Tentative translation

# Guidelines for Managed Recycling

March 2025

Ministry of the Environment, Japan

# Definition of Terms

| Terminology | Definition. |
|---|---|
| Act on Special Measures | Act on Special Measures concerning the handling of Environment Pollution by Radioactive Materials Discharged by the Nuclear Power Station Accident Associated with the Tohoku District-Off the Pacific Earthquake That Occurred on March 11, 2011 (Act No. 110 of August 30, 2011). |
| Managed recycling | Use (including maintenance and management) of removed soil converted into recycled material under appropriate management for the purpose of contributing to the reconstruction from the disaster caused by the accident at the TEPCO's Fukushima Daiichi Nuclear Power Station. |
| Removed soil | Soil generated as a result of measures such as decontamination of soil, etc. pertaining to Special Decontamination Areas (SDA) or Decontamination Implementation Areas (DIA) (Article 2, Paragraph 4 of the Act on Special Measures). |
| Decontamination operator | Entity who conducts managed recycling based on the provisions of the Act on Special Measures. The decontamination operator in the case of managed recycling of removed soil generated within Fukushima Prefecture is the national government (Ministry of the Environment (hereinafter “MOE”)), while the decontamination operator in the case of managed recycling of removed soil outside Fukushima Prefecture is the municipalities of each prefecture. |
| Operator of the structure | Entity who implements a project at the managed recycling site. |
| Managers of facilities, etc. | Entity who implements the maintenance and management of facilities, etc. at the managed recycling site. |
| Recycled materials | The act of making the removed soil ready for use as material for embankment, backfill, or filling by performing the necessary treatment for the intended use. |

TABLE OF CONTENTS

# Chapter 1 GENERAL OVERVIEW

## 1.1 Purpose

The use of removed soil processed into recycled materials is to be carried out based on the standards for managed recycling stipulated in the Ordinance for Enforcement (Ordinance of the Ministry of the Environment No. 33 of 2011), in accordance with Article 41, Paragraph 1 of the "Act on Special Measures concerning the handling of Environment Pollution by Radioactive Materials Discharged by the Nuclear Power Station Accident Associated with the Tohoku District-Off the Pacific Earthquake That Occurred on March 11, 2011." (Act No. 110 of August 30, 2011; hereinafter "Act on Special Measures")

These guidelines are based on the findings of demonstration projects implemented by the MOE in Fukushima Prefecture and expert meetings, and it outlines points to consider when decontamination operator implements managed recycling. It applies to the managed recycling of removed soil stored at the Interim Storage Facility (herein after "ISF") in Fukushima Prefecture, as well as removed soil generated outside Fukushima Prefecture. These guidelines describe measures that shall be taken additionally, items that are desirable to consider, and reference items in the case of not handling the removed soil processed into recycle materials by the handling of it. Items that do not arise from handling the removed soil processed into recycled materials shall be in accordance with existing laws, regulations, and technical guidelines. In addition, the MOE will conduct the necessary studies and, if necessary, expand and review the content of the guidelines in cooperation with relevant organizations, based on the knowledge accumulated to date, with regard to technical items related to design, construction and operation and maintenance, in accordance with the intended use and local conditions of the managed recycling site, before the full-scale implementation of managed recycling.

These guidelines have been prepared with the intention that they will also be referred to by the operators of the structures and managers of the facilities.

These guidelines are composed of the following three chapters. Chapter 1, "General Overview, ' describes the positioning of managed recycling, the background to the formulation of the guidelines, the basic approach to radiation protection in relation to managed recycling, and related laws and guidelines. Chapter 2, 'Basic Concepts, ' describes the commentary on the items stipulated in the standards for managed recycling. Chapter 3, "Precautions for implementation" describes items that should be additionally considered when handling removed soil processed into recycled materials.

## 1.2 Positioning of Managed Recycling

Since the Great East Japan Earthquake, the government has positioned the reconstruction of Fukushima as its top priority and has implemented various initiatives aimed at reconstruction.

With regard to environmental contamination caused by radioactive materials from the accident at the Tokyo Electric Power Company (TEPCO) Fukushima Daiichi Nuclear Power Station, measures such as decontamination have been taken based on the Act on Special Measures. This has contributed to reconstruction by reducing radiation levels in residential areas after the nuclear power station accident and lifting of evacuation orders. In the case of Fukushima Prefecture, where the volume of removed soil arising from decontamination activities was particularly large, the temporary storage sites set up in various locations within the prefecture were closed down from March 2015 onwards, and the soil was transferred to the ISF to facilitate the recovery process. As of March 2024, approximately 13 million $m^3$ of removed soil and waste had been stored there (approximately 330,000 $m^3$ of removed soil and waste had been stored outside Fukushima Prefecture) (see Figures 1-1 and 1-2).

With regard to the removed soil and waste generated within Fukushima Prefecture, in light of the fact that the residents of Fukushima are already shouldering a heavy burden due to the environmental contamination caused by the accident at the TEPCO's Fukushima Daiichi Nuclear Power Station, the "Law for the Japan Environmental Storage and Safety Corporation (Act No. 44 of 2003)" stipulates that " the government is responsible for taking necessary measures to complete final disposal of removed soil and waste generated from decontamination activities outside Fukushima Prefecture within 30 years after the start of interim storage".

Towards the final disposal outside Fukushima Prefecture, the government has decided on a policy to promote the volume reduction and managed recycling of removed soil and waste with the understanding of the public. (Basic Policy on Reconstruction from the Great East Japan Earthquake in the Second Reconstruction and Regeneration Period onwards). By promoting these measures, it will be possible to reduce radiation levels in residential areas, make effective use of removed soil, which is a valuable resource originally, and contribute to the reconstruction of Fukushima. In addition, it is necessary to make effective use of removed soil from decontamination activities outside Fukushima Prefecture, and to carry out landfill disposal in order to dissolve temporary storage sites.

For this reason, it is stated that " The use of removed soil processed into recycled materials (which means the treatment of removed soil to enable its use as materials for embankment, landfill or filling by means of the necessary treatment according to the use of the soil) for the purpose of contributing to the revitalization from the disaster caused by the accident, under appropriate management (including operation and maintenance)" (managed recycling), and that " the project shall be

implemented as a public works or other works projects for which the management entity and responsibilities are clearly defined, and the project will be carried out in a continuous and sustainable manner.".

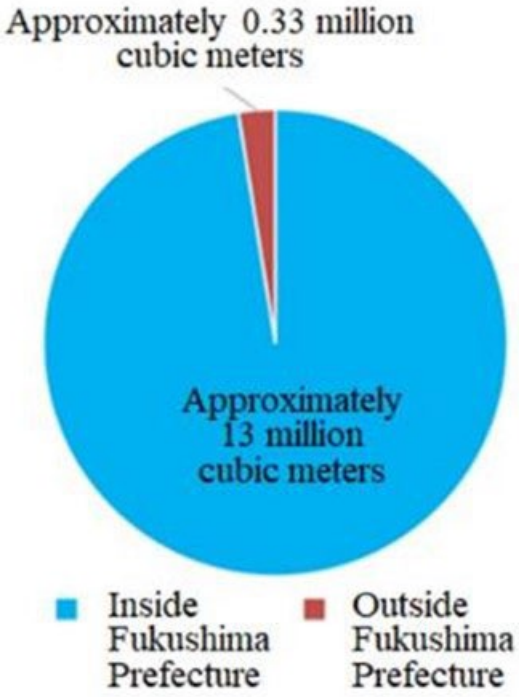



Figure 1-1 Volume of removed soil stored (as of March 2024)

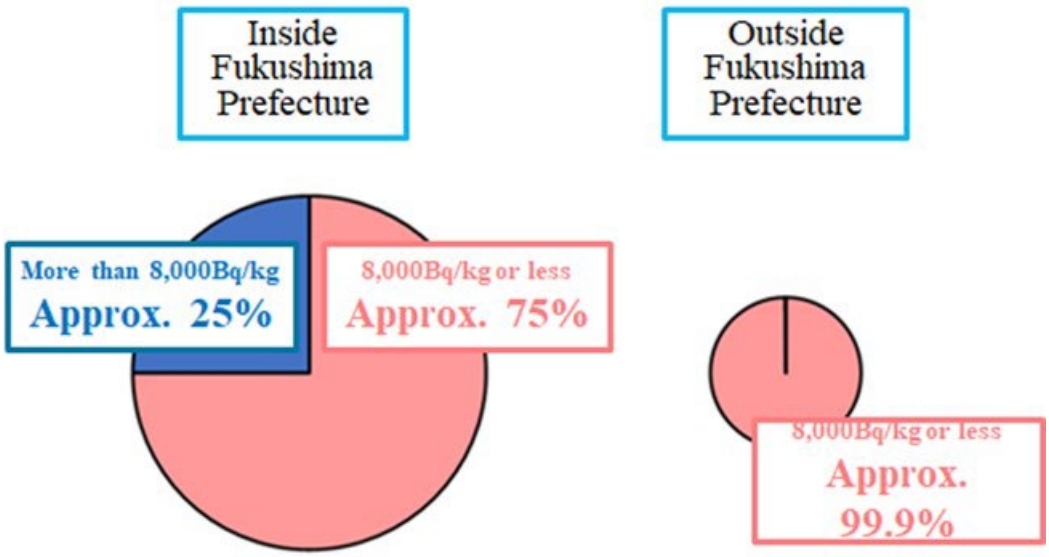



Fig.1-2Distribution of Radioactivity concentration in removed soil

(In Fukushima Prefecture: Radioactivity concentration at the time of transport to the ISF; outside Fukushima Prefecture: estimated as of March 2024)

## 1.3 Background of Guidelines Development

In the “Technology Development Strategy for Volume Reduction & Recycling of the Removed Soil and Waste under Interim Storage” formulated in April 2016 and the “Review for Achieving the Strategic Goals” compiled in March 2019, it is stated that (1) the basic concept of managed recycling shall be clarified, (2) demonstration and model projects shall be implemented, and (3) a “Draft Guide for the Recycling of Soil Generated from Decontamination and Other Measures in Fukushima Prefecture” (hereinafter referred to as the “Draft Guide for Managed Recycling”) to be published.

Based on this, the MOE compiled the ‘ Basic Concept for Safe Use of Removed Soil Processed into Recycled Materials’ (hereafter referred to as the ‘Basic Concept’) in June 2016, based on the deliberations of the ‘Strategy Study Group on the Technology Development Strategy for Volume Reduction & Recycling of the Removed Soil and Waste under Interim Storage’ (hereafter referred to as the ‘Strategy Study Group’), and the demonstration projects were implemented in Fukushima Prefecture based on the Basic Concept.

Furthermore, based on the findings of the demonstration project, measures for the managed recycling of removed soil were examined, and in December 2019, a “Draft Guide to Managed Recycling” was presented to the Strategy Study Group. After presenting the “Draft Guidelines for Managed Recycling”, the project continued to accumulate data through demonstration projects, and in August 2022, the “Working Group for Examining Measures for the Managed Recycling of Removed Soil and Waste at Interim Storage Facilities” (hereafter, “Managed Recycling WG”) was established, and in-depth discussions began on standards and guidelines for managed recycling. In addition, in 2023, 'The International Atomic Energy Agency (IAEA)-MOE Japan Experts Meeting on Volume Reduction and Recycling of Removed Soil Arising from Decontamination Activities' was held, and the MOE's initiatives for the managed recycling and final disposal of removed soil was assessed and advice was provided.

Based on these discussions, the standards for managed recycling have just been formulated. In addition, while taking into account the objectives of the “Basic Concept” and the “Draft Guidelines for Managed Recycling”, these guidelines have been compiled with explanations relating to the standards for managed recycling and notes on the implementation of managed recycling, with the aim of applying it to removed soil and waste outside Fukushima Prefecture.

(1) Demonstration Projects

The following three demonstration projects were implemented in Fukushima Prefecture to consider measures for the managed recycling of removed soil.

i. Demonstration project for the creation of a test embankment at the temporary storage site in Minamisoma City

A test embankment was constructed at the temporary storage site in the eastern part of Odaka Ward, Minamisoma City, Fukushima Prefecture (about 2 hectares) and the embankment was dismantled in September 2021 when the test ended. During the test embankment demonstration project, the air dose rate around the embankment was measured, the radioactivity concentration of the water seeping through the embankment was measured, and the air dose rate at the site boundary and the radioactivity concentration in the air were measured. With regard to the air dose rate around the embankment, no significant changes were observed from the time the embankment was completed until after the test embankment was dismantled, and it was generally the same level as the air dose rate at the site boundary. With regard to the radioactivity concentration of the water that seeped into the embankment, it was below the detection limit. With regard to the radioactivity concentration in the air, no significant changes were observed from before the removed soil was transported to the site until after the embankment was completed, and this also included the period from the start of the dismantling work on the test embankment in mid-August 2021. (See "Reference Material 1: Demonstration Project for the Creation of Test Embankments at the Temporary Storage Site in Minamisoma City")

ii. Demonstration Project for the Creation of Agricultural Land in the Nagadoro District of Iitate Village (Environmental Restoration Project)

Since November 2018, with the cooperation of local residents, a demonstration project for the creation of agricultural land in the Nagadoro District of Iitate Village (environmental restoration project) (approx. 22 ha) has been implemented in the Nagadoro District of Iitate Village, Soma County, Fukushima Prefecture.

In 2019, a trial was conducted to compare the growth of food crops with and without topsoil covering the removed soil processed into recycled materials, and the safety and growth of the crops were confirmed in relation to radiation. The results of the trial showed that the crops grew well and that the concentration of radioactive caesium in the cultivated food crops was well below the standard value for radioactive caesium (100 Bq/kg for general foods) .

In April 2021, agricultural land development began, and paddy field tests were conducted in two construction areas to confirm the safety of the radiation, as well as to confirm the permeability and bearing capacity required for paddy fields. The results of the tests confirmed that the radioactivity concentration of rice (brown rice, rice husks, rice straw) was well below the standard values for radioactive caesium in ordinary foods(100 Bq/kg) and agricultural materials (400 Bq/kg). In addition, since the permeability and drainage were generally good and the crops grew well, it was confirmed that the land could be used as a rice paddy field. (See “Reference Material 2: Demonstration Project for Creating Agricultural Land in the Nagadoro District of Iitate Village (Environmental Restoration Project)”)

iii. Demonstration Project for Road Embankment in the premise of the ISF

In the road embankment demonstration project, the safety of radiation and the of the stability of the structures were confirmed through monitoring of radiation and subsidence, and the usability of the structure was confirmed through driving tests. The results of the demonstration project confirmed that the air dose rate remained at a similar level before and after the construction of the road embankment terms of radiation safety. In addition, with regard to structural stability, monitoring results of settlement and driving tests in which large vehicles drove over the embankment to put load on it confirmed that there was no settlement or other damage that would compromise stability. With regard to the usability of the road, the results of the driving tests mentioned above confirmed that there was no change in the flatness of the road surface or ruts that would undermine the usability of the road. (See “Reference Material 3: Demonstration Project of Road Embankment in ISF”)

(2) Discussions at the Expert Meeting

The Managed Recycling WG was established under the Strategic Study Group in August 2022 with the aim of studying measures for safely using removed soil processed into recycled materials. These guidelines were developed based on the discussions at the Expert Meeting, with the Managed Recycling WG playing a central role.

(3) International Assessments and Advice from the IAEA

The International Atomic Energy Agency (IAEA)-MOE Japan Experts Meeting on Volume Reduction and Recycling of Removed Soil Arising from Decontamination Activities was held three times in FY2023 with the aim of providing international assessment and advice from a technical and social perspective on the MOE's initiatives for the future managed recycling and final disposal of removed soil and waste.

Following discussions at the international experts meeting and on-site observations of demonstration projects by the expert team, the final report on the experts mission was published in September 2024. The Executive Summary of the final report states that

- Approach and activities implemented by MOEJ to date for the managed recycling and the final disposal are consistent with the IAEA Safety Standards.
- Looking ahead, with continuous efforts to meet fully the advice provided by the team of experts, MOEJ's evolving approach will be consistent with the IAEA Safety Standards. This can be confirmed by future follow-up assessments

(See "Reference Material 4: Conclusions of the IAEA Expert Meeting on the Managed Recycling of Removed Soil and Waste").

