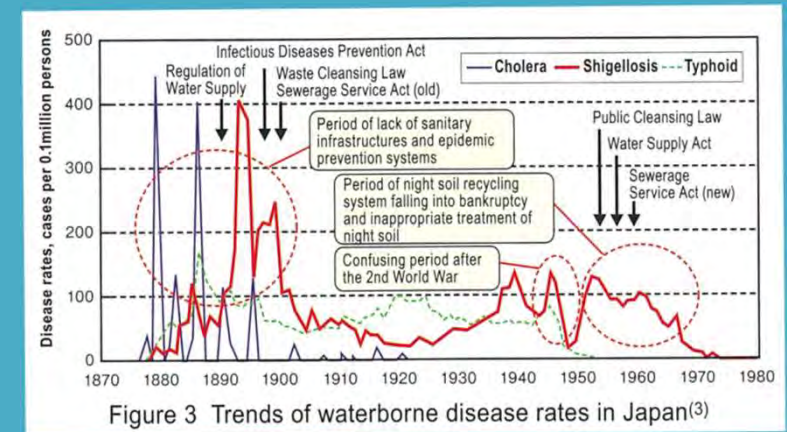


# **1. History of sanitation improvement in Japan**

# 1. History of sanitation improvement in Japan

- In the beginning of the 1900s, to prevent the outbreak of waterborne diseases, wastewater from toilets could not be discharged to the environment by law, unless it was treated by a designated method with the assurance that the treated water was free of hygienic problems.  
The situation remains unchanged after that time.
- In the 1920s, a “Filth treatment tank,” which is a septic tank combined with a trickling filter, was developed to treat wastewater from toilets. It was originally using Japanese characters and is the forerunner of today’s Johkasou.
- In 1950, the Structural Standards for Sewage Treatment Tanks (Johkasou) were stipulated. Septic tank, Imhoff tank and some aeration processes were introduced in the standards. Johkasou made of RC gradually spread from then. As the number of installed johkasou was small, the maintenance of johkasou was usually conducted at that time by technicians from johkasou manufactures. However, the desludging of johkasou was carried out by the workers of local vendors who, for generations, did the job of removing human waste from vault toilets.



# 1. History of sanitation improvement in Japan

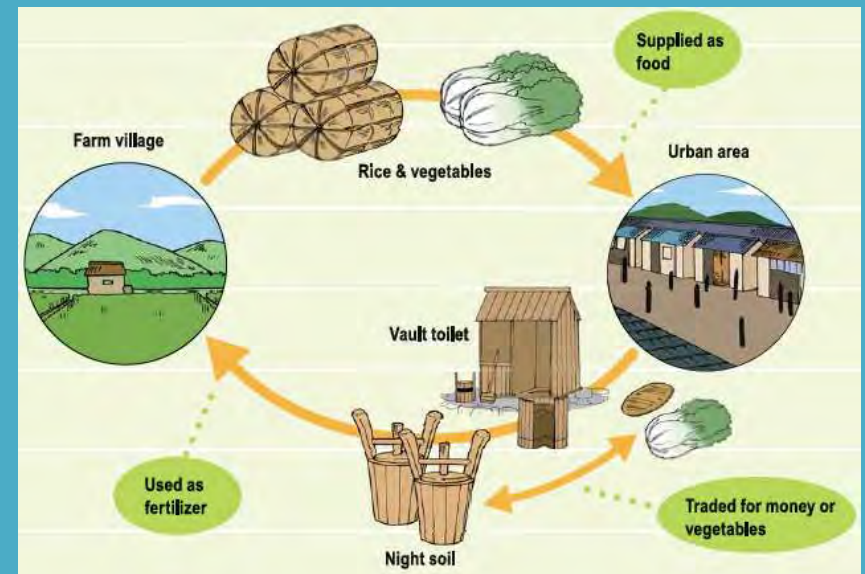
## ~ 2<sup>nd</sup> World War(~1945)

- **Social Background**

Night soil is valuable and used as fertilizer in rural areas

- **Treatment/disposal of night soil**

- ✓ Farmers buy night soil from residents by rice and vegetables.
- ✓ Gray water was discharged into gullies nearby.



# 1. History of sanitation improvement in Japan

1945 ~ 1955

- **Social Background**

- Decrease of use of night soil in agriculture due to the spread of cheap chemical fertilizer

➡ **Social needs for hygienic treatment of night soil**



**Japanese Vault toilet**

- **Treatment/disposal of night soil**

- ✓ Start to constructing night soil treatment facilities nationwide.
- ✓ Anaerobic digestion process was popular.

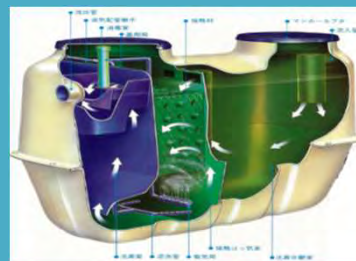
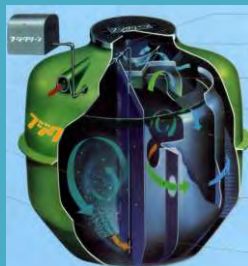
A night soil treatment facility built in the 1950s





# 1. History of sanitation improvement in Japan

- In the early 1960s, with the improvement of living standards along with the high economic growth, strong demands for flush toilets emerged.
- At that time, vault toilets were popular in houses, which necessitated to remove the night soil stored in tanks every 3-4 months by vacuum trucks and to transport it to night soil treatment facilities for sanitary treatment.
- When flush toilets were introduced, vault toilets could not be used anymore as it would be full of wastewater in a short period of time and the night soil collection/transportation system could not deal with it due to limited capacity.
- A treatment plant designed for the treatment of individual household wastewater from flush toilets and the discharge of the treated effluent to the environment was proposed .
- The improvement of the produced technology enabled the mass-production of household johkasou (Packaged Aerated Wastewater Treatment Plants-PAWTPs). This resulted in the explosive spread of johkasou.



FRP-made johkasou in the 1960s

# 1. History of sanitation improvement in Japan

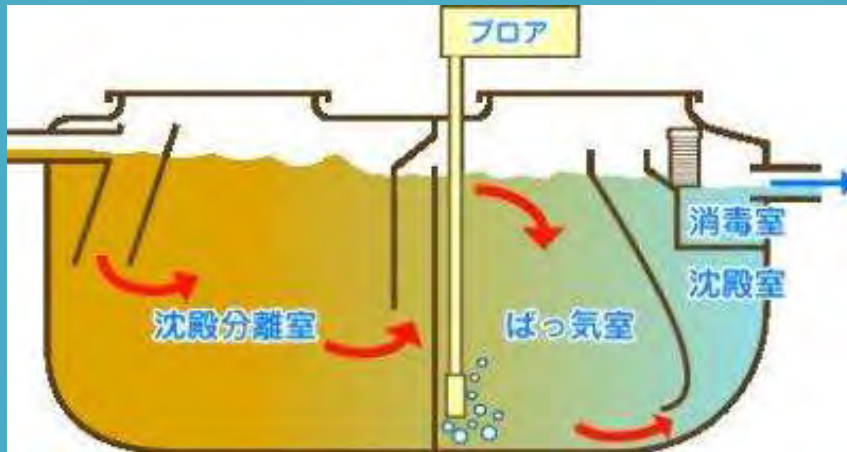
1960 ~

- Social Background

- Huge demands for flush toilets

- Treatment technology

- R&D of household wastewater treatment facility (tandoku-shori johkasou )
- Gray water discharged into public water bodies



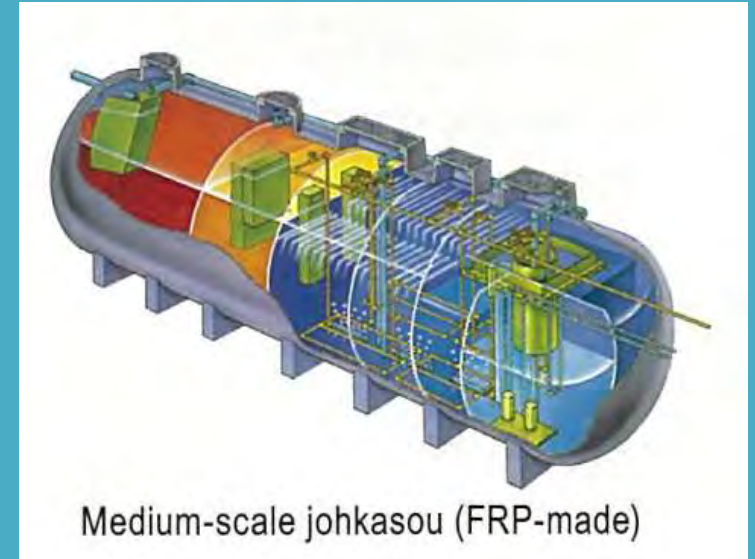
Japanese flush toilet

Tandoku-shori johkasou for treatment of wastewater from flush toilets (Effluent BOD 90 mg/L)

# 1. History of sanitation improvement in Japan

## 1955~1965

- **Social Background**
  - High economic development phase
  - Industrialization and urbanization
- **Treatment technology**
  - Medium/larger scale johkasou was developed and was put into market



