7. Present status of Combined Sewer Overflow and New CSO Control Policy in JAPAN

<u>Presenter</u>

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ABSTRACT

There are about 192 cities in Japan that have combined sewer systems. This is only 10% of the cities in Japan that implement sewage works, but these 192 cities account for about one third of the total sewered population in Japan. Of the cities that have combined sewer systems, 31% are currently planning projects to improve their sewerage systems, and 19% are implementing such projects.

The main method of carrying out combined sewer system improvement is to increase the capacity of intercepting sewers, although stormwater storage facilities are also provided when necessary. But many cities in Japan do not understand the characteristics of their sewer systems during wet weather and have insufficient data obtained by monitoring sewer systems.

In April 1999, balls of white oil were found coming ashore in the seaside port at Odaiba Tokyo. Initially it was assumed that these white balls were oil illegally dumped from ships. However subsequent investigations revealed that the oil had been in domestic wastewater discharged from the combined sewer system.

In response to rising public demand, the Japanese Government decided to establish New CSO Control Policy and apply them as national standards and exercise leadership to help local regional governments set improvement plans.

This New Policy was made public in March 2002 after a study of the matter by the Combined Sewer System Improvement Committee comprising representatives from the Ministry of Land, Infrastructure and Transport, the Japan Coast Guard, local authorities and academic experts.

This New Policy calls for the achievement of several goals within the next decade. The Ministry of Land, Infrastructure and Transport, the NILIM, and local governments are working to find solutions to problems with Combined Sewer Overflow (CSO).

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KEYWORDS

CSO, combined sewer system, improvement, goal, countermeasure, implementation, stormwater storage facility, 'separate sewer system equivalent', PWRI model

1. INTRODUCTION

In the 1960s, water pollution of rivers worsened throughout Japan, and a critical need for countermeasures against water pollution rapidly came to the fore. Under these circumstances, highly important Water Quality Standards and the Water Pollution Control Law were newly enacted. And a revision of the Sewerage Law in 1970 added contributing to the preservation of water quality in public bodies of water to the purposes of the Law.

It was during this period that the problem of combined sewer overflow finally became a serious concern. Surveys of overflow water quality and investigations into methods for calculating pollution loads were started, primarily at the Public Works Research Institute (PWRI). Based on the results of these surveys and investigations, the Provisional Guidelines for CSO Countermeasures[1] were published in 1982.

Now almost 20 years later, more than 60% of people in Japan are served by sewer systems. There is currently considerable discussion on the development of new sewerage measures for the future, with the key phrase; 'Ensuring a Sound Hydrological Cycle'. Combined sewer system improvement projects are very important in terms of contributing to the creation of fine water environments. However, the number of projects in progress is still insufficient.

This report first organizes the actual condition of combined sewer systems and the present state of countermeasures in Japan, then introduces new combined sewer system improvement policies, in order to summarize the present state of and problems with CSO countermeasures in Japan. Finally the report summarizes challenges facing CSO.

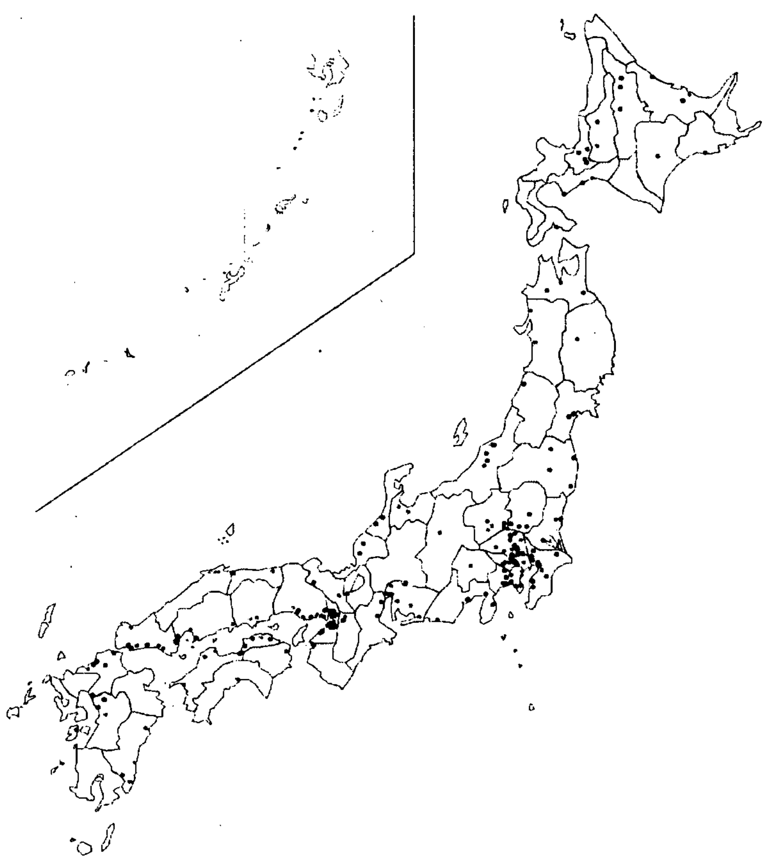
2. CURRENT STATUS OF COMBINED SEWER SYSTEMS

