Soil Contamination Countermeasures in Japan

September 2011

This document is based on the work carried out in collaboration with the Pollution Control Department (PCD) of Thailand and with the support of the Asia Environment Compliance and Enforcement Network (AECEN) with the view to sharing the Japan's experiences in undertaking soil contamination countermeasures in Japan.

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The members of the drafting group were grateful to PCD and AECEN partners for their support.

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Introduction

Soil contamination is environmental pollution that can impact human health but that which can be prevented if routes for taking in contaminated substances to the human body are blocked. If it is blocked, soil contamination no longer poses a threat to human health compared with other type of environmental pollution. Because soil contamination is one of the so-called "storage types" of contamination, concentrations of hazardous substances of more than ten thousand times the concentration of standard environmental values can occur. However, such concentration of these substances could be utilized for chemical experiments and at factories, in general. Appropriate management is required when hazardous substances are utilized, so as to mitigate problems and handle contaminated soil appropriately.

Soil contamination mainly occurs on private lands, so public organizations such as local governments cannot investigate contamination unless land owners accept. As a result, contamination cannot be discovered and investigated as other forms of pollution in public spaces.

In Japan, soil contamination became a social problem in the 1970's and gained much public exposure as a result of "Itai-Itai Disease" which resulted from rice contaminated by cadmium. Thereafter, based on the Agricultural Land Soil Pollution Prevention Act, prefectural governor's implemented countermeasures as public enterprise that covers the contaminated area by transported non-contaminated soil. The cost is borne by the polluter related to the proportion he contaminated. The rest of the cost is borne by the prefectural government. The state government can aid local governments with subsidies. After that, the Soil Environment Standard was established based on the Pollution Control Basic Act (which was revised to Environment Basic Act in 1993) as an administrative target in order to prevent human health impact caused by agricultural land and groundwater. In the end of 1990's, contaminated soil by dioxins became a social problem. Therefore, the Act on Special Measures Concerning Dioxins was established by Representatives' Initiative, including countermeasures following the system of the Agricultural Land Soil Pollution Prevention Act,

Soil contamination in urban areas that exceeds soil Environment Standard has increasingly been reported to local governments. This situation let neighborhoods with contaminated land act on their concerns for their health and guided communities in how to deal with the soil contamination in urban areas by linking this social issue with land use and property ownership procedures. The Soil Contamination Countermeasures Act was established in 2002. This Act had the purpose of appropriate management by registering contaminated zone to prefectural record (list) that is supposed to be implemented both in the case of existence of health impact potential and in the case of no existence of health impact potential. But, after establishment of the Act, concealment of soil contamination was widely spread because soil contamination found by private investigations were not reported to local government and surreptitious removal of contaminated soil was conducted for the purpose of avoiding registering the land as a contaminated zone to the prefectural record (list). Furthermore too much removal caused the spread of contaminated soil and environmental risks far beyond the original site. Most of conductors who conduct removal did not care where contaminated soil was removed to and how contaminated soil was disposed. Then, Soil Contamination Countermeasures Act was amended in 2009.

In an amendment in 2009, (1) prefectural record (list) was divided into two books; in the case of existence of health impact potential and in the case of no existence of health impact potential to humans. (2) Regulations for taking out, transporting and disposing of contaminated soil from two types of designated zone. In Japan, more than 97% of the population consume, or have access to, tap water; there are very few people who drink groundwater mainly or directly. Therefore it is a major problem that contaminated soil was taken out from the sites where there is no drinking use of groundwater and it was disposed to the areas for tap water sources, such as in a natural valley as opposed to an industrial site.

The situation of Thailand seems to be different from Japan. There are many areas and districts where there is a lack of tap water infrastructure, and where groundwater is the main water source. Therefore treatment of contaminated soil would be fundamentally different from Japan.

Soil contamination mostly occurs because of actions in the past when regulation of infiltrating hazardous substances in underground did not exist. Thus in Soil

contamination Countermeasures Act in Japan, countermeasures for preventing health impact is required in the limited case that there is health impact potential. Even in this case, it is not required to restore the soil to its original condition, simply blocking the routes of ingestion may be sufficient.

In order to prevent health impact from drinking groundwater, measures for groundwater contamination might be better than that of soil contamination in the view of cost effectiveness – such as filtration. Also in order to prevent health impact, countermeasures by public organizations should be necessary in the case when polluters are not identified or do not have enough financial ability for conducting measures.

What is the most important for coping with soil contamination is what kinds of countermeasures are the most suitable or effective in order to prevent health impact of residents who are living in the area surrounding the contaminated land.

Section I　Risk and standards for soil contamination

1. People take air and water for living, but they do not eat or drink soil. However, there is the potential of health damage caused by soil contamination. Figure 1 is showed some routes that human health is impacted or damaged by soil contamination.

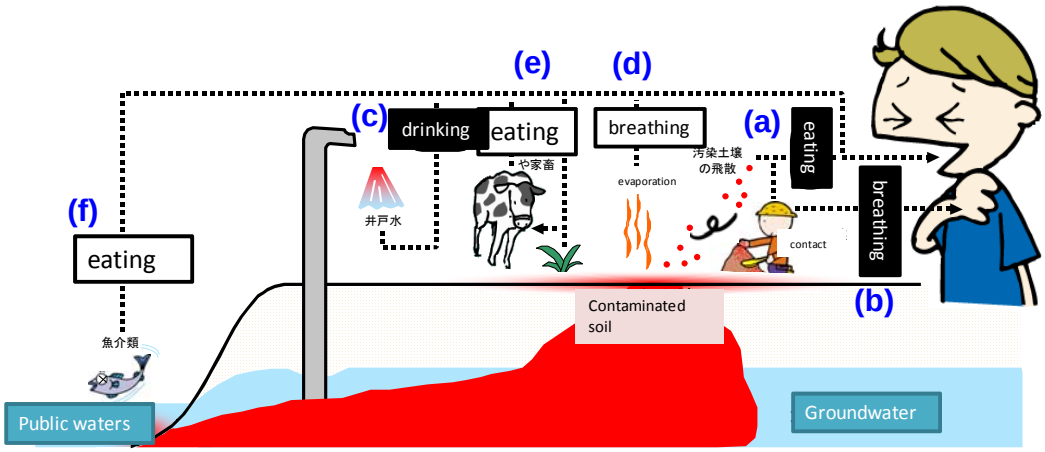


Figure 1: Environmental Risk related to Soil and Groundwater contamination [Source: MOEJ (Trans. IGES)]

Note:

(a) Direct ingestion of contaminated soil (including soil particulate)

(b) Dermal absorption

(c) Ingestion of groundwater contaminated by hazardous substances eluted from contaminated soil

(d) Inhalation of hazardous substances emitted from contaminated soil to atmosphere

(e) Discharge of soil containing hazardous substances to municipal waterways → accumulation in aquatic ecology → ingestion by human beings

(f) Accumulation of hazardous substances in crops and livestock raised on contaminated land → ingestion by human beings　⇒Agricultural Land Soil Pollution Prevention Act

(1) Soil Contamination Countermeasures Act deals with direct ingestion [(a) and (b)] and ingestion of groundwater in the view of precautionary approach.

Direct ingestion could happen when children play outside or in the sand and come into contact with contaminated soil or when contaminated soil is dispersed into the air and enters human body.

Ingestion of groundwater could happen when hazardous substances reach the groundwater which is drunk by people.

(2) Contaminated Soil caused by inappropriate disposal of waste (including waste dumping) is dealt in Waste Management and Public Cleansing Act

2. In Japan, Environment Standard is set based on the guideline of drinking water of WHO, considering into account; (i) situation of using volume of substances, and (ii) exceeded ratio from standard level by voluntary monitoring of municipalities. (in regard of POPs agreement, substances that are not set up water quality Environment Standard, like DDT and Chlordane, and others, are not already produced, and cannot be in the environment).

2

Problems caused by soil and groundwater contamination

☐ Why is contamination of the soil and groundwater a matter of concern?

- **Contaminated soil and groundwater can adversely affect human health, the living environment and ecosystems (generically referred to as environmental risks).**
- **Recently, aspects of corporate operational risks have been increasingly emphasized.**
  - Decreased appraised prices (asset values) for land in real estate appraisal
  - Impacts on business accounting due to the introduction of asset-impairment accounting
  - Expenses incurred for investigations and measures, and the related costs
  - Negative impact on the corporate image

➢ The existence of any of these risks is attributed to the presence of environmental risks.

3

Risk-based approaches for proper solutions

- **Original goals of measures against soil and groundwater contamination**
  - **To reduce potential environmental risks caused by soil and groundwater contamination to an acceptable level (involving the reduction and control of environmental risks).**

- **Risk-based measures against soil and groundwater contamination**
  - **To quantitatively evaluate and reduce potential environmental risks caused by soil and groundwater contamination.**
  - **Risk-based measures have been widely adopted for soil and groundwater contamination in Europe and North America and they have been providing successful solutions to brownfield issues.**
    - In Europe and North America, methods of evaluating environmental risks have been developed in individual countries.

4

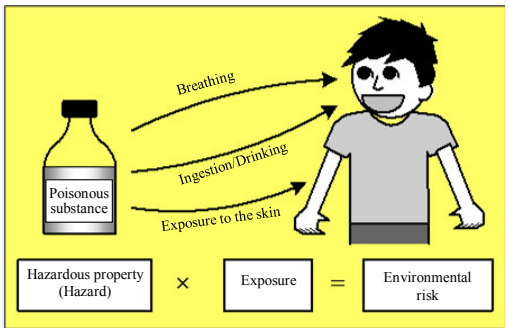
Environmental risks caused by soil and groundwater contamination

- **Environmental risks**
  - **Risk of (potential for) adverse effects from chemical substances in relation to human health and/or the living environment through the environment**

- **Environmental risks caused by soil contamination**
  - **Human health risk**
    - Susceptibility to human disorders, diseases or death
  - **Living environment risk**
  - **Ecosystem risk**

Definition of environmental risk

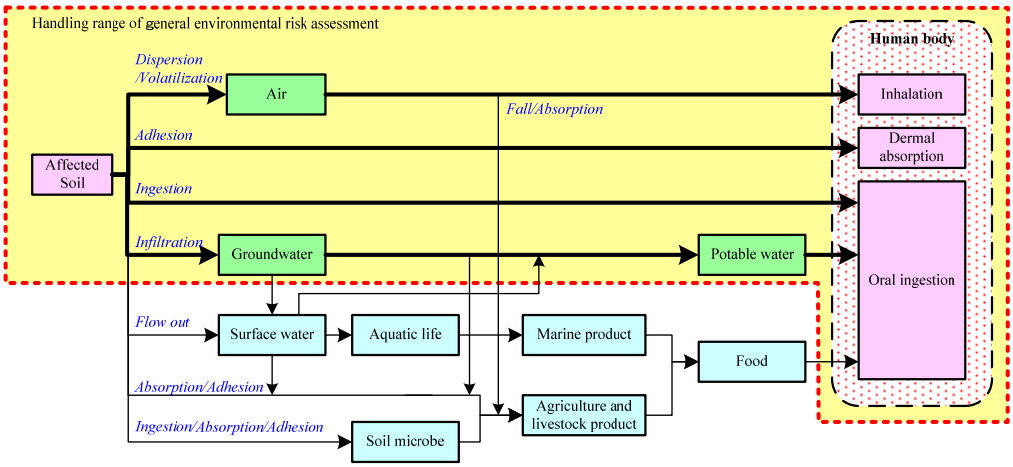
- **A series of conditions required to be present in combination in order for exposure to chemical substances to have an impact on human health**
  - **(1) The chemical substances involved must have hazardous properties (act as hazards).**
  - **(2) There must be the chance of exposure to the chemical substances.**
  - **(3) The amount (or level) of exposure to the chemical substances must be sufficient to develop a reaction to the toxicity of the substances.**



[Source: Nakasugi, GEPC 2008]

Health risks caused by contaminated soil

- **Exposure scenario for the contaminant from contaminated soil**

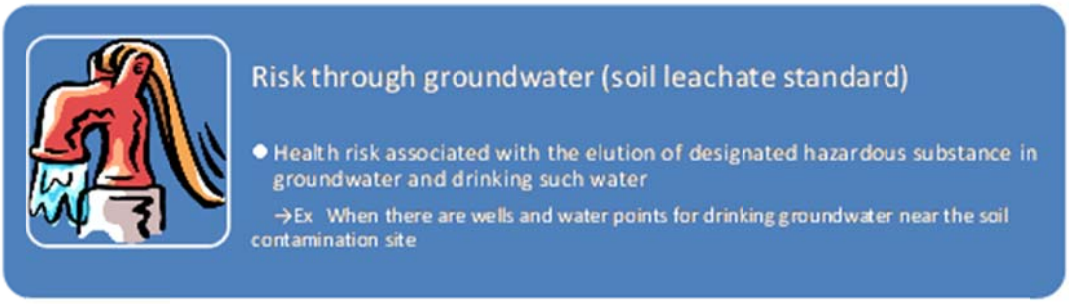


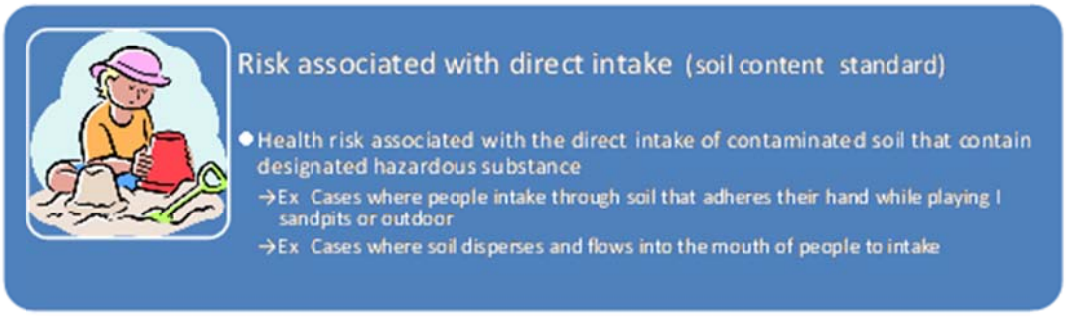
[Source: Nakashima and Wu 2007]

Designated standards for Designated Zone

- **Designated standards**
  - **Soil Leachate Standard (Concentration Standard)**
    - Established for the protection of human health against the drinking of contaminants leached out into the groundwater from contaminated soil.
  - **Soil Content Standard (Health Impact Potential Standard)**
    - Established for the protection of human health against direct exposure to contaminated soil.

- **Other standards**
  - **Standards for groundwater (Quality standards for groundwater contamination)**
    - Established for the protection of human health against groundwater contamination.





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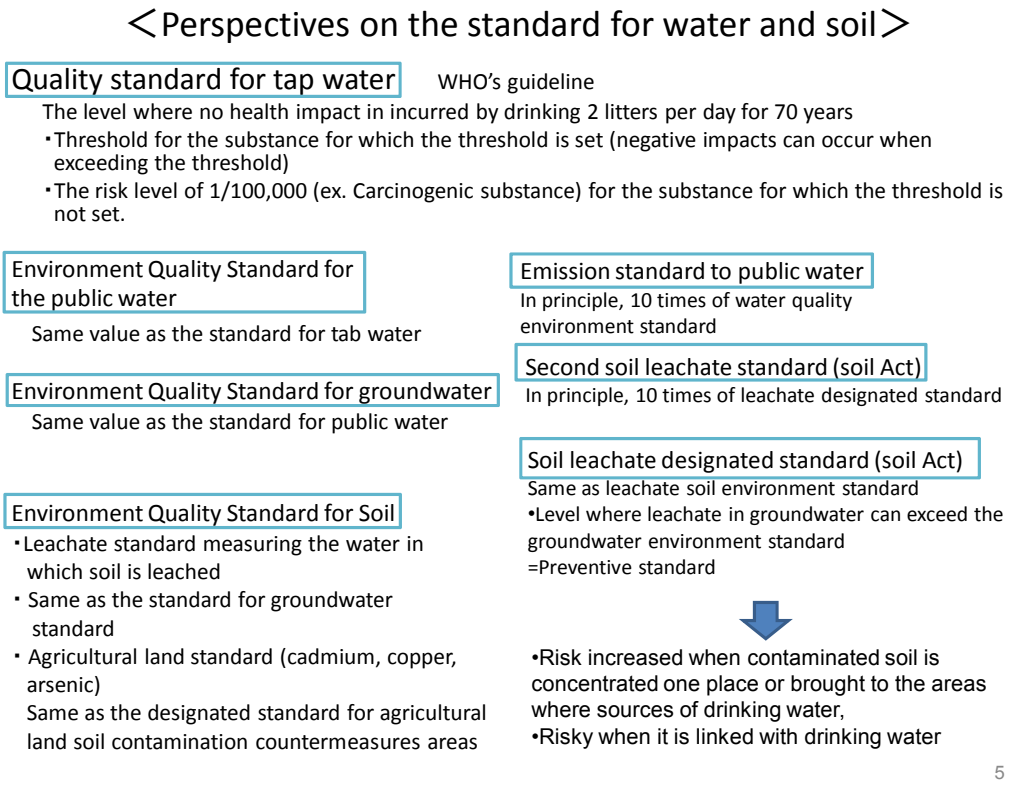

1. Risks through groundwater (soil leachate standard)

The health risk entailed if Designated Hazardous Substances reach the groundwater which is then drunk by people.

・The establishment of the soil leachate standard

By considering the health risks that could be entailed by consumption of Designated Hazardous Substances due to contamination of groundwater, the same standard as the soil environment standards have been set.

・Considerations on life-long toxicity

By assuming the daily consumption of 2L of groundwater during 70 years, the same standards as the groundwater environment and tap-water quality standards have been set.

(1) Elements with a certain tolerable threshold (under which negative impacts are not thought to occur)

→the standards have been set so that health risks stay negligible even when drinking the water throughout the lifetime.

・Setting of concentrations and standard values

(As not only groundwater is consumed, contribution of drinking water is considered to be 10%)

(2) Elements without tolerable threshold (such as those causing cancer)

(Benzene, Trichloroethylene)

→ The standards have been set so that health risks stay negligible even when drinking the water throughout the lifetime (risk increase of 1/100000)

Standards have been set for lead based on the risk projected for the infant's exposure and it is comparable with those for cyan.

Designation Standard

Soil is designated as contaminated if it exceeds the standard.

Target substances and standards

Designated hazardous substances (Article 2 of the Act)		Designation standard (Article 5 of the Act)		Reference: Soil Environment Standard (except for copper)
		Soil Content Standard <Risk for direct ingestion>	Soil Leachate Standard <Risk of ingestion from groundwater etc.>	
Carbon Tetrachloride	Category 1 (VOC)		≤ 0.002mg / L	≤ 0.002mg / L
1, 2 －Dichloroethane			≤ 0.004mg / L	≤ 0.004mg / L
1, 1 －Dichloroethylene			≤ 0.02mg / L	≤ 0.02mg / L
cis－1, 2 －Dichloroethylene			≤ 0.04mg / L	≤ 0.04mg / L
1, 3 －Dichloropropene			≤ 0.002mg / L	≤ 0.002mg / L
Dichloromethane			≤ 0.02mg / L	≤ 0.02mg / L
Tetrachloroethylene			≤ 0.01mg / L	≤ 0.01mg / L
1, 1, 1 －Trichloroethane			≤ 1mg / L	≤ 1mg / L
1, 1, 2 －Trichloroethane			≤ 0.006mg / L	≤ 0.006mg / L
Trichloroethylene			≤ 0.03mg / L	≤ 0.03mg / L
Benzene			≤ 0.01mg / L	≤ 0.01mg / L
Cadmium and its compound	Category 2 (Heavy metal etc.)	≤ 150mg / kg	≤ 0.01mg / L	≤ 0.01mg / L, and ≤ 1mg / 1kg rice on agricultural field
Hexavalent Chromium compounds		≤ 250mg / kg	≤ 0.05mg / L	≤ 0.05mg / L
Cyanides compounds		As isolated cyanides ≤ 50mg / kg	Less than detection limit	Less than detection limit
Total Mercury and its compounds		≤ 15mg / kg	≤ 0.0005mg / L	≤ 0.0005mg / L
Alkyl Mercury			Less than detection limit	Less than detection limit
Selenium and its compounds		≤ 150mg / kg	≤ 0.01mg / L	≤ 0.01mg / L
Lead and its compounds		≤ 150mg / kg	≤ 0.01mg / L	≤ 0.01mg / L
Arsenic and its compounds		≤ 150mg / kg	≤ 0.01mg / L	≤ 0.01mg / L and ≤ 15mg / kg soil on rice field
Fluorine and its compounds		≤ 4000mg / kg	≤ 0.8mg / L	≤ 0.8mg / L
Boron and its compounds		≤ 4000mg / kg	≤ 1mg / L	≤ 1mg / L
Simazine	Category 3 (Agrochemicals and PCBs)		≤ 0.003mg / L	≤ 0.003mg / L
Thiuram			≤ 0.006mg / L	≤ 0.006mg / L
Thiobencarb			≤ 0.02mg / L	≤ 0.02mg / L
PCB			Less than detection limit	Less than detection limit
Organic phosphorus compounds			Less than detection limit	Less than detection limit

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[Source: MOEJ (Trans. IGES)]

2. Risks through direct contact (soil content standard)

The health risk entailed if soil containing Designated Hazardous Substances is directly consumed (including Dermal absorption).

(Example of direct consumption)

・When children play outside or in the sand, and come into contact with contaminated soil.

・When the contaminated soil is dispersed into the air and enters people's body.

・The setting of standards on the amount of chemicals contained in the soil

Standards have been set due to the health risks entailed by direct consumption of soil that contains Designated Hazardous Substances

・The period of consumption

Assuming the lifelong settlement (70 years) on contaminated land

At concentration levels that exclude the possibilities of sudden impacts.

・The selection of standard values

The standards have been set to the same amount as the groundwater consumption levels that were estimated upon setting the soil content standards.

However this assumes that the accidental high quantity consumption (about 10g) of contaminated soil by children would not cause sudden impacts.