## 1985 ~ 1995

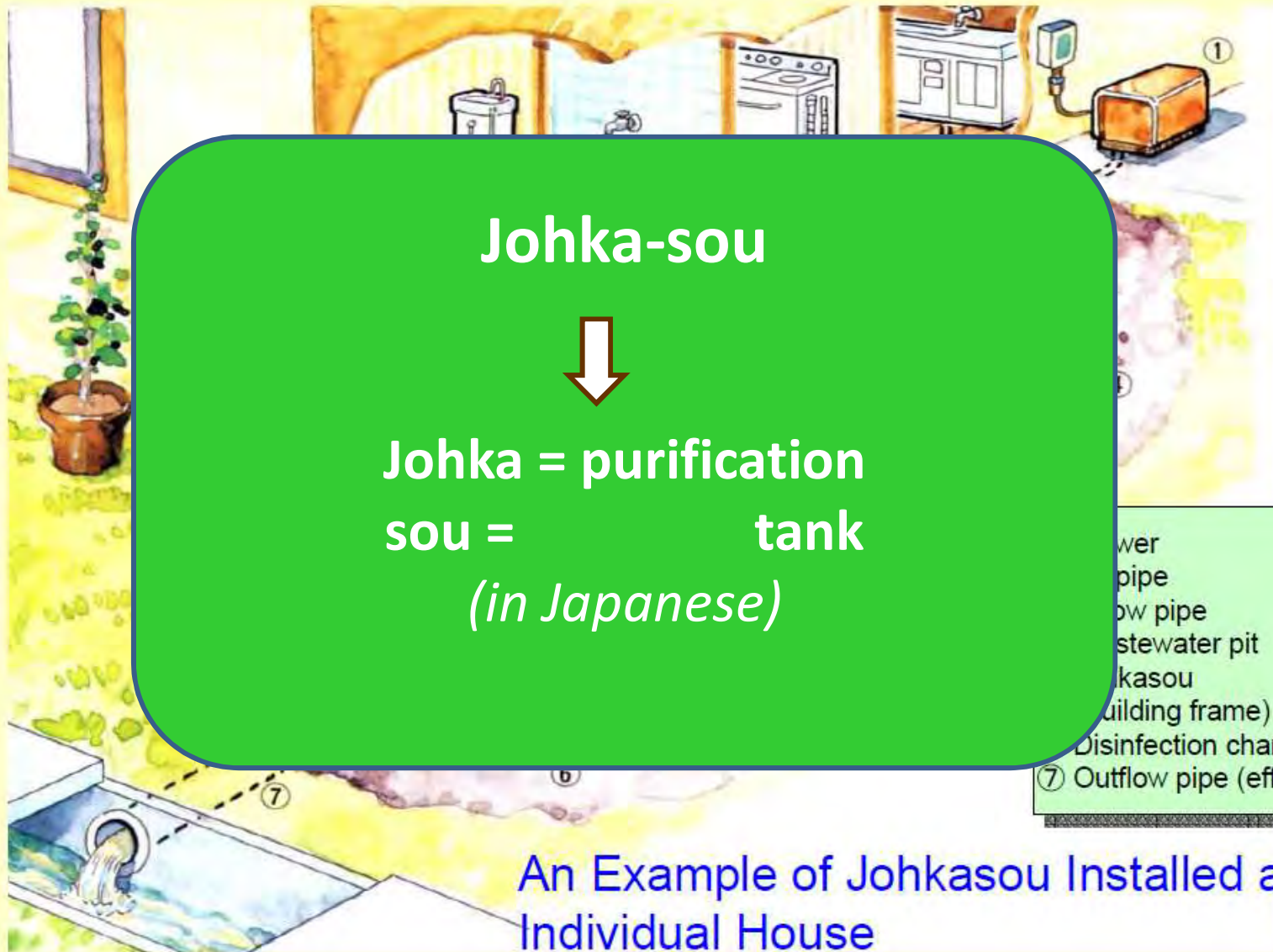
- **Social Background**
  - Increasing awareness of environment conservation
- **Treatment technology**
  - Household johkasou with high treatment performance was developed and was put into market. (effluent BOD < 20 mg/L)



## **2. Johkasou technology**



# What is Johkasou?



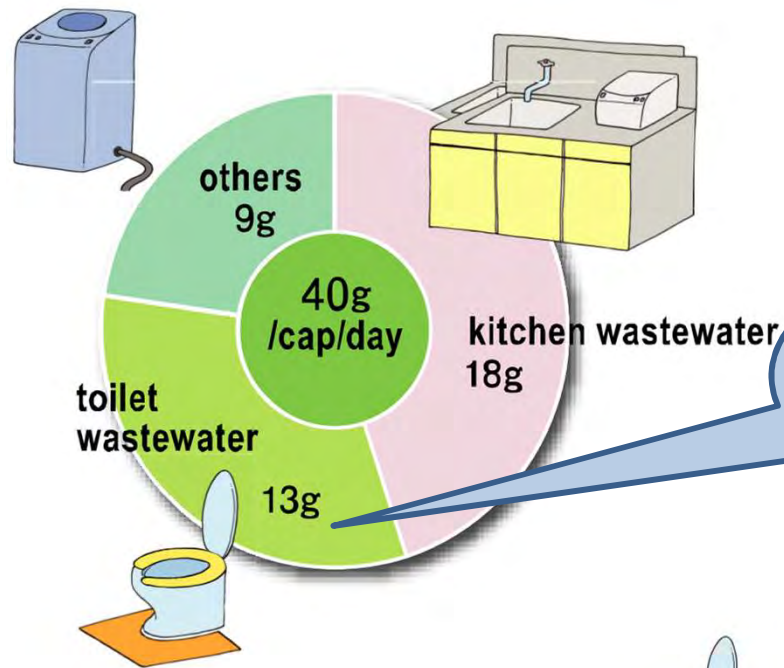
Johka-sou



Johka = purification  
sou = tank  
(in Japanese)

An Example of Johkasou Installed at Individual House

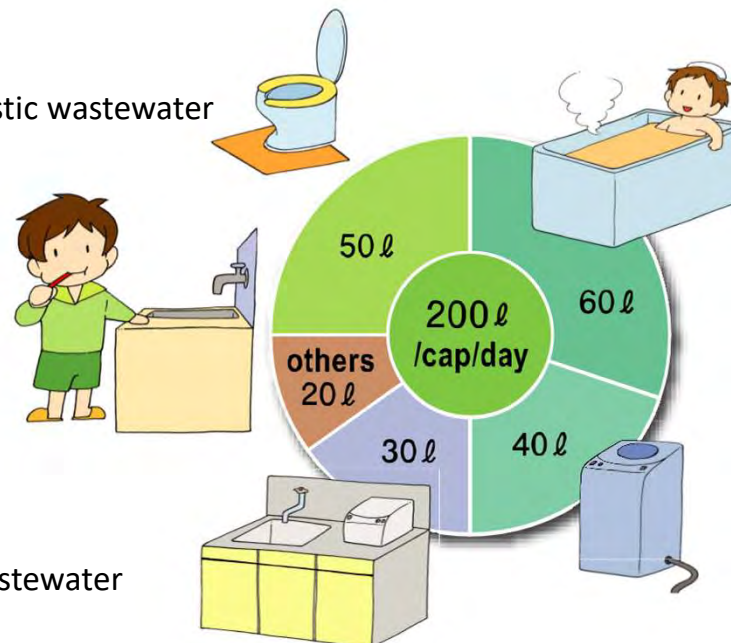
# Water Pollution by Untreated Domestic Wastewater



Pollutant loads (BOD) of domestic wastewater

High public health risks (pathogenic microorganisms)

Adverse environmental impacts



Daily amount of domestic wastewater



A road gully in tandoku-johkasou installation area in 1970s, (where whitish sludge was attached to)

Water pollution by untreated grey water



# Pollutant Loads for Johkasou Design

Source of wastewater		Wastewater amount [ l/cap.·day ]	BOD	T-N	T-P
			· Load [ g/cap.·day ]	· Load [ g/cap.·day ]	· Load [ g/cap.·day ]
Flush toilet wastewater	Flushing	50	13		
Miscellaneous domestic wastewater	Cooking	30	18		
	Washing	40	} 9		
	Bathing	50			
	Washing face/hands	20			
	Cleaning	10			
Total		200	40	10	1.0

Pollutant Loads for one PE (Person Equivalent)

# Determination of Johkasou Size in Buildings Classified by Purpose of Use (examples)

JIS A 3302 2000

Classification number	Purpose of building use		Number of users for designing	
			Calculation formula	Remarks
2	Housing and related facilities	Residence	$n = 5 \quad A \leq 130 \text{ m}^2$ $n = 7 \quad A > 130 \text{ m}^2$	$n$ = number of users for designing $A$ = total floor area ( $\text{m}^2$ )
		Lodging house and dormitory	$n = 0.07A$	$n$ = number of users for designing $A$ = total floor area ( $\text{m}^2$ )
		School dormitory, Self Defense Force camp, old-age home, and protective institution	$n = P$	$n$ = number of users for designing $P$ = capacity



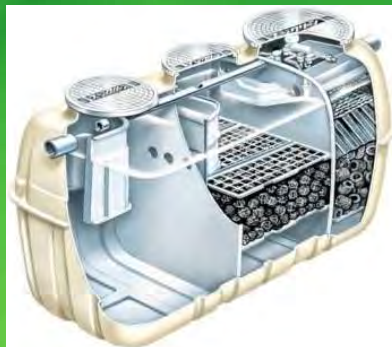
# Structures and Treatment Performances of Johkasou

Class	Type of treatment	Treatment process	Number of users for design							BOD removal rate	Treatment performance					
											Effluent quality (mg/ℓ)					
			5	50	100	200	500	2000	5000		BOD	COD	T-N	T-P		
1	Combined domestic wastewater treatment	Separation-contact aeration process	<div></div>							90% or more	20 or less	—	—	—		
		Anaerobic filter-contact aeration process	<div></div>												20 or less	—
		Denitrification type anaerobic filter-contact aeration process	<div></div>													
4	Flush toilet wastewater treatment	Septic tank process	<div></div>							55% or more	120 or less	—	—	—		
5		Land infiltration process	<div></div>							SS: 55% or more	SS: 250 or less	—	—	—		
6	Combined domestic wastewater treatment	Rotating biological contactor process	<div></div>	<div></div>						90% or more	20 or less	30 or less	—	—		
		Contact aeration process	<div></div>													
		Trickling filter process	<div></div>													
		Extended aeration process	<div></div>													
		Conventional activated sludge process	<div></div>													
7		Contact aeration and trickling filter process	<div></div>							—	10 or less	15 or less	—	—		
		Coagulation separation process	<div></div>													
8		Contact aeration and activated carbon absorption process	<div></div>							—	10 or less	10 or less	—	—		
		Coagulation separation and activated carbon absorption process	<div></div>													
9		Nitrified water recirculation type activated sludge process	<div></div>							—	10 or less	15 or less	20 or less	1 or less		
		Tertiary treatment type denitrification dephosphorization process	<div></div>													
10		Nitrified water recirculation type activated sludge process	<div></div>							—	10 or less	15 or less	15 or less	1 or less		
		Tertiary treatment type denitrification dephosphorization process	<div></div>													
11		Nitrified water recirculation type activated sludge process	<div></div>							—	10 or less	15 or less	10 or less	—		
		Tertiary treatment type denitrification dephosphorization process	<div></div>													
12	Emission standard under the Water Pollution Control Law	Class: 6 - 11	COD (mg/ℓ): 60	SS (mg/ℓ): 70	n-Hex (mg/ℓ): 20	pH: 5.8-8.6	Total coliforms (N/mℓ):			3,000 or less						
		6 - 11	45	60	20	5.8-8.6				3,000 or less						
		6 - 11	30	50	20	5.8-8.6				3,000 or less						
		7 - 11	15	15	20	5.8-8.6				3,000 or less						
		8	10	15	20	5.8-8.6				3,000 or less						

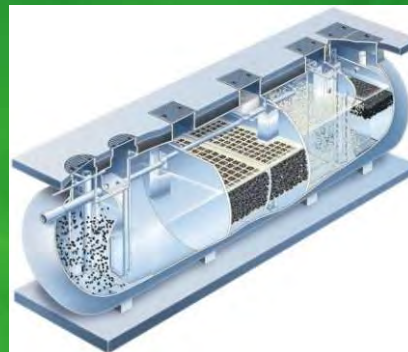
note: Class 2 and Class 3 were deleted in 2006.

