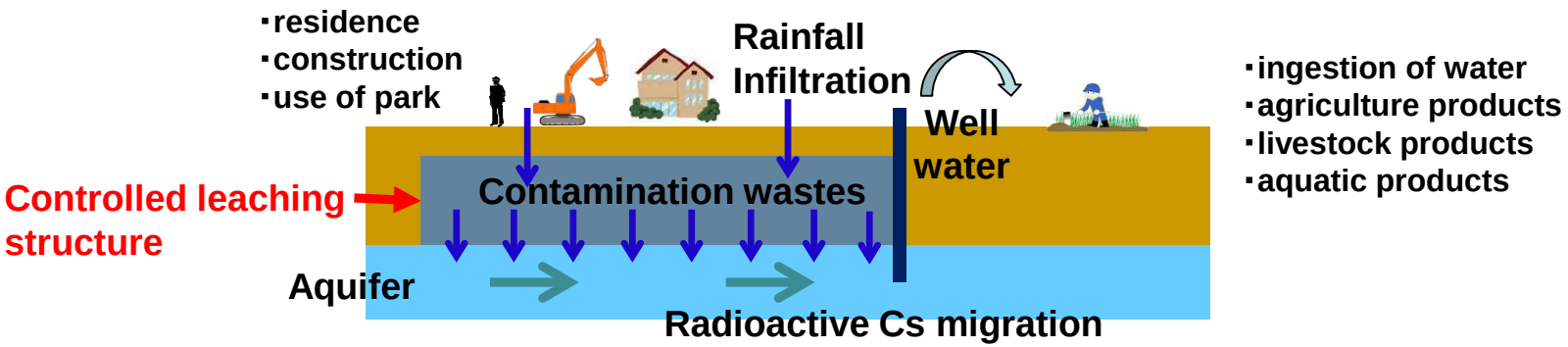
Dose estimation for contamination wastes

- Dose estimation of the public and worker for treatment of contamination wastes, represented by disaster wastes, dehydrated sludge, and incinerated ash.
- Method of previous clearance level estimation in Japan can be applied to that.
- Exposure pathways are basically similar to those in the clearance estimation.



Model and Parameter setting

- We applied the dose estimation model to external and internal exposure pathways, which are equivalent to the models in IAEA Safety Guide No.RS-G-1.7.
- Parameter values are
  - cited from the clearance level estimation,
  - basically decided as realistic values such as mean value or most probable value
  - conservatively selected in the case of large uncertainty and variation.
  - set up for additional pathways from information on regular treatment.



Example of conservative conditions

- 1D advection-dispersion
- radiocesium leaching from wastes
- using well water at lower edge (0m) of landfill site

Scenario of waste disposal (Controlled landfill site)

Dose criteria

Jun. 3, 2011: **The Nuclear Safety Commission of Japan** indicated a policy

" Near-term policy to ensure the safety for treating and disposing contaminated waste around the site of Fukushima Daiichi Nuclear Power Station of TEPCO" :

- The dose for the workers engaged in processing should not exceed 1mSv/y.
- The dose for the residents living in the vicinity of the facilities during the treatment of contaminated materials is under 1mSv/y.

  ⇨ Scenarios: Treatment of contamination wastes, Incineration plant, Interim storage

- The dose for the residents living in the vicinity of the facilities after termination of institutional control is under 10μSv/y.

