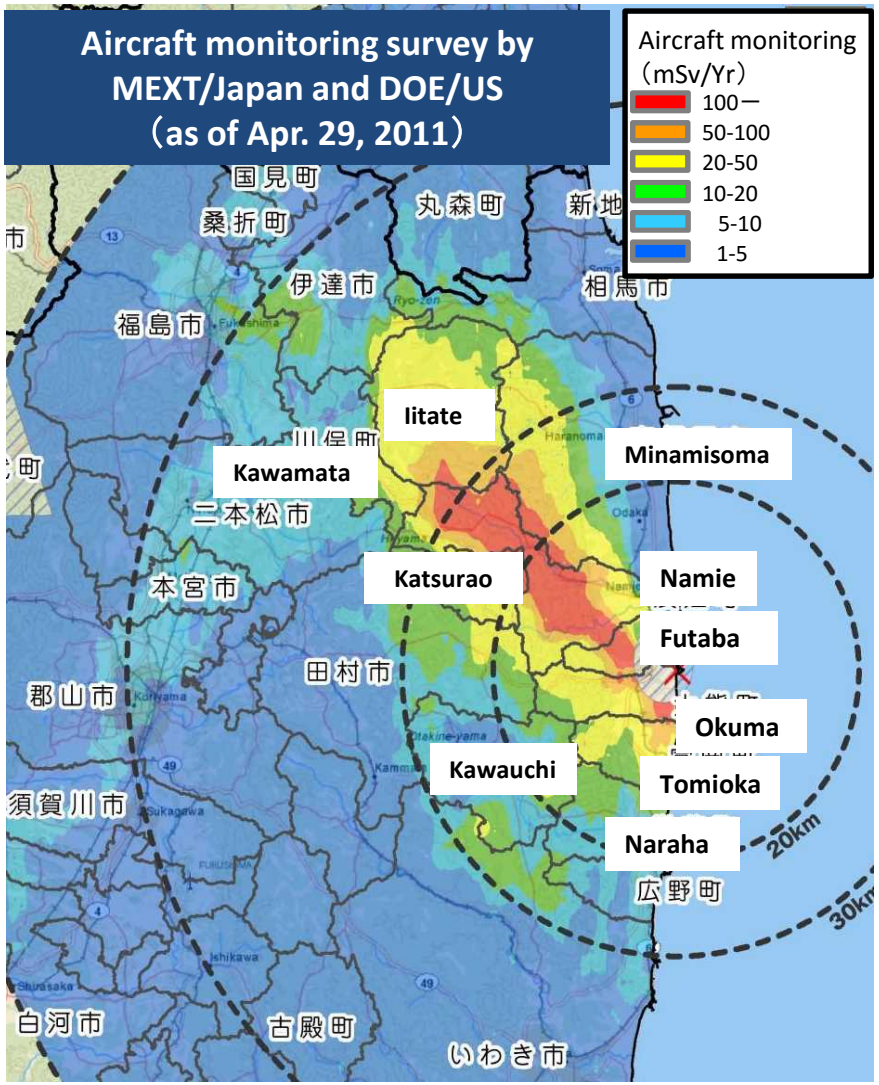
Environmental Remediation in Japan

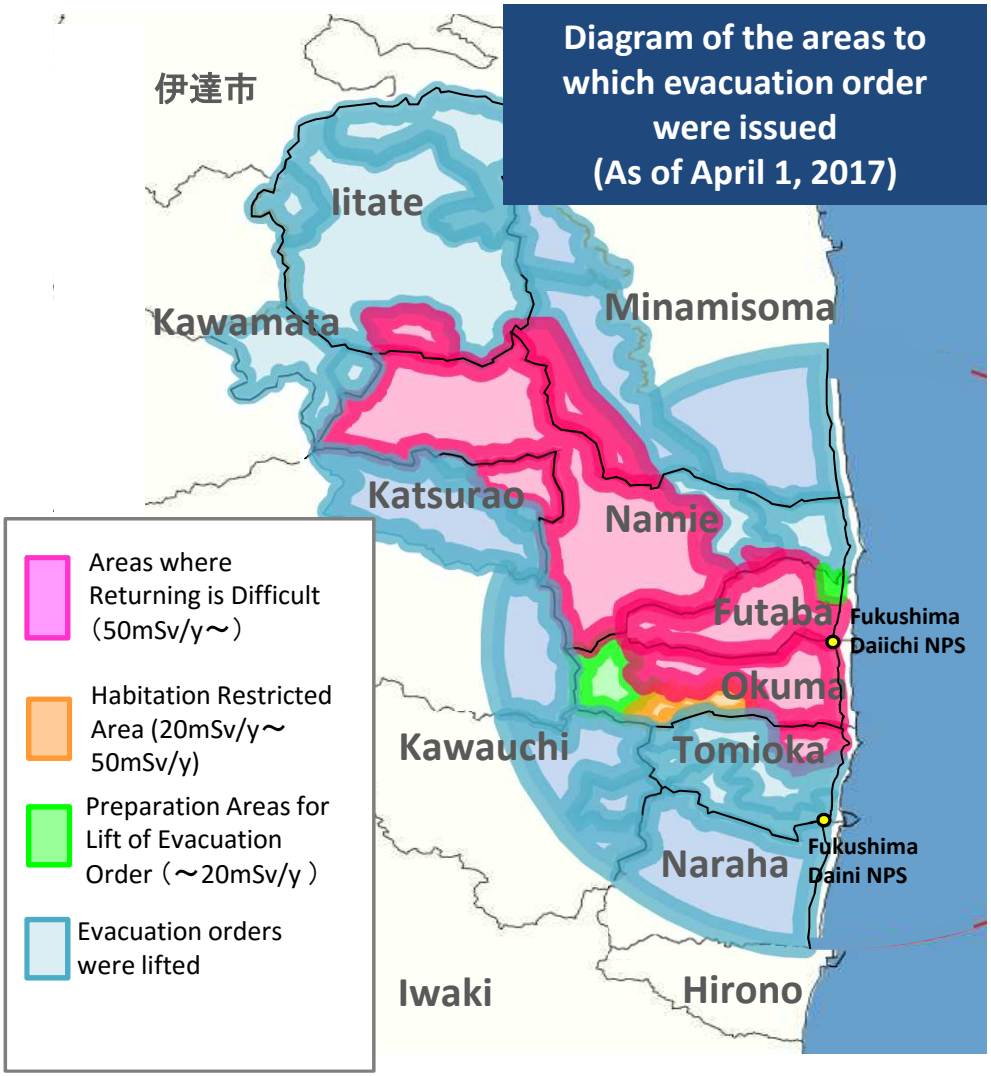
March 2018

Ministry of the Environment, Japan

Outline

Radioactive Pollution Caused by the Accident at TEPCO's Fukushima Dai-ichi NPS





Decontamination based on the “Act on Special Measures”

1) Special Decontamination Area (*)
(80,000 residents, 1,150 km^2)

Designation of SDA
by the Minister

↓

Development of the decontamination implementation plan
in the SDA
by the Minister

↓

Implementation of decontamination
by the national government

2) Intensive Contamination Survey Area
(6,900,000 residents, 24,000 km^2)

Designation of ICSA by the Minister
(Areas where air dose rate is 0.23μSv/h or more)
※0.23μSv/h is a criterion for designation of ICSA and not a decontamination target

↓

Survey measurement by the mayors

↓

Development of the decontamination implementation plan by the mayors

↓

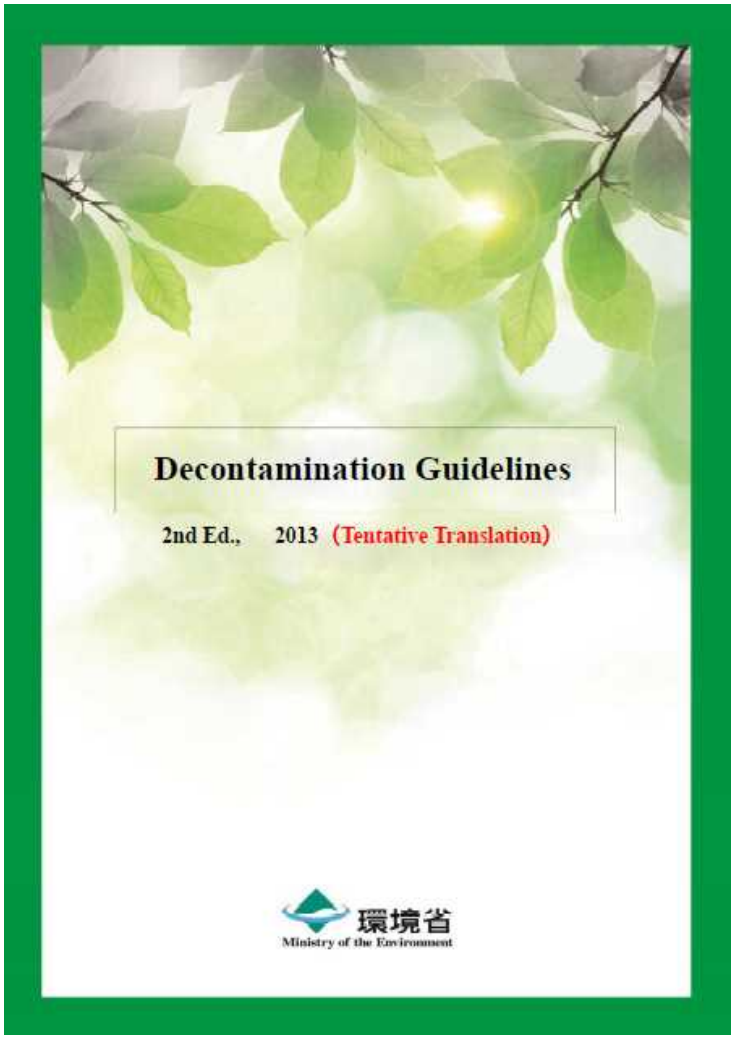
Implementation of decontamination
by the municipalities, etc.
(The national government allocates budgets.)