# Johkasou classified by treatment capacity

- **Small-scale johkasou:** 5 to 50 PE, or the average amount of wastewater less than 10 m<sup>3</sup>/day.
- **Medium-scale johkasou:** 51 to 500 PE, or the average amount of wastewater less than 100 m<sup>3</sup>/day.
- **Large-scale johkasou:** 501 PE or more, or the average amount of wastewater more than 100 m<sup>3</sup>/day.



For Residential



For Commercial

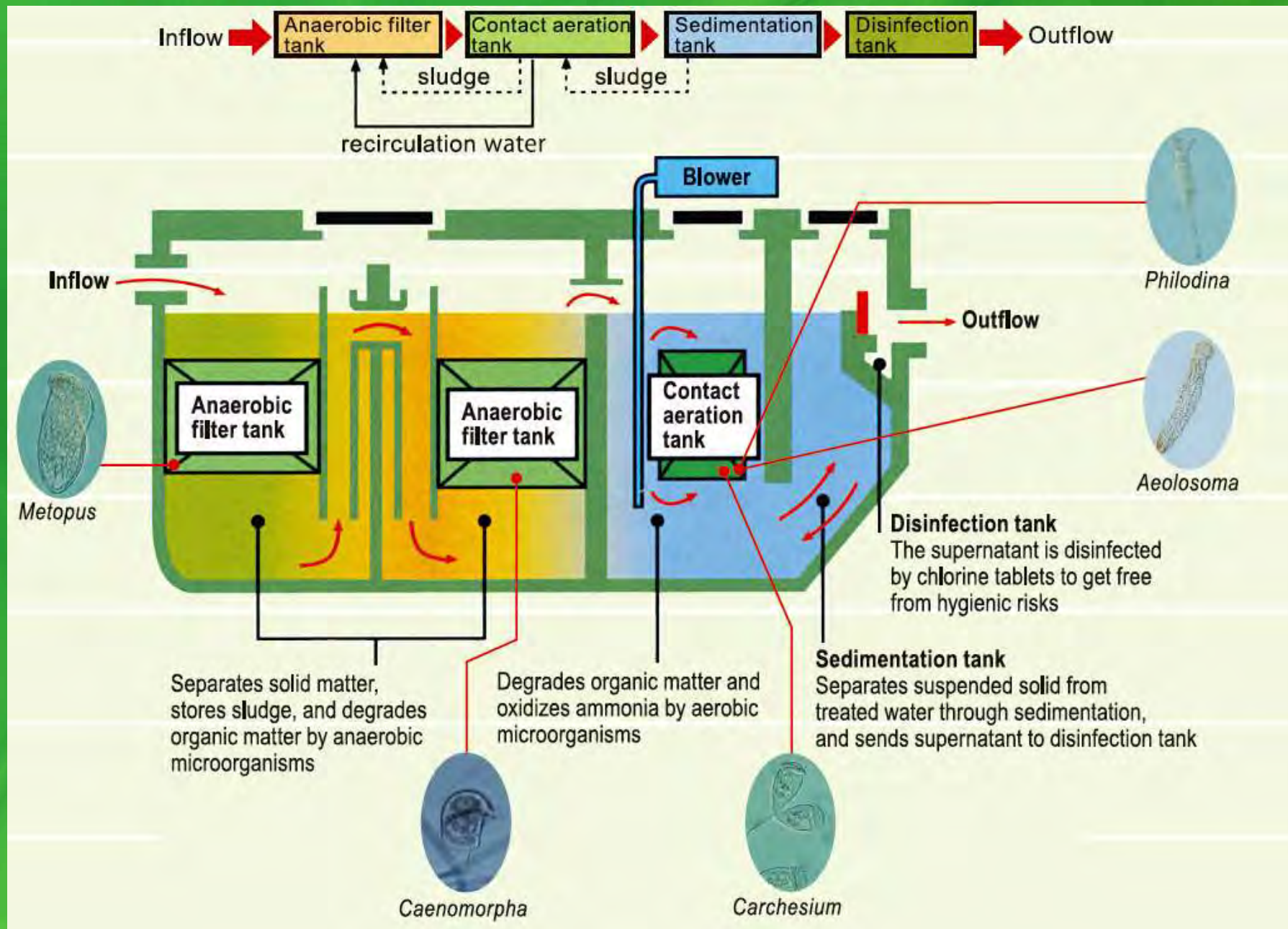


Large-scale johkasou (RC-made)

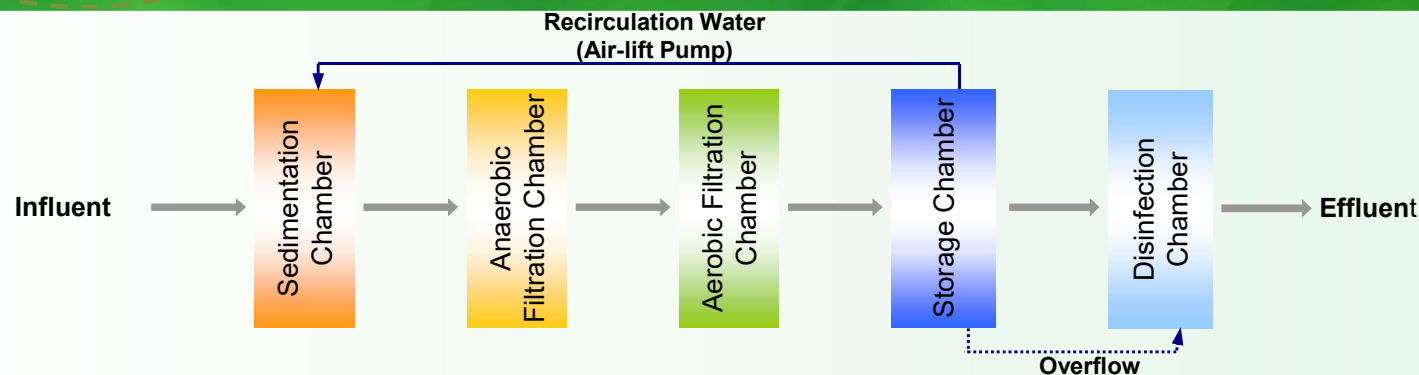
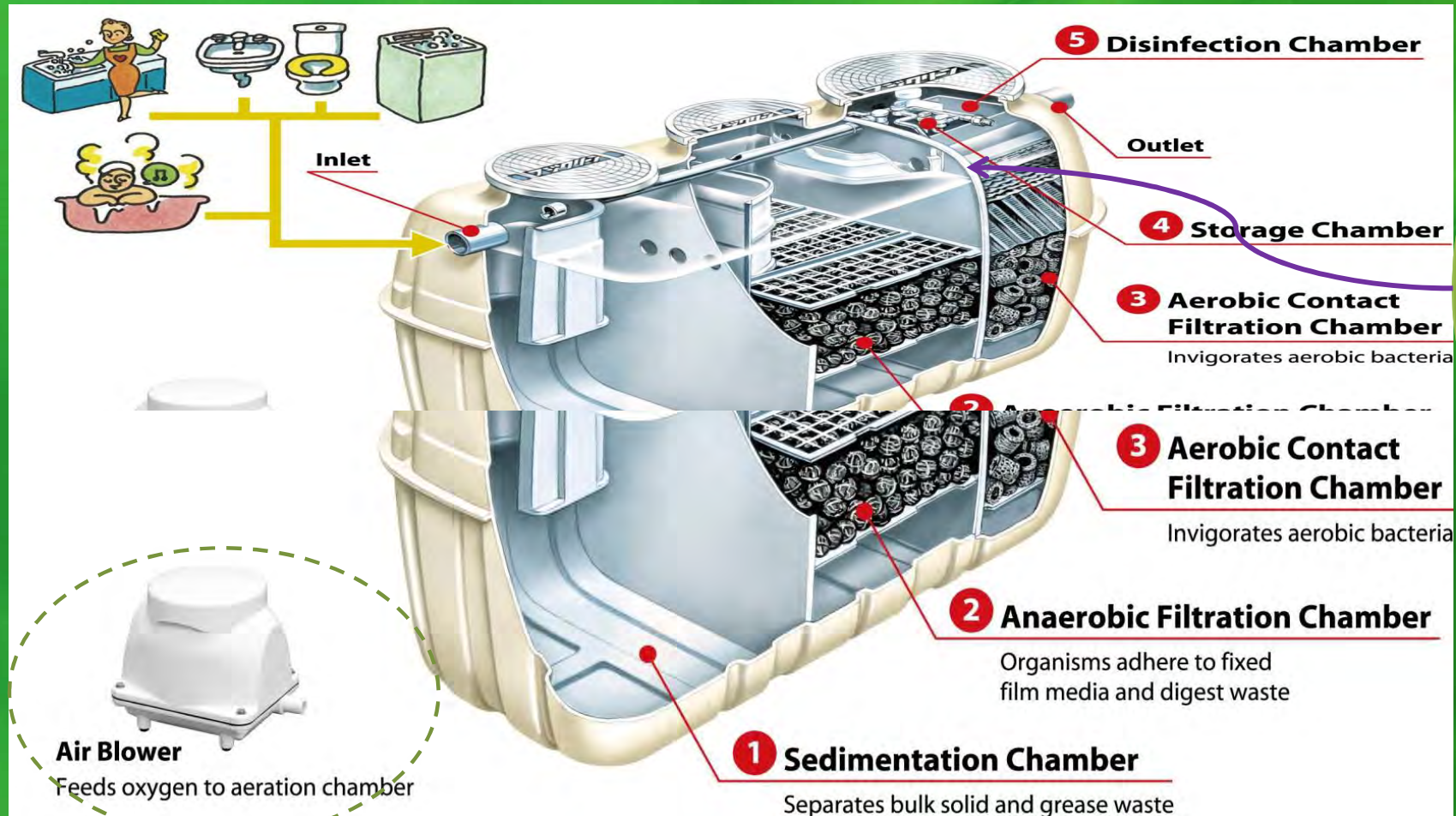
For Community/village



