

4-3 Network of sewage treatment plants using connection pipe and its efforts

Yuuji Nakatsubo¹, Shigeki Chiba¹, Hiroshi Baba¹, Kenzo Sato^{1*}

¹ Planning Section, Engineering Department, Regional Sewerage Office, Bureau of Sewerage, Tokyo Metropolitan Government.

ABSTRACT

Tokyo Metropolitan Government (TMG) is now the constructing the network system by using connection pipes which connect the sewage treatment plants (we call “water reclamation center”). By using this system, wastewater, sludge, etc are sent each other, and shared the capacity of treatment each other. This network system is expected to profit various effects, such as saving construction and renewal cost by sharing and enlarging the capacity of the facilities, improvement of the efficiency of operation and maintenance facilities, backup function in case of disaster, and the stabilization of wastewater treatment. It reports on the outline and the effects of connection pipe which is operating now.

KEYWORDS: Network, Connection Pipe, Sharing of Sewerage Treatment Function

INTRODUCTION

Tama area, situated in the west of Tokyo, is about 116,000ha. Excluding the mountainous district, about 49,000ha is regional sewerage planned area. At the end of 2008 fiscal year, percentage of sewered population is 98%. Most of the regional sewerage planned area is located in Tama-river basin.

Fig.1 shows the location of water reclamation centers in Tama-river basin. There are six water reclamation centers, all of which located on the both sides of Tama-river, and 3 pairs of water reclamation centers are faced each other. So it is possible to network these faced centers by constructing connection pipe under the river.

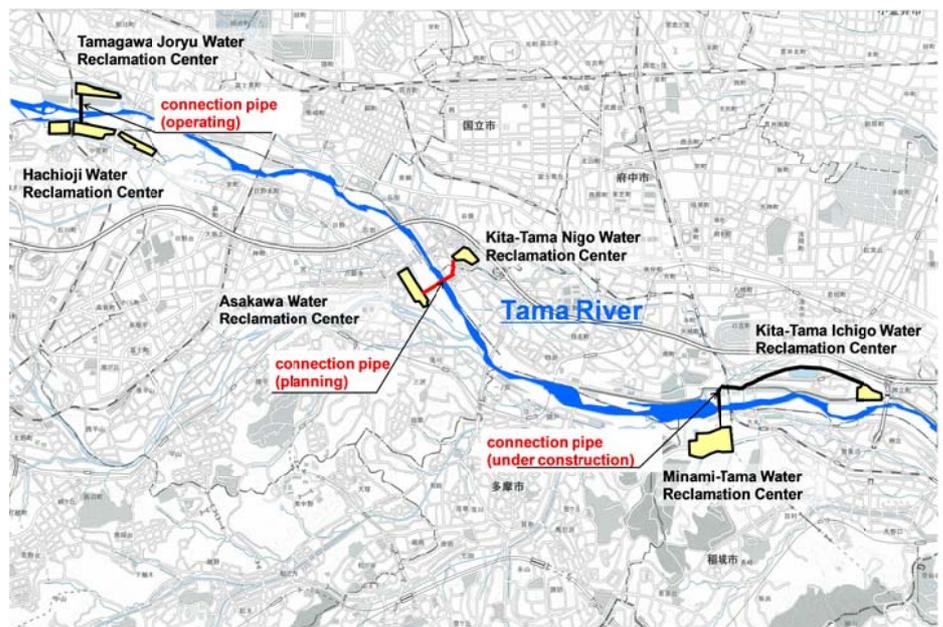


Fig.1 Location of water reclamation centers in Tama-river basin

Six water reclamation centers started one by one. The first was Minami-Tama in 1971, the latest were Asakawa and Hachioji in 1996. All of these centers have passed about 15 to 40 years since constructed, so a number of facilities need to be renovated. Moreover, in order to improve the water quality and prevent from global warming, advanced wastewater treatment such as A2O method and reducing greenhouse gases and improving energy efficiency such as high temperature incineration, carbonization, and sludge gasification needs to be implemented along with the renewal of facilities. To advance these measures with limited financial resource, it is necessary to maximize the capability of existing treatment facilities and reduce the construction and maintenance cost.