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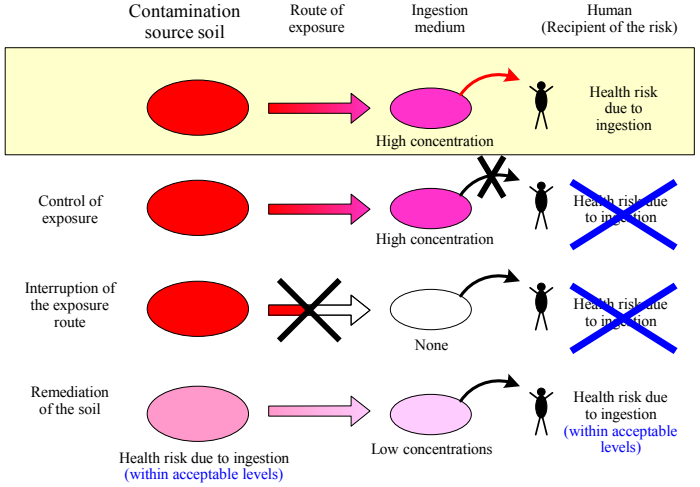
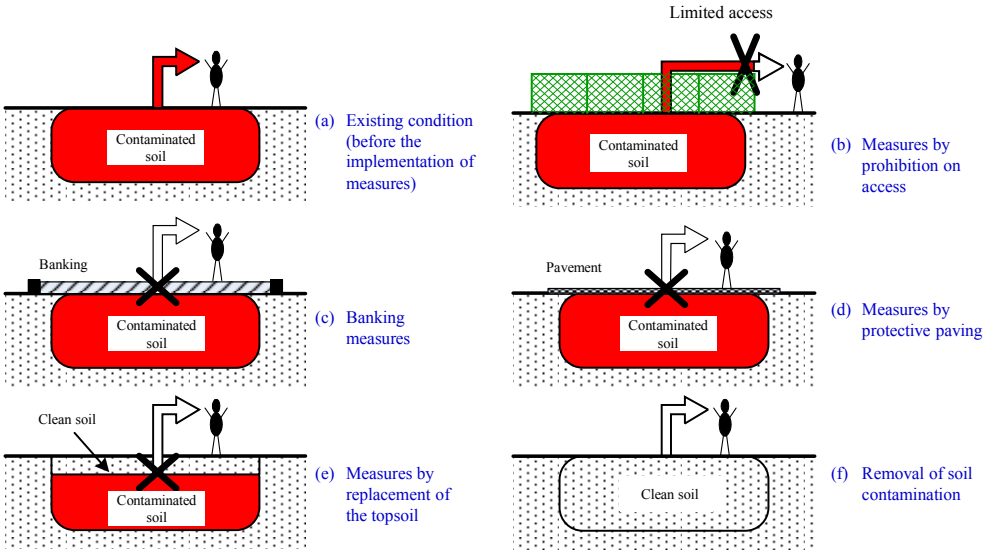
Measures to intercept exposure of contaminants to conform with the Soil Contamination Countermeasures Act

☐ Concept of reducing the environmental risk (human health risk) by taking measure



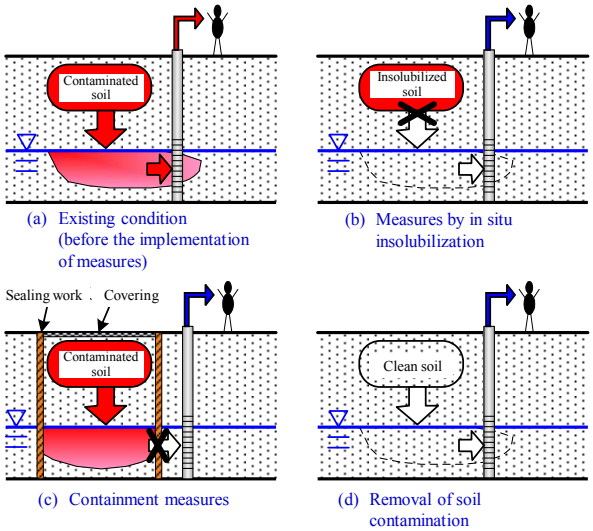
[Source: Nakashima 2009]

Measures to intercept exposure of contaminants in conformity with the[10] Soil Contamination Countermeasures Act (Measures related to risks due to direct ingestion)



[Source: Nakashima]

Measures to intercept exposure of contaminants in conformity with the[11] Soil Contamination Countermeasures Act (Measures related to risks due to ingestion of the groundwater)



[Source: Nakashima]

Section II: Japanese Experience concerning Soil Contamination Problem

2.1 History of Soil Pollution Problem in Japan

Before 1970's, huge number of environment pollution was occurred in Japan. Many people were damaged of their health conditions by these pollutions.

Contaminated Agricultural Land

- 1880's～1970s' Mineral Poison Damage of Ashio Copper Mine, Tochigi Pref. in Watarase River (Damages on rice growth, etc)
- 1910's～1970's "Itai-Itai Disease" of Jinzu River Basin in Toyama Pref. (Health Damage: Cadmium poisoning by contaminated rice, etc)
- 1920's～1960's Mineral Pollution from Toroku Mine in Miyazaki Pref. (Damage: arsenic poisoning, and rice growth, etc)

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In 1970, **the Agricultural Land Soil Pollution Prevention Act** was legislated by the Diet

The origin of Act related to Soil contamination in Japan

(at the same time, the Diet established "Water Quality Pollution Control Act" and "Waste Management and Public Cleansing Act." The Diet was called "Pollution Session of the Diet"

3

Contamination in Urban areas（1）

- In 1975, Soil contamination caused by hexavalent Chromium compounds from a site where a chemical factory closed
- In 1980's, Groundwater Contamination caused by trichloroethylene, etc becomes a social issue
- In 1986, Drawing up of "Draft Countermeasures Guideline related to Soil contamination in Urban cities" by Environment Minister Agency
- In 1989, Amendment of Water Pollution Prevention Act. Regulation that ban of facilities utilizing designated hazardous substances disseminating those substances in underground, was implemented
- In 1991, Establishment of "Environment Quality Standard for Soil (Soil Environment Standard)"

8

- In 1994, Drawing up of "Guideline on Soil Contamination Survey and Countermeasures related to heavy-metal, etc" and "Draft Guideline on Soil and Groundwater Pollution Survey and Countermeasures related to Volatile organic compounds" by Environment Minister Agency
- In 1995, Amendment of Water Pollution Prevention Act. Prefectural governor could order the polluter to clean up contaminated groundwater when this water is used for drinking.
- In 1996, Establishment of Environment Quality Standard for groundwater (adjust to Water Environment Quality Standard for public water=clean up standard of groundwater)

Legal system of soil contamination countermeasures is not consolidated as a whole, but countermeasures based on guidelines, that are related to survey and measures for blocking intake routes of soil contaminations, through standardization conducted by Environment Minister Agency voluntary base, is promoted

9

The Soil Environment Standards were set based on Environment Basic Act in 1991 (with concern for the pathways to human intake through groundwater consumption and use of agricultural land).

Prefectural governor could order the polluter to clean up contaminated groundwater when this water is used for drinking by amendment Water Pollution Prevention Act was set in 1995. The Groundwater Environment Standards were set based on Environment Basic Act in 1996. Clean up based on Water Pollution prevention Act has not ordered yet. Prefectural governors require polluters to implement measures voluntary. The Article of this order facilitates such voluntary administrative guidance. Polluters seem to think that it would be better to implement measures voluntary than to be ordered for implementation by prefectural governor.

Problems of Soil Contamination

- "Stocked pollution"; the negative impacts from hazardous substances are accumulated inside soils over a long period
- Contaminated soil area; private land (private property)
- Measures depending on the land-use, contaminated lands may not entail any health impacts

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As Numerous issues to be better understood and synthesised, it is difficult to enact legislation

9

Numerous issues to be better understood and synthesized. Therefore it is difficult to set legislations. Environment Minister Agency established "Survey and

Countermeasures Guidelines for Soil and Groundwater Contamination" on January, 1999. This guideline has no legal force, but this guideline was created in order to integrate investigation (survey) approach. "Soil contamination Investigation" process, that was established in these guidelines, can contribute to recognize the quality of soil, that is whether soil is contaminated or not.

Soil Contamination caused by Dioxins

- The end of 1990's: High concentrations of dioxins are detected from soils (around waste incinerators). Soil contamination caused by dioxins became a social issue

↓

In 1999, **the Act on Special Measures Concerning Dioxins** legislated by representatives' Initiative

Comprehensive Countermeasures; not only for soil contamination countermeasures, but also on dioxin emissions and disposal process of dust and ash from waste incinerators

In the framework of Environmental Standard for soil contamination, it was the first time that risk assessments were implemented with regards to the direct intake of contaminated soil

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The end of 1990's, dioxins were detected from soil. Around that time, soil contamination by Dioxins was reported a few case and became social problems. Also because the rule of survey and countermeasures toward contamination were not clear, many people were worried about health damage caused by soil contamination. Act on Special Measures Concerning Dioxins was established in 1999 (enforcement in 2000).

The Environment Standards for dioxin-contaminated soil (with concerns for direct human intake) were set in 1999 based on this Act. Contamination route through groundwater was not taken into consideration, since Dioxins is chemical compound

do not solve in the water. Only direct intake was targeted for Environment standard.

Contamination in Urban areas（2）

- Reports of soil contamination discovery were increasing
- The rules for investigation and countermeasures were not specified
- Concerns about health damage from soil contamination

the Act on Special Measures Concerning Dioxins was established in 1999, but there were no regulations on other substances

↓

In 2002, **Soil Contamination Countermeasures Act** was established at the regular Diet session

（In 2009, **amendment** of Soil Contamination Countermeasures Act at regular Diet session） 14

Driving forces leading to the establishment of the soil contamination countermeasures act in Japan:

1. There was an accumulation of reports where environmental standards were exceeded (noted through reports from local governments to the MoEJ)

2. Act on Special Measures Concerning Dioxins was established in 1999, followed by the second environmental plan in 2000, creating a momentum towards solving the problems related to negative heritages from past contamination events. Not only health impact through groundwater considered by Soil Environment Standards, but also health impacts through direct intake from hazardous substances had become a social concern.

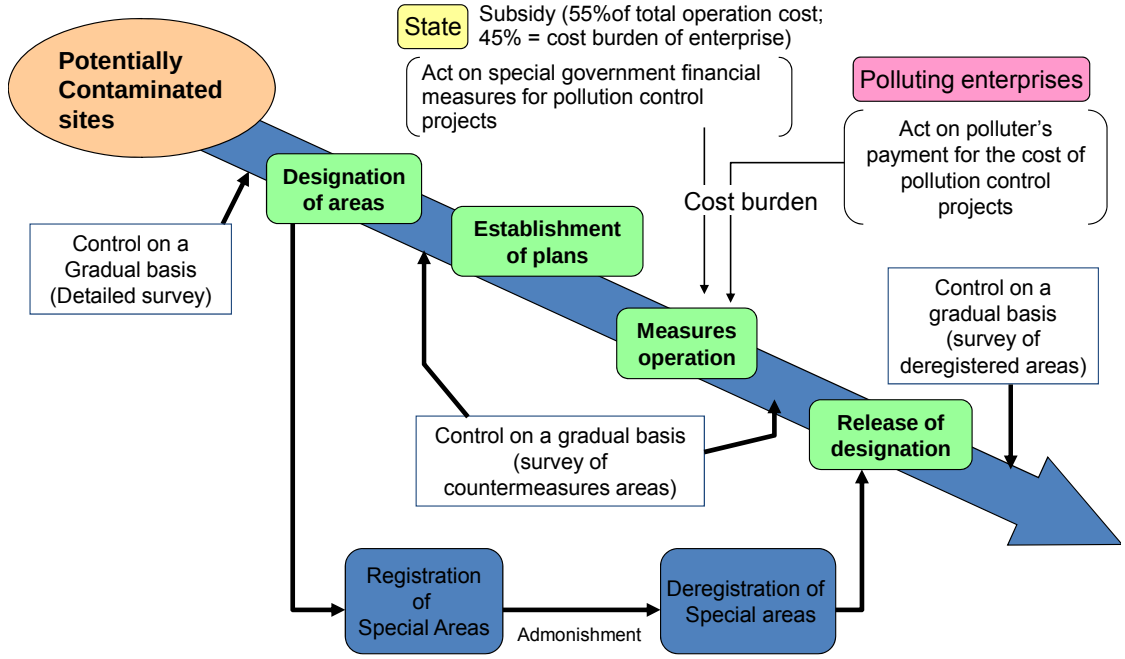
3. In order to integrate approaches for investigation and measures relevant to contamination of soil and groundwater, Ministry of the Environment, Japan (MoEJ) established "Survey and Countermeasures Guidelines for Soil and Groundwater Contamination" on January, 1999.

4. With the spread of voluntary soil investigation measures when selling or purchasing land, there were increasing numbers of landowners who were required to but could not afford to clean up their land below the levels of environmental standards. There was therefore a need to clarify the status of the various countermeasures apart from clean up.

In 2002, Soil Contamination Countermeasures Act was established (enforcement in 2003, amend in 2009, amendment enforced April 2010).

2.2 Agricultural Land Soil Pollution Prevention Act

Outline of Agricultural Land Soil Pollution Prevention Act (Established in 1970)



[Source: MOEJ (Trans. IGES)]

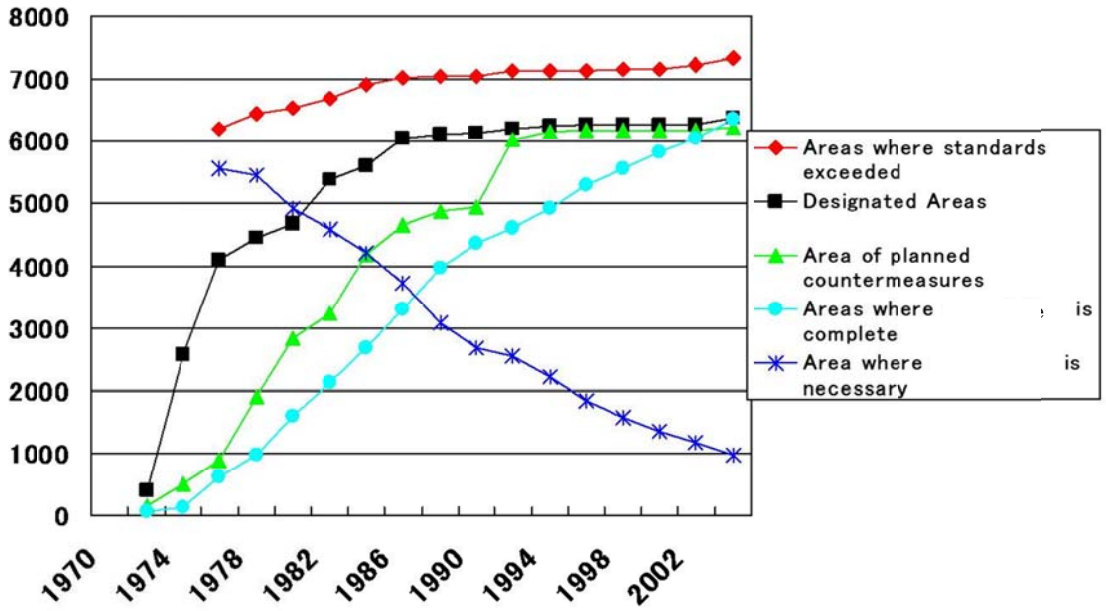
・Designated Substances are Cadmium in rice in the view of prevention of human health, Copper and Arsenic in the view of prevention of bad growth of rice (value of area designated standard in areas for countermeasures is equivalent to Soil Environment Standard's. Area designated standard was established first and Soil Environment Standard was set afterward).

・Local Governments conduct measures as public enterprise. Most common measure is covering contaminated soil by transported non-contaminated soil from other places. Because the length of rice roots is about 20cm, contaminated rice could not be harvested from contaminated rice paddy, if they cover 30cm level of non-contaminated soil over contaminated soil

・Ministry of Health, Labor and Welfare draws up of the food standard that is considered the volume of average food intake in Japan . In the case of cadmium, this chemical is taken into consideration only for rice. In April 2010, the amendment of Cadmium standard for rice was implemented. The standard changed "Don't exceed 1ppm," into "within 0.4ppm." In addition to this amendment, in June 2010, Countermeasures of Designated Standard for Agricultural land was revised "more than 1ppm" to "exceed 0.4ppm" and implemented. This standard consider water (volume) management when is it measured (the reason for this is that it was realized rice cannot absorb Cadmium when water is remained in rice paddy during rice production).

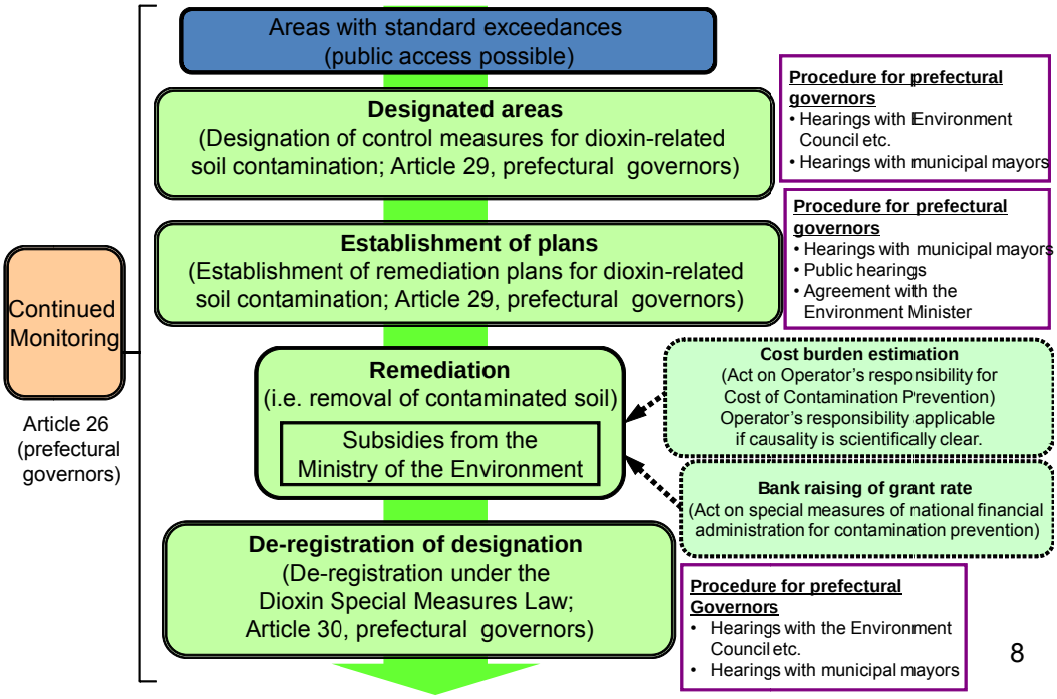
Change in the status of farmland soils since the enforcement of Agricultural Land Soil Pollution Prevention Act

Through the proceeding above, "Area where measure is necessary" is decreasing, and "Area of planned countermeasures" and "Areas where measure is complete" are increasing year by year.



2.3Act on Special Measures Concerning Dioxins

System for remediation of soil contamination based on the “Act on Special Measures Concerning Dioxins” (Established 1999)



[Source: MOEJ (Trans. IGES)]

Dioxins are substances not manufactured on purpose. They are formed unintentionally, most often during the course of incineration, especially waste incineration. Dioxins are consisted of Polychlorinated Dibenzo-p-Dioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs). Dioxins are by-products generated from processes when heat is applied to substances containing carbon, oxygen, hydrogen and chlorine. In general they are colorless solids with very low water solubility and low vapor pressure properties. On the other hand, dioxins characteristically exhibit a high degree of solubility in fats and oils.

This Act is based on the system of Agricultural Land Soil Pollution Prevention Act, and is operated as countermeasures by local government as public enterprise Prefectural governors should observe the situation of dioxins-contaminated soil. They have the authority to enter private site if necessary. Through this monitoring system from prefectural governor, contaminated soil caused by dioxins could be found

Based on this Act, countermeasures implementation plan is agreed in five areas till now. Specific actions of countermeasures are operated by removing or remediation utilized by high heat (melt-solidification). Only one area implemented containment. Because residents are very interested in these actions, monitoring by committee of experts is implemented every year.

When voluntary countermeasures are included, about 0.3 million tons of contaminated soil caused by dioxins are founded within a decade.

For instance, Nose district where is located in Osaka, was familiar with the first site for contaminated soil caused by Dioxins in Japan. This case was occurred before establishment of Act on Special Measures Concerning Dioxins. As a result, three tons of contaminated soil was disposal with through local bond issued and state government covered 80 % of local bond by special tax allocation (Non-harmful by melt-solidification method was conducted).

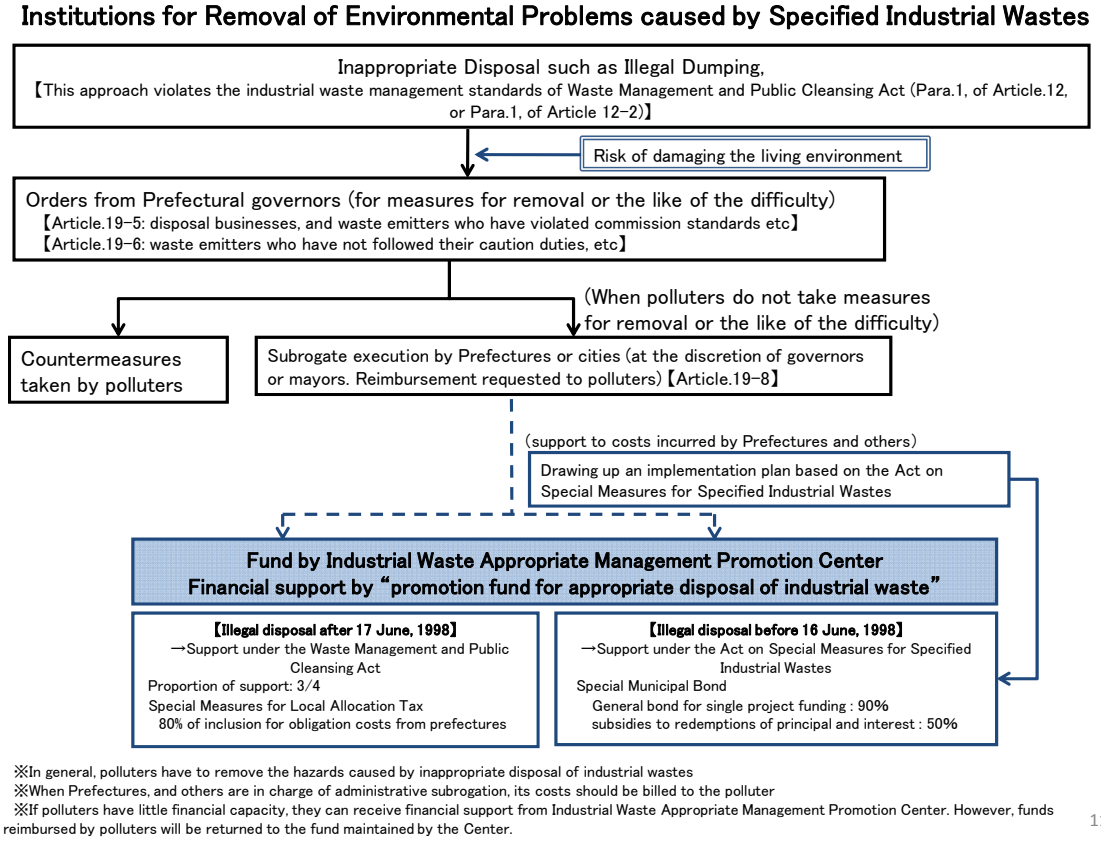
2.4 Waste Management and Public Cleansing Act

In regard of waste management, it has been implemented since 1970's. From the end of 1990's, in order to promote waste management, subsidy schemes and fund system were settled.