Table 1 shows the cities in Japan that implement sewage works classified according to the collection type[2]. Only 27 cities predominantly use the combined type, but including cities that have adopted the combined type to at least some extent raises this figure to 192, which is about 10% of the cities that implement sewage works. (The total number of cities in Japan is 3,224 in 2001.)

Table 1 Number of cities classified according to collection type[2)]

Collection type	Combined	Separate	Total
Number of cities	192	2,027	2,219
Served area (ha×10^3)	227	1,389	1,616
Sewered Population (million)	23	57	80

Fig. 1 shows these 192 cities plotted on a map of the country. It can be seen that those cities that have adopted combined type are distributed throughout Japan. This indicates that problems associated with combined sewer systems are nationwide.



Japan is very mountainous, meaning that only a small proportion of the land is habitable by humans. The population is, therefore, concentrated into small areas, in particular alluvial plains. Accordingly, sewerage first started to become widespread in cities located in these low flat areas. In such cities, it was vital to prevent flooding of the built-up areas and to remove wastewater as rapidly as possible. Because a combined type system is cheap, can be built quickly, and is particularly suited to narrow city streets, many cities selected the combined type at that time.

With the revision of the Sewerage Law in 1970, however, it became a rule that when new sewerage systems were built, they should in principle be separate systems. In more recent years, most of the cities that have introduced sewage works for the first time have been small- or medium-sized cities with relatively low populations. As a result of the above, it is generally the case that the larger the city, the more likely it is to have adopted the combined type. In terms of population, 23 million people live in areas served by combined sewer systems [3], which is about one third of the total sewered population in Japan or about one sixth of the total population of the country.

3. CSO COUNTERMEASURES

3.1 Current Status of Combined Sewer System Improvement Projects

There is no authorized index used in Japan for indicating the degree of progress that has been made in combined sewer system improvement work. However, according to a survey by the MLIT [2] in 2002, the number of the cities that are either implementing or planning improvement projects is about 31 % of the cities that have combined sewer systems and 19% are implementing such projects.(**Fig.2**)

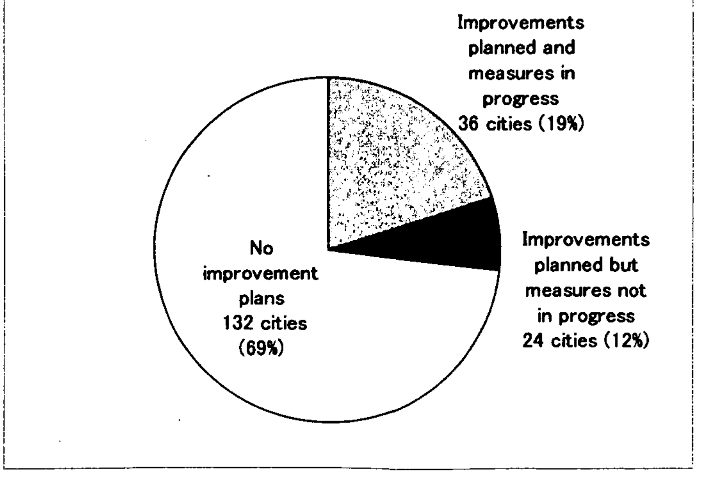


Fig.2 State of Improvement Plans in Cities

The only cities that are actively pushing forward with improvement projects are the large cities that have a very high percentages of the sewered population and some of the cities that have closed bodies of water. In cities where many people are unsewered, priority is being given to new sewerage system construction projects rather than to combined sewer system improvement projects. Considering sewerage projects as a whole, this is quite a natural situation, and in addition, from the standpoint of reducing the pollutant load on public waters, it is considered more effective to give priority to the construction of new sewerage systems than to the improvement of combined sewer systems.