# Treatment Principles of Johkasou

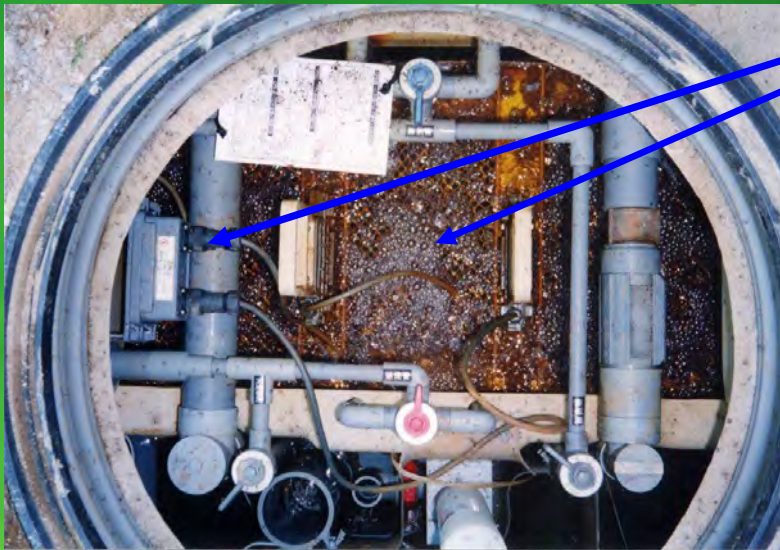
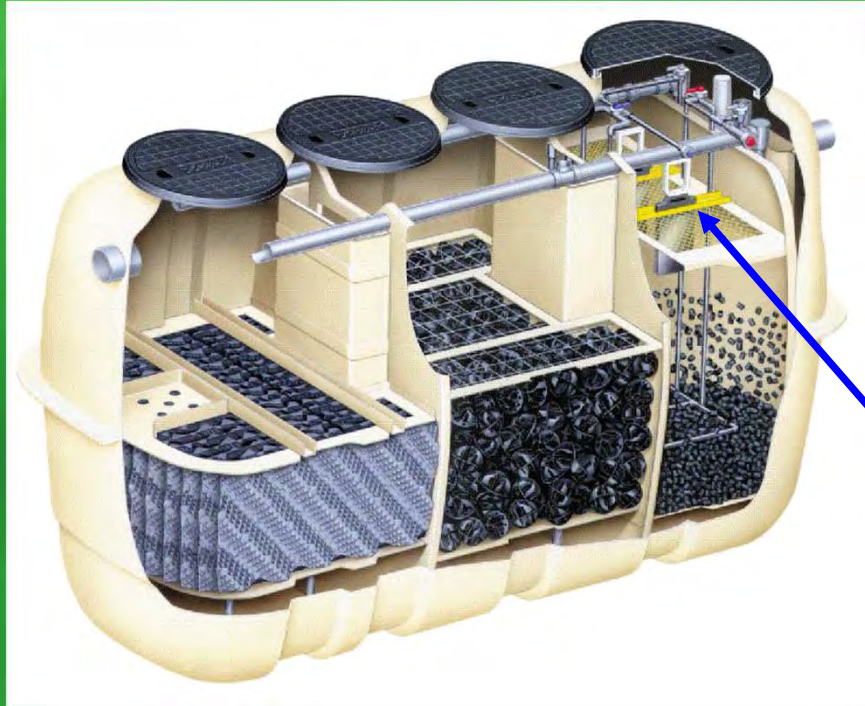


# An Example of Small-scale Johkasou (FRP)

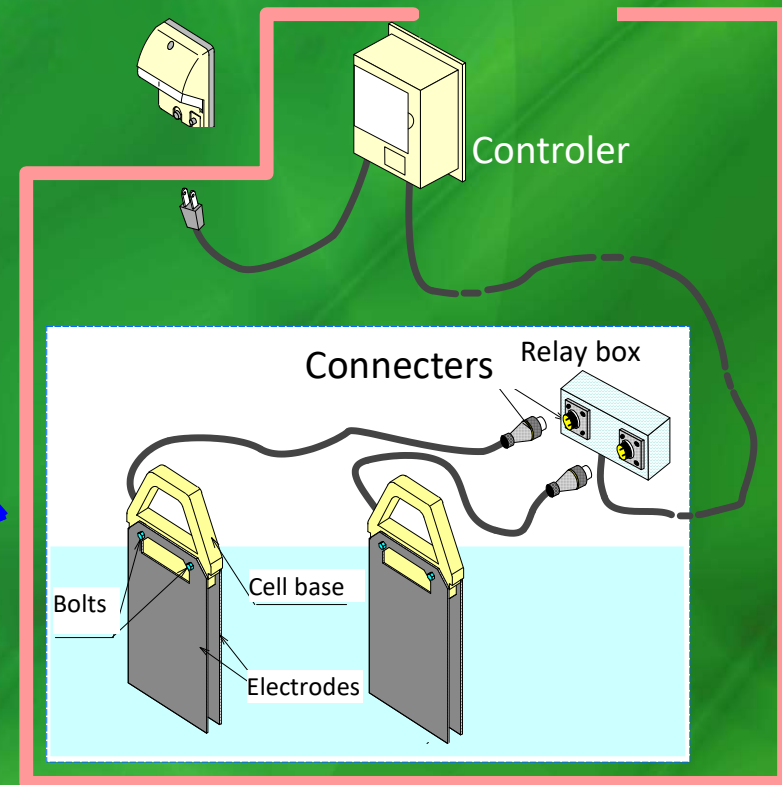




# A Johkasou for BOD & N&P Removal



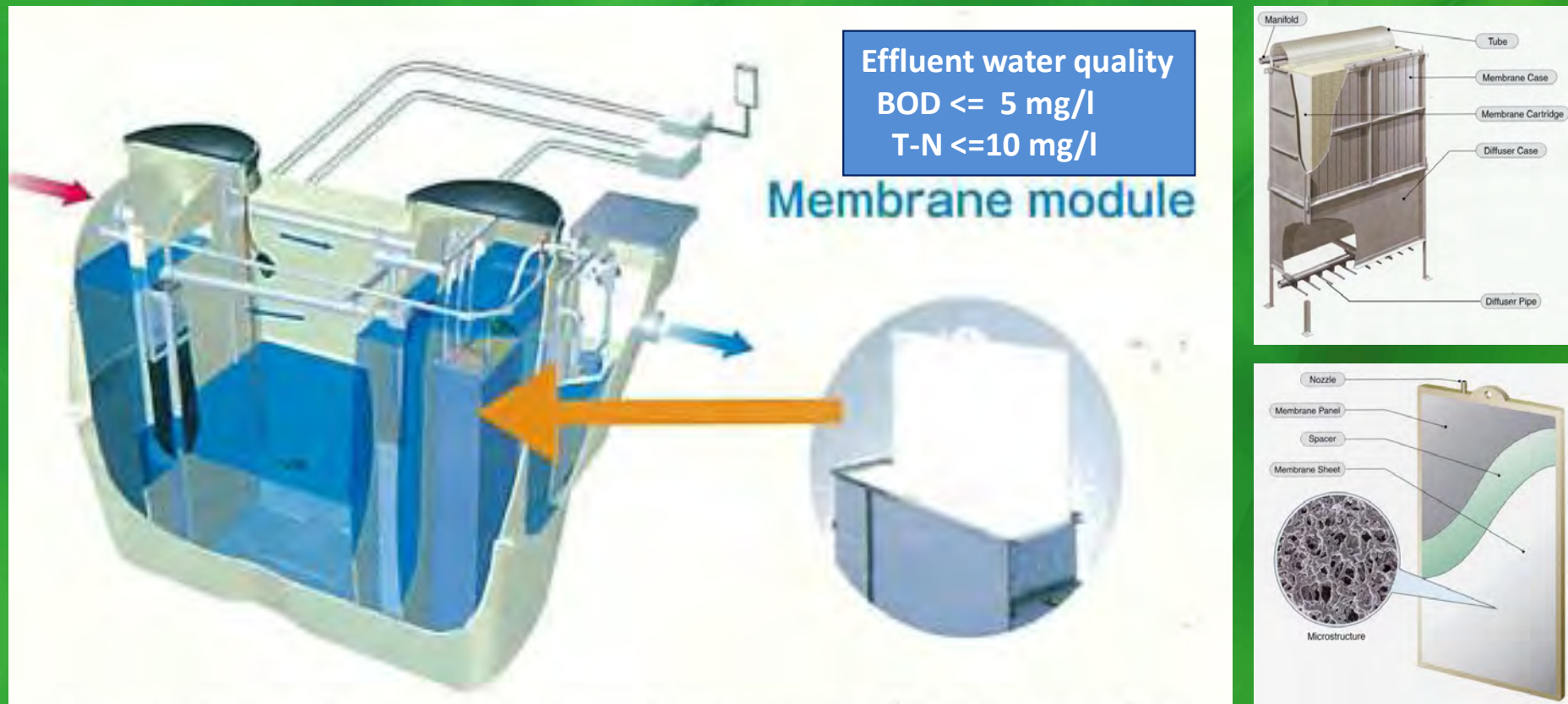
Device for phosphorous removal



## Effluent water quality

BOD  $\leq 10$  mg/L  
T-N  $\leq 10$  mg/L  
T-P  $\leq 1$  mg/L

# A Small-scale Membrane Johkasou

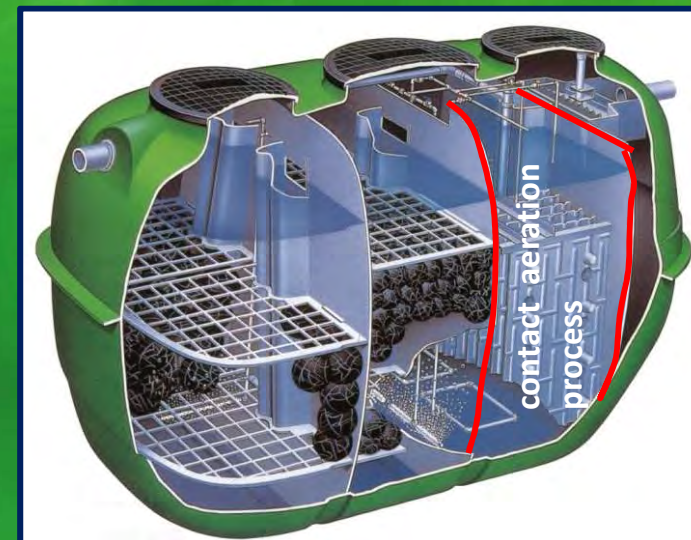


This membrane johkasou could be applied to areas where reuse of treated water is a matter of high priority because of water shortage.