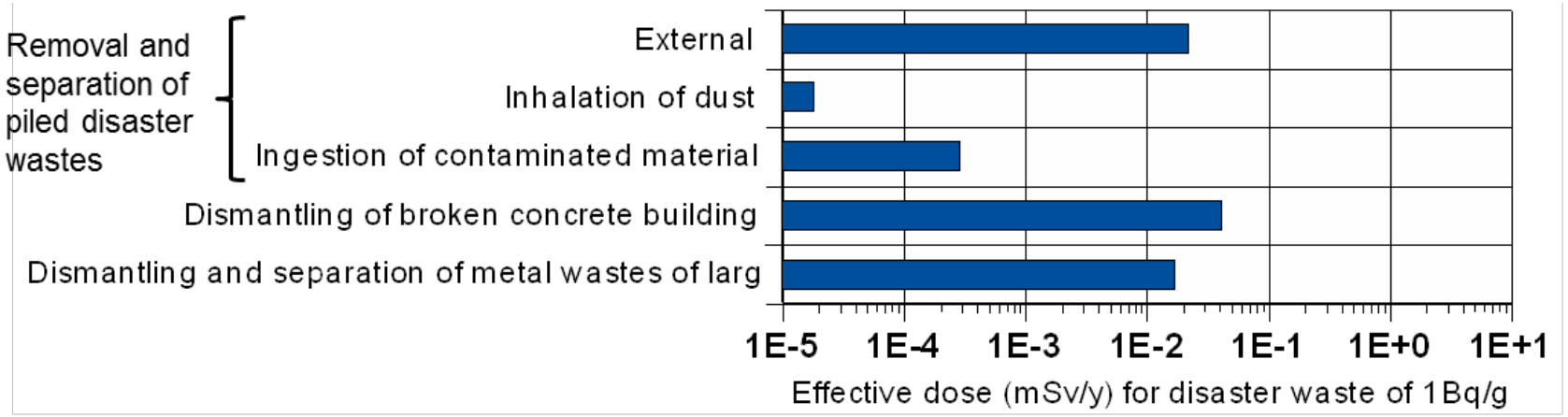
  ⇨ Scenarios: Waste disposal

⇩

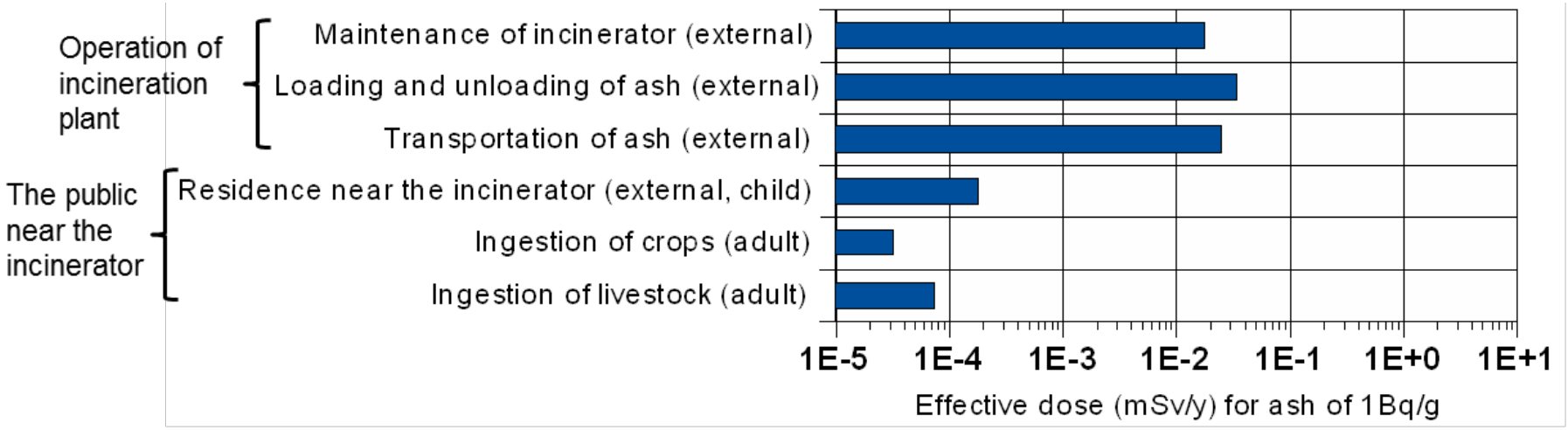
- Effective dose calculation for contamination waste of 1 Bq/g.
- Based on comparison with this dose criteria, radiocesium concentration was derived to restrict regular treatment of the wastes.