The amount of treated water discharged from six water reclamation center is about half of stream water in Tama-river. In proportion to increasing sewerred population, water quality of Tama-river has improved so well that more than a million of sweet fish runs up Tama-river. Tama-river is previous water-shed area, and 20 millions of people visit in a year. So if the function of water reclamation plant is stopped by disaster such as earthquake, not only the life of people but also the water environment are seriously damaged.

To prepare such a situation, the TMG advances the construction of network system using connection pipe so as to reduce construction, renovation and maintenance cost and make a backup in case of disaster.

CONSTRUCTION OF CONNECTION PIPE AND ITS EFFORTS

The purpose of connection pipe

The purposes of construction connection pipe are as follows:

1. Saving construction and renewal cost by sharing and enlargement facilities

Using connection pipe, water reclamation centers can send wastewater and sludge each other. So, these centers can share the facilities of wastewater treatment and sludge treatment during renovation and inspection of facilities. As a result, the cost of construction and renovation these preparatory sharing facilities can be saved. Moreover, the cost of sludge facilities such as sludge incinerators can be saved because sharing sludge incinerators between centers enable the scale of each incinerator to

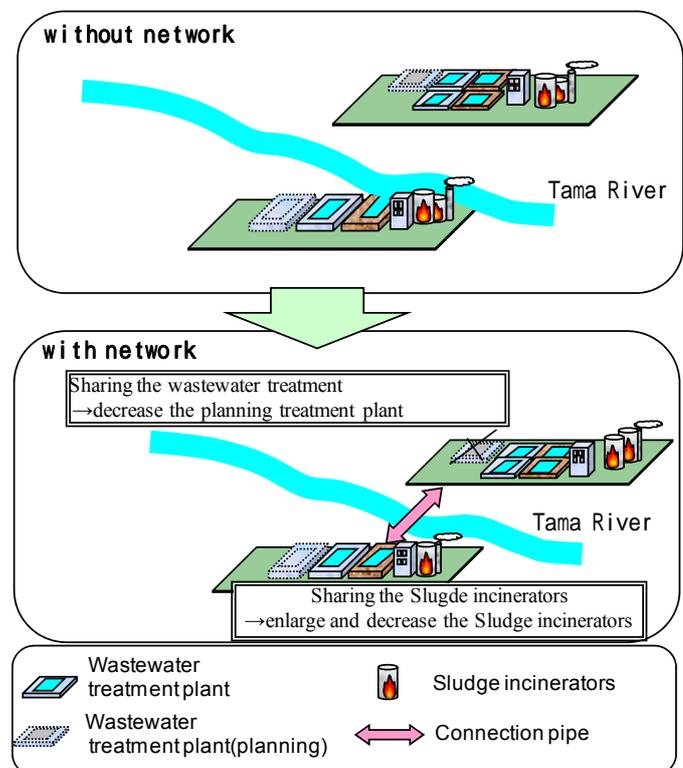


Fig.2 Image of sharing facilities with network

enlarge and the number of incinerator to decrease. Fig.2 shows the image of sharing facilities with network.

2. Increase efficiency of operation and maintenance facilities and stabilization of effluent quality

Sending wastewater and sludge to each other, it is expected that water reclamation centers can be operated and maintained more efficiently, such as:

- (1) Reduction of fuel cost by sending sludge each other and increasing load factor of incinerator.
 - (2) Reduction of energy cost by sending wastewater each other and operating blower efficiently.
 - (3) Reduction of labor cost by concentrating supervisory control of two wastewater treatment plants.
- Also, even if the inflow volume or quality was changed rapidly, stable wastewater treatment can be done by sending inflow to the other.