* Decontamination at Fukushima Daiichi: Implemented by TEPCO

Note: The air dose rate 0.23μSv/h corresponds to a cautiously estimated individual exposure dose of 1mSv/y assuming that people spend
① 8 hours outside ② 16 hours in a wooden house with a low shielding rate in a day

Outline

Formulation of the Decontamination Guidelines



- Technical guidelines for carrying out decontamination
- Developed to complement the Ordinance of the Ministry of the Environment
- Used as reference when contracting decontamination projects

Contents
1. Guidelines on the methods of investigating and measuring environmental pollution in Intensive Contamination Survey Areas
2. Guidelines pertaining to measures on decontamination
3. Guidelines pertaining to the collection and transportation of the removed soil
4. Guidelines pertaining to the storage of removed soil

URL:
http://josen.env.go.jp/en/policy_document/pdf/decontamination_guidelines_2nd.pdf

Techniques Used for Decontamination ①

- **Houses, buildings**

  Removing deposits from the roof, deck and gutters

  Wiping off roofs and walls, high-pressure washing etc.

- **Gardens and trees**

  Mowing, removing fallen leaves, topsoil stripping etc.

- **Roads**

  Removing deposits in ditches, high-pressure washing etc.

Decontaminating roofing tiles (by wiping)

Decontaminating paved surfaces
(by a collective type high-pressure water cleaner)

Decontaminating gardens (by removing soils etc.)

Photos provided by: Date City

Techniques Used for Decontamination ②

- **Schoolyards, gardens and parks**
  Stripping soils and topsoil etc.
- **Farmlands**
  Reverse tillage, stripping topsoil etc.
- **Forests and woods**
  Removing fallen leaves and lower twigs, pruning etc.

Decontaminating a schoolyard

Photo provided by: JAEA

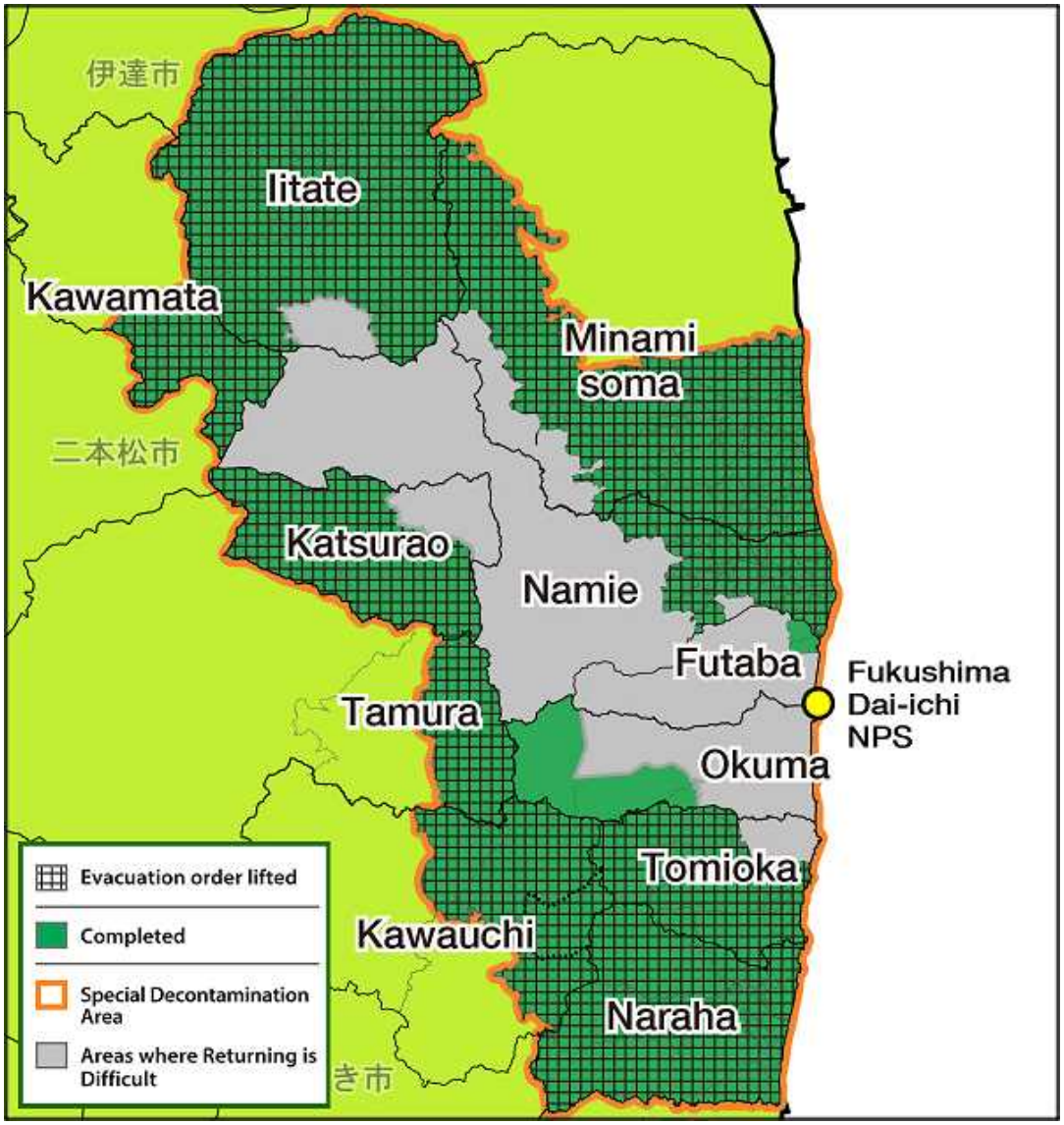
Decontaminating a grass plot

Photo provided by: Japanese Society of Turf grass Science

Decontaminating a forest (by removing fallen leaves)

Photo provided by: JAEA

Progress in the Special Decontamination Area ① (as of April 1, 2017)



Municipality	Evacuation order was lifted on
Tamura city	April 1, 2014
Kawauchi village	October 1, 2014*1 / June 14, 2016*2 *1 Former Preparation Areas for Lift of Evacuation Order *2 Former Habitation Restricted Area
Naraha town	September 5, 2015
Katsurao village	June 12, 2016
Minamisoma city	July 12, 2016
Iitate village	March 31, 2017
Kawamata village	March 31, 2017
Namie town	March 31, 2017
Tomioka town	April 1, 2017

Municipality	Completion of decontamination
Tamura city	June 2013
Naraha town	March 2014
Kawauchi village	March 2014
Okuma town	March 2014
Katsurao village	December 2015
Kawamata town	December 2015
Futaba town	March 2016
Iitate village	December 2016
Tomioka town	January 2017
Minamisoma	March 2017
Namie	March 2017

Completion of the Decontamination in SDA (as of the end of March 2017)

Decontamination works in following municipalities have been completed by the end of March 2017 as the Government target

Municipality	Residential area	Farmland	Forest	Road	Evacuation order was lifted on
	Number of implementated houses	Implemented area ha	Implemented area ha	Implemented area ha	
Minamisoma	4,500	1,700ha	1,300ha	270ha	July 12, 2016
Namie	5,600	1,400ha	390ha	210ha	March 31, 2017
Tomioka	6,000	750ha	510ha	170ha	April 1, 2017
Iitate	2,000	2,100ha	1,500ha	330ha	March 31, 2017
Futaba	97	100ha	6.2ha	8.4ha	————
Kawamata	360	600ha	510ha	71ha	March 31, 2017
Katsurao	460	570ha	660ha	95ha	June 12, 2016
Okuma	180	170ha	160ha	31ha	————
Kawauchi	160	130ha	200ha	38ha	Former Preparation Areas for lift of Evacuation Order : October 1, 2014 Former Habitation Restricted Areas: June 14, 2016
Naraha	2,600	830	470ha	170ha	September 5, 2015
Tamura	140	140ha	190ha	29ha	April 1, 2014
Total Number	22,000	8,500ha	5,800ha	1,400ha	

・”Forest” means that is close to residential area
・MOE continues decontamination works at areas where residents’ consents are newly obtained