The main combined sewer system improvement measure taken is to increase the capacity of intercepting sewers. Intercepting sewers are generally designed to have a capacity of 3Q, where Q is the maximum hourly wastewater flow rate. In addition, in order to effectively achieve the previously mentioned goal of a 'separate sewer system equivalent', in some cases there are plans for offsite storage facilities such as storage tanks or storage sewers for pollution control. According to a survey by the PWRI [4] in FY 1994, 32 stormwater storage facilities constructed to improve combined sewer systems were in operation. If facilities that are currently under construction or being planned are included, this figure rises to 80. It should be noted, however, that almost half of these facilities have been constructed/planned not purely for combined sewer system improvement purposes but also as flooding prevention measures. When constructing such storage facilities for combating CSO, one of the biggest problems is obtaining the required land. In the case of a storage tank for pollution control, a large site is required. If suitable land cannot be found, it is common to build storage sewers under roads. In this case, it is necessary to confer with the road administrator, but not to obtain the land.

It is not the case that all cities are adopting these kinds of methods. For example, there are cities where various restrictions make it difficult to increase the capacity of intercepting sewers, so plans have been made whereby the countermeasures will involve only offsite storage facilities and not intercepting sewers. There are also about 20 cities that are either implementing or planning projects in which their combined sewer systems will be changed to separate sewer systems. There are two ways of doing this depending on the condition of the individual drainage basin. One involves using the existing combined sewers as stormwater sewers and the other involves using them as sanitary sewers.

Onsite stormwater infiltration facilities are also gradually being introduced. These facilities also offer an effective way of carrying out combined sewer system improvement. In 1994, the Ministry of Construction set up a system under which sewage works administrators are given subsidies to help with the establishment of such facilities. However, it is difficult to quantitatively measure the positive effects of such measures and so such facilities are, for the time being, regarded as no more than additional facilities.

3.2 Typical Examples of Facilities to Fight CSO

There are 3 representative types of facility that are used as countermeasures against CSO – pollution control storage tanks, pollution control storage sewers and stormwater sedimentation tanks. Below is a brief introduction to actual examples in which each of these types of facility have been used in Japan.

In the case of the Fukue Stormwater Storage Facility in Nagoya[5], it is planned to act both as a CSO countermeasure facility and as a flooding prevention measure. It started operating in FY 1999. The total area of the site is 5,850m^2, with the storage tanks situated underground so that the land above can be used effectively, as an urban industrial park for example. When full, the depth of water in the storage tanks will be 13m. As shown in **Fig. 3**, the storage tanks are split into three blocks – a tank for exclusive use as a flooding prevention measure (A: capacity 5,000m^3), a tank for exclusive combined sewer system improvement use (B: capacity 9,000m^3), and a tank for joint use (C: capacity 17,000m^3). The area of the district targeted for combined sewer system improvement is 437ha. If only tank A is used, stormwater corresponding to 2mm/h of rainfall can be stored. And if tank C is also used, then stormwater corresponding to 6mm/h of rainfall can be stored. The issue to be addressed in the future is how to carry out real-time control of the joint-use tank based on rainfall information.

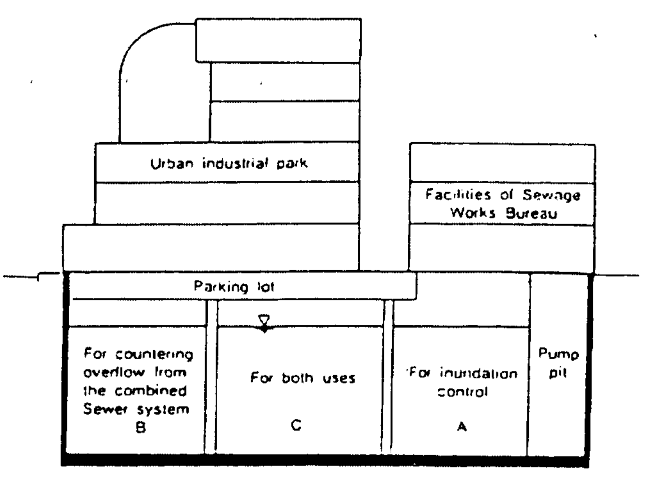


Fig. 3 Fukue Stormwater Storage Facility in Nagoya[5]