# Innovation of Johkasou Technology

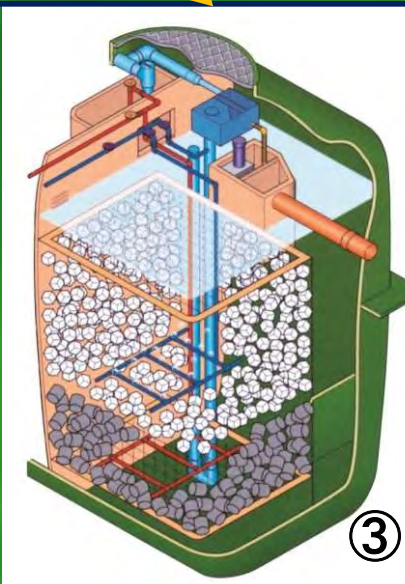
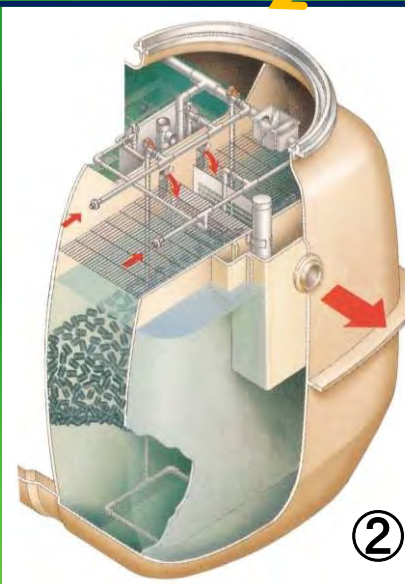
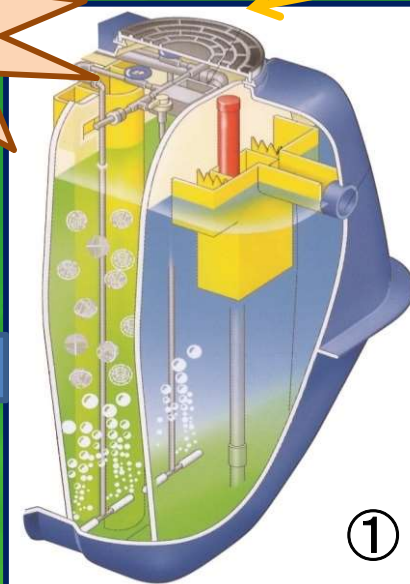
- Downsizing of johkasou by  
Introduction of new biological treatment processes
  - ① Moving bed biofilm process;
  - ② Biofilm filtration process; and
  - ③ Moving bed biofilm-filtration process,instead of traditional contact aeration process



Product of the year 2000:

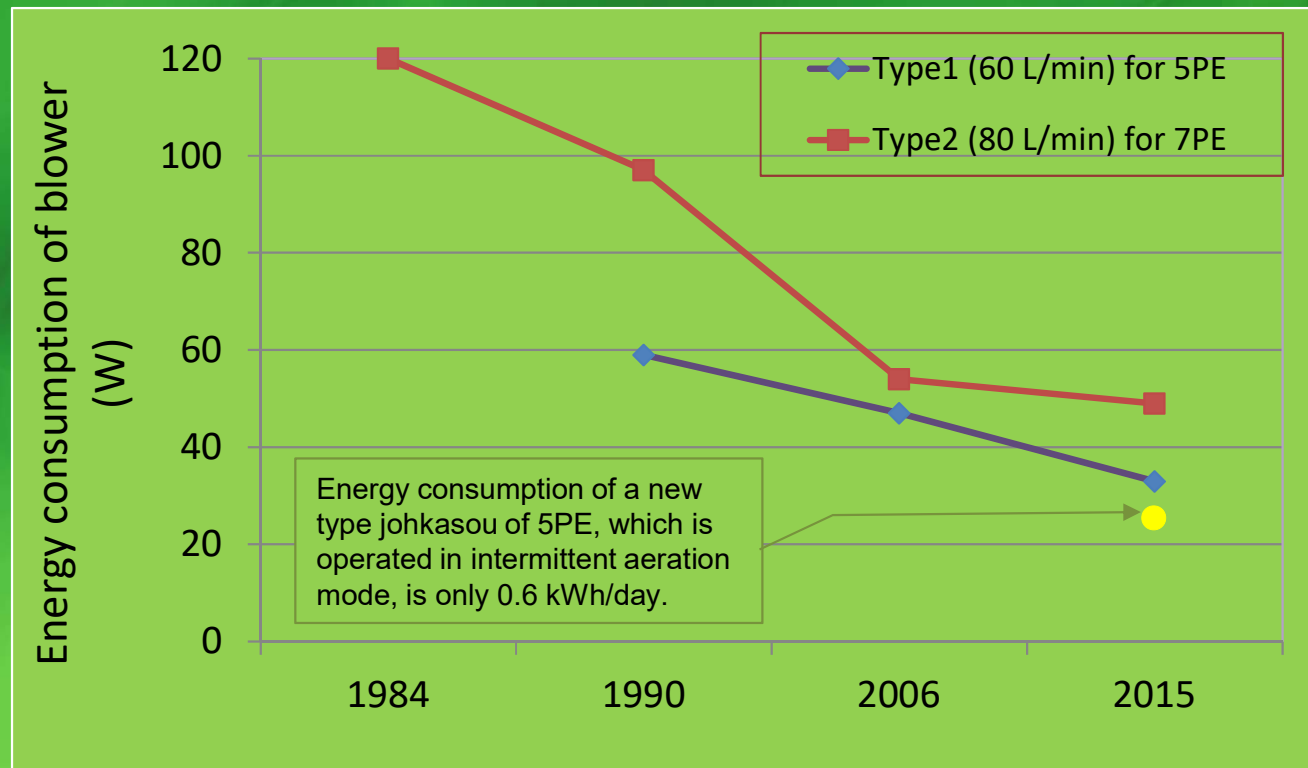
**L 2,790mm; W 1,140mm H 1,750mm**

**64% DOWN  
in space**



# Innovation of Johkasou Technology

- Reduction of energy consumption by
  - ① Development of energy-saving blowers;
  - ② Introduction of intermittent aeration operation





### **3. Legal system and measures for decentralized treatment**

### 3. Legal System for Decentralized Treatment – **Johkasou Act**

#### History of Johkasou Act

1960 to around 1980	With increasing population of flush toilet, rapid installation of tandoku (old type) johkasou to treat black water only
<b>1983</b>	<b>Johkasou Act</b> enacted (legislation introduced by a Diet member, came into force in 1985)
1987	National subsidy program for gappei (current type) johkasou (to treat both black and gray water) established
<b>2000</b>	Revised: New installation of tandoku-shori johkasou systems basically prohibited
2005	Revised: Stricter water quality management systems introduced, defining water quality conservation targets

During high economic growth period, water pollution accelerated.

To promote the spread of gappei johkasou and the replacement of tandoku johkasou systems

#### Purpose of Johkasou Act

Promotion of human waste and gray water treatment by Johkasou for;

- Conservation of water quality in public water area, preservation of the living environment and improvement of public health

#### ⇒Articles in Johkasou Act

- ①Johkasou installation (※related to “Building Standard Law”)
- ②**Operation/maintenance** of Johkasou
- ③**Approval of Johkasou models**
- ④**Johkasou business** for Installation and Operation/Maintenance
- ⑤**Nationally qualified “Johkasou technicians”**
- ⑥Miscellaneous and penalties

### 3. Legal System and Measures for Decentralized Treatment

Ministry of the Environment



General provisions (Articles 1–4): Purpose/definitions

Johkasou installation (Articles 5–7)

Johkasou operations/maintenance (Articles 8–12)

Approval for johkasou desludging vendors (Articles 35–41)



(Articles on waste treatment and desludging)

Johkasou operators (Articles 45–47)

Registration of maintenance and inspection vendors (Article 48)

Miscellaneous provisions (Articles 49–58)

Penalties (Articles 59–68)

Ministry of Land, Infrastructure, Transport and Tourism



(Articles on construction standards)

Approval for types of johkasou (Articles 13–20)

Registration for johkasou construction vendors (Articles 21–34)

Johkasou installers (Articles 42–44)



### 3. Legal System and Measures for Decentralized Treatment

#### Water quality standards (Article 4-1)

##### Technical standards for discharged water quality

- Water discharged from gappei-shori johkasou must have a biochemical oxygen demand (BOD) concentration of 20 mg/L or less
- $(\text{Influent BOD} - \text{effluent BOD}) \div \text{influent BOD} \geq 0.9$ 
  - \* Comparable to the treatment level of modern sewerage treatment plants

(Johkasou Enforcement Ordinance Article 1-2)

- The above regulations were created to reflect current technological standards in light of best available technologies (BAT) or best available techniques not entailing excessive costs (BATNEEC) according to the development and spread of johkasou.



### 3. Legal System and Measures for Decentralized Treatment

#### ▪ Johkasou Installation Procedure

Installation notification (Article 5)



←..... (Certify under the Building Standards Act when necessary)

Construction (Article 6)

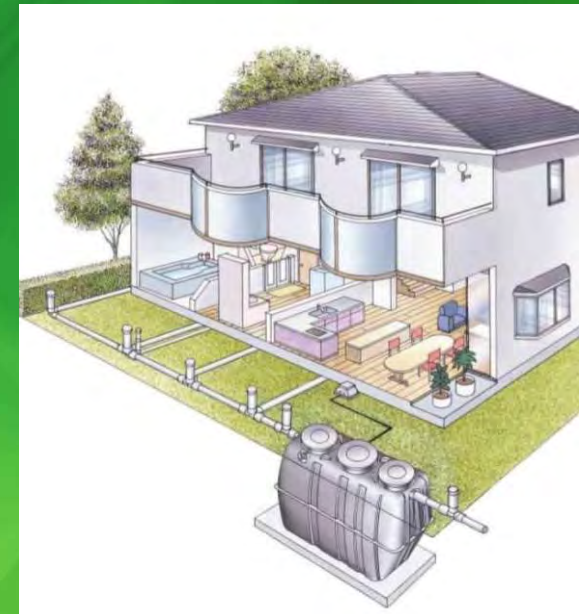


←..... (Can issue administrative recommendations when necessary)

Post-installation legal inspections (Article 7)



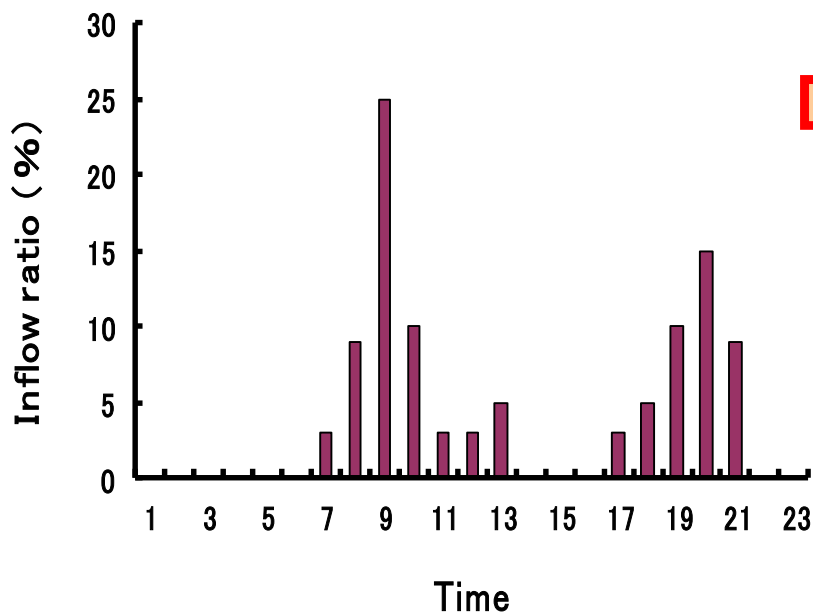
Discontinuance notification (Article 11-2)



