Current Status of Combined Sewer System in Japan

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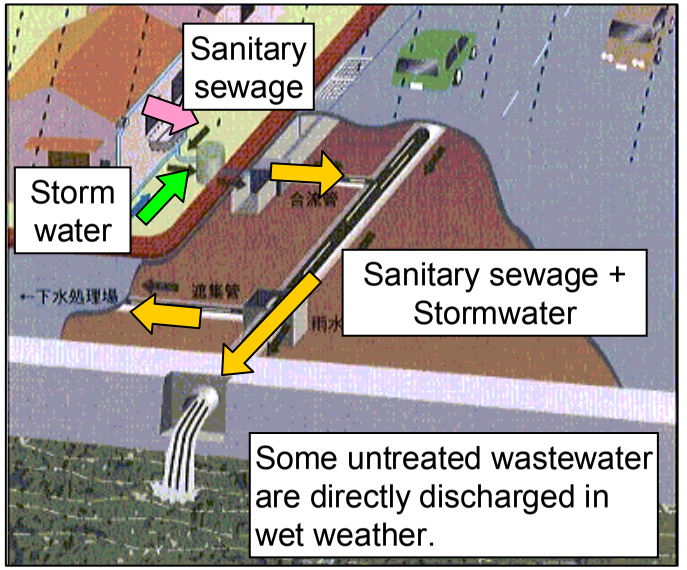
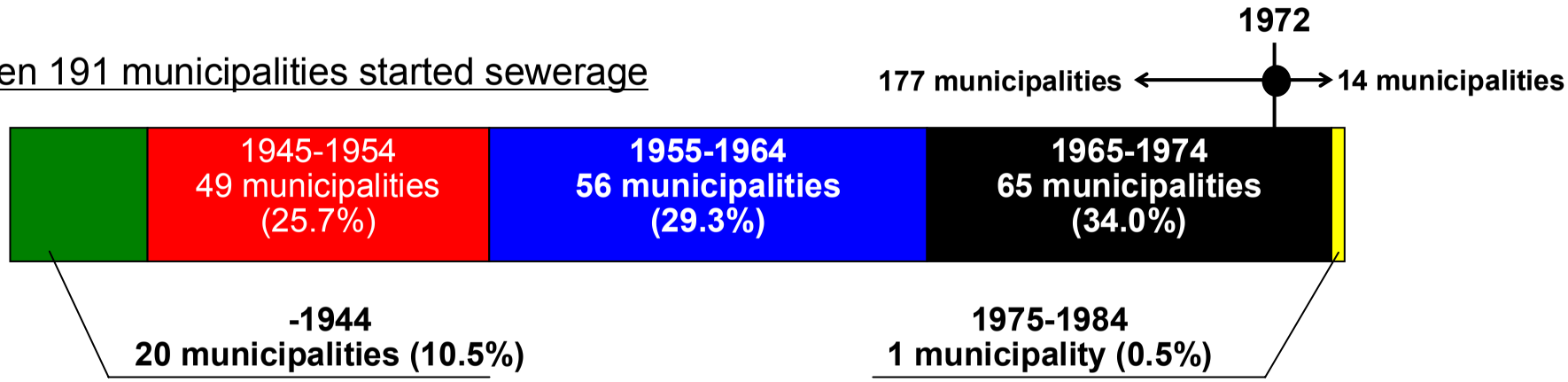
1.Current status of combined sewer systems

- 191 municipalities : 10% of all municipalities with sewerage system (about 1500 municipalities).
- 230,000ha: 20% of all areas served by sewerage (about 1,400,000 ha)
- 30%: 30% of all population served by sewerage

Image of combined sewer systems



When 191 municipalities started sewerage

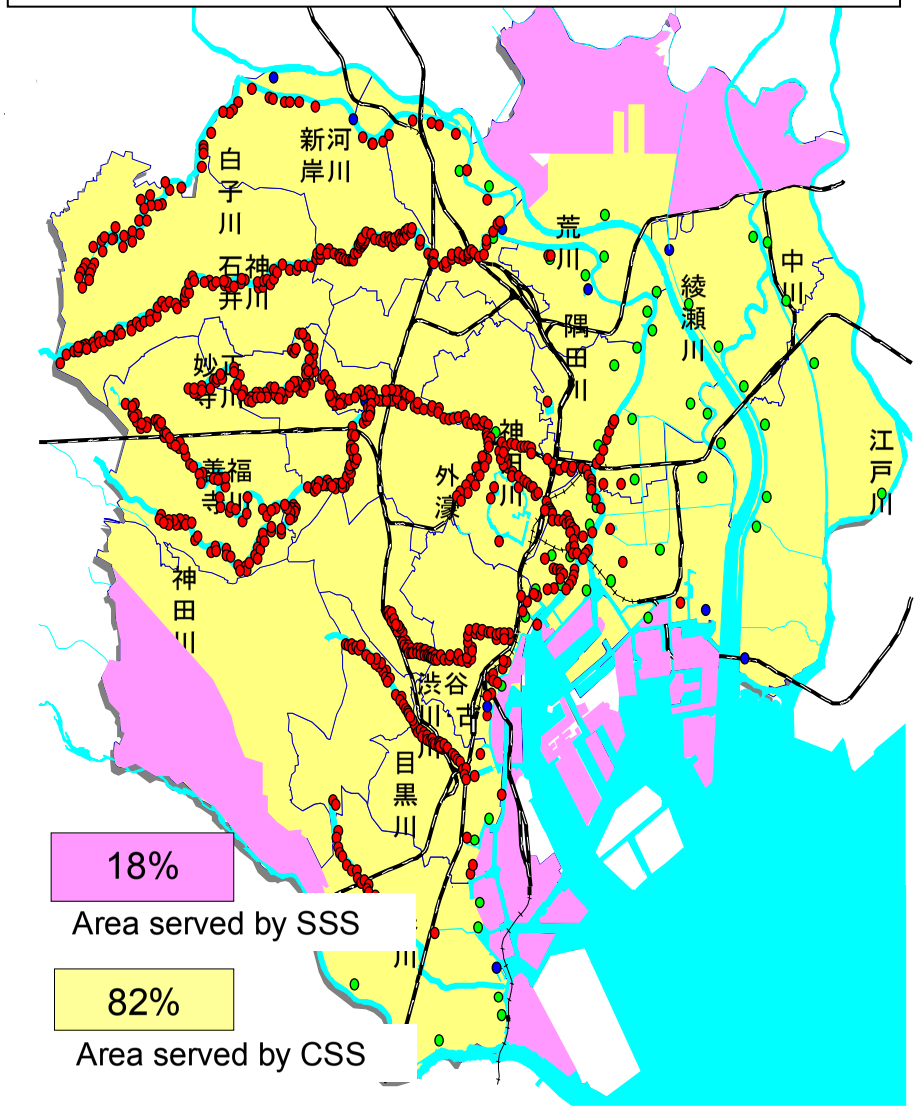


[Note] "Design Guideline of Sewerage Facility" amended in 1972 prescribes adoption of separate sewer system in principle.

Status of outfalls

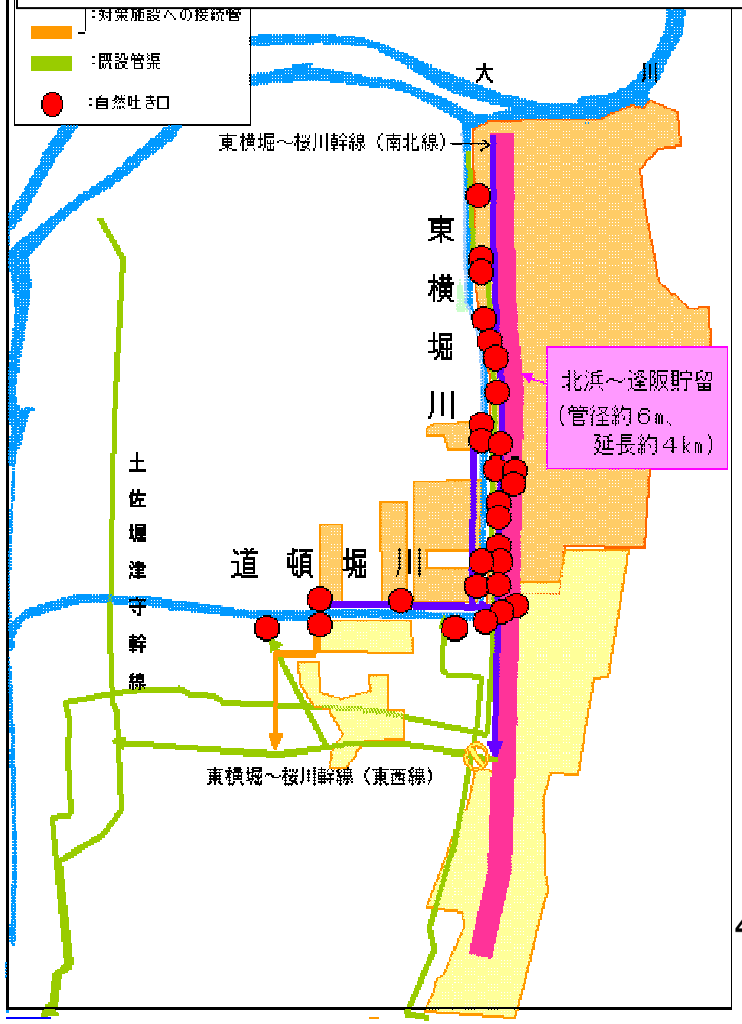
Tokyo Ward Area

Around 800 outfalls with annual 30 overflows



Dotonbori River and Higashi-yokobori River in Osaka

28 outfalls (114 outfalls in Osaka City with around 70 overflows in around 85 rainfalls events in a year)



2. Regulation for combined sewer overflows abatement

Water pollution caused by CSO

- Untreated wastewater overflowing into public water body in wet weather has been causing troubles of water pollution and public health.
- In CSSs, during rain, the discharge of untreated wastewater containing Oil Balls is becoming a social issue.

Overflow of Untreated Wet Weather Flow
未処理汚水の放流状況

Scenery in Fine Weather
晴天日

Scenery in Rainy Weather
雨天日

Oil Balls
オイルボール

Oil Balls Drifted Ashore in Odaiba Seaside Park
お台場に漂着したオイルボール（白色固形物）

Source : Sewage Works in Japan 2004 (Japan Sewage Works Association)

→ It is necessary to improve the combined sewer systems urgently

Amendment of “Enforcement Ordinance of Sewerage Law” related to CSOs abatement in 2003

Structure standards for outfalls [Article 5-5]

✓ In order to meet effluent water quality standards, equipment of weir with appropriate height and other measures shall be taken.

✓ In order to minimise overflow of debris, equipment of screen and other measures shall be taken.

Effluent water quality standard when rainfalls have great influence [Article 6]

✓ Ratio of sum of effluent pollution loads to that of effluent overflow volumes from each outfall shall be
BOD 40mg/l or less.

Application of structure standards and effluent water quality standard [Supplementary provision articles 2 and 5]

✓ Structure standards to be applied since 2013,
except drainage areas of 1,500 ha or more (5,000 ha or more in case connected to regional sewerage) where applied since 2023.

✓ Provisional effluent water quality standard of BOD 70mg/l or less is applied until structure standards starts to be applied.