Dose estimation results（1/2）

Treatment of contamination wastes

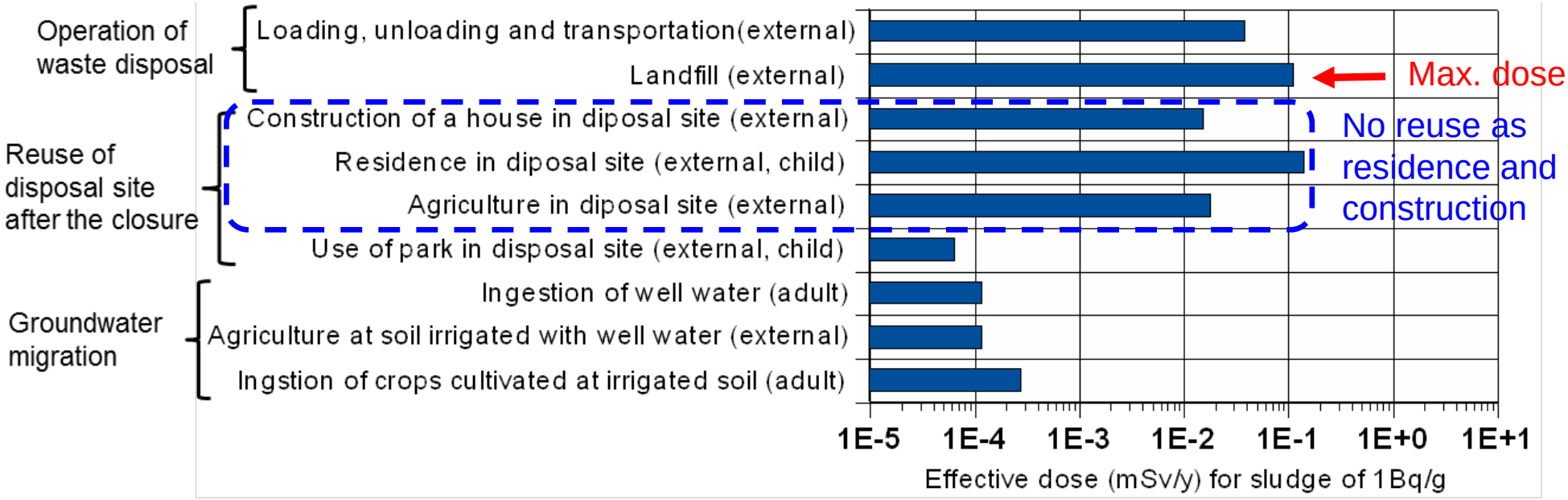


Incineration plant



Dose estimation results（2/2）

Waste disposal (Sludge)



- Radiocesium concentration of 8,900Bq/kg corresponding to 1mSv/y was derived from maximum dose.

Concentration criterion of 8,000Bq/kg was decided to distinguish between regular treatment and radioactive waste management.

2. Dose estimation to make the criteria for ensuring the safety of restricted recycle of decontamination soil

Basic policy for recycling decontamination soil

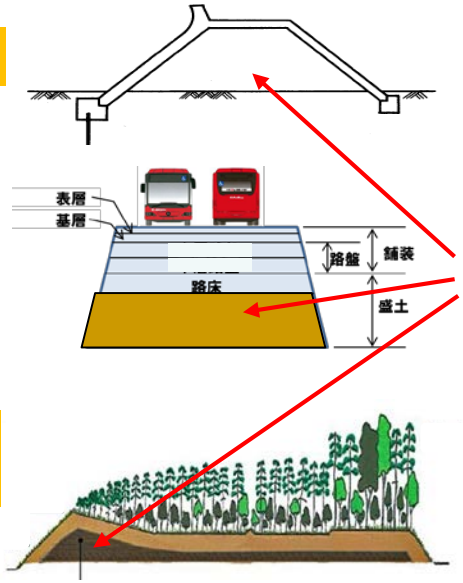
Basic policy

- MOEJ presented policy to recycle the low radioactive soil for public projects, in which the management system and responsibility for radiation protection are clarified.
- The recycling is limited to civil engineering structures such as coastal levees, road embankment and so on, which are not basically changed the form artificially for available period of the management system.

