2. Overview of decontamination methods

As explained in the previous chapter, the Act on Special Measures Concerning the Handling of Environmental Pollution by Radioactive Materials Discharged by the Nuclear Power Station Accident Associated with the Tohoku District Off the Pacific Ocean Earthquake That Occurred on 11 March 2011 (hereafter referred to as the "Act on Special Measures") designated the Special Decontamination Areas for the National Government to decontaminate and the Intensive Contamination Survey Areas for the local municipalities to decontaminate. In order to achieve the additional exposure dose of 1 mSv/y or less as the long-term goal, the decontamination was planned to be implemented in the following order.

(i) Investigate and measure the status of contamination and designate the areas in which decontamination and other measures are to be implemented (Articles 34 and 36)
(ii) Formulate the decontamination plan and implement decontamination based on the plan (Article 40)
(iii) Collect, transfer and store the removed soil, generated by the decontamination and related works (Article 41)

The Ministry of the Environment (MOE) formulated the "Decontamination Guidelines (1st Edition)" in December 2011 to explain these processes in a concrete manner. The guidelines are divided into the following four parts and each part corresponds to one of the above (i) to (iii).

- Part 1: Guidelines for the Methods for Investigation and Measurement of the Status of Environment Pollution in the Intensive Contamination Survey Areas (corresponding to (i))
- Part 2: Guidelines Pertaining to Decontamination and Other Measures (corresponding to (ii))
- Part 3: Guidelines Pertaining to the Collection and Transfer of Removed Soil (corresponding to (iii))
- Part 4: Guidelines Pertaining to the Storage of Removed Soil (corresponding to (iii))

While the guidelines mainly cover the decontamination by municipalities, they also cover decontamination by the National Government. Decontamination in accordance with these guidelines is deemed to be appropriate for the situations found in Japan.

The guidelines were revised in May 2013. Further, a supplement was added in December 2014 based on the opinions of specialists and local governments and it included the responses to improper decontamination, ways for conducting more effective decontamination, as well as giving the knowledge obtained and the new technologies made available since December 2011.

The four parts are outlined and explained below based on the revised 2nd Edition[77].

2.1. Guidelines for Methods for Investigation and Measurement of the Status of Environmental Pollution in the Intensive Contamination Survey Area

2.1.1. Basic Concept

The "Guidelines for Methods for Investigation and Measurement of the Status of Environmental Pollution in Intensive Contamination Survey Areas" corresponds to Part 1 of the Decontamination Guidelines. As shown in Figure 2-1, this part explains the following items: (i) the investigation and measurement of the status of environmental pollution by the accident-derived radioactive materials in the Intensive Contamination Survey Areas; (ii)

[77]Source: Ministry of the environment (MOE), "Decontamination Guidelines (2nd Edition)" (supplement added, December 2014) (http://josen.env.go.jp/material/pdf/josen-gl-full_ver2_supplement1412.pdf) Fig.2-1 to Fig.2-41 and Table 2-1 to Table 2-57 are from the same source.

details of the measurement methods necessary for decontamination and related works, and storage of removed soil in the decontamination implemented areas; and (iii) the methods for determining accuracy of measurement.

Measurements are needed to determine the appropriate decontamination measures and to monitor storage sites of removed soil as mentioned above, and in this context they also relate to other parts of the Decontamination Guidelines. This correlation is illustrated in Figure 2-2.

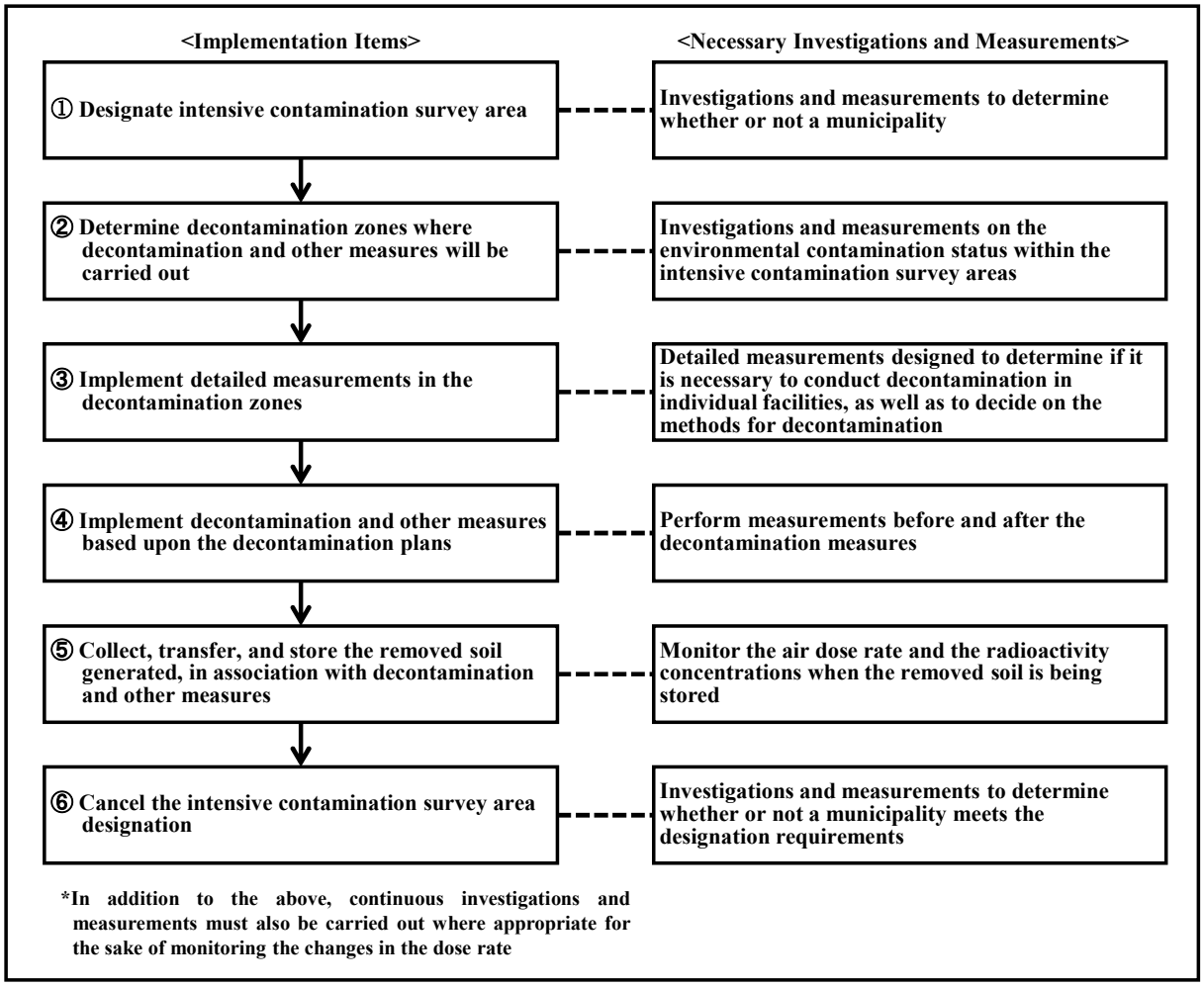
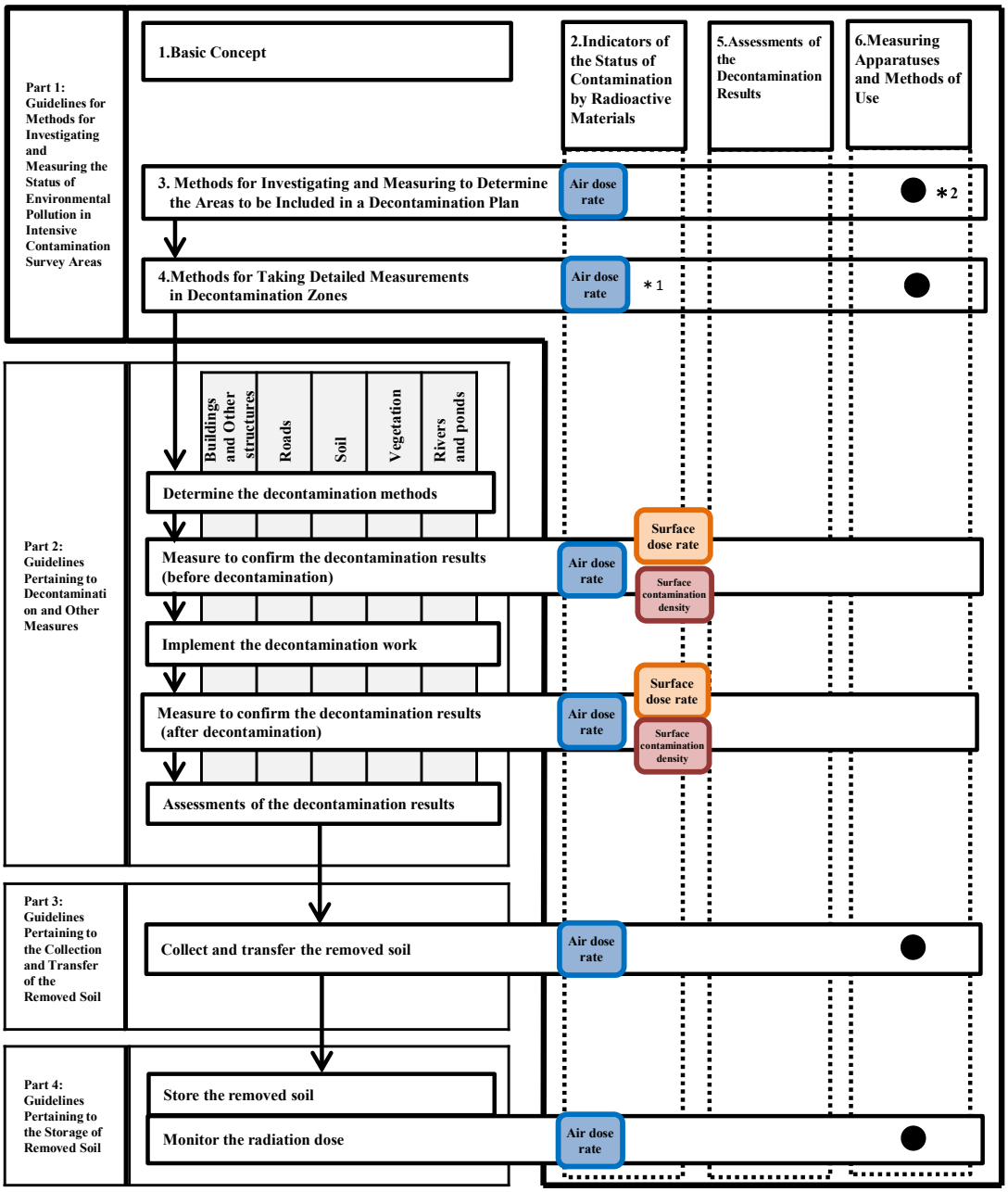


Figure 2-1 Implementation items and necessary investigations and measurements for carrying out decontamination.



*1: If "4. Detailed Measurements in Decontamination Zones" concurrently serve as "Measure to confirm the decontamination results (before decontamination)", then measurements of surface dose rate and surface contamination density shall also be performed.
*2: Those parts related to "5. Assessments of the Decontamination Results" and "6. Measuring Apparatuses and Methods of Use" are indicated with a "● "

Figure 2-2 Descriptive actions related to measurements in the Decontamination Guidelines

2.1.2. Indicators of the Contamination Status by Radioactive Materials

The indicators of the contamination status by radioactive materials use the air dose rates as the indicators of the contamination status in the living environment and the surface contamination densities and surface dose rates as the indicators of the contamination status of the objects subject to decontamination in order to grasp the contamination status by radioactive materials. Table 2-1 summarizes the indicators together with measurement methods.

Table 2-1 Summary of indicators of the contamination status by radioactive materials

<table>
<tr><td>Assessment perspectives</td><td>Status of contamination in living spaces</td><td colspan="3">Status of contamination of objects subject to decontamination</td></tr>
<tr><td>category</td><td>No. 1 measurement points(①)</td><td colspan="3">No. 2 measurements points(②)</td></tr>
<tr><td>Measurement objective</td><td>• Determine the decisions of decontamination zones
• Determine if it is necessary to conduct decontamination within individual facilities in the decontamination zones through detailed measurements in the zones(determine by using mean dose rate)
• Determine the comprehensive results of the decontamination within the individual facilities from the decontamination and other measures (however, attention must be paid to the fact that this is affected by background radiation*3)
• Monitor the radiation dose when the removed soil is stored</td><td colspan="3">• Determine the scope for the decontamination in individual facilities and determine the amount of radioactive materials (extent of the contamination) in conjunction with the detailed measurements carried out within the decontamination zones
• Confirm the degree to which the contamination of the objects subject to decontamination has abated due to the decontamination and other measures</td></tr>
<tr><td rowspan="2">Indicator (measurement position)</td><td rowspan="2">Air dose rate (1 m*1)</td><td rowspan="2">Surface contamination density (1 cm)</td><td colspan="2">Surface dose rate (1 cm)</td></tr>
<tr><td>Use a collimator</td><td>Vary the distance and measure*2</td></tr>
<tr><td>Examples of measuring apparatus</td><td>• NaI scintillation survey meter
• CsI scintillation survey meter</td><td>GM survey meter</td><td colspan="2">• NaI scintillation survey meter
• CsI scintillation survey meter</td></tr>
<tr><td>Methods for using the measurement results</td><td>• Determine the decontamination zones
• Assess the improvements in the contamination status in living spaces through the decontamination work</td><td colspan="3">• Determine the decontamination methods
• Assess the extent to which the radioactive materials have abated through the decontamination work</td></tr>
</table>

*1: For the contamination status in living spaces, in principle, measurements should be taken at a height of 1 m from the ground (it would also be fine to measure at a height of 50 cm at elementary and lower level schools, as well as special-needs schools, with consideration for the living spaces of infants and schoolchildren in the lower grades).

*2: The surface dose rate of the target object is to be measured at positions at the object's surface and at heights of 50 cm and 1 m, and then the measured values are to be compared.

2.1.3. Methods for Investigation and Measurement to Determine the Areas to be Included in a Decontamination Plan

（1） Basic concept

The methods for investigation and measurement to determine the areas to be included in the decontamination plan stipulate that the decontamination areas (areas to be included in a decontamination plan) are in principle divided by the unit of zones such as an a village section, a municipal block, or other units, where the dose rate is 0.23 μSv/hour[78] or higher, which is the condition for decontamination planning. But regarding the living environment for children, such as schools and parks, it is allowed to divide the decontamination zones based on each facility rather than on an area such as municipal blocks.

（2） Methods for investigation and measurements by zone units

The methods for investigation and measurements by zone units are used to judge whether a zone meets the decontamination planning requirements and then to select suitable measurement methods based on the judgement. Two examples are given. The first is based on the measurement results at various points (Figure 2-3) and the second is based on the measurement results at schools and in parks (Figure 2-4).

1）Designation based on the measurement results at various points

- Specific locations and number of points for measurement in a zone are first chosen in consideration of the following points, depending on the form of existing land use and the situation of the surrounding.
  - ✓ The locations of measurement are chosen in a manner that the general tendency in the zone can be represented.
  - ✓ Special locations such as the base area of trees, street drains and other locations where high dose rates may be recognized should not be chosen, because the measurements are intended to grasp the average dose rate in the zone.
  - ✓ More locations should be chosen in a living space where, for instance, there are many buildings.
  - ✓ Investigations and measurements may not always be needed in zones where people's exposure dose cannot be naturally reduced, such as forests.
  - ✓ Efficient investigations and measurements should be employed as needed, for example, measurements by using monitoring vehicles.
- Once the measurements are completed at all points in the zone, the average dose rate of the zone is calculated based on all the results of the zone.
- Based on the average dose rate, the judgment is derived whether that zone meets the decontamination planning requirements.

[78]The air dose rate per hour which is equivalent to the additional annual exposure dose per year of 1 mSv. This is calculated as follows: 0.19 μSv/h×（8 h＋0.4×16 h）×365 days= 1 mSv per year. The dose rate of 0.4 μSv/h due to exposure from the ground is added to 0.19 μSv/h and then air dose rate per hour of 0.23 μSv is obtained. (Refer to "Basis of the additional annual exposure dose of 1 mSv per year" (October 10, 2011): The first joint review meeting of the environment restoration review committee and the hazardous waste safety evaluation review committee.)

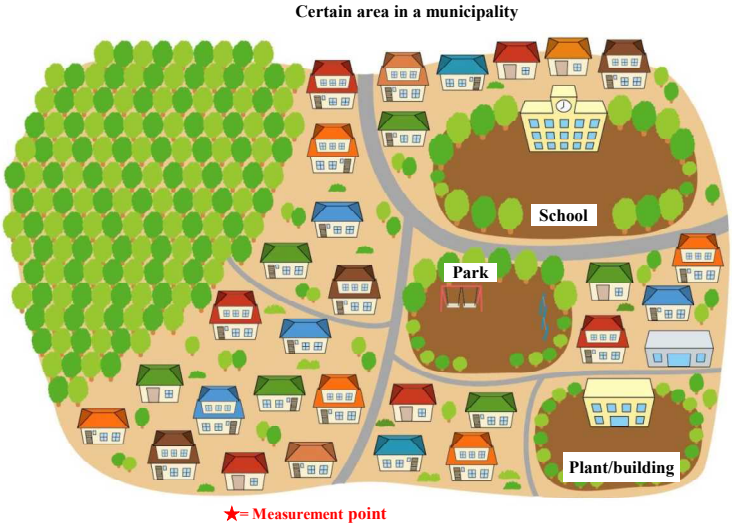


Figure 2-3 Example of the determination of whether the area meets the decontamination planning requirements based on the measurement results at various points.

2) Designation based on the measurement results at schools and in parks

- Specific locations and number of points for measurement in a zone are first chosen in consideration of the following points.
  - ✓ Measurements are to be made mainly in the living environment of children, such as schools and parks in the zone.
  - ✓ Special locations such as the base area of trees, street drains and other locations where high dose rates may be recognized should not be chosen, because the measurements are intended to grasp the average dose rate in the zone.
  - ✓ Measurements are to be done at about five points in each school or park.
- Once the measurements are completed at all points in the zone, the average dose rate of the zone is calculated based on all the results of the zone.
- Based on the average dose rate, the judgment is derived whether that zone meets the decontamination planning requirements

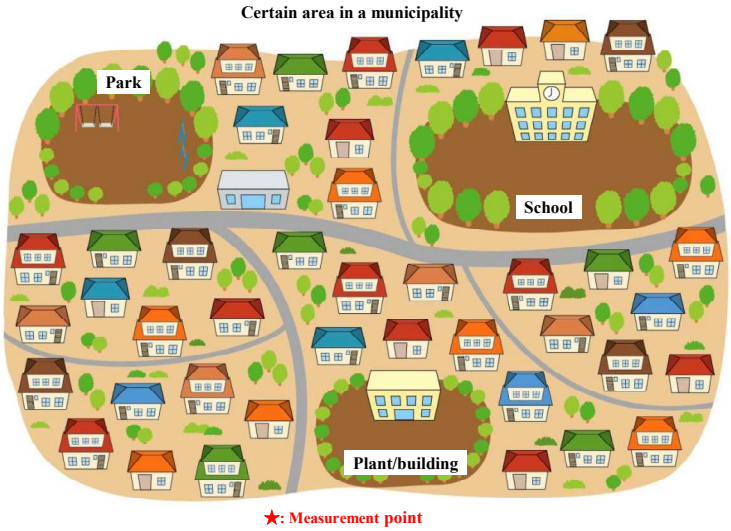


Figure 2-4 Example of the determination of whether the municipal area meets the decontamination planning requirements based on the measurement results for schools and parks.

（3） Methods for investigation and measurement of the living environment of children, such as schools and parks

Concerning the living environment for children such as schools and parks, it is allowed to designate a decontamination planning zone on a facility basis, as mentioned in (1) above. This subsection presents the decision criteria to judge whether each facility (zone) meets the planning requirements (Figure 2-5).

- Specific locations and number of points for measurement in a facility are first chosen in consideration of the following points.
  - ✓ Special locations such as the base area of trees, street drains and other locations where high dose rates may be recognized should not be chosen, because the measurements are intended to grasp the average dose rate in the facility.
  - ✓ Measurements are to be done at about five points in each facility.
- Once the measurements are completed at all points in the facility, the average dose rate of the facility is calculated based on all the results of the facility.
- Based on the average dose rate, the judgment is made whether that facility meets the decontamination planning requirements.

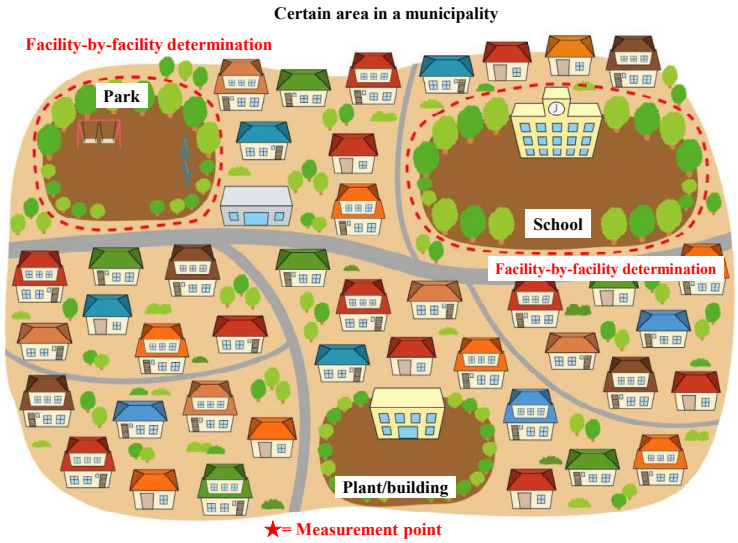


Figure 2-5 Example of the determination of whether the area meets the decontamination planning requirements based on the measurement results only from facilities used by children, such as schools and parks.

2.1.4. Methods for Taking Detailed Measurements in Decontamination Zones

The methods for detailed measurements in decontamination zones elaborates on the things to record in the measurements in detail. It also stipulates that the detailed measurements be included as part of the pre-decontamination work measurements.

The locations to be decontaminated and decontamination methods are described in Section 2.2, “Guidelines Pertaining to Decontamination and Other Measures”, and are not explained here.

2.1.5. Evaluation of Decontamination Results

The evaluation of decontamination results stipulates that the decontamination results can largely be evaluated by two ways: evaluation of air dose rates in the living environments in the decontamination zone as a whole and the individual targeted facilities; and evaluation of surface concentration densities of the objects subject to decontamination in the individual decontamination works. The former evaluation is expressed in terms of reduction rate of the air dose rate, while the latter evaluation may be expressed in terms of decontamination factor (DF) as well as the reduction rate.

Reduction rate [%] = (1- Radiation dose after decontamination ／Radiation dose before decontamination)×100

Decontamination factor [-] = Surface contamination density before decontamination／Surface contamination density after decontamination

2.1.6. Measuring Devices and Methods of Use

The measuring devices and methods of use explains the measurements necessary for the whole scope of activities covered by the Decontamination Guidelines, including not only the measurements for formulating decontamination plans but also measurements for confirming the results of radiation reduction through the decontamination works and other relevant measurements.

（1） Measuring devices and methods of use

Among the measuring devices and methods of use, scintillation survey meters (scintillation counters) are used for dose rate measurement and GM survey meters (GM counters) are used for surface contamination density measurement.

（2） Maintenance of measuring devices

Regarding maintenance of measuring devices, users should note that the measuring devices may give incorrect readings for such reasons as changes in the sensitivity of detectors caused by the measuring environment or degradation of any components in the electrical circuit. It is stressed that the measuring devices should be periodically calibrated and adjusted.

（3） Methods of use of measuring devices

The methods of use of measuring devices identifies the precautions to be taken for measurements using scintillation survey meters and GM survey meters, as summarized in Table 2-2. Furthermore, examples of the format of recording sheets for measurements are presented in Figure 2-6 and Figure 2-7.

Table 2-2 Summary of measuring devices and methods of use

<table>
<tr><td>Category</td><td colspan="2">No. 1 measurement point (①)</td><td colspan="2">No. 2 measurement point (②)</td></tr>
<tr><td>Purpose of measurements</td><td colspan="2">Contamination status of living spaces</td><td colspan="2">Contamination status of objects subject to decontamination</td></tr>
<tr><td>Object measured</td><td colspan="2">Gamma rays</td><td>Gamma rays</td><td>Beta rays</td></tr>
<tr><td>Examples of measuring apparatuses</td><td colspan="3">• NaI scintillation survey meter
• CsI scintillation survey meter</td><td>GM survey meter</td></tr>
<tr><td>Calibration</td><td colspan="4">• Measuring apparatuses shall be calibrated at least once a year in accordance with JIS.(Agent performing the calibration work)
• Businesses registered in accordance with the Measurement Act
• Measuring apparatus manufacturer</td></tr>
<tr><td>Daily check</td><td colspan="4">• The remaining battery level, breakage of cables and connectors, and status of high voltage application shall be checked, and inspections of switch operability, etc. shall be carried out.
• Measurements shall be performed at the same places where the background radiation does not vary substantially, and it shall be confirmed that there are no large variations by comparing with past values.
• If it is difficult to perform the calibrations more than once a year as described in the above section, this can be substituted by a method (adjustment) to compare the results with those obtained in the same location where measurements were also taken by using a separate measuring apparatus that has been fully calibrated and checked (this excludes GM survey meters).</td></tr>
<tr><td>Prevention of contamination</td><td colspan="4">• The body and detecting element of the measuring apparatus shall be preferably covered with a thin plastic sheet, etc.
• The plastic sheet, etc. shall be replaced with new material when it gets dirty or breaks.</td></tr>
<tr><td>Measurement</td><td colspan="2">• The air dose rate shall be measured at a height of 1 m from the ground.
• The air dose rates on roads and pedestrian overpasses near schools may be measured at a height of 50 cm from the ground for elementary schools and below, as well as special-needs schools, with consideration for the living space of infants and schoolchildren in the
• Lower grades.</td><td>[Using a collimator]
• The air dose rate shall be measured at a height of roughly 1 cm (a height where about one finger will fit between the detector element and the measurement point) from the surface of the measurement point while using a collimator to shield against external gamma rays.
[Measurements by varying the distance]
• The air dose rate shall be measured from</td><td>• Measurements shall only be taken roughly1 cm away from the surface.</td></tr>
</table>

		positions on the surface and at heights of 50 cm and 1 m away from it, and the measured values shall be compared.	
	• Prior to measurement, it shall be confirmed whether the background value of the measuring apparatus is being displayed abnormally (no indicators appear, or indicators are unusually high or low). • When measuring the air dose rate, the measurements shall be taken with the detecting element parallel to the ground surface and as far away as possible from the body. • The power to the measuring apparatus shall be turned on and the reading (measured value) shall be read off after waiting until the reading stabilizes. In doing so, with measuring apparatuses on which a time constant can be set, the measurer shall wait until a period of time that is three times longer than the time constant has elapsed before performing the measurements. • If the readings on the measuring apparatus disappear, switch the range and take the measurements, and if the readings disappear in the maximum range, either interpret those readings as being in the maximum range or higher, or use another type of measuring apparatus to take the measurements. • If readings vary, the average value shall be read.		
Records	The measurer shall record the air dose rate, etc. at each measurement point shown in the conceptual diagram, etc., along with the date and time of measurement and the measuring apparatus used (see Figures 1-14 through 1-18).		

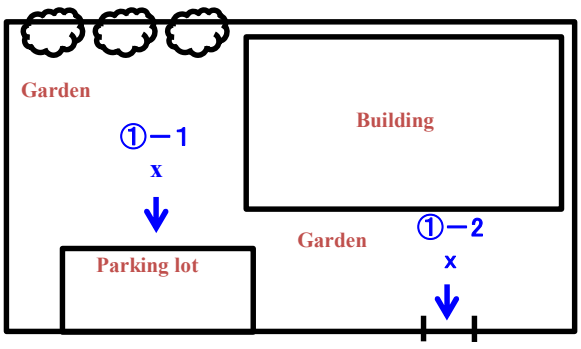
Manufacturer: Mode	City: Town: District:
Measuring apparatus	Manufacturer: Model:

Measurement Status Entry Column		
	Before Decontamination	After Decontamination
Date measured	Mon., April 22, 2013	Fri., April 26, 2013
Time measured	9:20~9:40	13:20~13:40
Measurer	Josen Taro	Josen Taro
Weather	Cloudy	Clea

Air Dose Rate Measurement Results Entry Section						
	Before Decontamination		Measurement height	After Decontamination		Measurement height
①-1 measurement point	3.0	μSv/h	(1m) 50cm	0.51	μSv/h	(1m) 50cm
①-2 measurement point	0.55	μSv/h	(1m) 50cm	0.16	μSv/h	(1m) 50cm
①-3 measurement point		μSv/h	1m 50cm		μSv/h	1m 50cm
①-4 measurement point		μSv/h	1m 50cm		μSv/h	1m 50cm
①-5 measurement point		μSv/h	1m 50cm		μSv/h	1m 50cm
①-6 measurement point		μSv/h	1m 50cm		μSv/h	1m 50cm
①-7 measurement point		μSv/h	1m 50cm		μSv/h	1m 50cm
①-8 measurement point		μSv/h	1m 50cm		μSv/h	1m 50cm
①-9 measurement point		μSv/h	1m 50cm		μSv/h	1m 50cm
①-10 measurement point		μSv/h	1m 50cm		μSv/h	1m 50cm
Notes						

Schematic Diagram of Air Dose Rate Measurement Points

(Example)



*The arrows indicate the direction of the measurements.