Establishment for Improvement Works

- ✓ “Guideline and Explanation for CSO Control” (2002)：

  Japan Sewage Works Association

- ✓ “CSO monitoring manual”(2003)：

  Japan Institute of Wastewater Engineering Technology

- ✓ “Urgent Subsidy for CSS improvement” (2002)：
- ✓ “CSO urgent improvement plan” (2005)：

  Ministry of Land, Infrastructure and Transport

Obligation to control CSOs by amendment of "Enforcement Ordinance of Sewerage Law"

The Enforcement Ordinance prescribes completion of CSO control projects within 10 years in principle, in consideration of importance and urgency of the control.

[1] Term of CSO control projects

Complete projects within **10 years (2004-2013),** 20 years (2004-2023) in large municipalities, in principle.

[2] Goal of CSO control projects

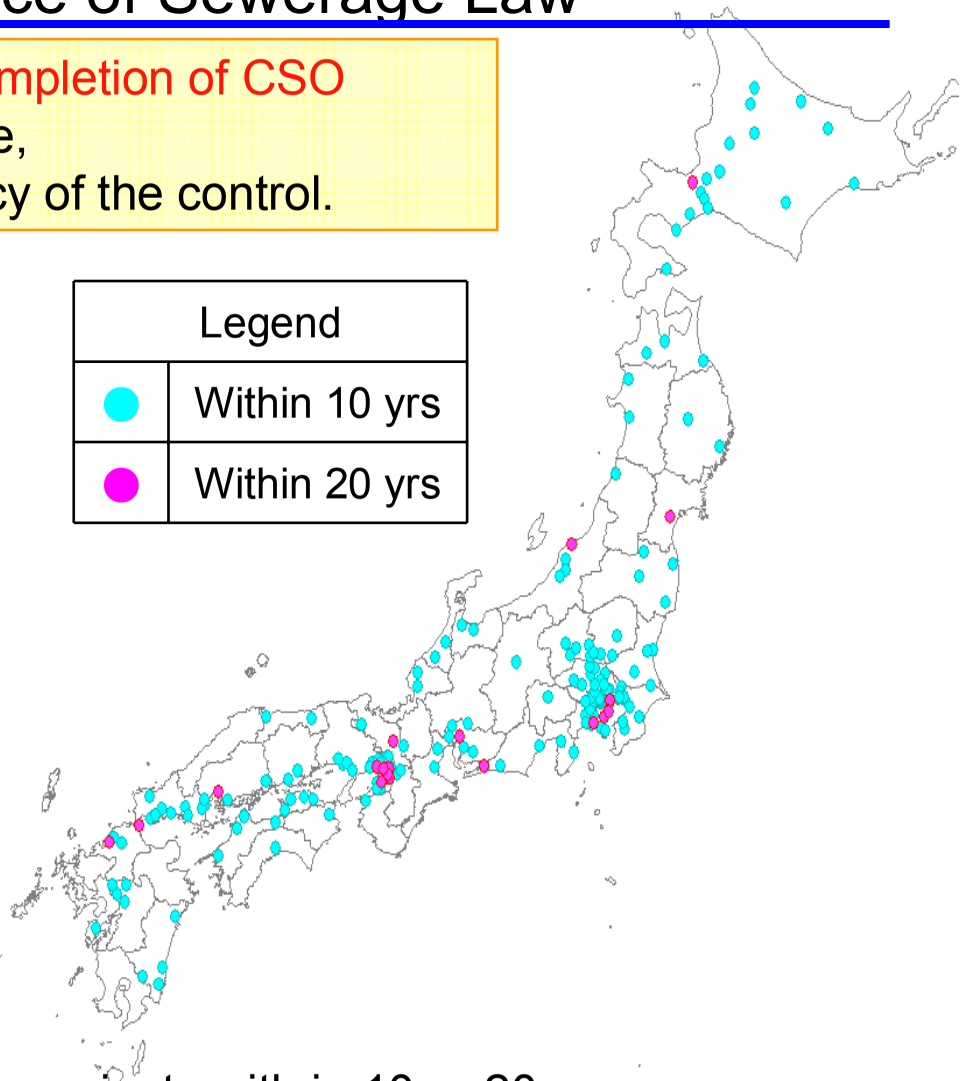
i) Reduce discharged pollution

ii) Halve frequency of untreated wastewater overflow

iii) Reduce overflow of debris

[3] Nationwide goal

Ratio of CSO control achievement: 17% (2004) → around 70% (2013)



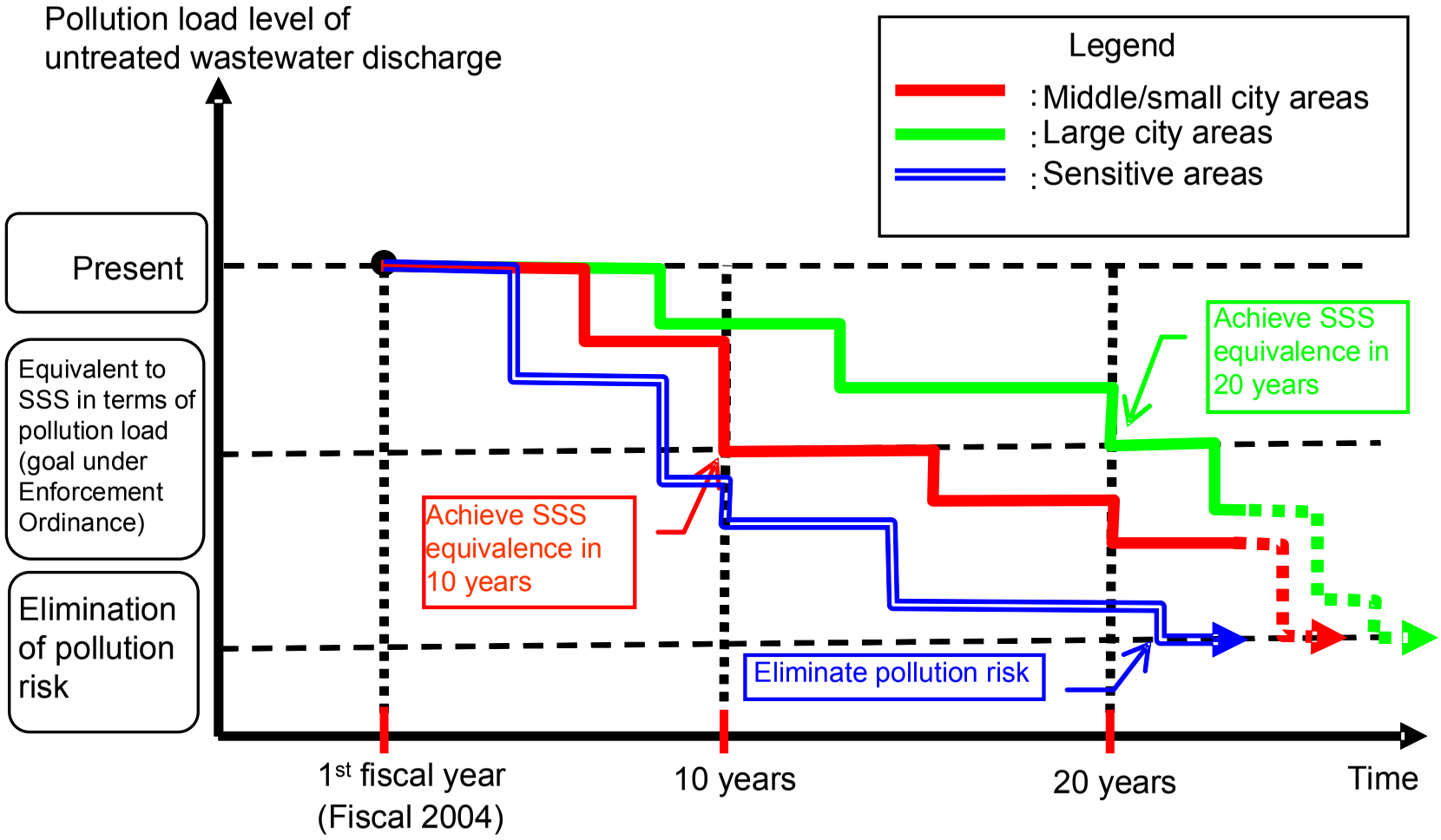
No. of municipalities to complete projects with in 10 or 20 years as prescribed in the Enforcement Ordinance.

Within 10 years: 170	Within 20 years: 21

CSO control goals

In future, aim to eliminate pollution risk by untreated wastewater in all areas, in order to avoid wet weather water quality risk by combined sewer systems.

Image of pollution load reduction related to CSO control projects



Phased approach of various control measures to reduce untreated wastewater discharge, such as stormwater reservoir for pollution control/flood control, and partial separation.

The goals of the plan

①Reduce pollutant loads from the CSSs to less than equivalent amount of pollutant loads from the separate sewer systems.

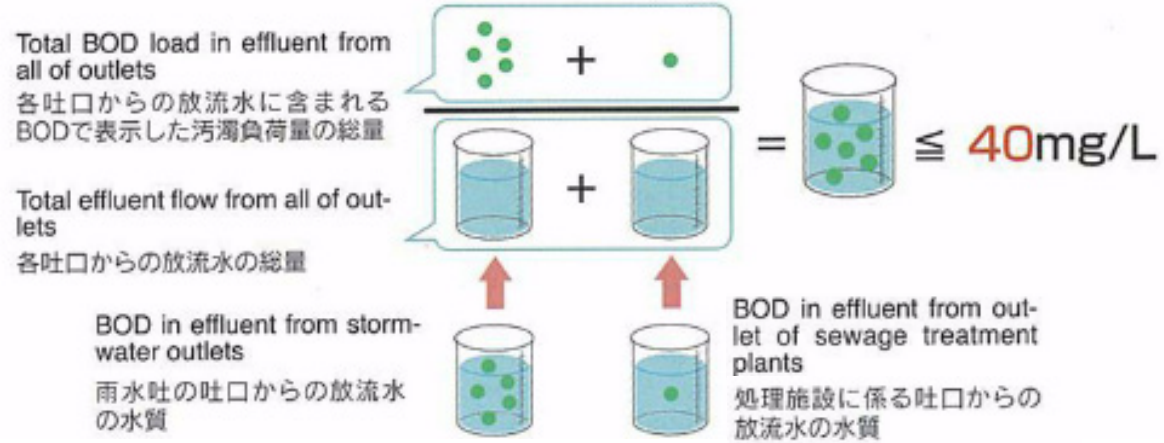


Figure. Water Quality Standard for Combined Sewer System Stipulated by the Sewerage Law