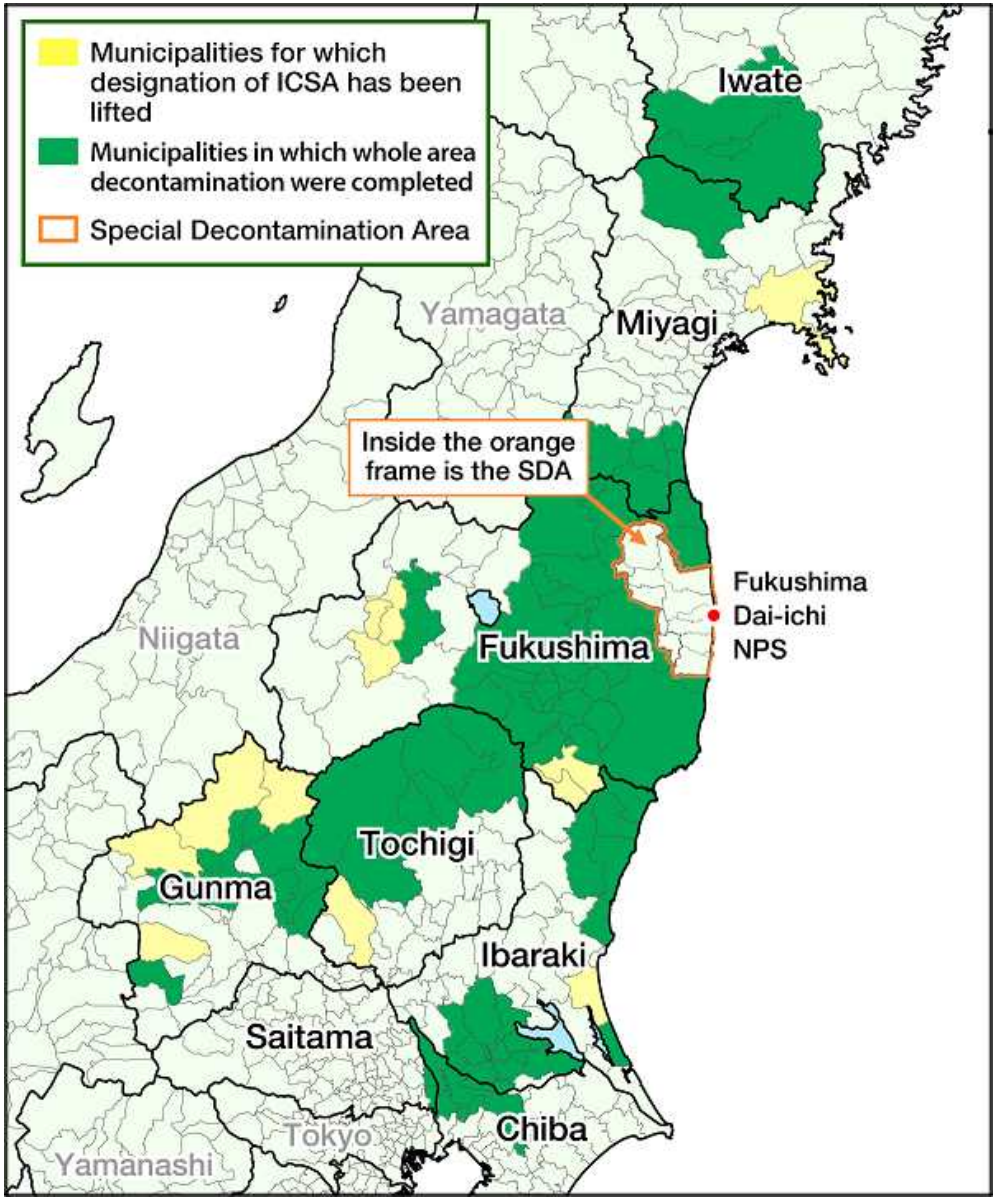
Progress in the Intensive Contamination Survey Area ①

Whole area decontamination was completed on March 19, 2018

◇ The progress of decontamination

•In Fukushima Prefecture :
(as of March 19, 2018)
Residential houses / Public facilities / Roads / Farmland & meadows / Forests in living areas:
Completed in all categories

•Outside Fukushima Prefecture :
(as of the end of March 2017)
Residential houses / Schools & nurseries/ Parks, sports facilities / Roads / Farmland & meadows/ Forests in living areas:
Completed in all categories



Progress in the Intensive Contamination Survey Area ②

Within Fukushima Pref. (as of the end of February 2018)	Ordered			Achievement		
	Ordering ratio (%)	Number of ordering	Number of planning	Achievement ratio (%)	Number of achievement	Number of planning
Residential houses	**100**	418,583	418,583	**100**	418,583	418,583
Public facilities	**100**	11,958	11,958	**100**	11,958	11,958
Roads (km)	**100**	18,802	18,802	**99.9**	18,778	18,802
Farmland / meadows (ha)	**100**	31,060	31,060	**99.9**	31,059	31,060
Forests in living area (ha)	**100**	4,552	4,552	**100**	4,552	4,552

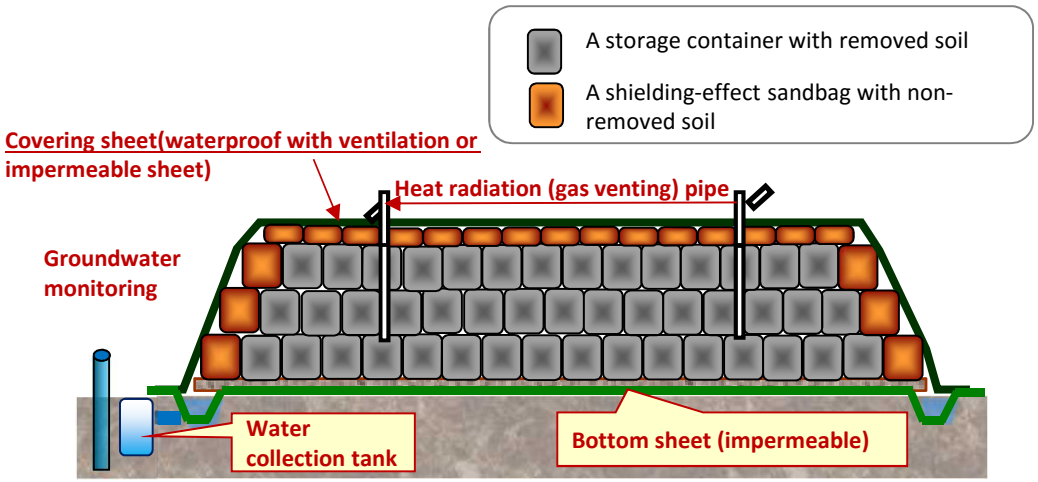
Note: Based on the investigation result released by Fukushima Prefecture on February 20, 2018. The number of planning might be revised in future.

Outside Fukushima Pref. (as of the end of March 2017)	Ordered			Achievement		
	Ordering ratio (%)	Number of ordering	Number of planning	Achievement ratio (%)	Number of achievement	Number of planning
Residential houses	**100**	147,656	147,656	**100**	147,656	147,656
Public facilities	**100**	1,592	1,592	**100**	1,592	1,592
Parks / sport facilities	**100**	3,936	3,936	**100**	3,936	3,936
Other facilities	**100**	6,275	6,275	**100**	6,275	6,275
Roads (km)	**100**	5,399	5,399	**100**	5,399	5,399
Farmland / meadows (ha)	**100**	1,588	1,588	**100**	1,588	1,588
Forests in living area (ha)	**100**	300	300	**100**	300	300

Note: The number of planning is the total number as of May 12, 2017.

Storage in Temporary Storage Sites (TSS)

♦Basic structure of a TSS / Routine management & checkup (A case in the SDA)



< Checkup points >

Routine checkup/ weekly	・Visual check ・Air dose rate measurement
Routine checkup / monthly	・Groundwater measurement
If necessary	・Leachate measurement and treatment in water collection tank
Emergency inspection in unusual weather and earthquake	・Visual check ・Air dose rate measurement

♦Number of TSS and the volume of removed soil

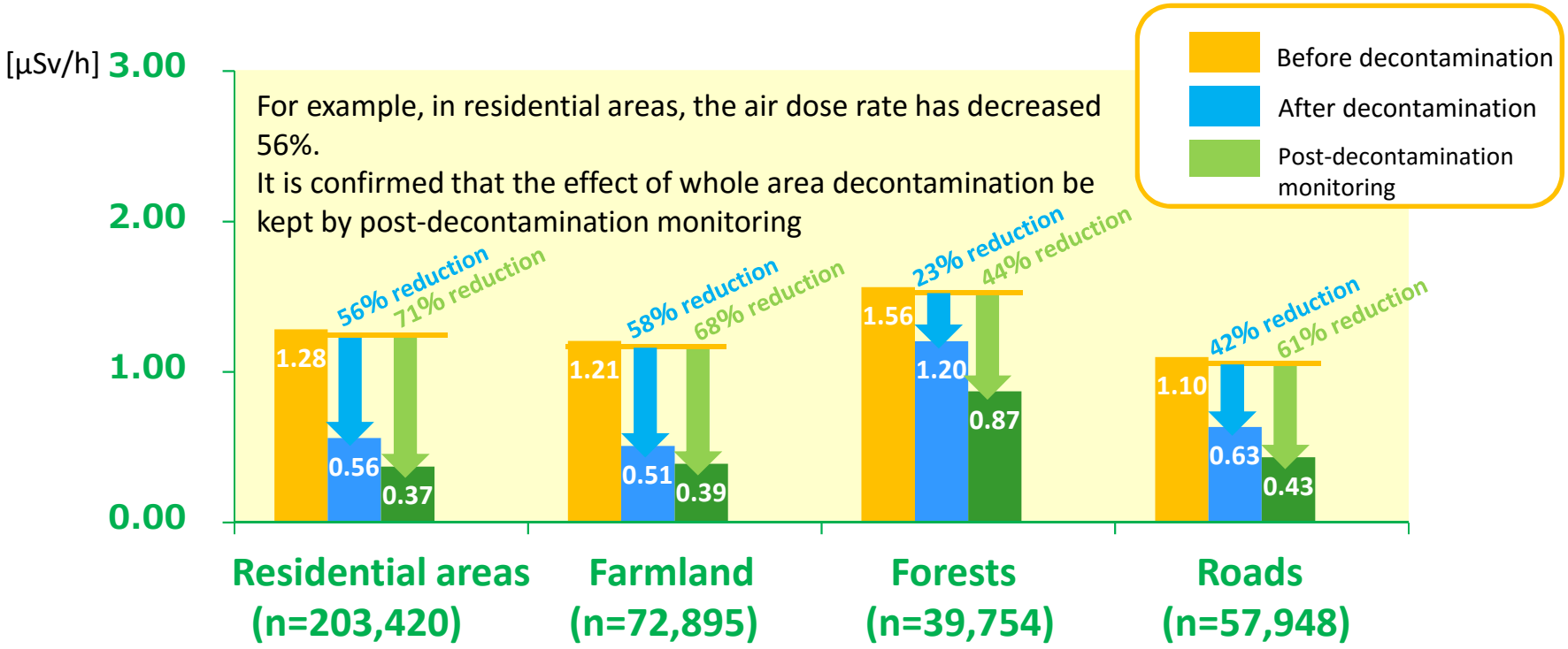
※The number in SDA is as of the end of January 2018 and the number in ICSA is only in Fukushima Prefecture as of the end of September 2017