Measures against Illegal Dumping, etc.
in the Waste Management and Public Cleansing Act and other Acts

- 1971: Enforcement of Waste Management and Public Cleansing Act
  - Introduction of notification system for waste disposal facilities (structure quality standard of disposal facility construction , and operating and maintenance quality standard of disposal facility runnning)
  - Introduction of a system of order for actions by prefectural governors and city mayors when there are cases of illegal dumping , etc.
  - Introduction of a subrogation system (if polluters have no financial ability to conduct countermeasures)
- 1990: Case of illegal dumping in Teshima, Kagawa Pref. is raised as a major problem
- 1991: Introduction of a permission system for waste disposal facilities over a certain size (regarding landfills, all are placed under the system regardless of the size)
- 1998: If polluters are unknown or absent, and prefectural governors execute countermeasures by subrogation, the expenses are covered by a fund from the Waste Management and Public Cleansing Act (fee is based on fund (public: private =1:2), and when polluters are later identified, the expenses are billed to them)
- 2002: establishment of the Act on Special Measures for Specified Industrial Wastes (in the case of illegal disposal done before 16 June, 1998, if subrogation is implemented by governors, financial support is provided via government subsidies or special municipal bond)
- 2005: (Local budget system reformation) for cases with ministerial approval after 2006, the provision of government subsidies under the Act on Special Measures for Specified Industrial Wastes are terminated. And in Special Measures, appropriation rate of General bond for single project funding is raised to 90%
- 2009: For pre-2005 cases under the Act on Special Measures for Specified Industrial Wastes, the government has been providing subsidies directly since 2008

10

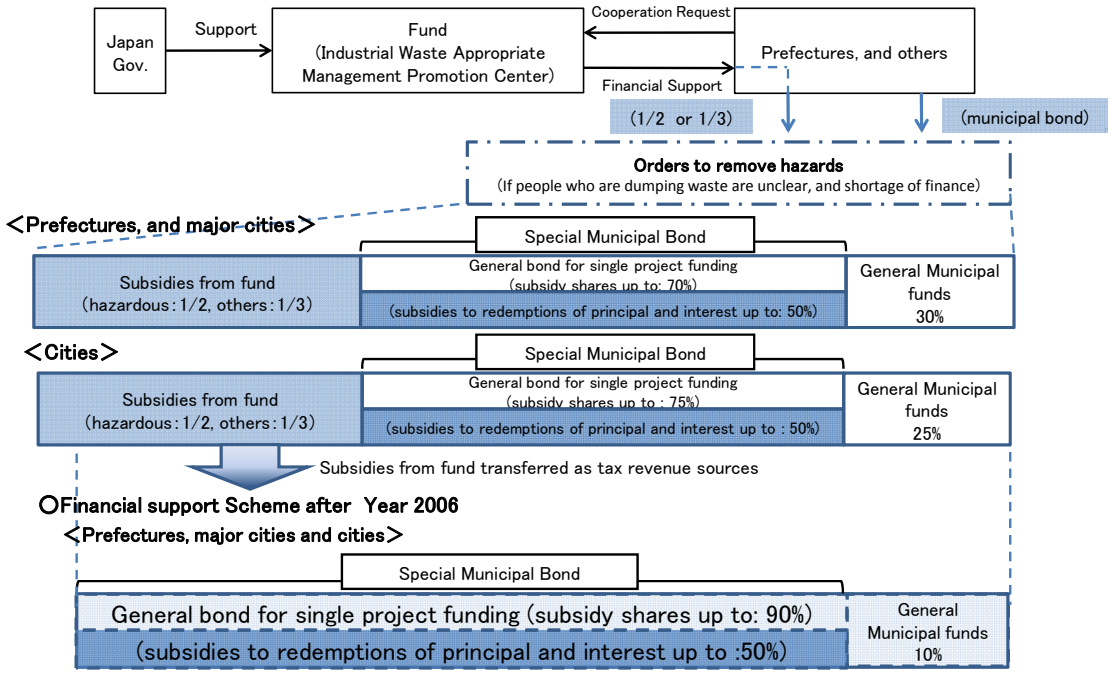


[Source: MOEJ (Trans. IGES)]

Specified industrial waste, financial scheme was involved in Japan, the Industrial Waste Appropriate Management Promotion Center, Prefectures and others. Prefectures and others require for financial cooperation to the Center that has support fund of waste from Japan, in order to remove specified industrial waste. Financial support scheme was divided into 2 types (prefectures/ large cities, and cities) until year 2005. Since year 2006, this scheme was integrated.

◇Financial Support Scheme

1. Fund Scheme under the Act on Special Measures for Specified Industrial Wastes【Illegal dumping before 16 June, 1998】



(note) Since April 2006, "Local budget system reformation" was established. Subsidies of countermeasures case for restoring to original state is excluded from those that transfer as tax revenue sources. Also, general bond for single project funding of special municipal bond issues is increasing to 90%. Furthermore, some cases implemented until March 2005, can get subsidies partly from government directly. 12

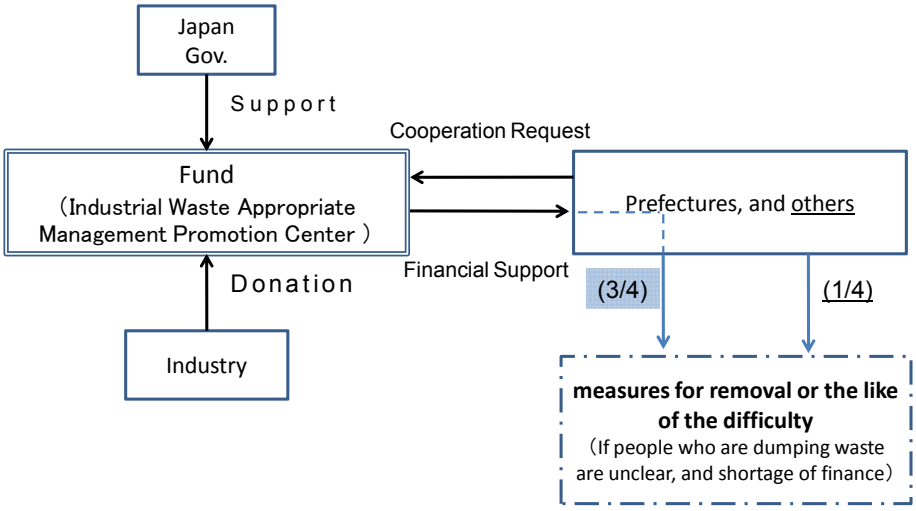
[Source: MOEJ (Trans. IGES)]

For Waste Management and Public Cleansing Act, fund scheme was worked since June, 1998. This fund system is operated by Japan Gov., business industries, prefectures, and others. Industrial Waste Appropriate Management Promotion Center is given fund support from Japan Gov, and donation from business industries. With these subsidies and donation, the Center provides to prefectures, and others the financial support that they asked for the Center.

In Japan, most of severe soil or groundwater contamination cases are caused by inappropriate waste management. In general, polluter is identified but he is already bankrupt or has no financial ability. Coping with these cases such as Teshima, Prefectural governor organized a special committee for risk assessment and considering countermeasures.

2. Fund Scheme based on Waste Management and Public Cleansing Act

【Illegal dumping waste implemented after June, 1998】



∗ Industry : Japan Gov. : Prefecture, and others = 2 : 1 : 1
∗ Compare with quantity of prefectural burden is (1/4), proceeding of special tax allocation to local governments is (frequency of inclusion: 0.8)

5

[Source: MOEJ (Trans. IGES)]

2.5 Soil Contamination Countermeasures Act of Japan

The Soil Contamination Countermeasures Act was proclaimed in May 2002, and entered into force in February 2003 (the amendment in 2009).

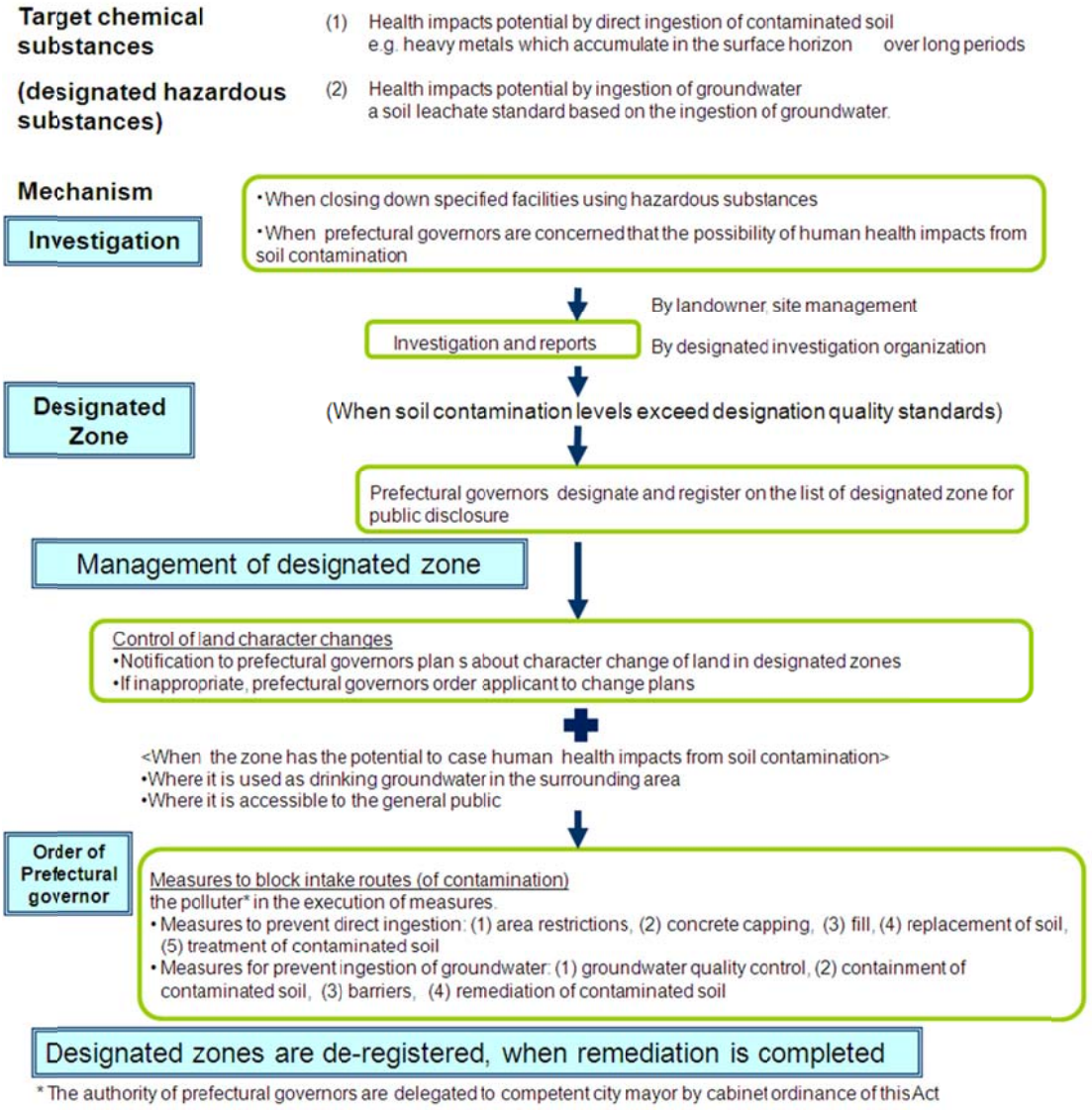


Figure 2: Outline of Soil Contamination Countermeasures Act before amendment

Prefectural governors have been ordered landowners when governors are concerned that the possibility of human health impacts from soil contamination five cases since enforcement in February, 2003. Out of five cases, three cases are designated as designated zones due to find soil contamination.

Implementation of measures for reducing risks in the case of health risk probability

○Soil Contamination Countermeasures Act obliges Land owner to conduct measures to block intake routes of contaminated soil in the limited case where exist human health impacts potential even when he has no negligence of soil contamination

When the land owners do not have enough financial capabilities, the government provides assistance through designated support organization.

○It is allowed that the authorities compel even no negligent landowners to conduct measures, because avoidance of public risk (=health impact potential) is required. Financial assistance is allowed by the reason to avoid public risk. Unless public risk is left unattended

Art. 8 of the Act Amendment allows land owner to demand the polluter to pay measure cost within the extent of instructed measure cost.

○There can be a case where no body is able to take measures in spite of public risk as polluters can be bankrupt or not pay enough expenses. Until polluters are identified, pollution can be left unattended despite of the health risk probability.

○Excluding land owner, polluters are not able to undertake measures that can entail land management change and no measure action can be undertaken.

○Countermeasures are for avoiding the current risk and not for seeking liability of pollution-thus, the Act doesn't require that soil be restored back to the original status prior to pollution.

3

○ Outline of Soil Contamination Countermeasures Act after amendment

Purpose

To prevent human health impact, ,measures for investigating situation of soil contamination, measures to block intake routes of contaminated soil, and regulation of transport and disposal of contaminated soil are established

Institution

Investigation

・When closing down specific facilities which use hazardous substances (Article.3)
・When prefectural governor receives notification for changing Characteristics of land (over 3000m2) and suspect soil contamination in this area (Article.4)
・When prefectural governor is concerned that the possibility of human health impact from soil contamination (Article.5)

Land owners can request that their own lands be designated by prefectural and city mayors when contamination is found through voluntary investigation (Article. 14)

Land owners, etc (proprietors, managers or occupants) ask designated investigation organization to implement investigation and the results are reported to prefectural governor

【 When soil contamination levels exceed designation quality standards】

Zone designation

①Designated Zone for countermeasures(Article. 6)

Because this zone has the potential to cause human health impacts, measures to block intake routes of contamination are needed
→Prefectural governor instruct measures (Article. 7)
→Prohibition to change the land characteristics (Article. 9)

When intake routes of contaminants have been blocked

②Notification Zone for Changing Land Characteristics (Article.11)

Because this zone has no potential to cause human health impacts , measures to block intake routes of contamination are not needed (this includes zones where intake routes have been blocked)
→Plan notification must be submitted to prefectural governor when characteristics of soil are going to be changed (Article. 12)

When contamination remediation has been completed, the designation is withdrawn

Regulation for transporting contaminated soil

・Regulation on transporting contaminated soil from zones ① and ②
(pre-notification, plan change orders, and countermeasure orders for transfers which do not follow the transport standards)
・Duty to deliver and preserve manifests related to soil contamination
Prefectural governor permit facilities to dispose contaminated soil transported from above Zone

※Amendment of Soil Contamination Countermeasures Act is executed since 1 April. 2010 ※Contents of the amendment are shown in red colored sections
※ The authorities of prefectural governor are delegated to competent city mayor by cabinet ordinance of this Act

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[Source: MOEJ (Trans. IGES)]

An increase in the number of contamination discoveries through voluntary investigations was observed, so there was a need to adequately and surely manage these contamination sites.

The Act sets soil coverage and on-site securing as the standard means to ensure that human contamination pathways are blocked. But, after establishment of the Act, regardless of non-existence of human health impact potential, removal and disposal has become the most common means of measures. However it must be recognized that removal and disposal also entails a risk of hazardous substances dispersion, therefore contaminated sites should be classifies according to the existence of human health impact potential (however the concentration of hazardous substances has nothing to do with classifying zones), and be managed accordingly.

Recent years have seen increasing numbers of inappropriate treatments of contaminated soil, especially removal and disposal (unnecessary removal excavation itself leads inappropriate disposal) it is important to set standards and regulations in the transport and treatment of contaminated soil so as to ensure that inappropriate treatments do not occur. Thus Environment Minister requests advice to the Central Environment Committee on May in 2008. Central environment Committee submitted the report to Environment Minister December in 2008. Japanese government submitted the bill revising the Soil Contamination Countermeasures Act March in 2009. The Bill was passed April in 2009. Then revised Act enforced April in 2010.

The Act with the amendment in 2009, the followings are important points;

(1) Prevention of removal excavation and proper management of contaminated soil that was taken out
(2) Expansion of investigation opportunities, including voluntarily investigation
(3) Clarify of zones and necessary countermeasures for managing found soil contamination properly

These points show “Extermination of removal excavation,” and “All landowner voluntary request to register Notification Zone.” What is the most important thing

is that everybody can realize contamination information that land owners found. This Act does not have the Article that prefectural governor should monitor the situation of soil contamination included on the Agricultural Land Soil Contamination Prevention Act and Act on Special Measures concerning Dioxins. Therefore, Prefectural governor should clarify zone where there is no need to take measures even contamination levels exceed designation quality standard.

1. Regulation for transport and disposal
Before the amendment, conductors who implement changing land characteristics of Designated zone, should submit plan to Prefectural governor. The governor orders to change plan to take the appropriate measures if these plans have inappropriate measures or procedures. If conductor cannot implement this order, they should be punished.

Contaminated soil was transported and disposed in accordance with changing land characteristics, but plan was accepted when explanation for transport and disposal after taking out from designated zone was proper way. After that, in the course of actual transport and disposal, even inappropriate transporting and disposal were occurred; prefectural governor cannot order to implement proper transport and disposal nor to entail punishment.

Therefore, firstly, action standards were set toward transport and disposal after taking out of contaminated soil. If it was not obeyed, prefectural governor can order conductor or operator to implement proper transport and disposal. Punishment was entailed when this order was not obeyed. Also in when disposal would be implemented as businesses, operator needs to get permission from Prefectural governor that include capacity of disposal facilities. It is because it might be increased risks through collecting and accumulating contaminated soil on one site.

2. Expansion of investigation opportunities, including voluntarily investigation,
However, regulation of transport and disposal is adapted only land that is designated as two type of designated zones on prefectural list. Thus, if result of investigation was not reported to prefectural governors even when contamination was founded form land, regulation might not be effective. Therefore, opportunities for investigation of soil contamination were expanding. (1) When land owners find contamination, he can voluntarily requests application for designated zones. (2)

Conductor should notify to prefectural governor when changing more than certain extent (Environment ministry ordinance stipulated 3000m2) of land characteristics is implemented. If prefectural governor suspect soil of that land is contaminated, he can order the conductor to investigate soil contamination. It is because dissemination of contamination would be high risk. Therefore, Prefectural governor takes into consideration related information that records of land utilization in the past, report of past investigation or some information that other departments have. .

Furthermore, in order to reduce investigation burden, omission of investigation process would be accepted. Land where investigation processes were omitted, was identified as one where there is the most contaminated condition. However, when omitted investigation processes were implemented for taking out contaminated soil, and if contamination was not detected, it would be allowed by prefectural governor to transport as non-contaminated soil.

From there situations, the amendment Act should manage land where is the potential of contamination under prefectural governors at the first stage even detail investigation is not implemented. Detail investigation would be required when contaminated soil would be taken out

3. Clarify of zone classification and necessary measures
In order to promote submission of information for contamination toward prefectural governors, unnecessary countermeasures should be banned. Therefore, land where exists soil that exceeds designation quality standards were divided into two categories; whatever existence of the potential of health impact or not.

The potential of health impact is identified two standards as followed; (1) whether drinking for groundwater that has connect with contaminated soil at surrounding of the land or not, and (2) whether general public can enter the land or not (in the case when employees of factories and others enter the land, it would not be existence of the potential of health impact)

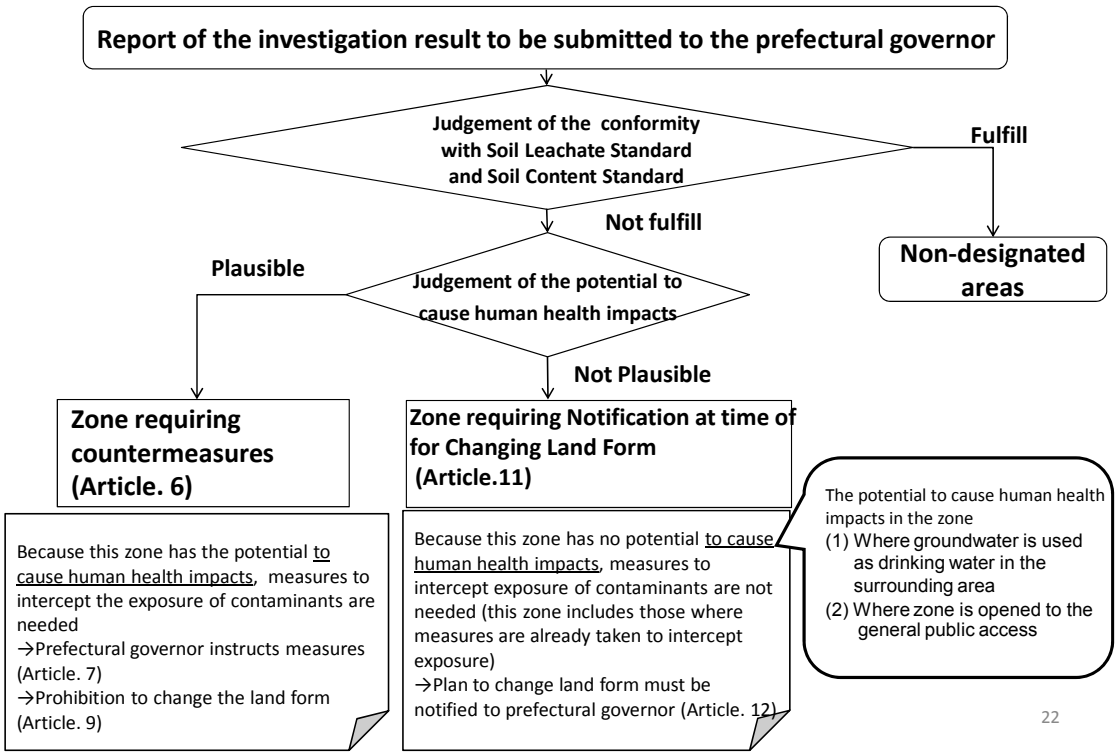
In the case when it has the potential of health impact, Prefectural governor can designate the land as designated zone for countermeasures, and at the same time,

they instruct necessary measures in order to block routes that human bodies intake contaminated soil
If instruction is not implemented, prefectural governor orders to conduct instructed measures. If the order is not obeyed, punishment is entailed. Instructed measures is regulated by the ordinance of Minister of the Environment, Japan, but removal and disposal is not accepted as instructed measures (removal and disposal is accepted as instructed measures only in the case of playing sandpit where is linked with soil for utilization,). Furthermore, land owners can require to pay for implementing measures to polluters based on Article. 8. However, in the case, in the extent of instructed measures is limited to require.

In the case when health impact potential would not be existed, Prefectural governor can designate as notification zones for changing land characters. Land owners submit plan to prefectural governor when changing land characters is conducted. If the plan includes inappropriate way of changing, prefectural governor can order to change plan (notification zones for changing land characters is the same as designated zone before the amendment). In the case when designated zone for countermeasures is implemented measures, the zone is identified as notification zone for changing land characteristics.

These two zones are registered different prefectural list.

○ The designation process of "Zone requiring countermeasures (Countermeasures zone)"and "Zone requiring notification on the time of Changing Land Characteristics (Notification Zone)" (based on Soil Contamination Countermeasures Act)



Note: The authorities, prefectural governor can be included competent city mayor whom delegated authorities of governor by cabinet ordinance based on the Act.