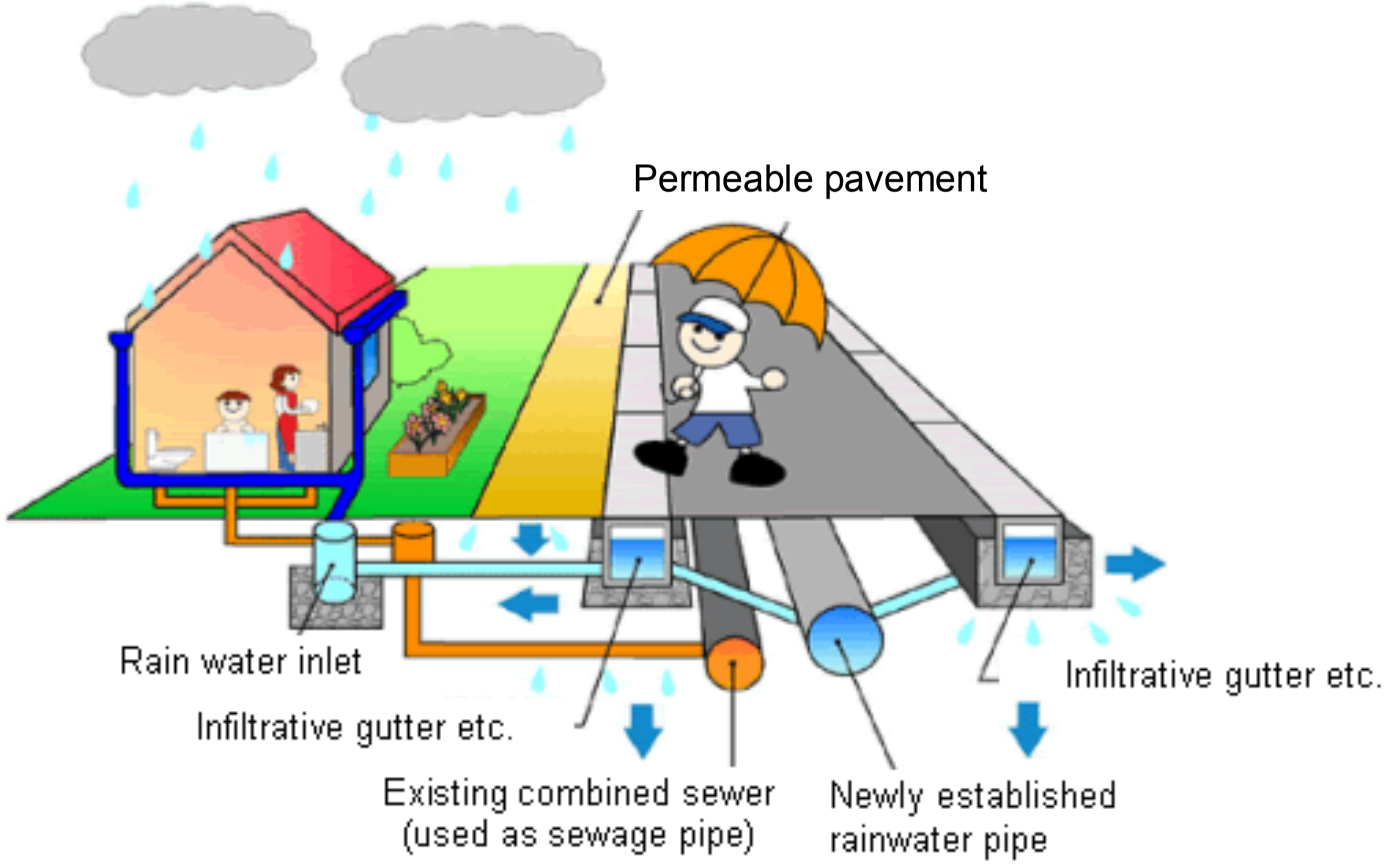
Source : Sewage Works in Japan 2004 (Japan Sewage Works Association)

②Halve the number of times of untreated wastewater overflow from stormwater outlet.

③Prevent debris overflow from stormwater outlet.

3. Control measures for CSOs abatement

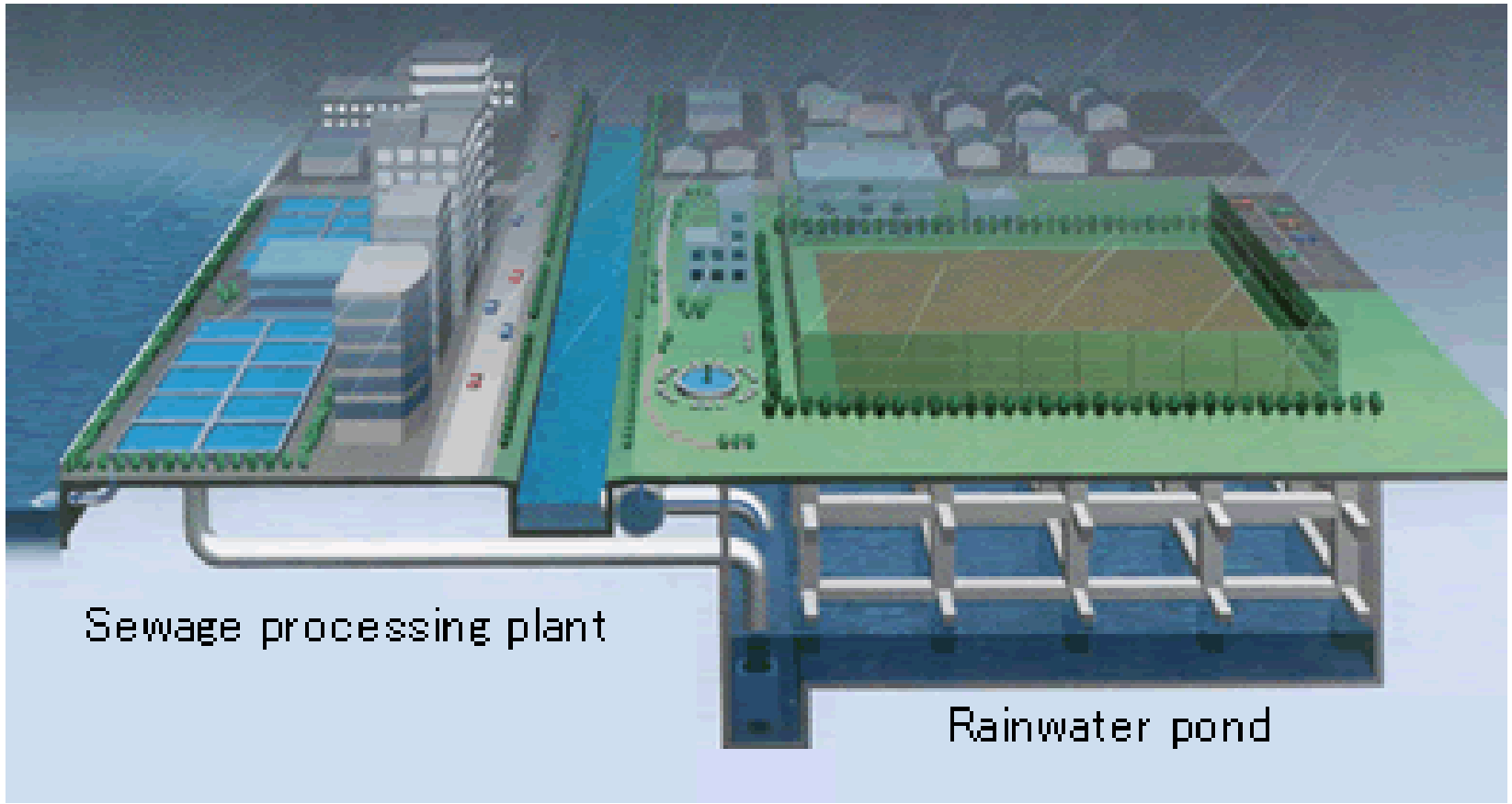
Control measure [Structural]



Construction of infiltration facility (inlet, gutter, pavement, etc.) and application of separated sewer system

Source : Homepage of Sewerage and Wastewater Management Development, Ministry of Land, Infrastructure, Transport and Tourism

Control measure [Structural]



Construction of retention facilities (Rainwater pond, etc.)

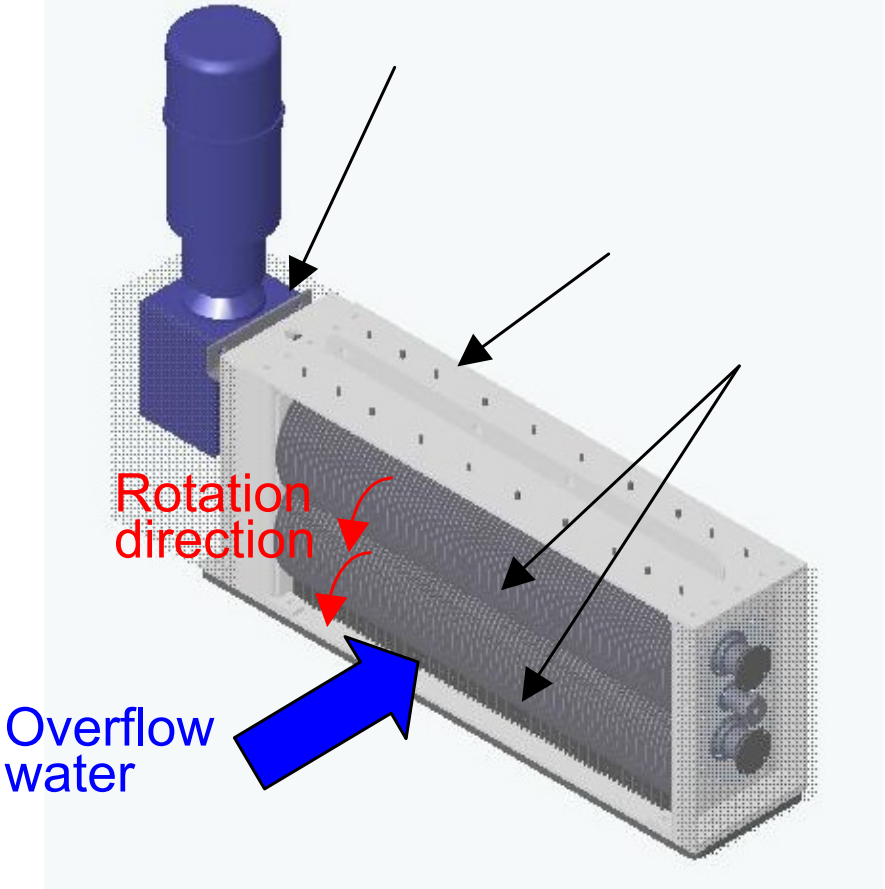
Source : Homepage of Sewerage and Wastewater Management Development, Ministry of Land, Infrastructure, Transport and Tourism

SPIRIT21

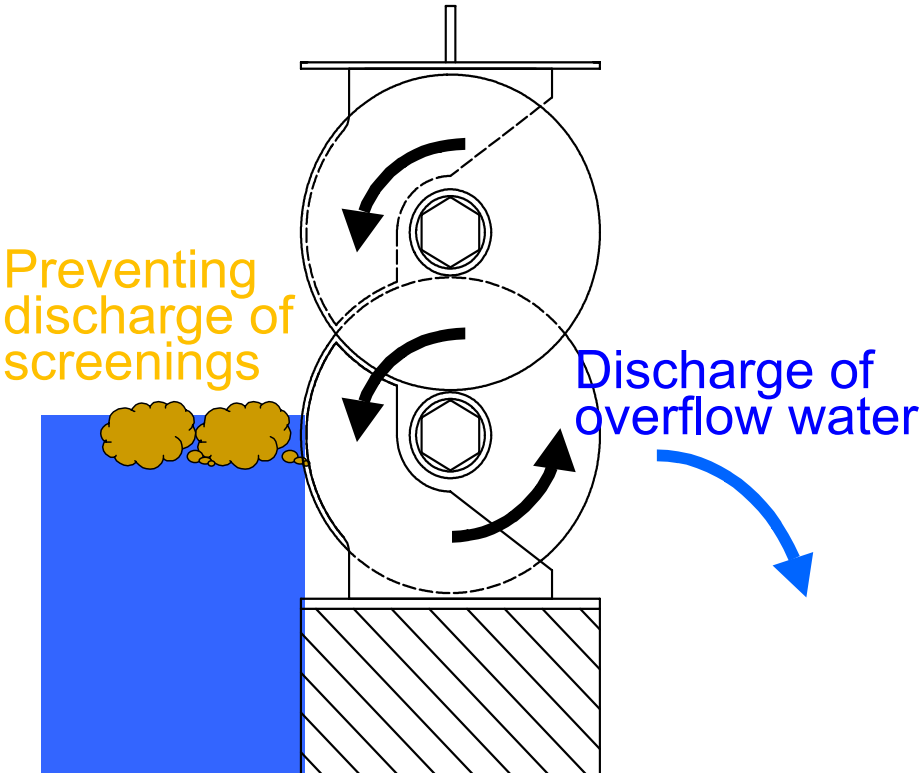
- To develop appropriate technologies for sewage works, MLIT initiated a project called “Sewage Project, Integrated and Revolutionary Technology for the 21st Century”, or SPIRIT 21.