	Number of TSS	Number of storage site	Volume of removed soil
SDA	241	—	7,310,305 bags
ICSA	843	137,266	5,995,220 ㎥

♦Storage in TSS～Transfer～Restore to original form～Return of land and extension of storage period

Effects of Decontamination Work ①

【Air dose rate at the height of 1m from the ground / Transition according to land category】



Whole SDA

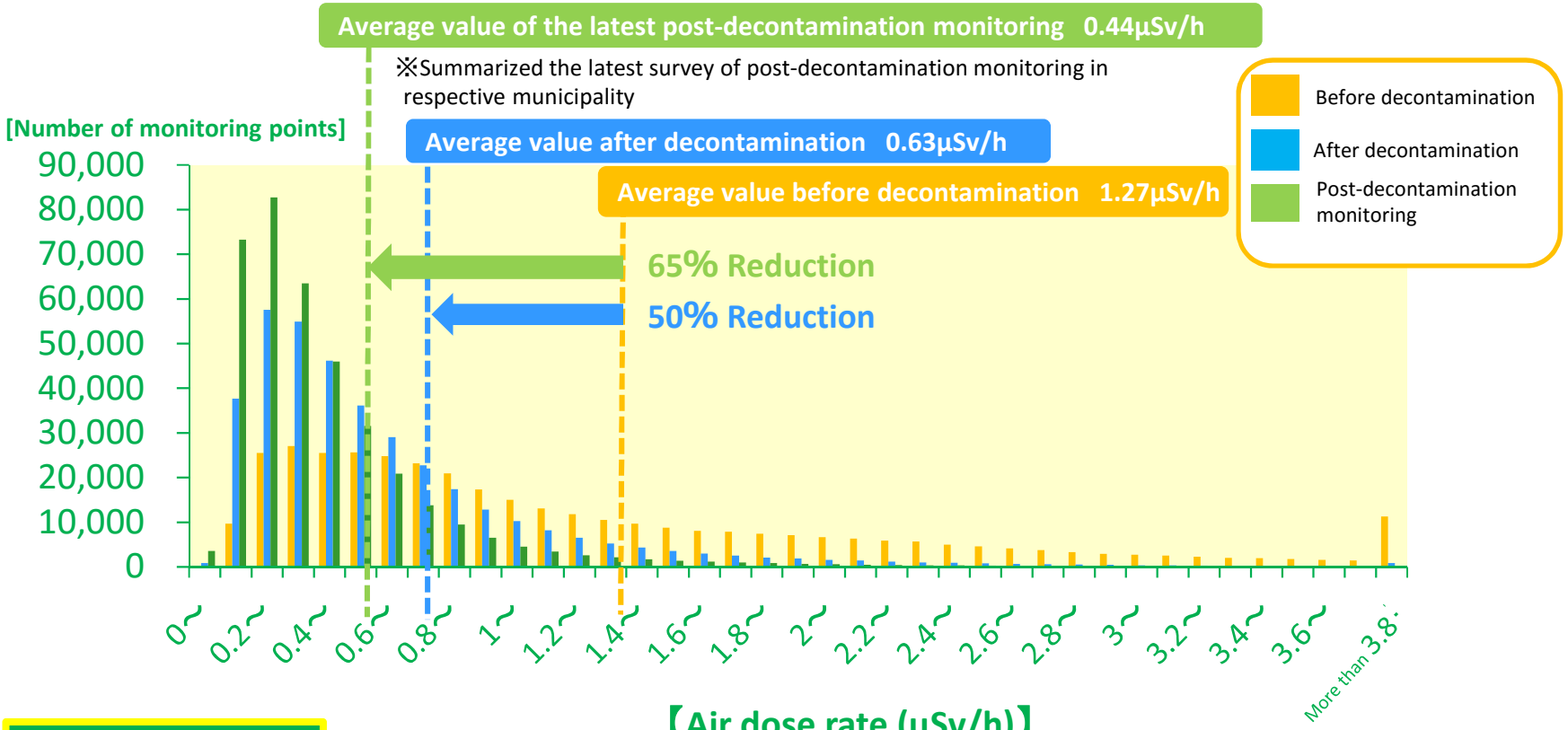
※Only in areas with the data, excluding Areas where Returning is Difficult

The chart shows the air dose rate average in each category (aggregated data of measuring points). Post-decontamination monitoring was implemented after 6 months to a year after the decontamination work. The latest result of post-decontamination monitoring in municipalities were summarized (the first or the second)

[Implementation period]
- Monitoring before decontamination: Nov.2011 - July 2016
- Monitoring after decontamination: Dec. 2011 - Sep. 2016
- Post decontamination monitoring: Oct. 2014 - Dec. 2016

Effects of Decontamination Work ②

【Air dose rate above 1m from the ground Dose Volume Histogram】 （n=374,017）



Whole SDA

※Only in areas with the data, excluding Areas where Returning is Difficult

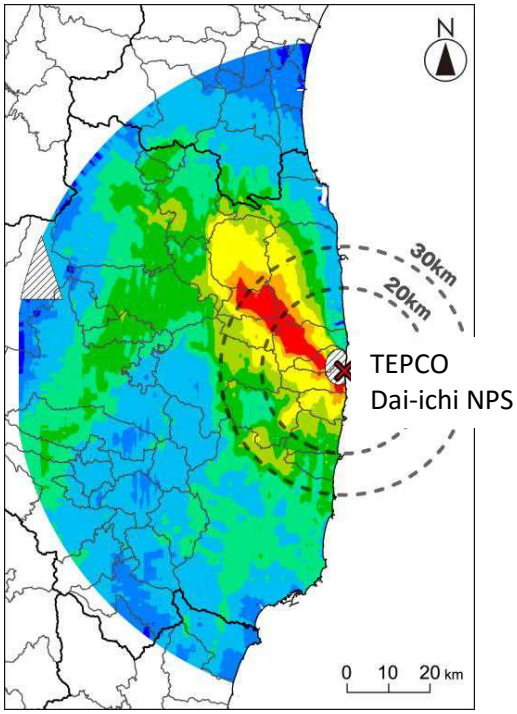
The frequency distribution chart shows air dose rate of residential area, farmland, forest and road before & after decontamination (summarized data on measuring points)

In residential area, implemented measuring at about 10points on each property in order to study average dose rate in an area

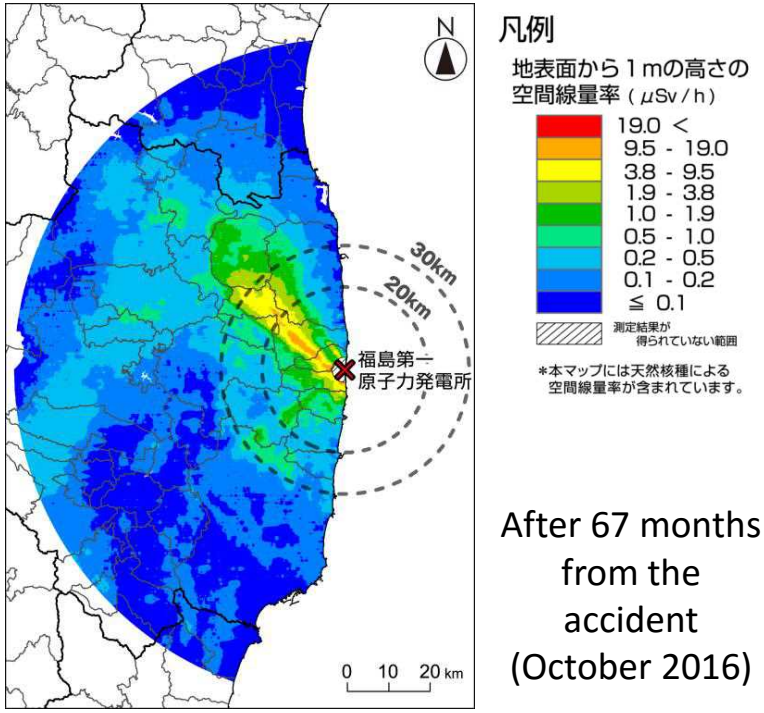
Transition of the Air Dose Rate

Compared air dose rate of 7months after the accident (as of Nov. 5, 2011) with that of 67months after the accident (as of Oct. 15, 2016), 71% decrease was found. This figure showed the decrease was faster than natural decay

Distribution map showing transition of the air dose rate within 80km radius



After a month from the accident (April 2011)



After 67 months from the accident (October 2016)

“Result of airborne monitoring in and around Fukushima Prefecture (as of February 13, 2017, NSR)

Scale of Whole Area Decontamination Project

◆The MOE has budgeted approx. JPY 2.9 trillion (= USD 27 billion) up to FY2017 for decontamination.
◆16,5mil.㎥ (among which approx. 16mil. ㎥ of the removed soil and wastes were estimated to have been removed until now *Estimation total number of SDA decontamination (as of January 2018) and ICSA decontamination (as of September 2017)
◆MOE is also working on "Decontamination Project Report“ to leave a record behind of the experiences, knowledge and lessons learned through decontamination works.