Figure 2-6 Entry sample of an air dose rate record sheet.

Manufacturer: Mode				City: Town: District:			
Measuring apparatus				Manufacturer: Model:			

Measurement Status Entry Column							
	Before Decontamination			After Decontamination			
Date measured	Day: ( ) Month: Year			Day: ( ) Month: Year			
Time measured							
Measurer							
Weather							
Air Dose Rate Measurement Results Entry Section							
	Before Decontamination		Collimator	After Decontamination		Collimator	
①-1 measurement point		cpm	Yes No		cpm	Yes No	
①-2 measurement point		cpm	Yes No		cpm	Yes No	
①-3 measurement point		cpm	Yes No		cpm	Yes No	
①-4 measurement point		cpm	Yes No		cpm	Yes No	
①-5 measurement point		cpm	Yes No		cpm	Yes No	
①-6 measurement point		cpm	Yes No		cpm	Yes No	
①-7 measurement point		cpm	Yes No		cpm	Yes No	
①-8 measurement point		cpm	Yes No		cpm	Yes No	
①-9 measurement point		cpm	Yes No		cpm	Yes No	
①-10 measurement point		cpm	Yes No		cpm	Yes No	
Notes							

Schematic Diagram of Air Dose Rate Measurement Points

Figure 2-7 Example of a surface contamination density record sheet.

2.2. Guidelines Pertaining to Decontamination and Other Measures

2.2.1. Basic Concept

（1） Role of the Guidelines

The Decontamination Guidelines use example cases to explain in a concrete fashion the Ordinance of the Ministry of the Environment (MOE) pertaining to standards for the measures for decontamination of the soil, etc. provided in Article 40, Paragraph 1 of the Act on

Special Measures.

Each municipality will formulate a decontamination plan based on prioritization and feasibility in light of the actual conditions in individual areas. Appropriate decontamination methods will be selected as needed from among those listed in these guidelines to advance the decontamination work based on individual decontamination plans.

At present, the methods given in these guidelines are deemed to be appropriate for implementing decontamination and related procedures, but decontamination work and new technologies are currently being developed and verified by various stakeholders. These guidelines will be revised as needed in light of trends in the development and verification of this knowledge and these technologies.

（2） Important points in implementing decontamination and other measures

This section explains the four aspects that are important in implementing decontamination measures. The radioactivity of radioactive materials decays naturally as time passes. In addition, the appropriate responses must be taken by fully considering the changes in the contamination status as a result of factors like the radioactive materials migrating due to rainwater and other factors.

- Measures shall be taken to prevent dispersion and outflow, as well as offensive odors, noise, and vibrations, and records of the quantities of removed soil and other necessary measures should be taken with respect to preserving of health of surrounding residents and conserving the living environment.
- To effectively reduce the radiation doses due to contamination, those locations that are contaminated at comparatively high concentrations that contribute substantially to the radiation dose must be identified, and appropriate methods of decontamination must be used in accordance with the characteristics of the contamination. The effectiveness of these methods must also be confirmed by measurements before and after the decontamination to effectively reduce the radiation doses in the living environment.
- The removed soil, etc. must be separated from other objects to ensure that there is no danger that it mixes with other objects, and the removed soil must also be separated from other decontamination wastes to the extent possible.
- It is important to strive to minimize the quantity of removed soil, etc. generated during decontamination. It is also important to ensure that the contamination does not spread as a result of the decontamination work. For example, washing activities using water produce drainage that contains radioactive materials. The workers carrying out decontamination and other measures should, to the extent possible, remove in advance those radioactive materials that can be removed by methods other than washing with water, properly treat wastewater, and find other ways to avoid affecting outflow destinations due to cleaning, etc. as much as possible. Moreover, periodic monitoring should be performed after the applicable measures are implemented when deemed necessary on account of the actual conditions in the area.

2.2.2. Decontamination and Other Measures for Buildings and Other Structures

This section explains preparation, prior measurements, decontamination methods, post-work measures, and subsequent measurements and records, as shown in Figure 2-8 of the basic flow pertaining to decontamination and other measures for houses, buildings, agricultural facilities, and other structures.

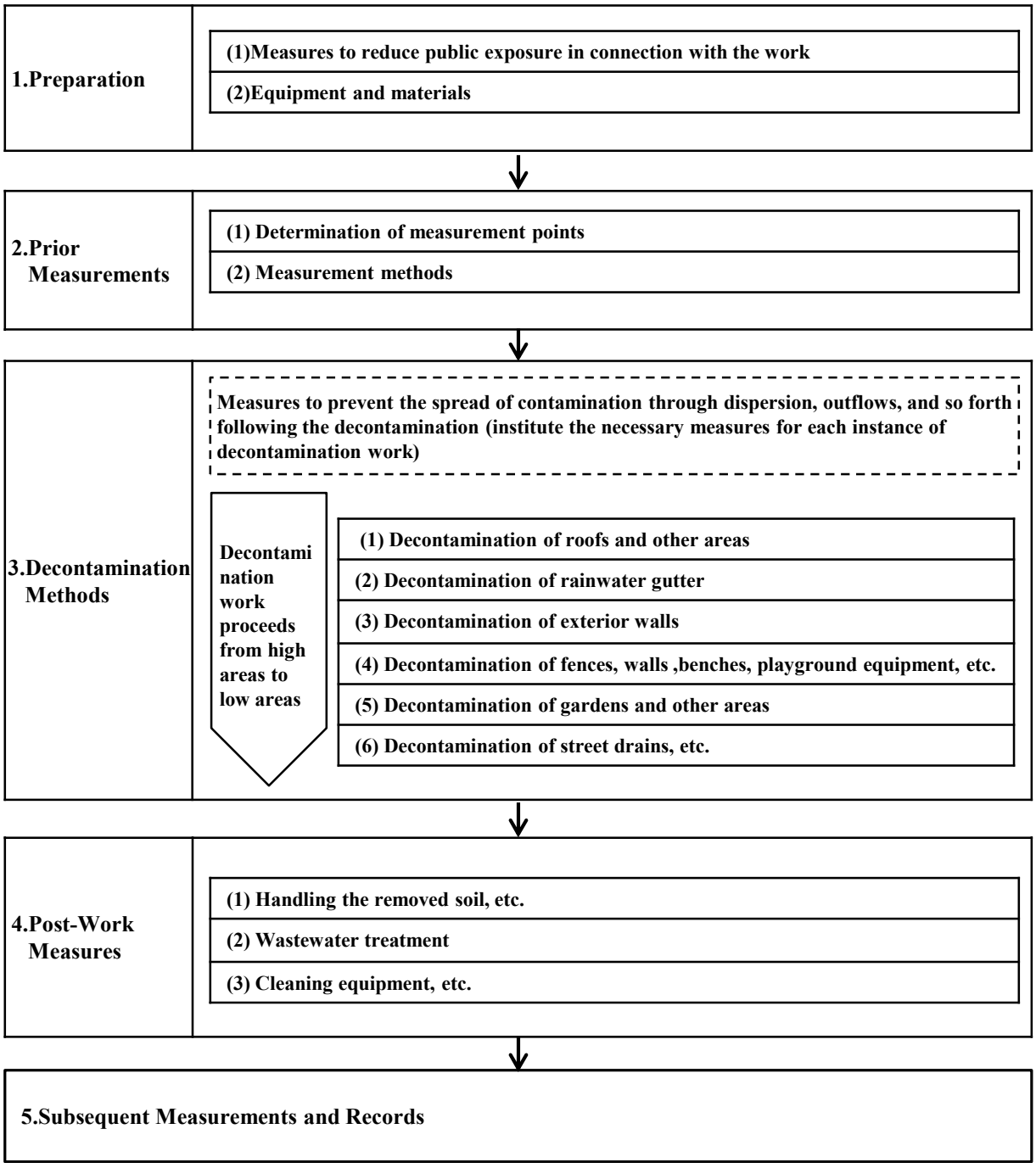


Figure 2-8 Basic flow for decontamination and other measures for buildings and other structures.

（1） Preparation

Before performing decontamination work, in addition to preparing the equipment required for the work, preparations must be made to ensure safety of workers and the general public to prevent their exposure to hazards, such as by inhaling dust generated during decontamination work; these preparations are summarized in Table 2-3.

Table 2-3 Preparation for decontamination and other measures

Measures to Reduce Public Exposure in Connection with Decontamination Work	Restriction of entry	• In cases where the general public is deemed likely to enter the area, the area shall be cordoned off with pylons or rope, etc. to prevent people from unnecessarily approaching the work site, and the entry of people and vehicles shall be restricted • In cases where radioactive materials may be dispersed in connection with the decontamination work, the perimeter of the decontamination area shall be fenced in with sheets, etc., water shall be sprayed, or other such measures shall be taken to prevent dispersion and the area shall be cordoned off with rope, etc.
	Signage	• In cases where the general public is deemed likely to enter the area, signs, etc. shall be put up to alert the public that decontamination work is being performed.
Preparation of Equipment and Materials Preparation of Equipment and Materials	General equipment	Examples : Mower, hand shovel, grass sickle, broom, bamboo-rake, dustpan, tongs, shovel, small shovel, metal rake, compact heavy machinery for scraping away topsoil, garbage bags (bags for burnable matter, burlap sacks for soil and sand (sandbags)), vehicles for transporting collected removed soil, etc. to the on-site storage location (truck, two-wheeled cart, etc.), ladder
	Equipment for cleaning with water	Examples : Hose, shower nozzle, high pressure water cleaner, brushes (scrub brush, brush for cleaning vehicles, brush for cleaning high places), scrubbing brushes (circular scrubber, steel wool brush, etc.), wire brushes, tools for pushing away water (broom, scraper, etc.), bucket, detergent, dust cloth, sponges, paper towels
	Equipment for cleaning metal surfaces	Examples : Brush, sandpaper, cloth, removing agents
	Equipment for cleaning wood surfaces	Examples : Brush, sandpaper, power sander, cloth, steam cleaner, water high pressure washer, tools for pushing away water (broom, scraper, etc.)
	Equipment for work in high places	Examples : Scaffold, mobile lift, aerial vehicle
	General equipment	Examples : Mower, hand shovel, grass sickle, broom, bamboo rake, dustpan, tongs, shovel, small shovel, metal rake, compact heavy machinery for scraping away topsoil, garbage bags (bags for burnable matter, burlap sacks for soil and sand (sandbags)), vehicles for transporting collected removed soil, etc. to the on-site storage location (truck, two-wheeled cart, etc.), ladder
	Equipment for cleaning with water	Examples : Hose, shower nozzle, high pressure water cleaner, brushes (scrub brush, brush for cleaning vehicles, brush for cleaning high places), scrubbing brushes (circular scrubber, steel wool brush, etc.), wire brushes, tools for pushing away water (broom, scraper, etc.), bucket, detergent, dust cloth, sponges, paper towels

（2） Prior measurements

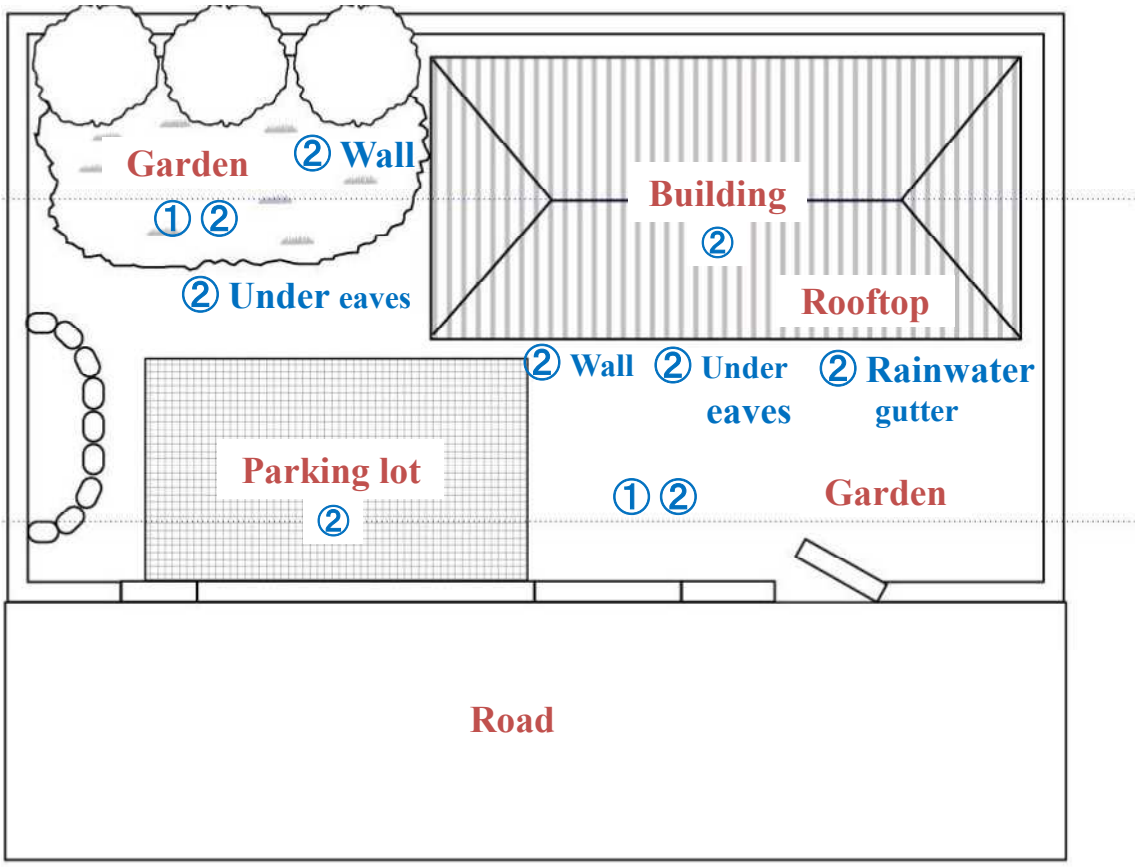
The air dose rate, etc. should be measured and recorded at the same location and by the same method both before and after decontamination work in order to confirm decontamination effects. The method of measurement for the air dose rate, etc. before decontamination work is explained below.

1）Determination of measurement points

Before decontamination work, determining the location where the air dose rate, etc. is measured (thereafter refer to as “measurement point”; Table 2-4) and preparing a diagram (Figure 2-9) with the areas to be measured, are done, and the structures to be used as markers, etc., are described and diagram examples are presented. In addition, it is explained that hotspots and their ambient areas can be excluded from the measurement points, if the residents are not expected to stay there for a relatively long time

Table 2-4 Reasoning behind the measurement points for air dose rates and other measures for the decontamination of buildings and other structures

Measurement point	No. 1 measurement points(①)	No. 2 measurement points (②)
Measurement target	Air dose rate in living spaces	Surface contamination density, etc. for objects subject to decontamination
Reasoning behind the measurement points	• For detached housing, in gardens and other outdoor locations, approximately two to five measurement points shall be set from among places where people are deemed likely to spend relatively large amounts of time. • For collective housing, public facilities, and so forth, in gardens and other outdoor locations, approximately five measurement points shall be set from among places where people are deemed likely to spend relatively large amounts of time.	• Measurement points for roofs, rooftops, and the sides of buildings shall be set near the center of each surface. • Measurement points for gardens and other grounds shall be set near their centers. (Choose places along the centerline for grounds that are long and thin or otherwise not square.) • Measurement points for fences and walls shall be set at intervals that enable the distribution of the air dose rate, etc. to be ascertained.[Example] Pitch of 5 to 10 m • Measurement points for benches, playground equipment, etc. shall be set at places people will be in contact with.



①:Contamination status for living spaces
(air dose rate: approximately two to five measurement points)

②:Contamination status for objects subject to decontamination
(surface contamination density, surface dose rate)

Figure 2-9 Example schematic diagram for reporting measurement points for use in decontamination and other measures for buildings and other structures.

2）Measuring methods

It is recommended that for the measurement point marked as ① the apparatuses such as NaI scintillation survey meters which are able to measure gamma rays should be used and for the measurement point marked as ② GM survey meters should be used.

（3） Decontamination methods

The flow of overall decontamination work is shown in Figure 2-10; basic features include implementing decontamination work from higher locations to lower locations and preventing contamination from spreading or being released. Individual decontamination measures for roofs, rainwater gutters, exterior walls, fences, ditches, gardens, street drains, etc. are described in terms of the items such as basic flow, necessary measures for prior decontamination work and decontamination methods and notes of caution.

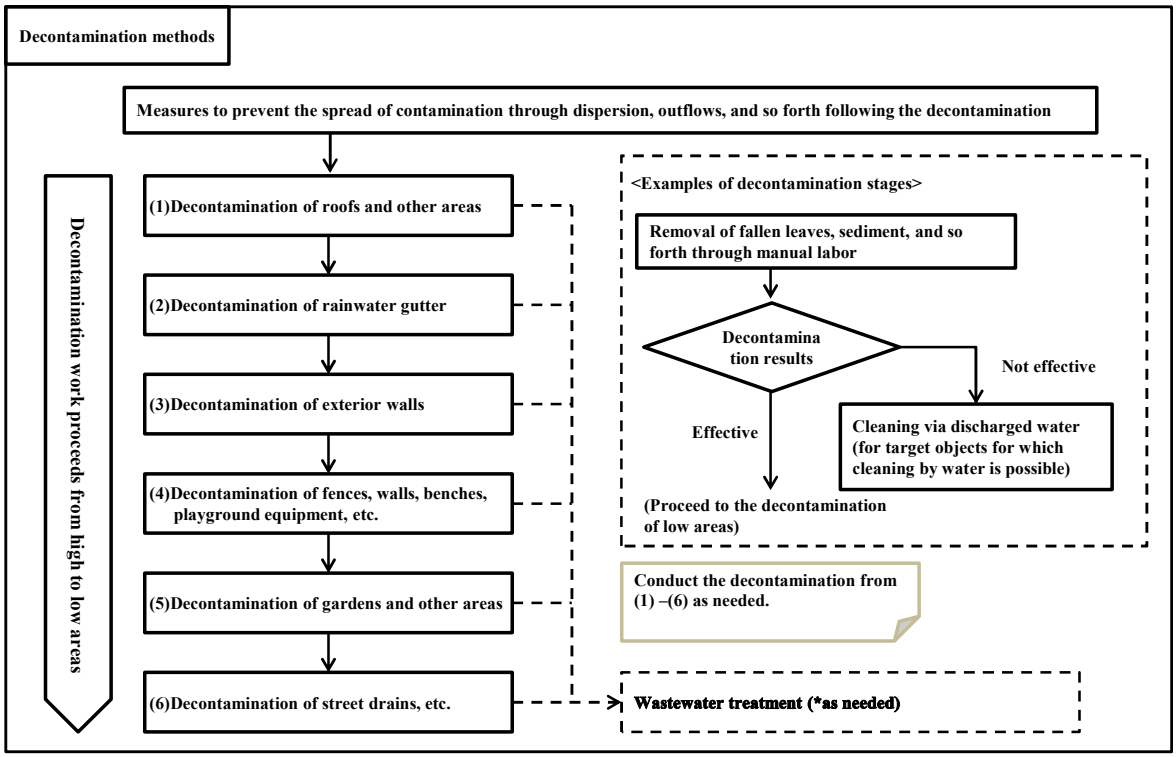


Figure 2-10 Basic flow for the decontamination of buildings and other structures.

1）Decontamination of roofs

The flow of decontamination for roofs is shown in Figure 2-11. The necessary measures prior to the decontamination work are shown in Table 2-5. The decontamination methods are shown in Table 2-6.

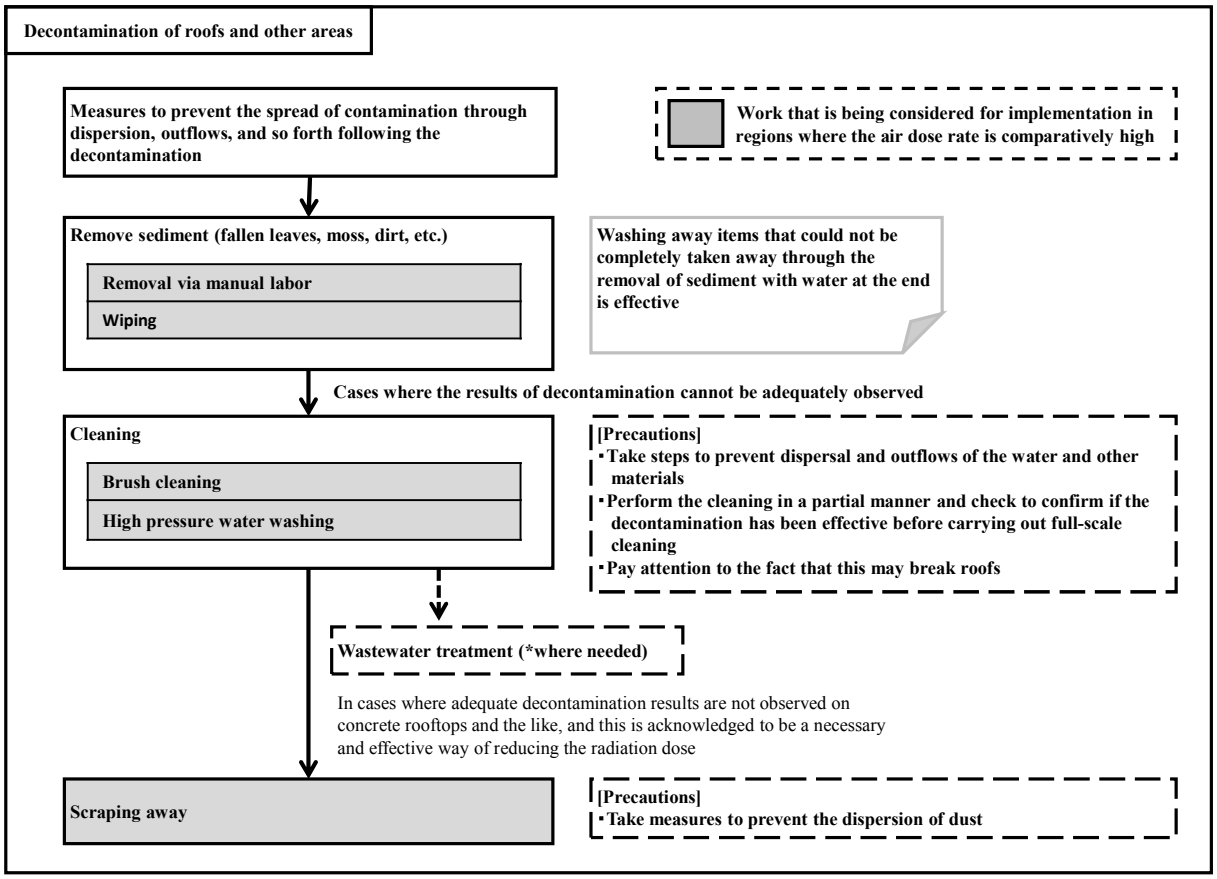


Figure 2-11 Basic flow for the decontamination of roofs and other areas.

Table 2-5 Necessary measures prior to the decontamination of roofs and other areas

Category	Decontamination methods and notes of caution
Safety measures	• When performing work in high places, appropriate safety measures shall be taken, such as erecting scaffolding and allocating aerial vehicles.
Prevention of dispersion	• If sidewalks and buildings are immediately adjacent, curing shall be performed to prevent dispersion of water, etc. • Using a method of water recovery-type high pressure water cleaning is also effective for preventing the dispersal of radioactive materials.
Ensuring drainage channels and wastewater treatment	• When using water to clean, the channel for cleaning water to flow shall be checked beforehand and the drainage channel cleaned in advance to enable smooth drainage. • See "4. (2) Wastewater Treatment" regarding the treatment of wastewater.

Table 2-6 Decontamination methods for roofs and other areas and notes of caution

Category		Decontamination methods and notes of caution
Removal of sediments	Decontamination through manual labor	• Fallen leaves, moss, mud, and other sediments shall be removed by hand by people wearing rubber gloves and by shovel, etc.
	Wiping	• Wiping shall be performed carefully through the use of paper towels or dust cloths that have been dampened with water. • All sides of folded paper towels, dust cloths, etc. used in wiping work shall be used. However, none of the surfaces that have already been used for decontamination (wiping) shall be touched with bare hands as these surfaces may have radiocaesium on them. • Consideration shall be given to preventing the contamination from re-adhering by such means as wiping it down with a new side of the cloth for each wipe according to the contamination status. • In some cases the results of the decontamination will be smaller due to effects from roofing materials like cement tiles, matte clay tiles, and painted steel sheets, as well as from rust. • When rust is present, the rust itself must be removed by being wiped away.
Cleaning	Brush cleaning	• Cleaning shall be thoroughly performed by using scrub brushes, scrubbing brushes, etc. • Cleaning shall be performed from high places to low ones so as to avoid dispersing water to the surroundings. • Rotary brushes shall not be used as they are not suitable for thatched or tiled roofs.
	High pressure water cleaning	• Any possibility of breakage or damage to roofs, etc. from high pressure water cleaning shall be checked in advance (obtaining advice from a specialist is recommended). • To prevent dispersion of soil, etc. by water pressure, cleaning shall be performed at low pressure initially and the pressure shall be raised gradually while checking the flow of cleaning water and the dispersion conditions. • To achieve a decontamination effect, the spray nozzle shall be brought near the place to be decontaminated. • Special attention shall be paid to cleaning the overlapping sections
Scraping away	Blast work	• Abrasive materials shall be shot at the surface with a shot blaster and scraped away from said surface uniformly. • In order to prevent dust from arising, curing, etc. shall be performed to prevent dispersion of dust to the surroundings and the dust shall be collected. • For blast work, curing shall be performed to ensure that abrasive materials and the like do not travel outside of the decontamination work area. What is more, after the abrasive materials and other materials have been used they shall be collected in a manner that ensures that they will not scatter the radioactive materials adhering to them to the surroundings.
	Scraping away	• Dispersion to the surroundings shall be prevented when scraping away contamination. (Example: use of dust collectors, sprinkling in advance, setting up simple plastic housings, etc.)

2）Decontamination for rainwater gutters

The flow of decontamination work for rainwater gutters is shown in Figure 2-12. The necessary measures prior to the decontamination work are shown in Table 2-7. The decontamination methods and notes of caution are shown in Table 2-8.

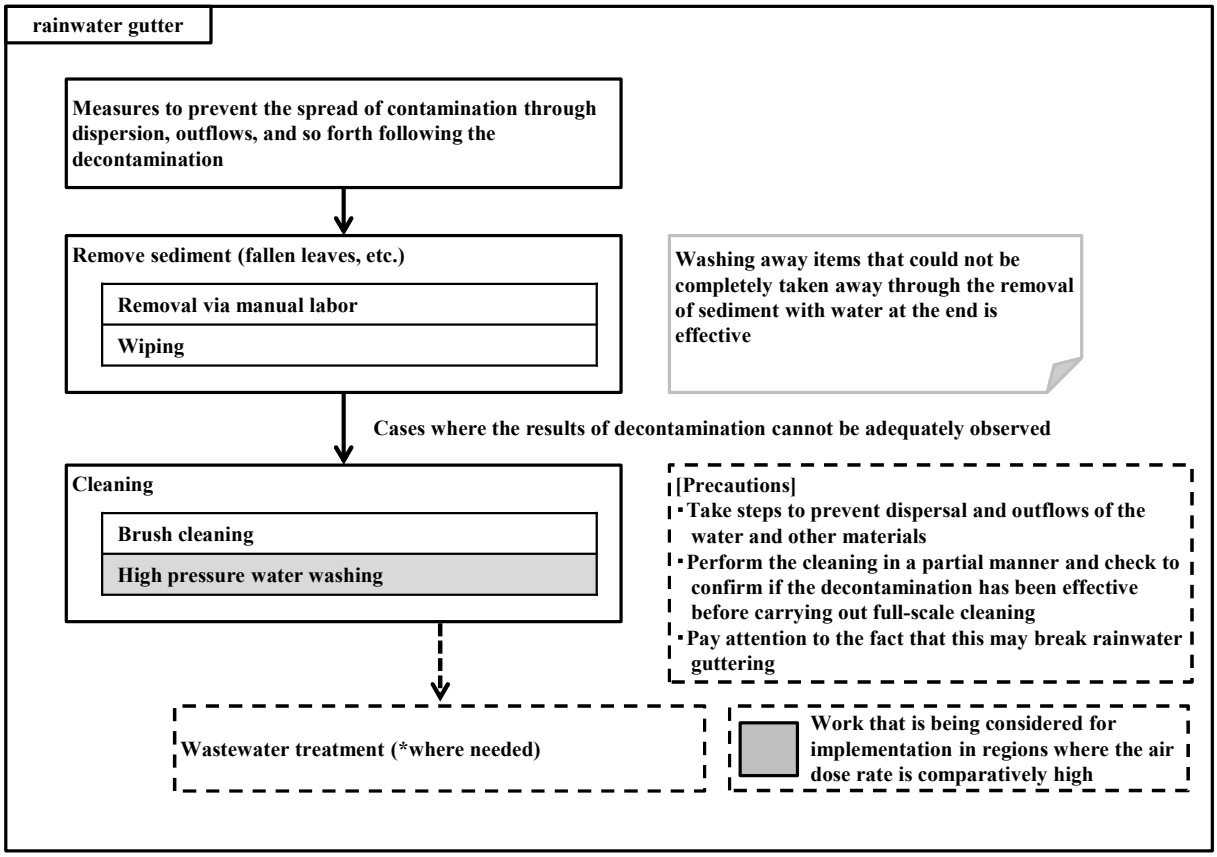


Figure 2-12 Basic flow for the decontamination of rainwater gutters.