- As the first theme, the project conducted research during 2002-05 in the following areas of CSO treatment and instrumentation.

➢Disc Screen

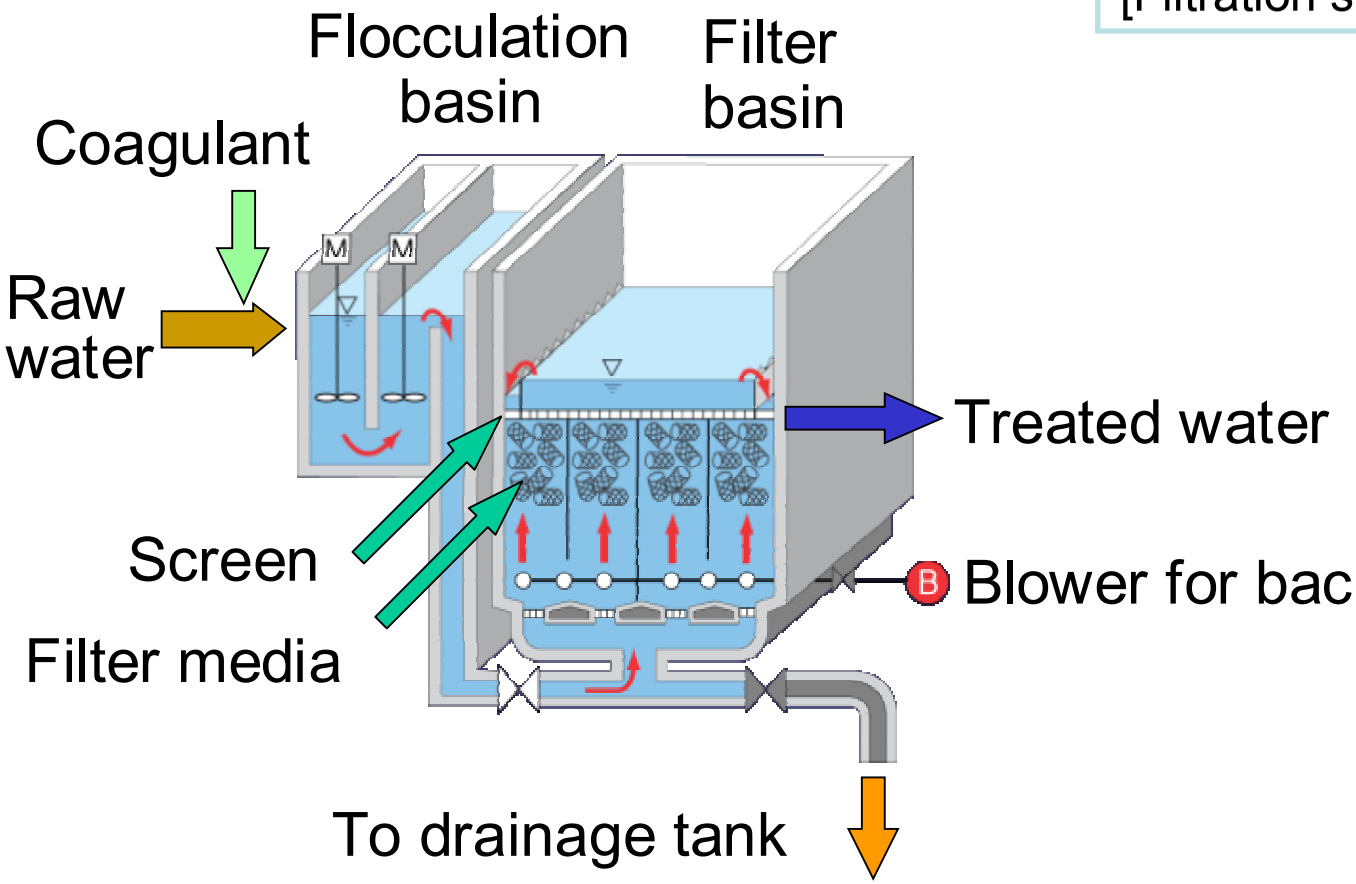


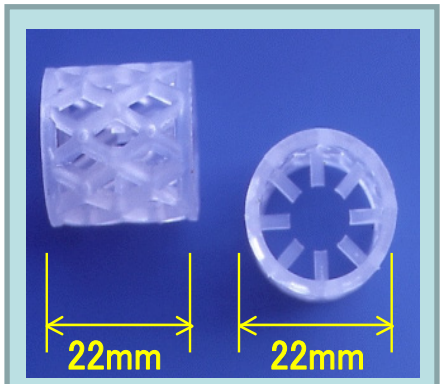
[SRV] 82% Kyoto city



➢High Rate Filtration Process

10times theat of conventional stormwater settling tanks
[Removal] >70%(SS)
>50%(BOD)
[Filtration speed] 1000m/day





Filter media

Development and Evaluation of CSO control technologies SPIRIT21

Technology category	No.	Technology	Technology proposed by	Site City
Debris Removal (Screen)	1	Hydroclean Brush Screen	KUBOTA	Osaka
	2	Rotamat RMK1 Screen	Nishihara Env. Tech.	Tomakomai
	3	CSO Screen	Sanki Eng., NIPPON STEEL, Nihon Inka, JFE Eng., Hitachi Plant Eng.	Sendai
	4	Disc Screen	Hitachi Kiden	Kyoto
	5	Storm Screen	Hitachi Kiden	Kyoto
	6	Ultra Fine Screen using perforated panel with tapered holes	Ataka Const. Eng., Kobelco, Hitachi Plant Eng., Maezawa	Nishinomiya
	7	The Copa Raked Bar Screen	Mitsubishi Kakoki	Chiba
	8	Rotary Screen	ISHIGAKI	Higashi Osaka
High Rate Filtration	9	Wet-weather high-speed wastewater filtration system	NGK INSU.	Yokohama
	10	High-Rate Filtration with a Synthetic Media	Mitsui Eng. Ship.	Kawasaki
	11	CDS Screen and the high-rate filtration method using specially-processed fibers of a material.	TSUKISHIMA, UNITIKA	Kyoto
	12	Super-High-Speed Fiber Filtration for Untreated Combined Sewage Water Overflow on Rainy Days	ISHIGAKI, Kurita, Kobelco, Sanki, Sumitomo Hvy Ind., Hitachi Plant Eng., Maezawa, NIPPON STEEL	Okayama
	13	High Rate Filtration Process	Hitachi Plant Eng.	—

Development and Evaluation of CSO control technologies SPIRIT21

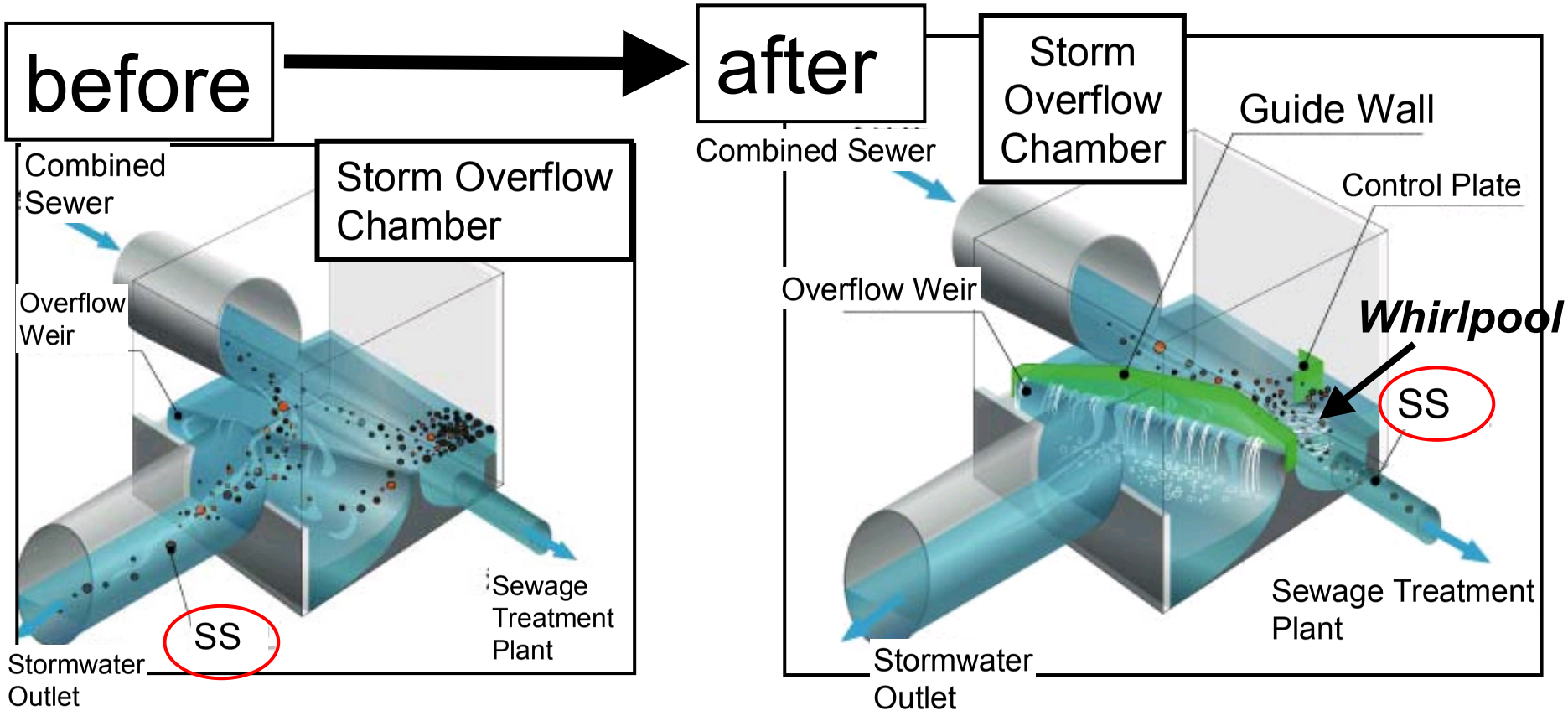
Technology category	No.	Technology	Technology proposed by	Site City
Coagulation/ Separation	14	ACTIFLO PROCESS	EBARA, Nishihara, Hitachi Plant Eng., Maezawa	Fujisawa
	15	High Rate Coagulation System using CDS Screen(FSS System)	Ataka, TSUKISHIMA	Kawasaki
Disinfection	16	Effective disinfection system with chlorine dioxide	KUBOTA	Tokyo
	17	CSO DISINFECTION SYSTEM BY MEDIUM-PRESSURE UV LAMPS	TSUKISHIMA	Kawasaki
	18	Rapid Disinfection of Combined Sewer Overflow using Chlorine Dioxide	JFE Eng.	Yokohama
	19	Rapid Disinfection Technique Using High Concentration Ozone for Combined Sewer Overflow	Mitsubishi Elec.	Yokohama
	20	BCDMH Disinfection	EBARA	—
	21	The economical ozone disinfection system by using ozone adsorbing technology	SHOWA ENG.	Hiroshima
	22	Ultraviolet disinfection system	Nishihara	Tokyo
Measurement/Control	23	Organic pollutant monitor(UV meter)	MEIDENSHA	Chiba
	24	Automatic coliform counter	MEIDENSHA	Chiba