[Source: MOEJ (Trans. IGES)]

(2) Content of instructed measures

○In the case when health impact potential exists, prefectural governor shall instruct landowner or polluter to take measures. Instructed measures are stipulated in the ordinance of MOEJ.
○When containment is difficult in the operating factory, measures for preventing the proliferation of contaminated groundwater outside of the site by water pumping of polluted groundwater and monitoring shall be defined newly as measures.
○Removal of soil contamination are stipulated as instructed measures only for the case of sand pits on playground

①Cases of the land where contamination exceeds soil content standard

	After amendment	
	Instructed measures	Equivalent measures
Sand pit or Playground	Removal of contaminants	Pavement, and entry ban
Land where mounding is not suitable	Replacement of the surface soil	Pavement, entry ban, and removal of contaminants
Others	Cover soil	Pavement, entry ban, replacement of the surface soil, and removal of contaminants

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[Source: MOEJ (Trans. IGES)]

②Case of the Land where contamination exceeds soil leachate standard

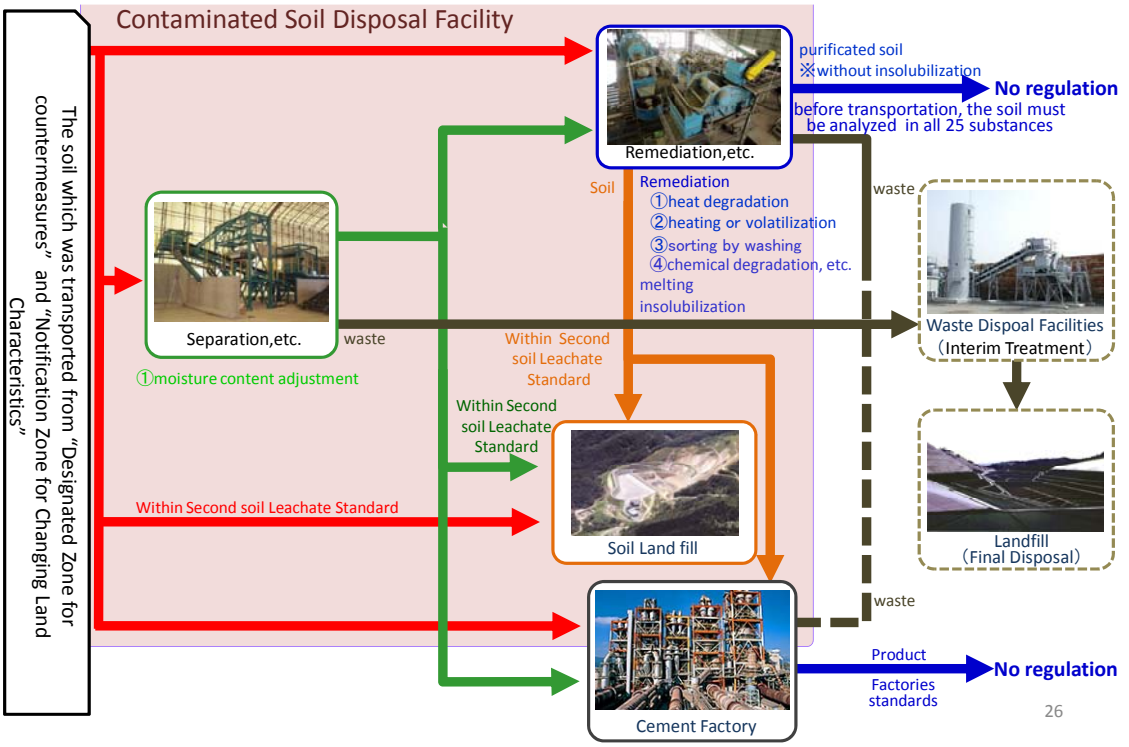
		After amendment	
		Operation	Equivalent measure
No contaminated groundwater		Monitoring for water quality of groundwater	Insolubilation, in-situ, situs containment using liner facilities, containment by waste isolation, removal of contaminants, and prevention for infection of groundwater contamination
Class Ⅰ	Exceed 2nd soil leachate standard	containment by seepage control work (situs containment)※	Prevention for infection of groundwater contamination and removing soil contamination
	Not exceed 2nd soil leachate standard	containment by seepage control work (situs containment)	Prevention for infection of groundwater contamination and removing soil contamination
Class Ⅱ	Exceed 2nd soil leachate standard	containment by seepage control work (situs containment)※	Containment by block control work, prevention for infection of groundwater contamination and removing soil contamination
	Not exceed 2nd soil leachate standard	containment by seepage control work (situs containment)	Insolubilization, containment by block control work, prevention for infection of groundwater contamination and removing soil contamination
Class Ⅲ	Exceed 2nd soil leachate standard	containment by block control work	Prevention for infection of groundwater contamination and removing soil contamination
	Not exceed 2nd soil leachate standard	containment by seepage control work (situs containment)	Containment by block control work, prevention for infection of groundwater contamination and removing soil contamination

※ when containment using liner facilities or situs containment are operated in land of 2nd standard for the amount of inappropriate elution, insolubization or situs purification that is suitable for 2nd standard for the amount of elusion, should be conducted

24

[Source: MOEJ (Trans. IGES)]

○ Contents of the disposal of the contaminated soil and the definition of the facility



[Source: MOEJ (Trans. IGES)]

Improvement for Reliability of designated investigation organizations

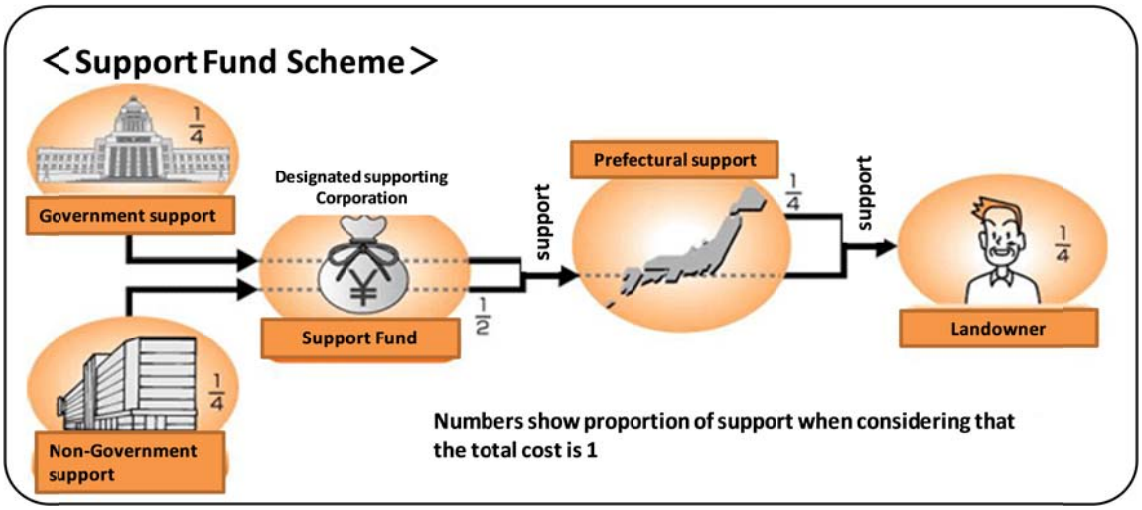
① To employment of technological managers, and to establish the duty for observation responsibilities by technological managers (technological managers who passed the examination implemented by minister of the environment)
＊In designated investigation organizations before the amendment, person who manages technologies, based on environment ministry ordinance before the amendment, are identified as technological managers until 31stof March, 2013.

② To tighten designated standard for designated investigation organizations (To set up the appropriate allocation for technological managers)

③ To establish duties for improving contents of business processes, and attach ledger sheets, and others

Financial support from the Soil Contamination Countermeasures Fund

If person, who is instructed measures in land at designated zone for countermeasures, is not a polluter and at the same time does not have enough financial resources. And prefectural government has support system such person, prefectural government can take subsidies related to measures from designated fund by MoEJ. Before the amendment, this support was limited when prefectural governor order to take of measures. After the enforcement in 2004, only one case was ordered and this was the only case for this fund. There are two local governments that have support measures (as of Aug, 2010).



[Source: MOEJ (Trans. IGES)]

Section III: Detecting and treating soil contamination

"Soil contamination Investigation" process can contribute to realize the quality of soil, that is whether soil is contaminated or not.

3.1 Investigation

3.1.1 Investigation of Groundwater Contamination (Identification of the source of groundwater contamination)

Investigation to identify the source of groundwater contamination

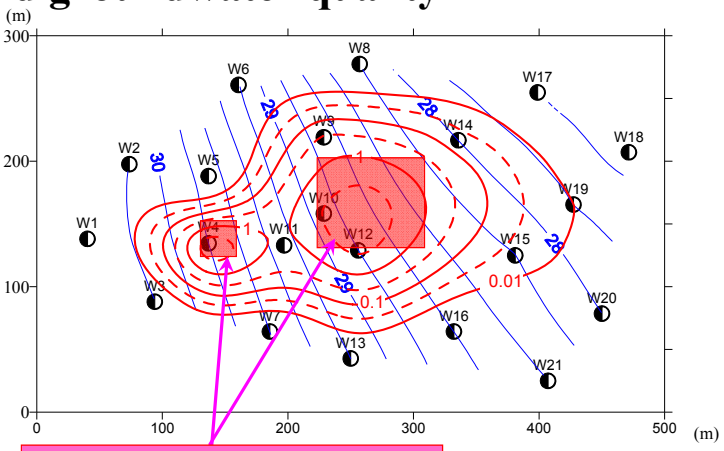
- **Purpose**
  - ◆ **Presumption of source of groundwater contamination**
- **Content of execution**
  - ◆ **Investigation of document**
    - ➢ Exhaust situation of target substances、hydrogeological condition and current state of groundwater contamination, etc.
  - ◆ **Groundwater investigation of existing wells**
    - ● Investigation of existing well design
      - ➢ Water withdrawal aquifer, well-head elevation and well-screen depth
    - ● Simultaneous groundwater level measurement investigation
      - ➢ Distribution of groundwater head of each aquifer (Groundwater flow condition)
    - ● Simultaneous groundwater sampling investigation
      - ➢ Current state of groundwater contamination

3

Investigation of the groundwater in existing wells

(Identifying the groundwater flow conditions and the situation of the contamination of the groundwater)

■ Simultaneous investigation of the groundwater level and groundwater quality

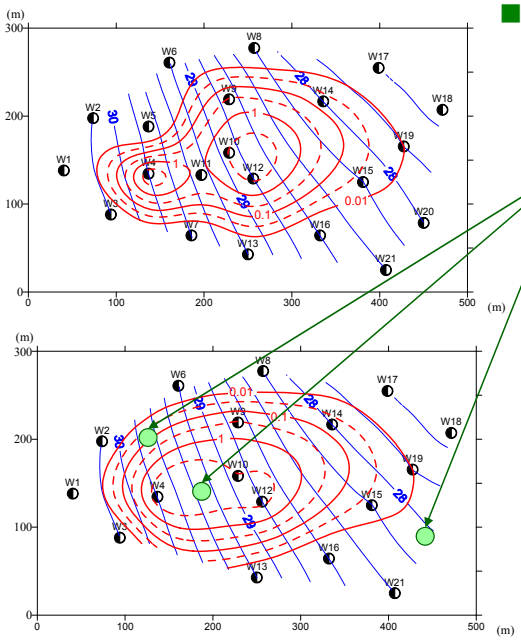


Position of the presumed source of groundwater contamination

Blue: elevation of the groundwater head (T.P. m)
Red: contaminant concentration (mg/L)

4

Investigation of the groundwater in existing wells Effects of the location of wells on the results of the investigation



■ Differences in the situation of contamination identified due to the location of existing wells

◆ Differences between these existing wells in the contaminated situation

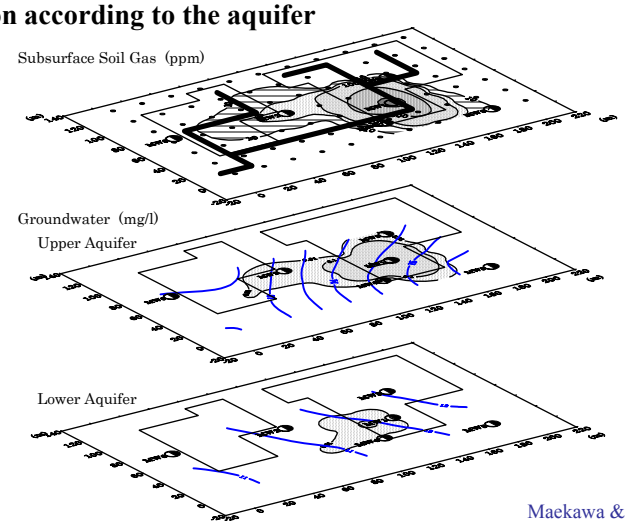
- Presence or absence of W5, W11 and W20
  - ➢ Differences in the identifiable situation of contamination
    - A possibility of missing the sources of contamination in the proximity of W10 and W11

Blue: elevation of groundwater head (T.P. m)
Red: contaminant concentration (mg/L)

5

Investigation of the groundwater in existing wells
Assessment according to the aquifer

- **Example of groundwater flow conditions and the contamination situation according to the aquifer**



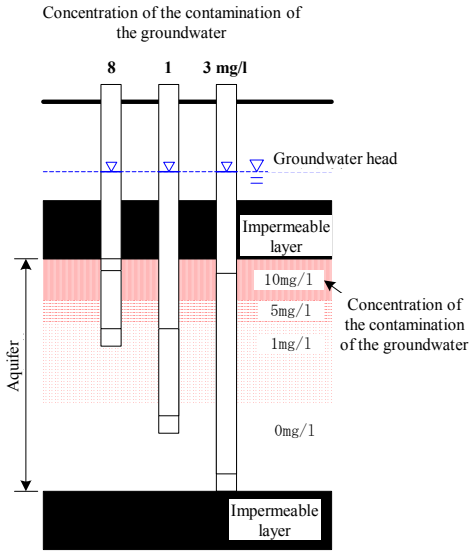
Maekawa & Nakashima (1998)

6

[Source: Maekawa and Nakashima 1998]

Investigation of the groundwater in existing wells
Effects of the well structure on the measured concentrations of the contamination of the groundwater

- **Effects of differences in well screened zones on the measured concentrations of the contamination of the groundwater**



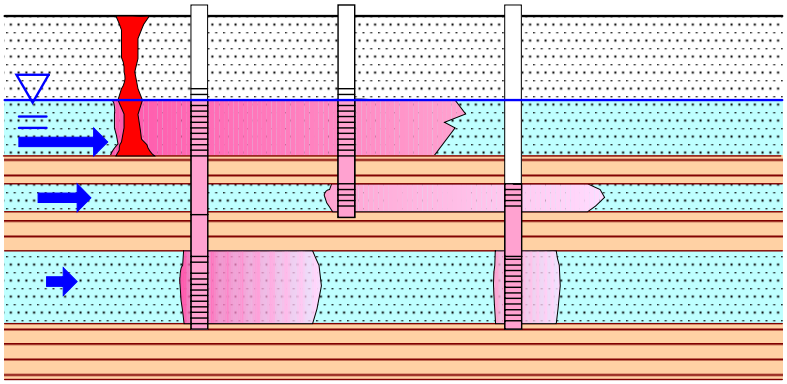
The Japanese Geotechnical Society (2003)

7

[Source: The Japanese Geotechnical Society (ed.) 2002, developed from Domenico & Schwartz 1997]

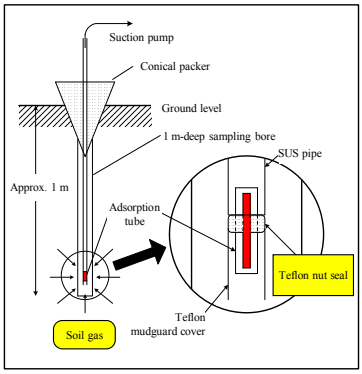
Considerations to be taken into account for assessment of the mechanisms of groundwater contamination

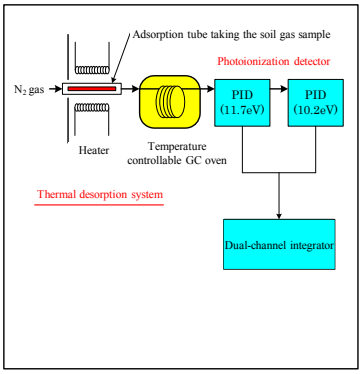
- **Extension of the contamination from one aquifer to another through multiple-screened wells (this also results from any defective water interception around the well tube)**



8

Schematic conceptual view of linear soil gas survey Example of a soil gas sampling and analysis method



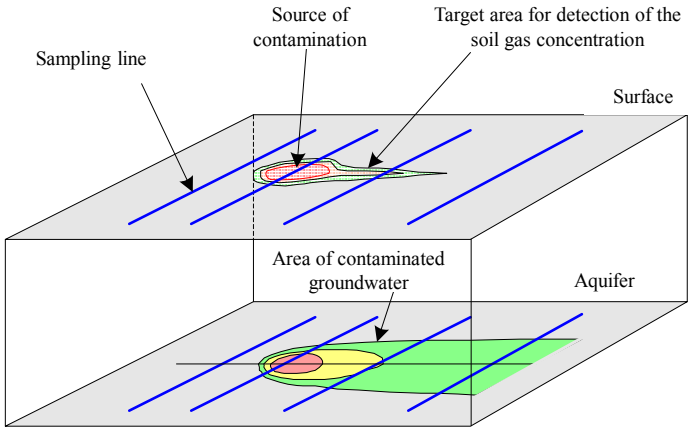


Adsorption/Thermal desorption/GC method
(Nonoguchi et al. (1991) revised partly by Nakashima et al. (1996)

9

[Source: Nonoguchi et al. 1991, revised partly by Nakashima et al. 1996]

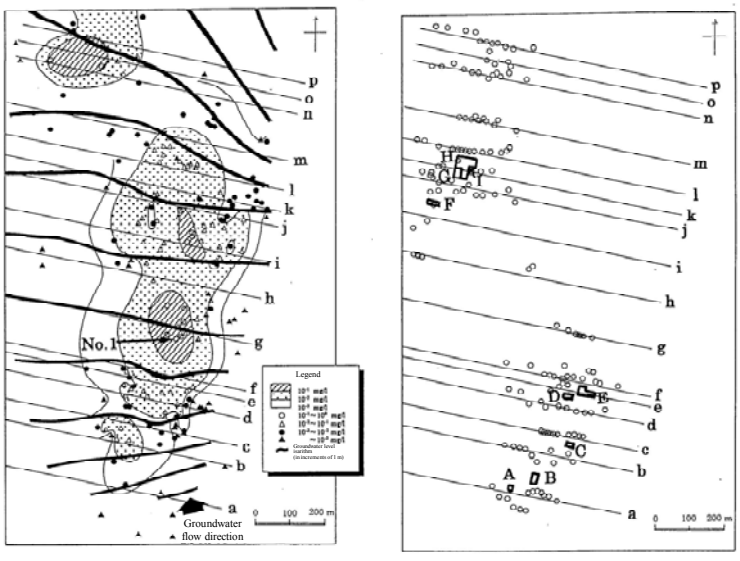
Schematic conceptual view of linear soil gas survey



10

[Source: Nakashima, Tezuka, Nakasugi, and Hirata. 1996]

Example of estimation of the sources of groundwater contamination by linear soil gas survey



Left/
Groundwater level and the distribution of PCE concentrations in the groundwater (First aquifer)

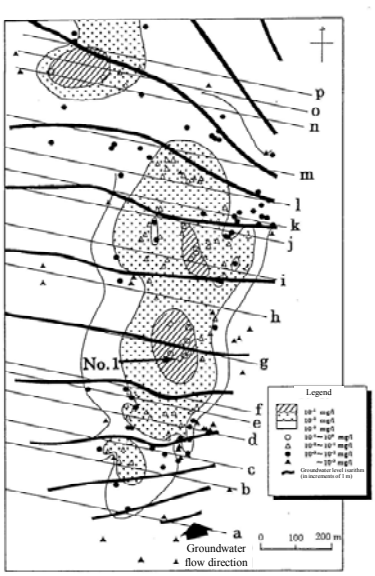
Right/
Soil gas sampling sites

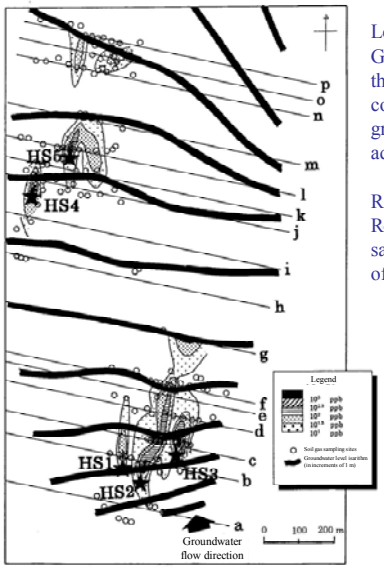
(Nakashima et al., 1997)

11

[Source: Nakashima, Sunami, Nakasugi, and Hirata. 1997]

Example of estimation of the sources of groundwater contamination by linear soil gas survey





Left/
Groundwater level and the distribution of PCE concentrations in the groundwater (First aquifer)

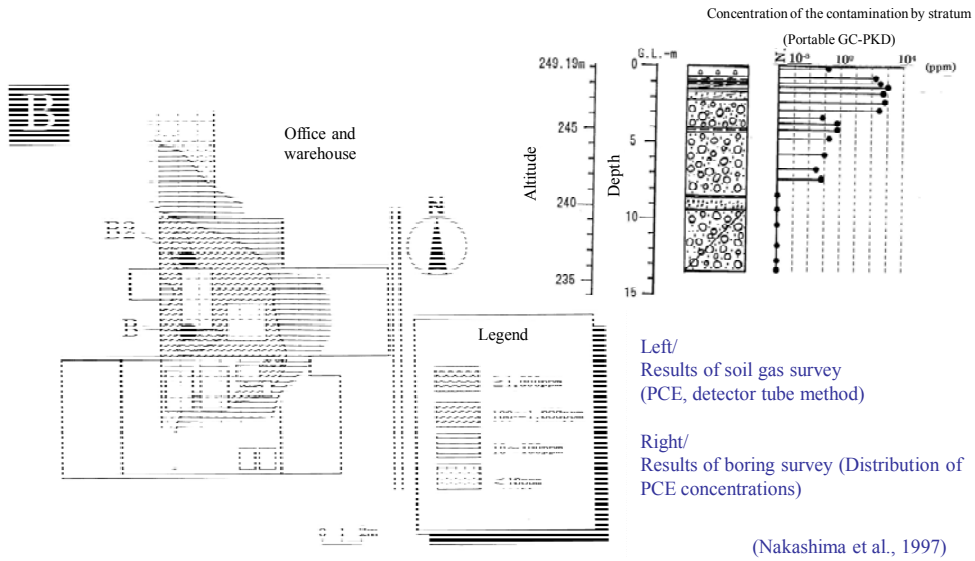
Right/
Results of soil gas sampling (Distribution of PCE concentrations)

(Nakashima et al., 1997)

12

[Source: Nakashima, Sunami, Nakasugi, and Hirata. 1997]

Detailed soil gas survey and boring survey at the site of a contamination source



Left/
Results of soil gas survey
(PCE, detector tube method)

Right/
Results of boring survey (Distribution of PCE concentrations)

(Nakashima et al., 1997)

13

[Source: Nakashima, Sunami, Nakasugi, and Hirata. 1997]

Investigation of the Groundwater

■ Filtration measurement

◆ Measurement of the groundwater (6 March 2003 MOEJ announcement of 17)

- Measurement of the content of the target substance in a sample
  - Concentrations including the compositions adhering to suspended solids (soil particles) in well water

For contamination with such heavy metals that have a low solubility and higher absorptive properties to soil particles, groundwater may be evaluated as contaminated as a result of official method of analysis in some cases despite the fact that the groundwater in its natural state is found not contaminated.

- Determination of the concentrations of the target substances through filtration analysis, focusing only on the soluble fractions
  - When any groundwater samples are found to be turbid, they are left to stand for 10 to 30 minutes and then the supernatant is filtered through a membrane filter of 0.45μm pore size only if the samples are expected to contain Category 2 Designated Hazardous Substances (heavy metals, etc.) and/or Category 3 Designated Hazardous Substances (agricultural chemicals, etc.).
    - The pore size of 0.45μm refers to the median of colloids expected to migrate in the soil.