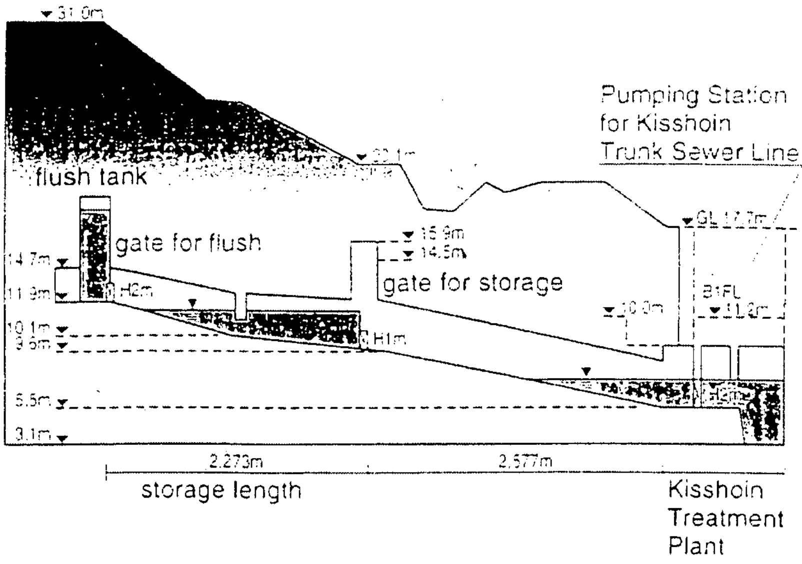


Fig. 4 Kisshoin Trunk Sewer in Kyoto[6)]

In the case of the Kisshoin Trunk Sewer in Kyoto[6)], a storage sewer for pollution control went into operation in 1994. Once again, the facility not only provides combined sewer system improvement effects, but also acts as a flooding prevention measure. As shown in **Fig.4**, in the central area of the trunk sewer, there is a gate used to stop the flow of water and the upstream side of this gate acts as a storage sewer for combined sewer system improvement. The length of the trunk sewer used for this purpose is 2,273m and its diameter is 2.8m.

The storage capacity of the sewer is 13,000m^3, which means that because the district targeted for combined sewer system improvement is 346ha in area, the storage capacity corresponds to 5mm/h of rainfall (runoff coefficient is 0.7). Stored sewage water is sent down to the wastewater treatment plant during dry weather so that it can all be treated. A survey to evaluate the effects of combined sewer system improvement is currently underway.

The Oshima Stormwater Reservoir in Kawasaki[7)] that started operation in 1991 is used only to improve the combined sewer system. The tanks of the reservoir are rectangular, with a width of 20m, a length of 29m and a depth of 4.5m. Because there are 8 tanks, the reservoir's total storage capacity is 21,000m^3. The district targeted for combined sewer system improvement is 393ha in area, meaning that the total storage capacity of the tanks corresponds to 5mm/h of rainfall. The storage tanks are situated behind the pumping station, meaning that even if they should become full, they can be used as stormwater sedimentation tanks by allowing stormwater to continue flowing into them. According to the results of a survey conducted by Kawasaki City, the removal efficiency of BOD by sedimentation was 30~76 % and that of SS was 44~78 %.

4. New CSO Control Policy

In April 1999, white oil balls were found coming ashore in the seaside park at Odaiba, Tokyo. Parents of children playing on the beach reported this to the Japan Coast Guard that was monitoring the water quality of Tokyo Bay. Initially it was assumed that these white balls were oil illegally dumped from ships. However subsequent investigations revealed that the oil had been in domestic wastewater discharged from the combined sewer system.

On September 25, 2000, the Mainichi Shimbun, a daily newspaper, reported that white oil balls were drifting ashore at Odaiba Seaside Park along Tokyo Bay, and said that this was an indication that the aquatic environment of Tokyo Bay was worsening.

Moreover, on August 8, 2001 and October 17, 2001, NHK TV (the national broadcasting system) programs reported to nationwide audiences that contaminants from the combined sewer system were being discharged into rivers and sea areas. Large numbers of citizens learned this fact about combined sewer systems for the first time. These newspaper reports and programs resulted in an increasing number of requests to sewerage authorities to improve combined sewer systems [8].