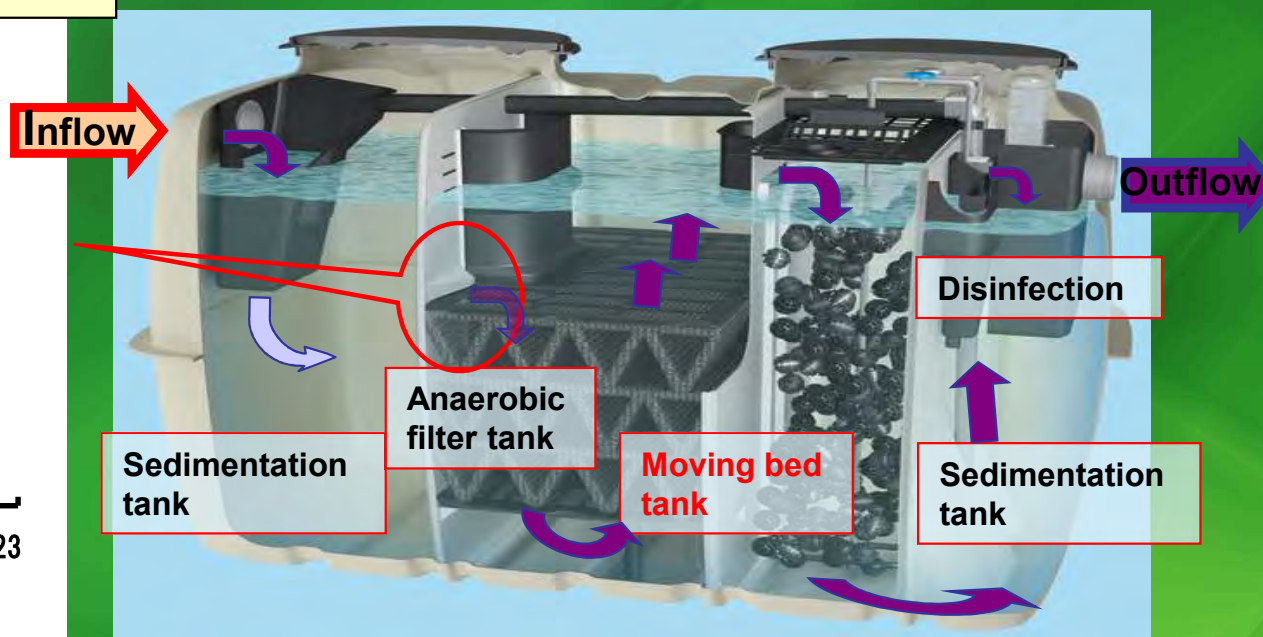
### 3. Legal System and Measures for Decentralized Treatment

#### ▪ Approval process for types of Johkasou (Johkasou Act Article 13)

- Parties intending to manufacture Johkasou in production plants shall obtain approval from the Minister of Land, Infrastructure, Transport and Tourism (MLIT) for the type of Johkasou to be manufactured (does apply to test manufacturing).
- This process is subject to Performance Evaluation System.



Inflow Pattern



Performance Evaluation Type Johkasou

### 3. Legal System and Measures for Decentralized Treatment

- Structural Standard vs Performance Evaluation System

- **Structural Standards for Johkasou**

- Construction Minister (then) stipulated Structural Standards in 1969  
--- treatment methods and performance.

- **Performance Evaluation System**

- Utilizing Performance Evaluation System operated from 2000,  
manufacturers competed for compactness and higher performance.  
Downsizing for home use and technology for higher treatment.

**Initial Type**: 70% downsized-content Johkasou appeared.

- To regulate water level at initial treatment to control flow capacity  
--- additional pump and maintenance of air-lift are necessary.
- Bio-film filtration or Moving bed type for secondary treatment.
- Solid-liquid separation by Bio-film or Moving bed plus automatic **backwash**.  
--- Blower equipped with valve change timer is necessary.



Requested by households with several Johkasou to ease the maintenance, compact Johakasou without flow-control/automatic **backwash**, with only one pipe from blower are on the increase.



### 3. Legal System and Measures for Decentralized Treatment

- Flow of Evaluation System

**Performance Evaluation Test** (approx. 6 months)

... by The Building Center of Japan



Application for Performance Evaluation Test (test result, technical data & drawings)



Evaluation by Special Committee



**Issuance of Performance Evaluation Document**



Approval by the MLIT Minister and for Model Adaptation



Model Approval by Johkasou Act and application for registration (in case for the subsidy of  $\leq 10$  persons)



Put into the market

### 3. Legal System and Measures for Decentralized Treatment

#### ▪ Test methods and Criteria

##### 1) Performance Criteria

BOD[20、15、10、5]、T-N[20、15、10、5]、T-P[2、1、0.5、0.1]  
SS[20、15、10、5]、n-Hex[20、10、5、3]、COD[30、15、10]

##### 2) Test Categories and Duration

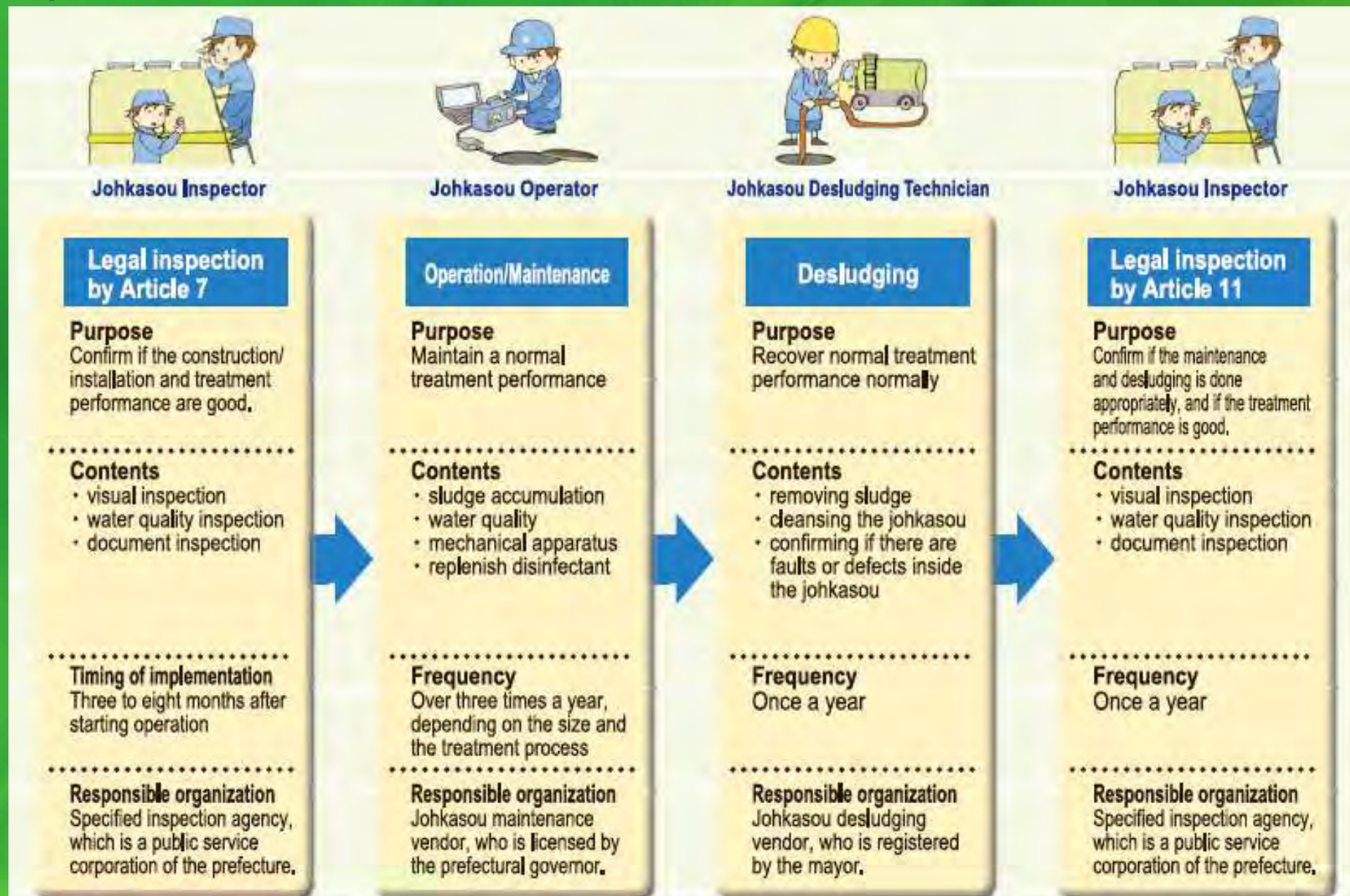
Sludge may be added in case of ①

Category	Test Method	Duration (weeks)	No. of unit	Evaluation Points
①	Short period constant temperature	Breeding - <b>over 16 weeks</b> (13 & 20°C 8 weeks respectively)	1 or 2	Water Quality/Sludge/Management
②	On-site test 1	Breeding + over 48 weeks	1	Water Quality/Sludge/Management
③	On-site test 2	Breeding + over 48 weeks	3	Water Quality/Sludge/Management



### 3. Legal System and Measures for Decentralized Treatment

#### • Inspections and Maintenance





### 3. Legal System and Measures for Decentralized Treatment

- Post-installation water quality inspection (Article 7)

Inspection category	Inspection items	
Visual inspection	▪ Installation status	▪ Usage status
	▪ Operational status	▪ Foul odors
	▪ Water flow	▪ Use of disinfectant
	▪ Mosquitoes, flies, etc.	
Water quality inspection	▪ Hydrogen ion concentration	▪ Chlorine ion concentration
	▪ Sludge settling ratio	▪ Residual chlorine concentration
	▪ Transparency	▪ Biochemical oxygen demand
	▪ Dissolved oxygen	
Document inspection	▪ Pre-usage maintenance inspection record	

- Because essential johkasou functions cannot be confirmed without actually using the equipment, inspections are carried out once those functions are generally up and running. Inspections focus on whether the johkasou is performing the expected treatment functions with the aim of rectifying any deficiencies as soon as possible.