Costal levees

Road embankment

Costal disaster prevention forest



Construction materials

Shielding effect of concrete and covered soil

- The concept of this recycling is different from that of unconditional clearance.
- Need to establish the criteria for recycling to specific objects

Provide Cs activity concentration and construction design for the recycling

Examples of recycling decontamination soil

Method of dose estimation (1/2)

Step1: Dose estimation in construction and service scenarios

- Basically, additional doses for workers and the public with the recycling process shall not exceed 1mSv/y[*1].
- Activity concentration corresponding to 1mSv/y

Step2: Review of construction condition to reduce exposure to the public in service scenario

- Additional doses to the public after construction shall be confirmed to be trivial with derived activity concentration.
- If the doses exceed 10μSv/y in service, review construction conditions.

Step3: Dose estimation in disaster scenario

- The exposure doses caused by collapse and restoration due to disasters shall not exceed 1mSv/y.

Derivation of activity concentration and construction conditions enabling the recycling of decontamination soil as construction materials

*1) Dose criteria of 1mSv/y are in the Act on Special Measures.

Scenario and parameter

Scenario development

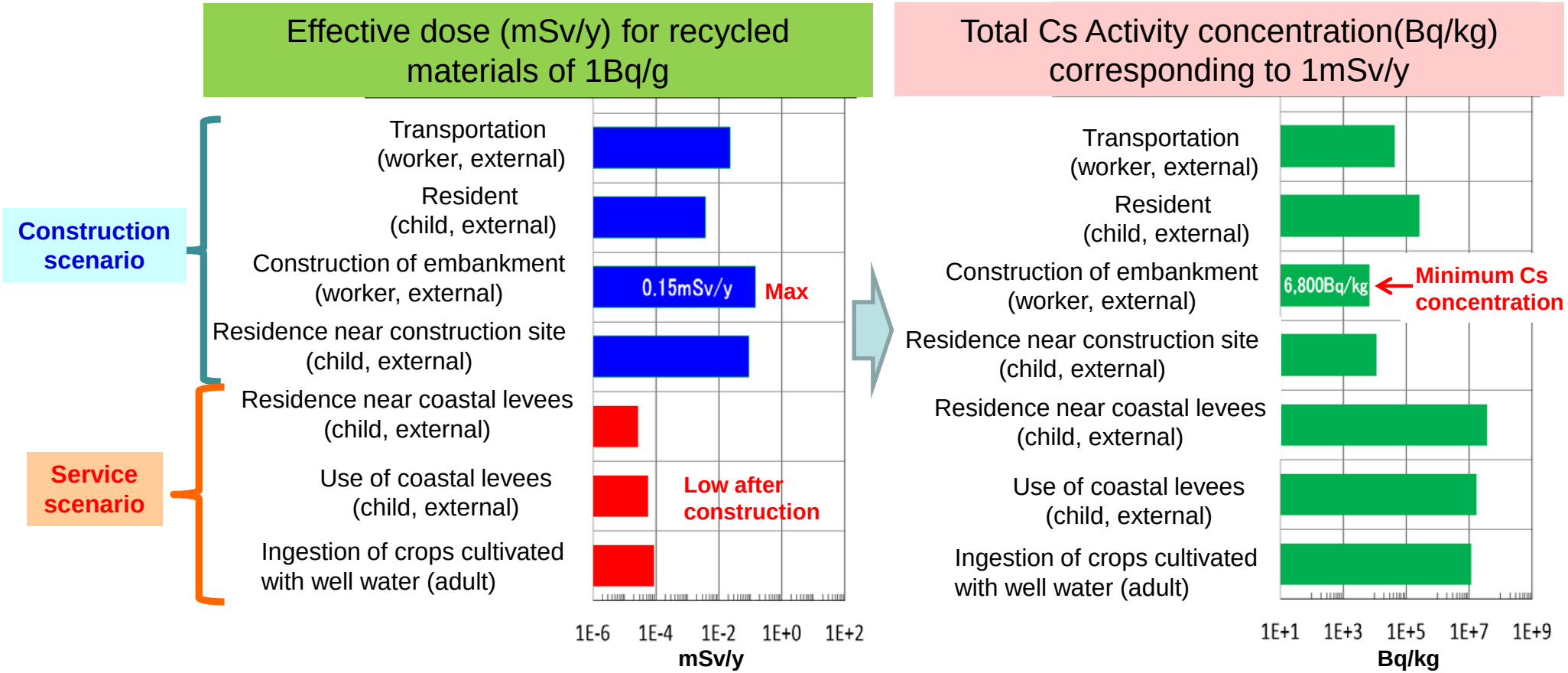
- The scenarios are set up for typical construction not for specific.
- *In construction scenario*, we extract the workers and residents near construction site which are susceptible to exposure in normal construction process.
- *In service scenario*, we select exposure pathways for worker for maintenance of construction, residents and users of construction.
- *In disaster scenario*, it is assumed that the construction is damaged by disaster events based on past disaster cases in Japan.