In June 2001, the Government of Japan responded to this situation by forming a committee of experts and officials from local governments to promote the introduction of measures to control CSO. The committee is conducting studies to clarify the actual state of the CSO problem (duration of overflows, water quality of overflows and receiving bodies of water etc.), CSO countermeasures, and their goals.

After studying this matter, the Combined Sewer System Improvement Committee comprising representatives from the Ministry of Land, Infrastructure and Transport, the Japan Coast Guard, local authorities and academic experts, made its final report public in March 2002.

This final report has no legal force, but actually presents Japanese Government policy concerning CSO countermeasures. That is way it is called a guideline. The following are key points in the report.

(1) Items concerning improvement goals

The improvement goals include a long-term goal and a short-term goal. The short-term goal is to be reached within 10 years. (setting staged goals and early achievement of their effects)

The long-term goal is to perform wet weather control to separate contaminated water from stormwater in order to absolutely minimize the discharge of untreated water during wet weather. In other words, aggressive conversion of combined sewer systems to

separate sewer systems and the promotion of seepage to store water on-site.
In the short term, priority will be placed on urgent highly efficient projects necessary to achieve the long-term goals and setting targets for the following three goals in all cities with a combined sewer system.

[1] Reduction of pollutant loads (continuation of past goal)

Reduction of the total annual BOD discharged from a combined sewer system to a level equal to or lower than that of a separate sewer system.

[2] Guaranteeing public hygienic safety (new goal)

To achieve a big reduction in the discharge of untreated wastewater into public bodies of water, halve the frequency that water is discharged from all outlets at drainage facilities and pumping stations.

[3] Reduction of large solids (new goal)

Prevention of the discharge of large solids from all outlets of drainage facilities and pumping stations.

In bodies of water where it is important to conserve water quality and which are particularly susceptible to the effects of water discharged during wet weather (sensitive area : areas where there is a public water supply intake, swimming areas, etc.), closing or moving outlets, the sterilization of pumping systems and other ways to strengthen countermeasures will be studied without being limited to the above three items.

(2) Items concerning the implementation of improvement measures

A combined system improvement plan that stipulates the way to achieve the short term goals will be enacted, items in the plan that concern facility improvement will be reflected in projects stipulated under the Sewerage Law, and countermeasures will be introduced quickly. (clarification of the legal position of the combined system improvement plan).

The combined system improvement plan will be enacted accounting for the results of complete studies of the present state of sewerage systems, state of discharge during rainy weather, and its effects on the receiving waters (preliminary monitoring), and during implementation of the countermeasures or after they have been completed, continuous monitoring of discharge during rainfall (post-improvement monitoring) will be done to clarify the combined system improvement effects of implementing the countermeasures and of the maintenance of sewerage systems. In addition, it will be necessary to set new discharge management indices that can be used to confirm whether or not the implementation of the countermeasures has reduced the pollution load discharged during rainy weather as stipulated by short term goal (1) (management indices for water discharged during wet weather).

Information such as the results of the monitoring and progress in improvement measures will be provided to the river basin residents and concerned organizations, and at the same time, measures will be introduced to encourage assistance and cooperation to install storage and seepage systems at individual buildings and clean urban districts.

Figure 5 is a chart representing the above program.