<Reference>
IAEA assistance to the Ministry of the Environment, Japan on 'volume reduction and recycling of removed soil arising from decontamination activities after the Accident of the Fukushima Daiichi Nuclear Power Station' Final Report on the Experts Mission
URL
https://kankyosaisei.env.go.jp/next/international/pdf/final-report_en.pdf

## 1.4 Basic Concepts of Radiation Protection for Managed Recycling

(1) The upper limit for the concentration of radioactive caesium in removed soil processed into recycled materials.

Decontamination operators must limit the radioactivity concentration of removed soil processed into recycled materials so that the additional effective dose of workers and the general public is less than 1mSv/year.
This additional effective dose refers to the exposure dose caused by radiation from the removed soil processed into recycled materials, and the radioactivity concentration equivalent to 1 mSv/year is calculated based on "2.2.1 Concept of radiation Protection (3) Additional exposure assessment".
(As a result) a radioactivity concentration of 8,000 Bq/kg was derived as the radioactivity concentration that would result in the additional effective dose of 1 mSv/year or less for workers engaged in construction work, and the upper limit for the concentration of radioactive caesium in the removed soil to be recycled was set at 8,000 Bq/kg.

(2) Rationale for setting 1 mSv/year as the dose criterion

Radiation protection after the accident is considered to be equivalent to radiation protection in the existing exposure situation. In radiation protection in the existing exposure situation, optimization is carried out using reference levels, but when using removed soil for managed recycling, the "approach similar to the planned exposure situation" is also introduced. Therefore, the dose limit for the public in the planned exposure situation, 1 mSv/year, is used as the criterion.
The dose criterion will be treated as a management standard for radiation protection of recycled materials from removed soil, and the decontamination operator will specify the monitoring method for verifying the dose criterion for each individual project, and confirm through monitoring that the additional effective dose of workers and the general public is less than 1 mSv/year.

(3) Radiation protection of workers during transportation and construction work

Workers engaged in handling removed soil processed into recycled materials are not classified as radiation workers because their additional effective dose is less than 1 mSv/year, but the decontamination operator should explain to the workers that they will be handling soil containing radioactive materials, and should also provide them with information on radiation safety, such as information on radiation doses and monitoring.

(4) Optimization and monitoring during operation and maintenance for managed recycling

Although it is possible to maintain a certain level of safety for removed soil processed into recycled materials based on dose criterion, the principle of optimization of radiation protection requires that exposure to those involved be maintained or reduced to as low a level as reasonably achievable, while taking into account social, environmental and economic aspects.

Optimization also requires that the most appropriate protective measures be taken by taking into account any other disadvantages that may result from reducing radiation doses. In implementing optimization for individual projects, it is necessary to consider protective measures that incorporate the opinions of relevant organizations, including local stakeholders. Decontamination operators should set "target values" for each individual project that will serve as a reference of optimization for workers. Specifically, since monitoring provides information that enables an objective grasp of the situation, monitoring should be carried out as necessary for each individual project, taking into account the opinions of relevant organizations, including local stakeholders, and the results should be promptly made public.

(5) Response in the event of an emergency situation

When selecting a location for the use of removed soil as managed recycling, decontamination operators must give full consideration to the risk of scattering or runoff of the removed soil processed into recycled materials and must conduct sufficient investigation and planning.

In the event of abnormal situations such as heavy rain or earthquakes, if there is a possibility that the removed soil processed into recycled materials could lead to exposure via a different route than usual, the decontamination operator will take measures to restore the situation, etc., based on the content of the consultations held in advance between the decontamination operator and the facility manager. Monitoring will be carried out as necessary, and the relevant parties in the area will be promptly notified and the information made public.

* The term "planned exposure situation" refers to a situation in which exposure occurs as a result of the intentional introduction and planned operation of a radiation source, while the term "existing exposure situation" refers to a situation in which exposure already exists at the time when protective measures are decided, as in the case of an accident (Source: Created based on "Summary of Basic Concepts of Radiation Protection - Response by the Radiation Council").
* The "target value" in optimization is called the "dose constraint value" in planned exposure situations and the "reference level" in existing exposure situations, and is used as a guide dose that takes into account individual circumstances in order to improve exposure situations.

## 1.5 Relevant laws, regulations and guidelines

In addition to the standards for managed recycling, the main related laws and regulations are listed below for the use of removed soil processed into recycled materials.

<Related Laws and Regulations>

- Act on Special Measures Concerning the handling of Environment Pollution by Radioactive Materials Discharged by the Nuclear Power Station Accident Associated with the Tohoku District-Off the Pacific Ocean Earthquake That Occurred on March 11, 2011 (Act No. 110 of August 30, 2011)
- Standards for the transportation of removed soil, standards for the storage of removed soil, and standards for the disposal of removed soil (Ordinance for Enforcement of the Act on Special Measures concerning the handling of Environment Pollution by Radioactive Materials Discharged by the Nuclear Power Station Accident Associated with the Tohoku District-Off the Pacific Earthquake That Occurred on March 11, 2011 (Ordinance of the Ministry of the Environment No. 33 of 2011))
- Ordinance on Prevention of Ionizing Radiation Hazards at Work to Decontaminate Soil and Wastes Contaminated by Radioactive Materials Resulting from the Great East Japan Earthquake and Related Works (Ordinance of the Ministry of Health, Labour and Welfare No. 152 of 2011)*

<Guidelines>

- Decontamination Guidelines (2nd edition, May 2013, with supplements, March 2018, Ministry of the Environment)
- Waste Guidelines (2nd edition, March 2013, Ministry of the Environment)
- Guidelines for the Prevention of Radiation Hazards to Workers Engaged in Work under Specified Doses (No. 6 of the June 15, 2012, issue of the Ministry of Health, Labor and Welfare Bulletin, last revised with the April 27, 2023, issue of the Ministry of Health, Labor and Welfare Bulletin No. 6)*

*Only relevant where managed recycling is carried out in locations within areas such as the Special Decontamination Areas where the average air dose rate exceeds 2.5 μSv/h due to accident-derived radioactive materials.

# Chapter 2 FUNDAMENTALS

## 2.1 Managed Recycling

Article 58-4

The standards for managed recycling (meaning the use of removed soil processed into recycled materials[1] under appropriate management[2] for the purpose of contributing to reconstruction from the disaster caused by the accident; hereinafter the same shall apply) specified by the Ordinance of the Ministry of the Environment referred to in Article 41, paragraph 1 of the Act shall be as follows.

(i) Managed recycling shall be implemented as follows

b. The project shall be implemented as a public works or other works projects for which the management entity and responsibilities are clearly defined, and the project will be implemented in a continuous and sustainable manner.

### (1) What is Managed Recycling?

In the standards for managed recycling, "managed recycling" is defined as "the use of removed soil processed into recycled materials for the purpose of contributing to the reconstruction from the disaster caused by the accident, under appropriate management,", and it is stated that "The project shall be implemented as a public works or other works for which the management entities and responsibilities are clearly defined, and the project will be implemented in a continuous and sustainable manner".

Managed recycling is generally expected to be carried out in accordance with the flow shown in Figure 2-1, from (1) to (4).

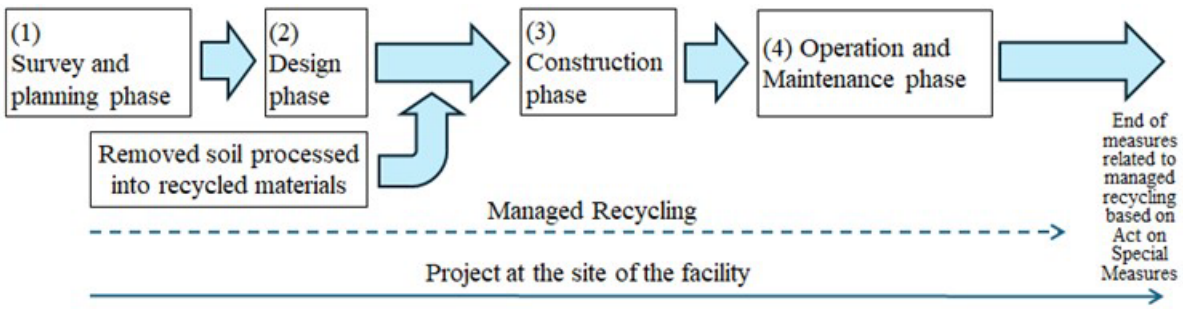



Figure 2-1 Flow of Managed Recycling

[1] Removed soil processed into recycled materials:
Refer to the act of using removed soil as materials for embankment, landfill or filling by subjecting it to necessary treatment according to its use

[2] Under appropriate management:
Including operation and maintenance

<Reference> The difference between managed recycling and the clearance concept

Managed recycling is carried out in accordance with the provisions of the Act on Special Measures.

On the other hand, there is a clearance concept for the handling of materials used by nuclear operators. The clearance concept is a concept in which nuclear operators receive confirmation that the radioactive materials contained in materials and other objects used in facilities are below the clearance level* specified by the Nuclear Regulation Authority.

Materials that have been confirmed as such can be handled as not requiring "measures to prevent radiation hazards".

(Source: Created based on the Nuclear Regulation Authority's website "Overview of the Clearance Concept")

* According to the "Regulations Concerning Confirmation that the Radioactivity Concentration of Radioactive Materials Contained in Materials and Other Items Used in Factories, etc. Does Not Require Measures to Prevent Radiation Damage (2020 Nuclear Regulation Authority Regulation No. 16)", for example, the radioactivity concentration of Cs-134 and Cs-137 is specified as 100 Bq/kg.

The removed soil processed into recycled materials that are subject to managed recycling are not generally freely distributed but are used under the responsibility of the decontamination operator, with measures such as preventing dispersal and runoff and monitoring, with the aim of contributing to recovery from the disaster caused by the accident. Therefore, the managed recycling and clearance concepts are different in terms of the underlying approach (whether or not there is management, whether or not it is subject to regulation).

(2) Processing into recycled materials

Processing into recycled materials is the act of removing foreign objects such as grass and trees from removed soil by decontamination operators, adjusting the quality as necessary to meet the required quality for the site of managed recycling, and then measuring the radioactivity concentration, so that the soil can be used for purposes such as embankment, landfill, or filling.

In Fukushima Prefecture, most of the removed soil is transported to ISF, where it is stored after foreign objects such as grass, trees and roots are removed. However, soil and waste generated outside Fukushima Prefecture is stored in large container bags at temporary storage sites, so the storage conditions are not uniform. Considering these differences in storage conditions, the removed soil is processed into recycled materials.

(3) Communication with Relevant Organizations, etc.

In order to promote managed recycling, it is important to communicate with the relevant organizations, including decontamination operators and local stakeholders, from an early stage.

Decontamination operators should promote communication with the relevant organizations, including local stakeholders, based on the actual situation in the area. For example, from the perspective of fostering understanding, it is possible to measure air dose rates with the participation of the local community (see “2.4 Measurement of air dose rates (during construction and operation and maintenance) (1) Measurement point and frequency”).

(4) Completion of measures with regard to managed recycling based on the Act on Special Measures.

As radioactivity decays over time, the time will come when various measures with regard to managed recycling based on the Act on Special Measures will no longer be necessary. When this time comes and various measures with regard to managed recycling based on the Act on Special Measures are no longer necessary, this is referred to as “the completion of measures with regard to managed recycling”.

MOE will organize the concept of the end of special attention for managed recycling (under what conditions or after what period of time can various measures based on the Act on Special Measures be terminated) in the future.

## 2.2 Radioactive Caesium Concentration in Removed Soil Processed into Recycled Material

### 2.2.1 Concept of Radiation Protection

Article 58-4.
(i) Managed recycling shall be implemented as follows
(e) The removed soil shall be used at a radioactivity concentration level specified by the Minister of the Environment as being such that the effective dose to the public from the managed recycling will be 1 mSv/year or less , as a result of measurement of the radioactivity concentration of the accident-derived radioactive material using a method specified by the Minister of the Environment.

Notification No. 32 of the Ministry of the Environment in 2025
The radioactivity concentration of removed soil used for managed recycling
The radioactivity concentration specified by the Minister of the Environment in Article 58-4, Item 1, (e) of the Ordinance for Enforcement of the Act on Special Measures concerning the handling of Environment Pollution by Radioactive Materials Discharged by the Nuclear Power Station Accident Associated with the Tohoku District-Off the Pacific Earthquake That Occurred on March 11, 2011 shall be the sum of the radioactivity concentration of the accident-derived radioactive material caesium-134 and caesium-137 which shall be 8,000 Bq/kg or less.

(1) Additional effective dose and radioactivity concentration of removed soil

In the standards for managed recycling, the radioactivity concentration of removed soil used for managed recycling is set at a level that ensures the additional effective dose of the public is 1 mSv/year or less. Specifically, the concentration is set at 8,000 Bq/kg or less for the sum of Cs-134 and Cs-137. The approach to radiation protection in considering these standards is as follows.

<Approach to radiation protection>

As managed recycling is an initiative aimed at reconstruction from the accident, the reference level for existing exposure situations (1-20 mSv/year) is the starting point for discussion, and as it is to be used under the responsibility of the decontamination operator, assuming appropriate operation and maintenance. Therefore, the dose criterion (additional effective dose) was set at 1 mSv/year or less, with 1 mSv/year as the upper limit of the dose limit and dose constraint value in planned exposure situations.

In addition, as shown in “(3) Additional Exposure Assessment”, it is possible to reduce the additional effective dose to 1 mSv/year or less by using removed soil with a radioactivity level of 8,000 Bq/kg or less, but from the perspective

of optimizing protection, decontamination operators should consult with relevant organizations, including local stakeholders, to further reduce the additional effective dose for each individual project taking into account societal and economic aspects, to implement managed recycling. Note that "optimization of protection" is different from minimizing radiation dose.

Table 2-1: Explanation of terms related to "Concept of Radiation Protection"

| Terminology | Description. |
|---|---|
| Existing exposure situation | Situation where exposure already exists at the time a decision is made about management. |
| Planned exposure situation | Situations where the source is intentionally introduced and operated |
| Dose limit | Limits of exposure received by an individual from any source in a planned exposure situation |
| Dose constraint | Upper limits for exposure from individual radiation sources |

(Source: Prepared based on "Organizing the Basic Concept of Radiation Protection - Responses at the Radiation Council")

<Reference> What is optimization of protection?
The process of determining what level of protection and safety would result in the magnitude of individual doses, the number of individuals (workers and members of the public) subject to exposure and the likelihood of exposure being as low as reasonably achievable, economic and social factors being taken into account (ALARA). (IAEA Glossary)

(2) Safety of managed recycling

Radiation and radioactive materials are widely present in nature, and in Japan, the average annual exposure to natural radiation is 2.1 mSv per person (see Fig. 2-2). According to the 2007 recommendations of the International Commission on Radiological Protection (ICRP), there is scientific evidence that the risk of cancer increases with doses of 100-200 mSv or more exposed over a relatively short period of time.

It is extremely difficult to detect stochastic effects in the low dose range of 100 to 200 mSv using epidemiological methods (see "<Reference> Effects of Radiation on the Human Body").

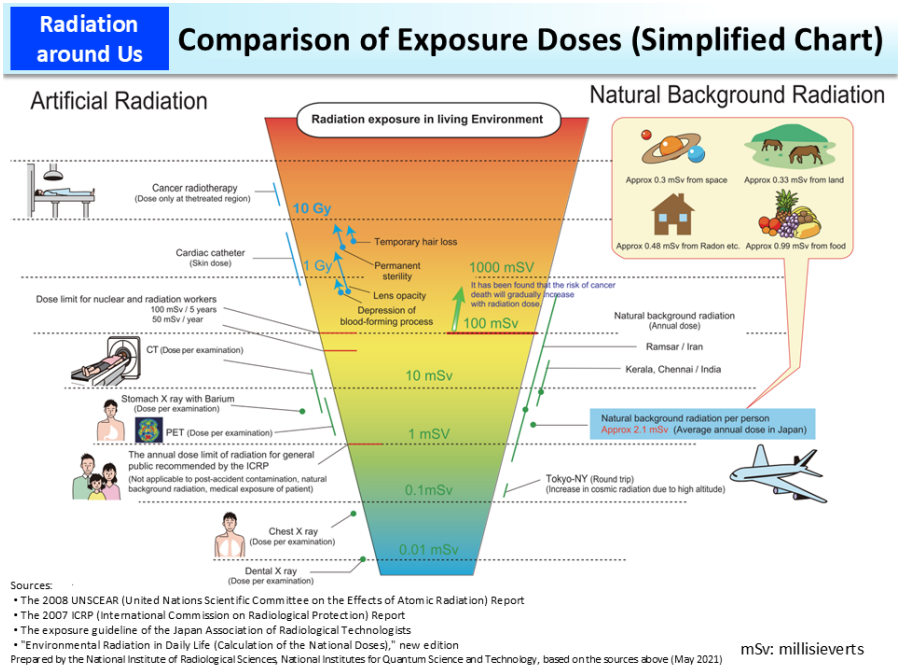



Figure 2-2 Comparison of exposure doses

<Reference> Effects of radiation on the human body

For low doses of 100 to 200 mSv or less, it is extremely difficult to detect stochastic effects using epidemiological methods, so the International Commission on Radiological Protection (ICRP) has set radiation protection standards based on the assumption that there are dose-dependent effects (linear dose response) even in the low dose range.

