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WASTEWATER UTILITY BUSINESS CONTINUITY PLAN FOR LARGE-SCALE EARTHQUAKES

PLAN CIĄGŁOŚCI SYSTEMU OCZYSZCZANIA ŚCIEKÓW (WASTEWATER UTILITY BUSINESS CONTINUITY PLAN) W PRZYPADKU TRZĘSIENIA ZIEMI O DUŻEJ SKALI

In the event a large-scale earthquake prevents sewerage systems from functioning properly, the resultant disruptions, including sewage spills and unusable flush toilets, are likely to have an enormous social impact. At the same time, resources (work sites, personnel, lifeline systems, etc.) necessary for recovery are likely to be considerably constrained. This study presents a method for maintaining and restoring the functions of earthquake-damaged sewerage systems more quickly and to a higher level of service than previously possible.

1. Background and Purpose

In the event a large-scale earthquake causes damage to sewerage systems and prevents their proper functioning, not only will residents be greatly inconvenienced in their inability to use their bathrooms as usual, but also their lives and properties can be threatened by such public health hazards as sewage backups and wastewater overflows.

A fundamental solution to the above is disaster prevention, where systematic measures are taken to make sewerage systems structurally quakeproof. This, however, takes considerable time and money.

Meanwhile, large-magnitude earthquakes are predicted for Tokyo and certain other regions in Japan. Areas assessed to have low risk of earthquakes are not entirely safe as well, as there have been cases of low-risk regions being hit by a major earthquake, such as Noto Peninsula in 2007.

Photo 1 Earthquake-damaged sewer

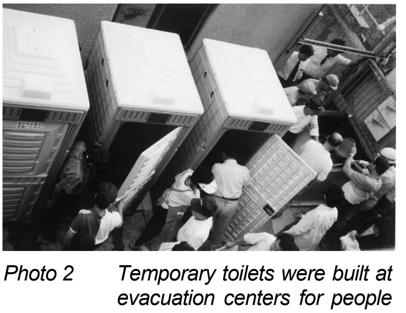


Photo 2 Temporary toilets were built at evacuation centers for people without usable toilets at home.

In view of the foregoing, disaster mitigation measures aimed at minimizing the damaging effects of an earthquake on sewer lines and wastewater facilities should be carried out in addition to disaster prevention measures.

Business continuity plans (BCPs) have comprised a vital element of corporations' crisis management systems since the September 11 terrorist attacks on the World Trade Center. In Japan, national and local government authorities have started preparing public-sector BCPs as a crisis management measure in times of disaster.

The primary objective of a BCP is to allow business continuation in a manner appropriate to the limited amount of resources available after a disaster. It identifies operations to be resumed on a priority basis and reviews various measures—such as allocating the necessary resources, simplifying procedures, and defining the chain of command—necessary for resuming operations more quickly and at a higher level of service than otherwise possible (see Figure 1). In this respect, the BCP can be highly effective as a disaster mitigation tool for wastewater utilities.

This study presents methods for BCP formulation that regional wastewater management authorities can follow, together with some specific considerations to be reviewed during the planning process, so that sewerage functions disrupted by an earthquake can be restored more quickly and at a higher service level.