Decontamination in SDA

- Total number of labor:
  approx. 13,600,000 workers
  ※as of the end of January 2018

- Budget: approx. JPY 1.5 trillion
  ※ MOE's budget until FY2017 (excluding unnecessary cost)

- Volume of the generated soil:
  approx. 9,000,000㎥

  From the above volume of soil already transported from TSS*: approx. 1,700,000㎥ (estimation as of the end of January 2018)

* Volume transported either to the ISF or to Temporary incineration facilities (TIFs)

Decontamination in ICSA

- Total number of labor:
  approx. over 18,000,000 workers
  ※ estimated from interviews with relevant municipalities

- Budget: approx. JPY 1.4 trillion
  (within Fukushima Pref. : approx. JPY 1.3 trillion,
  outside Fukushima Pref. : approx. JPY 5 billion
  ※MOE's budget until FY2017 (excluding unnecessary cost)

- Volume of the generated soil:
  approx. 7,500,000㎥ (estimation)
  (within Fukushima 7,000,000㎥,
  outside Fukushima 500,000㎥, both are estimation)

  From the above volume of soil already transported from TSS*: approx. 1,300,000㎥ (as of the end of January 2017)

※Considered 1US$ =JPY107

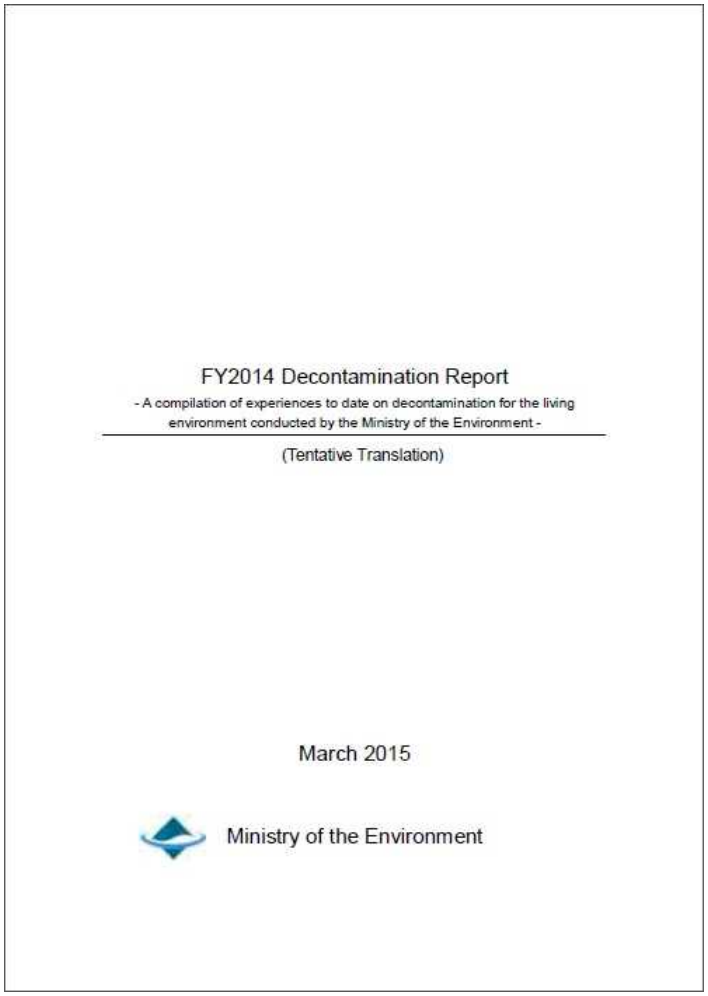
Decontamination Report

Decontamination Report (March 2015, MOEJ)

- A compilation of experiences to date on decontamination for the living environment conducted by the Ministry of the Environment

(Contents)

1. The basic features of off-site decontamination in Japan
2. Overview of decontamination procedures
3. Management and treatment of removed soil and waste
4. Management of decontamination project
5. Effects of decontamination
6. Overview, usage and applicable conditions, and verification of effects of decontamination technologies


FY2014 Decontamination Report

- A compilation of experiences to date on decontamination for the living environment conducted by the Ministry of the Environment -

(Tentative Translation)

March 2015

Ministry of the Environment

URL: http://josen.env.go.jp/en/policy_document/pdf/decontamination_report1503_full.pdf

Outline

What is an Interim Storage Facility (ISF)?

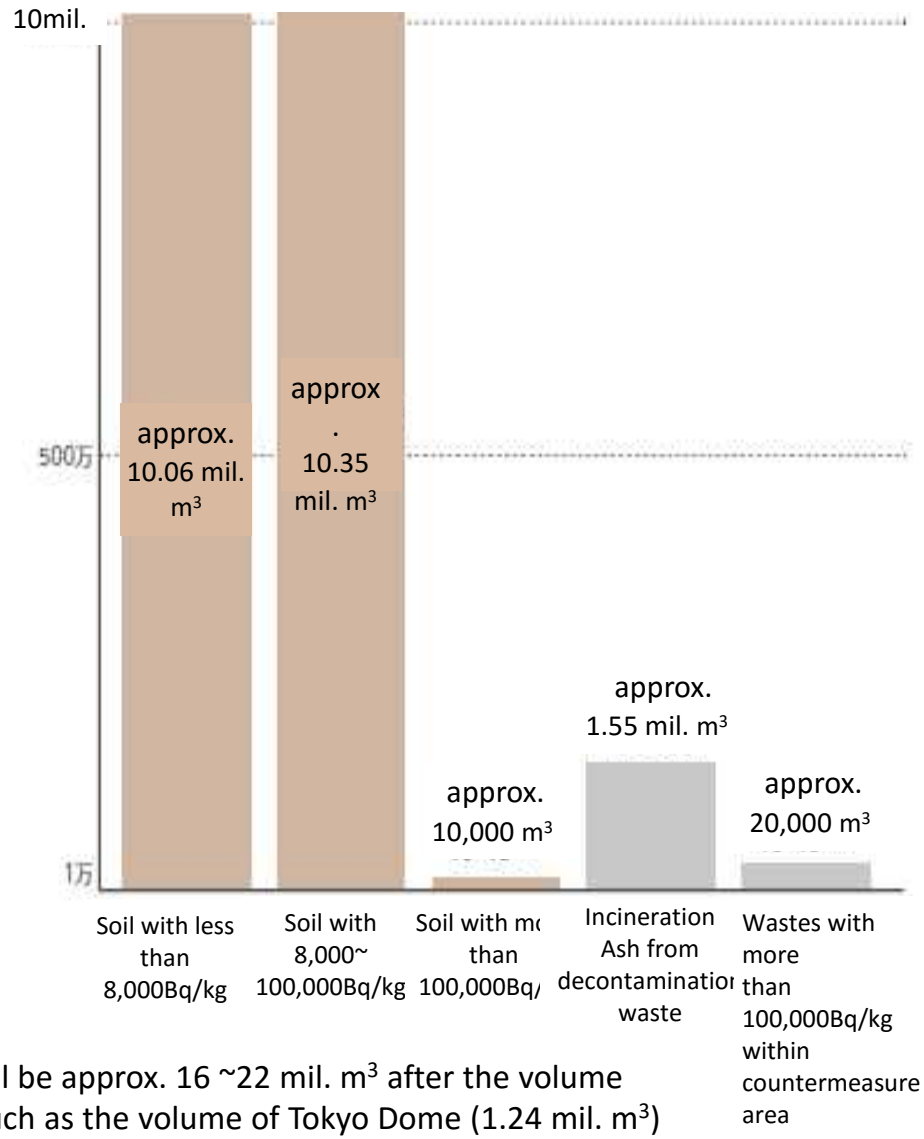
♦In Fukushima Prefecture, large quantities of removed soil and waste have been generated from decontamination activities.
♦Currently, it is difficult to clarify methods of final disposal of such soil and waste.
♦Until final disposal becomes available, it is necessary to establish an Interim Storage Facility (ISF) in order to manage and store soil and waste safely .

The following materials generated in Fukushima Prefecture will be stored in the ISF.

1. Soil and waste (such as fallen leaves and branches) generated from decontamination activities, which have been stored at the Temporary Storage Sites.

2. Incineration ash with radioactive concentration more than 100,000 Bq/kg.

Estimated volume of generated soil, etc. from decontamination work (in case of 22 million ㎥)

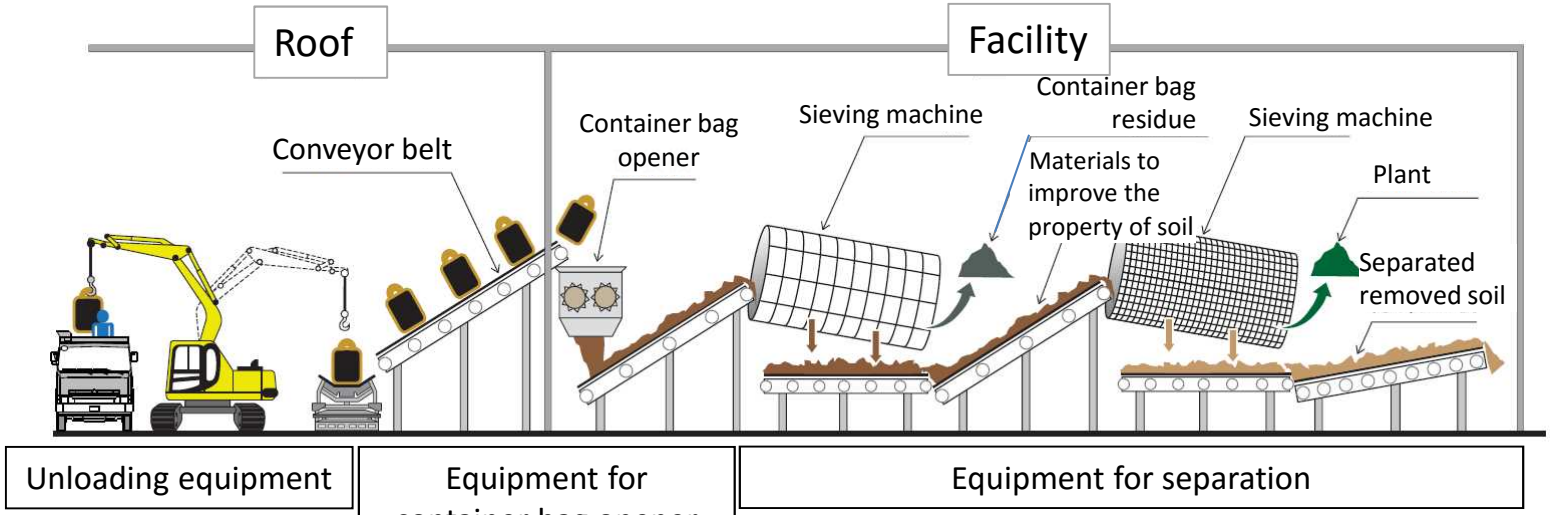


♦It is estimated that generated soil from decontamination will be approx. 16 ~22 mil. m³ after the volume reduction incineration (Ref: approximately 13~18 times as much as the volume of Tokyo Dome (1.24 mil. m³)
※In considering the plan for the Interim Storage Facility, storage of products whose volume is difficult to estimate at this moment is also taken into account.