In addition, animal experiments and experimental studies using cultured cells have shown that, in cases where a low dose is received over a long period of time (low dose-rate exposure), the risk of effects is lower than in cases where a high dose is received over a short period of time (such as in the case of an atomic bomb), even if the total dose of exposure is the same.

(Source: Created based on "Unified Basic Materials on Health Effects of Radiation, 2023 Edition" by the Ministry of the Environment and the National Institutes for Quantum and Radiological Science and Technology)

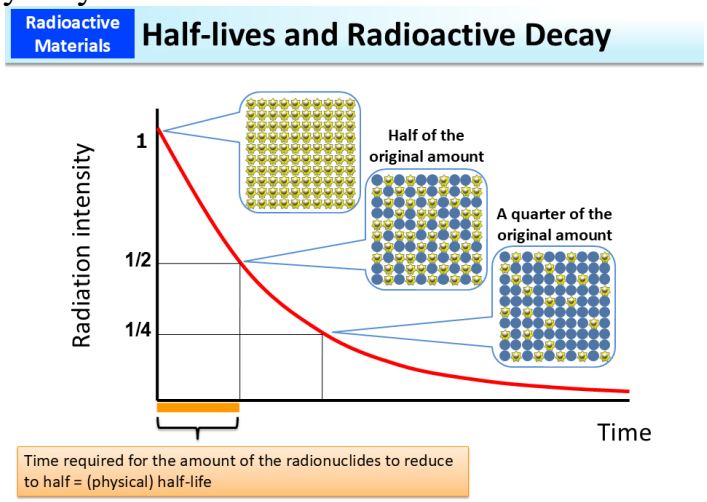
In managed recycling, additional effective doses will be 1 mSv/year or less even for workers who will be most affected, as standards have been set for the radioactivity concentration of removed soil. (see (3) Additional Radiation Exposure Assessment), so the impact on local residents and users will be even smaller. In addition, decontamination operators will consider further reducing additional effective doses from the perspective of optimizing protection.

In addition, since radioactivity decays over time, the annual exposure dose will also decrease over time.

<Reference> Half-life and radioactive decay

Substances that have become energetically stable by emitting radiation will no longer emit radiation. The time required for radioactivity to weaken and reduce to half is called a (physical) half-life.

Since the intensity of radioactivity decreases by half every time half of the half-life elapses, twice the half-life will result in one-quarter of the initial intensity of radioactivity.Half-lives vary depending on the type of radioactive material. For instance, the half-life is approximately 2 years for Cs-134 and approximately 30 years for Cs-137.




(Source: Ministry of the Environment, National Institute of Quantum Science and Technology, based on "Unified Basic Material on Health Effects of Radiation, 2023 Edition")

(3) Additional exposure assessment

The radioactivity concentration of removed soil that results in an additional effective dose of 1 mSv per year or less is 8,000 Bq/kg, based on the results of the assessment shown in Figure 2-3 and also taking into account the uniformity of the regulatory system in the Act on Special Measures.

As a specific assessment, taking into account the advice from the IAEA and domestic experts regarding the conservativeness of the assessment, and

considering the actual construction conditions of the demonstration project, the scale of the construction (embankment) was set at approximately 500m x 500m x 5m in height, and assessment calculations were carried out on the exposure pathways of workers involved in the construction, residents living in the surrounding area, and users of the area. (See “Reference Material 5: List of Assessment Parameters for Additional Exposure Calculations”)

As a result, the point where workers receive maximum exposure dose was at the center of the embankment during construction and the additional effective dose was 0.93 mSv/year (the concentration corresponding to an additional effective dose of 1 mSv/year was approximately 8,600 Bq/kg), as shown in Figure 2-3, when the radioactivity concentration of the removed soil processed into recycled materials was 8,000 Bq/kg. In addition, as shown in Figure 2-4, after the completion of the construction of the same embankment, the additional effective dose for users in the center of the embankment was 0.12 mSv/year (in the case of a 20 cm thick covering layer) and 0.0020 mSv/year (in the case of a 50 cm thick covering layer).

Furthermore, when trial calculations were made on the assumption that all of the covering layer had been washed away during a disaster and that this situation continued for one year, the additional effective dose for recovery workers was 0.93 mSv/year, and the additional effective dose for residents in the surrounding area was 0.75 mSv/year (0.97 mSv/year for children), resulting in an annual additional effective dose of 1 mSv/year or less (see “3.5.2 Response in the event of an emergency”).

In addition, in order to promote understanding when implementing individual projects for managed recycling, decontamination operators will assess additional exposure based on the actual design, and present the results to the relevant organizations, including local stakeholders.

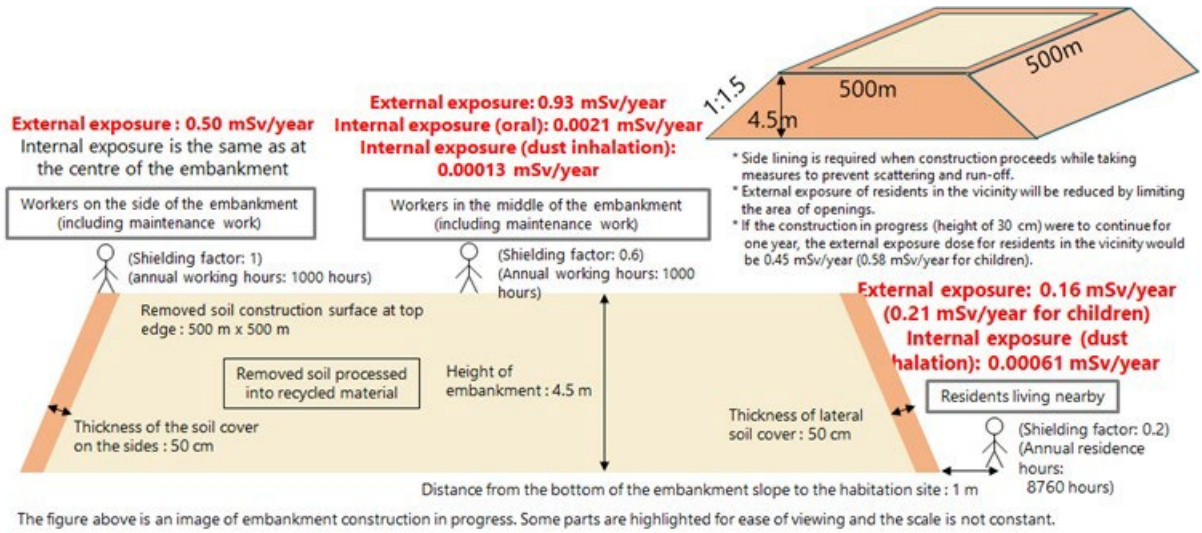



Figure 2-3 Results of additional exposure assessment calculation (during construction)

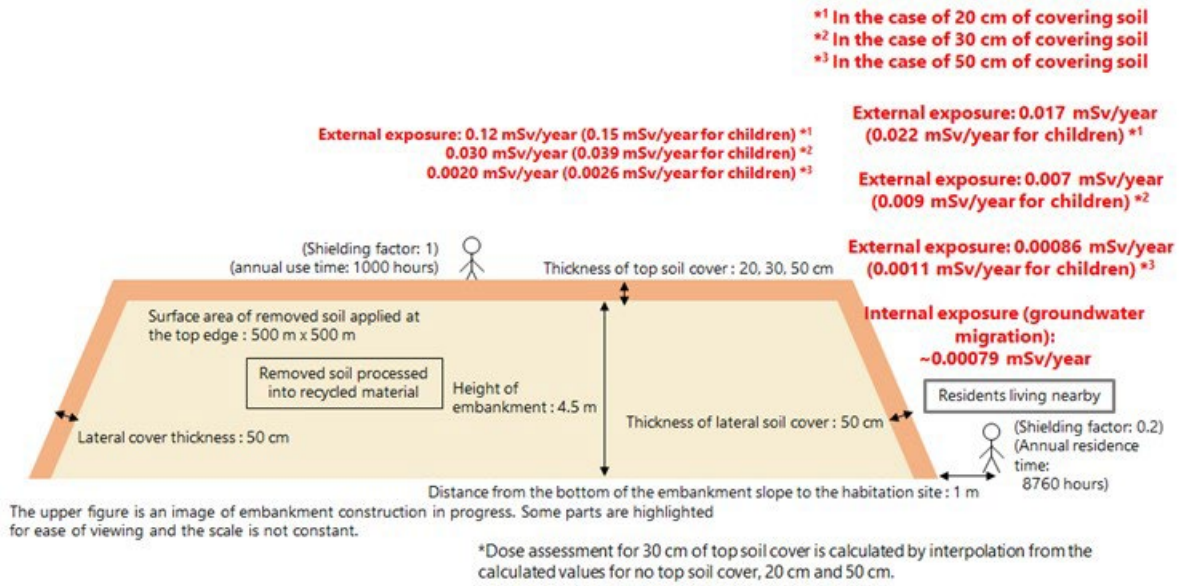



Figure 2-4 Additional exposure assessment calculation (during maintenance)

2.2.2 Methods of Investigating Radioactive Caesium Concentration

Notification No. 31 of the Ministry of the Environment, 2025

Survey Methods of the Contamination of Removed Soil by Accident-derived Radioactive Materials

The method specified by the Minister of the Environment referred to in Article 58-4, item 1 (v) of the Enforcement Regulations of the Act on Special Measures shall be as follows.

(i) In the case of a survey using a device that can continuously measure radioactivity concentration, the following shall be applied.

(a) The survey shall be conducted by dividing the removed soil to be surveyed into survey units and conducting the survey for each survey unit.

(b) The radioactivity concentration of Caesium 134 and the radioactivity concentration of Caesium 137 shall be measured for all of the removed soil in the survey units divided in accordance with the provisions of (a) above, using the measuring instruments listed in Appended Table 1.

(ii) In cases other than those listed in the preceding item, the following shall be followed.

(a) The survey shall be conducted by dividing the removed soil to be surveyed into survey units and conducting the survey for each survey unit.

(b) Four or more samples shall be collected for each survey unit.

(c) For each survey unit, mix the samples collected in accordance with the provisions of item (b) in roughly equal weight.

(d) For all of the samples mixed in accordance with the provisions of item (c), measure the radioactivity concentration of Caesium 134 and the radioactivity concentration of Caesium 137 using the measuring instruments listed in Appended Table 2.

Appendix Table 1

1. Germanium semiconductor measuring device
2. Scintillation measuring device

Appendix Table 2

1. Germanium semiconductor detector
2. NaI(Tl) scintillation spectrometer
3. LaBr3(Ce) scintillation spectrometer

The survey methods for confirming that the removed soil processed into recycled materials has a radioactivity concentration of 8,000 Bq/kg or less are prescribed in Notification No. 31 of the Ministry of the Environment in 2025 as two types: continuous measurement and measurement by sampling. Regardless of which measurement method is used, measurement should be carried out after processing into recycled materials. The equipment used for measurement should be inspected and calibrated, referring to the equipment's user manual, etc.

(1) Method of survey using equipment that can continuously measure radioactivity concentration (continuous measurement)

One method of survey using equipment that can continuously measure radioactivity concentration (hereinafter “continuous measurement equipment”) is to attach the measurement equipment to a belt conveyor and measures the soil as in the example of the test embankment construction demonstration project at the Minamisoma City temporary storage site shown in Figure 2-5.

The unit of measurement is the amount measured in one measurement by the continuous measuring equipment, which is defined as the amount of removed soil processed into recycled materials that passed over the belt conveyor during one measurement by the measuring equipment.

Measurements shall be conducted for all removed soil processed into recycled materials. The equipment used for measurement is a germanium semiconductor detector and a scintillation detector, and the radioactivity concentration of Cs-134 and Cs-137 is to be measured.

If the measurement results exceed 8,000 Bq/kg, the removed soil processed into recycled materials for that survey unit shall be removed (the equipment for this purpose shall be provided as a set with the continuous measurement equipment) and not used for managed recycling.

Fig.2-5 Radioactivity concentration measuring equipment using a conveyor belt
(Example of a demonstration project of test embankment construction at a temporary storage site in Minamisoma City)

(2) Method of survey by sampling (sampling and measurement)

In the method of surveying by sampling, the removed soil processed into recycled material to be surveyed is divided into survey units, and four or more samples are collected and mixed for each unit, and then the radioactivity concentration is measured.

The survey units should be as shown in the table below.

Table 2-2 Survey units by sample collection

| | |
|---|---|
| (1) When it can be considered that there is no risk of exceeding 8,000 Bq/kg | 5,000$m^3$ |
| (2) When the risk of exceeding 8,000 Bq/kg is unclear | 900$m^3$ |
| (3) Cases other than the above | 100$m^3$ |

* The concept of this survey unit was based on the "Method of Survey of Contamination Status of Soil by Specific Hazardous Substances when Soil Brought in from Outside the Soil Contamination Countermeasures Area is Used (Ministry of the Environment Notification No. 6, 2019)" based on the Soil Contamination Countermeasures Law.

As for the removed soil within Fukushima Prefecture, the radioactivity concentration of the removed soil is checked when it is transported to the ISF, and the removed soil with a radioactivity concentration of 8,000 Bq/kg or less is stored separately from the removed soil with a radioactivity concentration of more than 8,000 Bq/kg. Therefore, in the case of removed soil stored in a soil storage facility classified as 8,000 Bq/kg or less, it is (1), and in the case of removed soil stored in a soil storage facility classified as more than 8,000 Bq/kg, it is (3).

For removed soil generated outside Fukushima Prefecture, if the radioactivity concentration is checked when storing it, it will be classified as either (1) or (3) in the same way as for the removed soil within Fukushima Prefecture. On the other hand, if the radioactivity concentration of the removed soil stored is unclear, such as the radioactivity concentration is not checked when storing, it will be classified as (2).

The main steps in sample collection and measurement are as follows.

Step 1: The removed soil processed into recycled materials to be measured is divided into survey units.

Step 2: Collect samples from at least four locations for each survey unit. In order to ensure representativeness, the samples should be collected from different locations as far apart as possible, as shown in Figure 2-6.

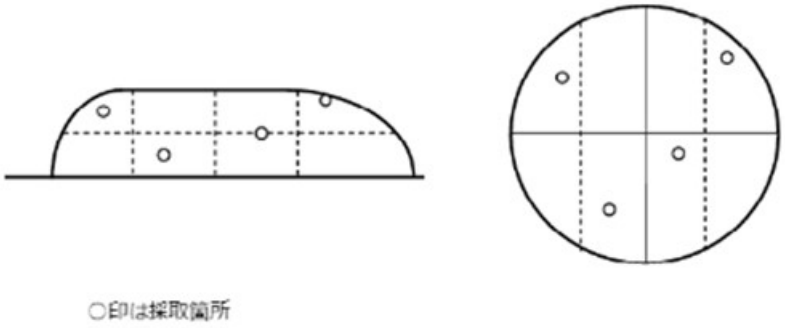



Fig. 2-6 Image of sample collection location

Step 3: After milling the collected sample as necessary, place approximately the same weight of the sample in a single container and then mix thoroughly. The amount of sample to be collected for measurement shall be approximately 500g to 1kg in total, as specified in “JIS K0060:1992 Sampling methods for industrial waste”.

Step 4: For the mixed sample, measure the radioactivity concentration of Cs-134 and Cs-137 using either a germanium semiconductor detector, NaI(Tl) scintillation spectrometer, or LaBr3(Ce) scintillation spectrometer.

When using each of these instruments for measurement, follow the instructions in the manuals below.