Development and Evaluation of CSO control technologies SPIRIT21

at the end of August, 2010

Technology category	Conventional technology	Evaluation results (general)	Number of places employed	Unit number employed
Debris Removal (Screen)	○Debris smaller than bar space cannot be removed.	○60 to 100% of debris larger than 5.6mm (unpleasant for scenery) can be removed.	267	312
High Rate Filtration	○Approximately 30% of BOD and SS can be removed by primary sedimentation. ○Design surface loading is about 150 to 300m^3/m^2・day.	○30 to 70% or more can be removed for SS with filtration velocity of 1,000 to 3,000 m/day. ○Removal of BOD and debris has been identified.	9	11
Coagulation/ Separation	○Approximately 30% of BOD and SS can be removed by primary sedimentation. ○Design surface loading is about 150 to 300m^3/m^2・day.	○60 to 75% or more can be removed for BOD and 80% or more for SS. ○80% or more can be removed for T-P. ○Removal of COD and N has been identified.	5	6
Disinfection	○It is impossible to deal with large fluctuation of flow rate and water quality. ○Design detention time for chlorination is 15 minutes.	○The standard for coliform group count, 3,000cm^3, can be achieved with one-third (5 minutes) or less disinfection.	10	35
Measurement/ Control	○It is impossible to deal with large fluctuation of water quality of discharge on rainy days.	○SS, COD and coliform group count can be measured automatically and consecutively in short time.	0	0
Sum total			291	364

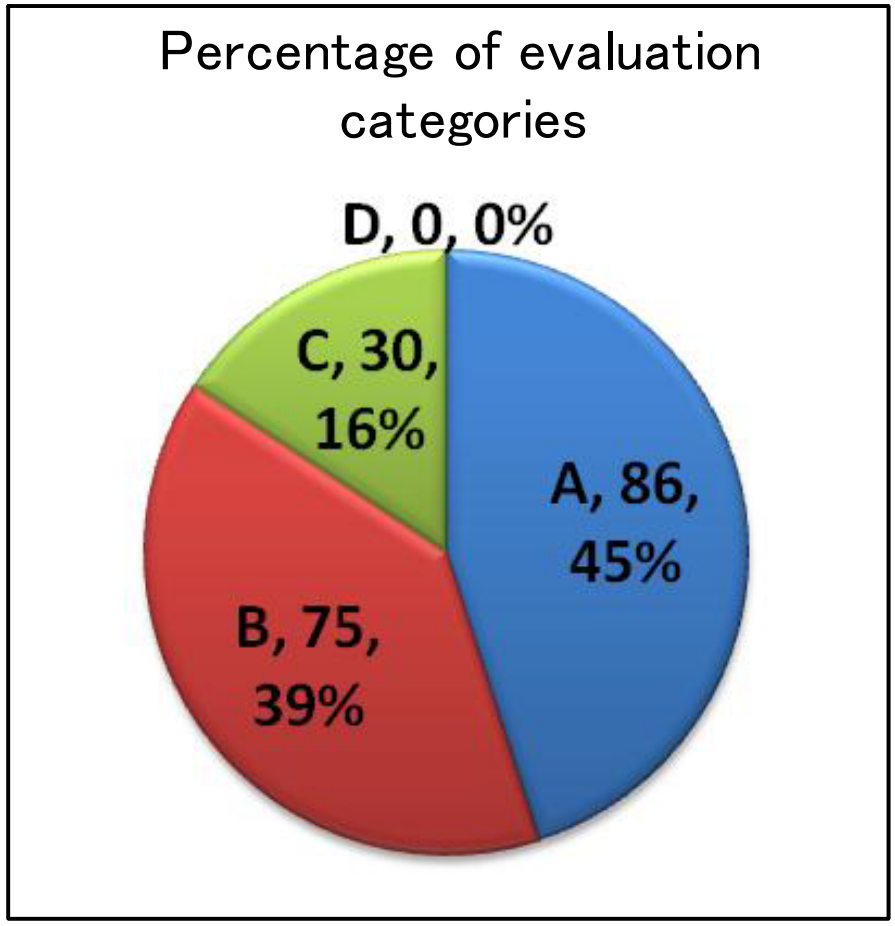
The Feature of Water Surface Control System



Oil balls and Debris can be removed efficiently using whirlpool.

4. Promotion of CSOs control measures

Condition of improvement of CSSs



A: For the accomplishment of the target, smooth implementation is being carried out.
Acceleration of task accomplishment is possible through project efficiency.
B: Task accomplishment is possible with the introduction of new technology and selection of appropriate countermeasures.
C: Project not carrying out following the plan makes it difficult to achieve the goals.
D: Most of the projects have not been implemented and it is difficult to accomplish the tasks under the current conditions.

Condition of improvement of combined sewer system《191 cities》(end of FY 2009)

“Manual for Efficient Settling of Urgent CSO Control Plan”

Objective

Towards sure achievement of CSO control goals, aimed to early implementation of projects
by settling more efficient/effective urgent CSO control plan in consideration of the following;

- ✓Cost reduction of control facilities
- ✓Setting appropriate CSO control goals
- ✓Control promotion in consideration of water usage in the receiving waters

Features

Sort out matters that require attention in settling plan

Composed according to steps for setting plan

Attached with substantial info on examples of control measures, outline of new technologies etc.

Steps for settling urgent CSO control plan

Evaluate CSO control projects conducted so far etc.

▼

Sort out water usage in the receiving waters + set important impaired water areas