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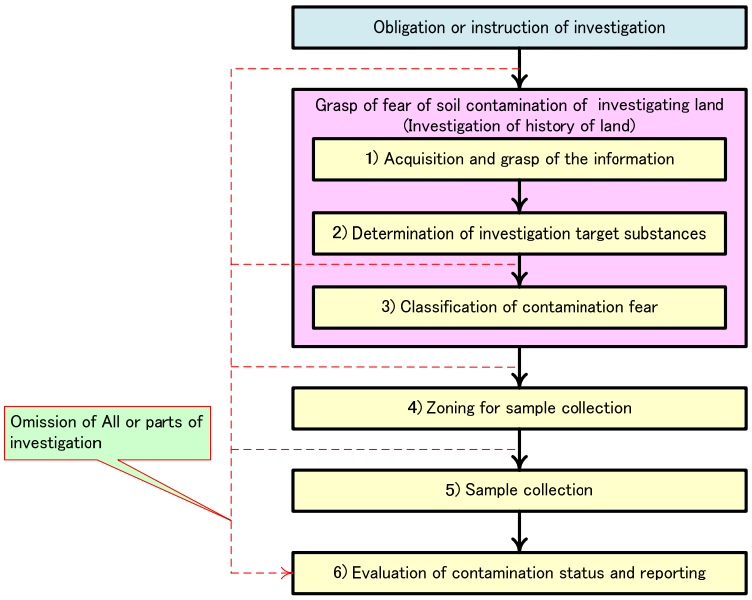
3.1.2 Investigation of Soil Contamination (on Soil Contamination Countermeasures Act after amendment)

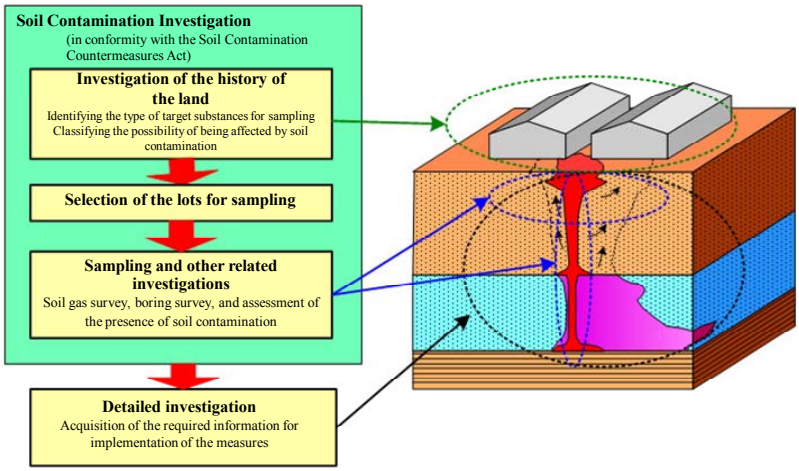
Investigation of soil contamination status



16

[Source: MOEJ (Trans. IGES)]

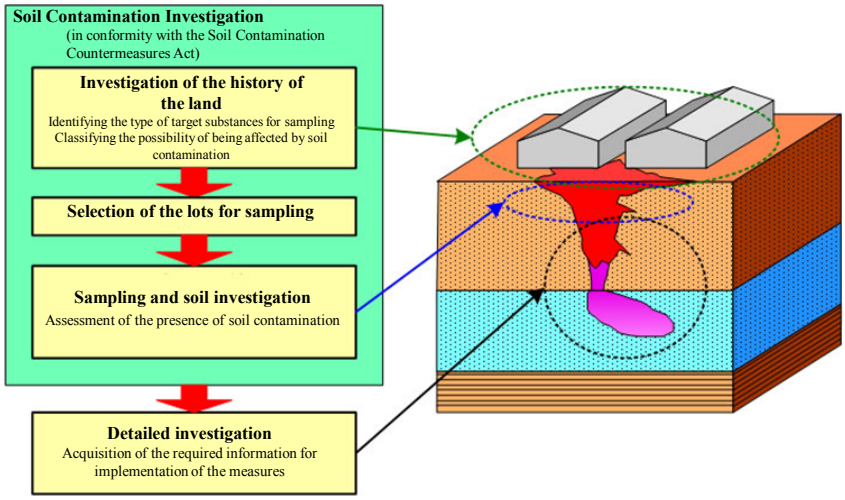
Flow of Investigation
VOC (Category 1)



17

[Source: Nakashima]

Flow of Investigation
Heavy metals (Category 2), Agricultural chemicals and PCBs (Category 3)



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[Source: Nakashima]

Positioning and Timing of Soil Contamination Investigations

- **Positioning of Soil Contamination Investigations**
  - **To identify the situation of contamination with any Designated Hazardous Substances at the target site for investigation for the purpose of eliminating possible harmful effects on human health resulting from the contaminated soil at the site.**

- **Timing of Soil Contamination Investigations**
  - **Investigation based on Article 3 of the Act: When any secified facility using hazardous substances has discontinued operation:**
  - **Investigation based on Article 4 of the Act: When an order is issued for an investigation of land of 3,000 m^2 or more in area with suspected soil contamination at the time of changing the character of the land:**
  - **Investigation based on Article 5 of the Act: When an order is issued for an investigation in cases where there is a suspected threat of a health hazard due to soil contamination:**

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Criteria for the evaluation of land suspected to be contaminated with Designated Hazardous Substances

- **The land is evaluated as suspected of being contaminated if any of the following applies:**
  - **(1) Land in which the situation of soil contaminated with Designated Hazardous Substances is found not to conform to the prescribed standards for the situation of contamination**
    - Including land where the fact of soil contamination is identified as being due to natural causes
  - **(2) Land in which solids or liquids containing Designated Hazardous Substances have been buried, scattered, spilled, and/or have penetrated areas below the ground surface (buried)**
  - **(3) Land that is being used or has been used as the site of a plant or workplace pertaining to a facility involved in manufacturing, using or processing (utilizing) Designated Hazardous Substances**
  - **(4) Land that is being used or has been used as the site of a plant or workplace pertaining to a facility for preserving or storing (preserving) Designated Hazardous Substances or solids or liquids containing Designated Hazardous Substances (excluding such facilities with measures or other proper precautions specified by the Minister of the Environment to control the penetration of any liquids containing Designated Hazardous Substances into areas below the ground surface)**
  - **(5) Land in which the situation of soil contaminated with Designated Hazardous Substances has been found not to conform to the prescribed standards for the situation of contamination at a similar level to any of the land listed above in (2) through (4)**
    - Including such land located adjacent to land where the fact of soil contamination is identified due to natural causes

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Target Areas for Investigation

- **Investigations in conformity with Article 3 of the Act**
  - **All areas of land that were the site of a plant or workplace pertaining to a specified facility using hazardous substances, the use of which has been discontinued**
- **Investigations in conformity with Article 4 of the Act**
  - **Excavated portions of land where the character of the land is to be changed and which correspond to areas contaminated with Designated Hazardous Substances specified in the Ministry of the Environment's Act**
- **Investigations in conformity with Article 5 of the Act**
  - **Land where there is a considerably high probability of soil contamination and also the possibility of human exposure to soil that does not conform to soil contamination standards prescribed**

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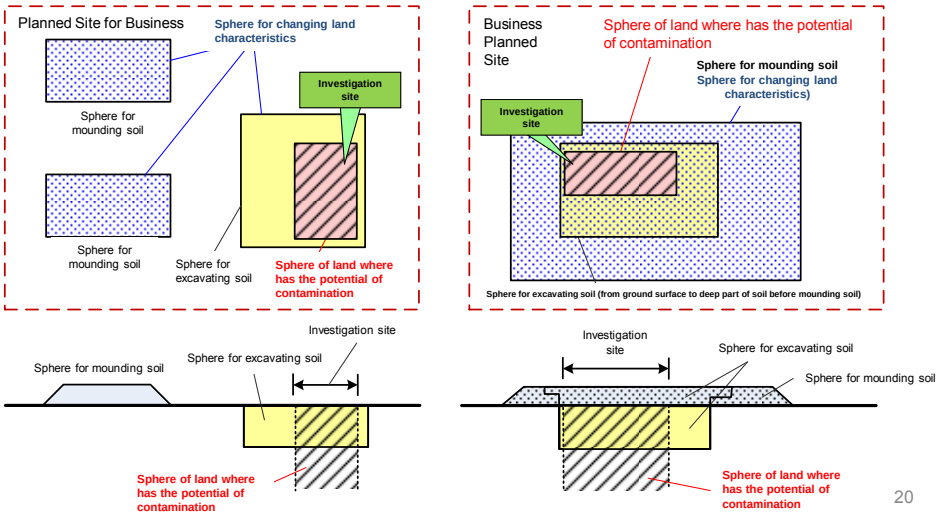
Article 4. Attitude of Specific Place for Investigation

○Sphere of land where; (1) characteristics of land would be changed, (2) is planned to excavate, and (3) Prefectural governor identifies the land has the potential of contamination.



[Source: Guideline of Investigation and Measure based on Soil Contamination Countermeasures Act]

Assessment of the risk of soil contamination in land areas that are the target of investigation (Investigation of the history of the land)

■ Purpose

◆**To acquire useful information for estimating the possibility of soil contamination at target sites for investigation, including the surrounding land.**

■ Information acquisition and assessment methods

◆**Investigation of documents**

- Private documents, public legal reporting documents and disclosed documents

◆**Hearing surveys**

◆**Site exploration**

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Target substances for investigation of the history of the land

- **Period to be covered for investigation of the history of the land**
  - ◆ **Tracing back to around 1945**
  - ◆ **Tracing back to the time when the plant or workplace was established in cases where the target site was used for this plant or workplace before 1945**
- **Target substances for investigation of the history of the land**
  - ◆ **Article 3 of the Act**
    - ● All of the 25 Designated Hazardous Substances
  - ◆ **Articles 4 and 5 of the Act**
    - ● Those types of Designated Hazardous Substances indicated in the documents for the ordering of the investigation

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Classification of the risk of contamination

Classification of the possibility of being affected by soil contamination	Characteristics of the relevant land and examples
(1) Land considered to be free from any possibility of being affected by soil contamination	Land whose continuous intended purpose is completely independent of the land where the Designated Hazardous Substances or solids or liquids containing Designated Hazardous Substances have been buried, or of the site of a facility for using or preserving Designated Hazardous Substances or solids or liquids containing Designated Hazardous Substances (Examples) Mountains and forests, green buffer zones, dwelling facilities and parking lots for employees, site grounds, gymnasiums, unused land, etc.
(2) Land considered less likely to be affected by soil contamination	Land not used as the site for a facility involved in the direct use or storage of Designated Hazardous Substances or solids or liquids containing Designated Hazardous Substances even though its intended purpose is not necessarily defined as being completely independent from that of the site • Land in use to attain a business purpose other than land found likely to be affected by soil contamination (Examples) Offices (allowing access for working employees), workshops, materials storage sites, warehouses, passages for employees and the operation of vehicles, parking lots for business use, courtyards and other open spaces (allowing access for working employees), sites for plant buildings that do not share any part of a series of production processes with the Specified Facility using Designated Hazardous Substances in cases where multiple plant buildings are present, etc.
(3) Land areas other than those listed above (Land considered relatively more likely to be affected by soil contamination)	Land areas other than those listed above in (1) and (2) are considered to be relatively more likely to be affected by soil contamination and these include: • Locations where Designated Hazardous Substances or solids or liquids containing Designated Hazardous Substances have been buried • Site for a facility where Designated Hazardous Substances or solids or liquids containing Designated Hazardous Substances have been used or stored • Land areas in which the above-described facilities are located, any piping connected to the facilities, facilities connected through the piping to the facilities involved and their buildings, water distribution pipes and wastewater treatment facilities for the facilities involved and associated facilities

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[Source: Nakashima]

○ The Flow of Soil Contamination Investigations

①Verification of the Investigation Target areas and Target Substances

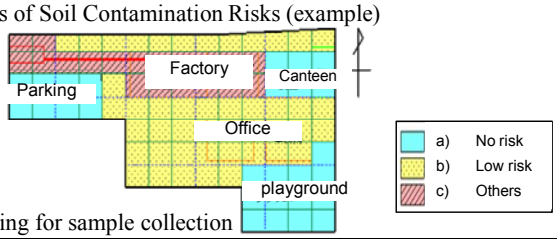
②Classification of Contamination Risks

③Zoning for sample collection

④Measurements and Analyses

⑤Evaluation of Contamination status and reporting

②Categories of Soil Contamination Risks (example)



③Land Zoning for sample collection

Categories		Collection method
(a) No risk of Soil Contamination	Land that is independent and isolated from the organisations using Designated Hazardous Substances. (ex) mountains and forests, staff accommodation, sports grounds, etc	No need for samples
(b) Low Contamination Risk	The land is not directly used for Soil Contamination Countermeasures, but may be under the influence of other facilities using Designated Hazardous Substances. (ex)Offices, Storages, Gardens, and areas not connected to the facilities using Designated Substances.	Collect samples from one spot or 5 spots within zones of 30m by 30m . (Every 900㎡) Note: VOC needs one sampling and heavy metals need 5.
(c) Others	(ex) Buildings accommodating facilities for the use of Designated Hazardous Substances, pipelines connected to them.	10m by 10m sampling method

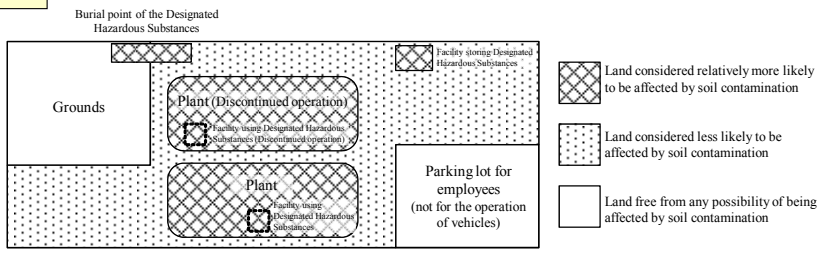
④Measurements and Analyses

The collection of documents	Measurement methods
Investigation of gas emissions from soil	The designation of methods for investigating gas emissions (6 March 2003 MOEJ announcement n.16)
Investigation of Soil Elution Levels	The designation of methods for investigating elution (6 March 2003 MOEJ announcement n.18)
Investigation of elements contained in the Soil	The designation of methods for investigating soil contents (6 March 2003 MOEJ announcement n.19)

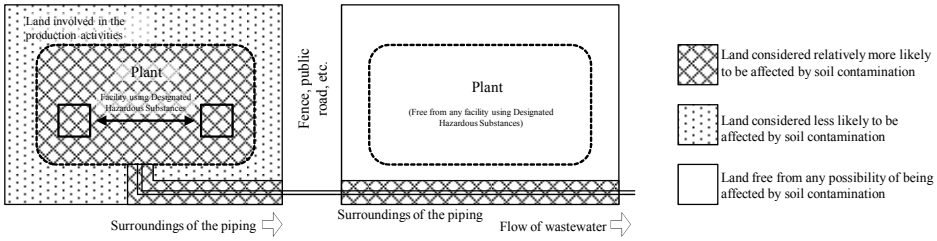
[Source: MOEJ (Trans. IGES)]

Examples of the classification of the risk of contamination

A. Plant and workplace



B. Plant and workplace



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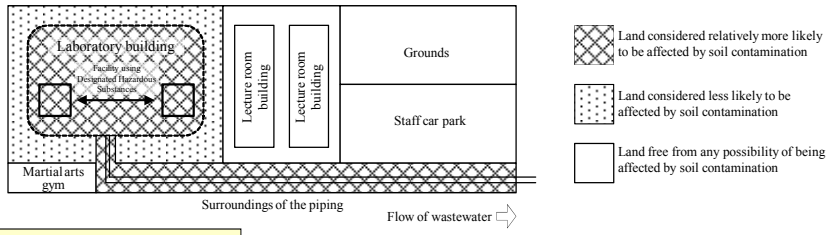
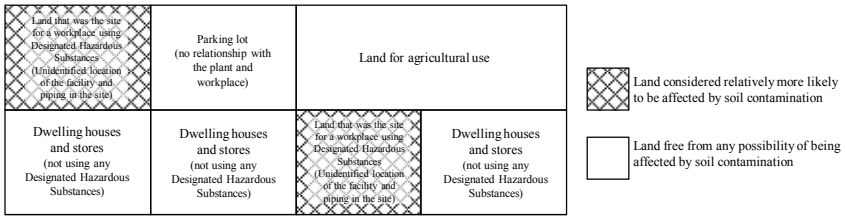
[Source: MOEJ (Trans. IGES)]

Examples of the classification of the risk of contamination

C. University



D. Site in an urban development project



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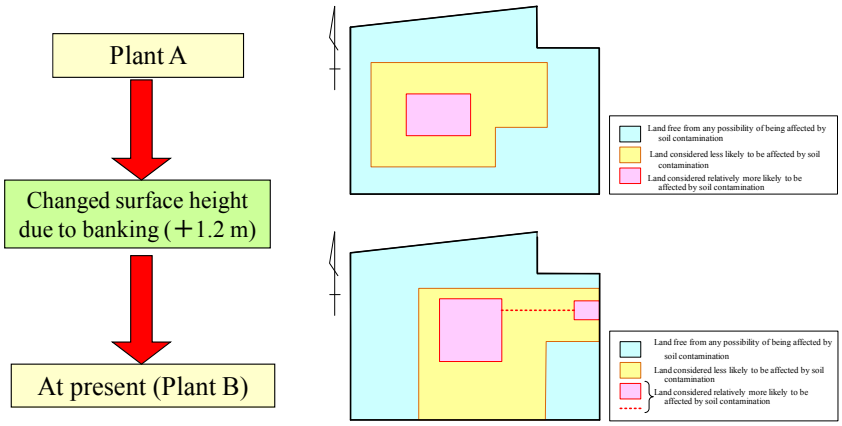
[Source: MOEJ (Trans. IGES)]

Examples of the classification of the risk of contamination

- **Classification of the possibility of being affected by soil contamination**
  - **Classify according to the "position of the location where the possibility of contamination occurs" for individual target substances for sampling.**



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[Source: Nakashima]

Zoning for sample collection

■ Definition of a unit block

◆ Selection of land blocks for sampling (to be defined for individual target substances for sampling)

- Category 1 Designated Hazardous Substances
  - ➢ Define the sampling blocks with the classification of the possibility of being affected by soil contamination overlaid.
- Category 2 and Category 3 Designated Hazardous Substances
  - ➢ Define the sampling blocks for individual positions in the locations where the possibility of being affected by soil contamination has occurred.

◆ Available types of unit blocks

- Unit block including land that is found to be relatively more likely to be affected by soil contamination (The entire block is to be covered by the investigation)
- Unit block including land that is found to be less likely to be affected by soil contamination (Parts of the block are to be covered by the investigation)
- Unit blocks other than those listed above (unit blocks composed only of land that is considered to be unaffected by soil contamination) (The block is to be left out of the investigation)

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Contents of the sample collection

Designated hazardous substances		Category 1 (VOC)	Category 2 (Heavy metals)	Category 3 (Agricultural chemicals and PCBs)
Sampling	Unit block that is more likely to include soil that does not conform to the standards	One point in each unit zone (100 m²)	One point in each unit zone (100 m²)	One point in each unit zone (100 m²)
	Unit block that is less likely to include soil that does not conform to the standards	One spot within a 30 m grid zone (Center of the 30 m grid zone)	Collect samples from five spots within a 30 m grid zone Uniformly blend the samples taken at the five spots.	Uniformly blend the samples taken at the five spots in the block in a 30 m grid, parts of which are defined as a target for investigation.
	Unit block that is free from any soil that does not conform to the standards	None	None	None
Investigation method		Soil gas survey ↓ Investigation of soil leachate (Boring investigation)	Investigation of soil leachate and its contents	Investigation of soil leachate

*Soil samples for the investigation should be taken through a 2 mm-mesh sieve in a natural condition without any crushing.

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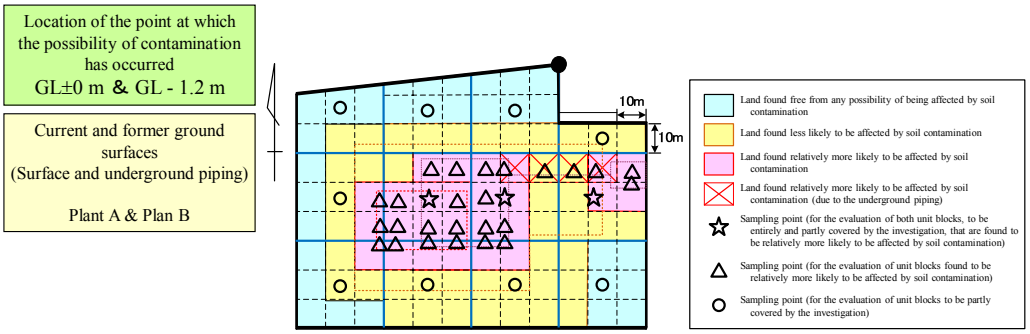
[Source: Nakashima]

Soil gas sampling points (Category 1 substances)



For the land blocks for soil gas survey and other investigations, follow the steps below.
(1) For each target substance for sampling, label the individual "points at which the possibility of contamination has occurred" according to the "classification of the possibility of being affected by soil contamination" and then plot the results on a single ground plan.
(2) Based on the single plotted drawing, select the blocks for sampling and the points for taking the samples.

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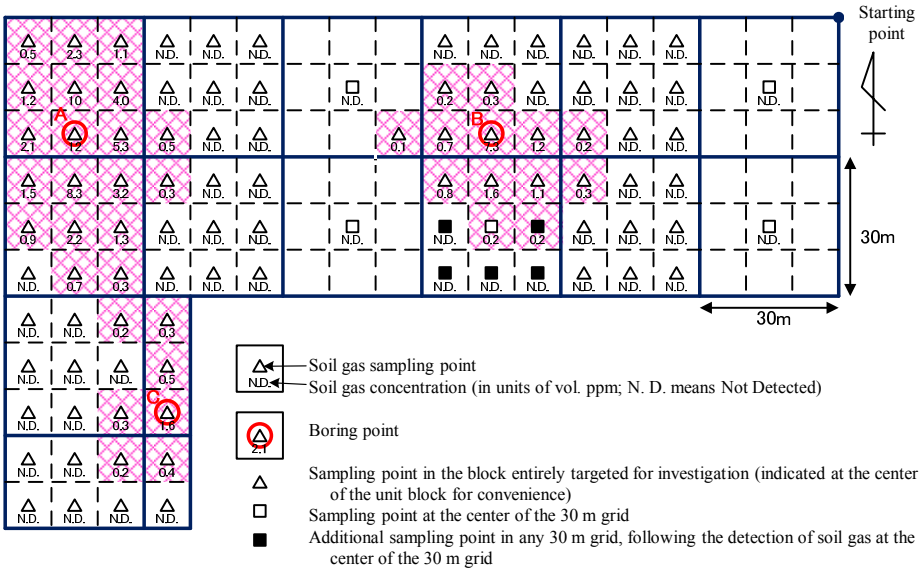
[Source: Nakashima]

Soil sampling points to be investigated by boring (Category 1 substances)



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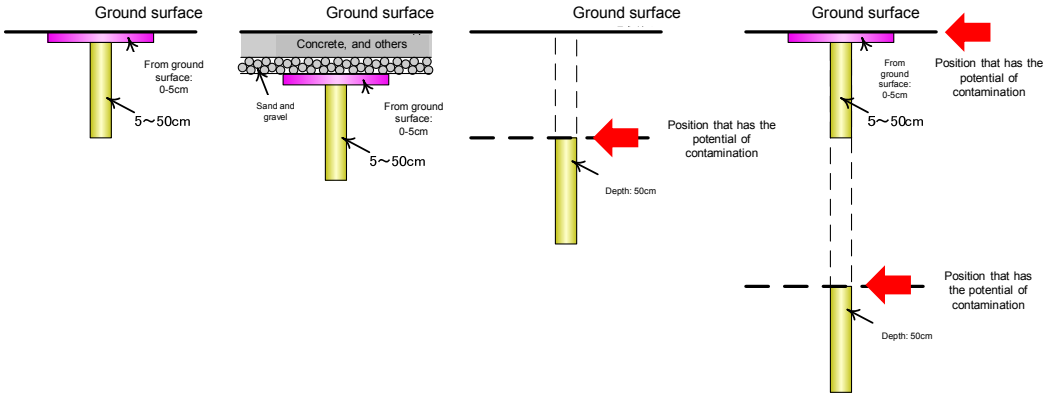
[Source: Guideline of Investigation and Measure based on Soil Contamination Countermeasures Act]

Attitude of depth for soil sampling extractions (except for soil gas investigation)

○To implement sampling extractions, but the place where has the potential of contamination should be taken into account (within 10m in depth)