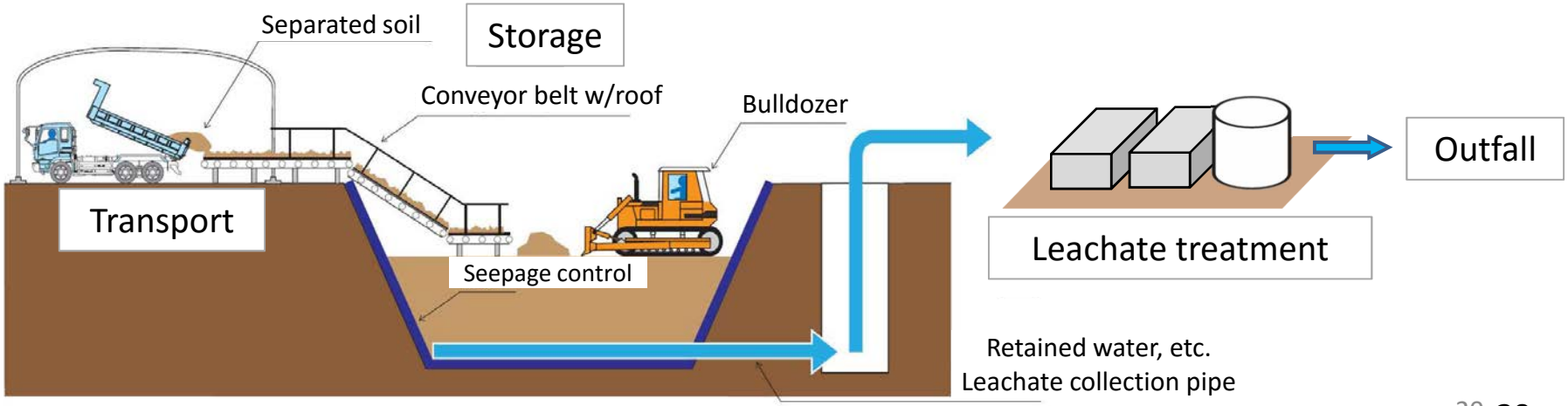
Reception / Separation / Soil Storage Facility

◆ Soil storage facility started the operation in December 2017 in both Okuma and Futaba

Reception / Separation Facility



Soil Storage Facility



Transportation to the ISF

◆In FY2017, approx. 500,000㎥ of removed soil is targeted to be transported

◆In FY2018, approx. 1,800,000㎥ of removed soil will be transported to the ISF

◆Safe and secure transportation will be sequentially conducted managing whole numbers of transport objects, managing traffic of trucks, and implementing environmental monitoring, and etc.

Facilitation of bags at Stock Yards

<Actual achievement in FY2017>

As of March 17, 2018

◆**Stored volume: 513,135 ㎥ (742,251㎥ in total)**

* Calculated on the assumption that the volume of a large bag is 1 m^3

◆**Total number of trucks used: 85,071 (123,109 in total)**

Operation of a truck screening

Status of Planned Site for the ISF

As of the end of February 2018

Whole Area approx. 1,600ha	Item	Whole area	Ratio to the whole area	Registration record detail (2,360pers.)
Private Land **approx. 1,270 ha** (approx. 79%)	Landowners with contact information	approx. 1,220ha	approx. 76% ※Areas with owners' contact information occupies approx. 96% to the total area	1,880 pers.
	Property investigations accepted	approx. 1,170ha	approx. 73%	1,640 pers.
	Property already investigated	approx. 1,160ha	approx. 73%	approx. 1,620 pers.
	Contracted	approx. 844ha	approx. 52.8%	1,380 pers.
National/ Municipality Land etc. **approx. 330ha** (approx. 21%)	Town owned -land	approx. 165ha	approx. 10.3%	
	National/ Municipality land/ Land without address	approx. 165ha	approx. 10.3%	

Prospect for 5year Ad-hoc Policy on Interim Storage Facility ①

FY		Land Acquisition	Volume of Transportation	Volume of soil generated from decontamination <> is the volume before incineration
2015	March 2015 Transportation started	Approx. 22 ha ※Actual amount as of march 25, 2016	Approx. 50,000 ㎥	＜Approx. 10.6 mil. ㎥＞ ※Actual amount as of the end of Dec. 2015 ※Total amount of storage and amount already delivered
2016		Approx. 140 – 370 ha	Approx. 0.2 mil. ㎥	Approx. 16 – 22 mil. ㎥ <approx. 18.7 – 28 mil. ㎥> ※Estimated value based on decontamination implementation plan as of July 2013 Among following items which are difficult to treat other than in ISF will be installed, but it is not included in above volume of soil generated from decontamination ① Approx. 0.7mil. ㎥ of removed soil with radioactive concentration of less than 8,000Bq/kg ② Approx. 0.4 mil. ㎥ of waste generated from ISF construction (①&② will possibly be significantly decreased or increased after the incineration) ③ Volume of waste in the “Area where people have difficulties in returning for a long time” and in future follow-up decontamination which are both difficult to estimate for the moment
2017		Approx. 270 -830 ha	Approx. 0.5 – 0.7 mil. ㎥	
2018	Opening between Ryozan & Soma IC (goal) Facilitation of Okuma IC completed (goal)	Approx. 400 – 940 ha	Approx. 1.4 – 2.5 mil. ㎥	
2019	Facilitation of Futaba IC completed (goal)	Approx. 520 – 1,040 ha	Approx. 3 – 6.5 mil. ㎥	
2020	July: Tokyo Olympic and Paralympic will be held	Approx. 640 – 1,150 ha	Approx. 5 – 12.5 mil. ㎥ (3.5 – 8 mil. ㎥ until June)	

※ This prospect will be reviewed according to the progress of ISF construction, as needed

< Concept of estimation >

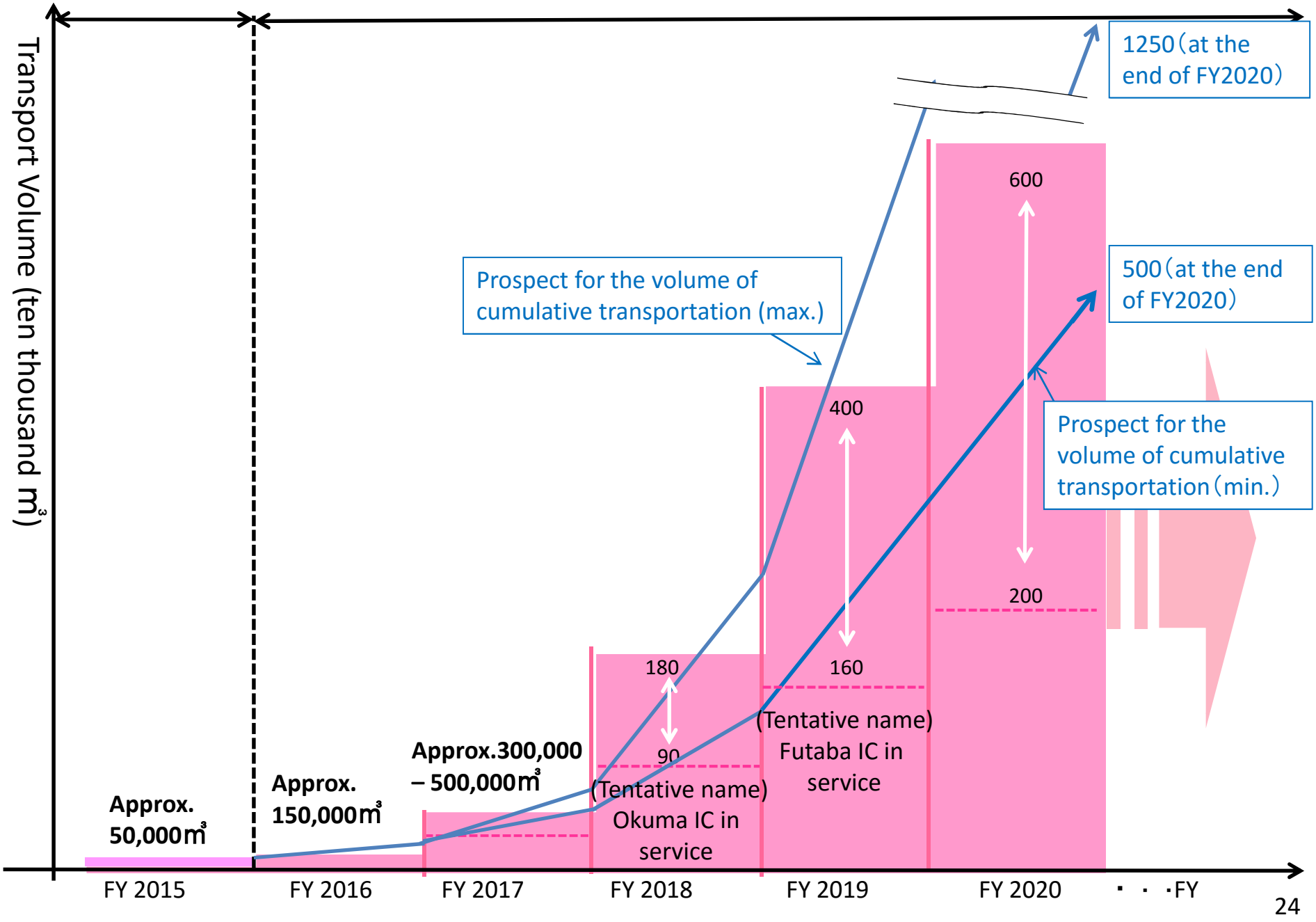
♦Area for land acquisition will be estimated flexibly according to explanation phase to the landowners