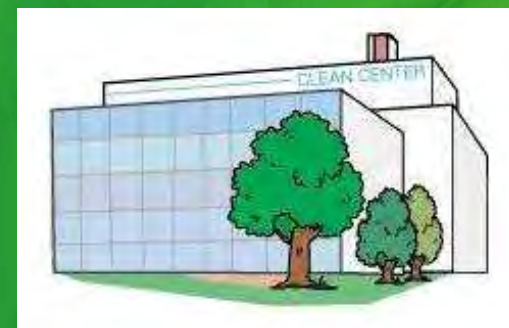
### 3. Legal System and Measures for Decentralized Treatment

#### Sludge collection, transport and treatment (Waste Disposal Act)



Johkasou  
desludging

Collect and  
transport



Night soil (black  
water) treatment  
facility

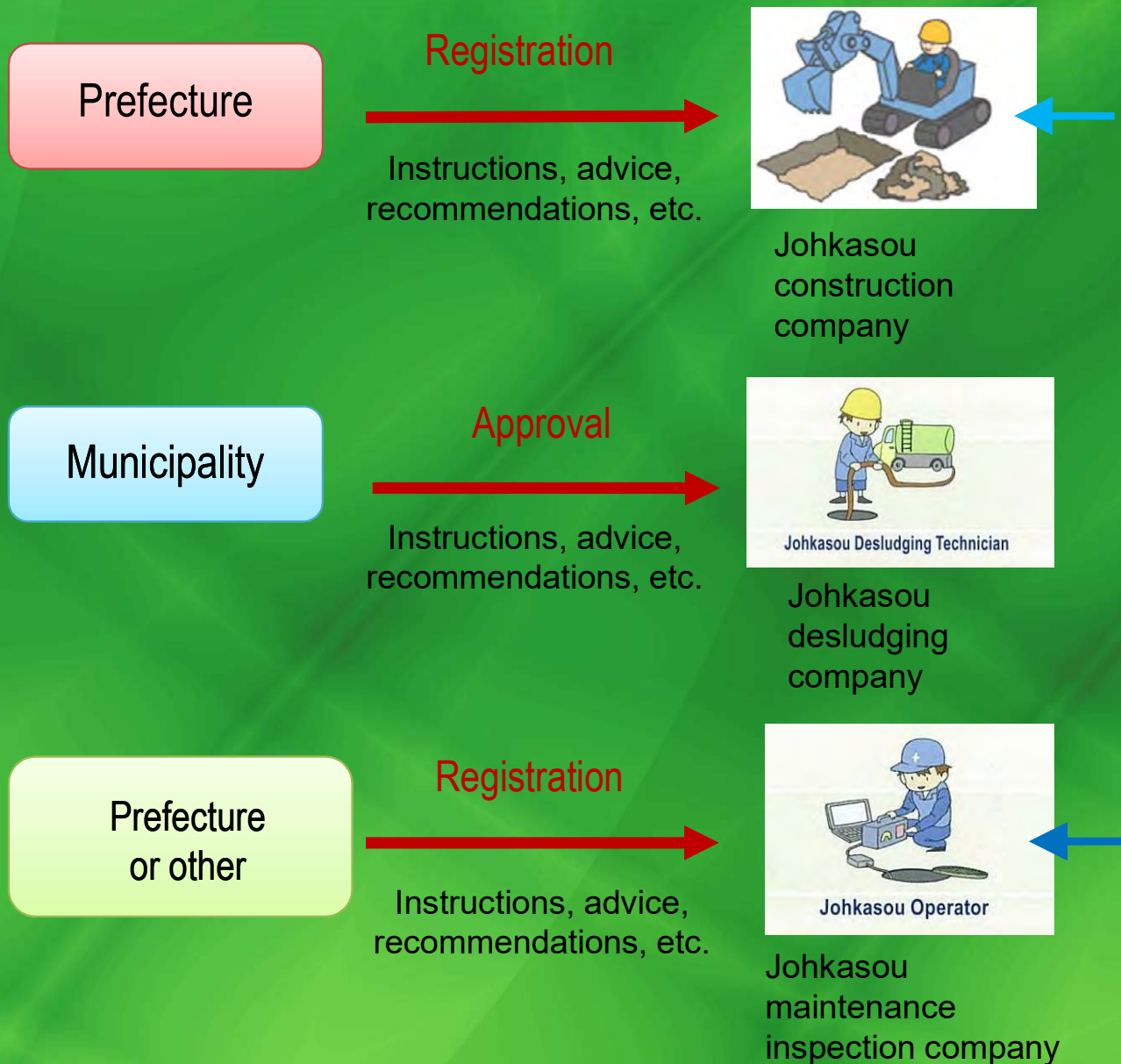
Collection and transport

Municipalities shall, in line with their general waste treatment plans, collect and transport johkasou sludge (general waste) in a manner that poses no threat to the maintenance of healthy living environments or public health, and treat the sludge at a black water treatment facility

(Article 6-2 of the Waste Management and Public Cleansing Act)

### 3. Legal System and Measures for Decentralized Treatment

#### ▪ Johkasou corporate registration process



#### ▪ National qualifications

##### 【Certified Johkasou Installer】

Person certified to supervise johkasou construction



##### 【Certified Johkasou Operator】


Person certified to supervise johkasou construction





### 3. Legal System and Measures for Decentralized Treatment

#### National johkasou qualifications

National qualification	Description	Certifying agency
Certified Johkasou Installer	Person certified to supervise johkasou construction	 <b>MLIT</b> Ministry of Land, Infrastructure, Transport and Tourism
Certified Johkasou Operator	Person certified to carry out maintenance inspections on johkasou	 <b>Ministry of the Environment</b> 環境省 Government of Japan

## 4. Examination/training system for johkasou technicians

# Education history of johkasou technicians

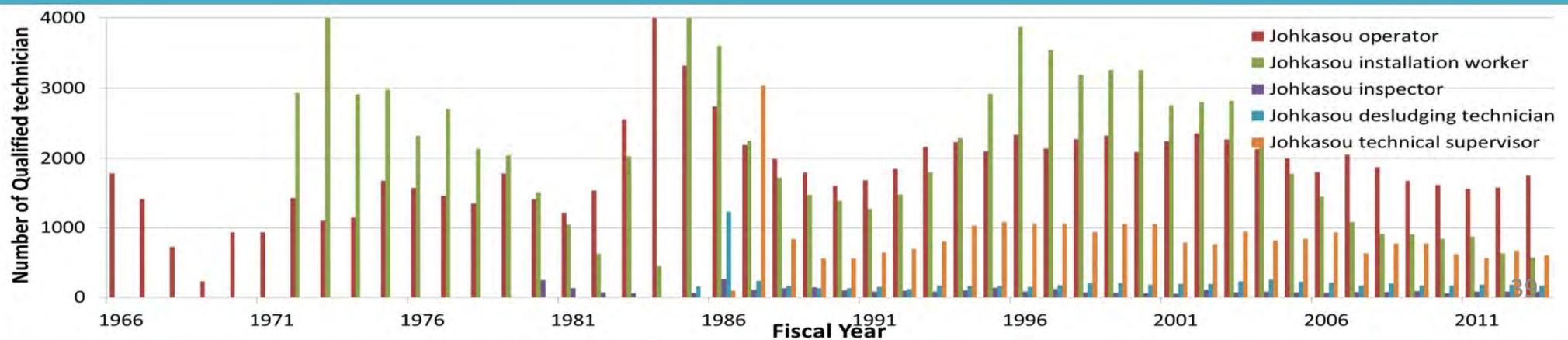
- The spread of johkasou in 1960s resulted in a huge shortage of johkasou technicians, such as installation workers, O&M operators, desludging workers and inspectors.
- To meet the demand for johkasou technicians and establish an education system of johkasou technician as permanent measure, Japan Johkasou Education Center, the precursor of JECES, was founded in 1966, with the support of administrations and johkasou related organizations.
- From then, technical training system for on-site wastewater treatment was established, and it has been developed along with the johkasou industry.





# Education history of johkasou technicians

- When JECES started in 1966, two training courses were launched; A course for O&M technician, and B course for desludging technician. A course for johkasou installation worker in 1972, and a course for johkasou inspector in 1980, were launched.
- The technicians trained through these training courses were succeeded by the Johkasou Act later and were certified as Johkasou Installation Worker, Johkasou Operator, Johkasou Desludging Technician and Johkasou Inspector, respectively.
- When Johkasou Act was enacted in 1983, a new course for johkasou technical supervisor, whom is required by the law for management of johkasou larger than 500PE, was created.
- In 1984 and 1985, national examination for Johkasou Operator and Johkasou Installation Worker started, these two certification can be obtained by passing the examination or by receiving the training course.
- JECES has been conducting the examinations and training courses, and trained various johkasou technicians more than 3000 persons every year, as shown below.



# Features of the training system for technicians of decentralized wastewater treatment

## 1. Position of the certifications in the Act

Johkasou Installation Worker

Article 42(1)(ii), Johkasou Act

Johkasou Operator

Article 45(1)(ii), Johkasou Act

Johkasou Technical Supervisor

Article 10(2), Johkasou Act

Johkasou Desludging Technician

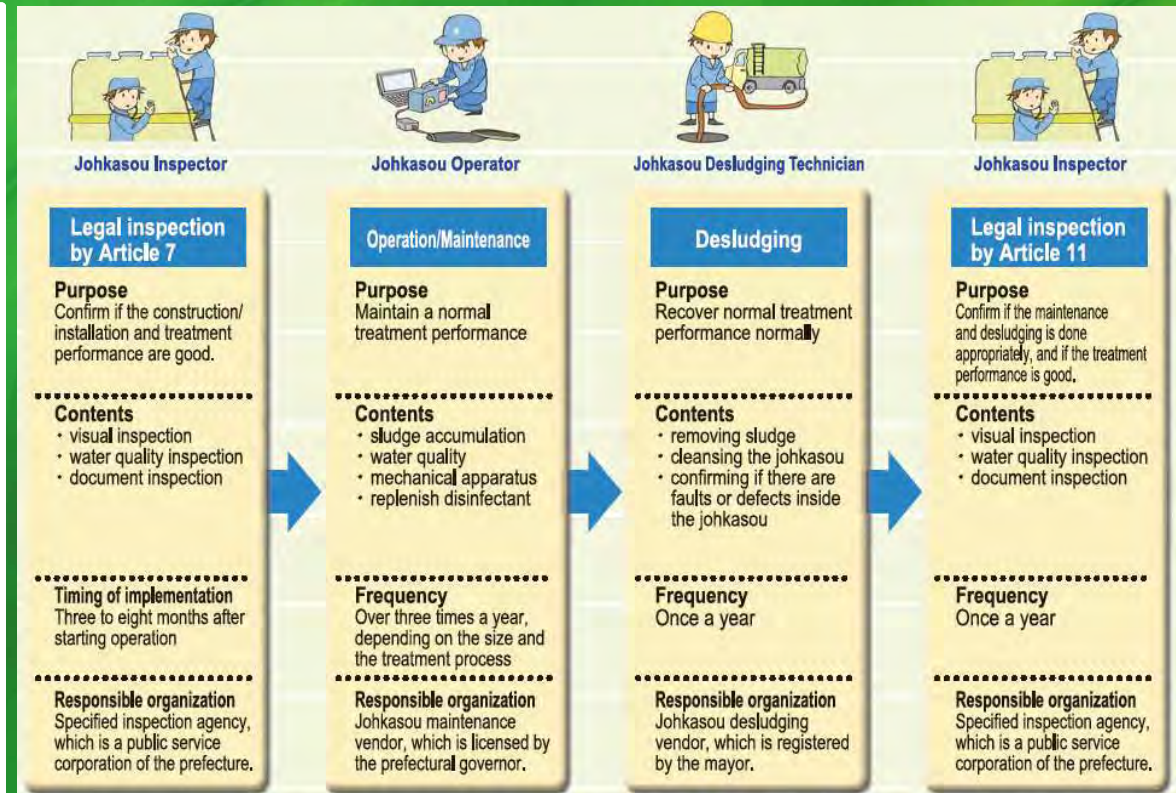
Article 11(iv), Ordinance of Johkasou Act