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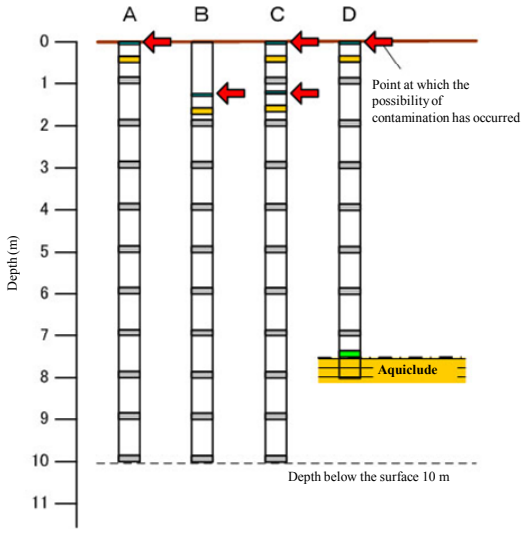
[Source: Guideline of Investigation and Measure based on Soil Contamination Countermeasures Act]

Soil sample collection depth when investigated by boring (Category 1 substances)



(1) Soil at the point at which the possibility of contamination has occurred (or the surface soil in cases where the point at which the possibility of contamination has occurred lies on the surface or the location of the point is unidentified) (for depths up to 10 m below the surface)

(2) Soil at a depth of 50 cm below the point at which the possibility of contamination has occurred (or soil at a depth of 50 cm below the surface in cases where the location of the point at which the possibility of contamination has occurred is unidentified) (for depths up to 10 m below the surface)

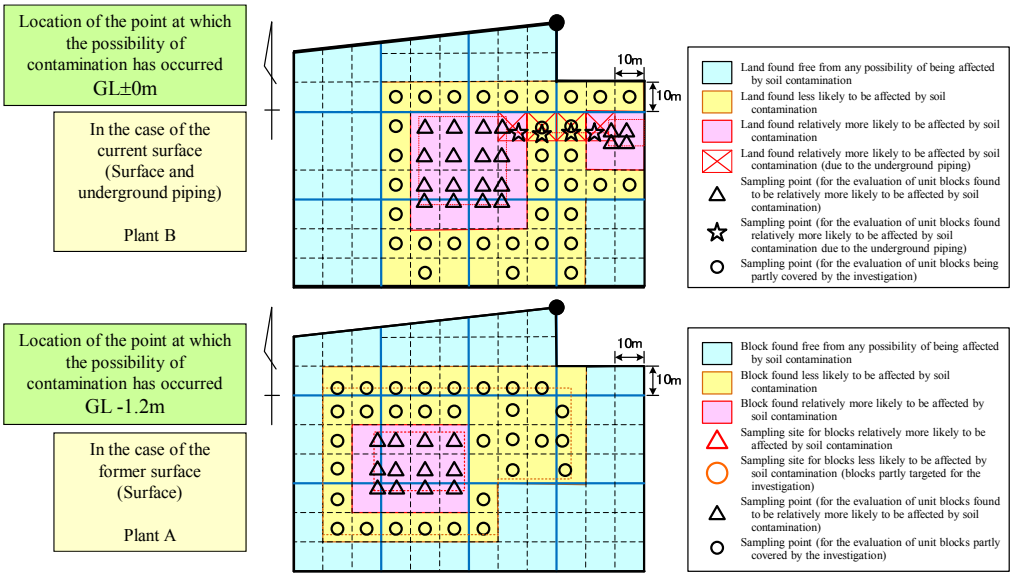
(3) Soil at depths of 1 to 10 m below the surface in increments of 1 m (excluding the soil from the surface to the depth at which the possibility of contamination has occurred, and the soil below the bottom of any aquifer located at a depth of up to 10 m below the surface)

(4) Soil at the bottom of any aquifer (only in cases where the bottom of the aquifer lies at a depth of up to 10 m below the surface)

35

[Source: Nakashima]

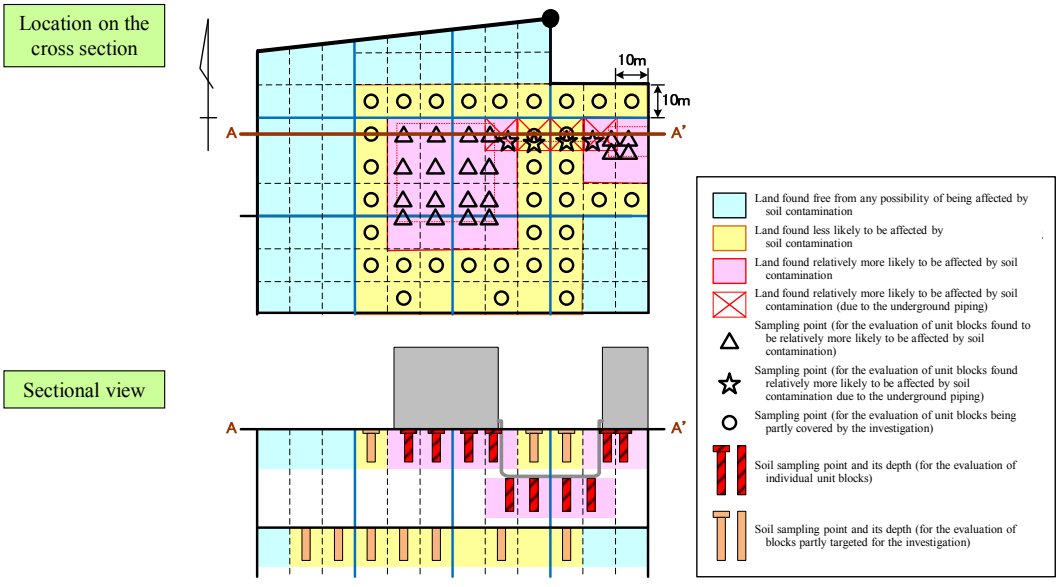
Soil sampling points
(Category 2 and 3 substances)



36

[Source: Nakashima]

Soil sampling depth
(Category 2 and 3 substances)

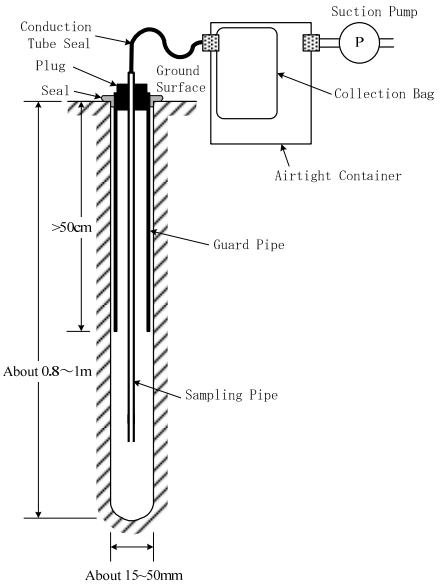


37

[Source: Nakashima]

Methods for Sampling Soil Gas

- **Collection of soil gas samples (6 March 2003 MOEJ announcement n.16)**
  - **Drill a sampling bore to a depth of 0.8 to 1.0 m below the surface and fit a guard pipe into the bore.**
  - **Seal the top of the guard pipe tightly, leave the guard pipe to stand for 30 minutes or more and then take the soil gas samples.**



Collection bag method

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Methods for Sampling Soil Gas (Collection bag method)

1) Drill a hole through the asphalt with a hammer drill.

2) Drive a boring-bar into the soil.

3) Install a guard pipe and a sampling pipe into the sampling bore.

4) Soil gas sampling

5) Field analysis using GC-(PID/ELCD)

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Analysis Methods of Soil Gas

■ Measurement of soil gas (6 March 2003 MOEJ announcement n.16)

◆Measurement method

- ● Either of the following methods
  - ➢ Gas chromatograph method using PID (GC-PID)
  - ➢ Gas chromatograph method using FID (GC-FID)
  - ➢ Gas chromatograph method using ECD (GC-ECD)
  - ➢ Gas chromatograph method using ELCD (GC-ELCD)
  - ➢ Gas chromatograph method using MS (GC-MS)
- ● Quantification limit
  - ➢ VOC except benzene 0.1 volppm
  - ➢ Benzene 0.05 volppm

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Sampling methods of soil (Category 2 and 3 substances)

■ Investigation of soil leachate and content

Sampling of soil

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Environmental boring methods for soil sampling

■ Typical environmental boring machines

Rotary boring machine

Direct thrust boring machine

Direct thrust boring machine

Vibratory-rotary boring machine

Features of environmental boring

- Taking appropriate samples for environmental chemical analysis
- Achieving faster and lower cost sampling for a certain scope of application
- Eliminating possible secondary contamination (with the aid of water-free excavation or other appropriate means)

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Analysis Methods of Soil

◆Measurement method

- Soil elution level
  - ➢ 6 March 2003 MOEJ announcement n.18
- Soil content level
  - ➢ 6 March 2003 MOEJ announcement n.19

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Evaluation of the investigation results of the soil contamination status

- **Evaluation of the results of a Soil Contamination Investigation for conformity to the prescribed standards for the situation of contamination (regarding the unit blocks in the target sites for investigation)**
  - **Land considered to conform to the prescribed standards for the situation of contamination**
  - **Land considered not to conform to the prescribed standards for the situation of contamination**
    - Land considered not to meet the standards for the elution amount in the soil
    - Land considered not to meet the second standards for the elution amount
    - Land considered not to meet the standards for the cocentration of the soil

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Measures to prevent health damage due to soil contamination

- **Instructions given by prefectural governor to take measures to block intake routes of contamination (instructed measures)**
  - **For the areas designated for implementation of the measures directed, the relevant prefectural governor instructs the required measures for the prevention of possible health damage in the form of instructed measures.**

    The measures directed are established objectively;
    - For the purpose of blocking the routes of human exposure to Designated Hazardous Substances due to soil contamination;
    - Based primarily on the situation of the contamination of the land concerned and the use of the land.
      - Independently from the subjective point of view of any land owners and polluters
    - Measures to remove soil contamination, especially removal by excavation, should be implemented sparingly and only as required in order to eliminate the possible risk of spreading the contamination.
      - Measures which remove soil contamination are considered as a measure to be directed only in a limited number of cases based on the intended use of the land.

3

Measures to prevent health damage due to soil contamination

Instructed measures

◆Land not conforming to the Soil Leachate Standard (sampling grid)

- Until the land concerned becomes in conformity with the Second Soil Leachate Standard (the standard values are 10 to 30 times higher than those specified in the Soil Leachate Standard for many target substances), remediation, insolubilization and other appropriate measures should be implemented and then in-situ containment or containment by sealing work is adopted.

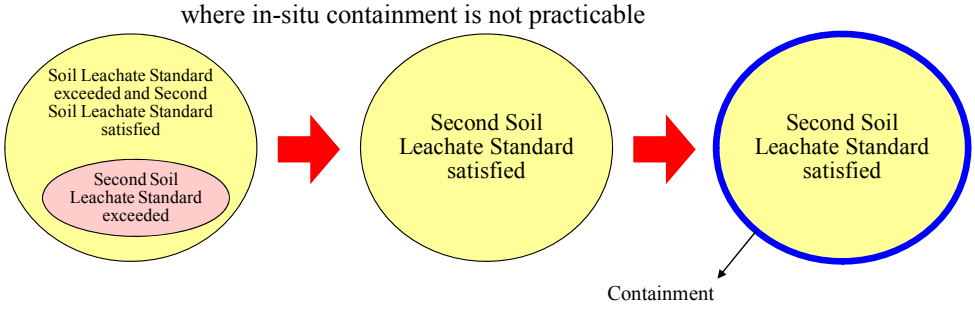
◆Land not conforming to the Soil Content Standard (sampling grid)

- Cover soil

4

Concept of instructed measures (Land not conforming to the Soil Leachate Standard)

- **Instructed measures**
  - **Basic concept**
    - The land concerned should first be improved to a situation of contamination that conforms to the Second Soil Leachate Standard. Then containment is implemented as follows:
      - In-situ containment where feasible
      - Containment based on seepage control work (or containment based on interception for Class 3 Designated Hazardous Substances) in cases where in-situ containment is not practicable



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[Source: Nakashima]

Concept of instructed measures (Land not conforming to the Soil Leachate Standard)

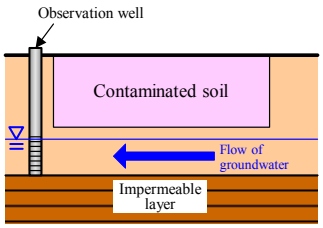
Designated hazardous substances			Category 1		Category 2		Category 3	
State of soil contamination (Second Soil Leachate Standard)			Conforms	Does not conform	Conforms	Does not conform	Conforms	Does not conform
Countermeasures	Groundwater is not contaminated	Monitoring of groundwater quality	●	●	●	●	●	●
	Groundwater is contaminated	In-situ containment	●	●*	●	●*	●	X
		Containment using liner facilities	●	●*	●	●*	●	X
		Prevention of the spread of groundwater contamination	O	O	O	O	O	O
		Removal of contaminant from the soil	O	O	O	O	O	O
		Containment by waste isolation	X	X	O	O	O	●*
		Stabilization	X	X	O	X	X	X

Legend: ● Measures directed; ○ Measures for the removal of contamination considered to have effectiveness equivalent to or higher than that of measures directed
*: The situation of contamination of the contaminated soil concerned should be remediated or insolubilized to conform to the Second Soil Leachate Standard first and then this action should be implemented.

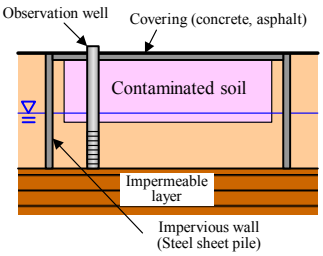
6

[Source: Nakashima]

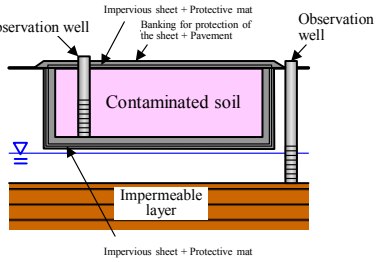
Concept of instructed measures
(Land not conforming to the Soil Leachate Standard)



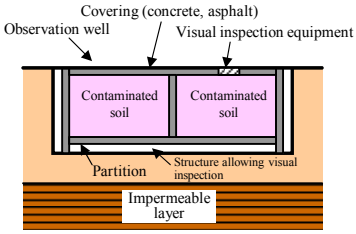
Monitoring of groundwater quality



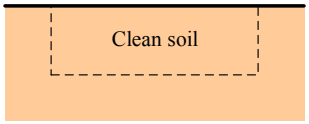
In-situ containment



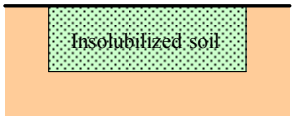
Containment using liner facilities



Containment by waste isolation



Measures to remove soil contamination



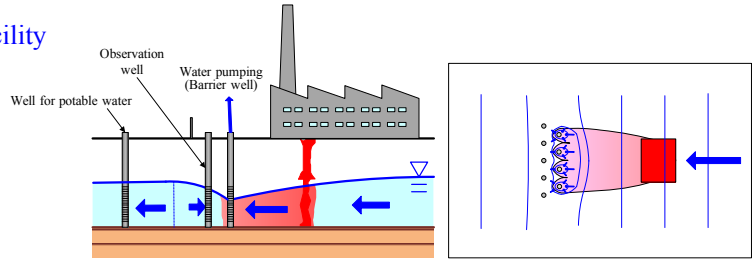
Stabilization

7

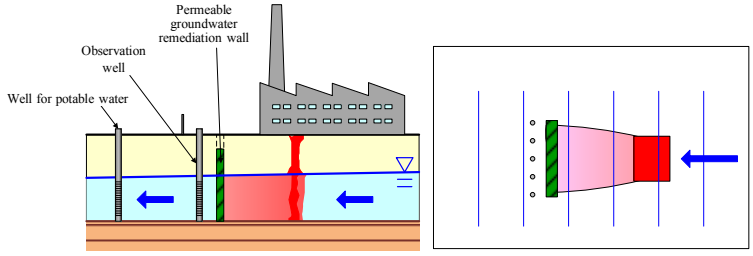
Concept of instructed measures
(Land not conforming to the Soil Leachate Standard)

■ **Prevention of the extension of the contaminated groundwater**

Using a pumping facility (Barrier wells)



Permeable reactive Barrier (PRB)



8

[Source: Nakashima]

Concept of instructed measures (Land not conforming to the Soil Content Standard)

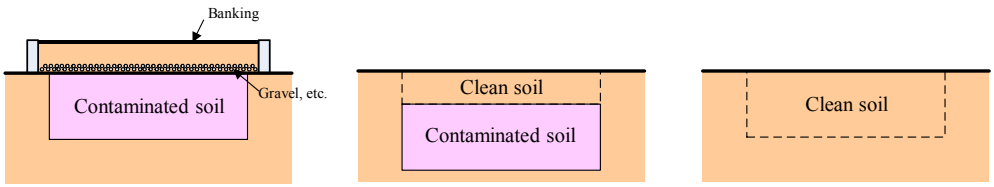
■ **Target: Class 2 Designated Hazardous Substances**

Status of the land use	Measures to block intake routes of contamination to be implemented (Instructed measures)	Measures to block intake routes of contamination considered to provide an equivalent or higher level of effectiveness compared to the instructed measures
Sand pits or kindergarten play areas utilized daily by younger children for playing with sand and soil	Measures to remove soil contamination	Pavement, Off-limits
Land that would cause serious damage to the daily life of the occupants of buildings on the land if the surface height is increased by 50 cm	Replacement of the surface soil	Pavement, Off-limits, Removal of soil contamination
Others	Cover soil	Pavement, Off-limits, Replacement of the surface soil Removal of soil contamination

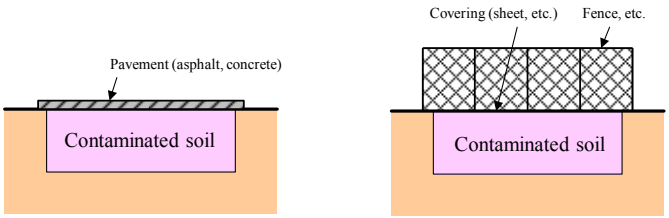
9

[Source: Nakashima]

Concept of instructed measures (Land not conforming to the Soil Content Standard)



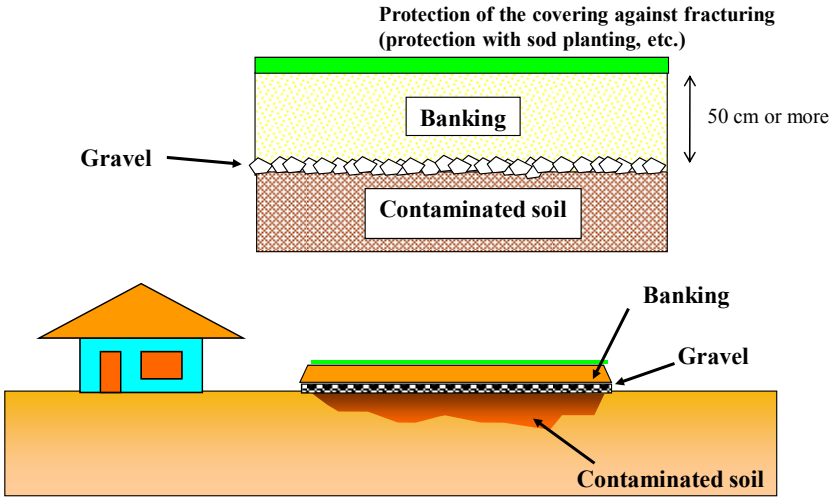
Cover soil | Replacement of the surface soil | Removal of soil contaminants



Pavement | Entry Ban

10

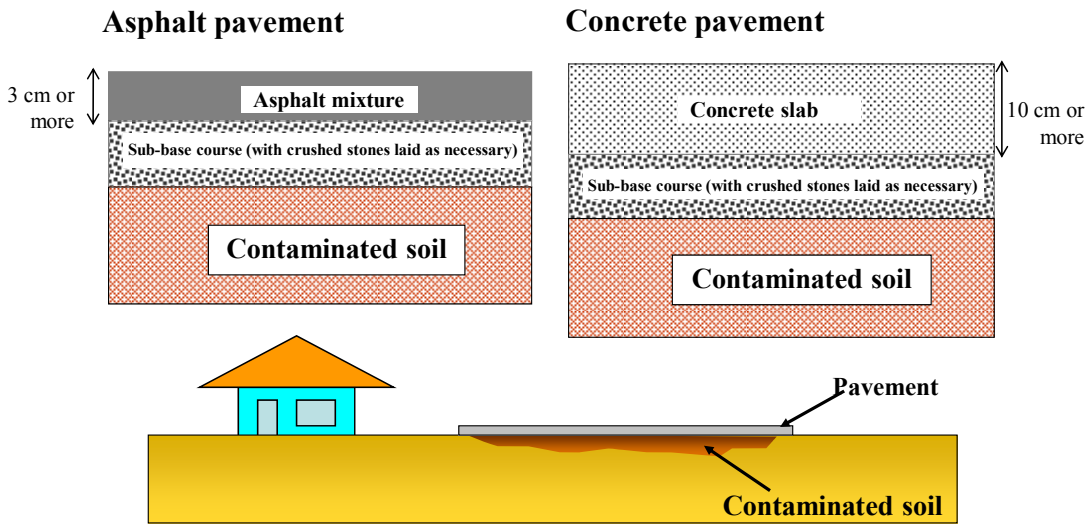
Cover soil



11

[Source: Nakashima]

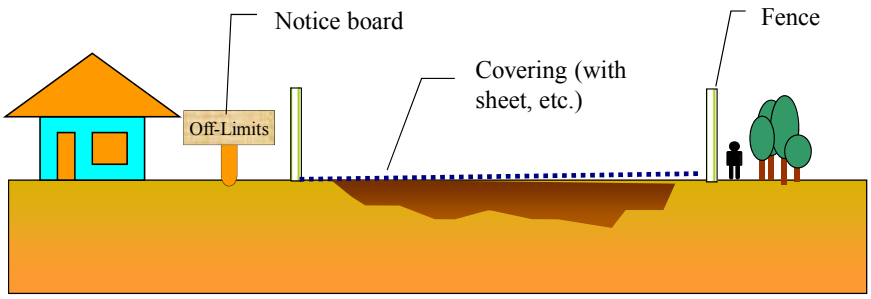
Pavement



(Note) Where the use of asphalt or concrete is difficult due to the steep slope of the land or for other reasons, the land may be covered with mortar or other appropriate materials.