3. Backups in case of disaster such as earthquakes

It is said that the probability that the earthquake of the M7 class will occur in South Kanto which area includes tama area within 30 years in the future is expected to be about 70%.

Even if the capacity of water reclamation centers decreases by disaster such as earthquake, the other one can back up by using connection pipe.

Construction of connection pipe

The first connection pipe between Tamagawa Joryu and Hachioji Water Reclamation Center was constructed from 2003 to 2005.

Table.1 shows the outline of these water reclamation centers. The operation of Tamagawa Joryu started in 1978, so many facilities are older than depreciation period, and have to be renovated one by one. On the other hand, the operation of Hachioji started in 1996, so facilities are younger than depreciation period.

Table.1 The outline of Water Reclamation Centers

Name of Center	Tamagawa Joryu	Hachioji
Planned Area(ha)	9,349	8,533
Planned Population	439,200	446,800
Treatment Capacity(m3/day)	248,200	160,400
Operation Started	1978	1996
The number of Wastewater treatment trains	2 trains: activated sludge process 2 trains: A2O process	2 trains: activated sludge process 2 trains: A2O process
Sludge Incinerations (sludge cake/day)	2incinerations:100 t 1incineration:150t	1incineration:100t 1incineration:50t

Fig.3 shows the profile of connection pipe. Considering the construction cost and maintenance, the tunnel structure under the riverbed of Tama-river was adopted. The length of the connection pipe is about 570m, and the depth from the ground to the invert elevation of connection pipe is about 20m. The diameter inside the connection pipe is 3,500mm, and the width of 1.2m was secured for people to walk through the connection pipe.