Table 2-3: Manuals for the instruments used in sample collection and measurement

| | |
|---|---|
| Germanium semiconductor detector: | Radioactivity Measurement Methods Series 7: Gamma-ray Spectrometry with Germanium Semiconductor Detectors" (Revised 2020, Nuclear Regulation Authority) |
| NaI(Tl) scintillation spectrometer and $LaBr_3$(Ce) scintillation spectrometer: | "Radioactivity Measurement Method Series 6: NaI(Tl) Scintillation Spectrometer Instrumental Analysis Method" (1974, Ministry of Education, Culture, Sports, Science and Technology) |

(3) Recording and preserving the results of the survey

The decontamination operator should record and preserve the following items on the results of measuring the radioactivity concentration by (1) continuous measurement or (2) sample collection measurement.

In the case of continuous measurement, this should be done for each measurement date or for each measurement amount, whichever is smaller. In the case of sample collection measurement, this should be done for each survey unit.

- Reference number
  A unique reference number should be assigned for each survey unit.
- Measurement location
  Record the location where the samples were collected and the location where the radioactivity concentration was measured. If the location where the samples were collected and the location where the radioactivity concentration was measured are the same facility, record the location where the samples were collected in the location where the radioactivity concentration was measured.
- Measurement date
  Record the date of sampling and the date of radioactivity concentration measurement. If the date of sampling and the date of radioactivity concentration measurement are the same, record the date of sampling in the date of radioactivity concentration measurement.
- Measurement method for each survey unit
  Record the following details about the measurement method.
  ・Continuous measurement / measurement for sample collection
  ・Equipment used (name of measurement device, detection limit, time constant or measurement time)
  ・In case of sampling measurement, the number and volume of samples collected.
  Note: It is desirable to prepare a drawing showing the location of sample collection.
  ・ In case of continuous measurement, the speed of the conveyor belt.
- Name of person who carried out the measurement
- Weight or volume of removed soil to be measured
- Measurement results (in case of continuous measurement, average and maximum values of radioactivity concentration)
  Note: The total radioactivity concentration of Cs-134 and Cs-137 shall be stated in Bq/kg.
- Location where the removed soil processed into recycled materials to be measured is used.

(4) Radioactive nuclides to be measured

In the Ministry of the Environment's Notice No. 31 of 2025, the radioactive nuclides to be measured are specified as Cs-134 and Cs-137.

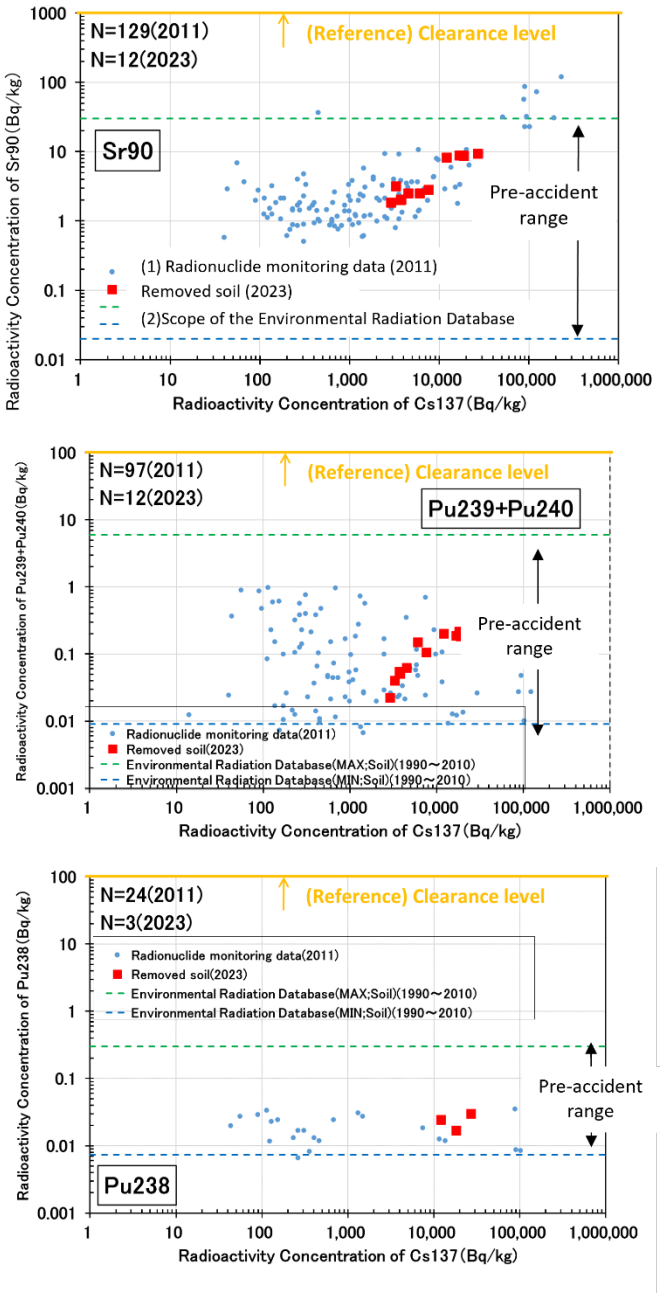
With regard to radioactive nuclides other than caesium, the MOE conducted a survey on 12 samples taken from the removed soil that had been sorted after being transported to the ISF (sample collection period: June to July 2023. (Survey objects: Sr-90, Pu-238, Pu-239, Pu-240, Pu-241). As a result, it was confirmed that the radioactivity concentration of radio nuclides other than caesium was the same as before the accident (see Figure 2-7). These results are considered to be consistent with the statement in the results of the research conducted by the Ministry of Education, Culture, Sports, Science and

Technology in FY2011* that “it is appropriate to focus on the amount of deposition of Cs-134 and Cs-137 when assessing future exposure doses and implementing decontamination measures”.

* Results of research on the dispersal status of radionuclides released in the accident at TEPCO's Fukushima Daiichi Nuclear Power Station (March 13, 2012, Ministry of Education, Culture, Sports, Science and Technology)

Therefore, in the Ministry of the Environment Notification No. 31 of 2025, the radionuclides to be measured for the purpose of managed recycling are considered to be Cs-134 and Cs-137. Furthermore, from the perspective of fostering understanding, the Ministry of the Environment will conduct similar surveys for radionuclides other than caesium in the future as necessary.

The half-life of Cs-134 is approximately 2 years, the half-life of Cs-137 is about 30 years, and assuming that the ratio of the presence of Cs-134 and Cs-137 was 1:1 immediately after the accident, it will be 0.013:1 as of March 2025, and the contribution of Cs-134 is small (Cs-134 contained in removed soil of 8,000 Bq/kg is about 100 Bq/kg).




<Reference> Clearance levels at nuclear facilities, etc.
Sr90: 1,000 Bq/kg, Pu238, Pu239, Pu240: 100 Bq/kg

<Sources>

(1)Radiation monitoring data (Results of survey after the accident at the TEPCO's Fukushima Daiichi Nuclear Power Station in March 2011)
Japan Atomic Energy Agency (JAEA), List of registered data of soil sample and environmental sample analysis (Reference: October 2023) https://emdb.jaea.go.jp/emdb_old/selects/b10203/
Note: Some data are unit-converted as 1Bq/kg = 65Bq/m2.

(2) Environmental Radiation Database1
Measured radioactivity concentrations in soil throughout Japan. The period covered is the 20-year period from January 1991 to December 2010. (The period from after the Chernobyl accident (April 1986) to the TEPCO's Fukushima Daiichi Nuclear Power Station accident (April 2011))
Note: A database of the results of environmental radioactivity surveys conducted since 1957 by the Science and Technology Agency - Ministry of Education, Culture, Sports, Science and Technology - Nuclear Regulation Authority with the cooperation of related ministries and agencies, 47 prefectures, etc.

Fig.2-7 Measurement Result of Radionuclides other than Caesium (2023)

## 2.3 Prevention of dispersion and runoff

Article 58-4
(1) Managed recycling shall be implemented as follows
(c) Necessary measures shall be taken to prevent the removed soil and waste from dispersal and runoff, such as covering the surface with soil and sand.

(1) Basic approach to covering removed soil.

When managing recycling, decontamination operators are required to take necessary measures such as covering the surface with covered soil to prevent removed soil processed into recycled materials from dispersal or runoff.

To prevent dispersal and runoff of the removed soil processed into recycled materials, decontamination operators should install a layer of soil or other covering (Layer A) to prevent dispersal and runoff, as shown in Figure 2-8. In addition to the layer of soil or other covering (Layer A), a layer (Layer B) will be installed by the operator of the structure, taking into account the necessary functions for the intended use of the structure.

➢In addition to covering such as covering soil (Layer A), the thickness required for the intended use (Layer B) will be secured, in consideration of the perspective of "optimization" to further reduce radiation exposure to the extent that is reasonably achievable.
Layer A: A layer that is necessary from the perspective of preventing dispersal and runoff of removed soil processed into recycled materials
Layer B: A layer that is set based on discussions with relevant parties, in consideration of perspectives such as "management of structures, etc." and "uses, methods of use, and actual use"

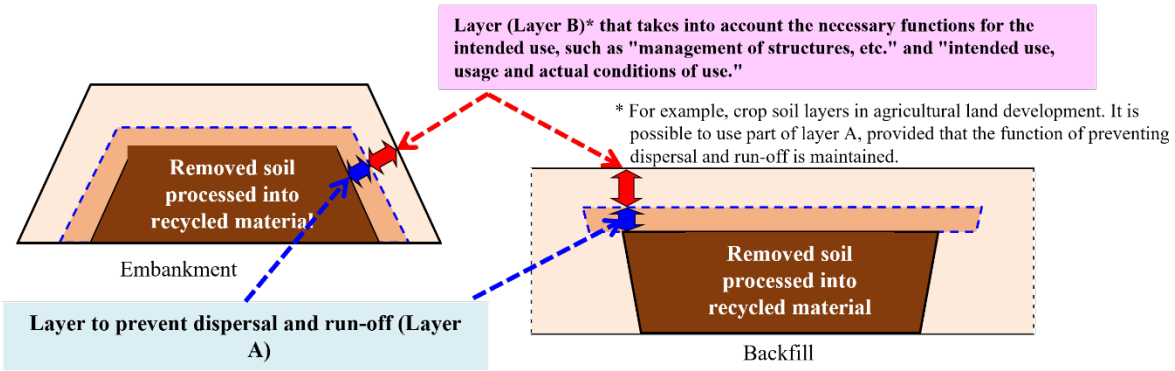



Figure 2-8 Concept of Covering Soil and Other Coverings

(2) Thickness of covering material, etc.

In demonstration project of agricultural embankments (environmental restoration project) in Nagadoro District of Iitate Village, it was confirmed that the function of preventing dispersal and runoff was maintained for approximately two years when covering material of 20 cm was used. In addition, depending on the purpose of use, the thickness of the finished layer of embankment construction is often 20 cm or less than 30 cm. Therefore, the thickness of the covering (Layer A) for preventing dispersal and runoff, such as covering with soil, should be around 20 to 30 cm, based on the findings of the demonstration project and the workability. In addition, it is also assumed

that materials other than soil will be used for Layer A, and in such cases, the structure and thickness shall be sufficient to ensure the function of preventing dispersal and runoff.

The thickness of the layer (layer B) that meets the necessary functions according to the intended use shall be determined by the operator of the structure, taking into consideration the operation and maintenance of the structure, the intended use, and the actual usage. (including underground buried objects such as buried pipes).

When using removed soil processed into recycled materials for embankments and covering the slope with soil, the total thickness of the covering layer (horizontal direction) consisting of layers A and B is expected to be more than 1 m, taking into consideration the thickness of layer A (20 to 30 cm) as a function to prevent dispersal and runoff, as well as workability.

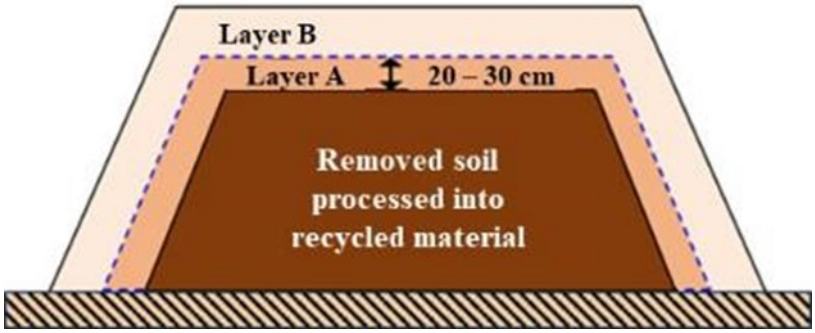



Figure 2-9 Concept of thickness of cover (layer A) such as soil cover

<Reference> Inspection status of the agricultural land development demonstration project (environmental restoration project) in the Nagadoro District of Iitate Village

In the agricultural land development demonstration project (environmental restoration project) in Nagadoro District of Iitate Village, a 20 cm layer of soil (Layer A) is placed on top of the removed soil processed into recycled materials, and visual inspections are carried out on a regular basis (at least once a month). It has been confirmed that the function of the covered soil layer has been maintained from December 2022 to October 2024 (as of November 1, 2024). In addition, there have been no significant fluctuations in the air dose rate in the surrounding area, and we have confirmed that the function of the covering is being maintained.

(3) Shielding by covering soil

In addition to preventing dispersal and runoff, the covering of removed soil processed into recycled materials, such as covering soil, also has a shielding effect against radiation.

As shown in "(2) Thickness of covering soil," by adding layer B to layer A (20cm to 30cm for soil and sand), a certain thickness of covering is provided around the removed soil processed into recycled materials, and the shielding effect of the entire covering soil (layer A + layer B) is expected to be significant, but in light of the perspective of "optimization of protection" that aims to reduce exposure to radiation as low as reasonably achievable, while economic and social aspects are taken into account, the decontamination operator should consult with the relevant organizations, including the local stakeholders, regarding the thickness of the entire covering soil. The decontamination operator should set the overall thickness of the covering soil (the amount of removed soil processed into recycled materials to be used) based on the thickness of layers A and B and the results of the aforementioned consultation and should decide on this after consulting with the operator of the structure.

As a reference, Figure 2-10 shows the relationship between the thickness of the covering soil and the shielding effect of radiation related to Cs-137 (in the case of shielding by soil).

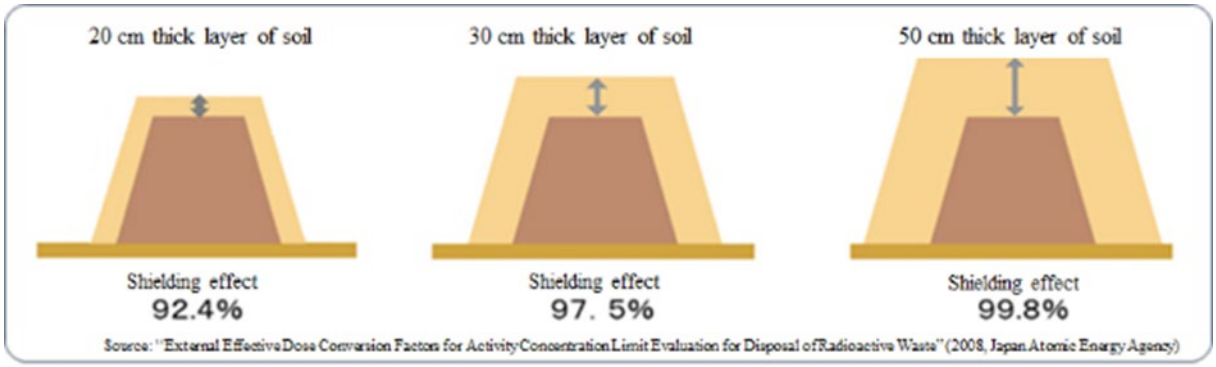



Fig.2-10 Example of shielding effect on Cs-137 by covering soil

(4) Prevention of dispersal and runoff during construction

When the removed soil processed into recycled materials is not covered with covering soil (during construction), the decontamination operator should take appropriate measures to prevent dispersal and runoff, such as sheet curing, watering during strong winds, and mud pulling measures using steel plates, as necessary, just as when the removed soil processed into recycled materials is not being handled.