Table 2-7 Necessary measures prior to the decontamination of rainwater gutters

Category	Decontamination methods and notes of caution
Prevention of dispersion	• If sidewalks and buildings are immediately adjacent, curing shall be performed to prevent dispersion of water, etc.
Ensuring drainage channels and wastewater treatment	• When using water to clean, the channel for cleaning water to flow shall be checked beforehand and the drainage channel cleaned in advance to enable smooth drainage. • Sediment in rainwater gutter shall be removed prior to cleaning with water. • See "4. (2) Wastewater Treatment" regarding the treatment of wastewater. • Damage to the end-flow sections of rainwater gutter or places where they are directly discharged into garden plots may result in high doses, so consideration shall be given to the decontamination of gardens and similar sites.

Table 2-8 Decontamination methods for rainwater gutters and notes of caution

Category		Decontamination methods and notes of caution
Removal of sediments	Decontamination through manual labor	• Fallen leaves, moss, mud, and other sediments shall be removed by hand by people wearing rubber gloves and by shovel, etc.
	Wiping	• Wiping shall be performed carefully through the use of paper towels or dust cloths that have been dampened with water. • All sides of folded paper towels, dust cloths, etc. used in wiping work shall be used. However, none of the surfaces that have already been used for decontamination (wiping) shall be touched with bare hands as these surfaces may have radiocaesium on them. • Consideration shall be given to preventing the contamination from re-adhering by such means as wiping it down with a new side of the cloth for each wipe according to the contamination status. • Since large quantities of radioactive materials accumulate on the sediments in rainwater gutter, it is effective to remove said sediments.
Cleaning	Brush cleaning	• Cleaning shall be thoroughly performed by using scrub brushes, scrubbing brushes, etc. • Sediment in downspouts (especially bend sections) tends to get overlooked, so these should be cleaned with a wire brush. • Cleaning shall be performed from high places to low ones so as to avoid dispersing water to the surroundings.
	High pressure water cleaning	• High pressure water cleaners shall be used to clean via pressure washing with a water pressure of generally 5 MPa or less and around 2 liters of water used per 1 m to ensure that rainwater gutter is not destroyed. This is primarily for narrow places where people cannot reach and other sections where it is difficult to perform wiping work. • ･The spray nozzle shall be brought near to the place being decontaminated (about 20 cm) in order to get results from the cleaning, and the cleaning shall be performed at the appropriate speed of movement. • ･Washing shall be performed from the upstream to the downstream of the drainage slope to ensure that water does not disperse to the surroundings.

3）Decontamination for exterior walls

The flow of decontamination for exterior walls is shown in Figure 2-13. The necessary measures prior to the decontamination work are shown in Table 2-9. The decontamination methods and notes of caution are shown in Table 2-10.

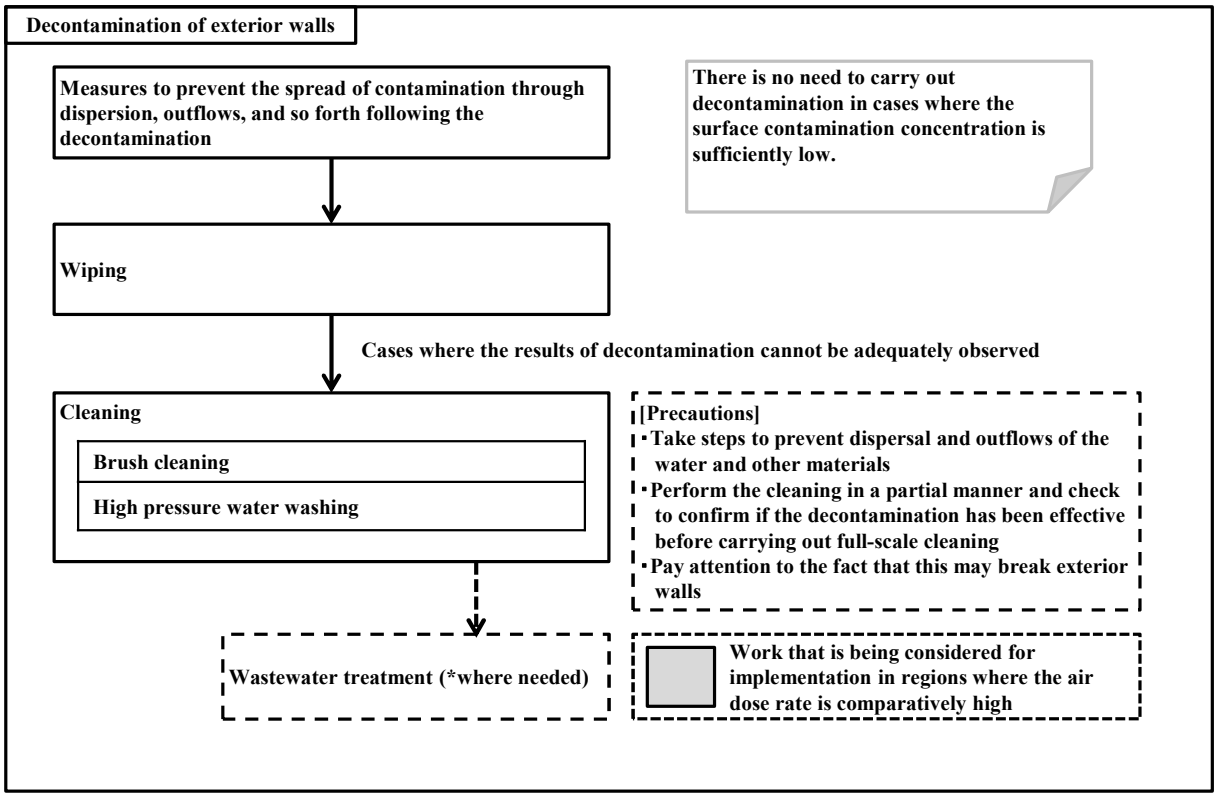


Figure 2-13 Basic flow for the decontamination of exterior walls.

Table 2-9 Necessary measures prior to the decontamination of exterior walls

Category	Decontamination methods and points to notes of caution
Prevention of dispersion	• If sidewalks and buildings are immediately adjacent, curing shall be performed to prevent dispersion of water, etc.
Ensuring drainage channels and wastewater treatment	• When using water to clean, the channel for cleaning water to flow shall be checked beforehand and the drainage channel cleaned in advance to enable smooth drainage. • See "4. (2) Wastewater Treatment" regarding the treatment of wastewater.

Table 2-10 Decontamination methods for exterior walls and notes of caution

Category		Decontamination methods and notes of caution
Removal of sediments	Wiping	• Wiping shall be performed carefully through the use of paper towels or dust cloths that have been dampened with water. • All sides of folded paper towels, dust cloths, etc. used in wiping work shall be used. However, none of the surfaces that have already been used for decontamination (wiping) shall be touched with bare hands as these surfaces may have radiocaesium on them. • Consideration shall be given to preventing the contamination from re-adhering by such means as wiping it down with a new side of the cloth for each wipe according to the contamination status.
Cleaning	Brush cleaning	• Cleaning shall be thoroughly performed by using scrub brushes, scrubbing brushes, etc. • Cleaning shall be performed from high places to low ones so as to avoid dispersing water to the surroundings.
	High pressure water cleaning	• To prevent dispersion of soil, etc. by water pressure, cleaning shall be performed at low pressure initially and the pressure shall be raised gradually while checking the flow of cleaning water and the dispersion conditions. • The spray nozzle shall be brought near to the place being decontaminated (about 20 cm) in order to get results from the cleaning, and the cleaning shall be performed at the appropriate speed of movement. • Attention must be paid to the fact that there is the possibility of damaging the property, such as by causing walls to peel, or having water seep indoors.

4）Decontamination for fences, outside walls, benches, and playground equipment, etc.

The flow of decontamination for fences, outside walls, benches, and playground equipment, etc., is shown in Figure 2-14. The necessary measures prior to the decontamination work are shown in Table 2-11. The decontamination methods and notes of caution are shown in Table 2-12.

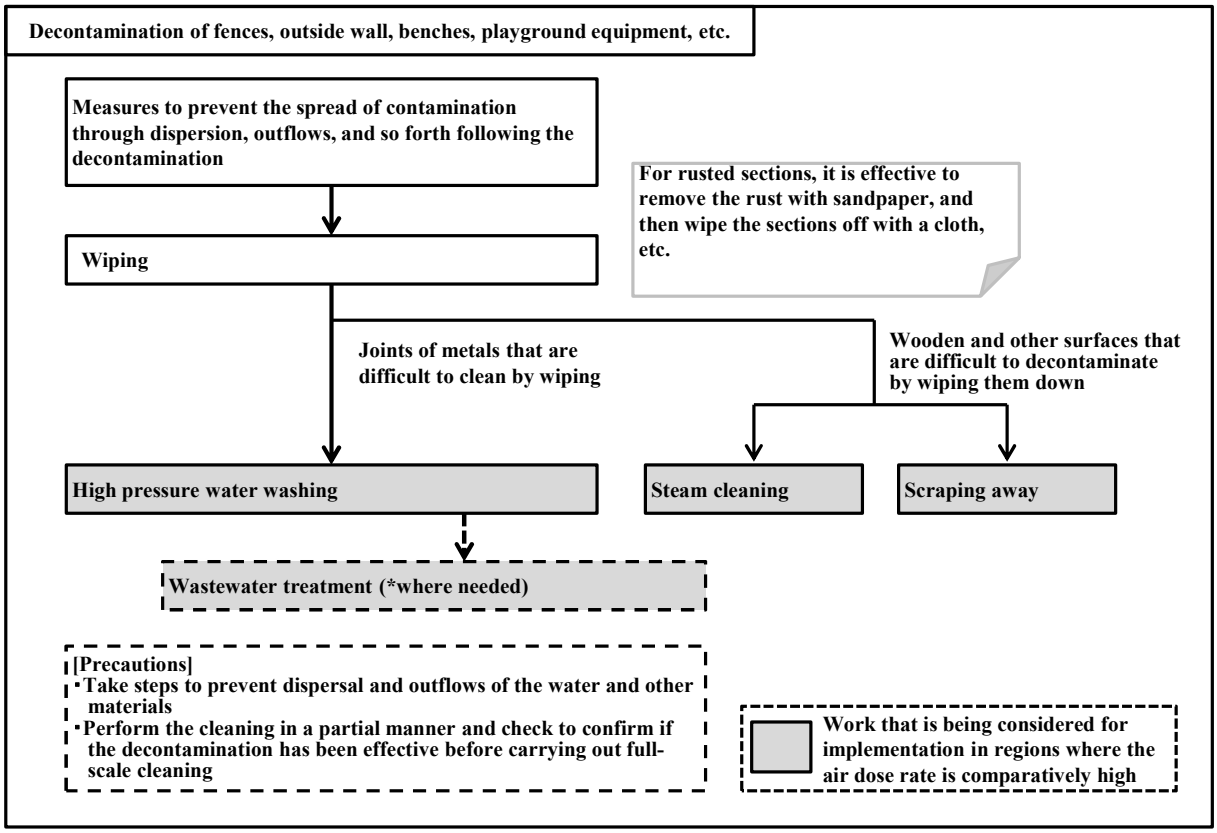


Figure 2-14 Basic flow for the decontamination of fences, outside walls, benches, playground equipment, etc.

Table 2-11 Necessary measures prior to the decontamination of fences, outside walls, benches, playground equipment, etc.

Category	Decontamination methods and notes of caution
Prevention of dispersion	• If sidewalks and buildings are immediately adjacent, curing shall be performed to prevent dispersion of water, etc.
Ensuring drainage channels and wastewater treatment	• When using water to clean, the channel for cleaning water to flow shall be checked beforehand and the drainage channel cleaned in advance to enable smooth drainage. • See "4. (2) Wastewater Treatment" regarding the treatment of wastewater.

Table 2-12 Decontamination methods for fences, outside walls, benches, playground equipment, etc. and notes of caution

Category	Decontamination methods and notes of caution
Wiping	• All sides of folded paper towels, dust cloths, etc. used in wiping work shall be used. However, none of the surfaces that have already been used for decontamination (wiping) shall be touched with bare hands as these surfaces may have radiocaesium on them. • Consideration shall be given to preventing the contamination from re-adhering by such means as wiping it down with a new side of the cloth for each wipe according to the contamination status. • The rust on metal playground equipment shall be removed through the use of sandpaper, a metal brush, or the like before it is thoroughly wiped down. • Once a side of a paper towel or dust cloth has been used on decontamination (wiping) or a brush, waste cloth, or sandpaper has been used for wiping there is the possibility that it will have radiocaesium adhering to it, and so it must not be touched directly by hand.
High pressure water cleaning (metal joints)	• High pressure water cleaning shall be performed on the joints of playground equipment and the like that are difficult to wipe down. • To prevent dispersion of soil, etc. by water pressure, cleaning shall be performed at low pressure initially and the pressure shall be raised gradually while checking the flow of cleaning water and the dispersion conditions. • The spray nozzle shall be brought near to the place being decontaminated (about 20 cm) in order to get results from the cleaning, and the cleaning shall be performed at the appropriate speed of movement.
Steam cleaning	• Wooden playground equipment shall be cleaned using a steam cleaner.
Scraping away (wooden playground equipment, etc.)	• The surface wood of wooden playground equipment shall be scraped away with electric power tools or the like. • Dust collectors, etc. shall be used when scraping off wooden surfaces, etc. to prevent dispersion to the surroundings.

5）Decontamination of gardens, etc.

The flow of decontamination for gardens and other similar areas is shown in Figure 2-15. The necessary measures prior to the decontamination work are shown in Table 2-13. The decontamination methods and notes of caution are shown in Table 2-14.

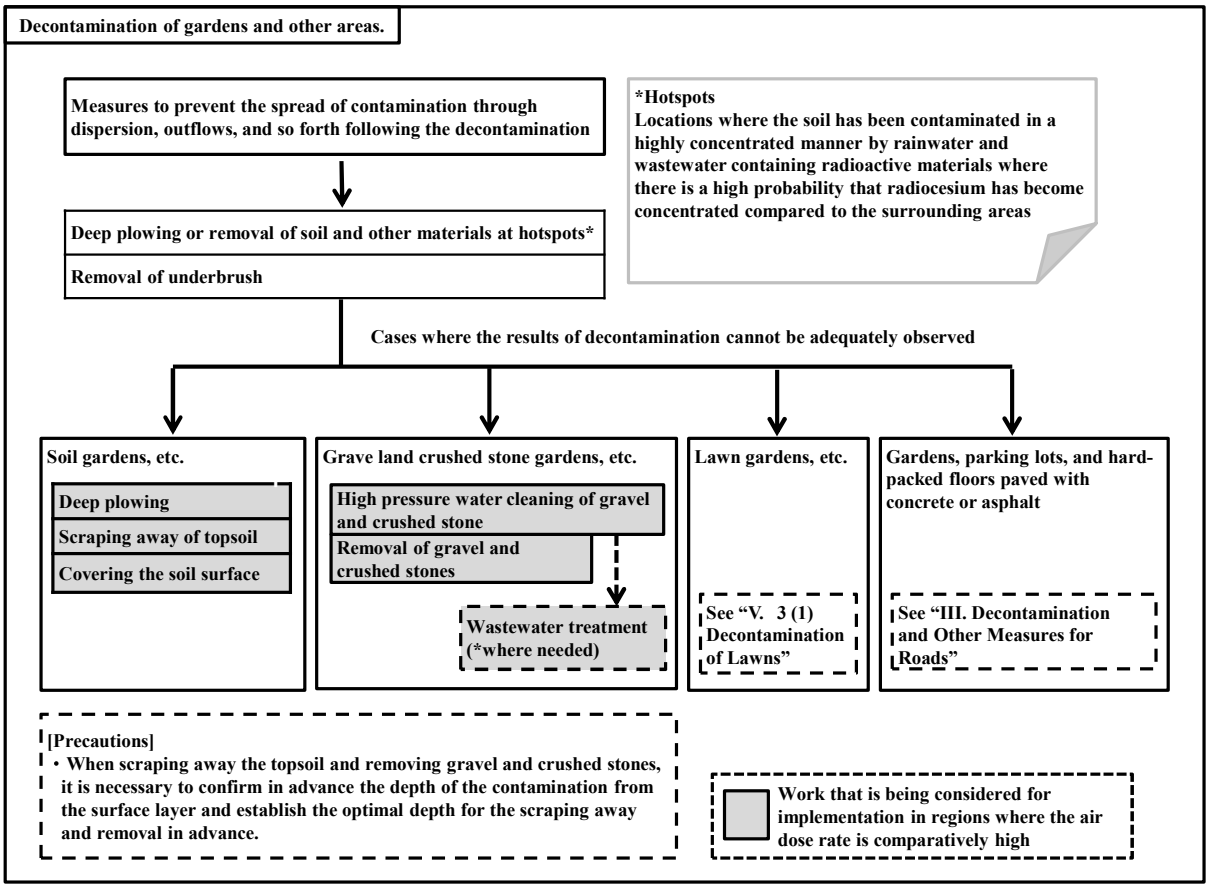


Figure 2-15 Basic flow for the decontamination of gardens and other similar areas.

Table 2-13 Necessary measures prior to the decontamination of gardens and other similar areas

Category	Decontamination methods and notes of caution
Prevention of dispersion	• If sidewalks and buildings are immediately adjacent, curing shall be performed to prevent dispersion of water, etc.

Table 2-14 Decontamination methods for gardens and other similar areas and notes of caution

Category		Decontamination methods and notes of caution
Deep plowing or removal of soil and other substances at hotspots		• Fallen leaves, moss, mud, and other sediments shall be removed by hand by people wearing rubber gloves and by shovel, etc. • The soil at hotspots below rainwater gutter and the like shall be deep plowed or removed. When this is implemented attention must be paid to the depth of the contamination. • In cases where it is difficult to perform deep plowing at a location, such as with soil that has been packed into rainwater chambers and the like, consideration shall be given to performing deep plowing in the vicinity of said rainwater chambers.
Removal of underbrush, etc.		• Before performing the deep plowing and the scraping away of topsoil, conduct weed removal and weeding on any weeds that would pose a hindrance to the work using a shoulder-type mower or human power. • In some cases the shielding effect for the beta rays by grass may be reduced by the grass cutting, and so the reduction rate may drop.
Gravel and crushed stone gardens, etc.	Deep plowing	• About 10 cm of topsoil shall be uniformly scraped away and temporarily piled on top of a plastic sheet or the like. • About 20 cm of subsoil shall be uniformly scraped away and piled on top of a separate location from the topsoil. • After the topsoil has been uniformly spread out, the subsoil shall be uniformly spread on top of it and the land will be leveled. It shall be restored to its original height at a compactness that is about the same as it was before.
	Scraping away surface soil	• A bamboo winnow or similar instrument shall be used to uniformly scrape away the garden topsoil. • Attention shall be paid to the fact that due to the planted vegetation and unevenness relative to the ground there may be reduced certainty with the decontamination work.
	Covering the surface soil	• The surface soil shall be covered with soil that does not contain radiocaesium.
Gravel and crushed stone gardens, etc.	High pressure water cleaning of gravel and crushed stones	• A shovel or the like shall be used to place the gravel or crushed stones into a water tank and then perform high pressure water cleaning. • To prevent dispersion of soil, etc. by water pressure when performing high pressure water cleaning, cleaning shall be performed at low pressure initially and the pressure shall be raised gradually while checking the flow of cleaning water and the dispersion conditions. • See “4. (2) Wastewater Treatment” regarding the treatment of wastewater.
	Removal of gravel and crushed stones	• The gravel or crushed stones shall be uniformly removed with a shovel or the like. • When gravel or crushed stones are removed, the area shall be covered by using the same type of gravel or crushed stones as before as needed, and it shall be covered to the same standing height as before and to about the same compactness as before.

6）Decontamination for street drains, etc.

The flow of decontamination for street drains, etc. is shown in Figure 2-16. The necessary measures prior to the decontamination work are shown in Table 2-15. The decontamination methods and notes of caution are shown in Table 2-16.

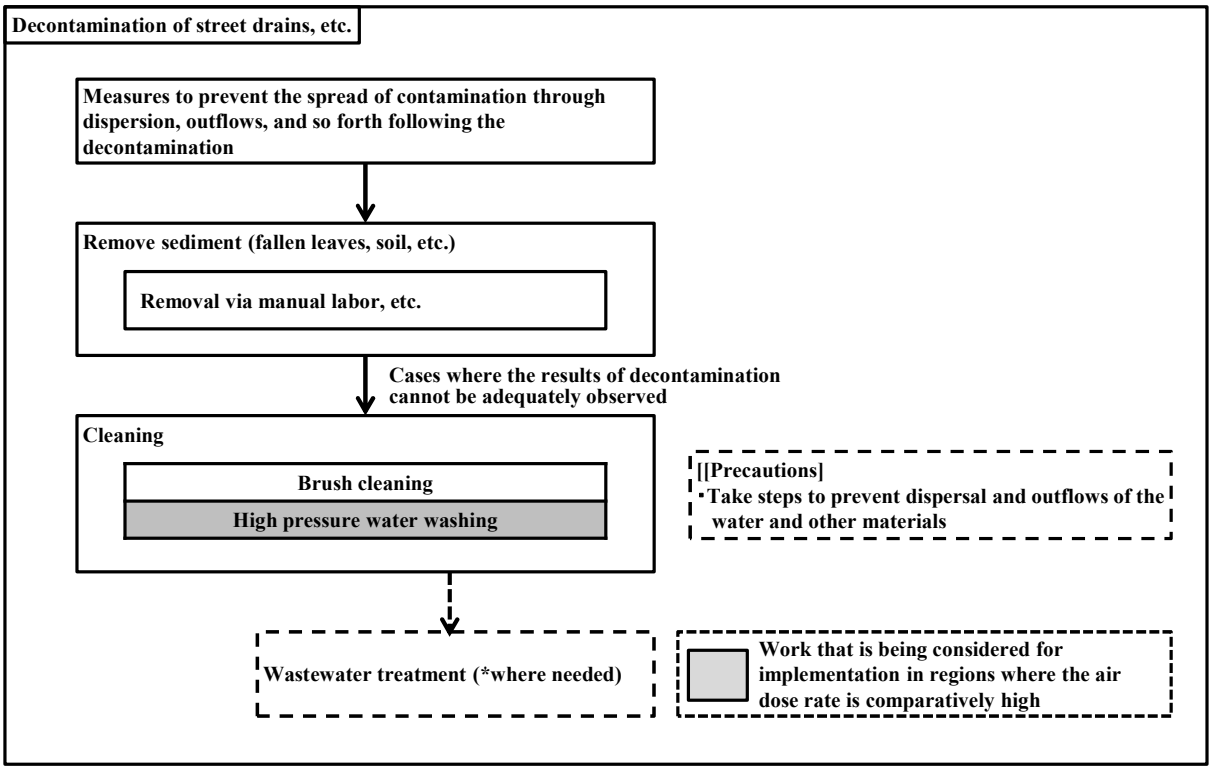


Figure 2-16 Basic flow for the decontamination of street drains, etc.

Table 2-15 Necessary measures prior to the decontamination of street drains, etc.

Category	Decontamination methods and points to notes of caution
Prevention of dispersion	• If sidewalks and buildings are immediately adjacent, curing shall be performed to prevent dispersion of water, etc.
Ensuring drainage channels and wastewater treatment	• When using water to clean, the channel for cleaning water to flow shall be checked beforehand and the drainage channel cleaned in advance to enable smooth drainage. • See "4. (2) Wastewater Treatment" regarding the treatment of wastewater.

Table 2-16 Decontamination methods for street drains, etc. and notes of caution

Category		Decontamination methods and notes of caution
Removal of sediments	Decontamination through manual labor	• Fallen leaves, moss, mud, and other sediments that are easy to remove shall be removed in advance by shovel, etc. • When the concrete joints of street drains are deep, a spatula or the like shall be used to remove the sediments from the joints. • When performing deep plowing at rainwater chambers it will be difficult to carry this out in such locations, and so deep plowing shall be carried out in the vicinity of said rainwater chambers. • In cases where sediment gets clogged in rainwater chambers and water overflows out of street drains like when it rains contamination will sometimes spread to the surroundings. In such cases the ground surface of the surroundings shall be measured and decontamination work shall be carried out in accordance with the configuration of the ground surface.
Cleaning	Brush cleaning	• Cleaning shall be thoroughly performed by using a deck brush or broom. • Cleaning shall be performed from high places to low ones so as to avoid dispersing water to the surroundings.
	High pressure water cleaning	• To prevent dispersion of soil, etc. by water pressure, cleaning shall be performed at low pressure initially and the pressure shall be raised gradually while checking the flow of cleaning water and the dispersion conditions. • The spray nozzle shall be brought near to the place being decontaminated (about 20 cm) in order to get results from the cleaning, and the cleaning shall be performed at the appropriate speed of movement.

（4） Post–work measures

This section explains handling the removed soil, etc., wastewater treatment, and cleaning equipment used, etc. as post-work measures.

1）Handling the removed soil, etc.

The removed soil, etc. is appropriately handled and transferred to an on-site storage or a temporary storage site. The basic flow of handling the removed soil, etc. is shown in Figure 2-17. The methods of handling and notes of caution are explained in Table 2-17.

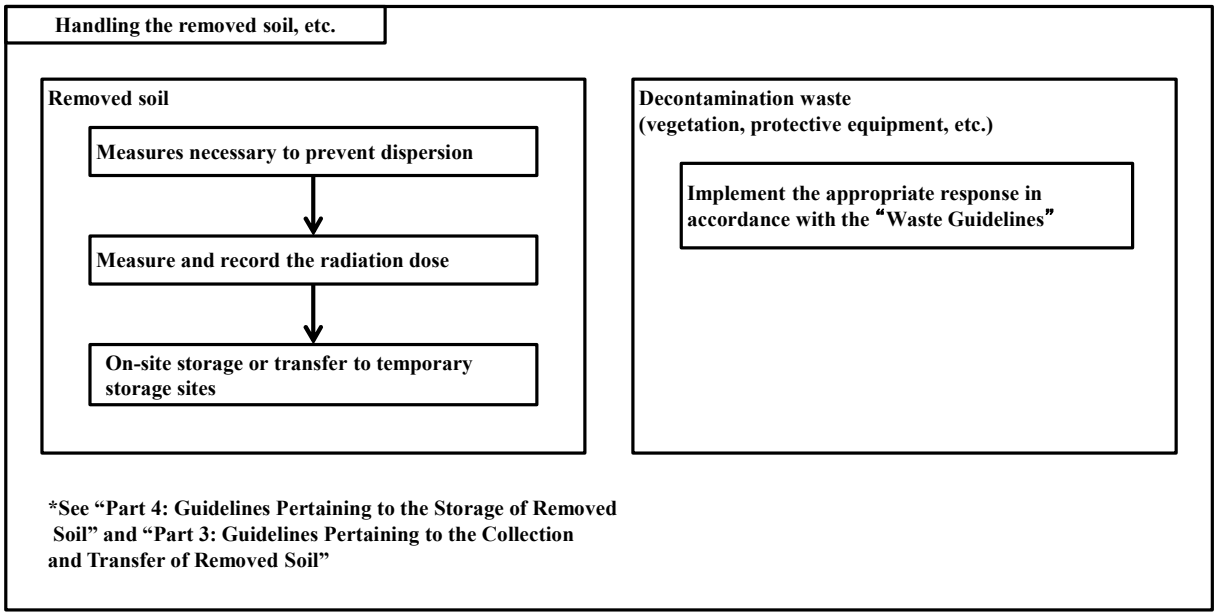


Figure 2-17 Basic flow for handling the removed soil, etc.

Table 2-17 Methods for the handling of removed soil, etc. and notes of caution

Category	Decontamination methods and notes of caution
Handling the removed soil, etc.	• To prevent dispersion, the removed soil, etc. shall be placed in bags or other containers and closed or sealed, or wrapped in sheets or similar material. • The removed soil, etc. shall be separated from decontamination waste to the extent possible and placed in separate bags or other containers to ensure there is no mixing. Please refer to the Guidelines on the Storage of Decontamination Waste (promulgated at the end of December 2011) for details on the handling of waste. • The air dose rate at the surface (from 1 cm away) of each container or set of multiple containers holding the removed soil, etc. shall be measured, and the radiation dose of the removed soil, etc. generated by the decontamination work shall be recorded and displayed in a manner that roughly indicates the dose level (range). • Vegetation and the disposable masks, etc. used in the decontamination work shall be treated and disposed of as decontamination waste in accordance with the Waste Guidelines (March 2013, Vol.2) and other relevant statutes.