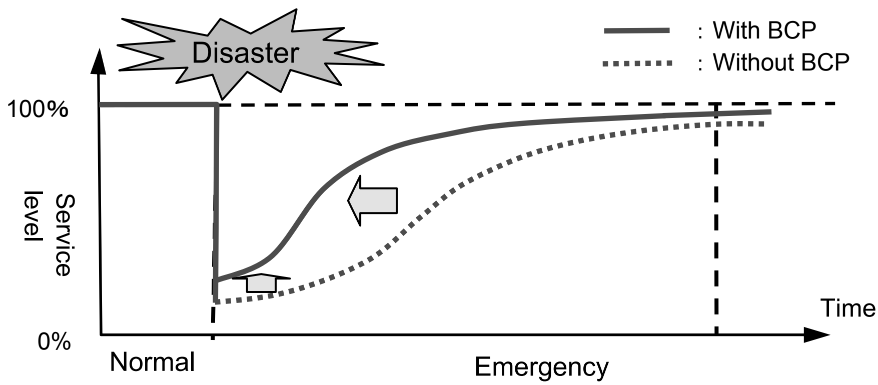


Fig. 1 Conceptual Diagram of BCP

2. Issues of Conventional Post-Quake Recovery Plans

At present in Japan, sewerage system recovery following earthquakes are carried out in line with disaster management plans prepared by local governments for their respective regions.

However, in the case of large-scale earthquakes, there is a possibility that post-quake activities called for in conventional disaster management plans cannot be carried out adequately owing to the limited amount of undamaged resources that can be used for investigation and emergency restoration (see Figure 2).

Furthermore, disaster management plans in many cases do not specify the target timeframe for recovery. Where they do, there is a possibility that the timeframe does not take into consideration resource constraints resulting from earthquake damages and therefore may not be realizable.

In view of the foregoing, it may be useful to add BCP perspectives (resource constraints, recovery timeframe, etc.) to conventional disaster management plans when monitoring and verifying the plans.

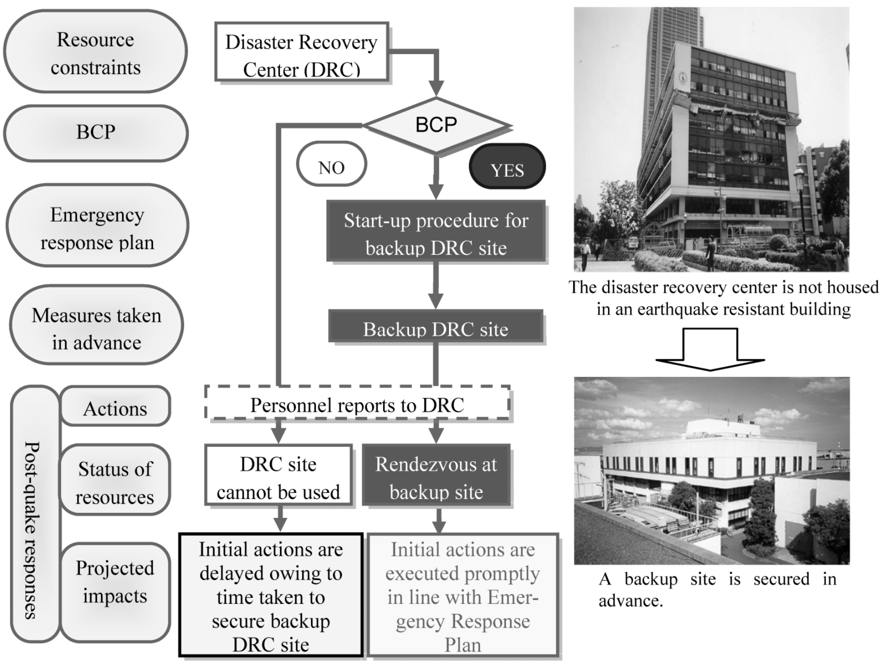


Fig. 2 Post-Quake Responses With and Without BCP

3. Formulation of Wastewater Utility BCP

3.1. Planning System

A wastewater utility BCP consists of an emergency response plan, a disaster preparedness plan, and a training, maintenance, and improvement plan. It is important to continually improve the individual plans, following the plan-do-check-act cycle. After preparing the plans, execute the procedures on a simulation basis (Do), identify any issues discovered during the training process (Check), and improve the plans as necessary (Act). In this way, the plans should be kept up-to-date and improved on an ongoing basis (see Figure 3).