Parameter settings

- Basically, we set typical and generic parameter values based on Japanese statistical data and construction standards.
- For parameters which have wide variety or high uncertainty, the values were assumed conservatively.
- Present ratio of Cs-134 and Cs-137 is 0.209 after 5 years of Fukushima accident.

Dose estimation result（Step1）

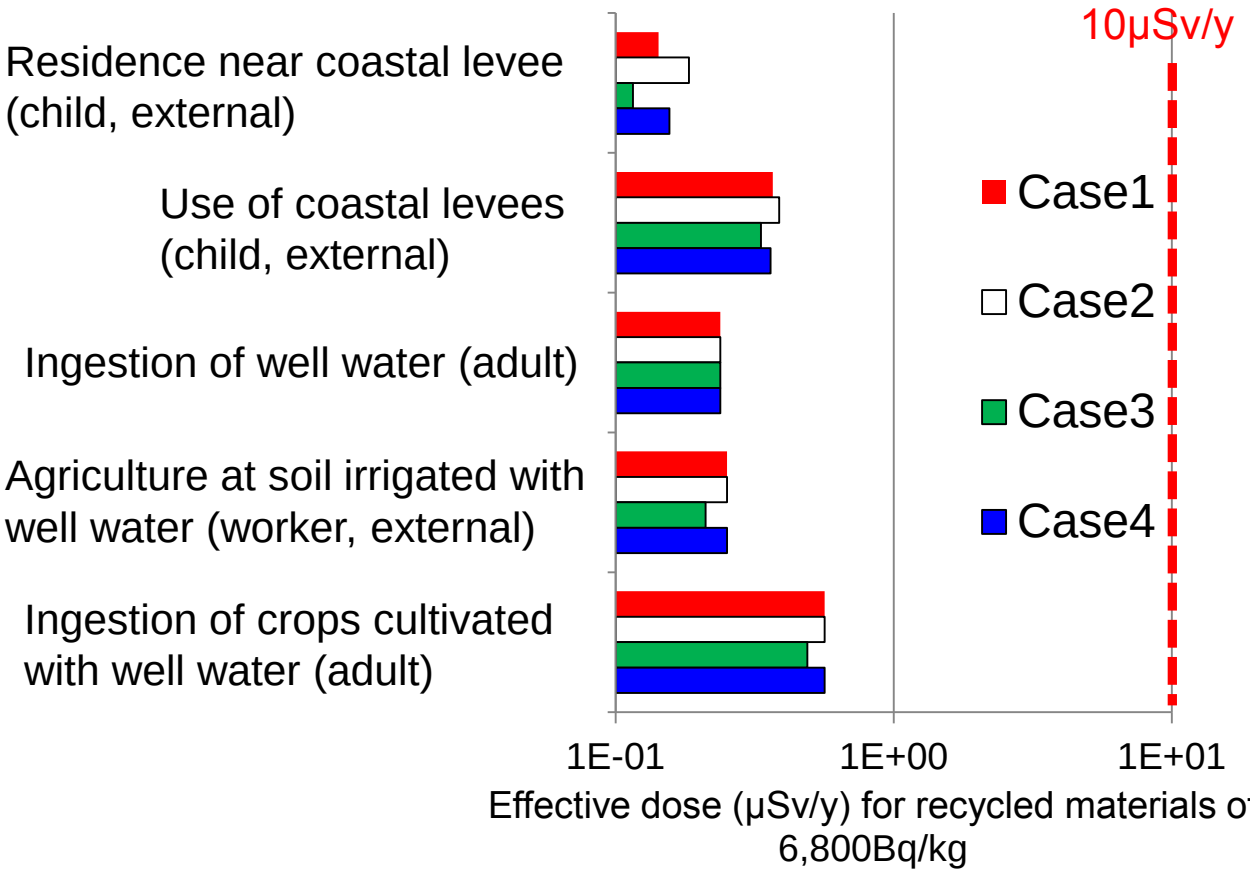
Example of dose estimation for costal levees