Johkasou Inspector

Article 5(1)(iv), Ordinance of Johkasou Act

## 2. Business content of the certifications

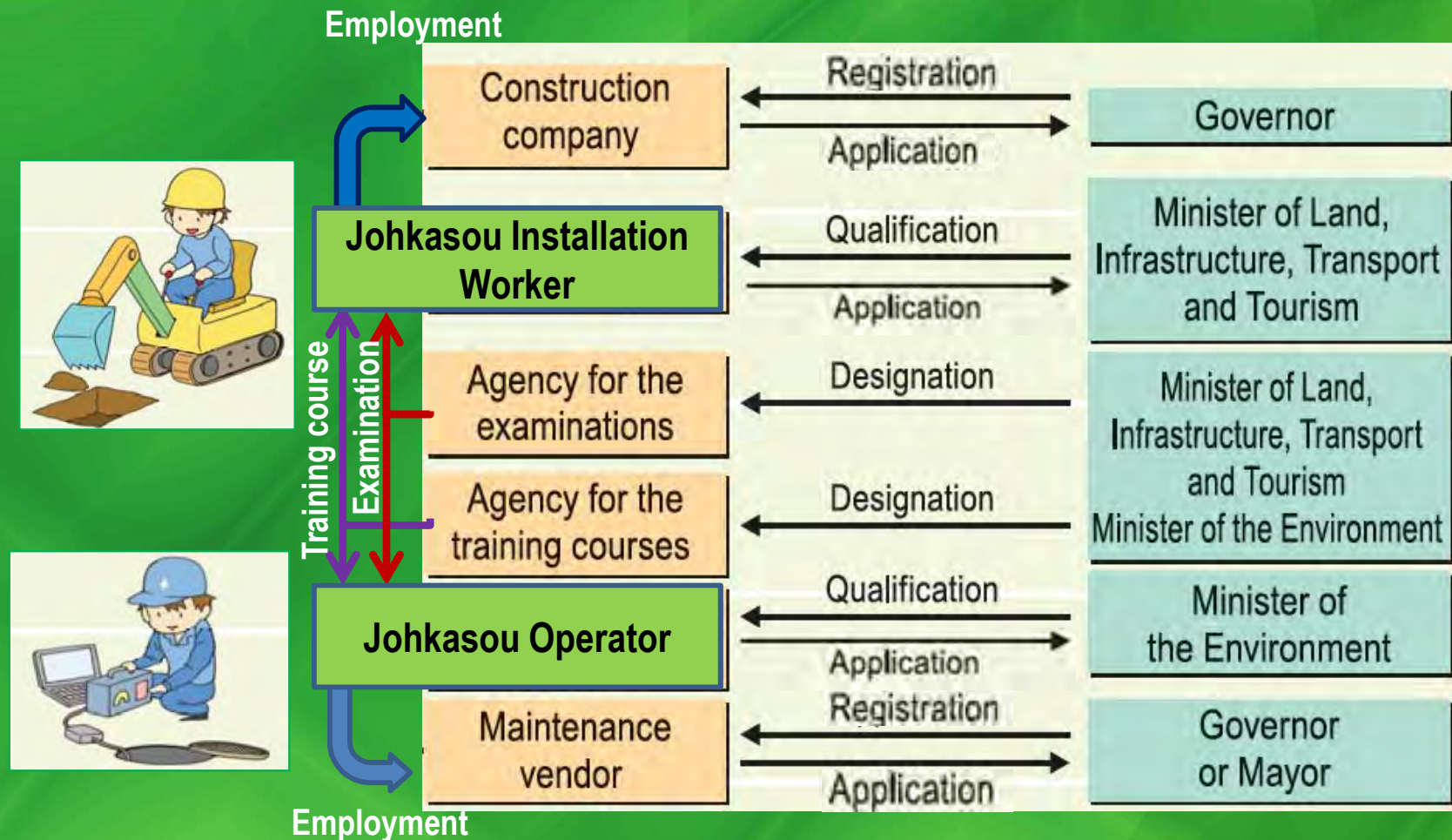
As shown in the right figure.



- These regulations make the certifications to be indispensable for persons who want to join the johkasou businesses, and give incentives to them.
- The certifications could be obtained by receiving training courses or passing national examinations.
- This training and certification system has played an essential role to enhance the technical level of johkasou technicians, and contributed to the appropriate spread of johkasou.



# Features of the training system for technicians of decentralized wastewater treatment



Procedures and relations of johkasou operator/johkasou installation worker in Johkasou A



# Features of the training system for technicians of on-site wastewater treatment

## Feature 3 : Working-level contents of curriculums for johkasou businesses

- Johkasou technicians should be equipped with extensive knowledge on not only wastewater treatment/johkasou, but also water environment conservation and public health.
- Curriculums for johkasou operator and johkasou installation worker are as shown below

Johkasou operator		Johkasou installation worker	
➤ Fundamental of johkasou	8 H	❑ Fundamental of johkasou	8 H
➤ Laws and regulations related with johkasou	4 H	❑ Laws and regulations related with johkasou	3 H
➤ Structure and function of johkasou	22 H	❑ Structure and function of johkasou	15 H
➤ Introduction to installation of johkasou	4 H	❑ Management of johkasou installation	8 H
➤ Operation and maintenance of johkasou	30 H	❑ Introduction to O&M and desludging of johkasou	3 H
➤ Water quality management of johkasou	10 H		
➤ Introduction to desludging of johkasou	2 H		
		Total	37 Hours
Total	80 Hours		



# Features of the training system for technicians of decentralized wastewater treatment

## Feature 4 : Follow-up to johkasou technicians and continuing professional development

- **Support the johkasou technicians by providing updated technical information on johkasou, and give them appropriate advices on johkasou O&M**

Publication of monthly journal JOHKASO and books related johkasou technology/ administration

Holding a national conference on johkasou technology, johkasou technicians and other stake-holders coming together

for exchanging information and discussing issues on johkasou businesses.

- **Seminar courses for CPD of johkasou technicians**

Special seminar for johkasou desludging workers

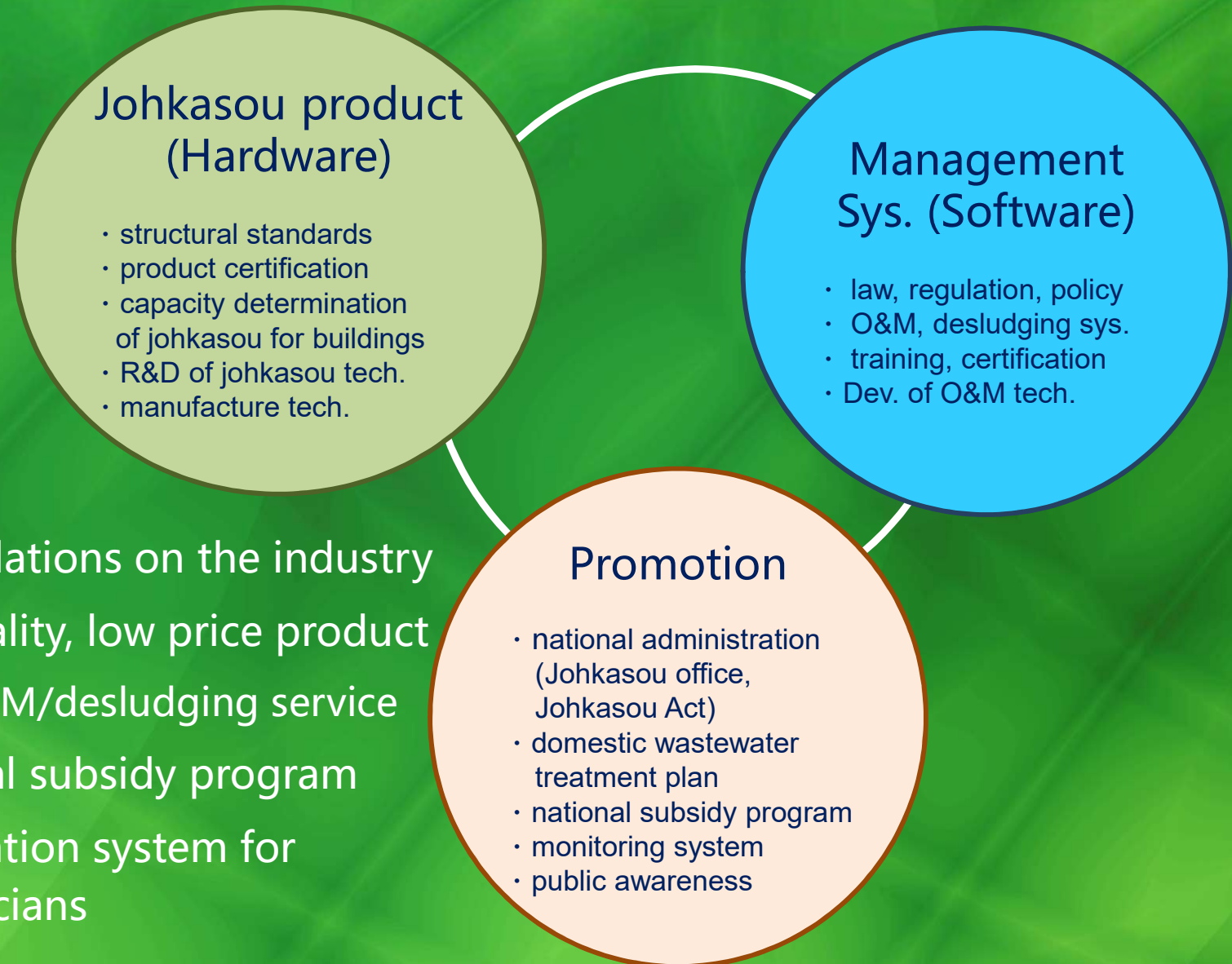
Special seminar on installation management of johkasou

Special seminar on O&M of compact type johkasou

Special seminar on desludging practice of compact type johkasou



# 5. Japan's experience on decentralized domestic wastewater treatment



- Strengthen regulations on the industry
- Provide high quality, low price product
- Provide good O&M/desludging service
- Establish national subsidy program
- Training/certification system for johkasou technicians