(1) Emergency response plan
Sets forth procedures to follow in the aftermath of an earthquake, when available resources will be limited

(2) Disaster preparedness plan
Sets forth measures to be taken in advance, including investments, so that recovery can be achieved more quickly

(3) Training, maintenance and improvement plan
Sets forth training programs to enable proper execution of emergency response plans, as well as measures aimed at maintaining and improving the BCP

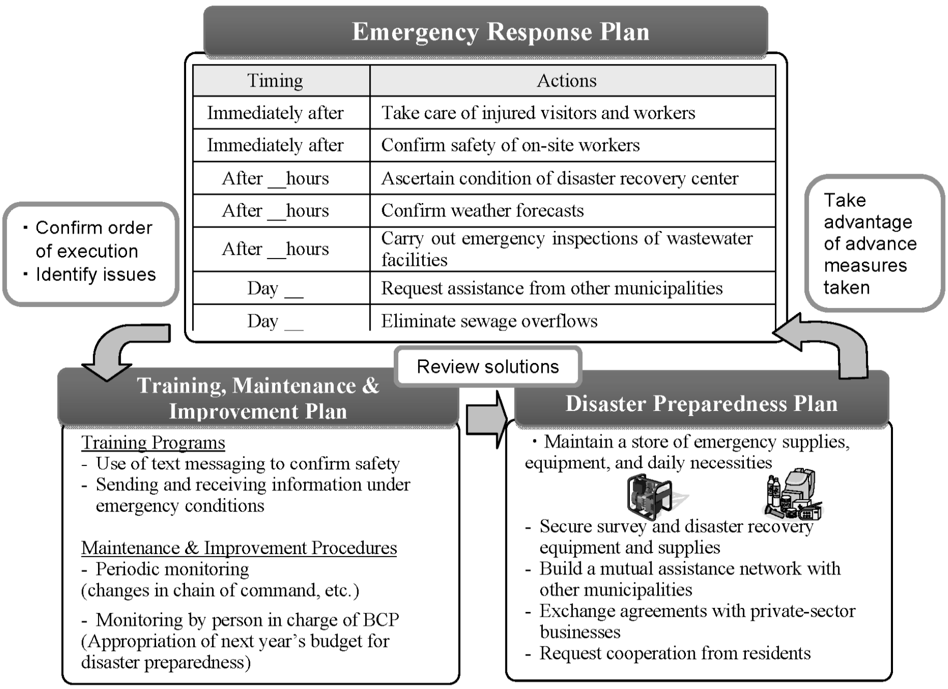


Fig. 3 Composition of Wastewater Utility BCP and PDCA Cycle for Ongoing Improvements

3.2. Preliminary Analysis

The figure below summarizes the procedures for preparing a wastewater utility BCP and the types of reviews required for the planning process.

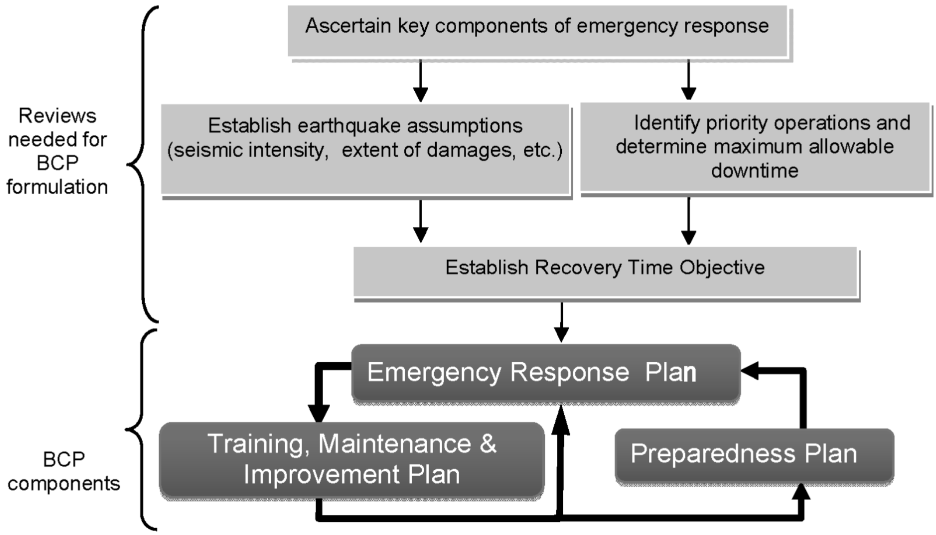


Fig. 4 Flow Chart of Wastewater Utility BCP Formulation Process

3.2.1. Key Factors of Emergency Response

Determine the following when preparing an emergency response plan:

(1) Organizational setup and chain of command to be followed in emergencies
Assign tasks to the employees in advance. Define the chain of command. For key persons such as division managers and team leaders (information team, investigation team, recovery team, etc.), designate two or more alternates and their order of priority, so that the chain of command is not disrupted even if a person along the chain is absent or inaccessible.

(2) Establish a method of communicating with key parties during emergencies
Identify government agencies, private organizations, and other parties that must be contacted as soon as possible after an earthquake, to notify conditions in the disaster area, request assistance, and other matters. Make a list of the contact persons, method and content of communication, and other particulars.

(3) Maintain a store of daily necessities and confirm inventory of equipment and supplies
As there is a possibility that relief supplies may not reach the disaster area quickly, ascertain that there is sufficient store of such supplies (drinking water, emergency rations, emergency toilets, etc.) on hand. Make an inventory of materials and equipment that will be needed for investigation and emergency restoration.

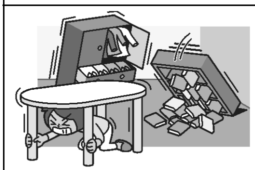
3.2.2. Earthquake Assumptions

(1) Assumed seismic intensity and time of occurrence

For the strength of earthquake, assume the same seismic intensity as that established by the government for the applicable region. If not established, assume a seismic intensity of Low 6 or High 6 (see Table 1).

Establish two scenarios for the time of earthquake occurrence—one for working hours and another for non-working hours (weekends, holidays, and after work on weekdays)—as relief activity will differ substantially between the two.

Tab. 1 Comparison of Low-6 and High-6 Earthquakes

Low 6	High 6
 	 
• Difficult to keep standing • Wall tiles and windowpanes shatter and fragments rain down	• Impossible to keep standing; must crawl to move from place to place • Wooden structures may list or collapse.

(2) Assumed damage

(a) Sewer lines

Determine the total length of sewers that are likely to be damaged by an earthquake, taking into consideration quakeproofing status, historical data, and other information (see Table 2).

Tab. 2 Sewer Damage Rates Recorded during Past Earthquakes

Seismic Intensity	Sewer Extension (km)		Rate of Damage		
	Total	Damaged	Average (%)	Maximum (%)	Minimum (%)
High 5	1,408.8	19.5	1.4	16.1	0
Low 6	9,039.6	140.3	1.6	8.1	0
High 6	4,895.9	232.9	4.8	25.6	0.6
7	43.0	9.3	21.7	—	—

(b) Treatment plants and pump stations

Figure 5 gives a flow chart for determining the assumed damage of an earthquake on a treatment plant or pump station.