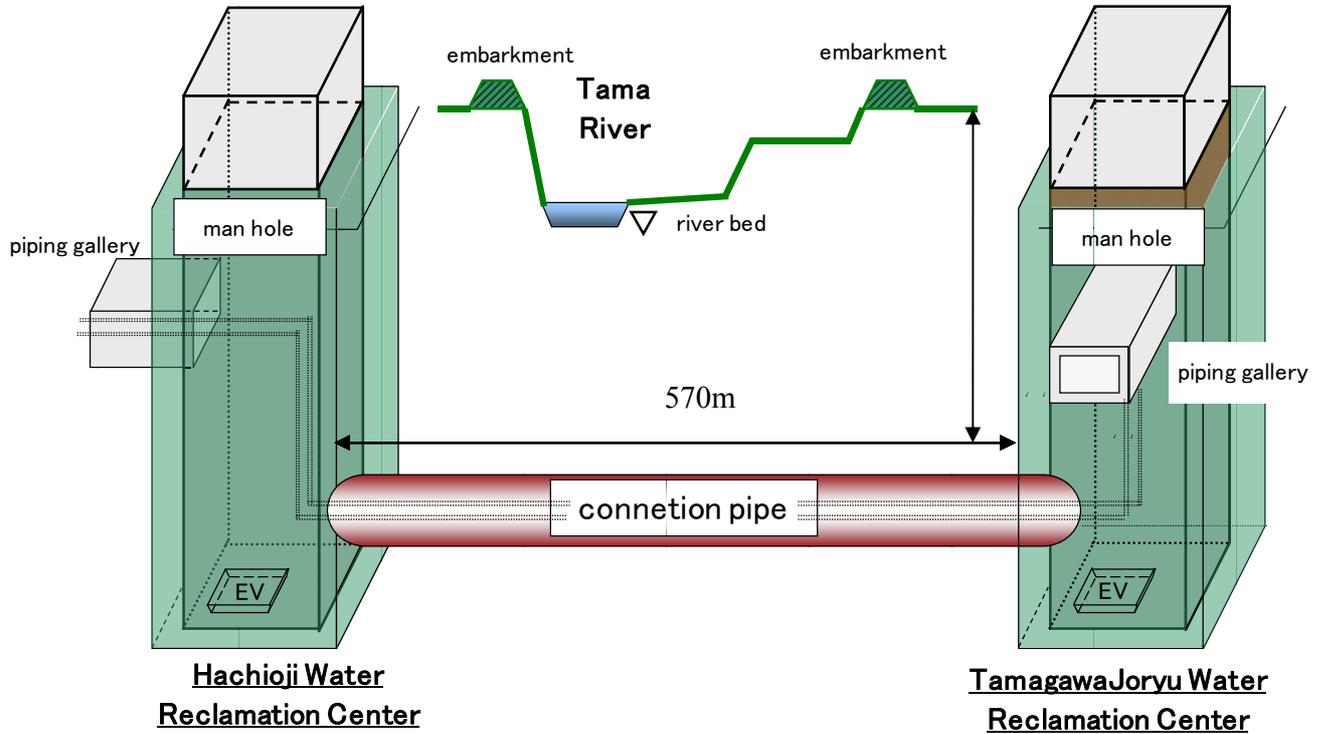


Fig.3 The profile of connection pipe

Fig.4 and Photo.1 show the inside of the connection pipe. Wastewater pipes, sludge pipes, reclaimed water pipe, et al are inside the connection pipe in order to send wastewater and sludge between the water reclamation centers. Using optical fibers which are also inside the pipe, concentrating supervisory control of two water reclamation centers can be possible.

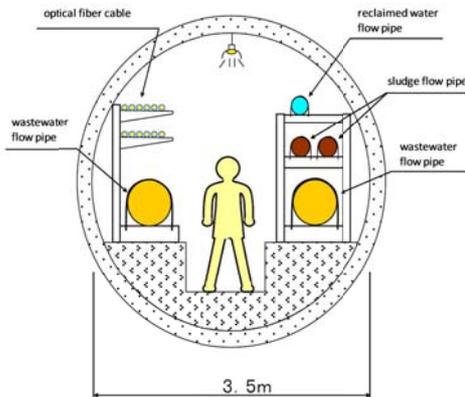


Fig.4 Sectional view of the connection pipe



Photo.1 Inside of the connection pipe

Table.2 shows the specification inside the connection pipe. There are two wastewater flow pipes, the diameters of which are 500mm. The sending capacity of wastewater pipe is equal to the largest train of water treatment of two water reclamation centers. That is because in case the capacity of water treatment system decreased during renewal and maintenance, water reclamation center can send wastewater to the other center and supply the shortage. Wastewater was sent from discharge well to discharge well of the other center using pump, or to receiving well with gravity flow. Fig 5 shows the system of sending wastewater using connection pipe.

There are two sludge flow pipes, the diameters of which are 200mm. The capacity of sludge pipe is equal to the largest incinerator of two centers because of the same reason as wastewater pipe.

Using respective sludge pipes, raw sludge and excess sludge can be sent separately from one center to another.

Elevators are established with both vertical shafts of connection pipe allowing for carrying materials and daily maintenance.

The method of tunnel construction was muddy water shield, and The TMG tried to reduce construction cost and period by using secondary lining Abbreviation method and wide segment et.al. Total construction cost of connection pipe is 3.2 billion yen, and construction period is about 2years 2months.

Efforts of connection pipe

The efforts of connection pipe between Tamagawa Joryu and Hachioji Water Reclamation Center are as follows.