▼

Set urgent CSO control goals

▼

Examine application of ‘exclusion,’ ‘conveyance’ and/or ‘storage’ of stormwater

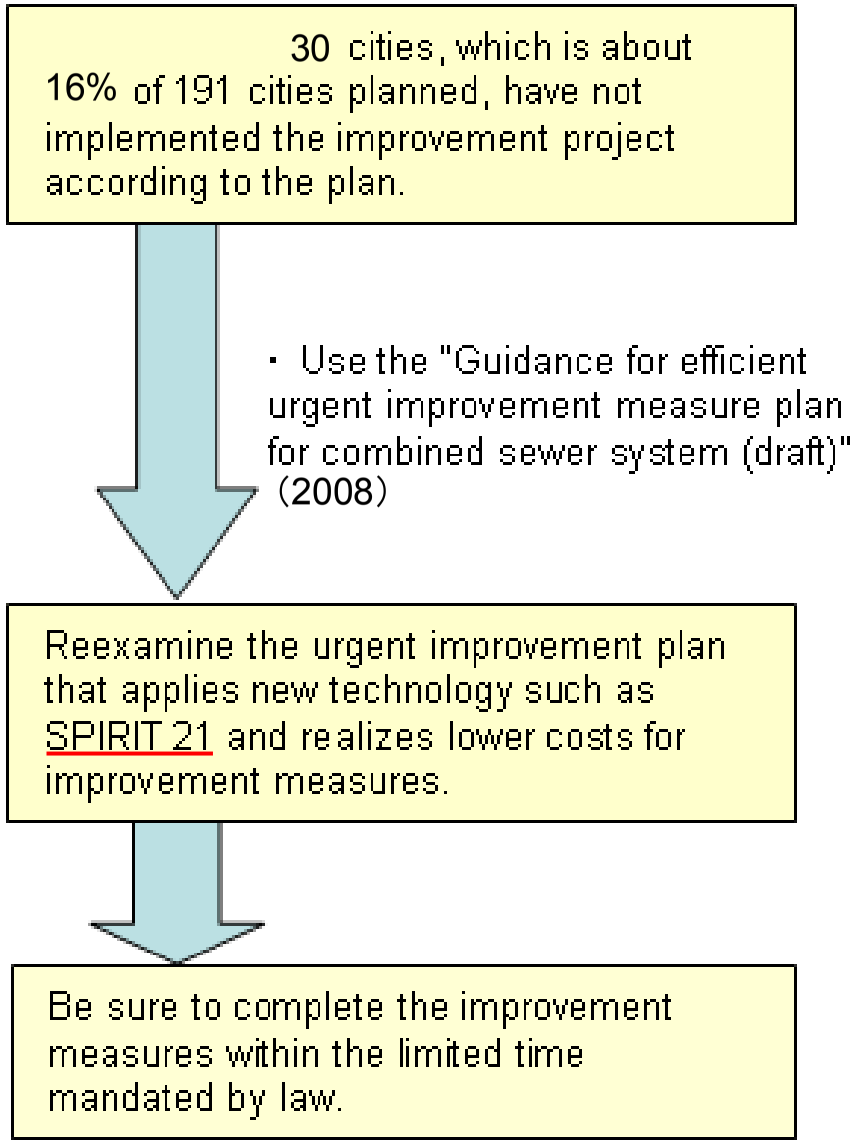
▼

Confirm efficiency of CSO control

▼

Settle annual plan + urgent CSO control plan

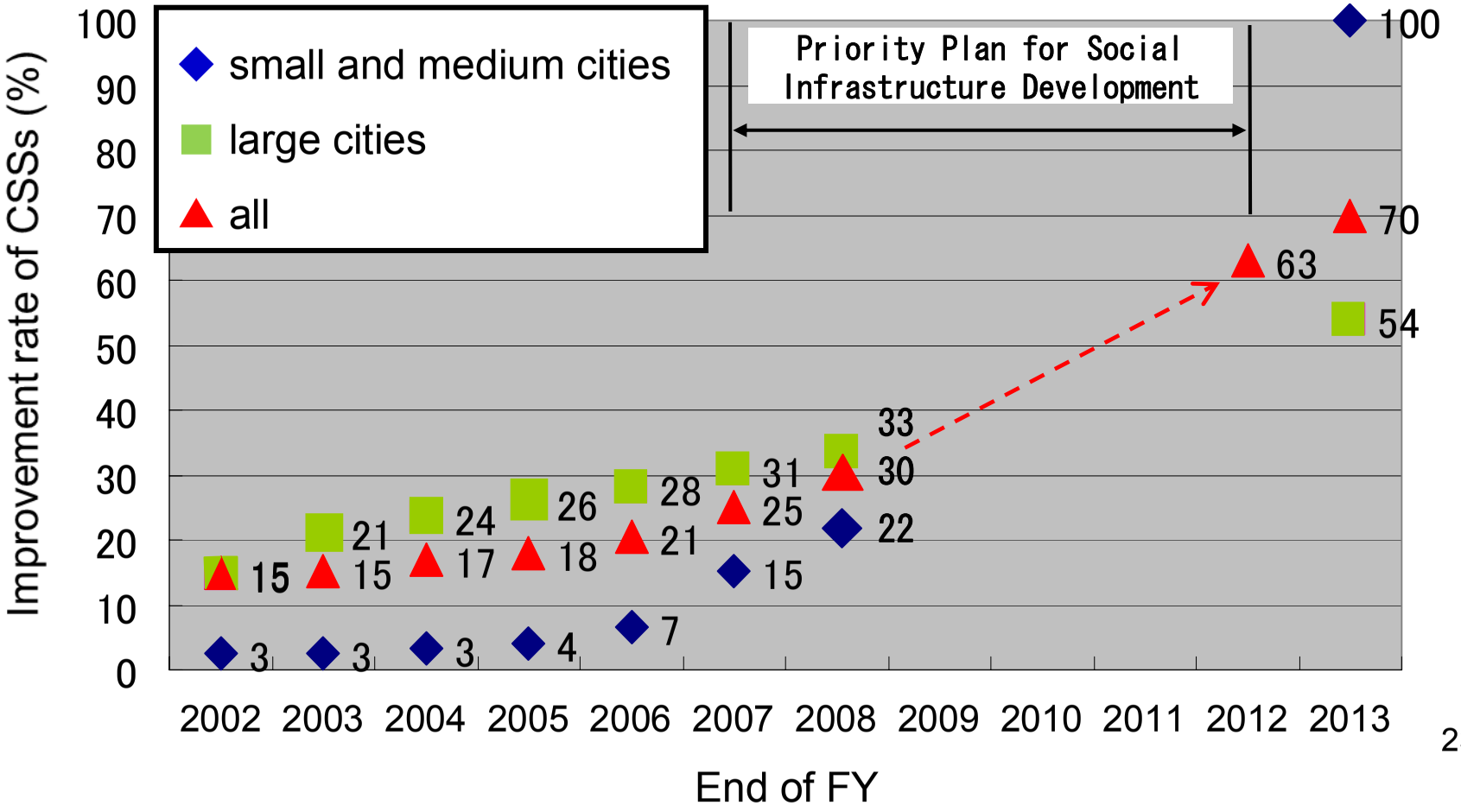
The check of the plan



The transition of CSSs improvement measures

The goal in Priority plan for social infrastructure development
(Cabinet decision of March 31st, 2009)

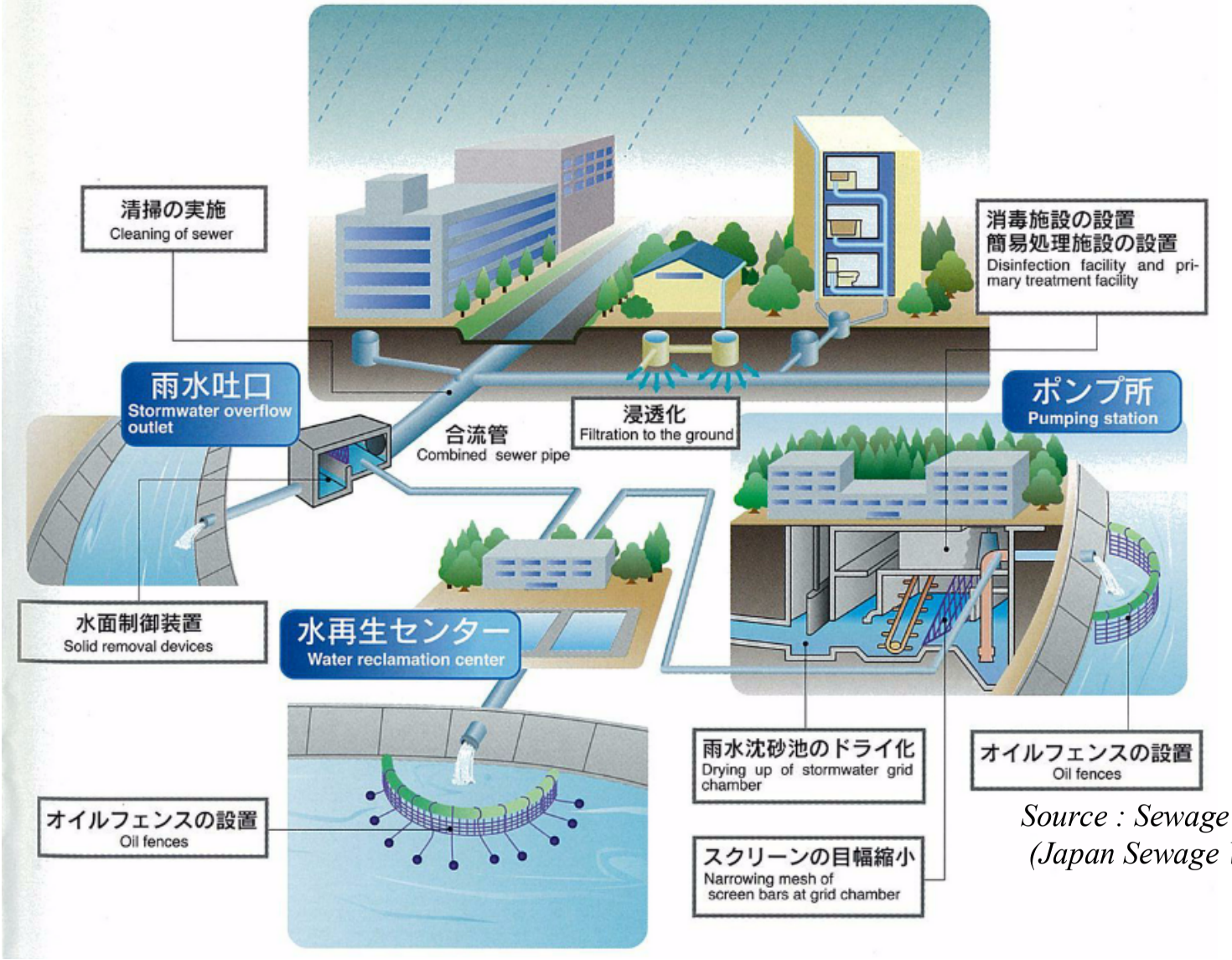
○Improvement rate of CSSs:
25% (End of FY 2007) → 63% (End of FY 2012)



5. Case study of CSOs control measures in municipalities

Case study in Tokyo

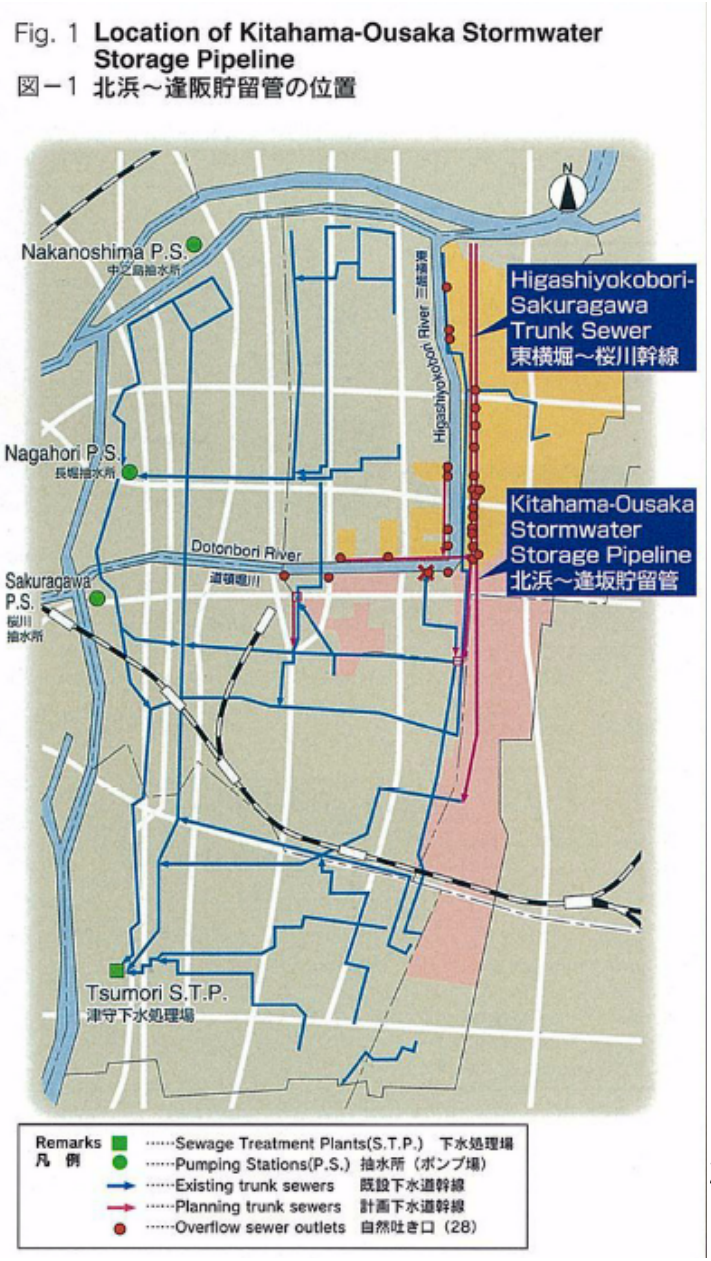
Fig. 1 **Outline of Quick Plan for CSO Control**
図－1 合流改善クイックプランのイメージ図



Source : Sewage Works in Japan 2004 (Japan Sewage Works Association)

Case study in Osaka City

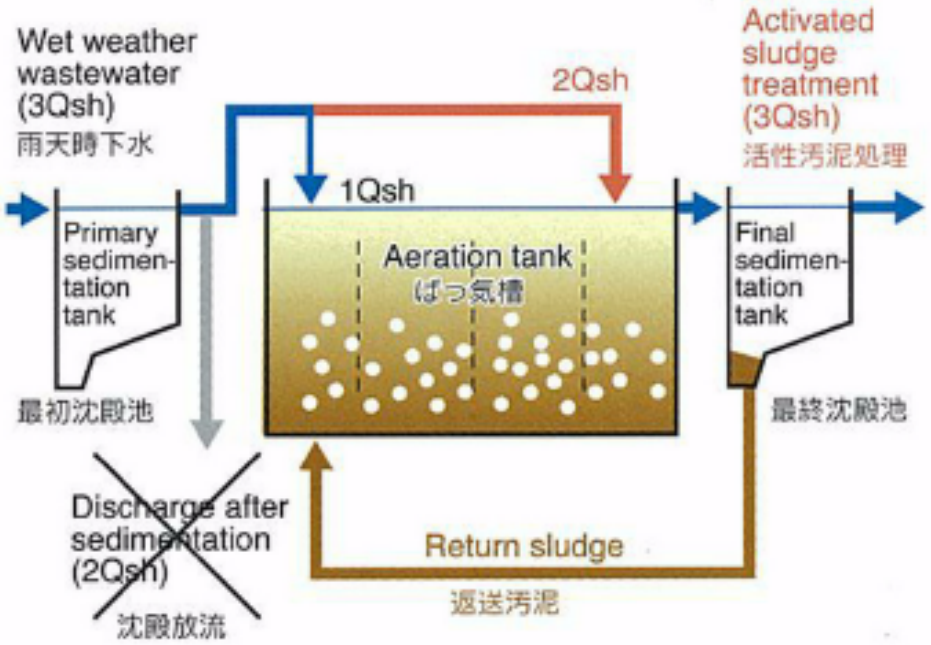
Photo 1 Unique Scenery of Dotonbori River
写真－1 現在の道頓堀川



Source : Sewage Works in Japan 2004
(Japan Sewage Works Association)

Case study in Osaka City

Fig. 2 **Activated Sludge Treatment in Wet Weather**
(Wet Weather Wastewater Treatment Process:3W Process)
図－2 **雨天時下水活性汚泥処理法**
(3W処理法：Wet Weather Wastewater Treatment Process:3W Process)



