Applying the Build Back Better strategy to sewage facilities (Minami-Gamo Wastewater Treatment Plant)

【Background】

Sendai City had been taking measures to improve the earthquake resilience of sewage pipes and to renew the emergency power supply in pumping stations since before the Great East Japan Earthquake. However, these measures were not fully adequate against a tsunami more massive than was ever imagined, and sewage treatment facilities in effect suffered catastrophic damage.

【Response】

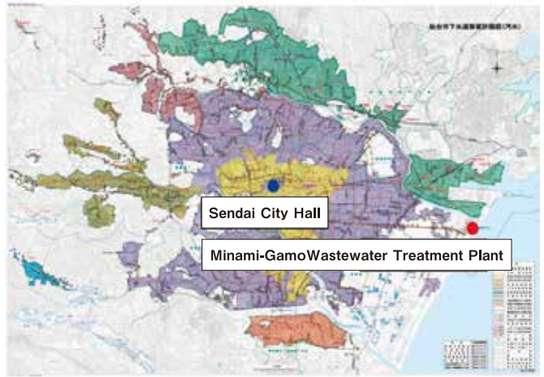
In preparation against the occurrence of the next disaster, Minami-Gamo Wastewater Treatment Plant, which suffered particularly severe damage due to its location along the coast, was restored as an environment-friendly, future-oriented facility that is resilient against earthquakes and tsunamis. Measures for improving the earthquake resilience of sewage pipes have also been further promoted based on asset management, and the plant's experiences and lessons learned from the earthquake disaster are actively being introduced in Japan and abroad.

1 Sewerage works in Sendai City

Sendai City began implementing sewerage works in 1899, and has the third oldest history in Japan following Tokyo and Osaka.

Approximately 99% (population ratio) of the city's sewage is treated by the public sewerage system, and more than 70% of Sendai City's sewage is treated at Minami-Gamo Wastewater Treatment Plant.

In addition to improving the earthquake resilience of sewage facilities, Sendai City is also directing its efforts to implementing measures against floods (development of rainwater drainage channels and rainwater pumping stations).



▲Sendai City Sewerage Works Map (sewage)

2 Disaster countermeasures for sewerage works before the earthquake disaster

From before the Great East Japan Earthquake, measures for improving earthquake resilience had been applied particularly to sewage pipes connected to hospitals and other such important facilities, and the renewal of emergency power supplies at pumping stations had been underway.

Additionally, in preparation against disasters, agreements were concluded with municipalities and relevant organizations regarding the restoration of sewage facilities, and business continuity plans (BCPs) were being formulated at some of the facilities.

▲Minami-Gamo Wastewater Treatment Plant berore the earthquake disaster

3 Damage to sewerage works in the Great East Japan Earthquake

Damage to sewerage works in the Great East Japan Earthquake (as of December 2012,approximate figures)

Works	Type of facility	Treatmentplant, etc.		Sewage pipes		Population ratio
		No. of facilities	No. of affected facilities	Total length	Length of pipes affected	
Public sewerage system	Treatment center	5	4	4,476km	94km	98%
	Pumping station	236	55			
	Government building, etc.	3	1			
Other		1,239	166	116km	8km	2%
Total		1,483	226	4,592km	102km	100%

The earthquake disaster caused damage to 226 treatment facilities and sewage pipes over a wide area of Sendai City (approx. 102km/4,592km), amounting to total damage worth approximately 72.6 billion yen (including damage worth approx. 57.6 billion yen at Minami-Gamo Wastewater Treatment Plant).

At pumping stations along the coast, the tsunami submerged electrical and mechanical equipment and shut down their water drainage functions. However, efforts were made to restore their functions by securing fuel to operate emergency power generators and installing temporary pumps.

At Minami-Gamo Wastewater Treatment Plant, which suffered particularly severe damage, most of the facilities were submerged by the tsunami, but all 101 personnel who were working at the plant when the tsunami hit evacuated to the roof of the administration building and were rescued by helicopter the following day.