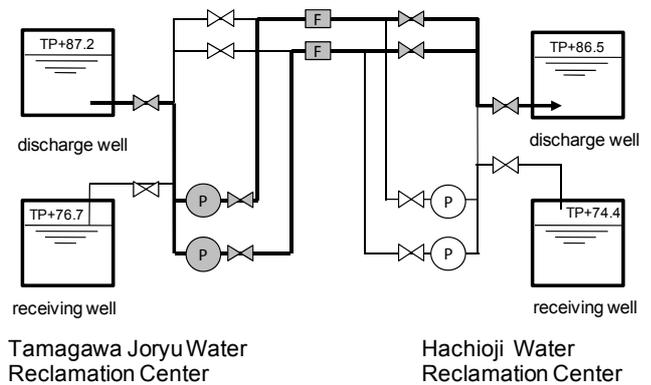
(1) Saving construction and renewal cost by sharing and enlargement facilities

Most of sludge incinerators in Tamagawa Joryu Water Reclamation Centers have passed more than 10 years since constructed, so the TMG advances the renewal of sludge incinerators

Table.2 The specification inside the connection pipe

Name of facilities	Scale of facilities
Wastewater flow pipe	φ500×2
Sludge flow pipe	φ200×2
Reclaimed water pipe	φ200×1
Passage for management	W1,200×H2,200
Others: Optical fiber, Electric cables et.al	

(1) Using Pump



(2) Gravity Flow

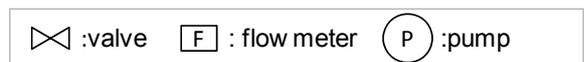
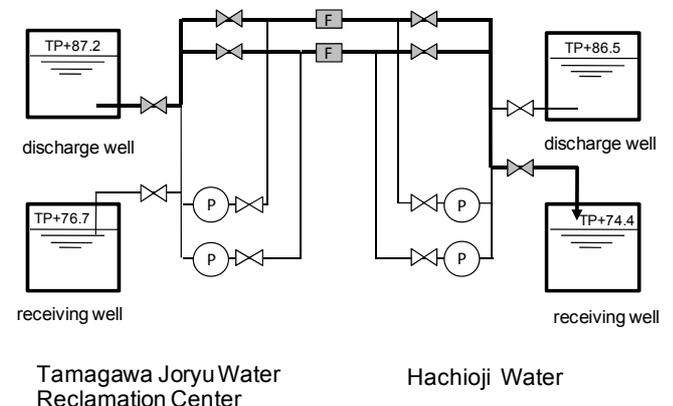


Fig.5 System of sending wastewater using connection pipe

premeditatedly and efficiently.

In 2005, 150t (sludge cake/ day) sludge incinerator was reconstructed instead of 50t and 100t old sludge incinerator, by sending sludge from Tamagawa Joryu to Hachioji Water Reclamation Center. Cost reduction of enlargement sludge incinerator is about 1.3billion yen. Fig.6 shows the reconstruction of enlargement sludge incinerator with network.