12

Entry Ban



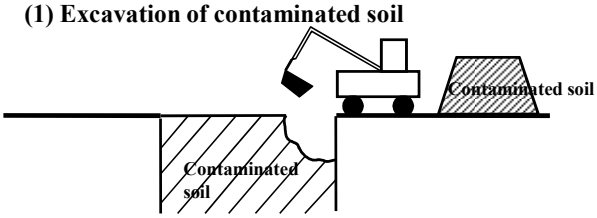
13

Replacement of the surface soil

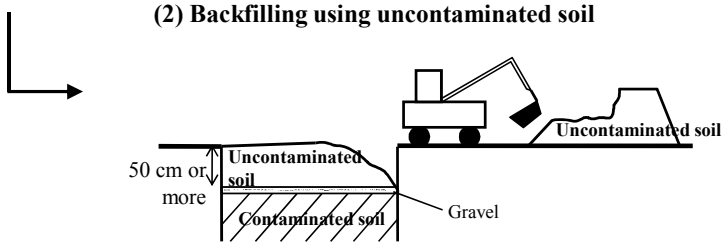
(Replacement of the soil using soil from an area other than the area designated for implementation of the measures directed)

Excavation of contaminated soil → Carrying out from the land → Backfilling using uncontaminated soil

(1) Excavation of contaminated soil



(2) Backfilling using uncontaminated soil

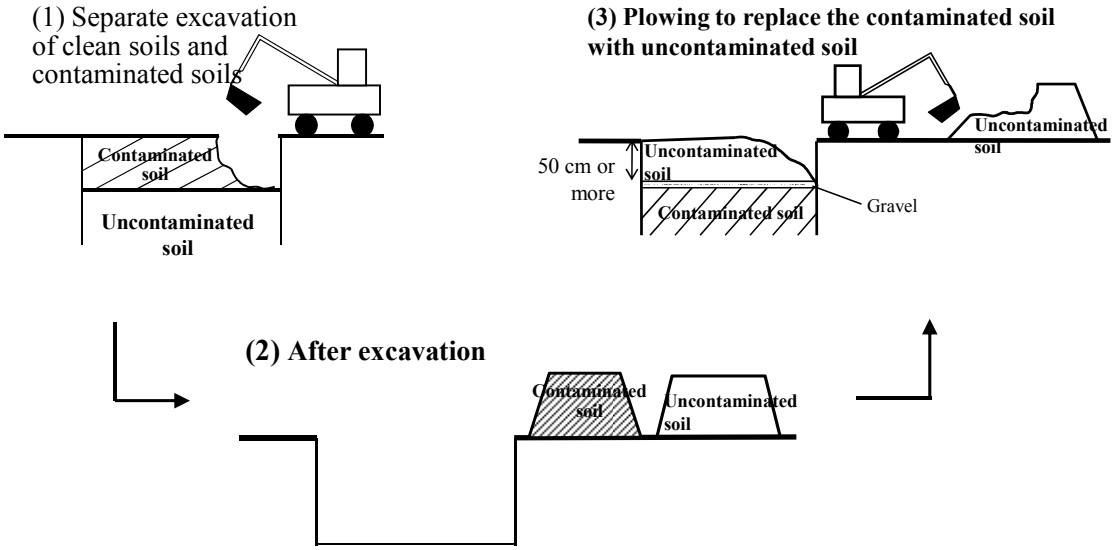


14

Replacement of surface soil

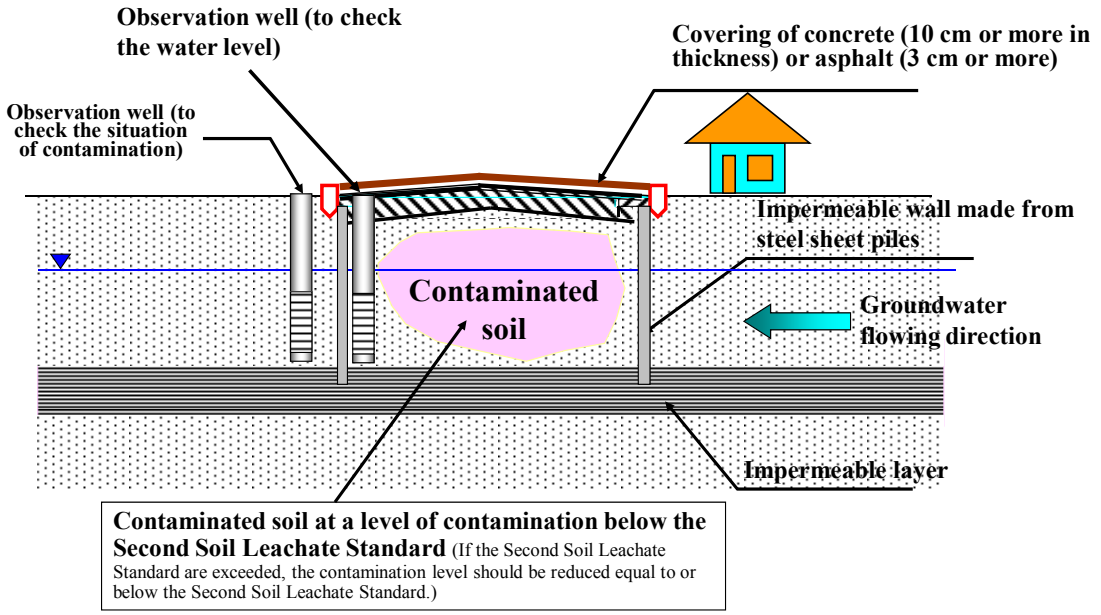
(Replacement of soil within the area designated for implementation of the measures directed)

Excavation of uncontaminated soil + contaminated soil → Plowing to replace the contaminated soil with uncontaminated soil



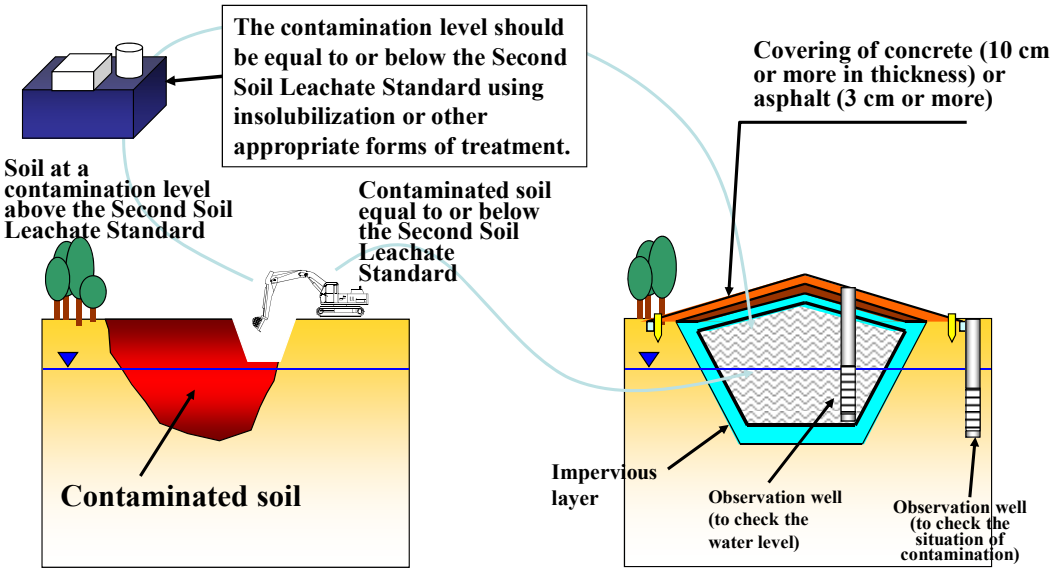
15

In-situ containment



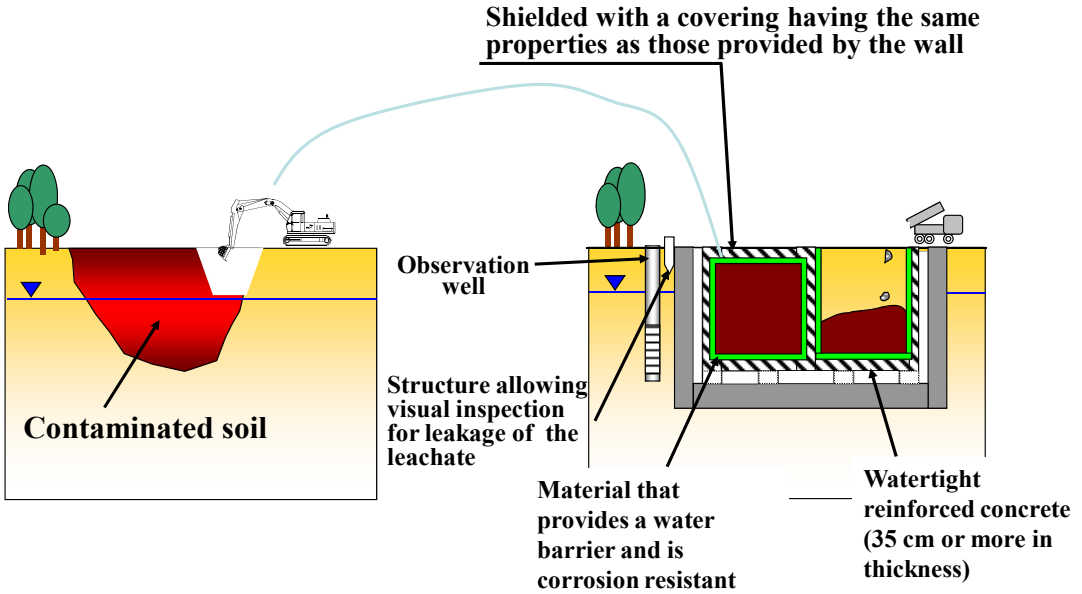
17

Containment using liner facilities



18

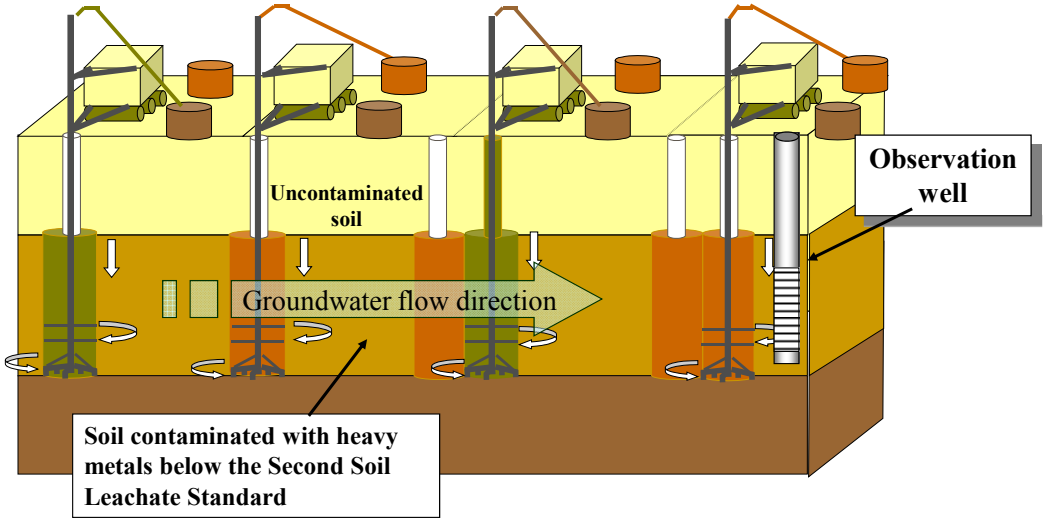
Containment by waste isolation



19

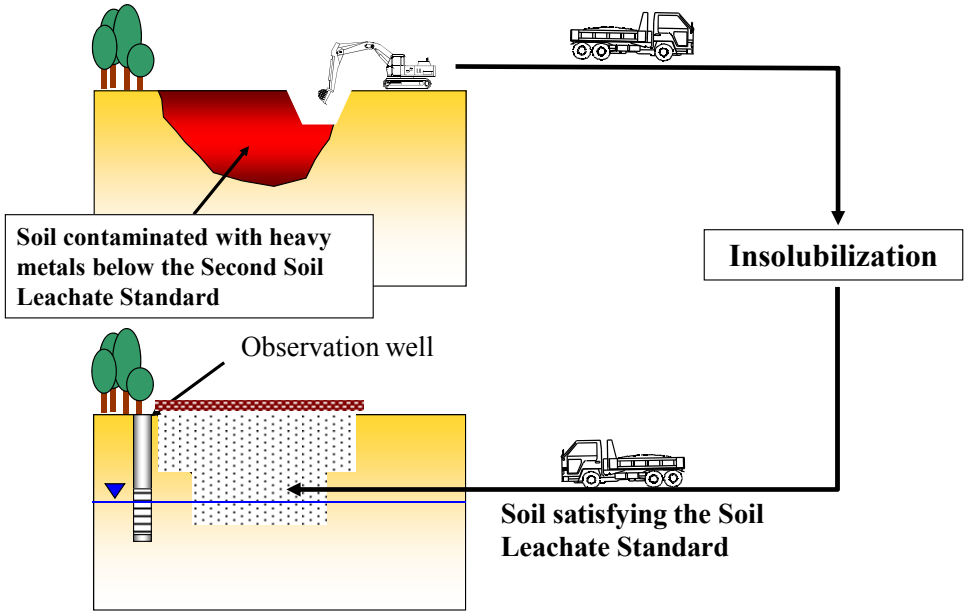
In-situ stabilization (Insolubization)

Chemicals to be injected and mixed with the soil to ensure conformity with the Soil Leachate Standard



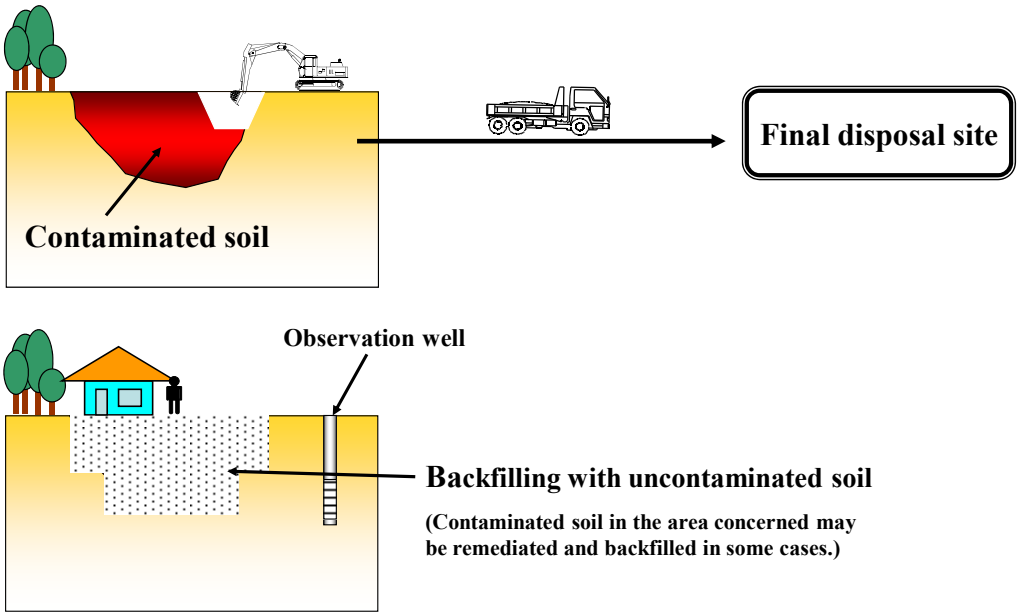
20

Removal of contaminants (Ex situ stabilization and backfilling)



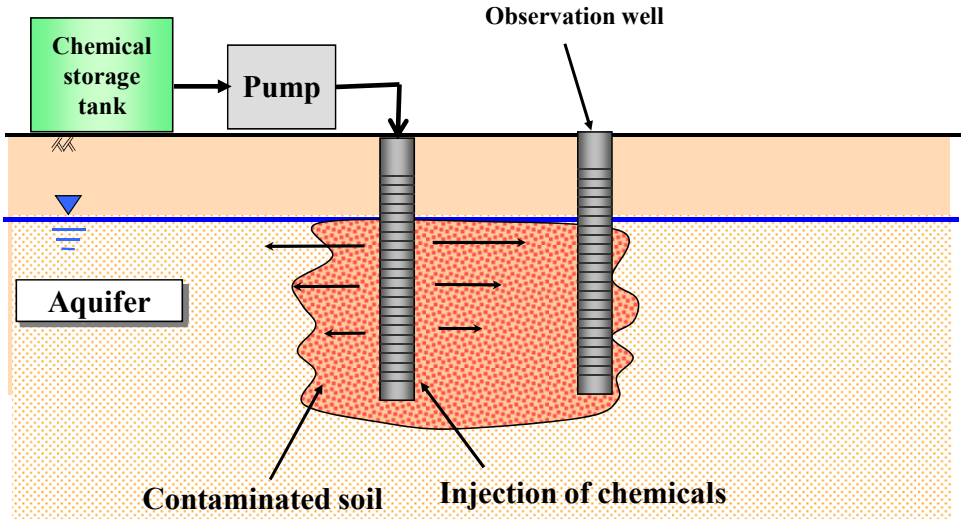
21

Removal of contaminants (Soil excavation)



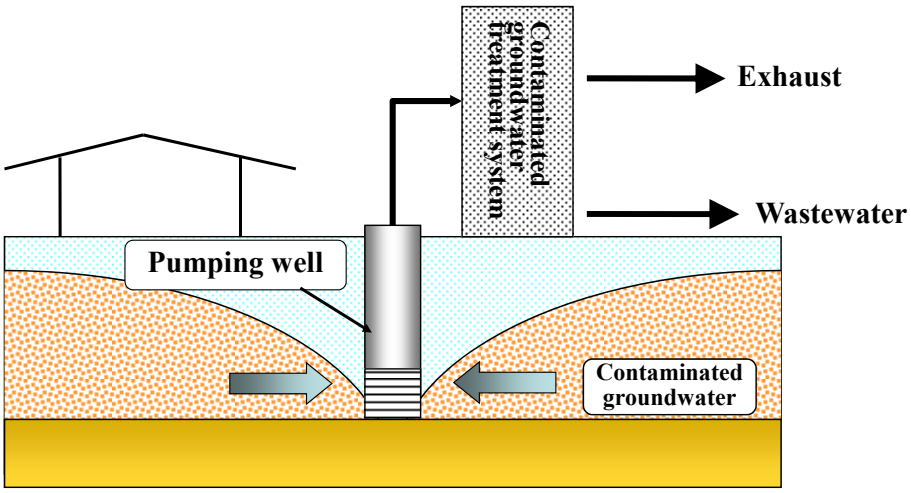
22

Removal of contaminants (In-situ remediation (Decomposition))



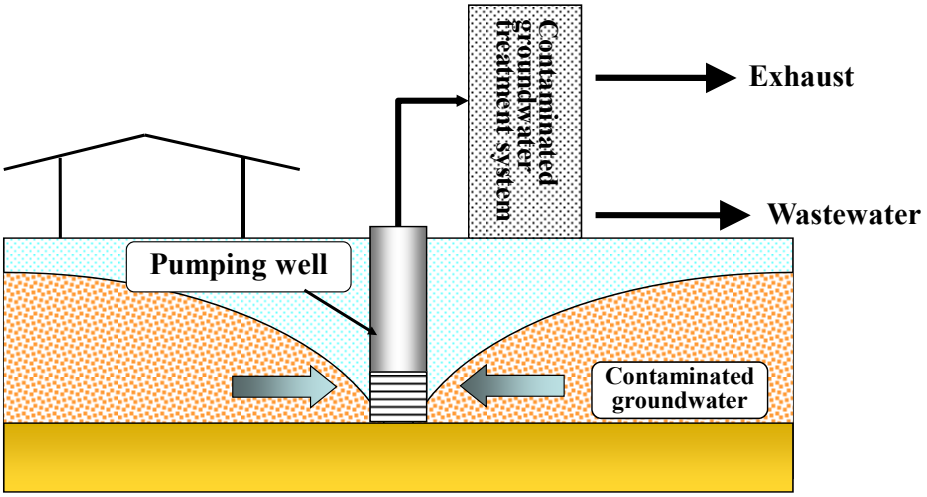
23

Removal of contaminants
(In-situ remediation (Pump and treat))



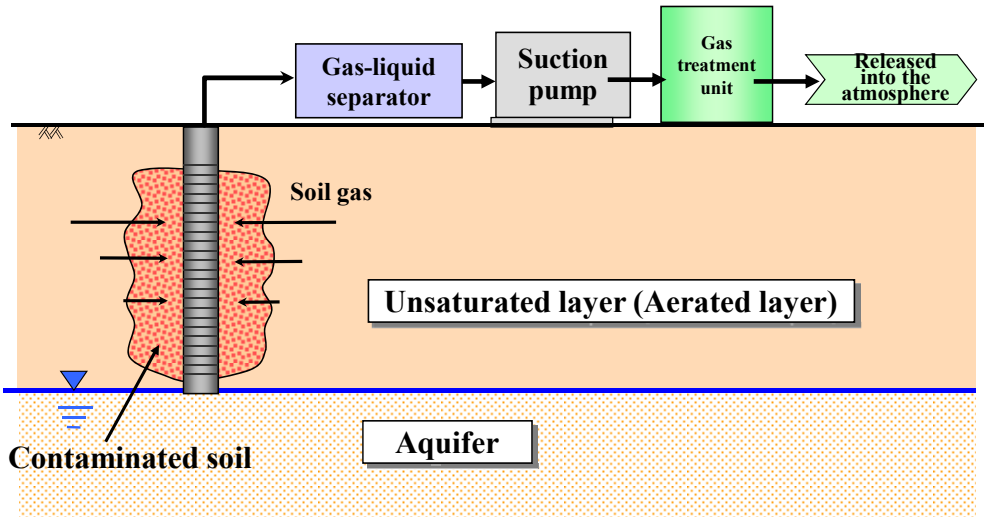
24

Removal of contaminants
(In-situ remediation (Pump and treat))



25

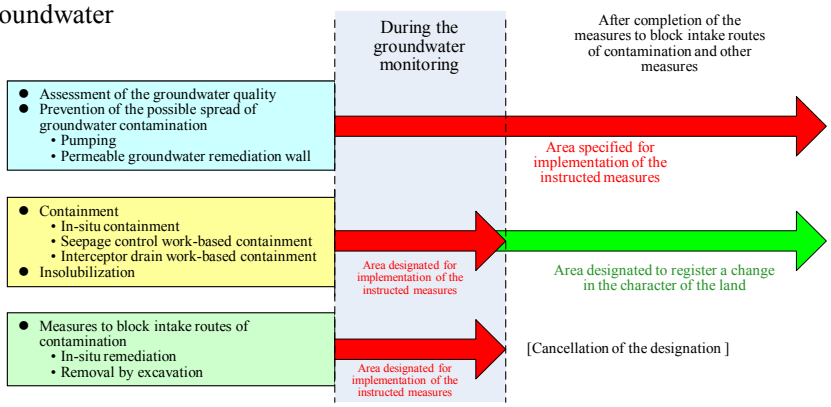
Removal of contaminants (In-situ remediation (Soil vapor extraction))



26

Designation of Designated Areas during and/or after implementation of measures to block intake routes of contamination

Risk due to the ingestion of groundwater



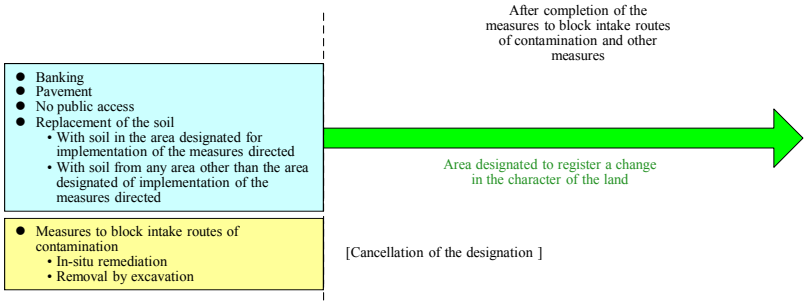
In cases where the measures to block intake routes of contamination is no longer effective after implementation of the measures, the relevant area may be re-registered as an area specified for the implementation of the instructed measures and instructed by the regulatory authorities to take the measures again.