2) Wastewater treatment

In cases where wastewater is generated as a result of decontamination, wastewater treatment should be carried out as needed. The flow of wastewater treatment is shown in Figure 2-18. The necessary measures prior to the wastewater treatment are shown in Table 2-18. The methods for treatment and notes of caution are shown in Table 2-19.

For decontamination in decontamination zones (zones subject to the decontamination plans established by municipalities) there is essentially no need to treat wastewater in cases where sediments are removed. However, it is a basic principle that wastewater treatment should be carried out in situations where the wastewater is highly turbid or the wastewater has been recovered from water recovery-type high pressure water washing.

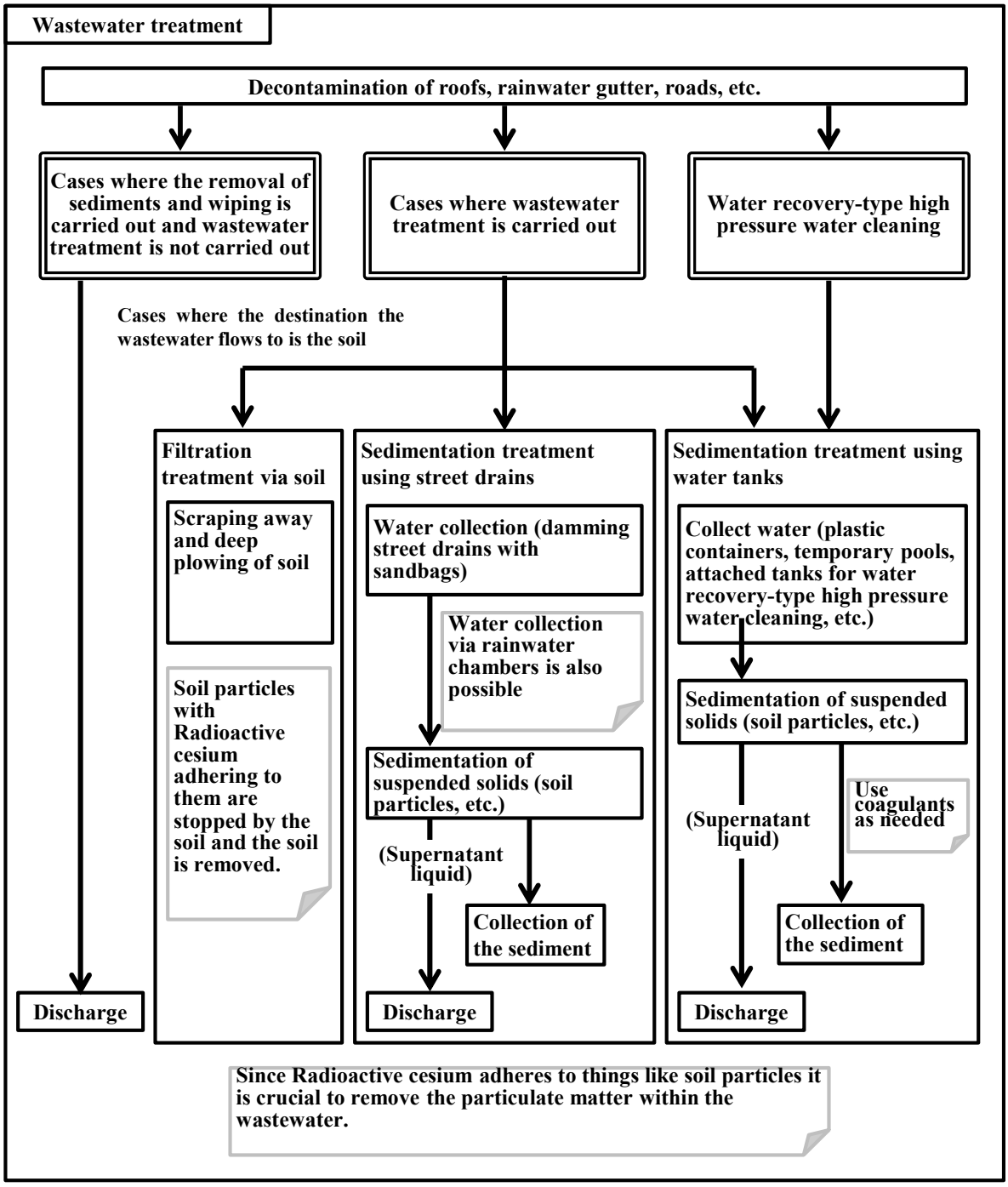


Figure 2-18 Basic flow for wastewater treatment.

Table 2-18 Necessary measures prior to the wastewater treatment

Category	Decontamination methods and notes of caution
Ensuring drainage channels and wastewater treatment	• The channel down which the wastewater will flow shall be checked beforehand and the drainage channel cleaned in advance to enable smooth drainage.

Table 2-19 Methods for wastewater treatment and notes of caution

Category	Decontamination methods and notes of caution
Filtration treatment via soil	• When the area under rainwater gutter consists of soil, radiation shall be captured by flushing wastewater generated on rooftops down to the soil via the rainwater gutter, and then said top layer of soil shall be removed after the decontamination of the rooftop.
Sedimentation treatment using water tanks	• Water shall be collected in plastic containers or temporary pools, then sedimenting out the particulate matter, and discharging the water from the supernatant liquid while collecting the sediment (agents to cause the liquid to undergo coagulating sedimentation shall be used). • The water in the supernatant liquid shall be checked to make sure there is no turbidity. • A simple filter will be installed and filtration shall be carried out as needed.
Sedimentation treatment using street drains	• The water shall be collected by damming up the street drains using sandbags, then sedimenting out the particulate matter, and discharging the supernatant liquid while collecting the sediment. • The water in the supernatant liquid shall be checked to make sure there is no turbidity. • A simple filter will be installed and filtration shall be carried out as needed.

3) Cleaning equipment used, etc.

With regard to the post-work cleaning of the equipment used and handling consumable materials for decontamination, as a general rule, the Ministry of Health, Labour and Welfare's "Ordinance on the Prevention of Ionizing Radiation Hazards Related to Decontamination Work of Soil Contaminated by Radioactive Materials Resulting from the Great East Japan Earthquake" and "Guidelines for Prevention of Radiation Hazards for Workers Engaged in Decontamination and Other Works" are to be followed. Moreover, it is important to keep in mind the items listed in Table 2-20.

Table 2-20 Methods for cleaning equipment and handling materials and notes of caution

Category	Details
Cleaning equipment and materials	• Heavy machinery, vehicles, and other objects used for which there is the possibility that a great deal of contaminated soil is adhering to them shall be checked to confirm the extent to which said soil is adhering to them. Those objects to which a great deal of contaminated soil is adhering shall be cleaned in a designated location, and other measures shall be taken to ensure that the contaminated soil, etc. is not spread around indiscriminately. • Likewise for shovels and other tools, shoes, and work clothes to which lots of contaminated soil is adhering, these shall be checked to confirm the extent to which said soil is adhering to them. Those objects to which a great deal of contaminated soil is adhering shall be cleaned in a designated location, and other measures shall be taken to ensure that the contaminated soil, etc. is not spread around indiscriminately. • The wastewater generated by the cleaning shall be treated as needed by referring to "(2) Wastewater Treatment." • When cleaning, the workers shall take care to ensure that they are not bathed in the spray from this. • In addition, even equipment or materials with a low possibility of contamination shall be checked to confirm whether or not contaminated soil is adhering to them. • The equipment, materials, and work clothes used shall be washed, cleaned, and reused to the extent possible. [Washing/cleaning examples] • Steam cleaning is effective for cleaning machinery, but scrubbing it down with brushes and a detergent is also sufficient. • Normal methods are sufficient for washing work clothes and other clothing. • When carrying the clothing, etc. used in decontamination work, it shall be placed in a box or bag, etc. to minimize dispersal of the attached matter. • When going indoors after decontamination work, mud shall be removed from shoes, clothing shall be changed, and other measures shall be taken to avoid bringing indoors dust attached to the workers.

(5) Subsequent measurements and records

To confirm the decontamination effect, the air dose rate, etc. after completion of the decontamination work should be measured and recorded as shown in Table 2-21.

Table 2-21 Subsequent measurements and records for the decontamination of buildings and other structures

Measurement of air dose rate, etc.	• The air dose rate, etc. shall be measured at each measurement point. • Measurements shall be carried out in the same location as the prior measurements and under the same conditions to the extent possible. • For the measuring apparatus, the same apparatus as was used for the prior measurements shall be used to the extent possible.
Recordkeeping	• The air dose rate, etc. at each measurement point, places where decontamination work was performed, decontamination date, names of the decontaminators, type of objects decontaminated, decontamination methods, total decontamination area (of soil, etc.), the approximate weight of the removed soil, etc., and the status of storage and disposal. • The equipment used in decontamination and the method of disposal after use. • See "Part 4: Guidelines Pertaining to the Storage of Removed Soil" for details on the items to record with regard to the storage of removed soil.

2.2.3. Decontamination and Other Measures for Roads

This section explains preparation, prior measurements, decontamination methods, post-work measures, and subsequent measurements and records, in the basic flow shown in Figure 2-19, pertaining to measures for decontamination of the paved surfaces of roads (including sidewalks), street drains, curbs, guardrails, and pedestrian overpasses.

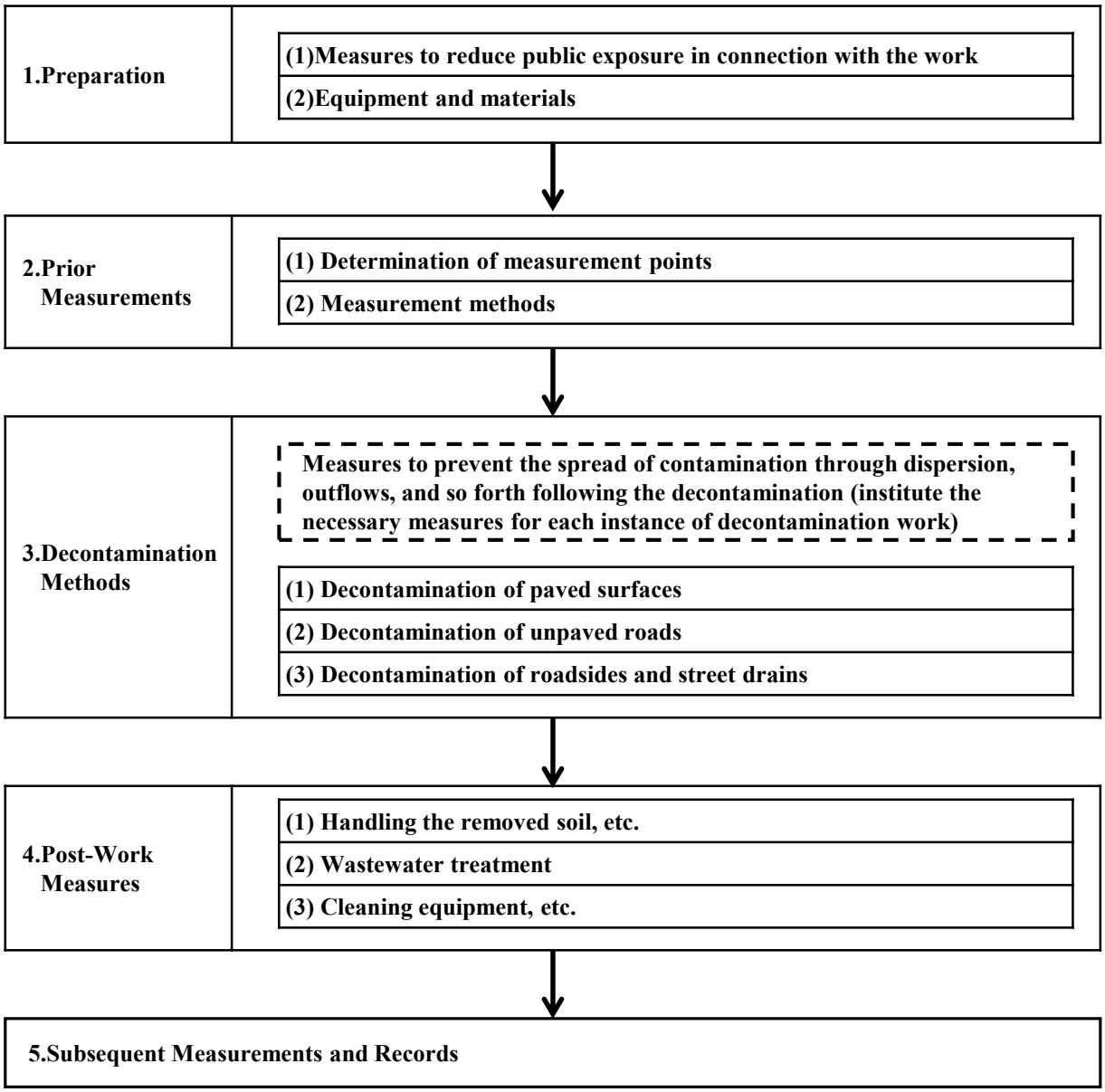


Figure 2-19 Basic flow for the decontamination and other measures for roads.

（1） Preparation

Before performing decontamination work, in addition to preparing the equipment required for the work, preparations must be made to ensure safety of workers and the general public to prevent their exposure to hazards, such as by inhaling dust generated during decontamination work; these preparations are summarized in Table 2-22.

Table 2-22 Preparation for decontamination and other measures for roads

Measures to Reduce Public Exposure in Connection with Decontamination Work	Restriction of entry	• In cases where the general public is deemed likely to enter the area, the area shall be cordoned off with pylons or rope, etc. to prevent people from unnecessarily approaching the work site, and the entry of people and vehicles shall be restricted. • In cases where radioactive materials may be dispersed in connection with the decontamination work, the perimeter of the decontamination area shall be fenced in with sheets, etc., water shall be sprayed, or other such measures shall be taken to prevent dispersion and the area shall be cordoned off with rope, etc.
	Signage	• In cases where the general public is deemed likely to enter the area, signs, etc. shall be put up to alert the public that decontamination work is being performed general
Preparation of Equipment and Materials	General equipment	Examples: Mower, hand shovel, grass sickle, broom, bamboo-rake, dustpan, tongs, shovel, small shovel, metal rake, compact heavy machinery for scraping away topsoil, garbage bags (bags for burnable matter, burlap sacks for soil and sand (sandbags)), vehicles for transporting collected removed soil, etc. to the on-site storage location (truck, two-wheeled cart, wheelbarrow, etc.), aerial vehicle, ladder, road sweeper
	Equipment for cleaning with water	Examples: Hose for water discharge, high pressure water cleaner, drainage pavement functional recovery car, brushes (scrub brush, brush for cleaning vehicles, etc.), tools for pushing away water (broom, scraper, etc.), bucket, detergent, dustcloth, sponge, paper towels
	Equipment for scraping off	Examples: Shot blaster, surface cutter, vibration drill, needle gun, grinding machine, equipment for scraping away, ultra high pressure water cleaner, equipment needed to prevent dispersion(dust collector, curing material)
	Equipment for removal of topsoil	Examples: Backhoe, bulldozer, hydraulic shovel
	Equipment for covering the soil surface	Examples: Self-propelled surface compaction roller, plywood for surface compaction, sprinkling equipment

（2） Prior measurements

The air dose rate, etc. should be measured and recorded at the same location and by the same method both before and after decontamination work in order to confirm

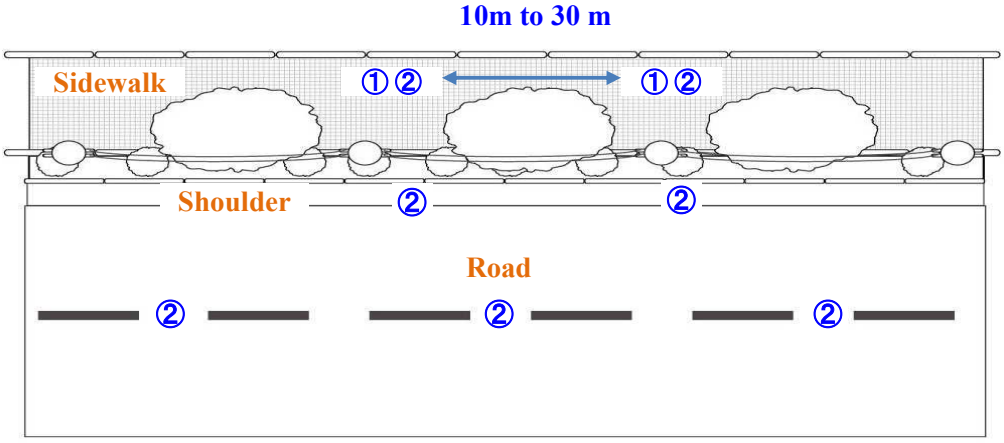
decontamination effects. The method of measurement for the air dose rate, etc. before decontamination work is explained below.

1）Determination of measurement points

Before decontamination work, the measurement points (Table 2-23) at which the air dose rate, etc. are to be measured should be decided and a schematic diagram illustrating the range of the measured objects, the measurement points, structures to be used as markers, etc. should be made (Figure 2-20). In addition, in setting these measurement points, hotspots and their ambient areas that contribute insubstantially to the radiation dose in the living space are not to be used as measurement points unless the users, etc. are deemed likely to spend relatively large amounts of time there.

Table 2-23 Reasoning behind the measurement points for air dose rates and and other measures and the decontamination of roads

Measurement points	No. 1 measurement points （①）	No. 2 measurement points(②)
Objects subject to measurement	Air dose rate in living spaces	Surface contamination density, etc. for objects subject to decontamination
Reasoning behind the measurement points	• Measurement points shall be set at intervals that allow the air dose rate distribution to be ascertained near the centerline of sidewalks. • If there are no sidewalks, appropriate points shall be determined by confirming the usage status of the road. (Example)Pitch of approx. 10 –30 m	• Measurement points shall be set at intervals that allow the air dose rate, etc. distribution to be ascertained for each road surface, road shoulder, street drain, and sidewalk. (Example)Pitch of approx. 10 –30 m



①:Contamination status for living spaces

②:Contamination status for objects subject to decontamination (surface contamination density, surface dose rate

Figure 2-20 Example schematic diagram for reporting measurement points for use in decontamination and other measures for roads.

2）Measurement methods

It is recommended that for the measurement point marked as ① the apparatuses such as NaI scintillation survey meters which are able to measure gamma rays should be used and for the measurement point marked as ②, GM survey meters should be used.

（3） Decontamination methods

This section explains the flow of the overall decontamination work for roads (Figure 2-21) that is efficiently focused on the places with comparatively high concentrations of radioactive materials that contribute substantially to the radiation dose. When water is used in decontamination work on roads or for similar work, radioactive materials may migrate to the roadsides or street drains. Therefore, when using water, it is more efficient to first remove the sediments from the roadsides and street drains, then clean the roads, and finally clean the roadsides and street drains again. Decontamination methods for roadsides and street drains, as well as paved surfaces and unpaved roads are described in terms of the items such as basic flow, necessary measures for prior decontamination work and decontamination methods and notes of caution.

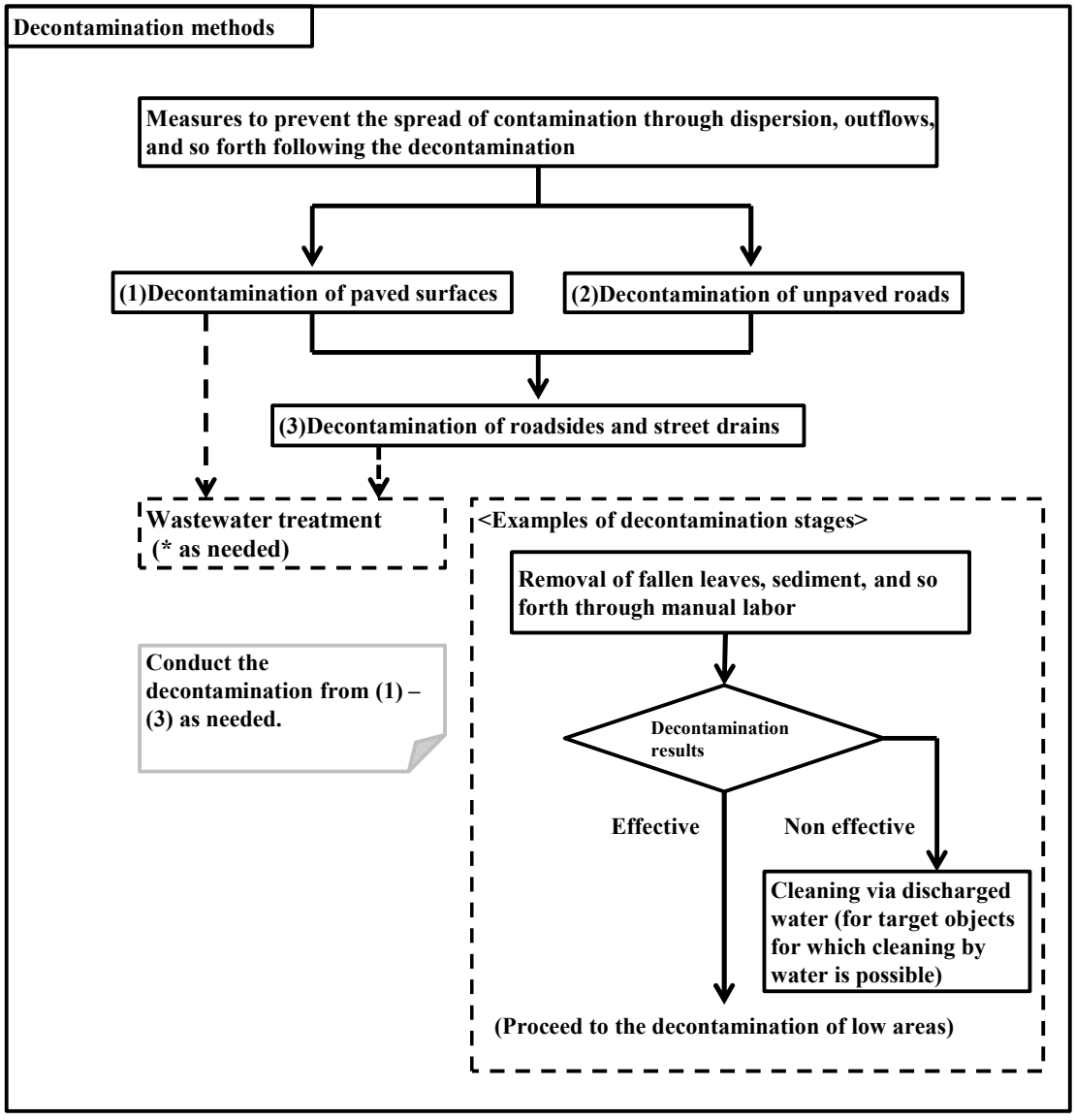


Figure 2-21 Basic flow for the decontamination of roads.

1）Decontamination of paved surfaces

This section explains the flow of decontamination for paved surfaces of roads (and sidewalks) as shown in Figure 2-22. The necessary measures prior to the decontamination work are in Table 2-24. The decontamination methods and notes of caution are in Table 2-25.

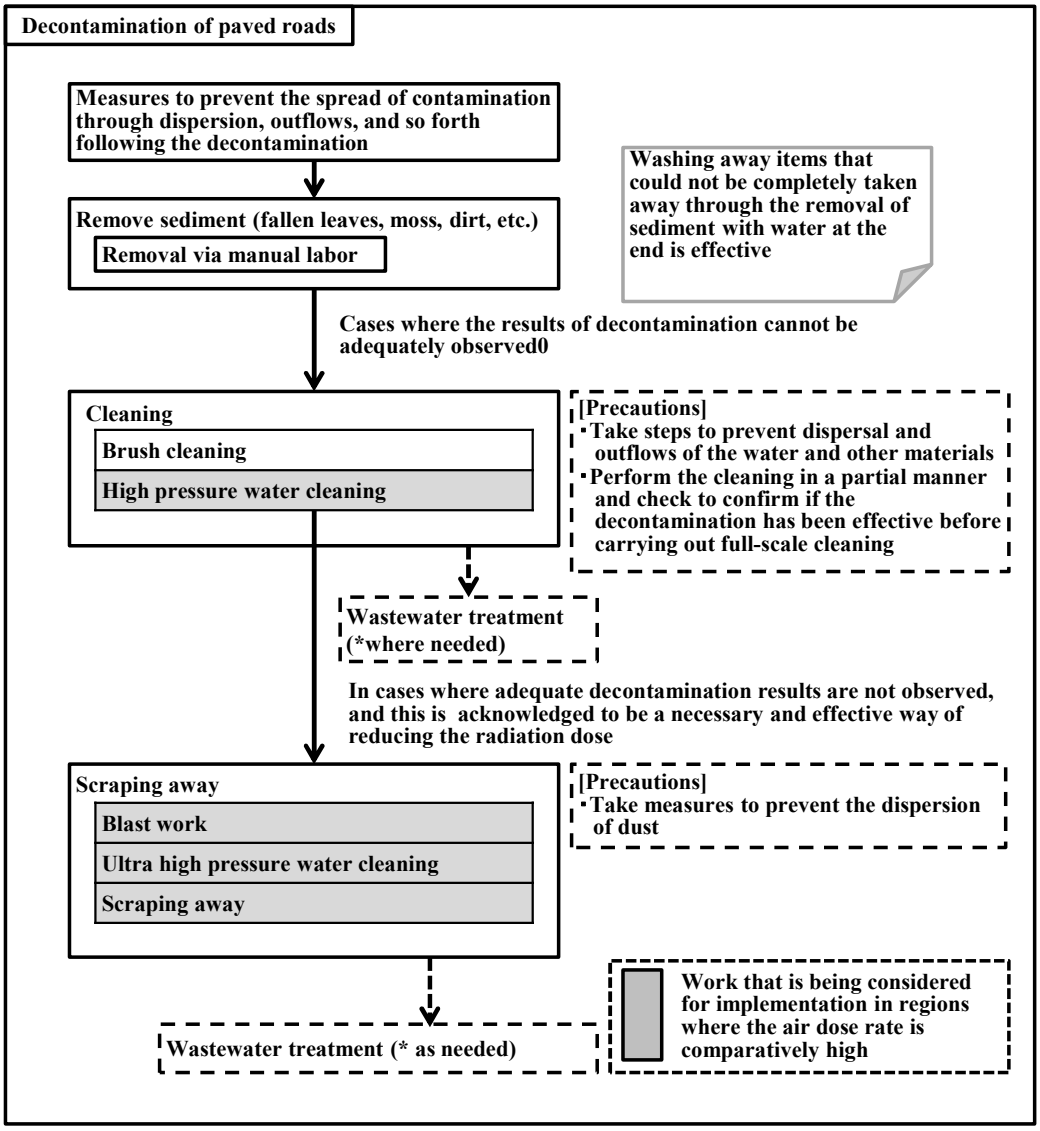


Figure 2-22 Basic flow for the decontamination of paved surfaces.

Table 2-24 Necessary measures prior to the decontamination of paved surfaces

Category	Decontamination methods and notes of caution
Safety management	• If traffic cannot be stopped when the decontamination work is carried out, then adequate safety management shall be undertaken through measures like allocating traffic controllers or the like.
Prevention of dispersion	• When carrying out decontamination work that uses water, measures shall be taken to prevent the dispersion of the cleaning water.
Ensuring drainage channels and wastewater treatment	• Sediment on roads, on roadsides, and in street drains shall be removed before cleaning with water. • When using water to clean, the channel for cleaning water to flow shall be checked beforehand and the drainage channel cleaned in advance to enable smooth drainage. • See “4. (2) Wastewater Treatment” regarding the treatment of wastewater.

Table 2-25 Decontamination methods for paved surfaces and notes of caution

Category		Decontamination methods and notes of caution
Removal of sediments	Removal through manual labor	• Fallen leaves, moss, mud, and other sediments shall be removed by hand by people wearing rubber gloves, shovel, or road sweeper, etc.
Cleaning	Brush cleaning	• Cleaning shall be performed from high places to low ones so as to avoid dispersing water to the surroundings. • With drainage pavement functional recovery cars, attention must be paid to the fact that in some cases their cleaning and drainage recovery functions may decline on surfaces where distortion or wear has occurred due to the effects of earthquakes, etc.
	High pressure water cleaning	• To prevent dispersion of soil, etc. by water pressure, cleaning shall be performed at low pressure initially and the pressure shall be raised gradually while checking the flow of cleaning water and the dispersion conditions. • Water recovery-type high pressure water cleaning is also effective. • To achieve a decontamination effect, the spray nozzle shall be brought near the place to be decontaminated. • When decontamination is carried out over a wide range, attention must be paid to ensure that no variance occurs between the work methods at different points (height of the nozzle over the ground, work time per unit of surface area, etc.)
Scraping away	Blast work	• Abrasive materials shall be shot at the surface with a shot blaster and scraped away from said surface uniformly. • In order to prevent dust from arising, curing, etc. shall be performed to prevent dispersion of dust to the surroundings and the dust shall be collected. • For blast work, curing shall be performed to ensure that abrasive materials and the like do not travel outside of the decontamination work zone. What is more, after the abrasive materials and other materials have been used they shall be collected in a manner that ensures that they will not scatter the radioactive materials adhering to them to the surroundings. • When scraping away material on interlocking concrete blocks, attention must be paid to the fact that scrapings and radioactive materials may be left behind in the gaps between the blocks.
	Ultra-high pressure water cleaning	• Ultra-high pressure water cleaner (cleaning water recovery-type) of 150 MPa or higher shall be used for scraping material away on paved surfaces. • A powerful vacuum truck shall be used to collect any scrapings that arise.
	Scraping away	• A surface cutter or the like shall be used to scrape away the paved surface. • Dispersion to the surroundings shall be prevented when scraping away contamination. • (Example: use of dust collectors, sprinkling in advance, setting up simple plastic housings, etc.)