♦To construct facilities, it will need comprehensive area and 2/3 will be assumed to be used for facilitation. The possible volume for installation is to be 10,000㎥/ha and 140,000㎥/5ha for a storage facility, and will be installed from TSS to ISF sequentially

♦Approximate period from contract with operators to ISF operation: 3months for TSS, 6months for delivery & separation, 12months for storage, 18months for incineration

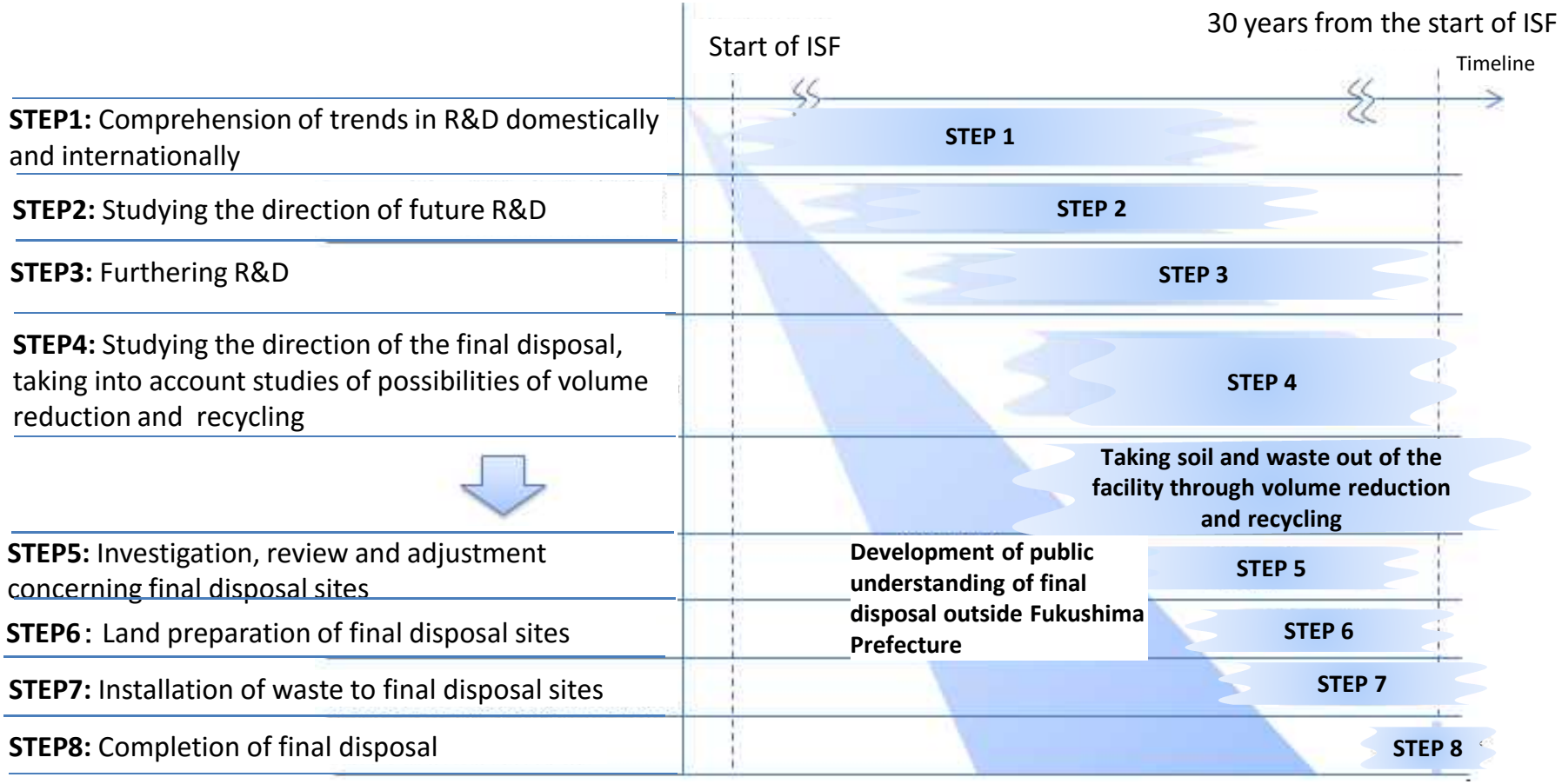
♦On the premise that infrastructure construction on roads for Okuma and Futaba IC would proceed as planned, the maximum volume of possible transportation is estimated: 2mil. ㎥ /y before the operation of both IC, 4mil. ㎥/y after Okuma IC & before Futaba IC, 6 mil. ㎥/y after the both ICs operation

Prospect for 5year Ad-hoc Policy on Interim Storage Facility ②



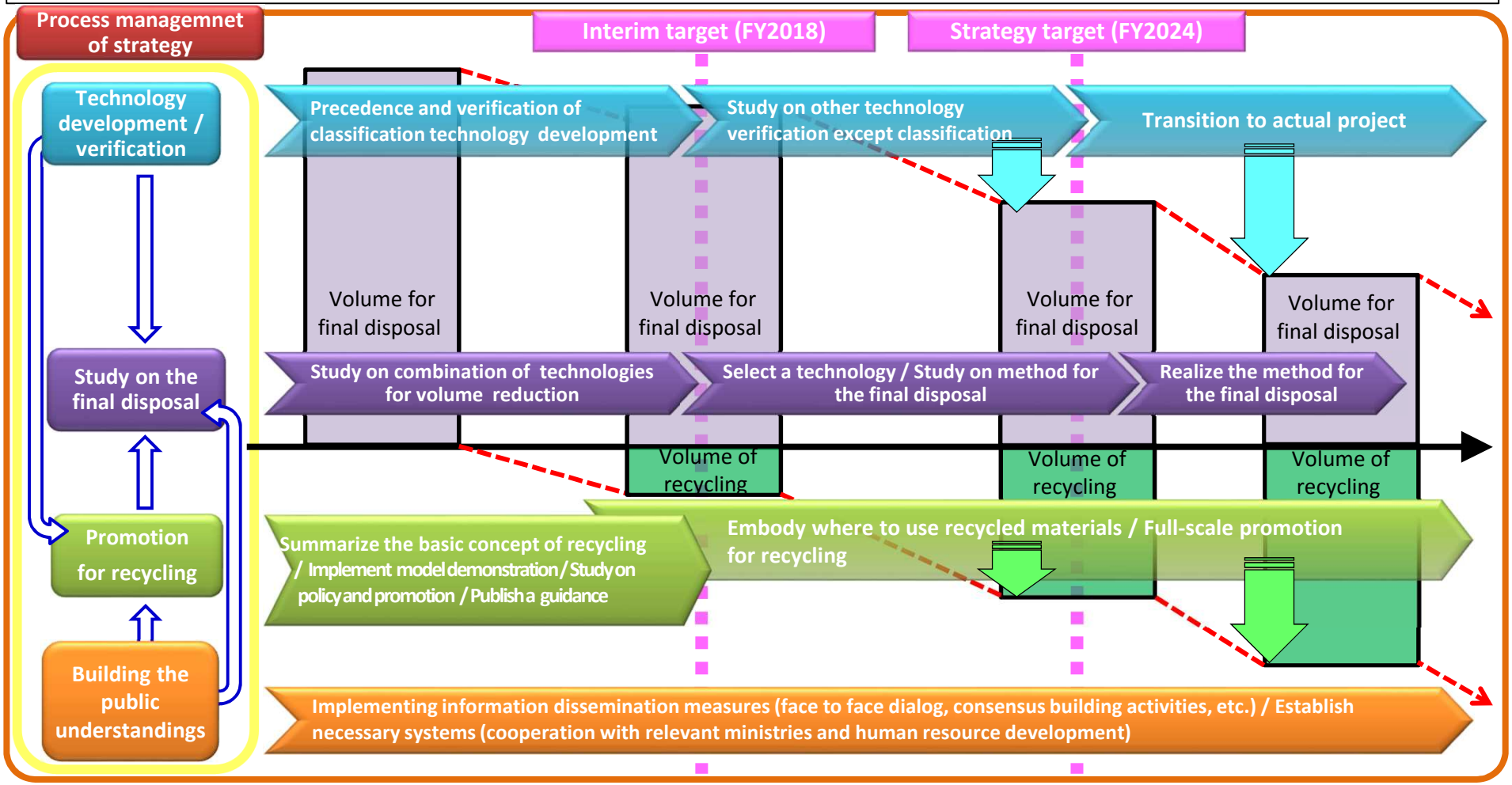
(Review) 8 Steps towards the Final Disposal outside Fukushima Prefecture within 30 years from the Start of the ISF

- MOE conducts R&D to examine how the final disposal to be implemented taking into account the effect of radioactive decay and the potential of volume reduction and recycling
- MOE disseminates, for public understanding, the information on recycling less radioactive material and the final disposal outside Fukushima Prefecture



(Review) Technology Development Strategy for Volume Reduction & Recycling of the Removed Soil

- Towards the final disposal of the removed soil outside Fukushima Pref., MOE will promote recycling of the soil after volume reduction technology as much as possible, which consequently would lead to reduce the volume of soil for the final disposal
- After clarifying the objectives and priority of technology development and volume reduction & recycling, basic technology development is planned to be completed within 10 years, then move onto a phase of treatment
- On the premise of securing safety, MOE will try to realize the recycling in the possible field, building public understandings for the safety
- Based on technology development and prospect of recycling in the future, MOE would propose some options for structure and necessary dimension of the final disposal



(Review) Basic Concepts on Safe Use of Contaminated Soil after Recycling (June 2016)

【Basic Concept】

The contaminated soil should be used mainly for public projects as the controlled materials (with radioactivity level below 8,000Bq/kg in principle and set according to purpose) after necessary treatment, e.g. removal of debris, classification treatment, and be managed by the public authorities.