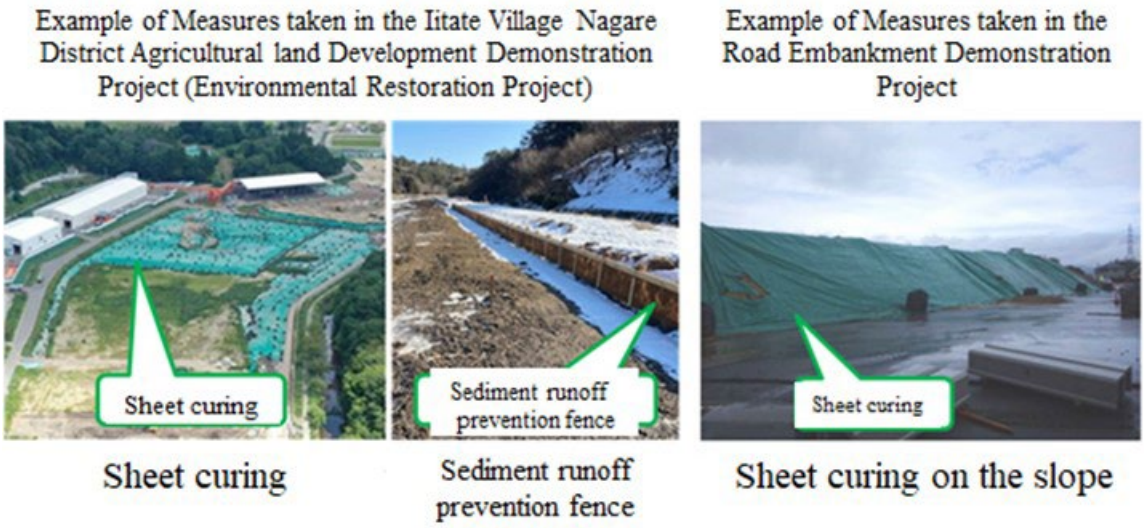



Fig.2-11 Examples of measures to prevent dispersal and runoff during construction work

(5) Measures to prevent groundwater contamination

When implementing managed recycling, measures will be taken to prevent dispersal and runoff of removed soil. However, since radioactive caesium is extremely difficult to leach from soil, no special measures are necessary to prevent groundwater contamination.

From a physical and chemical perspective, it is known that the majority of radioactive caesium in soil is fixed in the interlayers of minerals and is in a state that is difficult to move (see "Geotechnical Society of Japan Review of the Behavior of Radioactive Caesium in Soil").

The monitoring results for the leachate water from the agricultural land development demonstration project (environmental restoration project) in Nagadoro District of Iitate Village and the road embankment demonstration project show that the radioactive caesium concentration was below the detection limit or the effluent standard (see Reference Material 2: Agricultural Land Development Demonstration Project (Environmental Restoration Project) in the Nagadoro District of Iitate Village and Reference Material 3: Road Embankment Demonstration Project in the ISF). In addition, the results of measuring the radioactivity concentration in the leachate from the ISF (soil storage facility) and the original leachate water from the landfill disposal of removed soil generated outside Fukushima Prefecture showed that the majority of the results were below the detection limit, and even for those that were detected, the maximum value was around 10 Bq/L (see Figure 2-12). The results of the leaching tests conducted as part of the demonstration project for the landfill disposal of removed soil transported to the Interim Storage Facility and removed soil generated outside Fukushima Prefecture show that the majority of the samples were below the detection limit, and even in the cases

where they were detected, the maximum Cs-137 concentration was approximately 27,000 Bq/kg, or approximately 5 Bq/L (see Figure 2-13).

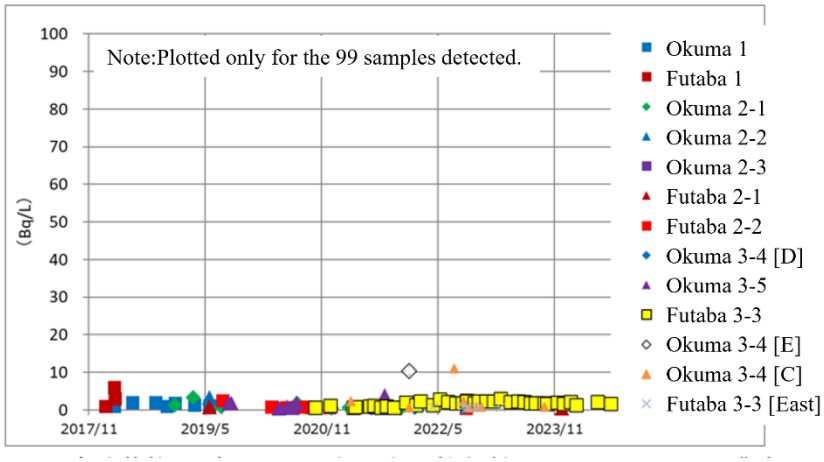



Fig.2-12 Radioactive caesium (Cs-137) concentration of original leachate water for each soil storage facility
(November 2017 - July 2024)

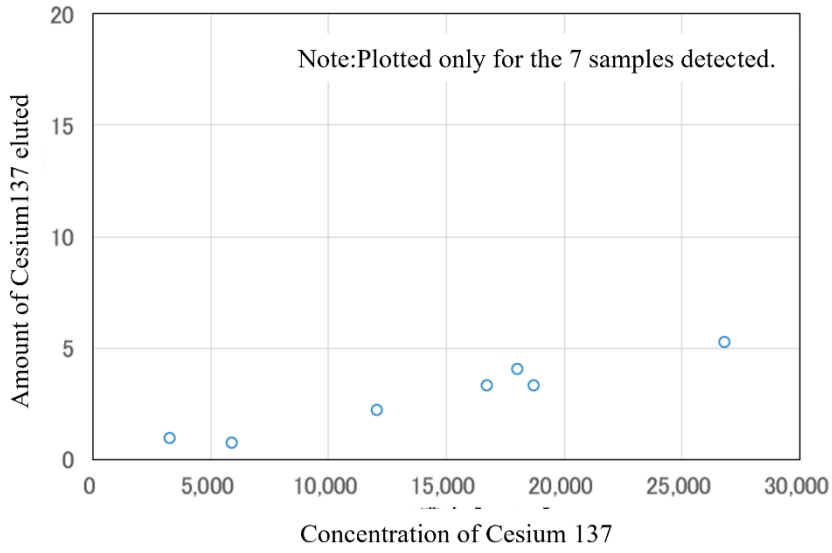



Fig.2-13 Elution test results of removed soil transported to the Interim Storage Facility

## 2.4 Measurement of air dose rate (during construction, and operation and maintenance)

Article 58-4.
(iii) At the location where the managed recycling is implemented, the dose of radiation shall be measured at least once every seven days using the method specified by the Minister of the Environment under Article 15, item (xi), and the results shall be recorded. However, if operation and maintenance pertaining to the managed recycling has commenced, the dose of radiation shall be measured periodically, and the results shall be recorded.

(1) Measurement location and frequency

The standards for managed recycling state that decontamination operators shall measure air dose rates both during construction and during operation and maintenance, but the specific measurement locations and frequency sould be as follows in principle.

In addition, decontamination operators shoulsmeasure air dose rates before the start of managed recycling (before construction) in order to ascertain background values, so that they can be compared with measurements taken during construction and operation and maintenance.

Decontamination operators shoulddetermine the location and frequency of measurements during construction and operation and maintenance based on consultations with relevant organizations, and the following should be used as a guide. The frequency of periodic measurements during operation and maintenance should be at least once a year.

Table 2-4: Measurement location and frequency for air dose rate measurements.

| Monitoring Item | Location | Frequency | |
|---|---|---|---|
| Air dose rate | Required:<br>At least one location above the removed soil installation site<br>Optional:<br>Several location around the site boundary | During construction | At least once a week<br>* Measurements will also be conducted when construction is completed. |
| | | During operation and maintenance | At least once a year |

In principle, the above should be followed for monitoring using measurements of air dose rates, but decontamination operators may change the measurement locations and frequency after consulting with the relevant organizations, taking into account the amount of soil to be used, the scale of the work, the timing of the monitoring, the monitoring results, etc.

Decontamination operators should publish the results of measurements of air dose rates in a timely manner. From the perspective of fostering understanding,

it may also be considered to carry out measurements of air dose rates with the participation of the local community.

* Regarding managed recycling, the additional exposure dose can be kept below 1 mSv/year by using soil with a radioactivity level of 8,000 Bq/kg or less, as determined by additional exposure assessment. However, decontamination operators should organize the results of measurements of air dose rates, etc., and confirm that the additional exposure dose is kept below 1 mSv/year.

(2) Measurement method

Measurement of air dose rates shall be carried out in accordance with the method specified by the Minister of the Environment in Article 15, Item 11 of the Enforcement Regulations of the Act on Special Measures. The method specified by the Minister of the Environment is as follows.

Ministry of the Environment Notification No. 110 of 2011

(Methods of Measuring Radiation Dose Specified by the Minister of the Environment)

The method specified by the Minister of the Environment in Article 15, Item 11 of the Enforcement Regulations of the Act Special Measures is to measure the air dose rate at a height of between 50 cm and 1 m above the ground using a gamma ray measuring instrument.

Air dose rates should be measured using radiation measuring instruments that have been inspected and calibrated, referring to the manuals for use of the instruments.

(3) Recording and preserving measurement results.

Decontamination operators should keep records of the following items regarding the measurement results.

- Measurement location
  The height of measurement should also be recorded.
- Measurement date
- Type and model of radiation measuring instrument
- Measurement results (air dose rate)
- Name of person who carried out the measurement

(4) Items other than air dose rate

As shown in “2.3 Preventing dispersal and runoff (5) Measures to prevent groundwater contamination”, radioactive caesium in the removed soil is extremely difficult to dissolve, and monitoring results from the demonstration project have also shown that almost no radioactive caesium has been detected in infiltrating water. For this reason, monitoring is not necessary. However, based on consultations with the relevant organizations, decontamination operators may consider monitoring these items as necessary to foster public understanding.

In addition, in the event of a disaster or other situation where it is difficult to follow the principles outlined above, decontamination operators may add monitoring items, based on consultations with relevant organizations.

## 2.5 Preservation of the living environment (noise, vibration, etc.)

Article 58-4
(i) Managed recycling shall be implemented as follows
  (a) The provisions of Article 26, paragraph 1, item 1 (b) and item 9 shall be applied accordingly.

Article 26, paragraph 1
(i) Landfill disposal of specified waste shall be implemented as follows.
  (b) Necessary measures shall be taken to prevent any adverse effects on the preservation of the living environment due to odors, noise or vibration caused by the landfill disposal of specified wastes.
(ix) When establishing facilities for the landfill disposal of specified wastes, necessary measures shall be taken to prevent any adverse effects on the preservation of the living environment.

In the standards for managed recycling, in accordance with Article 26 of the Enforcement Regulations of the Act on Special Measures, the decontamination operator shall take necessary measures to prevent any adverse effects on the living environment due to odors, noise or vibration caused by managed recycling, and to prevent any adverse effects on the living environment when establishing facilities for managed recycling.
Examples of relevant laws and guidelines for managing odors, noise and vibration are shown below. Decontamination operators should refer to these when managed recycling, and when setting up facilities for managed recycling (facilities that are expected to process recycled materials), they shall also refer to other relevant laws and take appropriate measures.

Table 2-5: Relevant laws and guidelines for managing odors, noise and vibration.

| Environmental measure | Related environmental laws and regulations | Related guidelines |
|---|---|---|
| Odor control | Offensive Odor Control Act | ・Manual for the measurement of specific odor materials (issued March 21, 1996 by the Japan Environmental Health Center) |
| Noise reduction | Noise Regulation Act | ・Manual for the assessment of environmental standards for noise (October 2015, Ministry of the Environment) |
| Vibration countermeasures | Vibration Regulation Act | ・Easy to understand guide to vibration prevention in construction work (2004, Office of Odor, Noise and |

| | | |
|---|---|---|
| | | Vibration, Environmental Management Bureau, Ministry of the Environment, Japan)<br>・Guide to construction work vibration control for local municipalities personnel (April 2012, Office of Odor, Noise and Vibration, Environment Management Bureau, Ministry of the Environment) |

## 2.6 Indication of the site where removed soil processed into recycled materials is used

> Article 58-4.
> (i) Managed recycling shall be implemented as follows
> (d) The project shall be carried out at a location indicated as a managed recycling site.

(1) Overview of the indication

At the site where managed recycling is implemented, the decontamination operator shall indicate in at least one place that the removed soil processed into recycled materials is being used, in order to notify the decontamination operator if damage caused by a natural disaster is discovered within the area of facilities where the removed soil is being used, and to promote understanding of managed recycling. The following information should be included in the display.

- A statement that the area is a site for managed recycling
- The name and contact details of the decontamination operator

In addition, based on the purpose of the display, the decontamination operator may also include information such as the purpose and significance of managed recycling, or a link to the MOE website where related information such as the results of measurements of air dose rates can be checked.

(2) Points to note when displaying information

Decontamination operators should take the following points into consideration when displaying information. Unless there are fences or restricted access around the facilities where the managed recycling is to take place, there is no need to set up fences or restricted access around the removed soil processed into recycled materials just for the managed recycling.

- When displaying information, take into consideration the structural safety, durability, ease and certainty of operation and maintenance, and harmony with the surrounding area.
- Take care to ensure that the usability and safety of other structures in the vicinity are not affected, that traffic is not affected, and that the safety of pedestrian traffic in the vicinity is ensured.
- Carry out operation and maintenance to ensure that the effectiveness of the display is not impaired, and it is recommended to inspect immediately after disasters such as typhoons.

## 2.7 Record and Preserve the Location of Use, Amount used and Radioactivity Concentration of Removed Soil Processed into Recycled Materials

Article 58-4.

(iv) The following items shall be recorded, and diagrams indicating the location where the managed recycling is carried out shall be prepared. In addition, these shall be preserved until the measures pertaining to the managed recycling are completed.

(a) Information on the planning and design of the work related to the managed recycling

(b) The concentration of accident-derived radioactive material in the removed soil processed into recycled materials and the amount of the removed soil processed into recycled materials related to the managed recycling

(c) The dates of commencement and completion of embankment, landfill or filling using the removed soil processed into recycled materials in the work related to the managed recycling, and the date of commencement of operation and maintenance related to the managed recycling

(d) The name of the person who accepted the removed soil processed into recycled materials and the name of the person who transported that removed soil, and if the transport was carried out using a vehicle, the vehicle registration number or vehicle number of the vehicle used for transportation.

(e) Measurements, inspections and other measures (including measurements taken in accordance with the provisions of the preceding item) taken in managing the removed soil related to the managed recycling.

In addition to recording and preserving the records as shown in Table 2-6 for the purpose of ensuring traceability of the removed soil processed into recycled materials and for appropriate operation and maintenance, such as smooth response in the event of a disaster, decontamination operators should also prepare and store the as-built drawings of the construction work related to the managed recycling (drawings that show the range of the removed soil processed into recycled materials used for the managed recycling, the radioactivity concentration of the said removed soil processed into recycled materials, and the compaction history and soil properties, etc. related to the structural safety of the facility where the soil is used). It is also recommended to share these records between decontamination operators and the operators of the structures, as necessary. Records shall be kept until the measures for managed recycling have been completed (see "2.1 Managed Recycling (4) Completion of measures based on the Act on Special Measures). MOE will organize the concept of the end of special attention for managed recycling (under what conditions or after what time period can various measures based on the Act on Special Measures will no longer be necessary) in the future.

Table 2-6 Information to be recorded and preserved

| | |
|---|---|
| Information relating to the planning and design of construction works | Name and location of the managed recycling and construction plan (e.g. cross-sectional view of managed recycling) |
| Specifications of removed soil | Quantity of removed soil used for managed recycling, radioactivity concentration (Refer to 2.2.2), other quality (detail and results of quality adjustments made according to the intended use at the site). |
| Information relating to the date of construction and commencement of operation and maintenance | Construction period and the date of commencement of operation and maintenance related to managed recycling |
| Information on transportation | Person in charge of handing over/accepting removed soil processed into recycled material, and vehicle number of the transport vehicle. |
| Information on monitoring, inspections and other measures taken regarding management. | Air dose rate (Refer to 2.4)<br>Inspection results of the managed recycling sites. In case of damage, the damaged area, the damage situation, the temporary storage area, the amount and concentration of removed soil that ran off. |

## 2.8 Involvement of Relevant Organizations

Article 58-4.

(ii) For the purpose of appropriate management of the removed soil, when implementing managed recycling, the items that is determined by the Minister of the Environment as basic items concerning the construction, operation and maintenance of the works related to the managed recycling, shall be determined in consultation with the entities listed below

(a) The operator of the structure (which means the entity that carries out the construction work itself or the entity that orders the construction work, as described in the preceding item (b)).