2）Decontamination of unpaved roads

The flow of decontamination for unpaved surfaces of roads is shown in Figure 2-23. The necessary measures prior to the decontamination work are in Table 2-26. The decontamination methods and notes of caution are in Table 2-27.

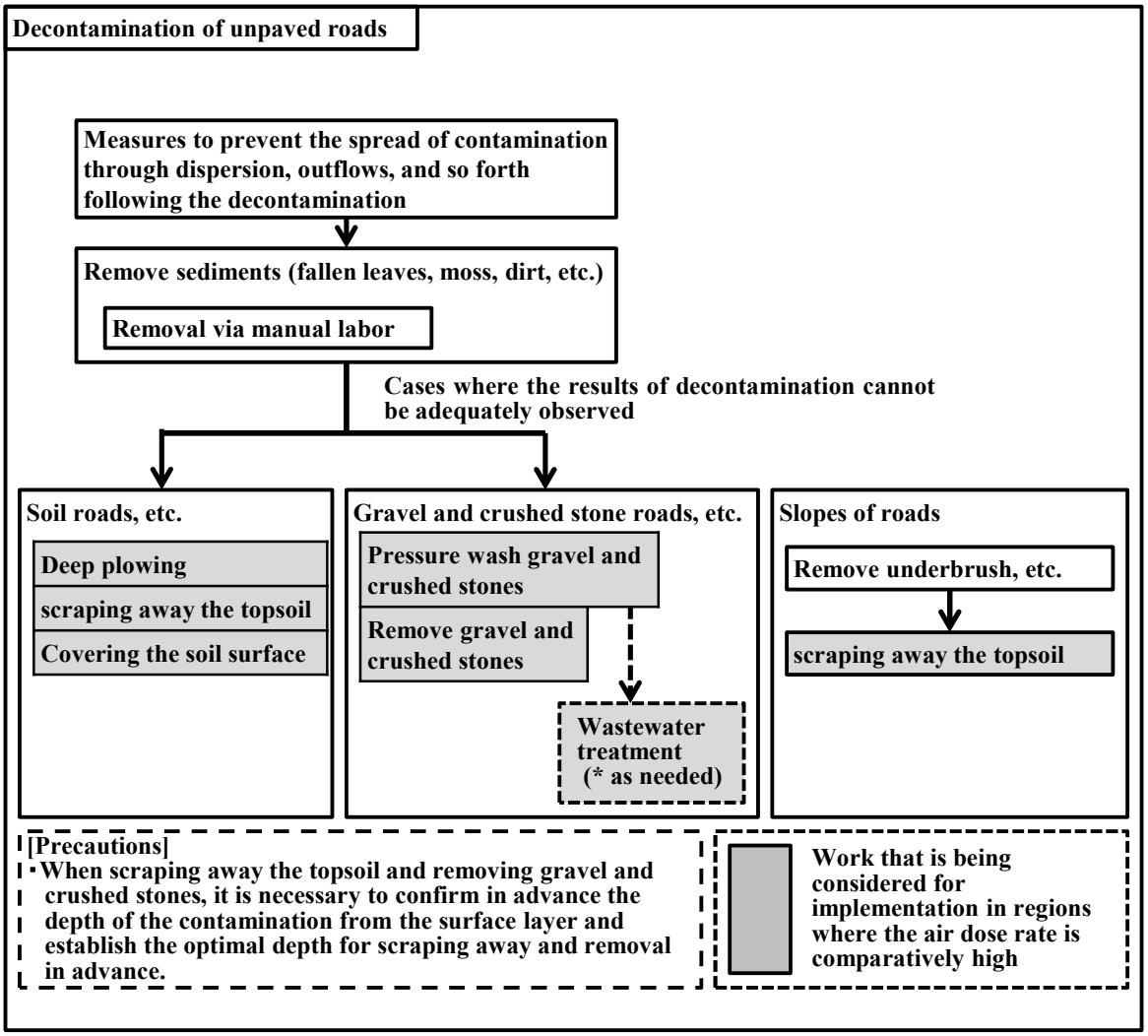


Figure 2-23 Basic flow for the decontamination of unpaved roads.

Table 2-26 Necessary measures prior to the decontamination of unpaved roads

Category	Decontamination methods and notes of caution
Prevention of dispersion	• When scraping away the topsoil when it comes to dried soil, efforts can be made to prevent the dispersion of dust by scattering solidification agents over the area in advance to solidify the soil surface.

Table 2-27 Decontamination methods for unpaved roads and notes of caution

Category		Decontamination methods and notes of caution
Removal of sediments	Removal through manual labor	• Soil with fallen leaves, moss, mud, and other sediments shall be removed by hand by people wearing rubber gloves and by shovel, etc.
Soil roads, etc.	Deep plowing	• About 10 cm of topsoil shall be uniformly scraped away and temporarily piled on top of a plastic sheet or the like. • About 20 cm of subsoil shall be uniformly scraped away and piled on top of a separate location from the topsoil. • After the topsoil has been uniformly spread out, the subsoil shall be uniformly spread on top of it and the land will be leveled. It shall be restored to its original height at a compactness that is about the same as it was before.
	Scraping away topsoil	• A backhoe or the like shall be used to uniformly scrape away the surface. • Dispersion to the surroundings shall be prevented when scraping away contamination. (Example: use of dust collectors, sprinkling in advance, setting up simple plastic housings, etc.)
	Covering the surface soil	• The surface soil shall be covered with soil that does not contain radiocaesium.
Gravel and crushed stone roads, etc.	High pressure water cleaning of gravel and crushed stones	• A backhoe or the like shall be used to place the gravel or crushed stones into a water tank and then high pressure water cleaning will be performed. • To prevent dispersion of soil, etc. by water pressure when performing high pressure water cleaning, cleaning shall be performed at low pressure initially and the pressure shall be raised gradually while checking the flow of cleaning water and the dispersion conditions. • See "4. (2) Wastewater Treatment" regarding the treatment of wastewater.
	Removal of gravel and crushed stones	• The gravel or crushed stones shall be uniformly removed with a backhoe or the like. • When gravel or crushed stones are removed, the area shall be covered by using the same type of gravel or crushed stones as before, and it shall be covered to the same standing height as before and to about the same compactness as before. • Attention shall be paid to the fact that because of the large air gaps when covering with crushed stones, density adjustments shall be performed via the appropriate surface compaction.
Slopes of roads	Removal of underbrush	• Weed removal and weeding shall be conducted using a shoulder-type mower or human power.
	Removal of topsoil	• Human power, a backhoe, or the like shall be used to uniformly scrape away the surface. • Dispersion to the surroundings shall be prevented when scraping away contamination.

3）Decontamination of roadsides and street drains

The flow of decontamination for roadsides and street drains is shown in Figure 2-24. The necessary measures prior to the decontamination work are in Table 2-28. The decontamination methods and notes of caution are in Table 2-29.

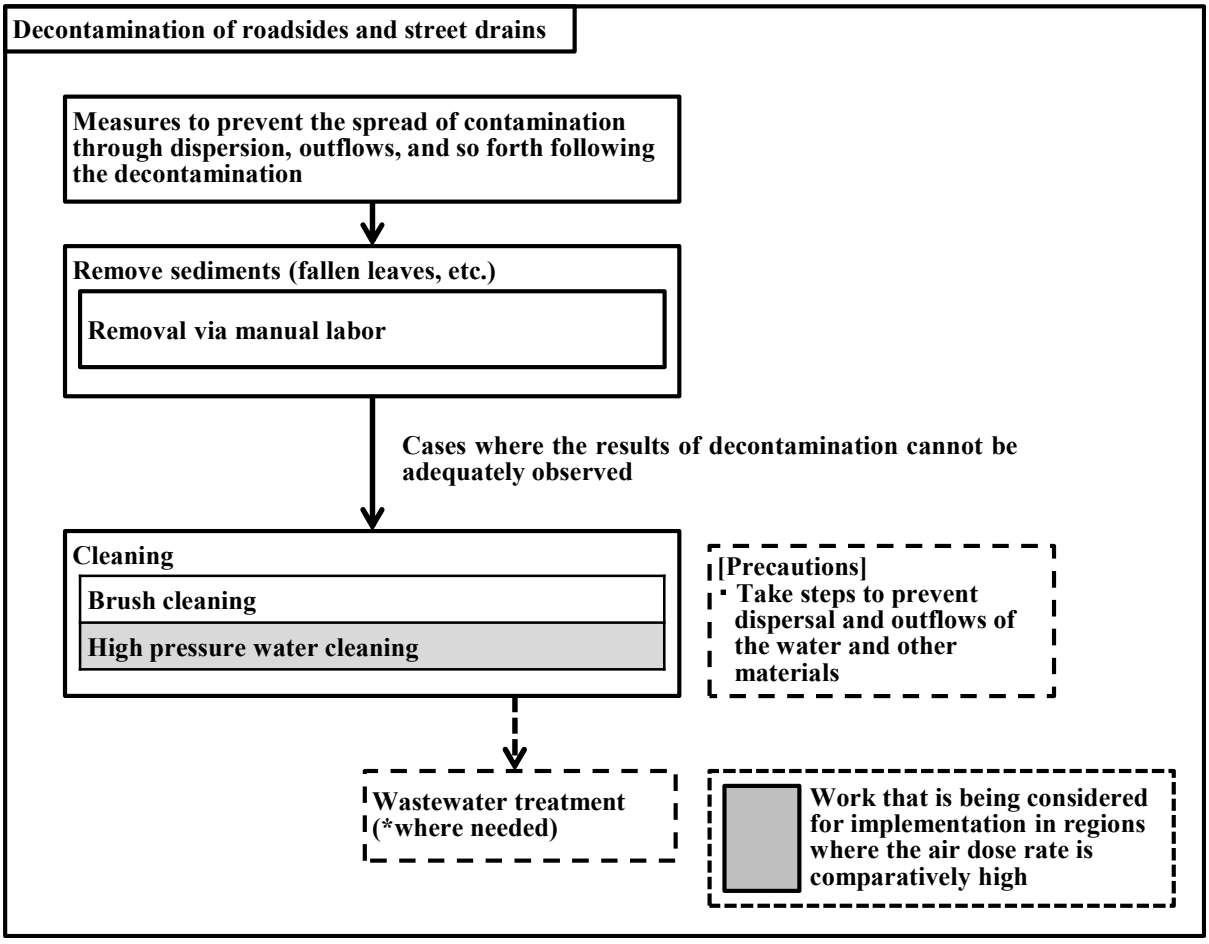


Figure 2-24 Basic flow for the decontamination of roadsides and street drains.

Table 2-28 Necessary measures prior to the decontamination of roadsides and street drains

Category	Decontamination methods and notes of caution
Prevention of dispersion	• If sidewalks and buildings are immediately adjacent, curing shall be performed to prevent dispersion of water, etc.
Ensuring drainage channels and wastewater treatment	• When using water to clean, the channel for cleaning water to flow shall be checked beforehand and the drainage channel cleaned in advance to enable smooth drainage. • See "4. (2) Wastewater Treatment" regarding the treatment of wastewater.

Table 2-29 Decontamination methods for roadsides and street drains and notes of caution

Category		Decontamination methods and notes of caution
Removal of sediments	Removal through manual labor	• Fallen leaves, moss, mud, and other sediments that are easy to remove shall be removed in advance by shovel, etc. • When the concrete joints of street drains are deep, a spatula or the like
Cleaning	Brush cleaning	• Cleaning shall be thoroughly performed by using scrub brushes or scrubbing brushes. • Cleaning shall be performed from high places to low ones so as to avoid dispersing water to the surroundings.
	High pressure water cleaning	• To prevent dispersion of soil, etc. by water pressure, cleaning shall be performed at low pressure initially and the pressure shall be raised gradually while checking the flow of cleaning water and the dispersion conditions. • To achieve a decontamination effect, the spray nozzle shall be brought near the place to be decontaminated.

(4) Post–work measures

This section explains handling the removed soil, etc., wastewater treatment, and cleaning equipment used, etc. as post-work measures.The details appear in 2.2.2.(4) of this report.

(5) Subsequent measurements and records

To confirm the decontamination effect, the air dose rate, etc. should be measured after completion of the decontamination work and recorded as shown in Table 2-30.

Table 2-30 Subsequent measurements and records for the decontamination of roads

Measurement of air dose rate, etc.	• The air dose rate, etc. shall be measured at each measurement point. • Measurements shall be carried out in the same location as the prior measurements and under the same conditions to the extent possible. • For the measuring apparatus, the same apparatus as was used for the prior measurements shall be used to the extent possible.
Recordkeeping	• The air dose rate, etc. at each measurement point, places where decontamination work was performed, decontamination date, names of the decontaminators, type of objects decontaminated, decontamination methods, total decontamination area (of soil, etc.), the approximate weight of the removed soil, etc., and the status of storage and disposal. • The equipment used in decontamination and the method of disposal after use. • See "Part 4: Guidelines Pertaining to the Storage of Removed Soil" for details on the items to record with regard to the storage of removed soil.

2.2.4. Decontamination and Other Measures for Soil

This section explains preparation, prior measurements, decontamination methods, post-work measures, and subsequent measurements and records, in the basic flow (Figure 2-25), pertaining to decontamination and other measures for soil in schoolyards, kindergarten yards, parks, farmland, and other comparatively large land spaces.

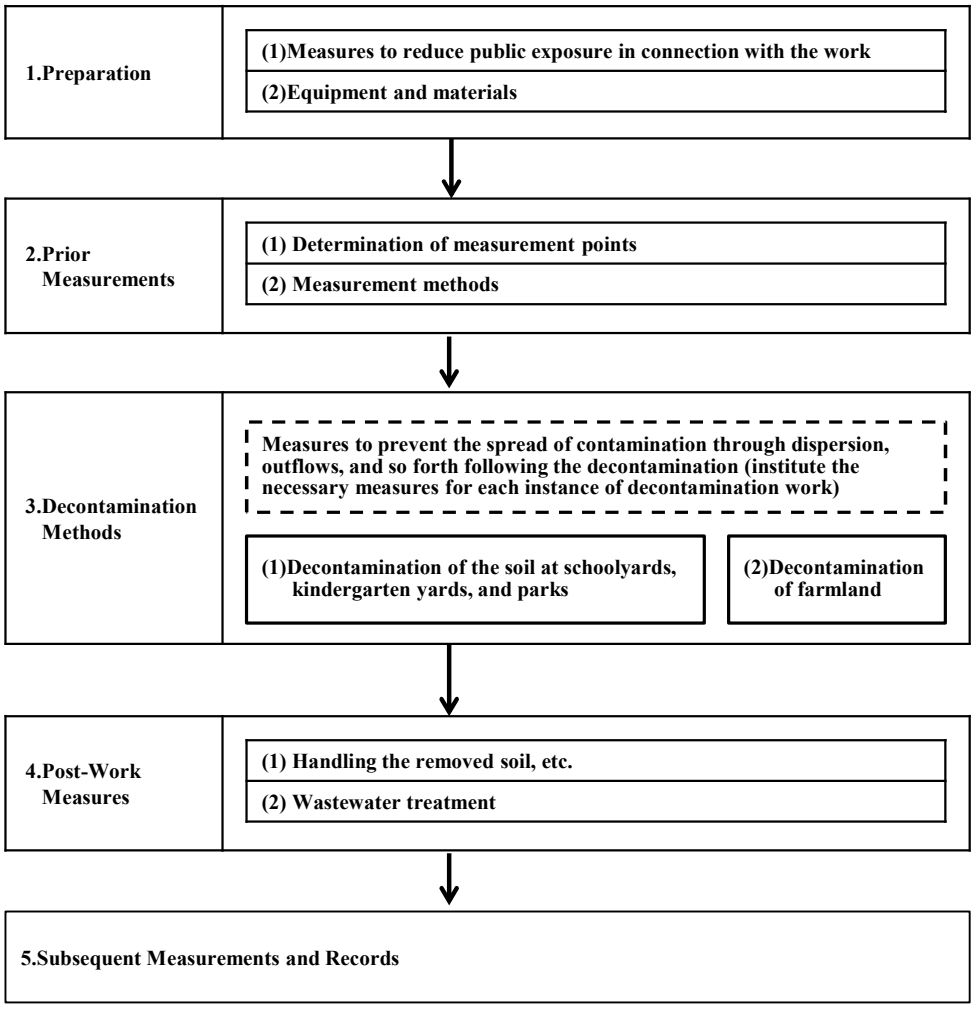


Figure 2-25 Basic flow for decontamination and other measures for soil.

（1） Preparation

Before performing decontamination work, in addition to preparing the equipment required for the work, preparations must be made to ensure safety of workers and the general public to prevent their exposure to hazards, such as by inhaling dust generated during decontamination work; these preparations are summarized in Table 2-31.

Table 2-31 Preparation for decontamination and other measures for soil

<table>
<tr><td rowspan="2">Measures to Reduce Public Exposure in Connection with Decontamination Work</td><td colspan="2">Restriction of entry</td><td>• In cases where the general public is deemed likely to enter the area, the area shall be cordoned off with pylons or rope, etc. to prevent people from unnecessarily approaching the work site, and the entry of people and vehicles shall be restricted.
• In cases where radioactive materials may be dispersed in connection with the decontamination work, the perimeter of the decontamination area shall be fenced in with sheets, etc., water shall be sprayed, or other such measures shall be taken to prevent dispersion and the area shall be cordoned off with rope, etc.</td></tr>
<tr><td colspan="2">Signage</td><td>• In cases where the general public is deemed likely to enter the area, signs, etc. shall be put up to alert the public that decontamination work is being performed.</td></tr>
<tr><td rowspan="7">Preparation of decontamination equipment and materials</td><td colspan="2">General equipment</td><td>Examples:
Mower, hand shovel, grass sickle, broom, bamboo rake, dustpan, tongs, shovel, small shovel, metal rake, compact heavy machinery for scraping away topsoil, garbage bags (bags for burnable matter, burlap sacks for soil and sand (sandbags), large sandbags, flexible containers), vehicles for transporting collected removed soil, etc. to the on-site storage location or temporary storage site(truck, two-wheeled cart, etc.), aerial vehicle, ladder</td></tr>
<tr><td colspan="2">Equipment for cleaning with water</td><td>Examples:
Hose for water discharge</td></tr>
<tr><td colspan="2">equipment for removal of topsoil</td><td>Examples:
Bulldozer, hydraulic shovel</td></tr>
<tr><td colspan="2">Equipment for covering soil surfaces</td><td>Examples:
Self-propelled surface compaction roller, plywood for surface compaction, sprinkling equipment</td></tr>
<tr><td rowspan="3">Decontamination equipment for use on farmland</td><td>Equipment for scraping away topsoil</td><td>Examples:
Equipment required for scraping away topsoil, inversion tillage, and deep tillage (bulldozer, hydraulic shovel, tractor, vertical harrow and other attachments, rear blade, front loader), backhoe, grader, crane, vacuum car, mower, high pressure water cleaner, chipping machine, hammer knife mower, flexible containers</td></tr>
<tr><td>Equipment for mixing with water</td><td>Examples :
Tractor, vertical harrow and other attachments, drainage pump, backhoe, crane, mower, water shielding sheets, flexible containers</td></tr>
<tr><td>Equipment for inversion tillage and deep tillage</td><td>Examples:
Tractor, deep-tillage plow, deep-tillage rotary, mower</td></tr>
</table>

（2） Prior measurements

The air dose rate, etc. should be measured and recorded at the same location and by the same method both before and after decontamination work in order to confirm decontamination effects. The method of measurement for the air dose rate, etc. before decontamination work is explained below.

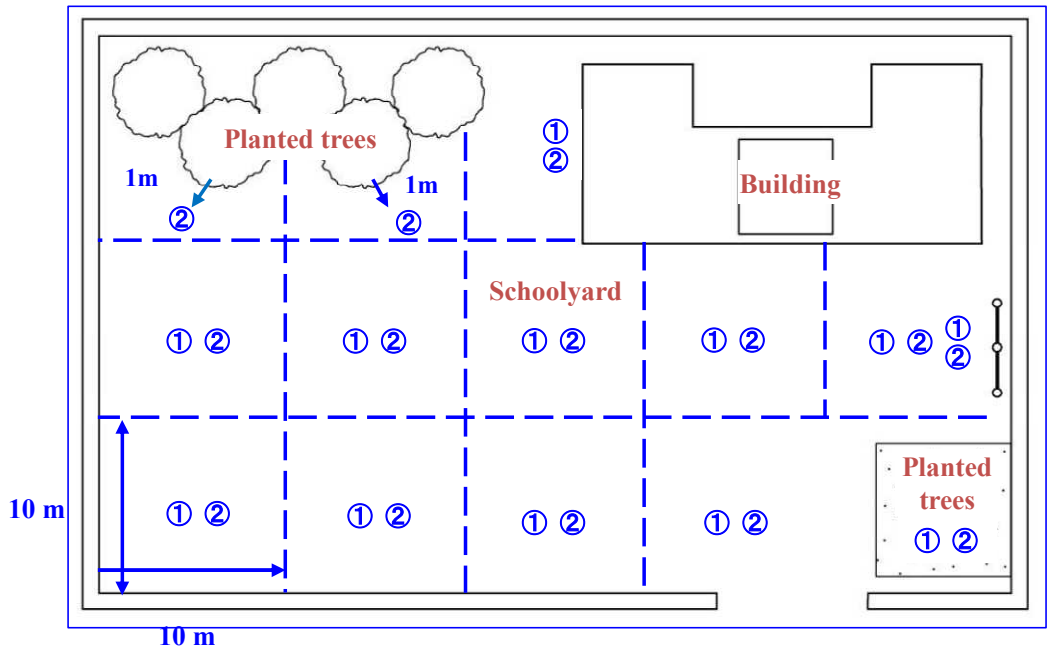
1）Determination of measurement points

Before decontamination work, the measurement points (Table 2-32) at which the air dose rate, etc. are to be measured should be decided and a schematic diagram illustrating the range of the measured objects, the measurement points, structures to be used as markers, etc. should be made (Figure 2-26). In addition, in setting these measurement points, hotspots and their ambient areas that contribute insubstantially to the radiation dose in the living space should not be used as measurement points unless the users, etc. are deemed likely to spend relatively large amounts of time there..

Table 2-32 Reasoning behind the measurement points for air dose rates and other measures for the decontamination of soil

Measurement point	No. 1 measurement points(①)	No. 2 measurement points（②）
Measurement target	Air dose rate in living spaces	Surface contamination density, etc. for objects subject to decontamination
Reasoning behind the measurement points	• ・Measurement points shall be set at intervals that allow the air dose rate distribution to be ascertained. 【Schools (school buildings, schoolyards)】 • For schoolyards, the schoolyards shall be divided up into meshes of about 10 –30 m and measurements shall be conducted at one spot in each mesh (in cases where there will presumably be little variance in the air dose rate, measurements may also be taken in approximately five locations that have been uniformly dispersed). The need to conduct decontamination and the contents of this shall be determined based on the mean values from this. • For school buildings, measurements shall be carried out in approximately five measurement points at places where people are deemed likely to spend relatively large amounts of time in the vicinity around school buildings. The need to conduct decontamination and the contents of this shall be determined based on the mean values from this. For the school building as a whole, measurements can be carried out at multiple points in places where people are deemed likely to spend relatively large amounts of time (roughly the total from the several measurement points in the schoolyard and school building mentioned above), and the need to conduct decontamination and the contents of this can be determined based on the mean values from this.	Same as with No. 1 measurement points.（①）

	【Farmland and pastureland】 • Farmland and pastureland shall be divided up into meshes of about 10 –30 m and measurements shall be conducted at one spot in each mesh. However, changes can be made to this in cases where said land has a vast surface area according to the conditions. The need to conduct decontamination and the contents of this shall be determined based on the mean values from this.	



①:Contamination status for living spaces
②:Contamination status for objects subject to decontamination (surface contamination density, surface dose rate)

Figure 2-26 Example of a schematic diagram for reporting measurement points for use in decontamination and other measures for soil (schoolyards).

2）Measurement methods

It is recommended that for the measurement point marked as ① the apparatuses such as NaI scintillation survey meters which are able to measure gamma rays should be used and for the measurement point marked as ②, GM survey meters should be used. Table 2-33 presents measurement methods specifically for radiocesium concentration in farmland soil.

Table 2-33 Measurement methods for the radiocesium concentration in farmland soil

Measuring apparatus used	• Estimates from germanium semiconductor detectors, NaI scintillation spectrometers, LaBr3(Lanthanum bromide) scintillation spectrometers, and air dose rate
Calibration	• At least once a year, calibration shall be performed using standard radiation sources with known amounts of radioactivity.
Daily check	• The remaining battery level, breakage of cables and connectors, and status of high voltage application shall be checked, and inspections of switch operability, etc. shall be carried out. • Measurements shall be performed at the same places where the background radiation does not vary substantially, and it shall be confirmed that there are no large variations by comparing with past values.
Prevention of contamination	• ・The body and detecting element of the measuring apparatus shall be covered with thin plastic sheet, etc. • The plastic sheet, etc. shall be replaced with new material when it gets dirty or breaks.
Measurement	• For rice fields, soil shall be extracted from the surface of the measurement point down to 15 cm deep in the ground, and after the soil has been dried the radiocaesium concentration in the soil shall be measured using a germanium semiconductor detector. • For dry fields, soil shall be extracted from the surface of the measurement point down to the depth of the plow layer (15 to 30 cm), and after the soil has been dried the radiocaesium concentration in the soil shall be measured using a germanium semiconductor detector.
Records	• The measurer shall record the air dose rate, etc. and radiocaesium concentration at each measurement point shown in the conceptual diagram, etc., along with the date and time of measurement and the measuring apparatus used.

（3） Decontamination methods

This section explains the flow of the overall decontamination work for soil (Figure 2-27) that is efficiently focused on the places with comparatively high concentrations of radioactive materials that contribute substantially to the radiation dose. The arrangement of the overall schedule should be made so as to avoid undertaking decontamination of two or more large areas within a municipality at the same time whenever possible. The methods of decontamination for soil in schoolyards, kindergarten yards, and parks, as well as farmland are described in terms of the items such as basic flow, necessary measures for prior decontamination work and decontamination methods and notes of caution.

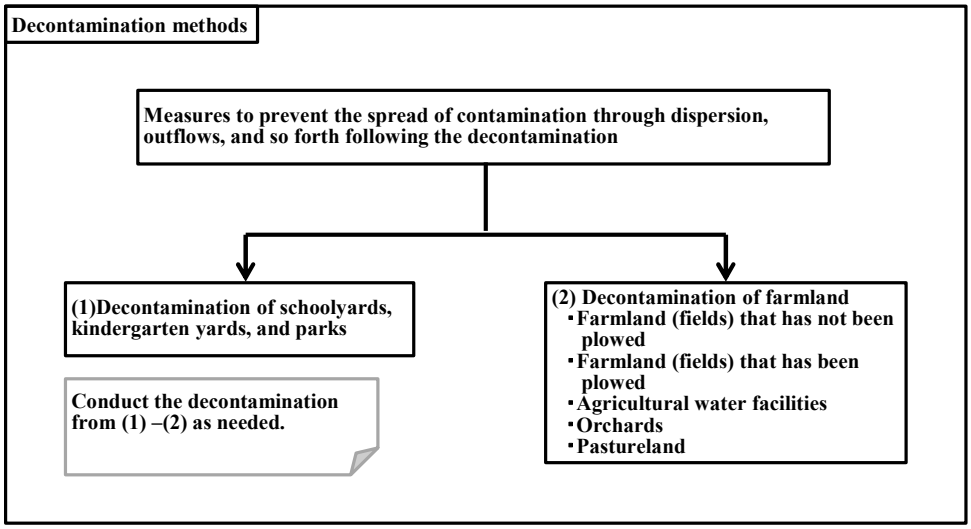


Figure 2-27 Basic flow for the decontamination of soil.

1）Decontamination of soil in schoolyards, kindergarten yards, and parks

The flow of decontamination for soil in schoolyards, kindergarten yards and parks is shown in Figure 2-28. The necessary measures prior to the decontamination work are in Table 2-34. The decontamination methods and notes of caution are in Table 2-35.