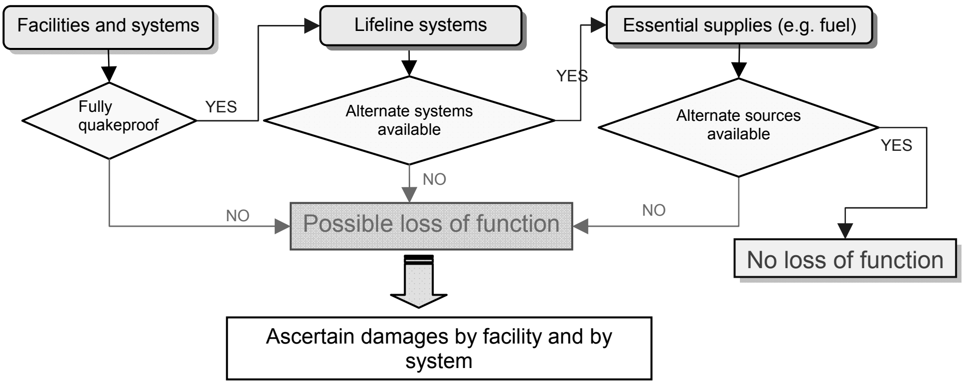


Fig. 5 Flow Chart for Treatment Plant/Pump Station Damage Assumption

(c) Resources

(i) Disaster recovery center
If the government building designated for the disaster recovery center is damaged, there are likely to be considerable delays in setting up a sewerage emergency headquarters and executing subsequent supervisory and other activities. Accordingly, assume that the disaster recovery center is operable if it is housed in an earthquake resistant structure and inoperable if not. In the latter case, secure an alternate seismically-resistant structure as backup.

(ii) Personnel
Estimate post-disaster personnel availability for the non-working-hour scenario by compiling a chronological list of employees who can be called in. To estimate the length of time it will take for each person to arrive, take into consideration the distance from the employee's residence to the rendezvous point and assume that travel will be on foot or bicycle (public transportation not running and private cars prohibited).

(iii) Lifeline systems
A large-scale earthquake can cause lifeline systems to be shut down for a considerable length of time. Lifeline disruptions are liable to greatly hamper operations. For example, government buildings may be unusable due to power failures, and phone lines may be tied up due to too many callers calling at once. Furthermore, power outages can reduce or terminate the functions of sewerage systems. Accordingly, it is important to estimate the downtime of lifeline systems and to review what to do during the outage period. A minimum of 24 hours should be assumed for the outage period, in consideration of the time assumed in other BCPs (see Table 3)

Tab. 3 Example of Lifeline System Assumptions

	Damage Assumptions	Recovery Forecast
Electric power	Power supply from the outside is highly likely to be disrupted immediately after an earthquake, due to severed power cables and other factors.	Recovery in the Kasumigaseki District is projected to take 1-2 days. Work will be limited to the capacity of the backup power generators.
Tele-phone	Telephone functions are unlikely to be disrupted by an earthquake, as phone facilities are highly earthquake resistant and buildings are equipped with redundant systems. Phone line congestion is expected.	In the unlikely event that a phone line is disrupted, it is likely to be restored in about 24 hours. Congestion of phone lines is likely to continue for 7 - 10 days.
Water	Water supply is highly likely to be dis-rupted immediately after an earthquake, due to damaged pipes and other factors.	Recovery in the Kasumigaseki District is projected to take 3 - 4 days. Water will be supplied from reservoirs and temporary toilets will be provided during the outage period.
Gas	Supply of medium-pressure gases will resume immediately after an earthquake, but that of low-pressure gases will be disrupted due to safety mechanisms.	Recovery of low-pressure gas supply is forecast to take from several days to about one month.

3.2.3. Priority Operations and Maximum Allowable Downtime

(1) Priority operations

Review emergency operations and operations carried out under normal circumstances to identify priority operations. Priority operations are those whose delay is estimated to have a strong impact on human life, property or socioeconomic activity or likely to generate strong public criticism of the government.

(2) Maximum allowable downtime

Establish deadlines (maximum allowable downtime) for the completion of individual priority operations, taking into consideration the social impact of a delay in their completion. Table 4 describes the five levels of social impact that delayed completion may have. At Level IV, the majority of people are dissatisfied with the government's response to the crisis.