Note : Design maximum hourly wastewater flow
注) 1Qsh: 計画時間最大汚水量

Source : Sewage Works in Japan 2004
(Japan Sewage Works Association)

Fig. 3 **Plate Settler**
図－3 **傾斜板沈殿池**

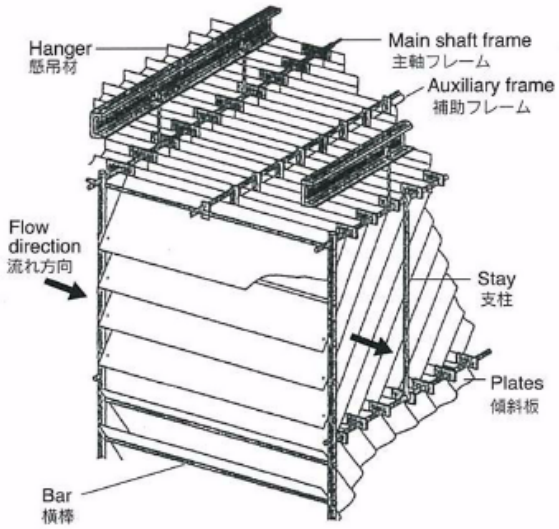
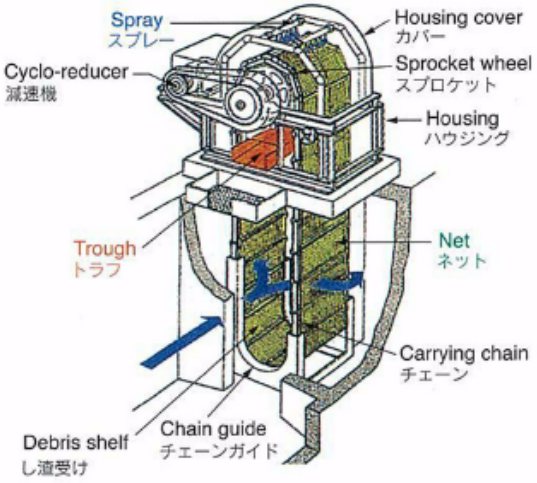
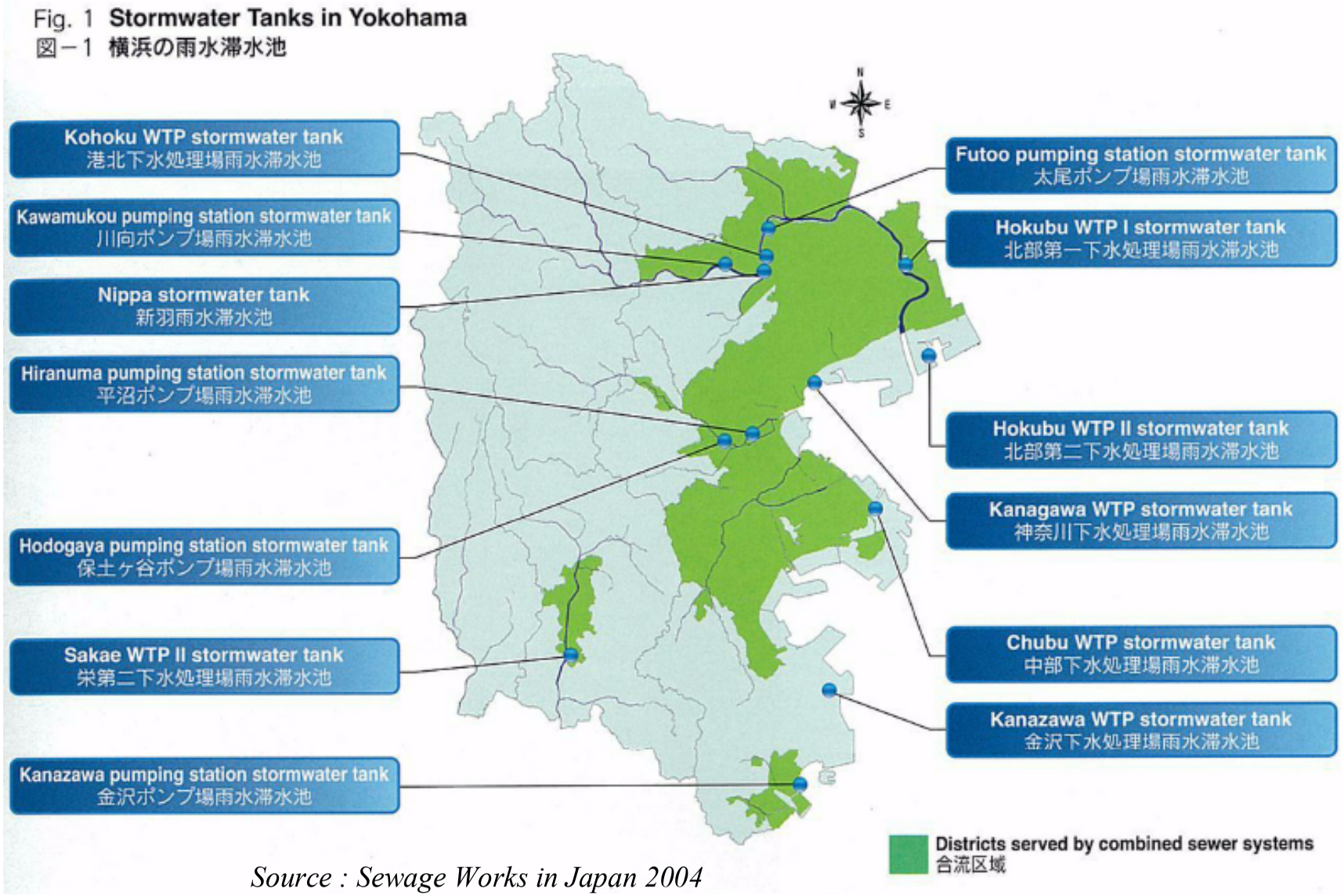


Fig. 4 **Fine-mesh Screen Equipment**
図－4 **微細スクリーン装置**



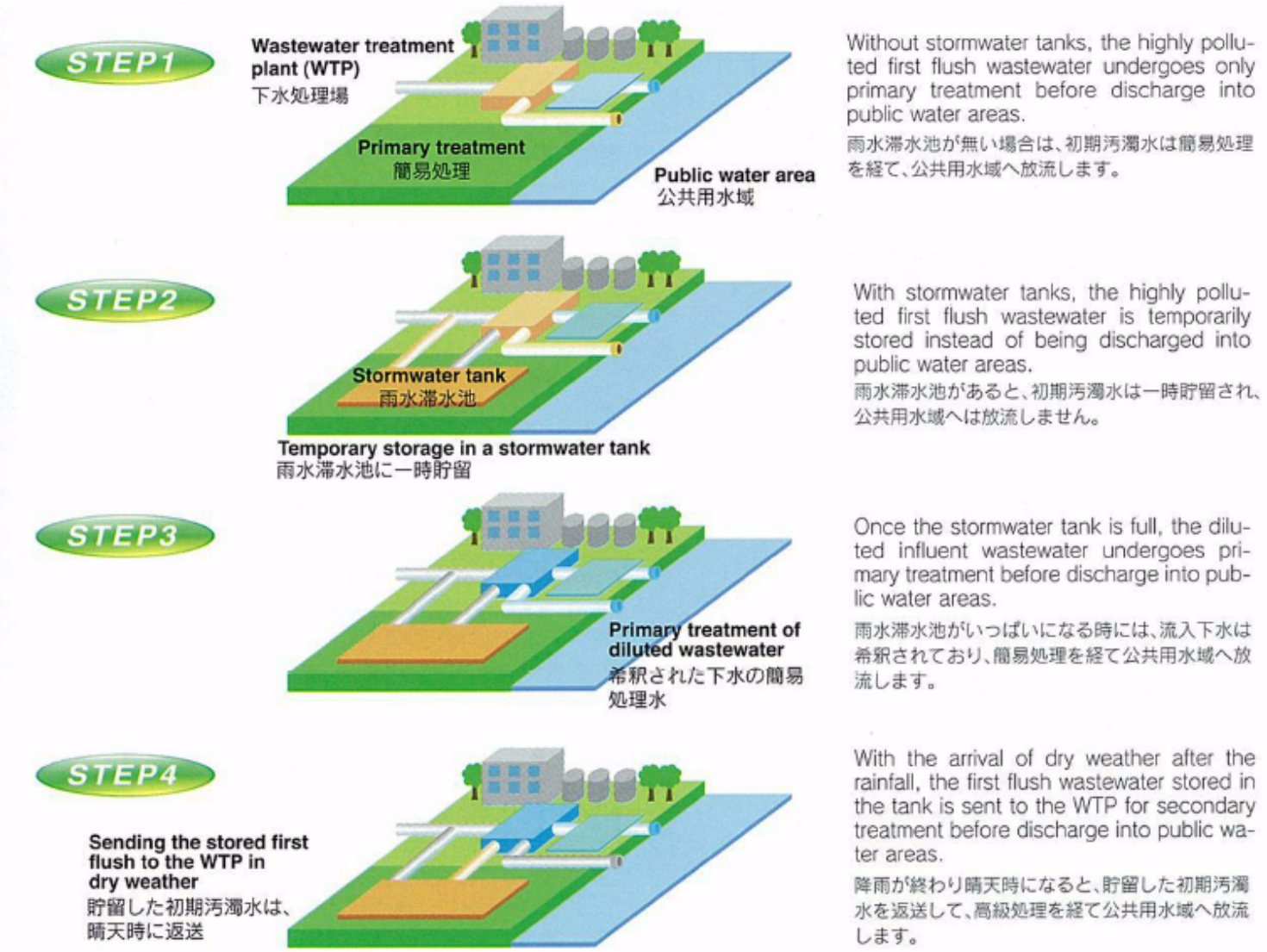
Case study in Yokohama City



Source : Sewage Works in Japan 2004
(Japan Sewage Works Association)

Case study in Yokohama City

Fig. 2 **Role of Stormwater Tanks**
図－2 雨水滞水池の役割



Source : Sewage Works in Japan 2004 (Japan Sewage Works Association)

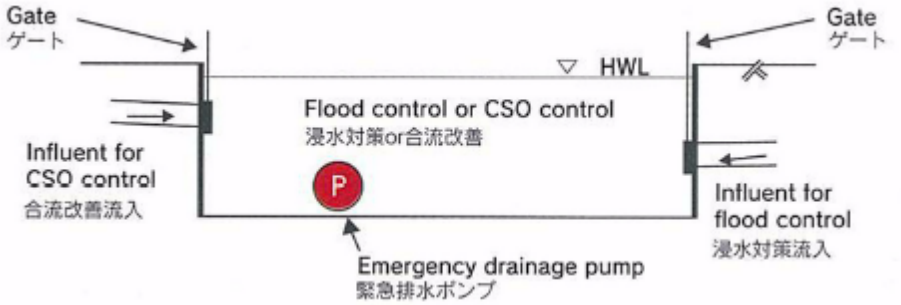
Case study in Nagoya City

Photo 1 Night Scene of Space along the Horikawa River (A view from the Nayabashi Bridge)
写真－1 堀川の夜景（納屋橋からの一望）

Fig. 1 **Basic Concept for Hybrid Use of Flood Control and CSO Control Functions**
図－1 併用利用の概念図

Based on the rainfall forecast of the weather information service center and the observation data collected from rain gauges distributed throughout the city, the gates and emergency drainage pump are operated to switchover between the flood and pollution preventation functions.