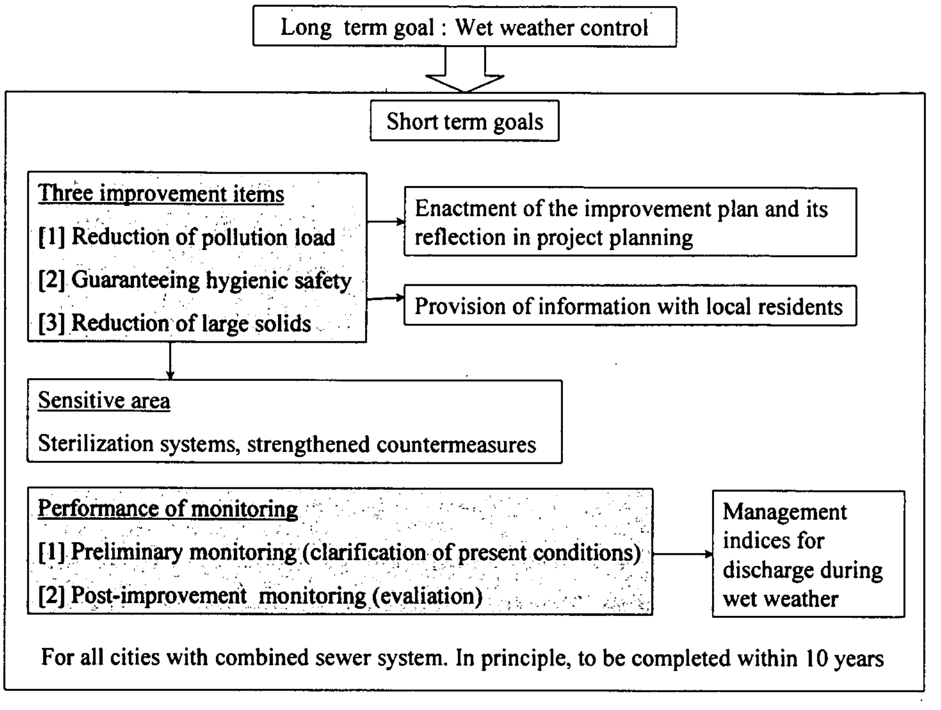


Fig.5 Key Points of the Basic Concepts in the Committee's Proposal

5. ISSUES AND SOLUTIONS

5.1 Technical issues

There are two main technical problems to be resolved to draw up a combined sewer system improvement plan. The first is that, when looking into countermeasure scenarios that consider the sewer network, it is very difficult and complicated to apply the PWRI model (which is used for calculating pollutant loads) because it is a lumped parameter type model. In order to solve this problem, the PWRI and the Japan Sewage Works Agency have decided to conduct joint research starting this year to make improvements to change the PWRI model into a distribution type model that is easy to use and befits the current age. Moreover, in recent years distribution type models such as Hydro Works, MOUSE and SWMM that have been developed and put to practical use in other countries have come on the market, and so the PWRI has looked into the possibility of using such models in Japan [9].

The other problem is that when performing calculations to compare a combined sewer system with a separate sewer system, the setting of the stormwater quality for the separate sewer system is not well grounded. Stormwater quality is one of the most important factors that determines the size of CSO prevention facilities, but the current situation is that there is a lack of actual measurement data for almost all cities. The PWRI has conducted surveys into stormwater quality under wet weather conditions in the past and has published the results in the form of a database, but there are great differences in the stormwater quality from area to area, and indeed great fluctuations from one rainfall to the next, meaning that it is necessary for surveys to be carried out and for data to be collected in all cities.

Moving on to other technological issues, there are a number of different types of investigations currently being carried out in Japan as follows.

- Structures of storm overflow chambers.
- Filter screens which provide a simple technique to prevent CSO
- Treating intercepted wastewater under wet weather conditions
- Predicting rainfall using radar rain gauges with the aim of enabling real-time control
- Dual usage of flood prevention facilities for combined sewer system improvement

5.2 Issues relating to Project Implementation

There is one main issue relating to the best way to push forward with combined sewer system improvement projects.

Drawing up project plans is important from the standpoints of the recognition of the necessity of the improvement projects, the responsibility of the authorities to give explanations, the effective implementation of projects, and the early achievement of improvement effects.

Even in the case of cities that are already carrying out combined sewer system improvement projects, it is often the case that no firm target date for the achievement of the goals has been set. It is thought that the main reason for this is the vast budget and long time required for combined sewer system improvement. It would seem that, in cases where it is hard to set a date when the long-term project goals should be achieved, it is necessary to set short- or mid-term goals and target dates for their achievement, and to push forward with the project at each stage.

Recently in Japan harsh questions have been asked regarding the transparency and efficiency of public works projects. This means that with regard to public works projects that require enormous budgets, it is vital to publicly disclose ample information on the necessity of the projects, and thus strive to obtain the consensus of residents. In particular, the CSO countermeasure projects fall under the category of projects for which insufficient explanation has been given to residents in the past, and so it would seem to be necessary to start by ensuring that residents have an awareness of why CSO constitutes a problem and of the issues involved.

If combined sewer system improvement projects are implemented following the kind of project plans that have been described above, we will then be able to expect results to be achieved in terms of improvements in water quality at an early stage.