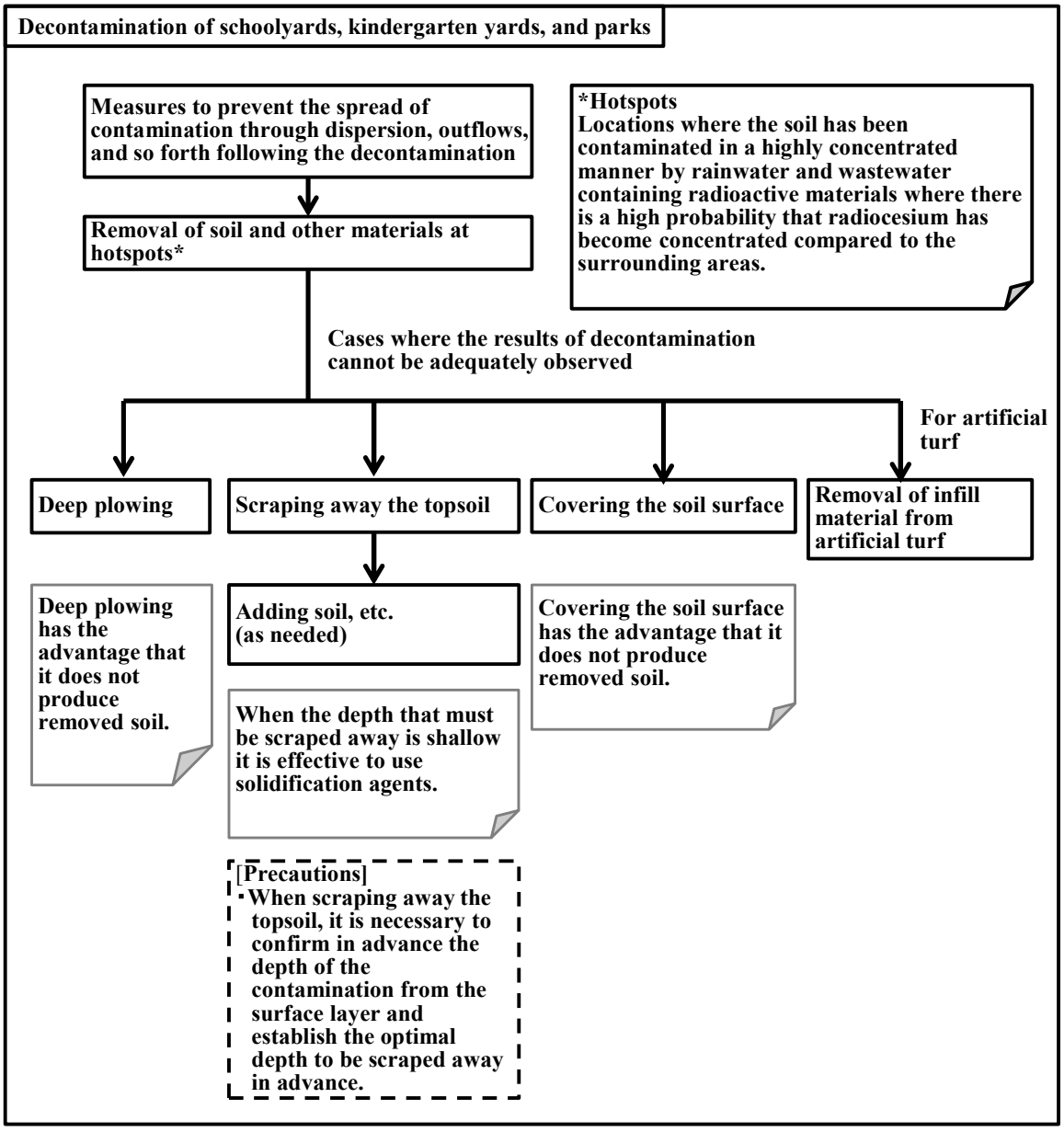


Figure 2-28 Basic flow for the decontamination of schoolyards, kindergarten yards, and parks.

Table 2-34 Necessary measures prior to the decontamination of schoolyards, kindergarten yards, and parks

Category	Decontamination methods and notes of caution
Prevention of dispersion	• When scraping away the topsoil when it comes to dried soil, efforts can be made to prevent the dispersion of dust by scattering solidification agents over the area in advance to solidify the soil surface.

Table 2-35 Decontamination methods for schoolyards, kindergarten yards, and parks and notes of caution

Category	Decontamination methods and notes of caution
Removal of sediments	• Fallen leaves, moss, mud, and other sediments shall be removed by hand by people wearing rubber gloves and by shovel, etc.
Deep plowing	• About 10 cm of topsoil shall be uniformly scraped away and temporarily piled on top of a plastic sheet or the like. • About 20 cm of subsoil shall be uniformly scraped away and piled on top of a separate location from the topsoil. • After the topsoil has been uniformly spread out, the subsoil shall be uniformly spread on top of it and the land will be leveled. It shall be restored to its original height at a compactness that is about the same as it was before.
Scraping away topsoil	• A backhoe or the like shall be used to uniformly scrape away the surface. • The remaining topsoil can be confirmed by means of sprinkling lime around in advance. • Scraping away by using a surface cutter or hammer knife mower is an effective method for covering vast areas. • Dispersion to the surroundings shall be prevented when scraping away contamination. (Example: use of dust collectors, sprinkling in advance, setting up simple plastic housings, etc.)
Covering the surface soil	• The surface soil shall be covered with soil that does not contain radiocaesium. • Attention shall be paid to the fact that because of the large air gaps when covering with crushed stones, density adjustments shall be performed via the appropriate surface compaction.
Removal of infill material from artificial turf	• The infill material found in artificial turf and the like shall be taken out via machinery that can absorb and remove said infill material.

2）Decontamination of farmland

The flow of decontamination for farmland is shown in Figure 2-29. The necessary measures prior to the decontamination work are in Table 2-36. The decontamination methods and notes of caution are in Table 2-37.

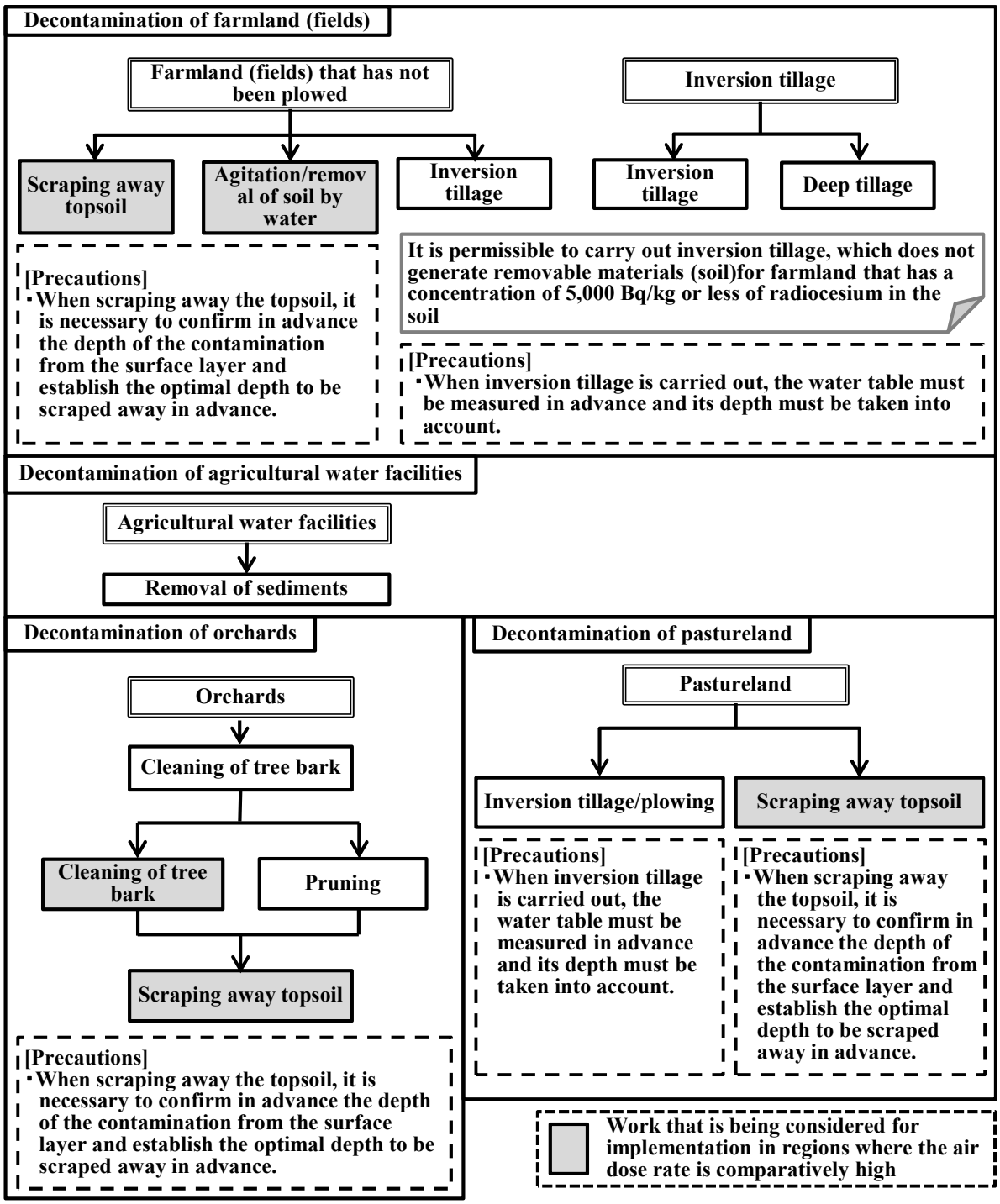


Figure 2-29 Basic flow of decontamination of farmland

Table 2-36 Necessary measures prior to the decontamination of farmland

Category	Decontamination methods and notes of caution
Prevention of dispersion	• When scraping away the topsoil when it comes to dried soil, efforts can be made to prevent the dispersion of dust by scattering solidification agents over the area in advance to solidify the soil surface.

Table 2-37 Decontamination methods for farmland and notes of caution

Category		Decontamination methods and notes of caution
Unplowed	Scraping away topsoil	• A backhoe or the like shall be used to scrape away the surface. • The remaining topsoil can be confirmed by means of sprinkling lime around in advance.
	Soil agitation or removal by water	• After the upper layer of soil has been agitated (shallow puddled), the turbid water with fine soil particles floating in it shall be forcefully drained via a pump. Then solid-liquid separation shall be performed in a grit chamber or similar device that has been covered with a plastic sheet to collect the soil particles.
	Inversion tillage	• A plow shall be used to invert the soil so that the contaminated soil in the top layer is moved to the bottom layer and the uncontaminated soil from the bottom layer is placed on the top layer. • The tillage depth for inversion tillage shall be 30 cm in principal. However, in cases where soil that is not suitable for use as the plow layer will come to the surface, such as soil that contains pebbles, then the tillage depth shall be set shallowly after first confirming that adequate decontamination results will be obtained from this. • The water table shall be measured and its depth taken into account when performing inversion tillage as needed. • Attention must be paid to the fact that small tractors cannot be used to agitate the soil in cases where the topsoil is frozen due to cold temperatures.
Plowed	Inversion tillage	• (Same as above)
	Deep tillage	• A deep tillage rotary tiller shall be used to deeply till cultivated land about two times. The tillage depth of deep tillage shall be about 30 cm in principal.
Water facilities	Removal of sediments	• Mud and other sediments that have accumulated in agricultural drainage canals and other such facilities shall be removed through the use of a shovel or the like.
Orchards	Debarking	• Tree bark shall be removed by primarily concentrating on the top sand sides of main trunks and main branches. • A dedicated chipping tool shall be used to scrape away so as to take off tree bark that has grown old.
	Cleaning tree bark	• Tree species that do not have a configuration in which old tree bark can be removed from their branches and trunks (peach trees, cherry trees, etc.) shall be subject to cleaning. • When cleaning bark or debarking with the use of a high pressure water cleaner, radiocaesium tends to easily disperse together with the water, and so the use of these procedures shall be avoided during the growing season and be carried out during dormant stages.

	Pruning	• Old branches to which it is thought that radiocaesium is directly • Adhering shall be removed. • The branches shall be removed during the tree's dormant stage so that this does not affect its growth.
	Scraping away topsoil	• The soil shall be removed by human power or via an earth blade on a small backhoe. Or a rotary tiller shall be attached to a small tractor and the soil shall be lightly tilled, after which the topsoil shall be removed by a method such as gathering up the topsoil through the use of a front loader (without a claw) on a tractor.
Pastureland	Inversion tillage / plowing	• A plow shall be used to invert the soil so that the contaminated soil in the top layer is moved to the bottom layer and the uncontaminated soil from the bottom layer is placed on the top layer. • The tillage depth for inversion tillage shall be 30 cm in principal. However, in cases where soil that is not suitable for use as the plow layer will come to the surface, such as soil that contains pebbles, then the tillage depth shall be set shallowly after first confirming that adequate decontamination results will be obtained from this. • The water table shall be measured and its depth taken into account when performing inversion tillage as needed. • Attention must be paid to the fact that small tractors cannot be used to agitate the soil in cases where the topsoil is frozen due to cold temperatures.
	Scraping away topsoil	• ・A backhoe or the like shall be used to scrape away the surface.

（4） Post–work measures

This section explains handling the removed soil, etc., and cleaning equipment used, etc. as post-work measures. Handling the removed soil, etc. is described in 2.2.2 (4) 1) of this report and cleaning equipment used, etc.is described in 2.2.2 (4) 3) of this report.

（5） Subsequent measurements and records

To confirm the decontamination effect, the air dose rate, etc. should be measured after completion of the decontamination work and recorded as shown in Table 2-38.

Table 2-38 Subsequent measurements and records for the decontamination of soil

Measurement of air dose rate, etc. and radiocaesium concentration, etc.	• The air dose rate, etc. and radiocaesium concentration in the soil (in the case of farmland) shall be measured at each measurement point. • Measurements shall be carried out in the same location as the prior measurements and under the same conditions to the extent possible. • For the measuring apparatus, the same apparatus as was used for the prior measurements shall be used to the extent possible.
Recordkeeping	• Air dose rate, etc. and radiocaesium concentration in the soil at each measurement point, places for which decontamination work was performed, date of decontamination, names of decontaminators, types of objects subject to decontamination, method of decontamination, total

	area decontaminated (soil, etc.), the approximate weight of the removed soil, etc., and the status of storage and disposal. • The equipment used in decontamination and the method of disposal after use. • See "Part 4: Guidelines Pertaining to the Storage of Removed Soil" for details on the items to record with regard to the storage of removed soil.

2.2.5. Decontamination and Other Measures for Vegetation

This section explains preparation, prior measurements, decontamination methods, post-work measures, and subsequent measurements and records, in the basic flow (Figure 2-30), pertaining to the decontamination and other measures for vegetation.

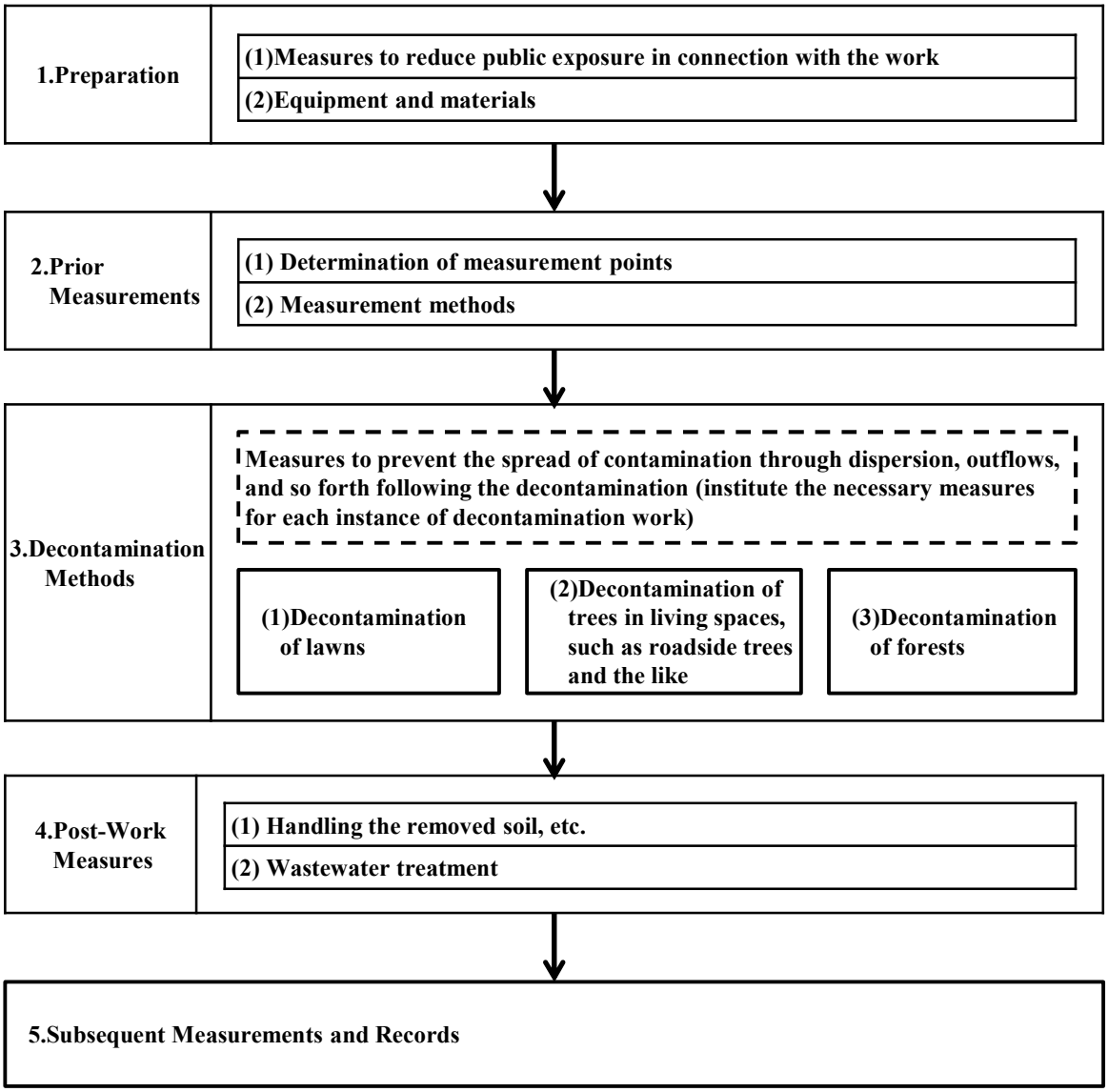


Figure 2-30 Basic flow for decontamination and other measures for vegetation.

（1） Preparation

Before performing decontamination work, in addition to preparing the equipment required for the work, preparations must be made to ensure safety of workers and the general public to prevent their exposure to hazards, such as by inhaling dust generated during decontamination work; these preparations are summarized in Table 2-39.

Table 2-39 Preparation for measures on decontamination work for vegetation

Measures to reduce public exposure in connection with decontamination work	Restriction of entry	• In cases where the general public is deemed likely to enter the area, the area shall be cordoned off with pylons or rope, etc. to prevent people from unnecessarily approaching the work site, and the entry of people and vehicles shall be restricted. • In cases where radioactive materials may be dispersed in connection with the decontamination work, the perimeter of the decontamination area shall be fenced in with sheets, etc., water shall be sprayed, or other such measures shall be taken to prevent dispersion and the area shall be cordoned off with rope, etc.
	Signage	• In cases where the general public is deemed likely to enter the area, signs, etc. shall be put up to alert the public that decontamination work is being performed
Preparation of Equipment and Materials	General equipment	Examples： Mower, hand shovel, grass sickle, broom, bamboo rake, dustpan, tongs, shovel, small shovel, metal rake, compact heavy machinery for scraping away topsoil, garbage bags (bags for burnable matter, burlap sacks for soil and sand (sandbags)), vehicles for transporting collected removed soil, etc. to the on-site storage location (truck, two-wheeled cart, etc.)
	equipment for pruning trees	Examples： Hatchet, pruner, chainsaw, stepladder, mobile lift, and saw

（2） Prior measurements

The air dose rate, etc. should be measured and recorded at the same location and by the same method both before and after decontamination work in order to confirm decontamination effects. The method of measurement for the air dose rate, etc. before decontamination work is explained below.

1）Determination of measurement points

Before decontamination work, the measurement points (Table 2-40) at which the air dose rate, etc. are to be measured should be decided and a schematic diagram illustrating the range of the measured objects, the measurement points, structures to be used as markers, etc. should be made (Figure 2-31). In addition, in setting these measurement points, hotspots and their ambient areas that contribute insubstantially to the radiation dose in the living space should not be used as measurement points unless the users, etc. are deemed likely to spend relatively large amounts of time there.

Table 2-40 Reasoning behind the measurement points for air dose rates and other measures for the decontamination of vegetation

Measurement point	No. 1 measurement points （①）	No. 2 measurement points （②）
Measurement target	Air dose rate in living spaces	Surface contamination density, etc. for objects subject to decontamination
Reasoning behind the measurement points	• Measurement points shall be set at intervals that allow the air dose rate distribution to be ascertained. Lawns • Lawns shall be divided up into meshes of about 10 –30 m and measurements shall be conducted at one spot in each mesh. Forests • Measurements shall be conducted at one spot about every 20 –50 m near the forest edge and the geographical center of the forest where work will be performed.	• Same as with No. 1 measurement points （①） for lawns. • For roadside trees, measurement points shall be established within a range that will presumably be affected by the roadside tree (example: a position that is about 1 m away from the side of the roadside tree). • For forests, the points shall be as with No. 1 measurement points.

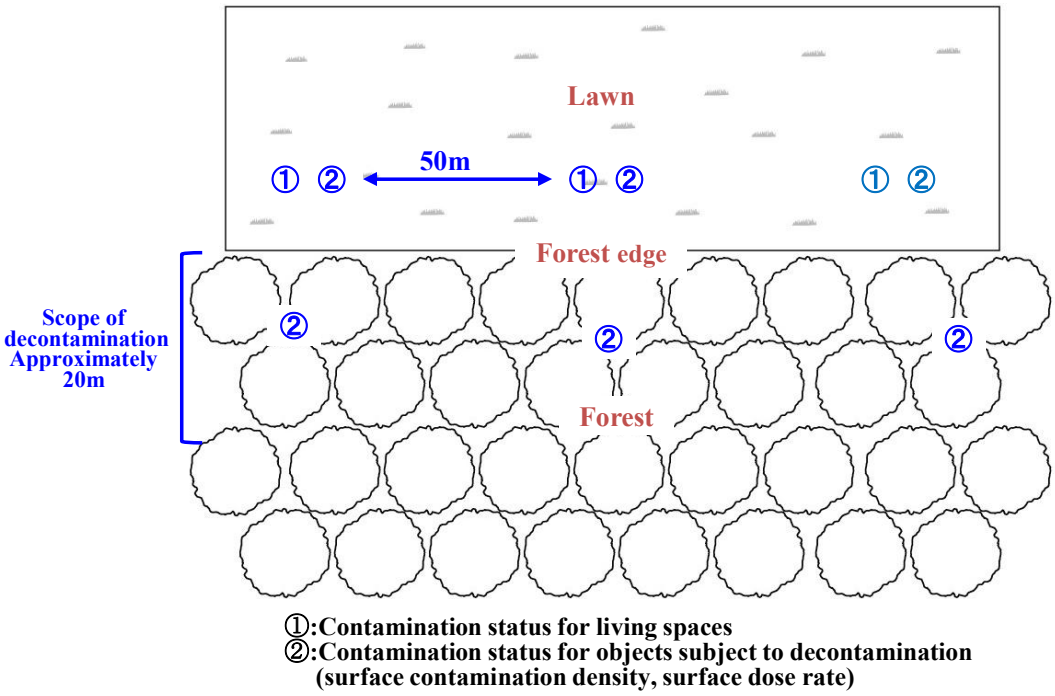


Figure 2-31 Example schematic diagram for reporting measurement points for use in decontamination and other measures for vegetation (forests).

2）Measurement methods

It is recommended that for the measurement point marked as ① the apparatuses such as NaI scintillation survey meters which are able to measure gamma rays should be used and for the No. 2 measurement point marked as ②,GM survey meters should be used..

（3） Decontamination Methods

The flow of decontamination for vegetation is explained in Figure 2-32. The necessary measures prior to the decontamination work are in Table 2-41. The decontamination methods and notes of caution are in Table 2-42.

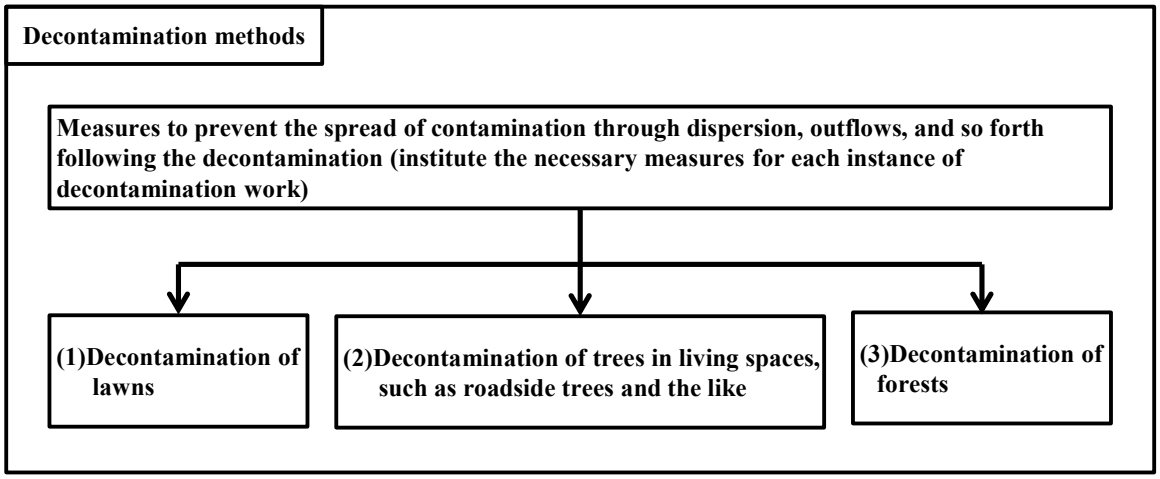


Figure 2-32 Basic flow for the decontamination of vegetation.

1）Decontamination of lawns

The flow of decontamination for lawns is in Figure 2-32. The necessary measures prior to the decontamination work are in Table 2-41. The decontamination methods and notes of caution are in Table 2-42.

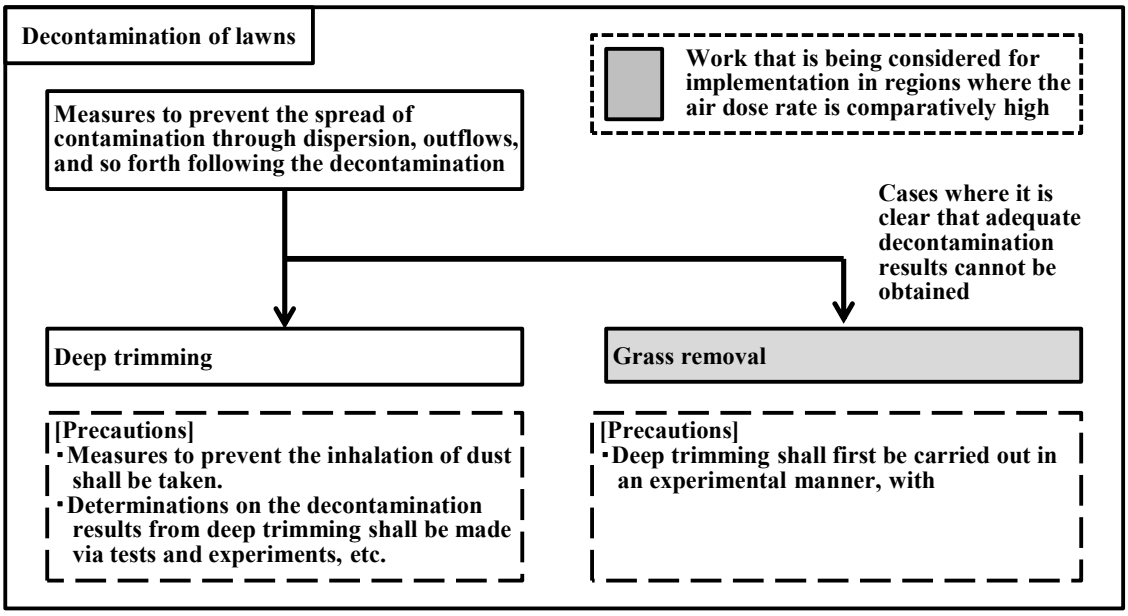


Figure 2-33 Basic flow for the decontamination of lawns.

Table 2-41 Necessary measures prior to the decontamination of lawns

Category	Decontamination methods and notes of caution
Prevention of dispersion	• If sidewalks and buildings are immediately adjacent, curing shall be performed to prevent the dispersion of dust, etc.

Table 2-42 Decontamination methods for lawns and notes of caution

Category	Decontamination methods and notes of caution
Deep trimming	• If large mowers will fit, then deep trimming shall be carried out using large mowers (shallow cutting down to approximately 3 cm, which is a level from which the grass can recover). • If large mowers will not fit, then the deep trimming of lawns shall be carried out using a hand guided mower (sod cutter, etc.)
Grass removal	• The flat claw for a backhoe bucket shall be installed and the grass and sod shall be removed (about 5 cm).

2) Decontamination of trees in living spaces, such as roadside trees and the like

The flow of decontamination for trees in living spaces, such as roadside trees and the like is explained in Figure 2-34. The necessary measures prior to the decontamination work are in Table 2-43. The decontamination methods and notes of caution are in Table 2-44.