The survey of damage to sewage pipes was able to be carried out smoothly by utilizing a system that was developed based on the introduction of asset management, as will be discussed later, and with support from twelve other cities. Nevertheless, roughly nine months were required to grasp the entirety of the situation due to the enormity of the damage. It is also worth mentioning that sewage overflow was able to be prevented in urban areas owing to immediate measures for necessary restoration after the disaster as part of the survey for identifying disaster areas.

▲Minami-Gamo Wastewater Treatment Plant being engulfed by the tsunami (March 11, 2011)

4 Restoration policy for Minami-Gamo Wastewater Treatment Plant

Along with the disposal of debris at the site of the plant, initiatives for early restoration began to be explored based on a discussion by a committee composed of outside experts. They raised the view that restoration measures should preferably take advantage of the natural gravity between the city center, situated at an altitude of approximately 45m, and the treatment plant located at an altitude of approximately 3m. There was also the view that it would be reasonable to restore the plant at its present site, from the perspectives of the restoration duration and project cost, in addition to proposals to implement tsunami disaster countermeasures, establish measures for securing electricity at times of disaster, and engage in efforts to reduce environmental burden. Six months after the earthquake disaster, a restoration policy that went beyond the restoration of conventional functions was ready to be approved.

However, in order for a project to be approved as a nationally subsidized disaster restoration project, as a rule it had to aim for restoration to a pre-disaster condition. In this respect, the abovementioned views of experts entailed restoration of what could be considered a different facility from the original, and there was thus the possibility that the project might fall outside the scope of the subsidy. Therefore, various project conditions were compared and examined, such as economic efficiency, construction time, and the water environment during the process of restoring the plant's sewage treatment function, and adjustments were made so that the project would emphasize the restoration of the plant's functions to pre-disaster conditions but would also include measures to cope with future tsunamis. The project was thus approved as a subsidized disaster restoration project.

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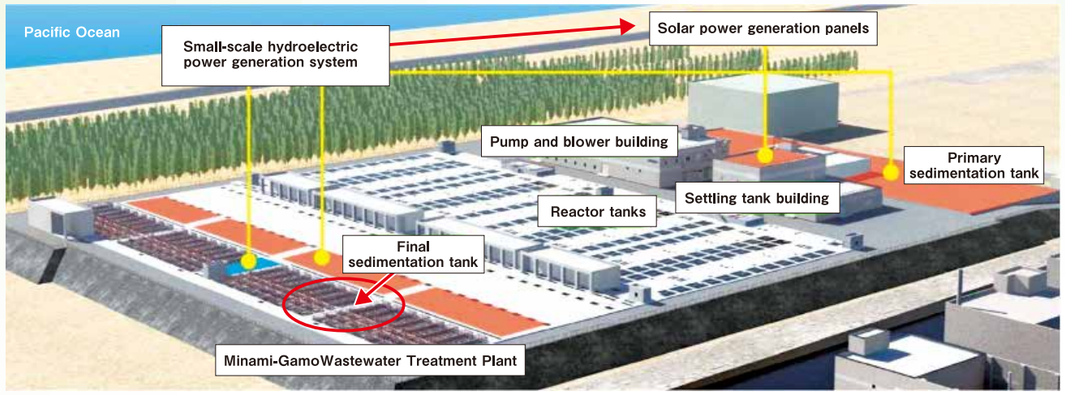
5 Features of the new facility (Minami-Gamo Wastewater Treatment Plant) (Budget: approx.64.7 billion yen)



▲ Image of Minami-Gamo Wastewater Treatment Plant after restoration

① Creative measures for facilities

The sedimentation equipment(※1) in the primary and final sedimentation tanks was designed as a two-level structure for compactness, and the reactor tanks(※2) were installed underground. These measures helped save space in the treatment facility, shorten construction time, and reduce construction costs.

(※1) Sedimentation equipment: Equipment that collects the sludge that settles and accumulates in the sedimentation tank and sends the separated wastewater to a different facility.
(※2) Reactor tank: Equipment for decomposing and treating organic matter in sewage by mixing bacteria and other such microorganisms in to the sewage and blowing in air.