6. CONCLUSION

While the public's concern with CSO is mounting, many points concerning the actual state of CSO and its effects on the receiving water bodies are unclear because there are few studies of these matters.

In the near future, local governments that operate combined sewer systems are expected to carry out fact-finding surveys and publicly release the results, and to clearly inform their residents of their determination to improve CSO improvement countermeasures. In the future, they must work aggressively with all concerned parties to transform combined sewer systems into sewer systems suited to twenty-first century cities.

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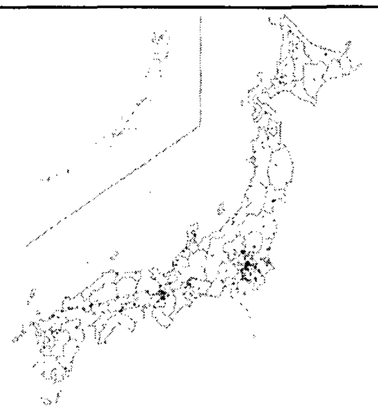
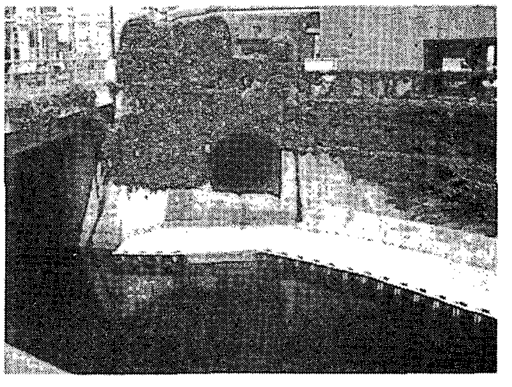
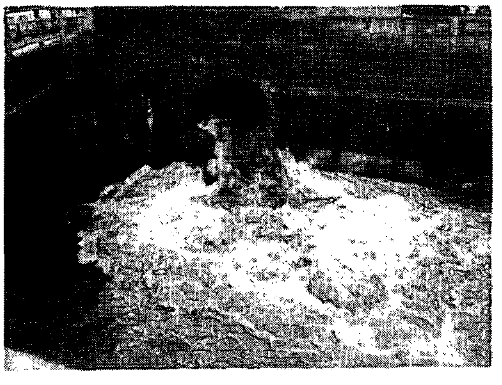
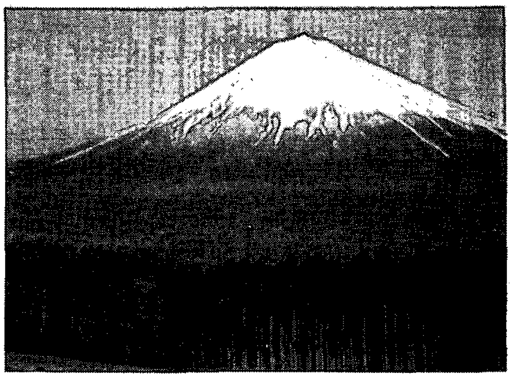