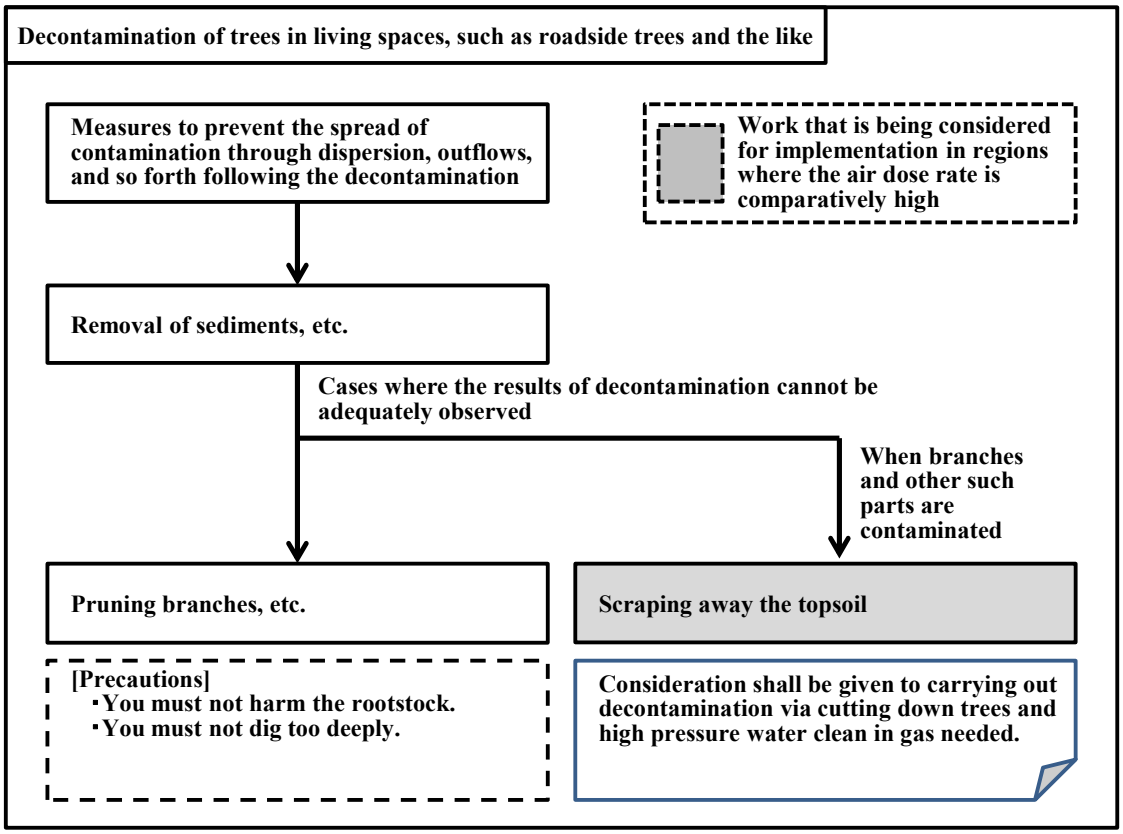


Figure 2-34 Basic flow for the decontamination of trees in living spaces, such as roadside trees and the like.

Table 2-43 Necessary measures prior to the decontamination of trees in living spaces, such as roadside trees and the like

Category	Decontamination methods and notes of caution
Prevention of dispersion	• If sidewalks and buildings are immediately adjacent, curing shall be performed to prevent the dispersion of dust, etc.

Table 2-44 Decontamination methods for trees in living spaces, such as roadside trees and the like and notes of caution

Category	Decontamination methods and notes of caution
Removal of sediments	• Fallen leaves, moss, mud, and other sediments shall be removed by hand by people wearing rubber gloves and by shovel, etc.
Scraping away topsoil	• Accumulated fallen leaves and soil shall be picked up by using a shovel or rake, etc.
Removal of branches, etc.	• Delimbing and pruning shall be carried out on roadside trees by using a pruner and branch cutter to an extent that does not give rise to any pronounced impact for the growth of trees according to the tree species and their delimbing period.

3）Decontamination of forests

The flow of decontamination for forests is explained in Figure 2-35. The necessary measures prior to the decontamination work are in Table 2-45. The decontamination methods and notes of caution are in Table 2-46.

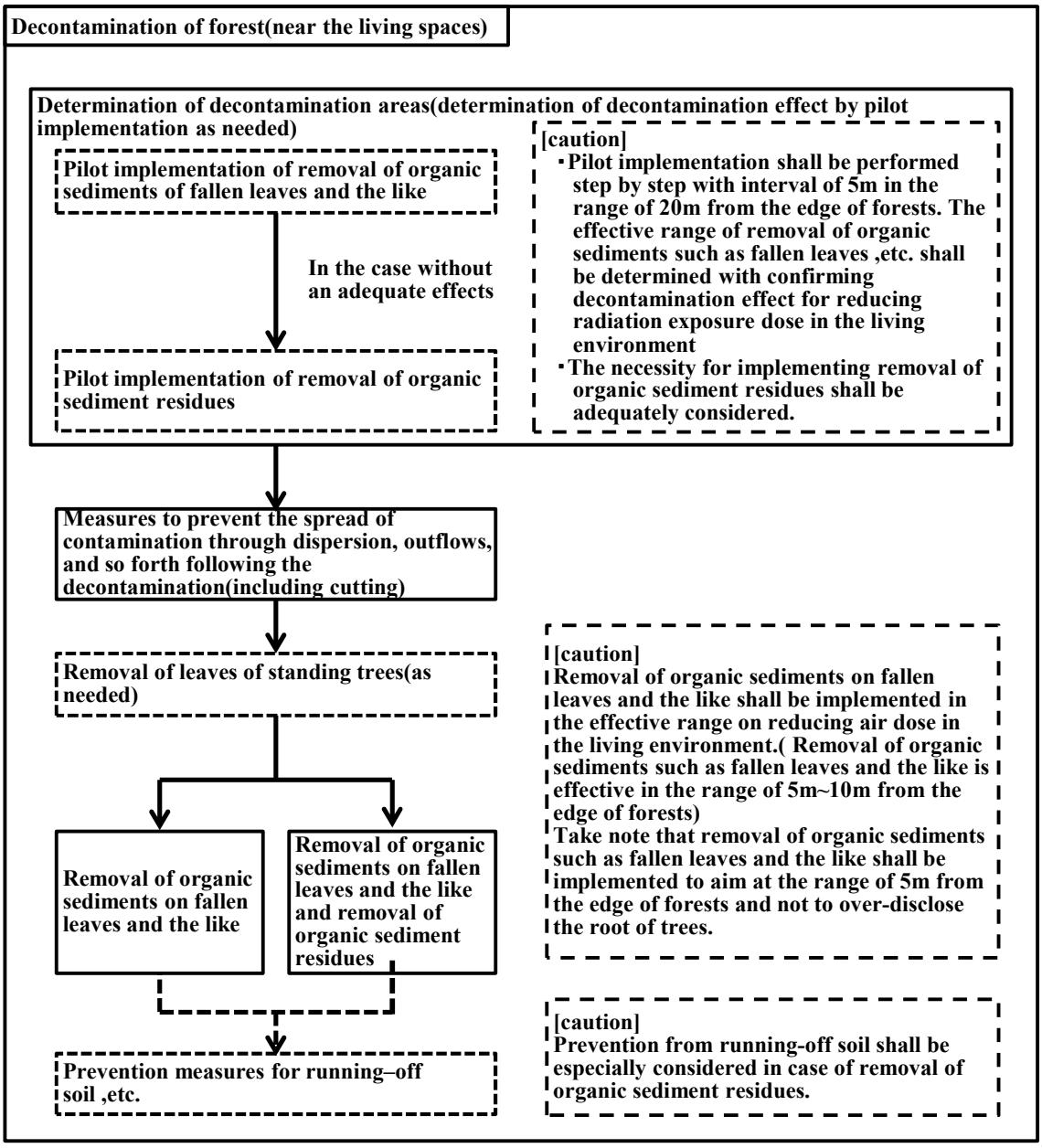


Figure 2-35 Basic flow of decontamination of forests (near living spaces).

Table 2-45 Necessary measures prior to the decontamination of forests

Category	Necessary measures prior to the decontamination
Prevention of dispersion	• If sidewalks and buildings are immediately adjacent, curing shall be performed to prevent the dispersion of dust, etc.
Cutting	• The cutting of weeds, shrubs, and other vegetation shall be carried out using a chainsaw or shoulder-type mower, etc.

Table 2-46 Decontamination methods for forests and notes of caution

Category	Decontamination measures and notices of caution
Removal of organic sediment	• Organic sediment shall be removed by bamboo-rake, etc. • Masks shall be worn to avoid inhaling suspended particulates produced during removal work.
Removal of organic sediment residue	• Organic sediment residue shall be removed by bamboo-broom, etc.if radiation dose is not effectively able to be reduced in the living environment after removal of organic sediment. • Masks shall be worn to avoid inhaling suspended particulates produced during removal work.
Removal of branches and leaves (only for evergreen trees)	• In case that a large contribution of radiation materials on the standing trees at the very edges of the peripheral areas around forests to radiation exposure dose in the living environment is deemed , the pruning and cutting of branches and leaves of standing trees at the very edges of the peripheral areas around forests shall be carried out to an extent that does not give rise to any pronounced impact for the growth of trees and the fallen branches and leaves shall be collected, • Generally, the very edges of the peripheral areas around forests contain a large volume of leaves affixed to trees, and so there is the possibility that a comparatively large amount of radioactive materials are adhering to them. Therefore, branches and leaves should be removed from as high up a position as possible (up to about half the length of the tree canopy). • Masks shall be worn to avoid inhaling suspended particulates produced during removal work.
Prevention measures of running - off soil	• Prevention of running-off soil shall be made by setting sandbags and fences at appropriate locations such as the very edges of the peripheral areas around forests.

（4） Post–work measures

This section explains handling the removed soil, etc., and cleaning equipment used, etc. as post-work measures. Handling the removed soil, etc.is described in 2.2.2 (4) 1) of this report and cleaning equipment used, etc. is described in 2.2.2 (4) 3) of this report.

（5） Subsequent measurements and records

To confirm the decontamination effect, the air dose rate, etc. should be measured after completion of the decontamination work and recorded as shown in Table 2-47.

Table 2-47 Subsequent measurements and records for the decontamination of forests

Measurement of air dose rate, etc.	• The air dose rate, etc. shall be measured at each measurement point. • Measurements shall be carried out in the same location as the prior measurements and under the same conditions to the extent possible. • For the measuring apparatus, the same apparatus as was used for the prior measurements shall be used to the extent possible.
Recordkeeping	• The air dose rate, etc. at each measurement point, places where decontamination work was performed, decontamination date, names of the decontaminators, type of objects decontaminated, decontamination methods, total decontamination area (of soil, etc.), the approximate weight of the removed soil, etc., and the status of storage and disposal. • The equipment used in decontamination and the method of disposal after use. • See "Part 4: Guidelines Pertaining to the Storage of Removed Soil" for details on the items to record with regard to the storage of removed soil.

2.2.6. Decontamination Measures of Rivers and Ponds, etc.

This section explains the basic policy for decontamination measures of rives and ponds, etc. that is, the exposure from radioactive materials in the sediments of rivers and ponds, etc. with a very large amount of water which has an effective shielding effect makes very little contribution to the radiation level of ambient areas. In the case of the seasonal water dried-up condition (which negates the expected shielding effect), for the living spaces where the air dose rate from accumulated radioactive cesium deposited on the sediments is high and many activities of the general public are carried out, the decontamination measures should be implemented as needed. The objectives for decontamination measures are the facilities which the general public often utilizes, such as facilities which are located near riverbeds and areas where there are sediments of rivers and ponds. For the former decontamination measures, the provisions for other specific places may be applied as shown in Table 2-48.

Table 2-48 Specific implementation methods for decontamination work, etc. for facilities located near riverbeds which the general public often utilizes.

objectives	Referred sections in "Decontamination Guidelines"
Fences・walls, benches and playing tools	2.2.2. (3) 4) Decontamination of fences・walls, benches and playing tools
Parts paved by concrete,asphalt ,etc.	2.2.3. (3) 1) Dcontamination of paved surfaces ,etc.
Parts of soil,etc. on ground surface	2.2.3. (3) 2) Decontamination of unpaved roads, etc. 2.2.4. (3) 1) Decontamination of soil of schoolgrounds,kindergaraten,parks
Parts of lawns on ground surface	2.2.5. (3) 1) Decontamiantion of lawns

On the other hand, the sediments of rivers and ponds (reservoirs) should be decontaminated only if the air dose rate increases significantly due to seasonal water dry-up in reservoirs located near living spaces such as residential areas and parks. For decontamination of sediments in reservoirs, the basic flow of decontamination measures is shown in Figure 2-36 and they consist of preparation, prior measurements, decontamination methods, post-work measures, and subsequent measurements and records.

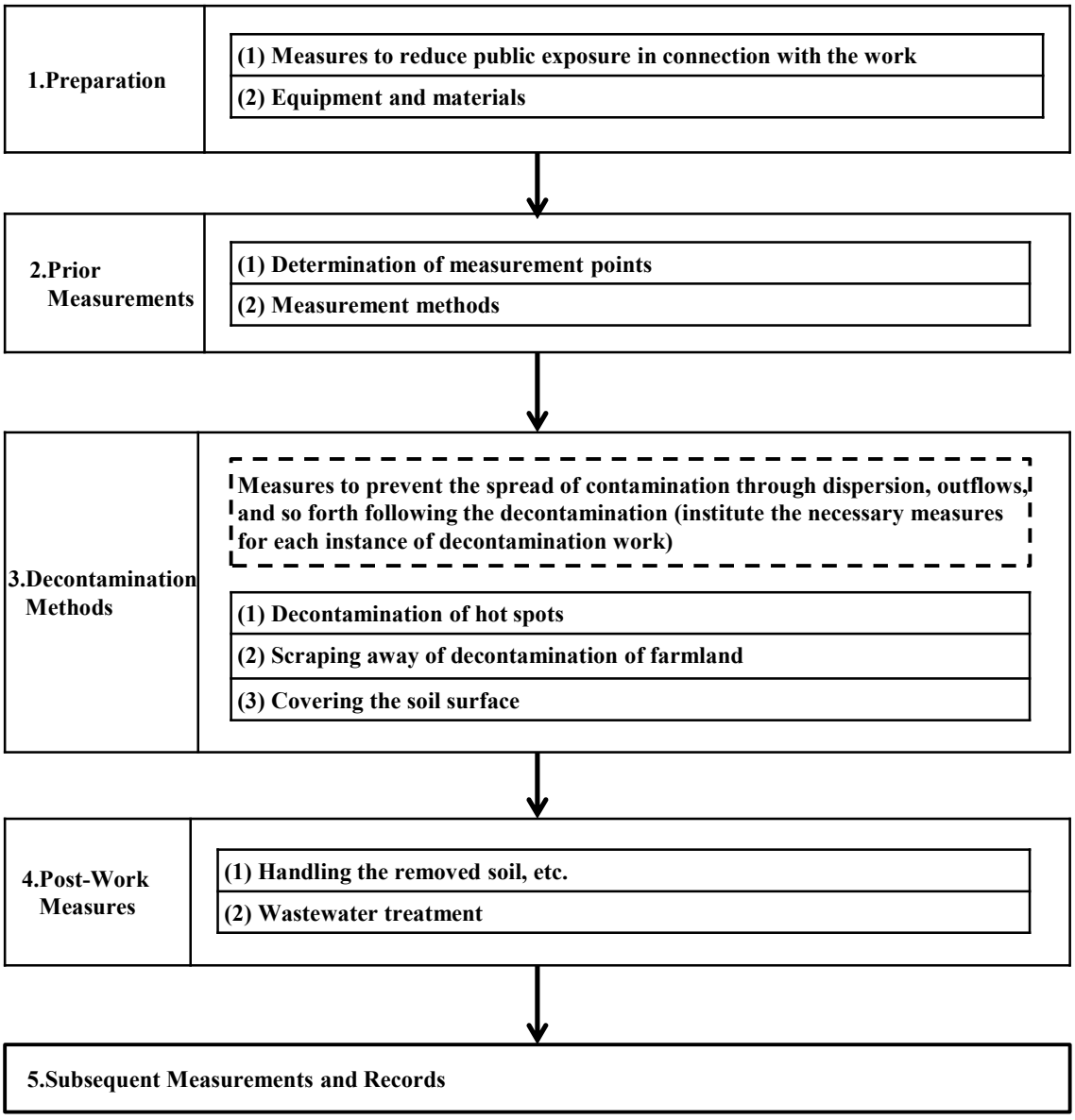


Figure 2-36 Basic flow of decontamination measures of sediments in reservoirs.

（1） Preparation

Before performing decontamination work, in addition to preparing the equipment required for the work, preparations must be made to ensure safety of workers and the general public to prevent their exposure to hazards, such as by inhaling dust generated during decontamination work; these preparations are summarized in Table 2-49.

Table 2-49 Preparation of decontamination measures for sediments in reservoirs

Measures to Reduce Public Exposure in Connection with Decontamination Work	Restriction of entry	• In cases where the general public is deemed likely to enter the area, the area shall be cordoned off with pylons or rope, etc. to prevent people from unnecessarily approaching the work site, and the entry of people and vehicles shall be restricted • In cases where radioactive materials may be dispersed in connection with the decontamination work, the perimeter of the decontamination area shall be fenced in with sheets, etc., water shall be sprayed, or other such measures shall be taken to prevent dispersion and the area shall be cordoned off with rope, etc.
	Signage	• In cases where the general public is deemed likely to enter the area, signs, etc. shall be put up to alert the public that decontamination work is being performed.
Preparation of equipment ,etc.	General equipment	Examples： Mower, hand shovel, grass sickle, broom, bamboo rake, dustpan, tongs, shovel, small shovel, metal rake, compact heavy machinery for scraping away topsoil, garbage bags (bags for burnable matter, burlap sacks for soil and sand (sandbags)), large sandbags, flexible containers vehicles for transporting collected removed soil, etc. to the on-site storage location (truck, two-wheeled cart, etc.), ladder
	Equipment for scraping away sediments	Examples: tractor, vertical harrow and other attachments, rear blade, front loader, backhoe, grader, crane, vacuum car, mower, chipping machine, hammer knife mower, flexible containers, bulldozer, hydraulic shovel, backhoe
	Equipment for covering sediments	Examples: Self-propelled surface compaction roller, plywood for surface compaction, sprinkling equipment, bulldozer, hydraulic shovel

（2） Prior measurements

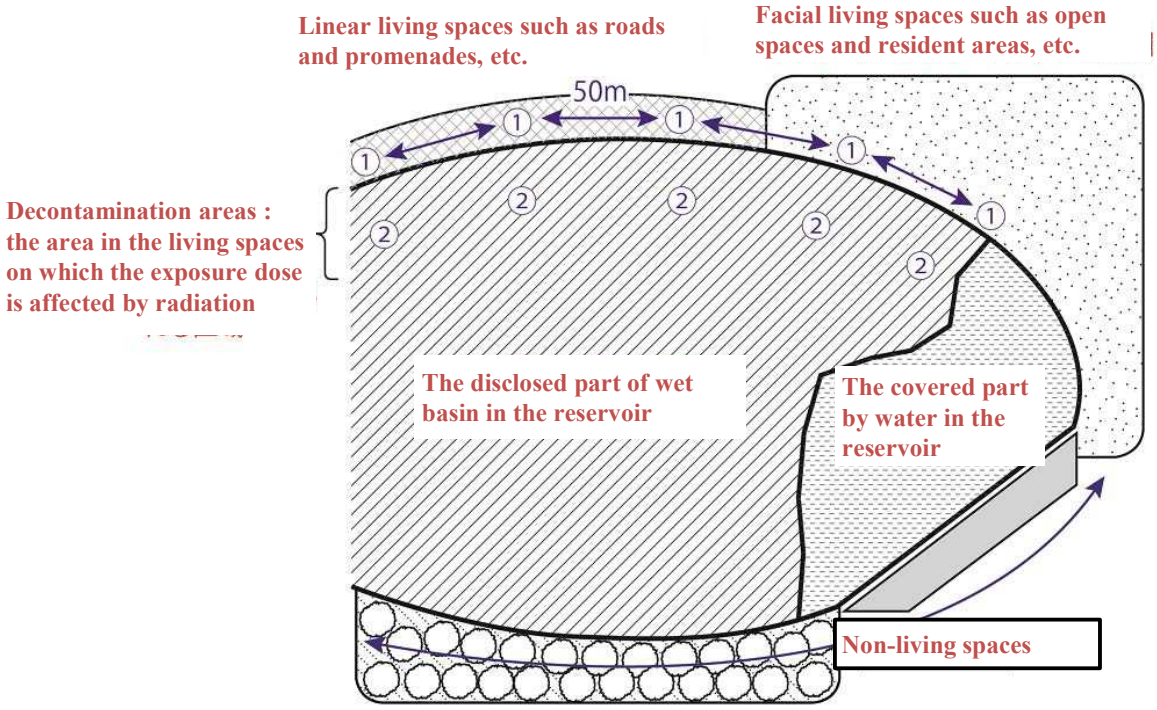
The air dose rate, etc. should be measured and recorded at the same location and by the same method both before and after decontamination work in order to confirm decontamination effects. The method of measurement for the air dose rate, etc. before decontamination work is explained below.

1）Determination of measurement points

Before decontamination work, the measurement points (Table 2-50) at which the air dose rate, etc. are to be measured should be decided and a schematic diagram illustrating the range of the measured objects, themeasurement points, structures to be used as markers, etc. should be made (Figure 2-37). In addition, in setting these measurement points, hotspots and their ambient areas that contribute insubstantially to the radiation dose in the living space should not be used as measurement points unless the users, etc. are deemed likely to spend relatively large amounts of time there..

Table 2-50 Reasoning behind the measurement points for air dose rates and other measures for the decontamination of sediments in reservoirs

Measurement point	No. 1 measurement points(①)	No. 2 measurement points (②)
Measurement target	Air dose rate in living spaces	Surface contamination density, etc. for objects subject to decontamination
Reasoning behind the measurement points	• The measurement points shall be determined with the distance between the points where the distribution of the air dose rate is able to confirm. • In the case that the air dose rate of the living spaces is significantly affected by radiation exposure from dried-up reservoir, the measurement shall be made at a point per the distance-interval of approximately 20m~50m, in the peripheral parts of the reservoir, when the basin of the reservoir is disclosed.	• The measurement shall be made at a point per the distance-interval of approximately 20m~50m, in the dried-up reservoir whose radiation exposure affects the air dose rate in the living spaces near the reservoir.



＊If the living environment will in future be deemed to be affected due to increase of the air dose rate from radiation exposure by in-flow and out-flow of the reservoir after decontamination, decontamination of sediment in the reservoir may , as needed, be implemented and the measuring points shall be determined according to the decontamination area .

① : Status of decontamination on the living space
② : Status of decontamination of decontamination objects

Figure 2-37 Example diagram on measurement points for decontamination of sediments in a reservoir.

2）Measurement methods

It is recommended that for the measurement point marked as ① the apparatuses such as NaI scintillation survey meters which are able to measure gamma rays should be used and for the measurement point marked as ②, GM survey meters should be used.

（3） Decontamination methods

This section explains that the decontamination methods should be implemented so as to prevent contamination expansion due to dispersion and outflow of radioactive substances caused by the decontamination work. The decontamination flow for the reservoir is shown in Figure 2-38. The necessary measures prior to the decontamination work are in Table 2-51. The decontamination methods and notes of caution are in Table 2-52.

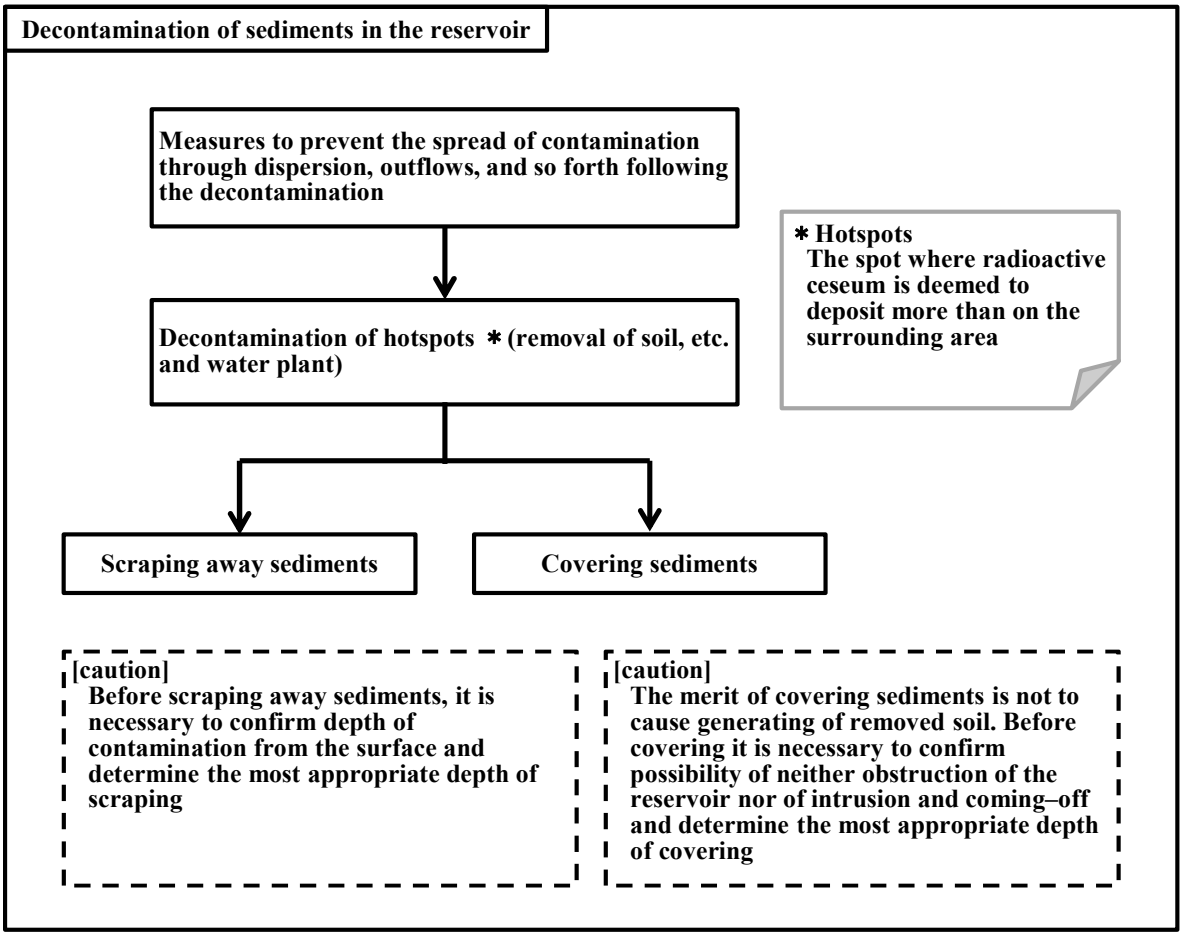


Figure 2-38 Basic flow of decontamination of sediments in reservoirs.

Table 2-51 Necessary prior measures for decontamination of sediments in reservoirs

category	Necessary prior-measures
Prevention of dispersion	• If sidewalks and buildings are immediately adjacent, curing shall be performed to prevent the dispersion of dust, etc. • If scraping topsoil of dried-up soil, prevention measure of dispersion of soil dust shall be implemented. There are the measures of solidifying the surface of the soil in advance by dispersing solidifying materials,etc.

Table 2-52 Decontamination methods for sediments in reservoirs and notes of caution

Category	Decontamination methods and notices of caution
Decontamination of hotspots	• Sediments and water plants shall be removed by hand with rubber-gloves and scoop.it is recommended that top sediment is scraped every approximately several centimeter with measuring surface contamination density etc.
Scraping and removal of sediments	• Before scraping sediments it is necessary to confirm depth of contamination from the surface and determine the most appropriate depth of scraping • It is recommended that for a small area in the appropriate location of the reservoir, top sediment shall be scraped every several centimeter depth of sediments with measuring surface contamination density and the depth to be scraped shall be determined. • Sediments shall be scraped by backhoe, etc. • It is able to confirm whether the residue of top sediments not to be removed exist by dispersing in advance calcium arsenate ,etc.
Covering sediments	• Sediments shall be covered by soil without radiocaesium while it shall be taken account into that covering layers over the sediments are run-off and the sediments are disclosed by the water flow after re-filling water ,etc.

（4） Post–work measures

This section explains handling the removed soil, etc., and cleaning equipment used, etc. as post-work measures. Handling the removed soil, etc. is described in 2.2.2 (4) 1) of this report wastewater treatment, in 2.2.2 (4) 2) of this report and cleaning equipment used, etc., in 2.2.2 (4) 3) of this report.

（5） Subsequent measures and records

To confirm the decontamination effect, the air dose rate, etc. should be measured after completion of the decontamination work and recorded as shown in Table 2-53.