(b) The entity that manages the facility or structure related to managed recycling or the entity that manages the land on which the managed recycling is carried out.

Notification No. 33 of the Ministry of the Environment in 2025

Basic Items Concerning Construction and Maintenance of Managed Recycling

The items specified by the Minister of the Environment in Article 58-4, Item 2 of the Ordinance for Enforcement of the the Ordinance for Enforcement of the Act on Special Measures concerning the handling of Environment Pollution by Radioactive Materials Discharged by the Nuclear Power Station Accident Associated with the Tohoku District-Off the Pacific Earthquake That Occurred on March 11, 2011 shall be as follows.

(i) Necessary treatment of removed soil required by the operator of the structure in accordance with the managed recycling.

(ii) Role sharing and communication structure for construction or operation and maintenance in normality and in the event of a disaster

(1) Responsible entity for managed recycling

Managed recycling is an action based on the Act on Special Measures, and the decontamination operator is responsible for managed recycling, as well as decontamination implementation and the storage of removed soil. The division of responsibilities between decontamination operator, operator of the structure, and manager of the facility, for managed recycling, is shown in Figure 2-14. The decontamination operator is responsible for the recycling of removed soil processed into recycled materials, transporting it to the site of managed recycling, and covering the removed soil processed into recycled materials and other materials to prevent dispersal and runoff (Layer A). Meanwhile, the operator of the structure or the manager of the facility is responsible for covering the soil above the layer that prevents dispersal and runoff (Layer B).

While the entity responsible is as mentioned above, the construction and, operation and maintenance of the cover (Layer A) for the removed soil processed into recycled materials and the cover for the soil to prevent dispersal and runoff, may be outsourced by the decontamination operator to the operator of the structure or the manager of the facility, after consultation with them.

In addition, the decontamination operator should explain to the local community about managed recycling and radiation safety, with the cooperation of the relevant organizations.

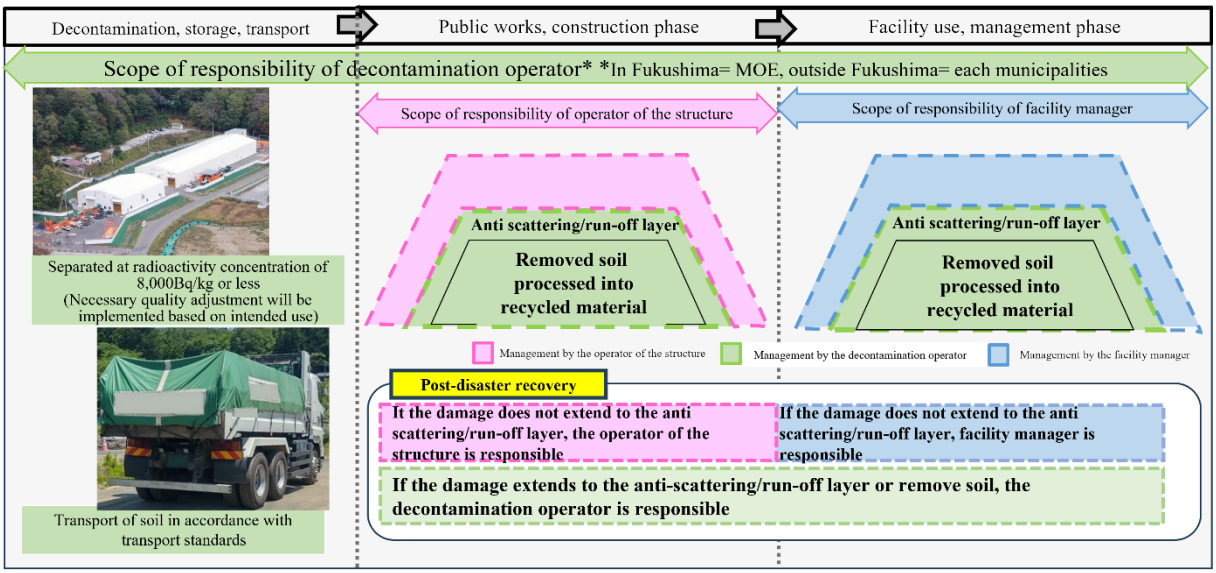



Fig. 2-14 Entities responsible for managed recycling

(2) Consultation between decontamination operators and operators of the structure

When carrying out managed recycling, consultation will be held between decontamination operators, operators of the structure, and managers of the facility, regarding construction, operation and maintenance. Consultation will also be held with the landowner as necessary.

The following are examples of items that may require consultation, including the basic items stipulated in Notice of the Ministry of the Environment No. 33 of 2025, but the decontamination operator should consult with the operator of the structure and the administrator of the facility (and the landowner if necessary) about the items necessary for implementing managed recycling according to the use of the site.

(Examples of items to be consulted)

- The necessary treatment of removed soil required by the operator of the structure (the quality of removed soil required by the user. The decontamination operator will adjust the quality as necessary after consultation)

- The division of roles and communication channels, including the sharing of costs for construction, operation and maintenance during both daily and disaster situations (including these items related to investigation, planning and design as necessary)
- Communication systems and procedures to be followed when there is a change in the owner of the project site
- Communication systems and procedures to be followed in advance when there is a change in the nature of the project site

(3) Building a system for collaboration between the parties involved

In cases where the managed recycling of the site is impleented not only by the "decontamination operator" and the "operator of the structure" but also by the landowner and other relevant parties involved, a system for collaboration between these parties involved should be built, and information related to the managed recycling should be shared appropriately.

<Reference>

In the agricultural land development demonstration project (environmental restoration project) in the Nagadoro District of Iitate Village, the "Iitate Village Nagadoro District Environmental Restoration Project Management Council" was established in August 2018, organized by local committee members, Iitate Village and other related organizations, experts, and the Ministry of the Environment. The opinions of the Management Council were reflected in the project.

Iitate Village Nagadoro District Environmental Restoration Project Management Council (October 2023)

# Chapter 3　Precautions for implementation

As described in “2.1 Managed Recycling (1) What is Managed Recycling?”, the process of managed recycling generally follows the flow chart below. In this chapter, we will describe the points to consider when implementing managed recycling, following this flow chart.

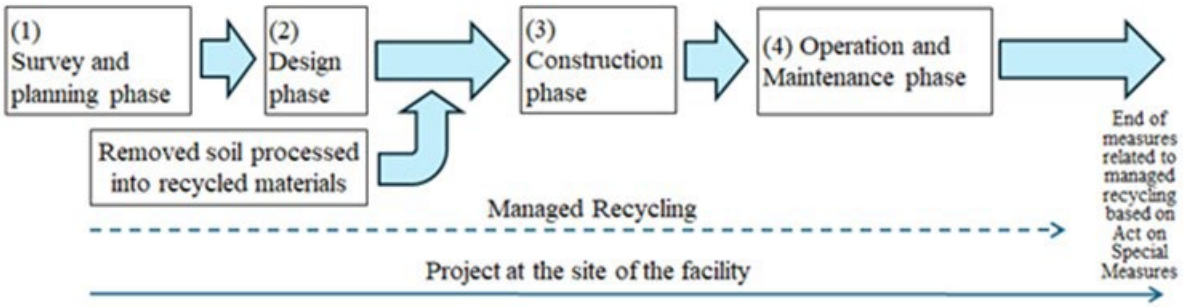



Figure 3-1 Flow of managed recycling

## 3.1 Survey and Planning Phase

### 3.1.1 Location and area of use

When planning managed recycling, the decontamination operator and the operator of the structure should select the location and area of use by taking into account the topography, geology, weather and other natural and social conditions (e.g. the presence of adjacent facilities) of the location where the removed soil processed into recycled materials will be used, and by considering safety in terms of radiation protection.

When selecting a site for use, the risk of scattering or runoff of removed soil processed into recycled materials should be taken into account comprehensively, and sufficient consideration should be given to the investigation and planning for selecting a site for use in places where artificial changes in landform are expected, as well as in places such as those listed below.

When selecting areas of use, sufficient consideration should also be given to the risk of scattering and runoff of removed soil processed into recycled materials due to artificial excavation or damage to structures in earthquakes, etc., for areas such as “backfill behind box culverts, bridge abutments and other structures”.

If the risk of scattering and runoff of removed soil processed into recycled materials is not considered to be low, these areas should basically be avoided as locations or areas of use.

(Examples)

(1) Areas with soft ground
(2) Landslide areas
(3) Areas with sloping ground
(4) Areas with a risk of liquefaction
(5) Roads where detour routes cannot be secured in the event of a disaster
(6) Areas with a high risk of dispersal or runoff due to storms, floods or earthquake damage
(7) Areas with a high risk of dispersal or runoff near structures in areas such as specified embankment control areas

When selecting specific locations for use, the decontamination operator and the operator of the structure will work together to select candidate locations for use, taking the above into account. In addition, the decontamination operator will explain the purpose of managed recycling and radiation safety to the people involved in the candidate locations for use, with the cooperation of the relevant organizations.

3.1.2 Geotechnical profile data

In order to assist in the selection of sites for managed recycling and areas of use, decontamination operators should, where necessary, obtain data on the properties of the soil as a civil engineering material, as shown in the examples below, and present this to the operator of the structure.

<Reference>
(1) Soil particle density
(2) Natural water content
(3) Particle size range
(4) Engineering classification (medium classification) using triangular coordinates
(5) Fine particle content (75μm or less) ratio
(6) Liquid limit, plastic limit, plasticity index
(7) Compaction curve
(8) Optimum water content and maximum dry density
(9) Cone index
(10) Cohesion and internal friction angle
(11) Compression index
(12) Ignition loss
(13) CBR and expansion ratio
(14) pH and electrical conductivity

## 3.2 Design Phase

### 3.2.1 Basics of Design

The operator of the structure should design the structure for managed recycling based on the information provided by the decontamination operator and in accordance with existing laws and guidelines for the use of the structure for managed recycling, using a method that has been established technologically.

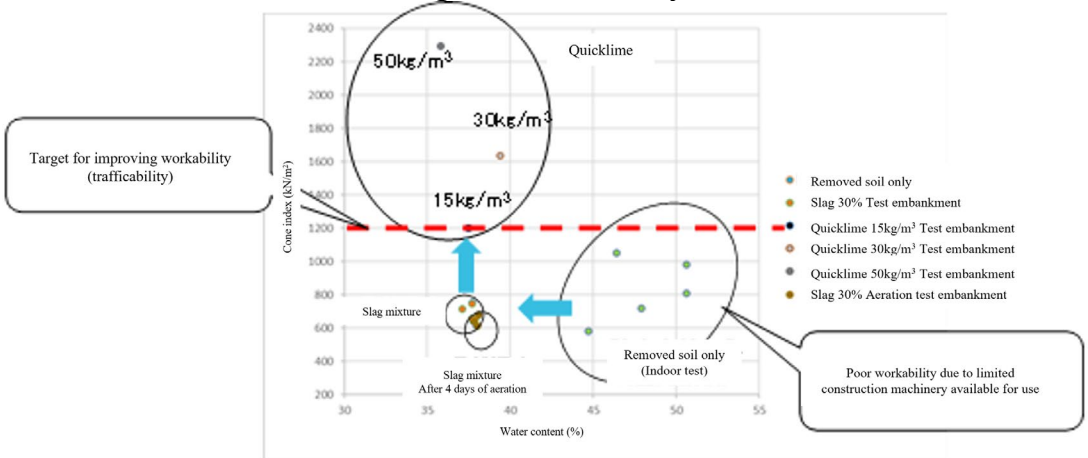
### 3.2.2 Quality Adjustment

The decontamination operator should, after consulting with the operator of the structure, make quality adjustments as necessary to ensure that the quality of the removed soil processed into recycled materials meets the required quality of the site where the managed recycling will be carried out, and shall deliver the removed soil processed into recycled materials that meet the required quality to the operator of the structure.

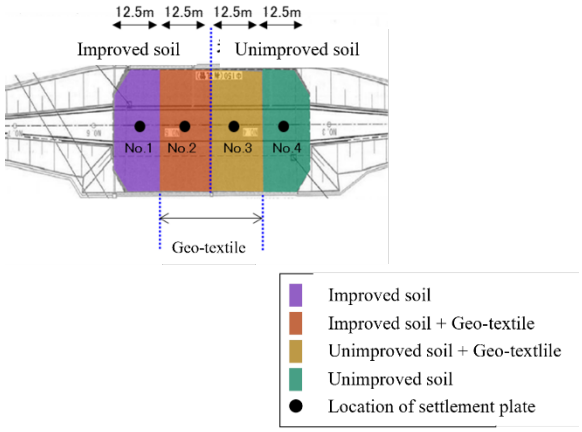
As for quality adjustment as a civil engineering material, as described in “2.8 Involvement of Relevant Organizations (2) Consultation between Decontamination Operators and Operators of Structures”, it will be carried out by the decontamination operator in consultation with the operator of the structure in advance, and in order to show that the necessary quality has been obtained, the decontamination operator will provide the operator of the structure with the results of soil tests, etc.

<Reference>

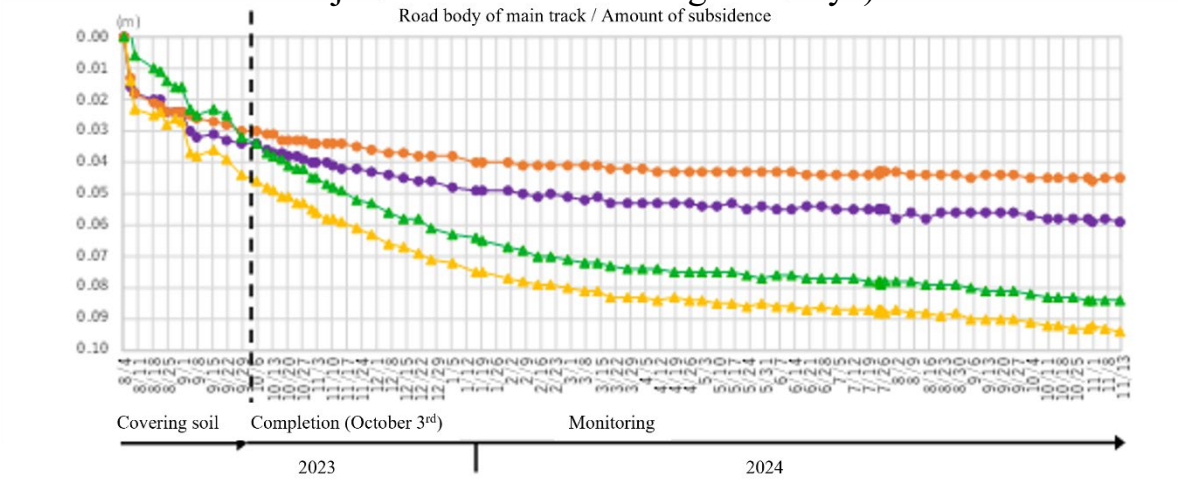
・ In the road embankment demonstration project in the Interim Storage Facility, quality adjustments were made with the aim of achieving a cone index of 1,200 kN/m$^2$ or more in order to improve the workability (trafficability) of the removed soil used. When 30% slag was mixed by weight, the water content decreased to a certain extent. Furthermore, by mixing 15kg/m$^3$ of quicklime, the target cone index was achieved. After quality adjustment, monitoring of the embankment confirmed that there was no subsidence that would compromise stability.



・ In the road embankment demonstration project, four sections were prepared: “improved soil” with the quality adjustment described above, “improved soil + geo-textile” with geo-textile laid as a reinforcing material, “unimproved soil + geo-textile” with geo-textile laid as a reinforcing material on removed soil that had not been quality-adjusted, and “unimproved soil” which was removed soil that had not been quality-adjusted, and the amount of subsidence in each was monitored.




・ As a result of the road embankment demonstration project, including the driving tests using large vehicles, there was no subsidence or displacement that would compromise stability, and by making quality adjustments as necessary, the stability and usability of the road embankment were confirmed. (See “Reference Material 3: Road Embankment Demonstration Project in the Interim Storage Facility”)




*A driving test was conducted on July 23 (gross weight: approx. 10 tons), July 24 (gross weight: approx. 20 tons), and October 29 (gross weight: approx. 25 tons) in 2024 to confirm the stability and usability of the embankment by applying the load of vehicle driving.