気象情報による降雨予測と市内に点在する地上雨量計の観測値から、ゲート管理、緊急排水ポンプで併用利用の切り替えを行う。



Source : Sewage Works in Japan 2004 (Japan Sewage Works Association)

Case study in Nagoya City

Fig.2 Completion Drawing of Fukue Stormwater Reservoir
図－2 福江雨水滞水池の完成図

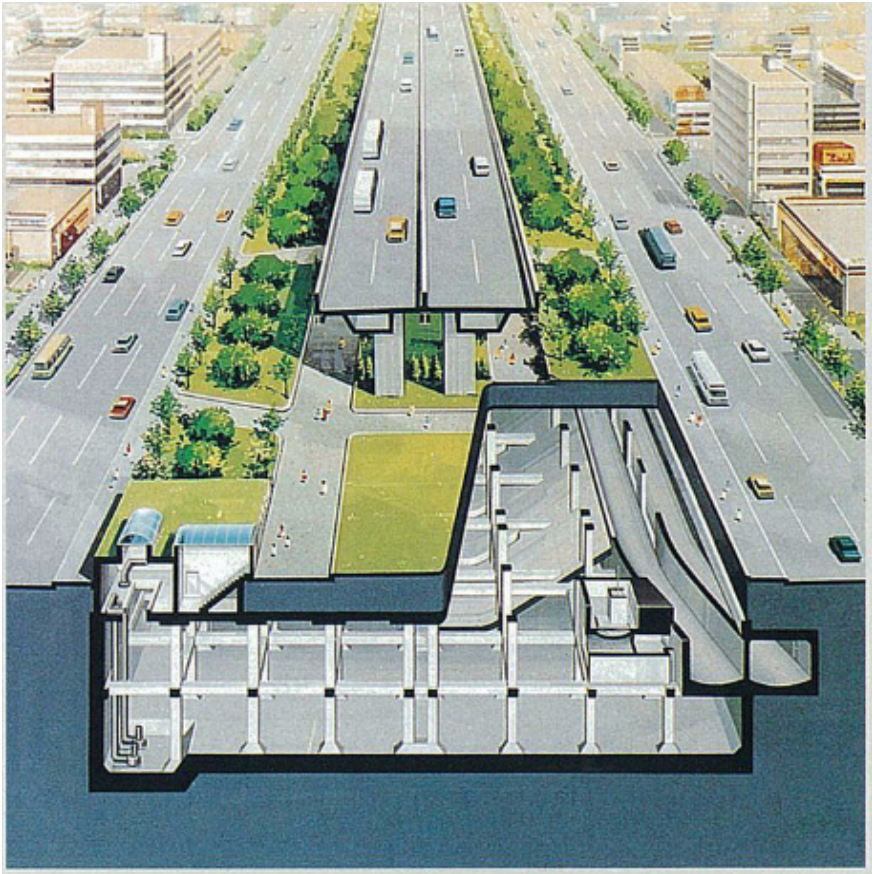


Fig.3 Completion Drawing of Wakamiya Odori Stormwater Reservoir
図－3 若宮大通調節池の完成図

Source : Sewage Works in Japan 2004 (Japan Sewage Works Association)

Case study in Kawasaki City

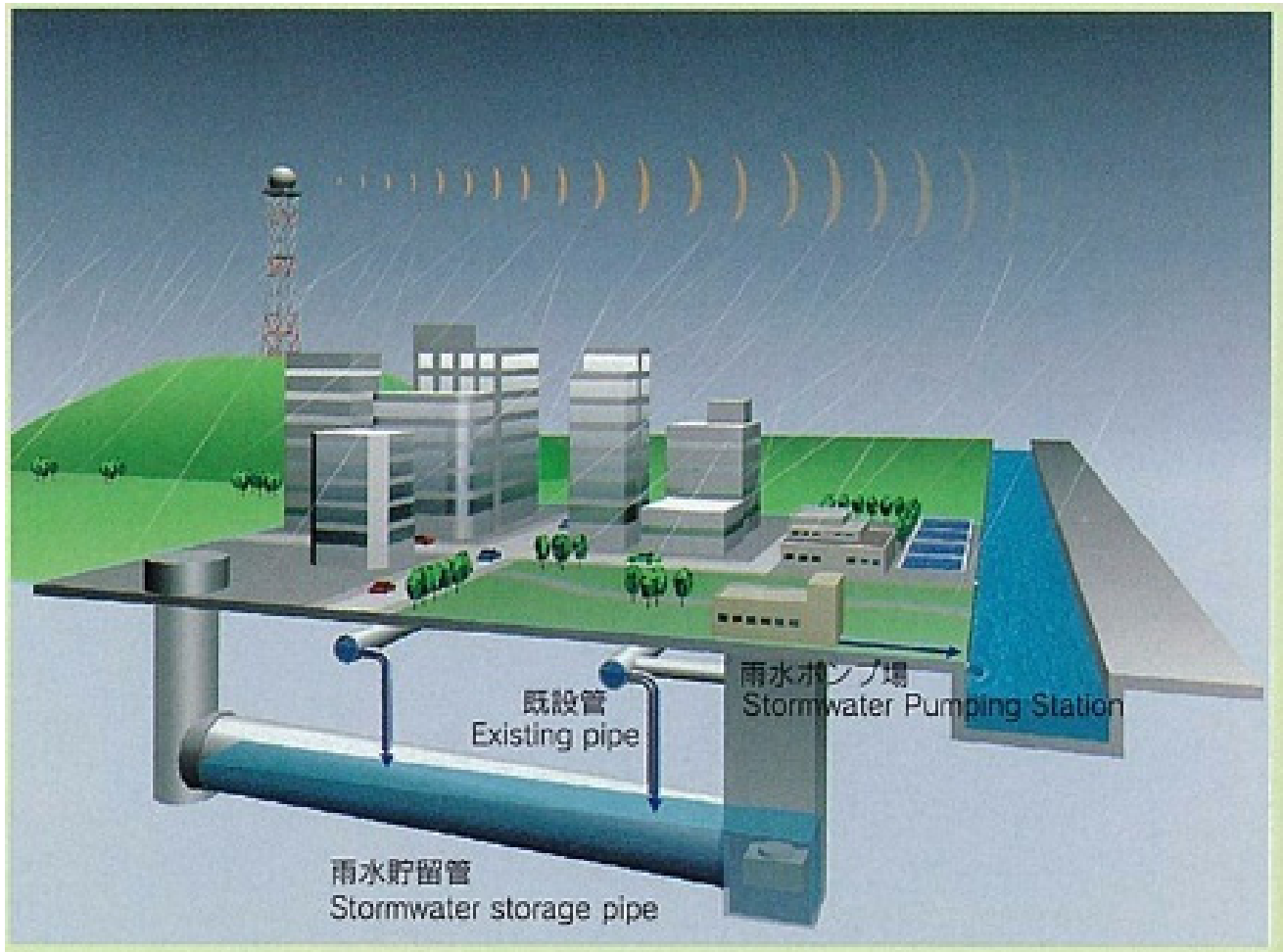
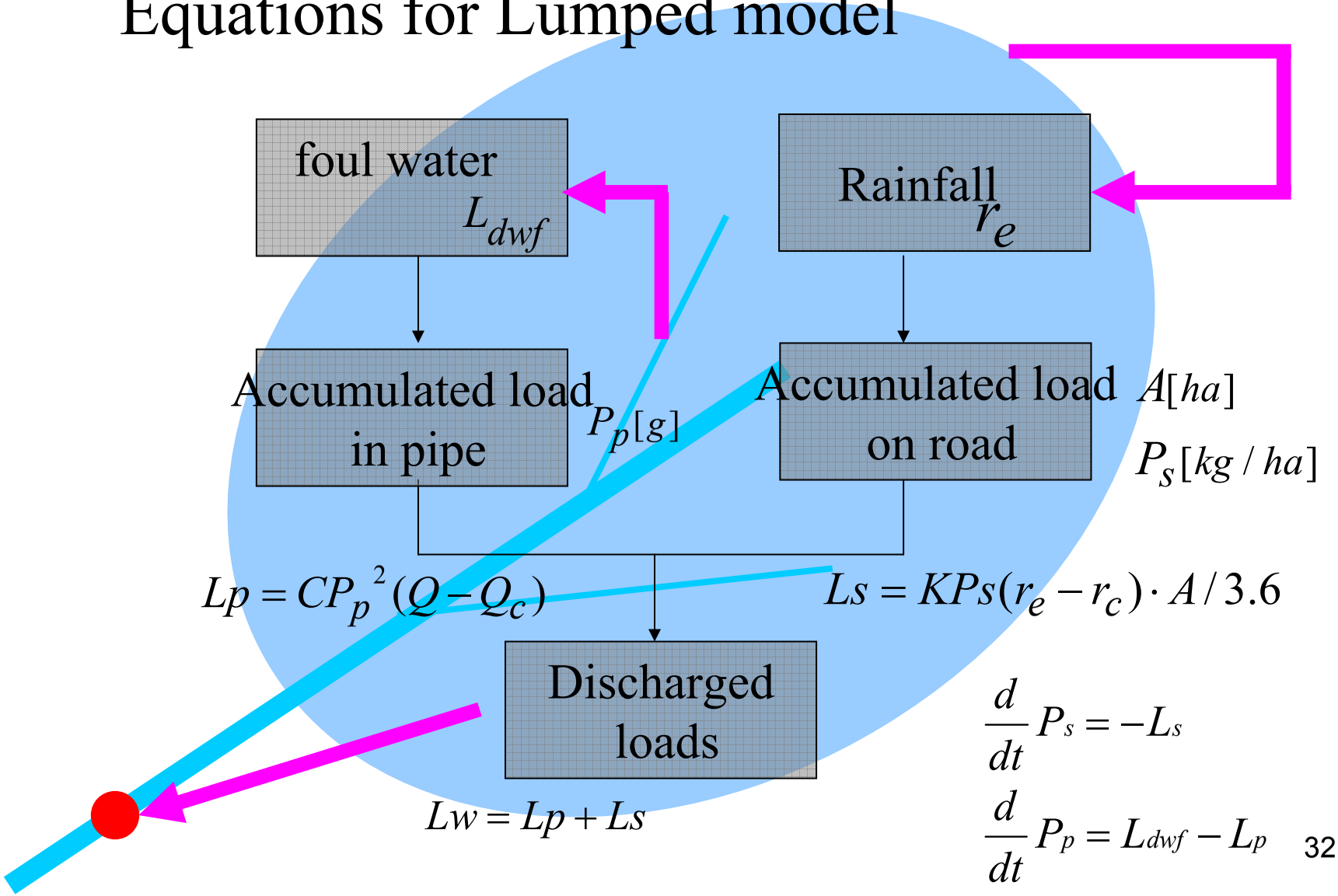


Fig.1 Role of Stormwater Storage Pipe
図－1 雨水貯留管の役割
WET WEATHER : For flood control , stormwater volume exceeding the existing drainage capacity is stored in the stormwater storage pipes.
雨天時:既設管の排水能力を超える雨水を貯留し浸水を防ぎます。

Source : Sewage Works in Japan 2004 (Japan Sewage Works Association)

PWRI Model

Equations for Lumped model



Distributed PWRI Model (WSD Model)