Table 2-53 Subsequent measurements and records of decontamination for sediments in reservoirs

Measurement of air dose rate, etc.	• The air dose rate, etc. and radiocaesium concentration in the soil (in the case of farmland) shall be measured at each measurement point. • Measurements shall be carried out in the same location as the prior measurements and under the same conditions to the extent possible. • For the measuring apparatus, the same apparatus as was used for the prior measurements shall be used to the extent possible.
Recordkeeping	• Air dose rate, etc. and radiocaesium concentration in the soil at each measurement point, places for which decontamination work was performed, date of decontamination, names of decontaminators, types of objects subject to decontamination, method of decontamination, total area decontaminated (soil, etc.), the approximate weight of the removed soil, etc., and the status of storage and disposal. • The equipment used in decontamination and the method of disposal after use. • See “Part 4: Guidelines Pertaining to the Storage of Removed Soil” for details on the items to record with regard to the storage of removed soil.

2.3. Guidelines Pertaining to the Collection and Transfer of the Removed Soil

2.3.1. Basic Concept

The "Guidelines Pertaining to the Collection and Transfer of the Removed Soil" use the example cases to explain in a concrete fashion the Ordinance of the Ministry of the Environment pertaining to standards for the collection and transfer of the removed soil provided in Article 41, Paragraph 1 of the Act on Special Measures.

When collecting and transferring the removed soil, safety measures are required to prevent radioactive materials contained in the removed soil from damaging human health and the living environment. The specific, necessary actions include 1) preventing the radioactive materials from dispersing or outflowing when the removed soil is loaded, unloaded, or transferred, and 2) preventing the public from being exposed to radiation emitted from the removed soil while it is being collected or transferred.

These guidelines organize and describe the requirements for collecting and transferring the removed soil as well as specific actions to be taken in accordance with the safety measures mentioned above while also referring to the existing rules related to the transfer of radioactive materials[79].

2.3.2. Requirements for Collection and Transfer of the Removed Soil

This section explains four types of requirements for collection and transfer of the removed soil.

- Requirements for Preventing Dispersion, Outflow, and Leakage
- Requirements for Radiological Protection
- Requirements for the Transfer Route
- Other Requirements

2.3.3. Specific Actions

Specific actions are necessary to collect and transfer the removed soil by using trucks in view of the requirements listed in 2.3.2.

- Preventing Dispersion, Outflow, and Leakage
  - ✓ When collecting and transferring the removed soil, it is put into flexible container bags, flexible containers, or drums with a lid, or wrapped in plastic sheets, etc. No other special measures are necessary if the soil is transferred by box trucks.
  - ✓ If the removed soil contains sharp or heavy materials such as relatively large stones, the containers should be prevented from being torn, for example by using containers with an inner liner.
  - ✓ Before the transfer of removed soil with a high water content, it is dehydrated as much as possible and measures are taken such as putting the soil in impermeable containers or laying down waterproof sheets.
  - ✓ When using non-waterproof containers, measures should be taken such as covering the removed soil with waterproof sheets to prevent rainwater from permeating the soil during collection and transfer. No such measures are necessary when using

[79]The ministerial ordinances based on the Act on the Regulation of Nuclear Source Materials, Nuclear Fuel Materials and Reactors (hereinafter the "Reactor Regulation Act"), which includes the "Rules Related to the Transfer of Nuclear Fuel Materials Outside Plants or Operating Sites (hereinafter the "external transfer rules")" and "Rules for Transferring Nuclear Fuel Materials by Vehicles (hereinafter the "vehicle transfer rules for nuclear fuel materials")," as well as the ministerial ordinance based on the Act on the Prevention of Radiation Hazards Due to Radioisotopes, etc. (hereinafter the "Prevention Act"), which includes the "Rules for Transferring Radioisotopes by Vehicles (hereinafter the "vehicle transfer rules for radioisotopes")".

box trucks.

- ✓ All containers should be visually checked for tears or cracks and the mouths of any flexible bags or flexible containers should be securely close to prevent the contents from being discharged if they collapse or fall over, or a fire breaks out. Drums should be selected that have locking mechanisms.
- ✓ Before driving a truck from an on-site storage area or a temporary storage site for removed soil on public roads, the exterior and tires of the truck should be washed if any soil is adhering to the truck. If water is used for washing, the drainage channel for the washing water should be checked in advance to ensure smooth drainage and if necessary, it should be cleared.
- ✓ Fire extinguishers should be kept in the trucks as a means of controlling any fires. Moreover, for the handling of any removed soil that has spilled out, the following items should be prepared: cleanup implements, bags for collection, barrier ropes or tapes to indicate the areas where people should not enter, flashlights, and communication devices such as mobile phones. If the carrier is a business operator, it is recommended a measuring apparatus be carried to check for radioactive contamination (calibrated scintillation survey meter).

- Shielding
  - ✓ When transferring the removed soil from areas where the radioactive dose rate exceeds 200 mSv/year, a calibrated scintillation survey meter (hereinafter referred to as the "measuring apparatus") should be used to measure the air dose rate around the truck after it is loaded with containers.
  - ✓ The measuring apparatus should be covered with a plastic bag to avoid contamination.
  - ✓ The detecting element should be held parallel to the ground surface during measurement.
  - ✓ After turning on the power of the measuring apparatus, it is necessary to wait until the readings become stable. After that, readings should be taken five times and the average of these values will be the measured value.
  - ✓ The measurements should be taken at a point 1 m from the front, rear, and both sides of the vehicle. If there is an open cargo area, the vertical planes of the external outline of the carried objects should be used instead of both sides of the vehicle.
  - ✓ Measurements should be conducted at the point where the highest air dose rate is observed after implementing an initial screening on each surface of the vehicle. If the point of the highest air dose rate is unknown, the measurements should be taken at the center of each surface.
  - ✓ Care should be taken that the maximum measured values (dose equivalent rates at 1 cm) does not exceed 100 μSv/hour, and the results should be recorded.
  - ✓ If the maximum dose exceeds 100 μSv/hour, the amount of the removed soil to be transferred should be decreased or shielding materials should be added to the containers holding the soil or to the truck itself.

- Loading limitations
  - ✓ If the removed soil is loaded together with other wastes on a truck, the two should be distinguished from each other during the collection and transfer.

- Signage
  - ✓ Collection and transfer of the removed soil using trucks shall be conducted in the following manner.

A. The following information should be displayed on the exterior of the truck.
   (1) Precautions to the effect that the truck is being used to collect or transfer removed soil.
   (2) Name of the person or entity in charge of the collection or transfer.
B. The information provided in items (1) and (2) above should be indicated using signage with easily identified colors and letters. The letter size of the precautions as provided under (1) should be not less than 140 points as specified in JIS Z 8305, and the letter size of the precautions as provided under (2) should be not less than 90 points as specified in JIS Z 8305.

✓ Transfer during the night should be avoided as much as possible. This is because visibility generally deteriorates at night, and so for example it would be harder to see the signage that is being displayed.

- Other matters

✓ Documents showing the following information should be kept in the truck.
(These apply when any of the national, prefectural, and municipal governments conducts or commissions a carrier to conduct the collection or transfer of the removed soil.)

- As a document to prove this fact, a copy of the contract between the government and the contractor (concerned party).
- Name and address of the person in charge of the collection or transfer and the name of the representative if the carrier is a corporation.
- Amount of the removed soil to be collected or transferred.
- Date on which collection or transfer is started.
- Names, addresses, and contacts of the sites where the removed soil is being loaded for the collection or transfer, and of the destination where the soil is being transferred to.
- Cautions pertaining to handling the removed soil.
- Emergency measures in case of an accident.

<u>(When the carrier (primary contractor) that has been commissioned by the National Government to collect or transfer the removed soil commissions such work to another carrier)</u>

- As a document to prove this fact, a copy of the contract between the primary contractor and the carrier (subcontractor).
- A document proving the fact that said subcontractor is the person who has been listed as those to whom the said primary contractor intends to subcontract the work of collection and transfer of the removed soil under the contract document pertaining to the agreement made between the National Government and the primary contractor.
- Name and address of the person in charge of the collection or transfer and the name of the representative if the carrier is a corporation.
- Amount of the removed soil to be collected or transferred.
- Date on which collection or transfer is started.
- Names, addresses, and contacts for the site where the removed soil is being loaded for collection or transfer and of the destination where the soil is being transferred to.
- Cautions pertaining to handling the removed soil.
- Emergency measures in case of an accident.

- ✓ The carrier should load and unload the removed soil by its own workers or instruct other workers to do this.
- ✓ If there are records on the decontamination work, the document showing the air dose rate on the surface of each bag or container should be kept in the truck.
- ✓ When selecting the transfer route, residential areas, shopping streets, school routes, and narrow roads should be avoided to the extent possible in order to prevent damage to human health and the living environment as well as to reduce any other effects on local residents. Moreover, the removed soil transfer by vehicles should be done while following the legally permitted speeds and avoiding the peak times for heavy traffic and the time periods when children are going to or returning from schools or kindergartens. When the removed soil is being loaded onto the truck, low-noise heavy machinery should be used to reduce noise.
- ✓ The following items should be recorded: the amounts of the removed soil collected or transferred; the dates on which each arrangement for the collection or transfer of the removed soil starts and ends; the name of the person in charge of the collection or transfer; the names and addresses of the sites where the removed soil is loaded and unloaded; and the registration or vehicle number of the truck used for the collection or transfer. The resulting records should be retained for five years from the date when the collection or transfer ends.

2.4. Guidelines Pertaining to the Storage of Removed Soil

These guidelines use example cases to explain in a concrete fashion the Ordinance of the Ministry of the Environment pertaining to standards for the storage of the removed soil provided in Article 41, Paragraph 1 of the Act on Special Measures.

- Facility Design

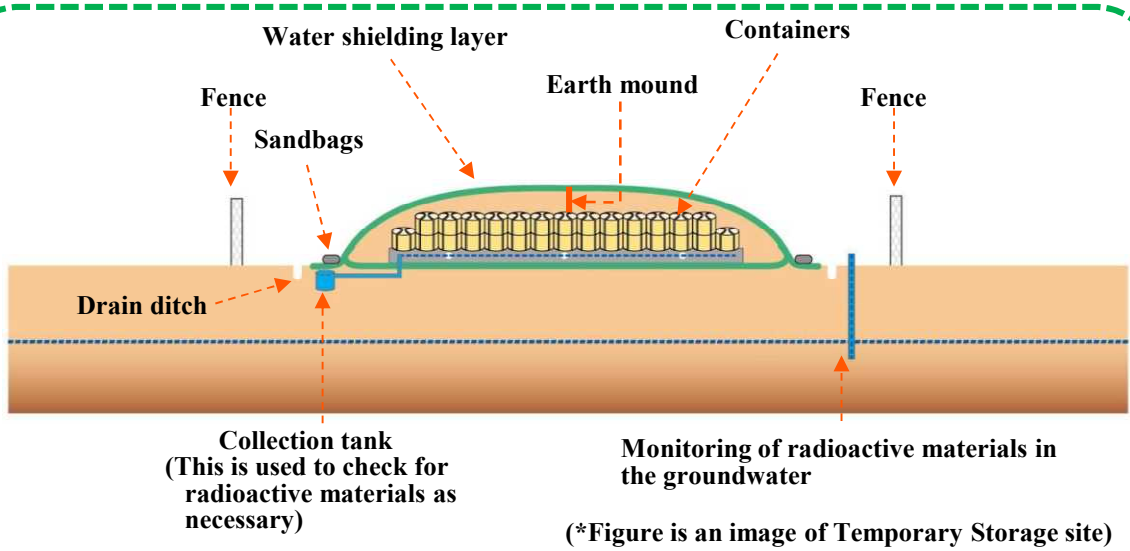
Construction of storage facilities (hereinafter "facilities") that can ensure safety according to the radioactivity concentration and amount of the removed soil

- Safety Management

Carrying out proper safety management of the removed soil during and after its delivery.
Taking measures if any problems occur.

2.4.1. Safety Measures and Requirements Necessary for Storage

This section describes organization of the facilities and management requirements based on the safety measures that are considered to be necessary and commonly applied when storing the removed soil (Figure 2-39).



Basic diagram of the safety measures for on-site and temporary storage sites

① Prevent radioactive materials from dispersing, outflowing, or penetrating the ground
----→ (e.g. water shielding layer and containers)
② Block radiation by shielding ----→ (e.g. earth mounds and sandbags)
③ Install fences to prevent intrusion ----→ (e.g. fence)
④ Monitor the air dose rate and groundwater continuously
----→ (e.g. monitoring of radioactive materials)
⑤ Take prompt measures when any abnormality is found.

Note: ③ and ④ apply only to temporary storage sites.

Figure 2-39 Basic diagram of the safety measures for on-site and temporary storage sites.

(1) Facility requirements

The seven following facility requirements are explained.

- Shielding and isolation
- Prevention of dispersion of the removed soil
- Prevention of penetration of rainwater, etc.
- Prevention of outflow of the removed soil and radioactive materials
- Prevention of effects from substances other than radioactive materials
- Resistance to earthquakes, etc.
- Other necessary measures

(2) Management requirements

The four following management requirements are explained.

- Restriction of entry
- Monitoring the radiation dose and carrying out repairs of the facilities
- Keeping records (Table 2-54 lists the items to be recorded)
- Confirmation that the vacant site is not contaminated after the removed soil that had been stored there was taken away

Table 2-54 Items to record pertaining to the storage of removed soil

Category	Items
Basic matters	• Amount of removed soil stored • Dates on which the storage starts for each batch of removed soil stored • Dates on which the storage ends for each batch of removed soil stored • Names and addresses of the receiving sites* • Names and addresses of the destinations of the removed soil after the storage
Information on delivery and receipt	• Names of the persons in charge of delivering the removed soil • Names of the persons in charge of receiving the removed soil • Registration or vehicle number of any trucks • (In case where such trucks were used for the transfer pertaining to the delivery)
Maintenance and control of storage sites	• Details of the measurement, inspection, and testing carried out to maintain and control the place for storage
Measurement of the air dose rate	• Position of the site boundary (fence) and position of the measurement points • Dates measured • Measuring methods • Measuring apparatuses used for the measurements • Measurement results (background and air dose rate along the site boundary) • Name of the inspector
Radioactive concentration of the removed soil, etc.	• Air dose rate on the surface of each container (On the surface of each container with the removed soil, or each group of multiple containers)

2.4.2. Specific Examples of Storage Methods Chosen on the Basis of the Facility/Management Requirements

This section describes two types of relatively small-sized on-site storage facilities both above ground and underground and two types of large-sized on-site storage facilities both above ground and underground in terms of facility specifications and safety management as shown in Table 2-55.

In addition, this section shows two types of both small-sized and large-sized temporary storage sites above ground and two patterns of temporary storage site both underground and on sloped ground in terms of facility specifications and safety management as shown in Table 2-55.

Table 2-55 Examples of storage methods

Storage site	Overground/ underground	Summarized contents of storage site
On-site storage	overground	Mound(2 × 2 × 1m) of removed soil generated during the decontamination of an area whose air dose rate is about 1μSv/hour as as an example of on-site storage over the ground
		Mound (20 × 20 × 1 m) of removed soil generated during the decontamination of an area whose air dose rate is about 1μSv/hour as as an example of on-site storage over the ground
	underground	Pit (2 × 2 × 0.5 m) of removed soil generated during the decontamination of an area whose air dose rate is about 1μSv/hour as as an example of on-site storage under the ground
		Pit (20 × 20 × 1 m) of removed soil generated during the decontamination of an area whose air dose rate is about 1μSv/hour as as an example of on-site storage under the ground
Temporary Storage site	overground	Mound(20 × 20 ×2 m) of removed soil generated during the decontamination of an area whose air dose rate is about 1μSv/hour as as an example of on-site storage under the ground
		Mound (100 × 100 ×2 m) of removed soil generated during the decontamination of an area whose air dose rate is about 1μSv/hour as as an example of on-site storage under the ground
	underground	Pit (50 × 50 × 2 m) of removed soil generated during the decontamination of an area whose air dose rate is about 1μSv/hour as as an example of on-site storage under the ground
	Sloped ground	Mound (20 × 20 × 2 m) of removed soil generated during the decontamination of an area whose air dose rate is about 1μSv/hour as as an example of on-site storage on the sloped ground

Two examples are presented here. The first is a pit (2 × 2 × 0.5 m) containing removed soil produced during the decontamination of an area whose air dose rate is about 1 μSv/hour; it is explained as an example of on-site storage underground. The second is a mound (20 ×20 × 2 m) of removed soil produced during the decontamination of an area whose air dose rate is about 1 μSv/hour; it is explained as an example of a temporary storage site above ground

- Pit (2 × 2 × 0.5 m) of removed soil produced during the decontamination of an area whose air dose rate is about 1 μSv/hour as an example of on-site storage underground (Figure 2-40)

An example of facility specifications and safety management details for the example on-site storage is shown in Table 2-56.

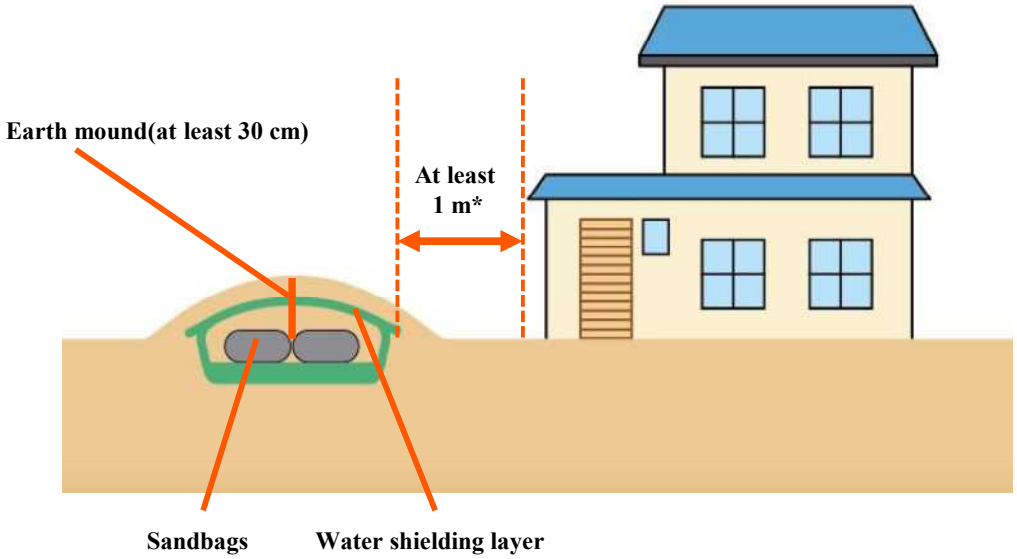


Figure 2-40 Example of on-site storage underground - Pit (2 × 2 × 0.5 m) containing removed soil produced during the decontamination of an area whose air dose rate is about 1 μSv/hour

Table 2-56 Example of facility specifications and safety management details for an underground pit (2 × 2 × 0.5 m) on-site storage of removed soil produced during the decontamination of an area whose air dose rate is about 1μSv/hour

Shielding and isolation	• After the delivery of the removed soil, shield it by putting sandbags containing uncontaminated soil on the top or cover it with soil. The sandbag or covering with soil shall be at least 30 cm thick. In this case, it is not necessary to maintain an isolation distance from residential buildings, such as private houses. • If the top surface is not shielded, place the removed soil at least 1 m away from residential buildings such as private houses.
Prevention of dispersion	• To prevent any radioactive material from dispersing, put the removed soil in sandbags or flexible containers whose openings can be closed, and close them securely. If the removed soil is not put into any containers such as sandbags, wrap it in a dustproof sheet.
Prevention of penetration of rainwater, etc.	• Cover the removed soil with a waterproof sheet and fix the ends so that the sheet cannot be blown by the wind as needed. For fixing, sandbags and blocks can be used. • Raise the center to prevent rainwater from accumulating on the surface of the sheet as needed.
Prevention of outflow	• Spread a waterproof sheet over areas where the removed soil is placed. No special measures are necessary if the removed soil is stored in waterproof flexible containers, etc. • When placing the removed soil, take care not to damage the waterproof sheet, etc.
Monitoring	• After completing covering with soil, etc. for the removed soil, use a calibrated scintillation survey meter to measure the air dose rate at the

	center (one spot) and places 1 m apart from four spots on the outer perimeter of the area where the removed soil has been placed and at a height of 1 m (four spots), and record the results. • If it is impossible to conduct such measurements at a place 1m apart from the outer perimeter, select other measurement points. • Record the measurement points by drawing a rough sketch to identify the place of measurement.
Record keeping	• Keep the records of measurement results of the air dose rates until the removed soil is taken out.

- Mound (20 ×20 × 2 m) of removed soil produced during the decontamination of an area whose air dose rate is about 1 μSv/hour as an example of a temporary storage site above ground (See Figure 2-41)

An example of facility specifications and safety management details for an example temporary storage site is shown in Table 2-57.

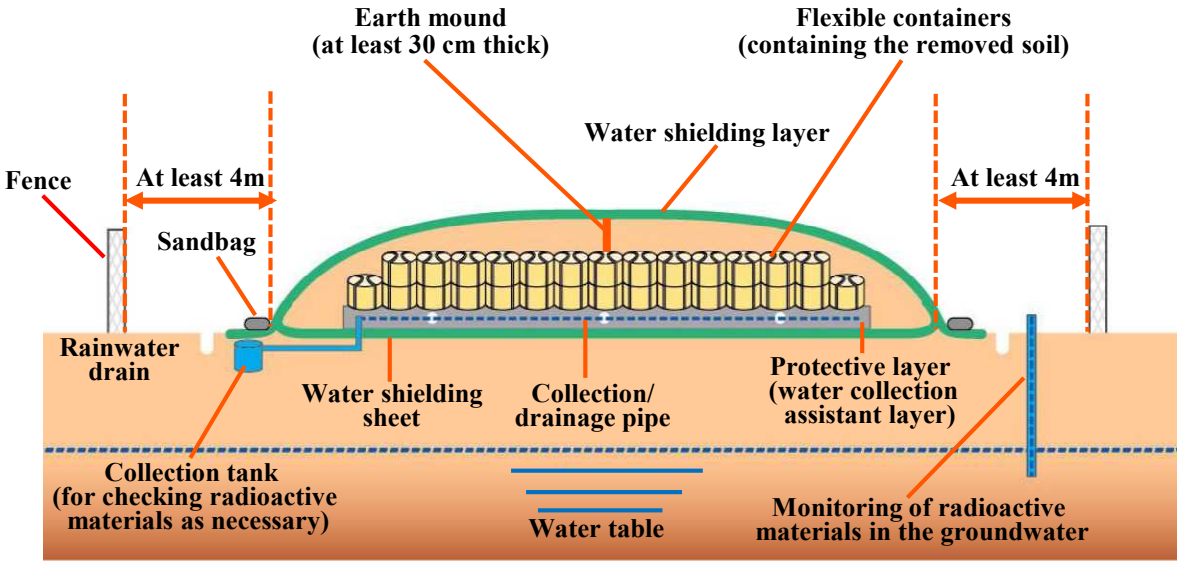


Figure 2-41 Example of temporary storage site above ground – Mound (20 ×20 ×2 m) above ground in temporary storage site of removed soil produced during the decontamination of an area whose air dose rate is about 1 μSv/hour

Table 2-57 Example of facility specifications and safety management details on a mound (20 ×20 ×2 m) above ground in a temporary storage site of removed soil produced during the decontamination of an area whose air dose rate is about 1μSv/hour

Shielding and isolation	• When the delivery work extends over a lengthy period of time, keep the removed soil at least 4 m away from residential buildings such as private houses from the viewpoint of curbing the public's additional exposure dose to not more than 1 mSv per year during the delivery. • During the delivery of the removed soil, shield it by putting flexible containers, etc. containing uncontaminated soil on the side or cover it with soil. The sandbag or covering with soil shall be at least 30 cm thick. • After the delivery of the removed soil, shield it by putting sandbags containing uncontaminated soil on the top or cover it with soil. The sandbag or covering with soil shall be at least 30 cm thick.
Prevention of dispersion	• When delivering removed soil, to prevent any radioactive material from dispersing, put the removed soil into a flexible container, and close it securely. If the removed soil is not put into any containers such as flexible containers, wrap it in a dustproof sheet.
Prevention of penetration of rainwater, etc.	• During and after the delivery of the removed soil, cover it with a weatherproof and waterproof sheet such as a water shielding sheet to prevent the soil from being exposed to the rain as much as possible. Fix the end of the water shielding sheet so that it cannot be blown by the wind. For fixing, sandbags and blocks can be used. No special measures are necessary if the removed soil is stored in waterproof containers or kept in a facility with a roof. • Raise the center to prevent rainwater from accumulating on the water shielding sheet, etc. • ・Arrange the removed soil so that it is positioned higher than the water shielding sheet, etc. for good drainage. • Install drainage facilities during the delivery to discharge any accumulated rainwater.
Prevention of outflow	• Spread a weatherproof and waterproof sheet such as water shielding sheet over areas where the removed soil is placed. • When placing the removed soil, take care not to damage the waterproof sheet, etc. • Installation of water shielding layer such as laying waterproof sheet can be omitted if the removed soil is stored in waterproof containers and a waterproof cover is properly applied to prevent rainwater from coming in.
Background measurement	Air dose rate • Before the delivery of the removed soil, use a calibrated scintillation survey meter to measure the air dose rate at points along the site boundary and at 1 m height on both sunny and rainy days, and record the results. • The measurement points shall have an interval of about 2 m along the site boundary and include the points on the site boundary nearest to the place of storage of removed soil. • If it is impossible to conduct such measurements at a place 4 m apart from the outer perimeter, select other measurement points. • Record the measurement points by putting a mark on the ground or drawing a rough sketch to identify the place of measurement. • Derive the approximations for the upper limit of variation from the

	measured air dose rate values (at tens of points) and the following equation: $m + 3\times\sqrt{\{(s_1-m)^2+(s_2-m)^2+\cdots+(s_k-m)^2+\cdots+(s_N-m)^2\}}/N$ where S1, S2, . . .Sk… SN: Measured values, m: Average of the measured values, and N: Number of the measured values. Radioactivity concentration of the groundwater • Before the delivery of the removed soil, dig a water sampling hole near the planned temporary storage site, sample the groundwater, measure the radiocaesium concentration of the sample, and record the results. • For the installation of the water sampling hole, prevent the intermixing of topsoil and surface water. In addition, implement measures to prevent the intermixing of topsoil and the like as needed. Radioactivity concentration of the leachate (if necessary) • This is not a standard for storage, but if measuring he leachate, install pipes into the protective layer to sample the leachate, and install a collection tank (e.g. working water tank or concrete measuring tank) on the outside of the temporary storage site to collect the sampled leachate. Radioactivity concentration of soil • Before the delivery of the removed soil, sample soil in the planned temporary storage site, measure the radiocaesium concentration of the sample, and record the results. • The measurement points shall be at the center and four corners of the area in which removed soil is placed.
Monitoring	Air dose rate • After the delivery of the removed soil starts, use a calibrated scintillation survey meter, to measure the air dose rate at a height of 1 m at four spots including a spot nearest to the place of storage of removed soil among the background measurement points, and record the results. • Take such measurements at least once a week. Radioactivity concentration of the groundwater • After the delivery of the removed soil starts, sample the groundwater from the sampling hole, measure the radiocaesium concentration of the sample, and record the results. • Samples of the groundwater should be taken when there is no turbidity. • Take such measurements at least once a month. Radioactivity concentration of the leachate (if necessary) • After the delivery of the removed soil starts, check whether water is accumulated in the collection tank at least once a month. • If water has accumulated, sample the leachate and measure the concentration of radiocaesium, etc. in the sampled leachate.
Record keeping	• Keep the following records until the period of operation of the facility ends. • The amount of the removed soil stored, dates on which the storage starts and ends for each batch of the removed soil stored, and the names and addresses of the receiving site and destinations of the removed soil after the storage. • The names of the persons in charge of receiving and delivering the removed soil concerning such removed soil received, and the registration or vehicle number of any truck in case where such truck was used for the transfer pertaining to the delivery. • The results of an air dose rate measurement and water quality test (measurement of the radioactivity concentration of groundwater).

Repair	• Confirm that the measured values of the air dose rate and the radiocaesium concentration of the groundwater are within the allowable variation range of the background values. (Note that during the delivery of the removed soil, the measured air dose rate shall not exceed the allowable variation range plus air dose rate equivalent to 1 mSv/year.) • If the measured value is observed to be exceeding the allowable variance range, etc., identify the cause. If it is found that the temporary storage site2 is the cause of such problem, take any necessary measures, such as adding shielding materials, repairing the facility, or collecting the removed soil.
Restriction of entry	• Construct fences (e.g. ropes, nets, or iron wire) at the periphery of the area at least 4 m away from the temporary storage site. • Install signboards at least 60 cm × 60 cm in visually obvious places to indicate precaution to the effect that the area is the place of storage of the removed soil, the contact details in the event of an emergency, and the height of the piled-up removed soil.
Vacant site check	• After the period of storage ends and the removed soil is taken out of the temporary storage site, measure the Cs-134 and Cs-137 concentration of soil at the vacant site and confirm that the resulting values are within the variation range of the background concentration. • The measurement points shall be at the center and four corners of the area in which removed soil had been placed. • If the measured value is observed to be exceeding the allowable variation range, decontaminate the site.