In addition, decontamination operators will consult with the operator of the structure and implement any necessary quality adjustments, referring to guidelines and other documents related to environmental regulations as necessary, as exemplified below.

<Reference>
・“Soil Environmental Standards (Appended Table)” (August 23, 1991, Environment Agency Bulletin No. 46)
・“Guidelines for the Effective Utilization of Reconstruction Materials Recycled from Disaster Waste” (October 2014, Japanese Geotechnical Society)
・“Manual for Dealing with Rocks and Soil Containing Heavy Metals of Natural Origin in Construction Work (2023 Edition)” (March 29, 2023, Ministry of Land, Infrastructure, Transport and Tourism)

## 3.3 Transportation Phase

### 3.3.1 Transport standards, etc.

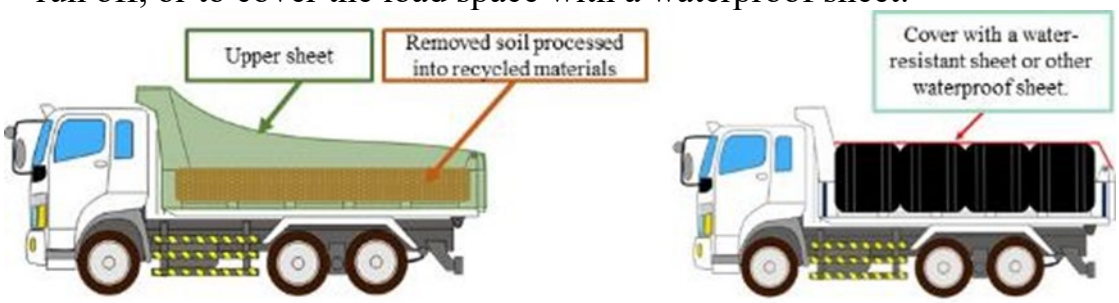
When transporting removed soil stored in soil storage facilities or temporary storage sites to facilities where it will be recycled, or when transporting it to managed recycling sites, decontamination operators must comply with the "Transportation Standards based on the Act on Special Measures (Article 57 of the Regulation for Enforcement of the Act on Special Measures) (hereinafter 'Transportation Standards')" , and take measures such as preserving the living environment, preventing dispersal and runoff, displaying information on the transport vehicle, and preparing written documents, as well as creating records of the transport.

Decontamination operators should transport removed soil processed into recycled materials appropriately based on the transport standards. For specific examples of measures to be taken when transporting removed soil processed into recycled materials, please refer to the "Guidelines Pertaining to the Collection and Transfer of Removed Soil (May 2013, 2nd Edition (September 2016, Supplementary Edition) Ministry of the Environment)".

(1) Preventing dispersal and runoff

When transporting removed soil processed into recycled materials, decontamination operators should take measures to prevent the removed soil processed into recycled materials from scattering or running off from the transport vehicle.

For example, to prevent dispersal and runoff from the storage area for removed soil processed into recycled materials, it is possible to wash the tires and bodies of the vehicles transporting the removed soil processed into recycled materials, as well as the boots of the workers. In addition, to prevent the removed soil processed into recycled materials from dispersing or running off from the vehicles, it is possible to make the load space of the vehicles so that the removed soil processed into recycled materials does not disperse or run off, or to cover the load space with a waterproof sheet.




Left: Example of covering the load space of a transporter with a waterproof sheet
Right: Example of combining a large sandbag or other container without an inner bag with a water-resistant sheet, etc.

Figure 3-2 Example of measures to prevent dispersal and runoff

(2) Separation from other materials

In order to prevent removed soil processed into recycled materials from being mixed with other materials, decontamination operators should collect and transport the removed soil processed into recycled materials separately from other materials.

For example, it is possible to load the removed soil processed into recycled materials in a dedicated container, or to load the removed soil processed into recycled materials into a transport container and transport it separately from other materials.

(3) Display of transport vehicle and provision of written materials

When transporting removed soil processed into recycled materials using a transport vehicle, the decontamination operator should display on the outside of the vehicle body a sign stating that the vehicle is being used to transport removed soil processed into recycled materials, as well as the name or company of the person carrying out the transport (The fact that the vehicle is used for transporting removed soil processed into recycled materials is indicated using letters of a size of 140 points or more as specified in JIS Z8305, and the name or company of the person carrying out the transport is indicated using letters of a size of 90 points or more in an easily identifiable color).

In addition, they are required to have on hand a document stating that they are a person who transports removed soil processed into recycled materials on consignment from decontamination operators, as well as a document stating the following items.

- The name or company and address of the person transporting the soil, and in the case of a corporation, the name of its representative
- The quantity of removed soil processed into recycled materials to be transported
- The date when the transportation began
- The name, location and contact details of the place where the removed soil processed into recycled materials to be transported is loaded and the place where it is to be transported to
- Items to be noted when handling the removed soil processed into recycled materials
- Items concerning emergency measures in the event of an accident

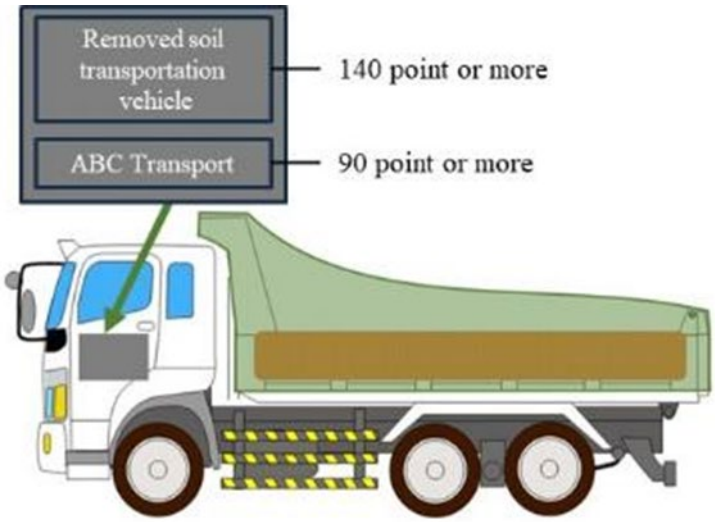



Figure 3-3 Indication on the outside of a transport vehicle body (example)

(4) Radiation protection measures

The transportation standards state that "necessary measures such as shielding should be taken so that the maximum value of the 1 cm dose equivalent rate at a distance of 1 meter from the front, back and both sides of the vehicle (or the vertical plane touching the outer contour of the vehicle in the case of an open-type vehicle) does not exceed 100 μSv/h.

On the other hand, the "Guidelines for the Collection and Transportation of Removed Soil" (May 2013, 2nd edition (September 2016, supplementary edition) Ministry of the Environment) states that even if removed soil with a high concentration of radioactive caesium (around 1 million Bq/kg) is loaded onto a relatively large transport vehicle, the maximum air dose rate 1 meter away from the vehicle will be less than 100 μSv/h, based on trial calculations. In addition, in the actual transportation of removed soil to the Interim Storage Facility, the air dose rate was measured at four locations: the front, back and both sides of the transport vehicle, from March 2015, when the transport of soil to the Interim Storage Facility began, to March of 2018. As shown in Figure 3-4, no vehicle was found to have an air dose rate exceeding 100 μSv/h. Therefore, since April 2018, only when the surface dose rate of the flexible container exceeds 30 μSv/h, we have confirmed that the air dose rate at a point 1 meter away from the vehicle does not exceed 100 μSv/h, and no vehicles have been confirmed to exceed 100 μSv/h.

Based on the above, it is thought that the air dose rate will not exceed the relevant dose rate when transporting removed soil processed into recycled materials with a radioactivity concentration of 8,000 Bq/kg or less for managed recycling, so it is not necessary to measure the air dose rate at a distance of 1 meter from the front, back and both sides of the transport vehicle (or the vertical plane touching the outer contour of the vehicle if it is an open-type vehicle). When removed soil with an average radioactivity concentration of 8,000 Bq/kg

is loaded onto a relatively large-sized transport vehicle, the air dose rate at a distance of 1 meter from the transport vehicle is estimated to be 0.72 μSv/h.

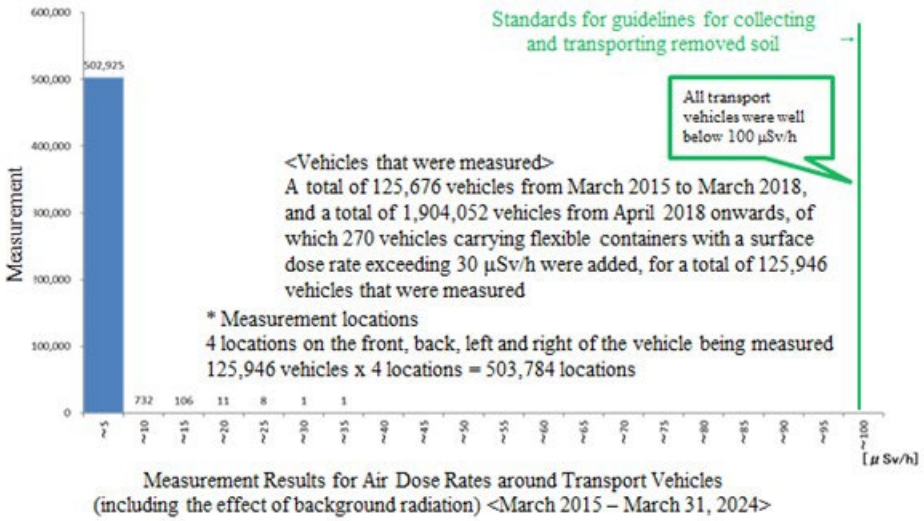



Figure 3-4 Measured air dose rates around transportation vehicles (March 2015 - March 2024)

When the series of transportation of removed soil processed into recycled materials is complete, the decontamination operator performs a screening of the vehicle as a safety precaution, in consideration of the possibility of transporting other materials afterwards, and may check that the surface contamination density of the vehicle (including the loading area and the area around the tires) is 1,300 cpm or less (when using a contamination inspection meter with a widely used incident window area of 20 $cm^2$, this is equivalent to 4 $Bq/cm^2$).

(5) On-site transportation

In cases where transportation is carried out within the same premises without using public roads, such as on-site transportation at a managed recycling site, decontamination operators should refer to the transportation standards and take care to prevent dispersal and runoff. Note that the display and documentation of transportation vehicles indicated in the transportation standards are not required. When loading and unloading removed soil processed into recycled materials, decontamination operators should take the same measures to prevent dust and dirt as during construction, such as spraying water when the soil is dry and windy, and wearing a mask when working in the vicinity of loading and unloading.

<Reference> Transportation Standards of the Act on Special Measures (Article 57 of the Enforcement Regulations of the Act on Special Measures)

- Ensure that the removed soil does not cause any damage to human health or the living environment.
- Take necessary measures to prevent the removed soil from scattering, spilling or leaking from the vehicle, such as storing it in a container.
- Take necessary measures to prevent rainwater from permeating, such as covering the surface of the removed soil with a waterproof sheet.
- Take necessary measures to prevent the preservation of the living environment from being disturbed by the bad odors, noise or vibrations caused by transportation.
- Separate the removed soil from other materials to prevent it from mixing with other materials.
- When establishing facilities for transportation, take necessary measures to prevent the preservation of the living environment from being disturbed.
- The transport vehicle and containers used for transport shall avoid scattering, spilling or leaking of removed soil and bad odors.
- When transporting removed soil using a transport vehicle, the following shall be implemented.
  - The following shall be displayed on the outside of the transport vehicle.

  (1) To indicate that the vehicle is being used to transport removed soil, and (2) The name or company of the person transporting the soil.
  - The items listed in (1) and (2) above must be displayed in easily identifiable colors, with (1) displayed in letters 140 points or larger in size and (2) displayed in letters 90 points or larger in size.
  - Take necessary measures to shield against radiation, ensuring that the maximum value of the dose equivalent rate at a distance of 1 meter from the front, back and sides of the vehicle does not exceed 100 microsieverts per hour.
  - Take necessary equipment for emergency measures in the event of an accident.
- Prepare the following records and keep them for five years from the day the transportation is completed.
  - Type of removed soil transported
  - The date when the transportation of each removed soil began and ended, the name and location of the place where it was loaded and the place where it was transported, and in the case of transporting removed soil using a transportation vehicle, the vehicle registration number or vehicle number of the relevant transportation vehicle
- In the case of transporting removed soil using a vehicle, the vehicle must be equipped with the documents specified in the following categories.
  - Entities such as the national government and those who transport removed soil on their behalf (referred to as “primary collection and transport consignee”):

  Documents certifying this and documents stating the following items (referred to as “required documents”)

  (1) The name and address of the entity transporting the soil, and in the case of a corporate body, the name of its representative
  (2) The quantity of removed soil to be transported
  (3) The date when transportation started
  (4) The name, location and contact details of the place where the removed soil to be transported is loaded and the place where it is transported to.
  (5) Items to be noted when handling removed soil.
  (6) Items related to emergency measures in the event of an accident.
  - A person whose name or title is stated in the contract for the consignment contract between an entity such as the national government and the primary collection and transport consignee as a person entrusted with the consignment work of the primary collection and transport consignee:

    A document certifying this, a document certifying that the person in charge is entrusted by the primary collection and transport consignee or another person whose name or title is stated in the contract, and a document stating the required items.

### 3.3.2 Points to be considered in transportation

Decontamination operators should pay full attention to traffic safety and other issues when transporting soil to managed recycling sites, coordinating with road administrators and other parties along the transport route. For example, it would be preferable to share information in advance with road administrators and other parties along the transport route about the transport route and rest areas. In addition, decontamination operators should explain to road administrators and other parties along the transport route in advance about the radiation safety of the soil being transported.

In light of the transportation of soil from temporary storage sites in various locations in Fukushima Prefecture to the Interim Storage Facility, the following measures, for example, are considered to be effective for safe transportation.

(Example)

- Transportation monitoring system (monitoring of transportation conditions, etc.)
  The location of the transportation vehicle is monitored on a real-time basis, and instructions are given in response to traffic conditions such as congestion and accidents.
- Pre-transportation training for drivers
  Training is provided in advance to raise the awareness of drivers about traffic safety and to enable them to drive appropriately in consideration of local road conditions, as well as how to respond in the event of an accident.

In addition, in preparation for accidents during transportation, decontamination operators should confirm the communication system with road administrators in advance. In the event of an accident during transportation, decontamination operators should measure the air dose rate in the surrounding area after ascertaining the condition of the removed soil processed into recycled materials, and then collect the removed soil processed into recycled materials. In addition, the decontamination operator should consult with the road administrator and other parties in advance regarding the specific measures of transport. After responding to the transport accident, the decontamination operator should measure the air dose rate in the surrounding area again.

For reference, the outline of the measures planned in the event of an accident during the transport of removed soil to the Interim Storage Facility is shown in “Reference Material 6: Preparing for and Responding to Accidents during the Transport of Removed Soil to the Interim Storage Facility”.

## 3.4 Construction Phase

When implementing managed recycling, decontamination operators should take appropriate measures to prevent dispersal and runoff as necessary, and also pay attention to the temporary storage of removed soil processed into recycled materials, etc.

The entity responsible for managed recycling is as described in "2.8 Involvement of Relevant Organizations, etc. (1) Entity Responsible for Managed Recycling" based on Article 41, Paragraph 1 of the Act on Special Measures, and the decontamination operator will be responsible for processing the removed soil into recycled materials, transporting it to the site of managed recycling, adjusting the quality as necessary, and covering the removed soil processed into recycled materials with soil or other materials to prevent dispersal or runoff. In addition, if it is reasonable to construct the covering of removed soil processed into recycled materials to prevent dispersal and runoff as part of the overall facility, it is possible to entrust the work, including measurement of air dose rates, to the operator of the structure, after consultation between the decontamination operator and the operator of the structure.

### 3.4.1 Precautionary measures during construction

(1) Measures to prevent dispersal and runoff

In cases that removed soil processed into recycled materials is not covered (e.g. during construction), the decontamination operator should take appropriate measures to prevent dispersal and runoff, such as covering with tarpaulins, sprinkling water during strong winds, and placing steel plates to prevent mud from being swept away, as necessary, in the same way as applied to the cases where the decontamination operator does not handle removed soil processed into recycled materials.


Figure 3-5 Examples of measures to prevent dispersal and runoff during construction work

(2) On-site storage of removed soil processed into recycled materials

When temporarily storing removed soil processed into recycled materials that has been transported to a site for managed recycling, decontamination operators should take the following points into consideration.