27

[Source: Nakashima]

Designation of Designated Areas during and/or after implementation of measures to block intake routes of contamination

Risk due to direct ingestion



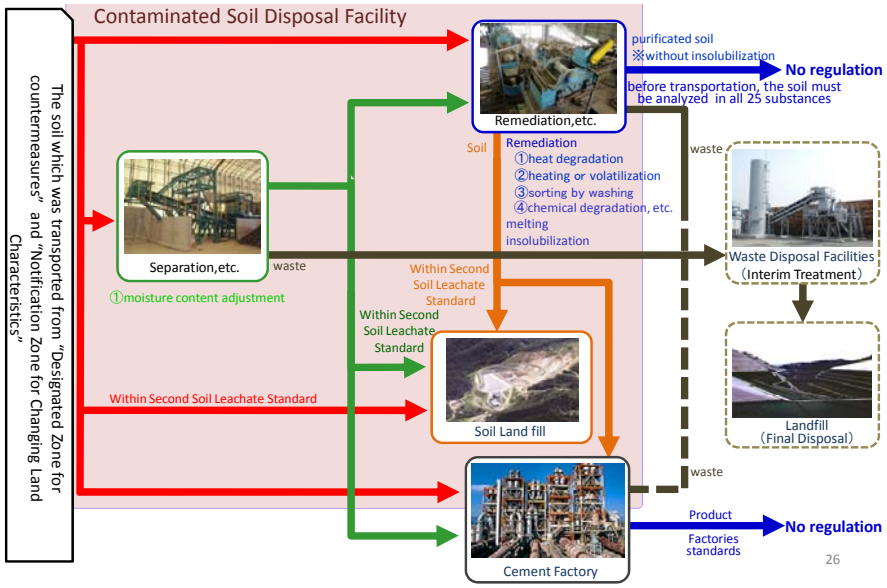
In cases where the measures to block intake routes of contamination is no longer effective after implementation of the measures, the relevant area may be re-registered as an area specified for the implementation of the instructed measures and instructed by the regulatory authorities to take the measures again.

28

[Source: Nakashima]

Treatment of contaminated soil that is carried out from an area and the facilities involved

○ Contents of the disposal of the contaminated soil and the definition of the facility

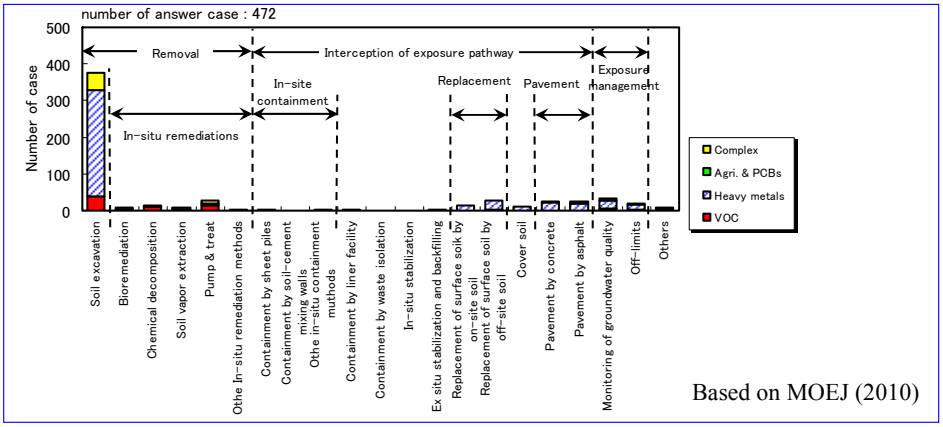


29

[Source: MOEJ (Trans. IGES)]

Extent of the implementation of measures to block intake routes of contamination

- **Status of the implementation of measures for the removal of contaminated soil in FY2008 (cases confirmed by local governments)**



○ Contamination cases with Class 1 Designated Hazardous Substances: Found treated primarily with removal by excavation (59%) and in-situ remediation (53%).
○ Contamination cases with Class 2 and Class 3 Designated Hazardous Substances: Found treated mostly with removal by excavation (83%).

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[Source: Nakashima 2010]

In-situ measures technologies for contaminated soil

Classification	Principle	Remediation method	VOCs	Heavy metals	Agricultural chemicals	PCBs Dioxins	Oil
Separation / extraction	Thermal	Extraction by electrical heating of the soil	○	△	○	○	○
	Physical / chemical	Soil vapor extraction (SVE)	○	×	×	×	△
		Pump and Treat (P&T)	○	×	×	×	△
		Dual extraction	○	×	×	×	△
		Air sparging	○	×	×	×	△
		Soil flushing	○	○	○	×	○
		Lime mixing	○	×	×	×	○
		Electrokinetic separation	×	○	△	×	×
	Biological	Phytoremediation	×	○	△	○	×
Decomposition	Physical / chemical	Oxidative decomposition	○	×	×	○	×
		Reductive decomposition	○	×	×	○	×
	Biological	Bioremediation	○	△	×	○	△
		Phytoremediation	△	×	×	×	△

Legend ○: Applicable, △: Applicable to some substances, ×: Not applicable

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[Source: Nakashima 2010]

On-site measures technologies for contaminated soil

Classification	Principle	Remediation method	VOCs	Heavy metals	Agricultural chemicals	PCBs Dioxins	Oil
Separation / extraction	Thermal	Thermal extraction	○	△	△	○	○
		Extraction by electrical heating of the soil	○	×	×	○	○
	Physical / chemical	Soil washing	○	○	○	○	○
		Chemical extraction	○	○	○	○	○
		Electrokinetic separation	×	○	×	×	×
	Biological	Phytoremediation	○	○	△	○	△
Decomposition	Thermal	Incineration	○	×	○	○	○
		Vitrification	×	○	○	○	×
	Physical / Chemical	Oxidative decomposition	○	×	○	×	○
		Reductive decomposition	○	×	×	○	×
		Alkali catalyst decomposition	○	×	○	○	×
		Electrokinetic decomposition	○	×	×	×	×
	Biological	Bioremediation	○	△	×	○	△
		Phytoremediation	△	×	×	×	△

Legend ○: Applicable, △: Applicable to some substances, ×: Not applicable

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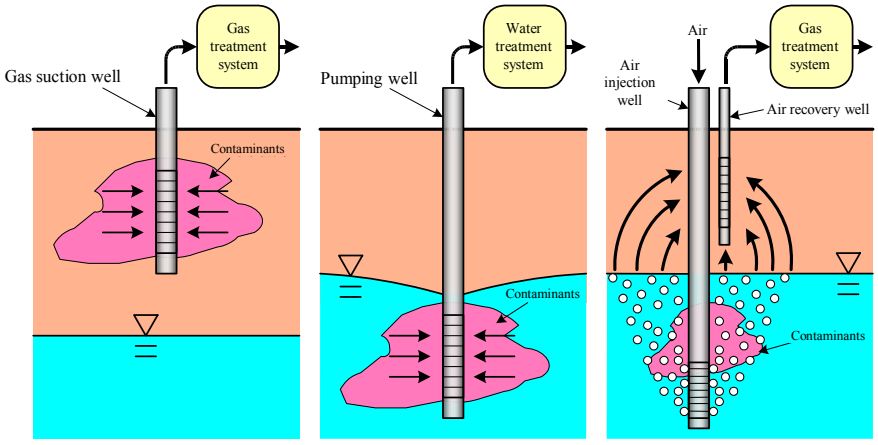
[Source: Nakashima 2010]

Examples of in-situ extraction technologies



(a) Soil vapor extraction (SVE) (b) Pump and Treat (P&T) (c) Air sparging

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[Source: Nakashima]

Treatment technologies for contaminated water

- **Treatment technologies for contaminated water**
  - **Category 1 substances（VOCs）**
    - Aeration method
    - Activated carbon adsorption method
    - Advanced oxidation method

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Treatment technologies for contaminated water

- **Regarding the contamination of tap water with low concentrations of VOCs (volatile organic compounds):**
  - Around 1990, when groundwater contamination with VOCs became a matter of public concern in Japan;
    - **Some local governments instructed citizens to bring drinking water (from groundwater) to the boil in a kettle for several minutes before use (in Chiba and some other prefectures).**
- **For the possible contamination of tap water with low concentrations of arsenic:**
  - The following protection methods are available:
    - **To absorb and filter the arsenic using sand or soil.**
    - **To mix iron (metallic iron, iron oxides) with the sand or soil to enhance the filtering effect.**
    - **To combine coagulating sedimentation with the filtering to increase the effects of the removal.**
      - **These methods have been implemented by Japanese researchers for water contaminated with arsenic in Bangladesh.**

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Treatment technologies for contaminated water

- **Treatment technologies for contaminated water**
  - **Category 2 substances (Heavy metals)**
    - Cation heavy metal (Cd, Hg, Pb)
      - Inorganic coagulant method (Cd, Pb)
      - Liquid chelate coagulation method (Hg)
      - Adsorption method (Cd, Hg, Pb)
    - Anion heavy metals (Cr(VI), Se, As)
      - Oxidation-reduction coagulation method
        - Cr(VI), Se : reductive treatment
        - As : oxidative treatment
      - Adsorption method (in the case of low concentrations)
    - Fluorine: F
      - Adsorption method (in the case of low concentrations)
    - Boron: B
      - Alkali coagulation method, Adsorption method

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Off-gas treatment technologies

- **Off-gas treatment technologies**
  - **Activated carbon adsorption method**
  - **Catalytic combustion method**
  - **UV decomposition method**

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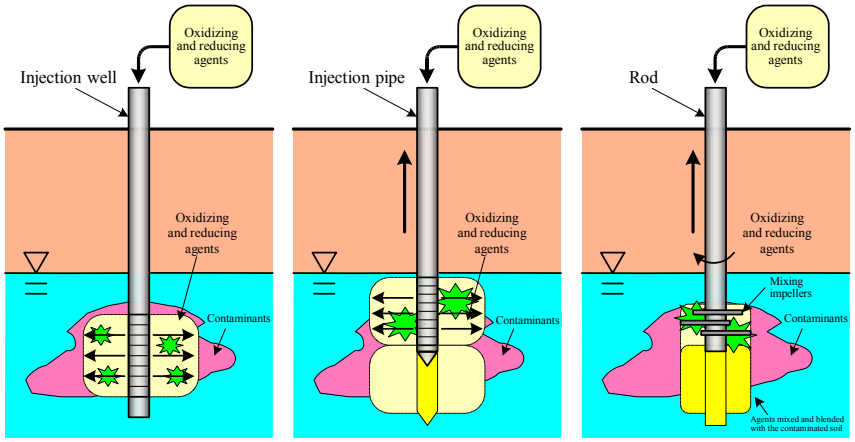
Schematic view of the injection of oxidizing and reducing agents for in-situ chemical decomposition



(a) Injection from a well (b) injection from a bore hole (c) mix and stir

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[Source: Nakashima]

Target substances and standards

Designated hazardous substances (Article 2 of the Law)		Concentration standard (Article 5 of the Law)		Second Soil Leachate Standard	Reference: Soil Environment Standard (except for copper)
		Soil Content Standard <Risk for direct ingestion>	Soil Leachate Standard <Risk of ingestion from groundwater etc.>		
Carbon Tetrachloride	Category 1 (VOC)		≤ 0.002mg / L	≤ 0.02mg / L	≤ 0.002mg / L
1,2-Dichloroethane			≤ 0.004mg / L	≤ 0.04mg / L	≤ 0.004mg / L
1,1-Dichloroethylene			≤ 0.02mg / L	≤ 0.2mg / L	≤ 0.02mg / L
Cis-1,2-Dichloroethylene			≤ 0.04mg / L	≤ 0.4mg / L	≤ 0.04mg / L
1,3-Dichloropropene			≤ 0.002mg / L	≤ 0.02mg / L	≤ 0.002mg / L
Dichloromethane			≤ 0.02mg / L	≤ 0.2mg / L	≤ 0.02mg / L
Tetrachloroethylene			≤ 0.01mg / L	≤ 0.1mg / L	≤ 0.01mg / L
1,1,1-Trichloroethane			≤ 1mg / L	≤ 3mg / L	≤ 1mg / L
1,1,2-Trichloroethane			≤ 0.006mg / L	≤ 0.06mg / L	≤ 0.006mg / L
Trichloroethylene			≤ 0.03mg / L	≤ 0.3mg / L	≤ 0.03mg / L
Benzene			≤ 0.01mg / L	≤ 0.1mg / L	≤ 0.01mg / L
Cadmium and its compound	Category 2 (Heavy metal etc.)	≤ 150mg / kg	≤ 0.01mg / L	≤ 0.3mg / L	≤ 0.01mg / L, and ≤ 1mg / 1kg rice on agricultural field
Hexavalent Chromium compounds		≤ 250mg / kg	≤ 0.05mg / L	≤ 1.5mg / L	≤ 0.05mg / L
Cyanides compounds		As isolated cyanides ≤ 50mg / kg	Less than detection limit	≤ 1.0mg / L	Less than detection limit
Total Mercury and its compounds		≤ 15mg / kg	≤ 0.0005mg / L	≤ 0.0005mg / L	≤ 0.0005mg / L
- Alkyl Mercury			Less than detection limit	Less than detection limit	Less than detection limit
Selenium and its compounds		≤ 150mg / kg	≤ 0.01mg / L	≤ 0.3mg / L	≤ 0.01mg / L
Lead and its compounds		≤ 150mg / kg	≤ 0.01mg / L	≤ 0.3mg / L	≤ 0.01mg / L
Arsenic and its compounds		≤ 150mg / kg	≤ 0.01mg / L	≤ 0.3mg / L	≤ 0.01mg / L and ≤ 15mg / kg soil on rice field
Fluorine and its compounds		≤ 4000mg / kg	≤ 0.8mg / L	≤ 24mg / L	≤ 0.8mg / L
Boron and its compounds		≤ 4000mg / kg	≤ 1mg / L	≤ 30mg / L	≤ 1mg / L
Simazine	Category 3 (Agrochemicals and PCBs)		≤ 0.003mg / L	≤ 0.03mg / L	≤ 0.003mg / L
Thiuram			≤ 0.006mg / L	≤ 0.2mg / L	≤ 0.006mg / L
Thiobencarb			≤ 0.02mg / L	≤ 0.06mg / L	≤ 0.02mg / L
PCB			Less than detection limit	≤ 0.003mg / L	Less than detection limit
Organic phosphorus compounds			Less than detection limit	≤ 1mg / L	Less than detection limit

[Source: MOEJ (Trans. IGES)]

ANNEX 1:

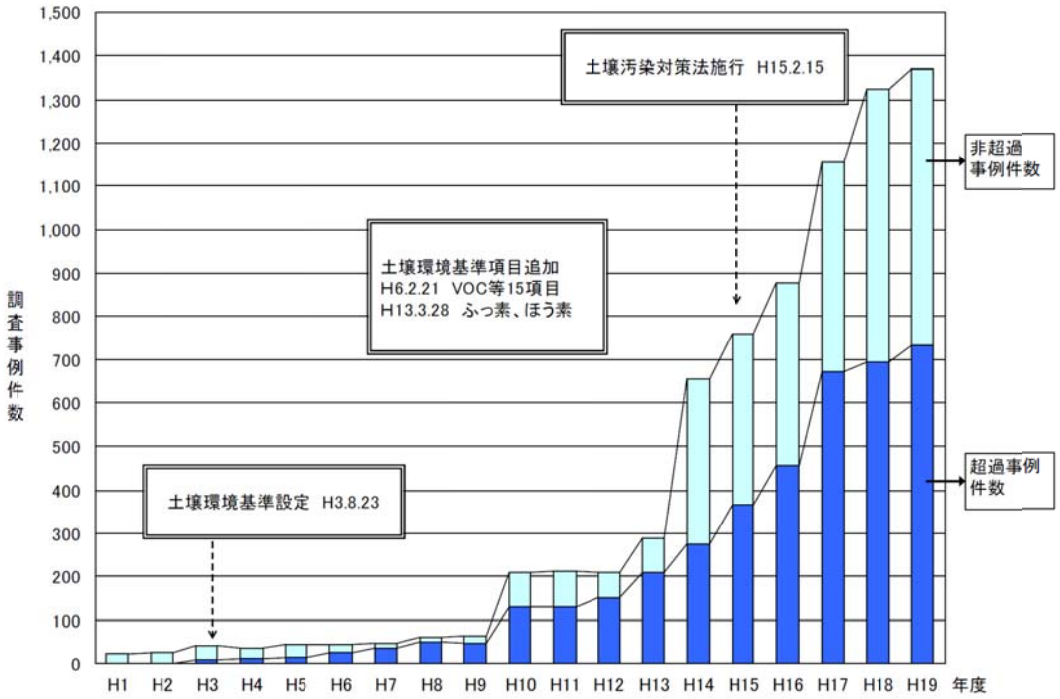
Implementation record of the Soil Contamination Countermeasures Act since the enactment in Feb 15 2003 to the 31 August 2008 (as of 31st August 2008)

(1) Article 3 Investigation	
Number of closures of facilities having used Designated Hazardous Substances	4,751
Number of investigations reported	1,030
Number of organizations undertaking soil contamination investigations	55
Number of organizations having obtained an exemption for investigations through verification by the Prefectural governor	3,676
Number of organizations currently following the above procedure	96
Others (Considering the two possibilities of carrying out the investigations or asking for an exemption)	79
Number of designations listed as needing investigation based on the Article 3.	298
(2) Article 4 Investigation	
Number of Investigation orders issued	5
Number of sites listed as contaminated under the above article.	3

[Source: MOEJ (Trans. IGES)]

The number of soil contamination investigations carried out according to the prefectural government data:

ANNEX 2:



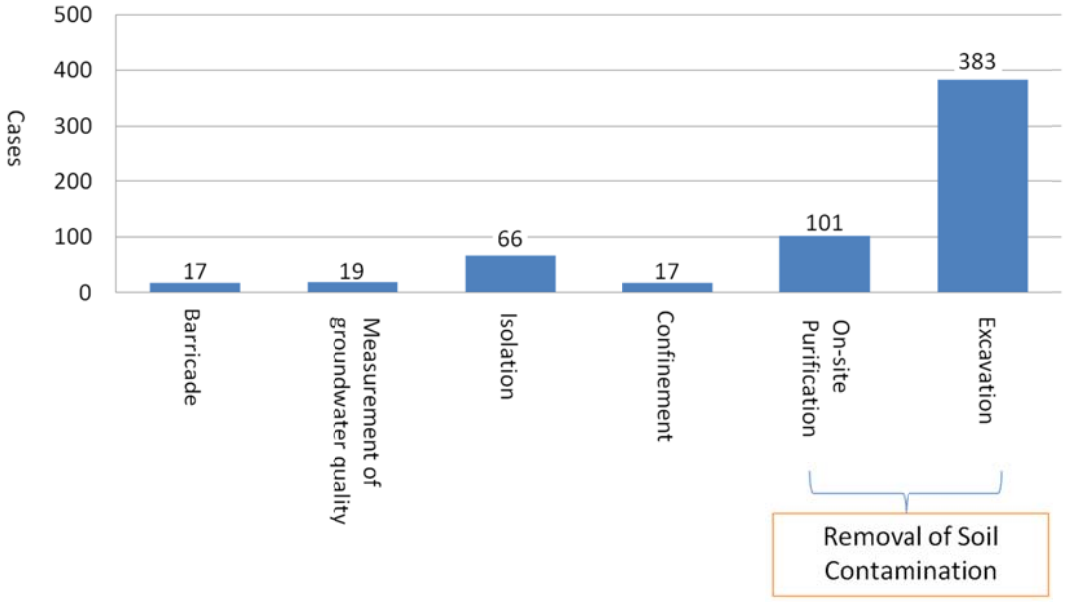
[Source: MOEJ]

（出典）「平成１９年度土壌汚染対策法の施行状況及び土壌汚染調査・対策事例等に関する調査結果」環境省 水・大気環境局

ANNEX 3:

Soil Contaminations Countermeasures Contents

Of the total Countermeasure implementation cases recorded by the prefectural governments (including those not ordered by law) 497 are classified according to countermeasure method.



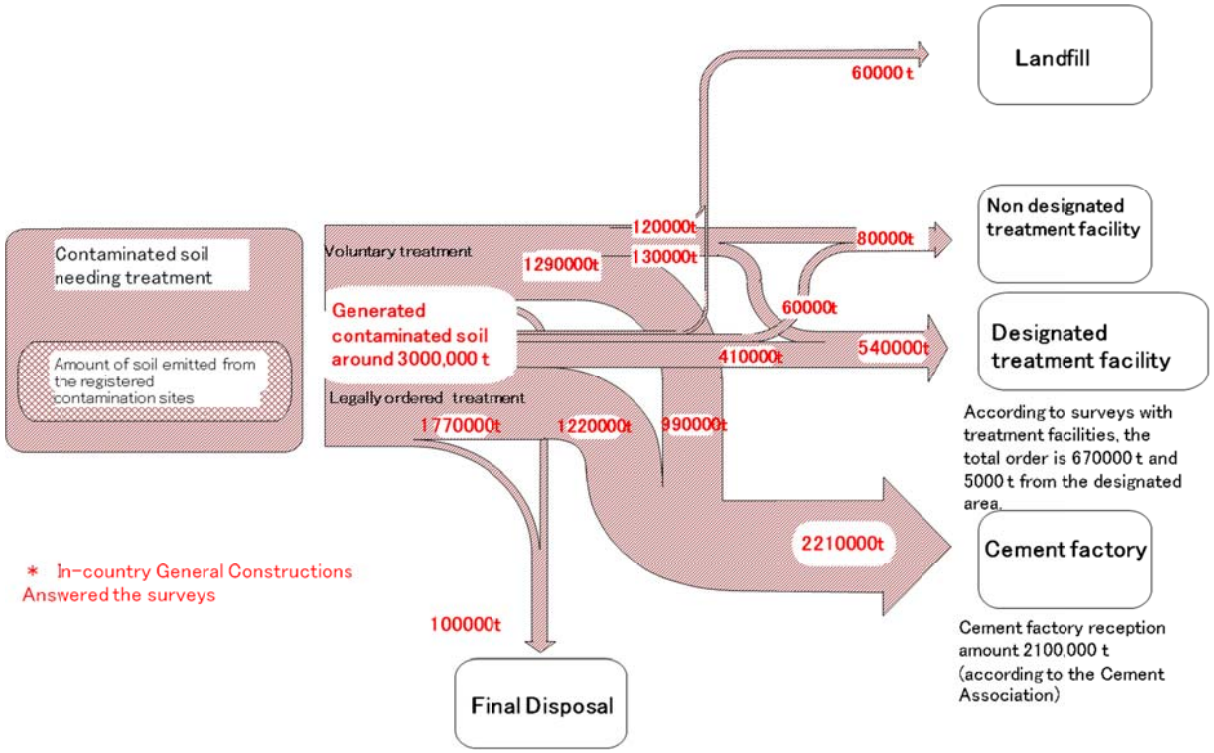
[Source: MOEJ (Trans. IGES)]

（出典）「平成１９年度　土壌汚染対策法の施行状況及び土壌汚染調査・対策事例等に関する調査結果」 環境省 水・大気環境局

Differences between countermeasures recommended by the law and the real practice

The Soil Contamination Countermeasures Act recommends various types of measures according to the degree of contamination and type of material. For sites registered as designated zone before August 2009, there are 18 sites where the removal of soil contamination is conducted. In reality, most of the countermeasures including those for excess soil contaminants (88) and excess elution (194) involve excavation. This situation leads spread of environment risks. It is one the reason why this Act was amended.

ANNEX 4:



[Source: MOEJ (Trans. IGES)]

Inappropriate disposal of contaminated soil

According to the data from the regional governments, there are many cases of inappropriate desposal of contaminated soil as can be seen in the following:

(A) Hexavalent chromium contaminated soil was abandoned (July 2006)

Hexavalent chromium was detected from the soil dumping site and despite the municipal request to rehabilitate the area, nothing was done. Now the buyer of the land is dealing with the soil contamination countermeasures

(B) Mercury contaminated soil (November 2003)

Mercury contamination occurred at a thermometre manufacturing centre. The soil was planned to be treated at appropriate facilities but in reality was transported elsewhere to undergo the melting process. The manufacturers had planned to treat 250m2.

(C) Arsenic-contaminated soil (October 2003)

Arsenic exceeding the standards was detected in a soil storage mound.

[Source: MOEJ]

Reference

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Documentation from MOEJ