【Limited Use】

The use will be limited such as basic structure material of banking for coastal levee, seaside protection forest, or embankment materials for roads, which assumed not to be changed the form artificially for a long time period. It will be also used as covering soil for waste disposal site.

【Management by the public authorities 】

- The criteria should be formulated based on the Act on Special Measures and be managed by MOE and public entities (municipalities, etc.)
- To be specific, in order to confine additional exposure dose as below 1mSv/y at the time of construction and below 0.01mSv/y at the time of service, radioactive level of recycled materials should be limited, covering soil should be installed, scatter and leakage should be prevented, ground form change should be observed, and the data should be recorded.

【Procedure of recycling】

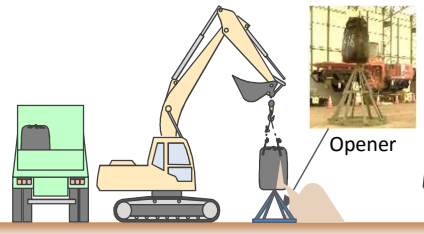
To realize the recycling of contaminated soil, demonstration and model projects based on concepts above should be implemented keeping the safety against radiation, studying specific verification of management method, and building stakeholders' understandings .

Recycling demonstration project in Minamisoma City

1. Preliminary treatment / quality control process (April 2017-)

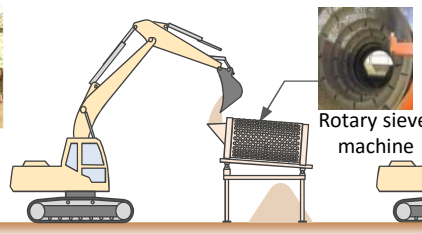
1. Open sandbags and remove large stones and debris

Open large sandbags and remove large foreign materials



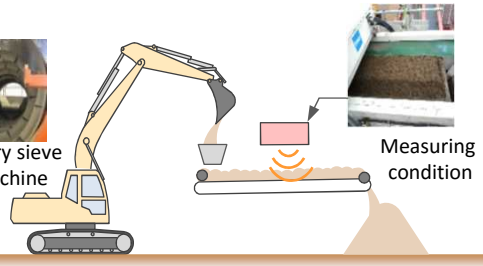
2. Further eliminate smaller debris

Eliminate small foreign materials through sieves



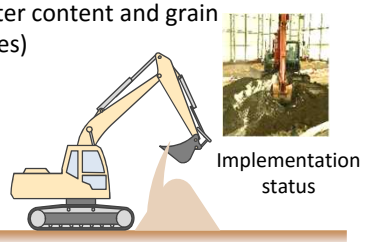
3. Classify soil by concentration

Measure radiation and classify soil



4. Control quality

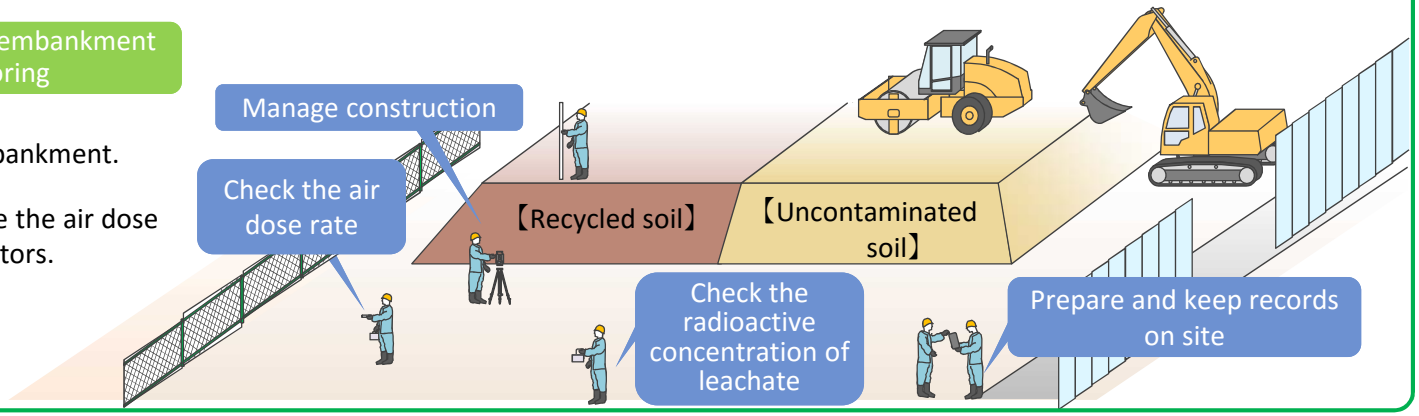
Control quality of soil to be used for embankment (such as water content and grain sizes)



2. Test embankment process (May 2017-)

5. Construct test embankment / Monitoring

- Construct a test embankment.
- Continue to measure the air dose rate and other indicators.



Outline

Cooperation with International Societies

Oct. 31-Nov. 1, 2016
The 5th Japan-UK Nuclear Dialogue (@Tokyo)

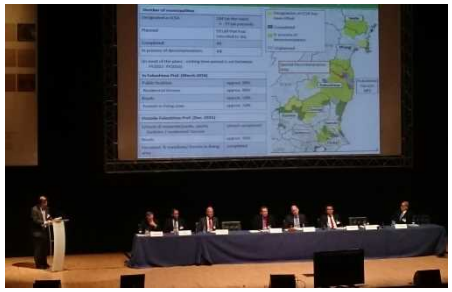
Nov. 15-16 2016

The 2nd IAEA-MOE Experts Meeting on Environment Remediation of Off-Site areas after the Fukushima Dai-ichi Nuclear Power Station Accident (@Tokyo)

Nov.24, 2016
The 6th meeting of the Japan-France Nuclear Cooperation Committee (@Paris)

Dec. 5, 2016
The 4th Meeting of Japan-Ukraine Joint Committee for the cooperation to advance aftermath response to accidents at nuclear power stations (@Tokyo)

Apr. 17-21, 2017
The 3rd IAEA-MOE Experts Meeting on Environment Remediation of Off-Site areas after the Fukushima Dai-ichi Nuclear Power Station Accident (@Tokyo)



Oct. 26-27, 2017
The 6th Annual Japan-UK Nuclear Dialogue (@London)

Nov. 6-10, 2017
The 4th IAEA-MOE Experts Meeting on Environment Remediation of Off-Site areas after the Fukushima Dai-ichi Nuclear Power Station Accident (@Tokyo)

Nov. 21, 2017
The 7th Meeting of the Japan-France Nuclear Cooperation Committee (@Tokyo)

Nov. 27, 2017
The 5th Meeting of Japan-Ukraine Joint Committee for the cooperation to advance aftermath response to accidents at nuclear power stations (@Kiev)

Public Communication

Provision of basic and comprehensive information

■ **Web http://josen.env.go.jp/en/**

■ **Call centers in Fukushima and in Tokyo**

Environmental Regeneration Plaza (Information hub run by MOE and Fukushima Pref.)

■ **Providing interactive communications with people and municipalities**

- Interactive exhibition and workshops
- Dispatch of experts to municipalities, communities, schools, etc.

Pamphlets, comic books, and videos

■ **Providing easy-to-understand information with detailed data on decontamination and radiation**

- Distributed at meetings, workshops, city offices, banks, and supermarkets in Fukushima, and also available on the Web

Collaboration with media

■ **Providing information that helps people understand remediation and the state of the region after remediation, in collaboration with media in Fukushima**

- Newspaper ads and TV/radio programs
- ”Thanks Helmet”, a campaign to motivate the decontamination workers and improve relationships between the residents and the workers

Development of national public understanding

■ **Widely disseminate information to the public of remediation and the state of the region after remediation so that they can correctly understand the current status of Fukushima and its products**

PR of rice harvested from decontaminated paddy fields

Exhibition at Tokyo about “Steps for Restoration of Fukushima”

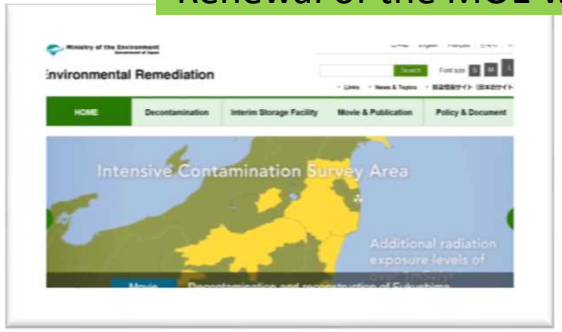
Current PR Activities by MOEJ

Ministry of the Environment, Japan (MOEJ) released an English booklet in August. English web-site, "Environmental Remediation" was also renewed and two TV shows are now available on MOE's web site.

English booklet

A comic style booklet, "Nasubi no Gimon" was released in August 2017, explaining radiation measures for food, etc.

Renewal of the MOE web-site



MOE renewed the web-site, adding more updated information http://josen.env.go.jp/en/

TV programs

"Fukushima Diaries" by Discovery Channel: In this 30-minitues show, three famous bloggers from overseas visited different destinations in Fukushima Pref. with their own interests. They showed the viewers what is really going on in Fukushima http://josen.env.go.jp/en/movie_publication/cooperation_index.html

Channel Japan/CNBC ASIA: CNBC broadcasted 15-minitues program 4times in a row. Each program showed you the key persons in Fukushima how hard they work to fight against misconceptions and to revitalize Fukushima. Each content is as follows;

#1 The story of Mr. McMichael, who tries to help widely communicate correct information on Fukushima to international communities

#2 The story of two young people who are eager to revitalize their hometown, Fukushima

#3 The story of small factories that tackle on the development of robots for decommission.

#4 The story of Dr. Hayano, who teaches what is radiation from academic point of views.