- Storage areas should be chosen to prevent scattering and runoff and should avoid hollows where rainwater tends to accumulate and areas with high groundwater levels. If there is a risk that the quality of the removed soil processed into recycled materials may be affected by rainwater infiltration or rising groundwater levels, measures to prevent rainwater and groundwater from infiltrating the soil may be considered, such as installing a drainage channel around the storage area.
- For example, measures such as placing traffic cones and stretching ropes may be considered to separate the temporary storage area for removed soil processed into recycled materials from other areas, and to indicate that it is a storage area using a signboard.
- Measures such as covering with sheets should be taken to prevent the removed soil processed into recycled materials from dispersal or running off.
- Measures such as covering with sheets or using sandbags to separate the removed soil processed into recycled materials from other materials, or separating the storage areas, should be taken to prevent the removed soil processed into recycled materials from mixing with other materials.

After storage is complete, the decontamination operator should measure the air dose rate at the storage site and compare it with the air dose rate before storage to confirm that there has been no significant increase.

(3) Precautions for workers handling removed soil processed into recycled materials

The radioactivity concentration of removed soil processed into recycled materials used in managed recycling is “8,000 Bq/kg or less”, which is outside the scope of the Ionizing Radiation Ordinance and other measures to prevent radiation damage (10,000 Bq/kg or less). Therefore, during construction and restoration in the event of a disaster, it is possible to respond within the scope of general work without requiring special protective measures.

As described in “2.2.1 Concept of Radiation Protection (3) Additional Radiation Exposure Assessment”, the additional radiation exposure dose (external exposure) of workers at the center of the embankment was the highest, and the additional radiation exposure dose when the radioactivity concentration of the removed soil processed into recycled materials was 8,000 Bq/kg resulted in 0.93 mSv/year. (See “Reference Material 5: List of Evaluation Parameters for Additional Radiation Exposure Calculations”)

<Results of additional exposure assessment calculation (under construction)>
(The figures in red are the additional exposure doses in the case where the radioactivity concentration of the removed soil processed into recycled materials is 8,000 Bq/kg)

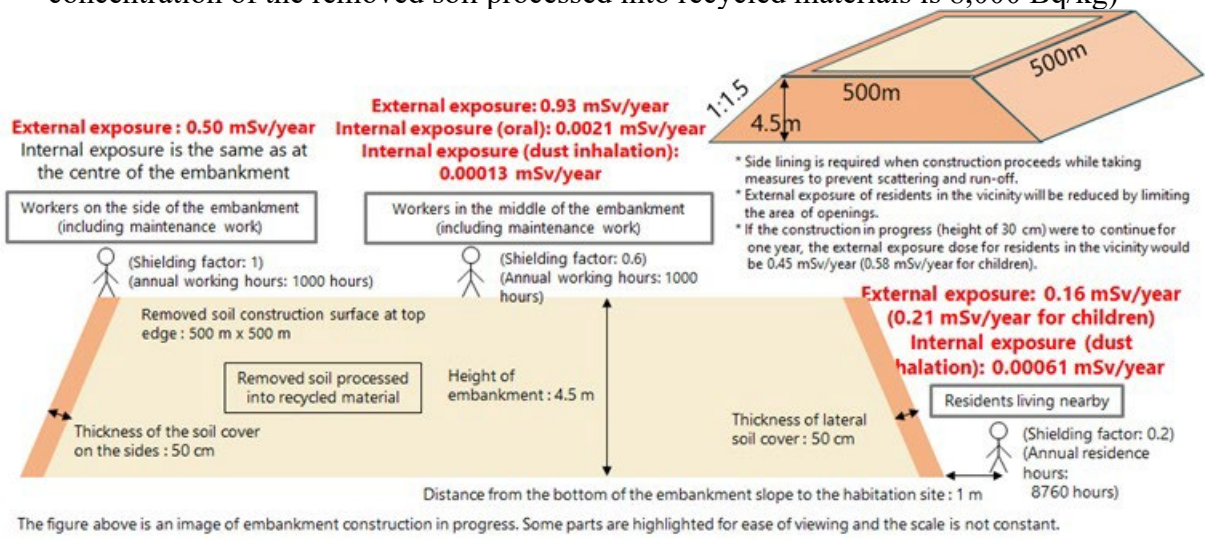



Fig.3-6 Results of additional exposure assessment calculation (under construction)

As mentioned above, radiation hazard prevention measures under the Ionizing Radiation Ordinance and other measures do not apply, but decontamination operators will consider further reducing the additional exposure dose of workers from the perspective of optimizing protection, as described in "2.2.1 Concept of Radiation Protection (1) Annual Additional Exposure Dose and Radioactivity Concentration of Removed Soil". In addition, since workers involved in managed recycling are not subject to the Ionizing Radiation Ordinance, and their additional exposure dose is generally 1 mSv/year or less, they are treated as members of the general public. However, since it is also possible that they will be working in close proximity to removed soil processed into recycled materials, decontamination operators should explain to workers in advance that the soil they will be using contains radioactive materials and that it is desirable to avoid unnecessary exposure. It is also possible for decontamination operators to explain to workers that it is possible to understand the radiation dose in the work environment by measuring the air dose rate during construction, and that it is possible to understand the additional radiation dose of workers by having a representative of the workers carry a personal dosimeter. Based on the results of the explanation to the workers, the decontamination operator will consult with the operator of the structure and consider the necessary measures. In addition, the decontamination operator will measure the air dose rate to determine the background level before the managed recycling work (before construction) and predict the additional exposure dose of the workers based on the results of the measurement of the radiation dose during construction, and confirm that the additional exposure dose of the workers is 1 mSv/year or less.

In addition, in the case that the work is subject to specific dose work (work other than "Decontamination and Other Duties" carried out in place where the

air dose rate in special decontamination areas, etc. exceeds 2.5 $\mu$ Sv/h due to radioactive materials discharged by the accident) specified in the “Ordinance on Prevention of Ionizing Radiation Hazards at Work to Decontaminate Soil and Wastes Contaminated by Radioactive Materials Resulting from the Great East Japan Earthquake and Related Works (Ordinance of the Ministry of Health, Labor and Welfare No. 152 of 2011)”, the decontamination operator shall implement radiation exposure control for workers in accordance with the said Ordinance.

## 3.5 Operation and maintenance phase

In the case of managed recycling, decontamination operators will carry out operation and maintenance with care taken to ensure that the function of the covering, such as the covering of soil, is maintained.

As stated in “2.8 Involvement of Relevant Organizations (1) Responsible entity for Managed Recycling” based on Article 41, Paragraph 1 of the Act on Special Measures, the decontamination operator has management responsibility for the removed soil processed into recycled materials and the covering materials used to prevent dispersal and runoff, but in some cases, it may be possible to outsource operation and maintenance to the facility manager, in consultation with the facility manager in advance, if it is deemed reasonable to manage the facility as a whole.

### 3.5.1 Precautions for Operation and Maintenance

(1) Operation and maintenance

As the removed soil processed into recycled materials and the covering (Layer A) to prevent dispersal and runoff are located inside the layer (Layer B) that takes into account the necessary functions according to the use of the managed recycling sites, the function of the covering is confirmed by visually checking the condition of Layer B from the outside during inspections and other operation and maintenance by the decontamination operator.

Decontamination operators' inspections are likely to be carried out in conjunction with the measurement of air dose rates described in “2.4 Measurement of air dose rates (during construction and operation and maintenance)”.

In addition, facility managers should contact decontamination operators if they discover any abnormalities in the range of facilities where removed soil processed into recycled materials is used during their regular facility inspections and patrols.

In the case where the operation and maintenance of facilities is outsourced to the facility manager, it is possible that the facility manager will visually check the condition of the facilities where removed soil processed into recycled materials is used during the regular facility inspections and patrols. The facility manager will provide the decontamination operator with the results of the visual checks of the condition of the facilities where removed soil processed into recycled materials is used.

(2) Actions such as excavation and landform modification.

The managers of facilities (including farmers in agricultural land) and decontamination operators should not, in principle, carry out actions such as

excavation or landform modification in order to prevent scattering and runoff of removed soil processed into recycled materials. If it becomes necessary to excavate or make modifications, the facility manager and decontamination operator should consult with each other in advance and take appropriate measures as necessary.

In the case of agricultural land, it is possible to use some of the soil cover, in order to prevent dispersal and runoff, on the condition that the function of preventing dispersal and runoff is maintained.

3.5.2 Response in the event of an emergency

In the event of damage to facilities, where removed soil processed into recycled materials is used, due to natural disasters such as earthquakes or heavy rain, restoration measures will be taken based on the content of the consultation between the decontamination operator and the facility manager.

In accordance with Article 41, Paragraph 1 of the Act on Special Measures, the decontamination operator is responsible for managing the removed soil processed into recycled materials and the covering materials used to prevent dispersal and runoff, and will restore these areas in the event of damage. From the perspective of early recovery, decontamination operators may consider entrusting the facility manager with the inspection of abnormalities, emergency and full recovery of the cover (Layer A) and the removed soil processed into recycled materials, after consulting with the facility manager in advance.

The radioactivity concentration of the removed soil processed into recycled materials used in managed recycling (8,000 Bq/kg or less) is outside the scope of the ionizing radiation regulations and other measures to prevent radiation damage (10,000 Bq/kg or less), so it can be handled within the scope of normal operations without the need for special protective measures when surveying the damaged areas or carrying out emergency or full restoration.

As stated in “2.2.1 Concept of Radiation Protection (3) Additional Radiation Exposure Assessment”, the results of the additional radiation exposure assessment (in the event of a disaster) were that the external radiation dose for restoration workers on the embankment was 0.93 mSv/year, and the external radiation dose for residents in the surrounding area was 0.75 mSv/year (0.97 mSv/year for children). (See “Reference Material 5: List of Evaluation Parameters for Additional Radiation Exposure Calculations”)

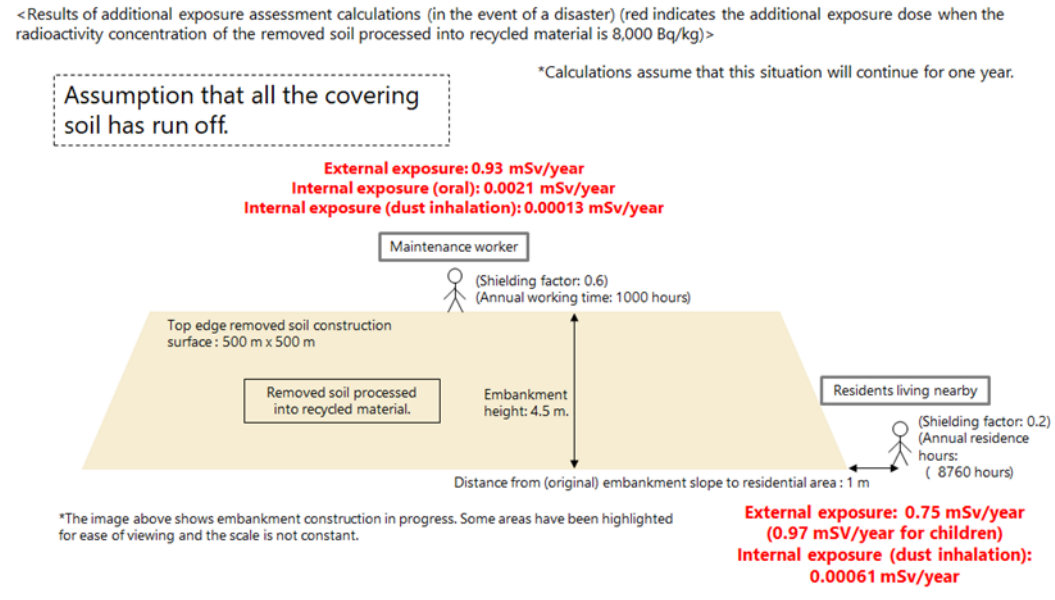



Fig.3-7 Results of additional exposure assessment calculation (in the event of disaster)

In the event of damage occurring at facilities where removed soil processed into recycled materials is used, the following flow is generally assumed. The following describes the response and precautions to be taken in the event of an emergency, in accordance with this flow. The response described below is to be carried out by the facility manager (if the decontamination operator does not outsource the inspection, emergency restoration and full restoration to the facility manager, these responses are to be carried out by the decontamination operator).

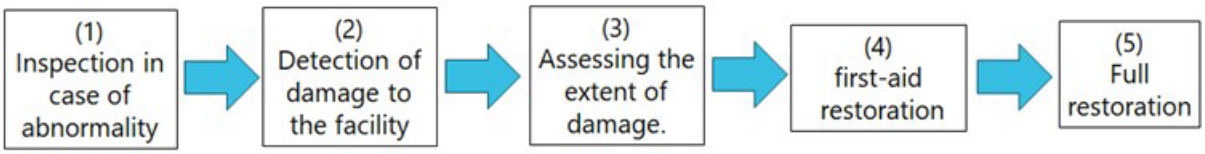



Figure 3-8 Disaster response flow

(1) Inspection in the event of an emergency

In the event of an earthquake or heavy rain, an inspection will be carried out in the event of an emergency.

(2) Detection of damage to facilities and equipment.

In addition to the inspection in the event of an emergency described in (1) above, it is assumed that damage will be detected in the range of facilities and equipment where removed soil processed into recycled materials is used, through inspections and patrols carried out during normal operation and maintenance by facility and equipment managers and decontamination operators, and through reports from third parties.

If damage to a facility and equipment is discovered in these cases, the extent and depth of the damage will be investigated in the same way as if a facility that does not use recycled soil had been damaged. If the decontamination operator discovers damage (including cases where a third-party reports damage to a facility to the decontamination operator), the decontamination operator will promptly contact the facility manager.

(3) Determining the extent of the damage

If the damage to the facility and equipment is detected in (2), determine whether the area of damage extends to the layer for preventing scattering and runoff or the layer of removed soil processed into recycled materials, using methods such as the following.

(Example)

- Determine by investigating the depth of damage at the site and comparing it with the as-built drawings.
- By comparing the air dose rate at the damaged area with the background value (the result of past monitoring of air dose rates) and the air dose rate at undamaged areas.

Based on the assessment results of the extent of the damage, the decontamination operator and the facility manager will consult emergency restoration and full restoration.

(4) First-aid restoration

As a result of '(3) determining the extent of the damage', if the area damaged extends to the layer to prevent dispersal and runoff or the removed soil processed into recycled materials*, the air dose rate will be measured at least once every seven days, both before first-aid restoration begins and during construction, to confirm safety for the surrounding area. The results of the measurements will be shared with the decontamination operator, who will then make the measured results public.

* If the area damaged does not extend to the layer that prevents dispersal and runoff, there is no need to measure the air dose rate.

In addition, it is assumed that removed soil processed into recycled materials due to the disaster may mix with the soil used for covering or the surrounding soil and be washed away, making it difficult to separate. In this case, the entire soil that has become difficult to separate is considered to be a unit of removed soil processed into recycled materials. The removed soil processed into recycled materials is collected and stored on-site or elsewhere, as agreed in advance between the facility manager and decontamination operator. Transportation to the storage location on-site or elsewhere is carried out in accordance with “3.3 Transportation”. For information on temporary storage, see “3.4.1 Points to note during construction”.

After collecting the unit of removed soil processed into recycled materials, first-aid restoration of the damaged facility is carried out. After the first-aid restoration is complete, measure the air dose rate and confirm that there are no abnormalities.

(5) Full restoration

In the same way as for the first-aid restoration, if the area damaged extends to the layer for preventing dispersal and runoff or the removed soil processed into recycled materials*, measure the air dose rate at least once every seven days while carrying out the full restoration. Share the results of the measurements with the decontamination operator, and the decontamination operator will make the measured results public.

* If the area damaged does not extend to the layer for preventing scattering and runoff, there is no need to measure the air dose rate.

If the unit of removed soil processed into recycled materials is temporarily stored during first-aid restoration, it should be used as much as possible as a material for the full restoration. If it is unavoidable and the unit of removed soil processed into recycled materials cannot be used, the decontamination operator will take responsibility for dealing with it. When using the unit of removed soil processed into recycled materials for the main restoration, the work should be carried out in accordance with “3.4.1 Precautions for Construction” and the unit of removed soil processed into recycled materials should be covered as described in “2.3 Preventing dispersal and runoff”.

After the main restoration is complete, the air dose rate should be measured to confirm that there are no abnormalities.