② Disaster countermeasures

The plant was elevated so it could withstand tsunamis of T.P.+10.4m(※3), and the buildings were equipped with watertight doors. Additionally, in preparation against a loss of power supply, a route was established that would allow wastewater to undergo the minimum treatment necessary and then be discharged without using a pump.

(※3) T.P. (Tokyo Peil) refers to Tokyo Bay mean sea level, which is the reference point for level surveying in Japan.

③ Environmental considerations

Solar power and hydroelectric power generation systems were newly installed to control the use of electricity, and various energy-saving devices were introduced.

By adopting the plan for restoring the plant with improved functions based on measures such as those mentioned below, the plant's facilities and equipment were in effect developed in consideration of disaster risk reduction and the environment. Furthermore, construction time was able to be shortened compared to the plan for restoring the plant to pre-disaster standards, and total project cost was able to be reduced by approximately 28.3 billion yen.

The project thus became a case example that embodies the concept of "Build Back Better."

Plan and result of time and cost for Minami-Gamo Wastewater Treatment Plant restoration

Item	Plan for restoration to pre-disaster standards	Plan for restoration with improved functions	Result of restoration with improved functions (FY2019)
Construction time	Approx. 55 months	Approx. 46 months	Approx. 43 months
Approximate project cost	Approx. ¥93 billion	Approx. ¥66 billion	Approx. ¥64.7 billion
Maintenance management expense (electricity charge for water treatment/year)	Approx. ¥170 million	Approx. ¥170 million	Approx. ¥280 million

6 Sewerage BCP

In the face of the Great East Japan Earthquake, prompt initial action was able to be taken, owing to a sewerage disaster response manual that was formulated in FY2006, and a business continuity plan (BCP) that was being formulated in FY2010.

After the earthquake disaster, the experience of the disaster, including a review of damage estimation and countermeasures, was incorporated into the BCP, and as a result, two types of BCPs were ultimately formulated, including one for earthquakes and tsunamis and the other for heavy rainstorms. As examples, the plans specify responses and actions to be taken by staff members in the event of a disaster, such as estimating the number of personnel needed to undertake damage investigations to facilitate smooth coordination among relevant departments. The plans also include regular emergency drills in cooperation with private businesses that are parties to a disaster agreement, and provide for other such initiatives that aim to maintain and enhance disaster responses based on the experiences and lessons learned from the earthquake disaster.

7 Asset management

Asset management is the process of systematically arranging and implementing construction and management operations to gain the maximum effect from assets (facilities) owned by organizations. The pipeline division of the Sendai City Sewerage Department acquired ISO 55001, the international standard for asset management systems, in FY2013 for the first time in Japan. Thereafter, the facilities division and septic tank division also acquired the certification in FY2014 and FY2017, respectively, such that all divisions of Sendai City's sewerage works are now ISO-certified.

Surveys conducted to date indicate that sewage pipes can be used for about 1.5 times longer than their standard service life, and sewage facilities about 1.5 to 2 times longer. By reducing the frequency of renewals, cost reductions can be realized.

Budgets and personnel resources may be limited, but by utilizing asset management to prioritize important projects and estimate long-term costs, projects for the maintenance management of sewage pipes and improvement of earthquake resilience can be implemented stably and efficiently, the safety of facilities can be secured, and flood countermeasures (development of rainwater drainage channels and rainwater pumping stations) can be taken.

8 Providing technical cooperation and sharing lessons learned with the world

With the cooperation of the Ministry of Land, Infrastructure, Transport and Tourism and Japan International Cooperation Agency (JICA), Sendai City is sharing the valuable experiences and lessons learned from the disaster with the world by sending lecturers to training programs held in Japan on disaster prevention and mitigation measures and on asset management, in addition to sending personnel to the City of Izmir in Turkey and participating in international conferences.

At Minami-Gamo Wastewater Treatment Plant, lessons learned from the earthquake disaster are being shared with visitors through videos showing the situation when the tsunami hit and the process from the formulation of the restoration policy to implementation of restoration works, and a tour of pumping station No. 3, which was distorted by the tsunami.

▲ Pumping Station No.3 at Minami-Gamo Wastewater Treatment Plant,which wasdistorted

▲ Visitors to Minami-Gamo Wastewater Treatment Plant

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