Tab. 4 Social Impact of Delayed Operations

Impact	Description
I	Delayed operations have minimal social impact. Most people either do not sense any impact or feel that the government's response to the crisis was acceptable.
II	Delayed operations have a slight social impact. Most people feel that the government's response to the crisis was acceptable.
III	Delayed operations have a moderate social impact. There is some public criticism, but the majority of people feel that the government's response to the crisis was acceptable.
IV	Delayed operations have a sizable social impact. There is public criticism, and the majority of people feel that the government's response to the crisis was unacceptable.
V	Delayed operations have an enormous social impact. There is considerable public criticism, and most people feel that the government's response to the crisis was unacceptable.

3.2.4. Recovery Time Objective

Review whether a priority operation can be completed within the timeframe of the maximum allowable downtime (MAD), and determine the recovery time objective. To determine the recovery time objective, analyze the implementation procedures for the priority operation in question and allocate the necessary resources to that operation.

Next, analyze resource constraints based on damage assumptions made previously and estimate current recovery time. If the current recovery time is not within the timeframe of MAD, or if it is but a further reduction in the recovery time is desired, move up the recovery time objective by taking into consideration pre-disaster measures that can be taken to shorten the current recovery time. It is also important to continually move up the recovery time objective through constant improvements (see Figure 6).

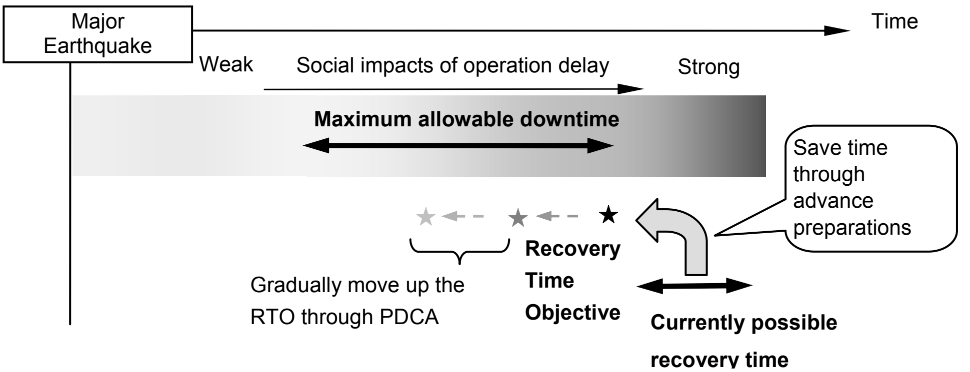


Fig. 6 Relationship among Maximum Allowable Downtime, Currently Possible Response Time, and Recovery Time Objective

4. Conclusion

While the study is focused on earthquakes, the BCP is applicable to other types of crisis situations, such as storms, floods, volcanic eruptions and other natural disasters, as well as terrorist attacks, IT breakdowns, and swine flu and other new contagious diseases.

Local governments must be prepared to respond to diverse crisis situations. A manual for preparing wastewater utility BCPs has been created on the basis of this study. The concepts set forth in the manual are anticipated to be of help in situations where natural disasters other than earthquakes affect wastewater facilities, as well as cases where utility employees are stricken with a new contagious disease.

References

[1] Cabinet Office. Director General for Disaster Management. June 2007. *Chuo shocho gyoumu keizoku guideline* [Business continuity guidelines for central government agencies].

[2] Tokyo Municipal Governance Research Institute. Mar 2009. *Shichoson no BCP* [BCP's for municipalities].

[3] National General Contractors Association of Japan. Apr 2009. *Chiiki kensetsu kigyo niokeru saigaiji jigyou keizoku no tebiki* [Guidelines on post-disaster business continuity for regional construction firms].

[4] Japan Sewage Works Association. 2006. *Gesuido no jishin taisaku manual* [Earthquake response manual for sewerage systems].

[5] Japan Sewage Works Association. Nov 2005. *Gesuido no fukkyu o isoge!! Niigata-ken Chuetsu jishin 100 nichi no tatakai* [Speed up sewerage restoration!! 100 days of struggle after the Niigata Chuetsu earthquake].

[6] Japan Meteorological Agency. Mar 2009. *Explanation table of JMA seismic intensity scale*.