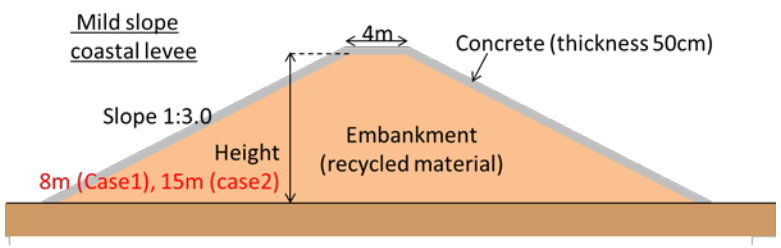
Total Cs activity concentration with which all additional doses meet 1 mSv/y：6,800Bq/kg

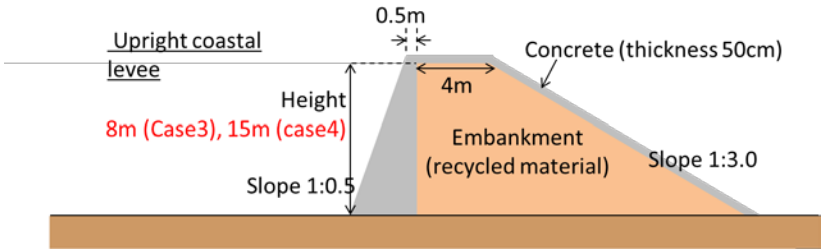
Dose estimation result（Step2）

Dose estimation for the public in service scenario of coastal levees with derived Cs concentration



- All additional doses were below 10μSv/y.
- The doses in service scenario are trivial for general construction design.

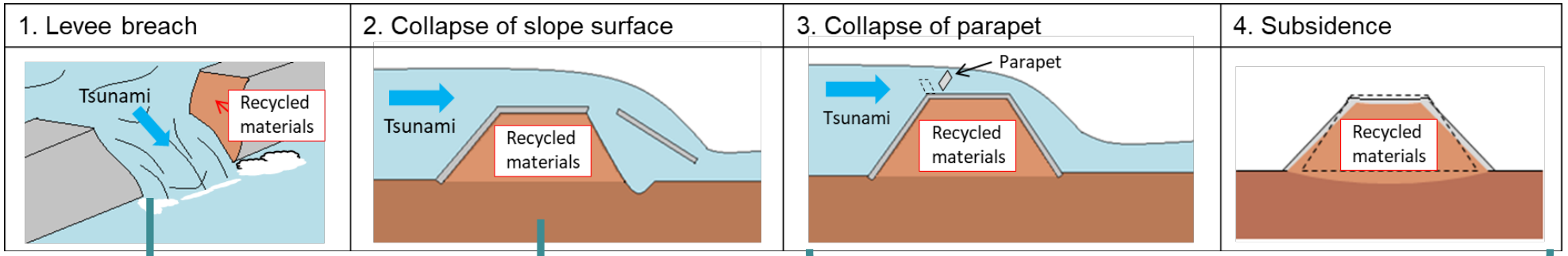




Outline of disaster scenario

Dose estimation in disaster scenario of coastal levees to confirm the safety for recycling of decontamination soil

- Divide collapse of coastal levees into four categories based on past disaster cases in Japan (earthquake and tsunami)



Embankment slope is emerged.