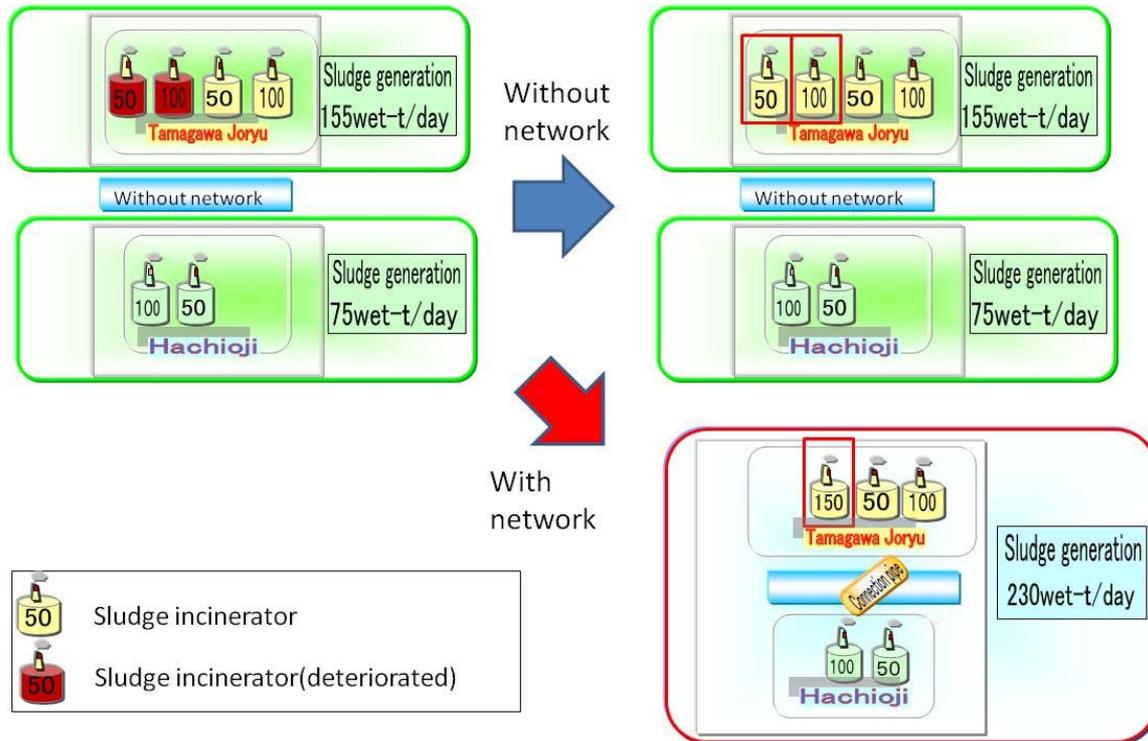


Fig.6 Reconstruction of enlargement sludge incinerator with network

There are five sludge incinerators in Tamagawa Joryu and Hachioji water reclamation center. It is expected that reconstruction of sludge incinerator cost reduced in the same way. The result of cost-effectiveness calculation is that cost reduction of reconstruction enlargement sludge incinerator is about as 1.3 times high as construction cost of connection pipe.

Moreover, two cycles of sludge incinerator cost-reduction effectiveness is expected. The connection pipe itself is civil structure, so effective working life is more than 50 years. On the other hand, effective working life of sludge incinerator is about 20 to 25 years.

(2) Improvement of the efficiency of operation and maintenance works

The result of experimental operation is that sending wastewater and sludge to another center each other can reduce the fuel and energy cost. But it is difficult to estimate cost reduction throughout the year because of various inflow rate and inflow pattern of wastewater. It is necessary to investigate how to reduce the fuel and energy cost using connection pipe continuously.

On the other hand, reduction of entrust labor cost by concentrating supervisory control exists. The reduction cost is scores of million yen in a year.

Moreover, two water reclamation centers can operate wastewater treatment and sludge treatment more stability while the treatment capacity is decreasing because of inspection and maintenance. Generally, sludge incinerator received periodic inspection and repair within one or two month every year. Sometimes sludge cake has to be moved with truck because of the lack of incinerator capacity. But after constructing network, land transportation of sludge, which sometimes leaks odor, is eliminated.

(3) Backup function such as earthquakes at disaster

We are happy not to use backup system of connection pipe at disaster from now, but no one knows when the earthquake occurs. the earthquake-proof measures to the sewerage structures is advanced, but it takes many years to complete the measures because there are many structures in the water reclamation center most of which cannot stop the function. By using connection pipe, even if the treatment capacity of one water reclamation center decreased in case of serious earthquake, it is possible to maintain treatment capacity by sending wastewater to the other center.

CONCLUSIONS

Constructing the connection pipe between the water reclamation centers so as to send the wastewater, sludge, at el to each other, the TMG can reduce the cost of construction and renewal facilities and build more strong sewerage system in the disaster.

The second connection pipe between the Kitatamaichigo and Minamitama water reclamation center is under construction, and the third connection pipe between Kitatamanigo and Asakawa is under planning.

After three connection pipes will be constructed, and the entire water reclamation center in the Tama-river basin is connected with another one, it is expected that this network system contributes to the protection of safety and comfortable life and more effectiveness sewerage works.