Fig.1 Cities that have adopted a combined sewer system in Japan







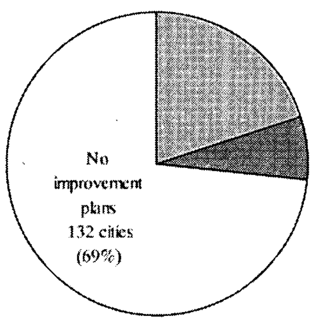
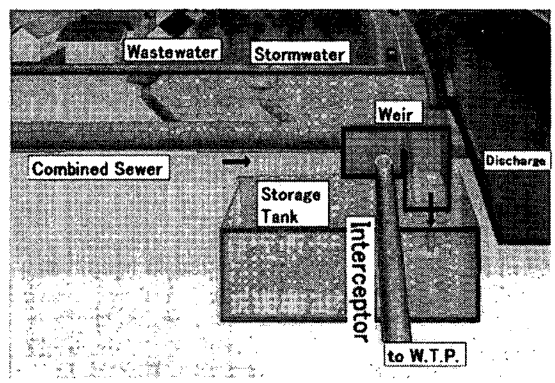
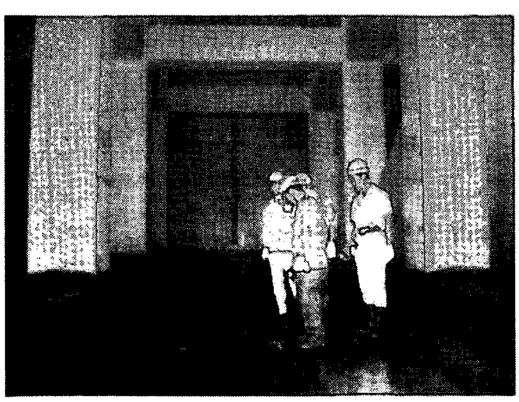
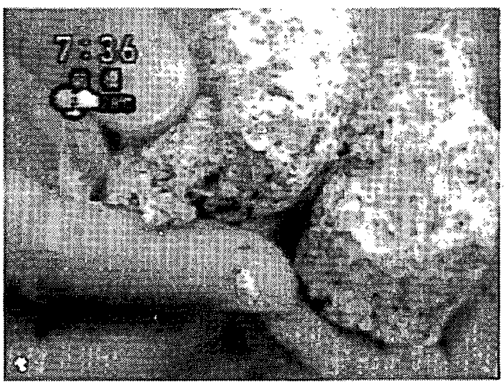
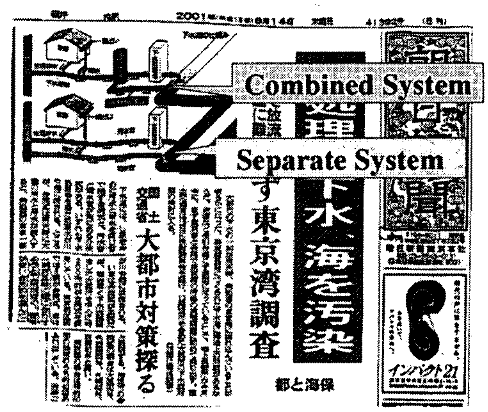


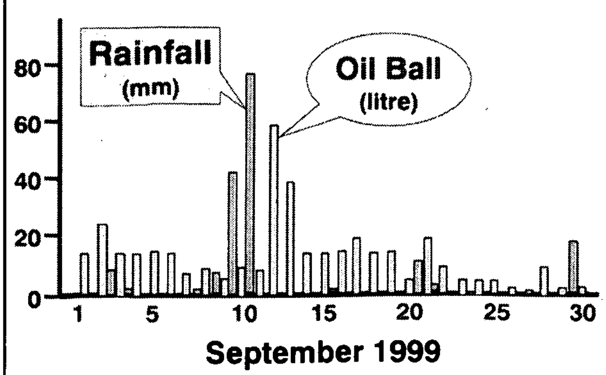
Fig.2 State of Improvement Plans in Cities





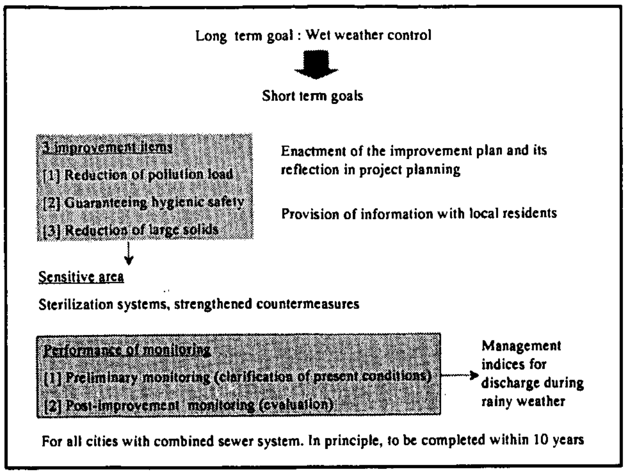






The Combined Sewer system Improvement Committee

- Organized in June 2001
- Ministry of land, Infrastructure and Transport, the Japan Coast Guard, Local government and academic experts
- Final report was released in March 2002



New improvement goals

- Long term goal ⇒ wet weather control
- Short term goals ⇒ 3 items
  ⇒ within 10 years
  ⇒ For all 192 cities

3 improvement items

- [1] Reduction of pollution load
- [2] Guaranteeing hygienic safety
- [3] Reduction of large solids

Issues and Solutions

How to

- Develop more practical CSO model
- Accumulate more observed date
- Estimate the relationship between the measures ant cost effectiveness

Conclusions

- Systematic research should be continued
- International exchanges of information