No emergence and no outflow of recycled materials

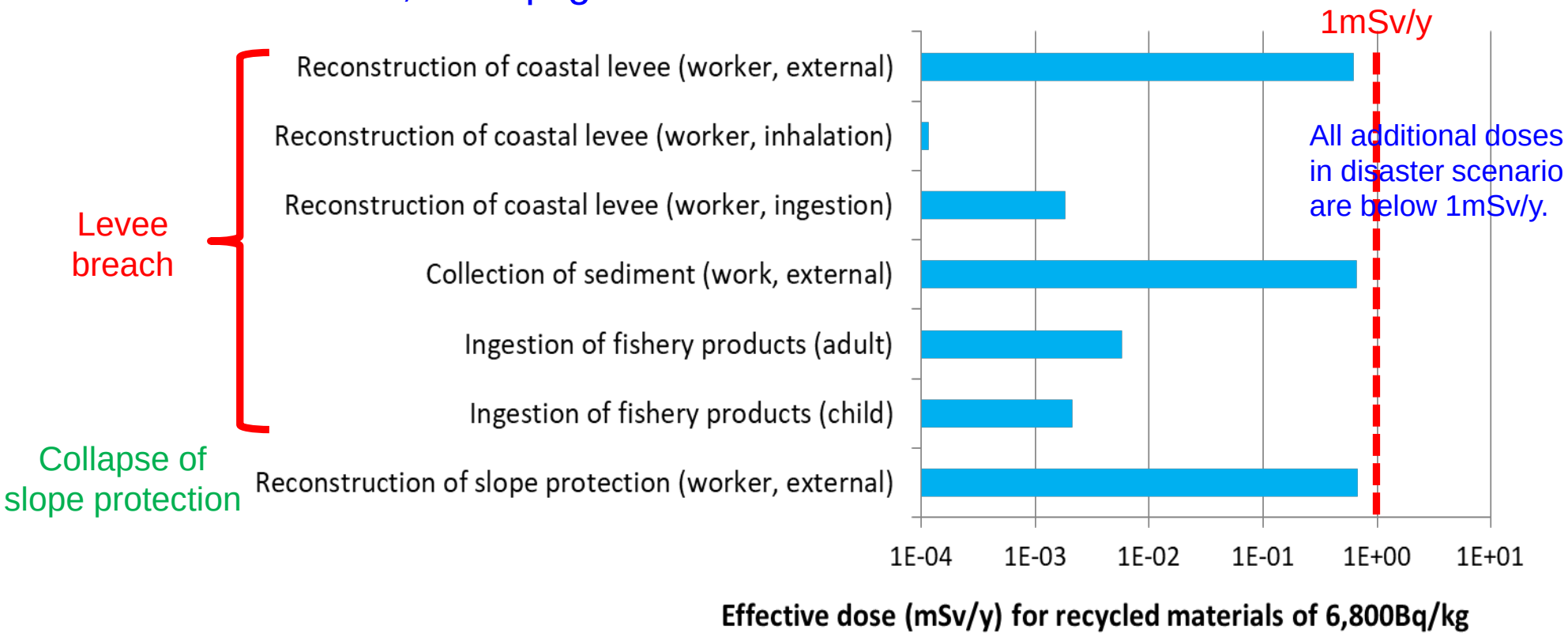
- Worker for reconstruction of slope

Coastal levees are washed away partially.
The recycled materials could be widely distributed as tsunami deposit or flow into the sea.

- Worker for reconstruction of collapsed coastal levees
- Worker for recovering of the deposit
- The public for ingestion of fishery products

Dose estimation result（Step3）

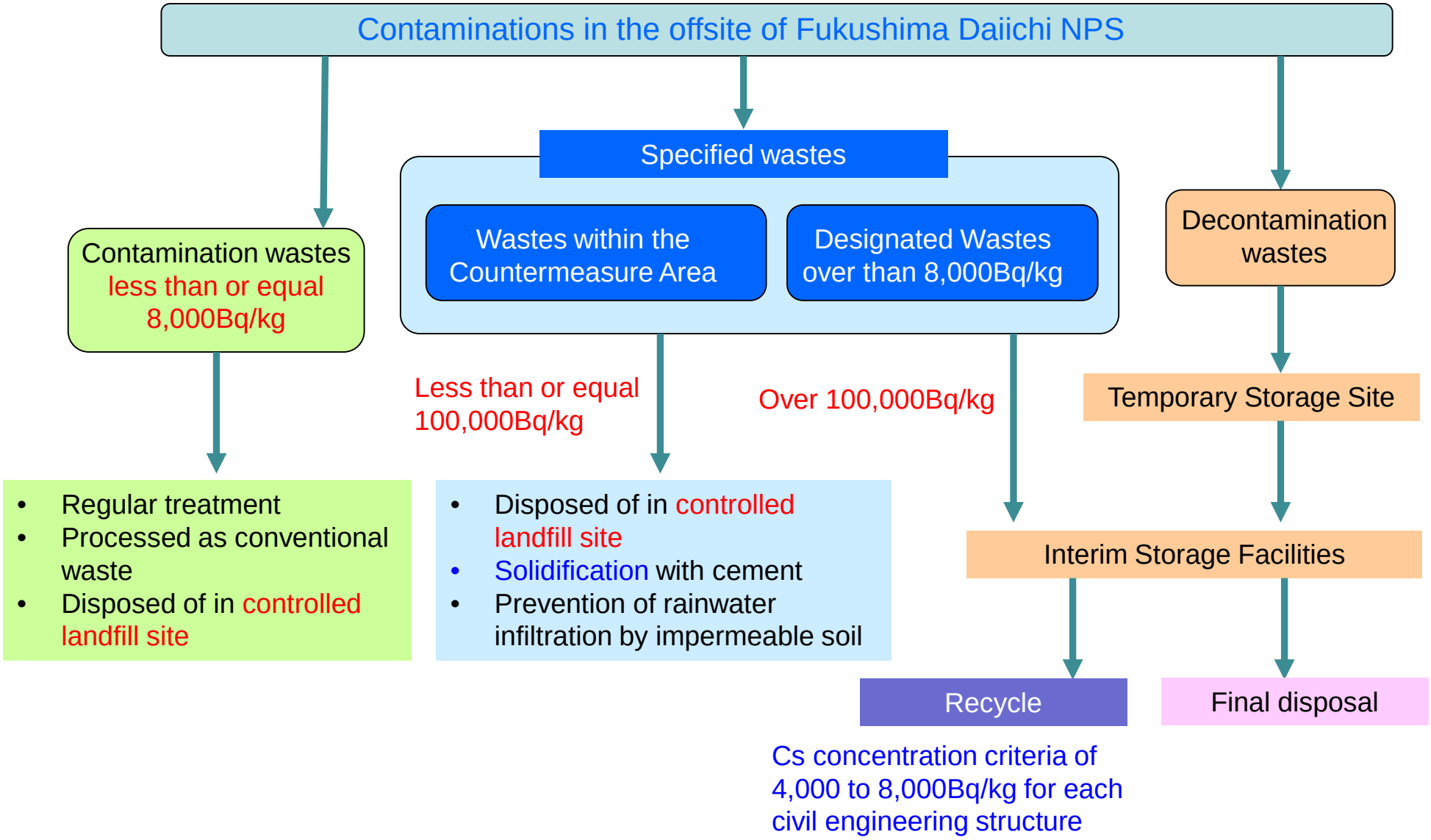
Result of dose estimation in disaster scenario of coastal levees with activity concentration of 6,800Bq/kg



- Evaluate effective dose for restricted recycling to the other civil engineering structures
- Provide Cs concentration criteria of 4,000 to 8,000Bq/kg for each civil engineering structure to ensure the safety of recycle of decontamination soil

3. Classification of contamination wastes generated from Fukushima Daiichi NPS accident

Classification of contamination wastes



Conclusions

- For many kinds of generated contaminants from the NPS accident, it is required to put highly contamination wastes under the regulatory control and to treat low-level contaminated wastes safely and promptly, in a recovery phase after emergency situation.

- Radiocesium concentration criterion of 8,000Bq/kg was decided from the dose estimation to distinguish between regular treatment and radioactive waste management.

- The recycling of decontamination soil limited to civil engineering structures such as coastal levees is one of important measures to achieve volume reduction of the waste for the final disposal.

- Radiocesium concentration criteria of 4,000 to 8,000Bq/kg were derived for each civil engineering structure to ensure the safety of recycling decontamination soil.

Thank you for your attention.