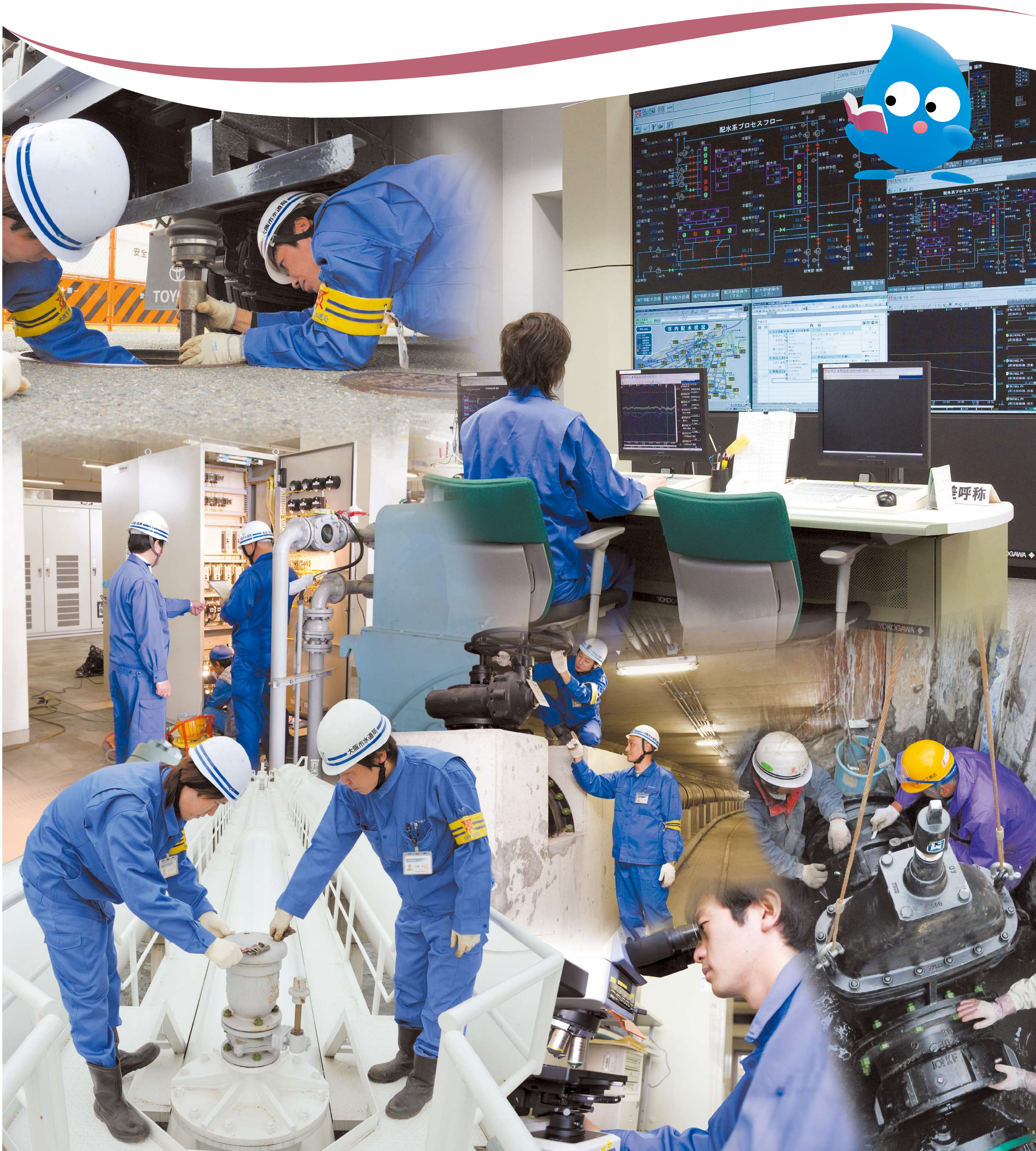
Osaka Municipal Waterworks Bureau

Osaka City Waterworks Technology

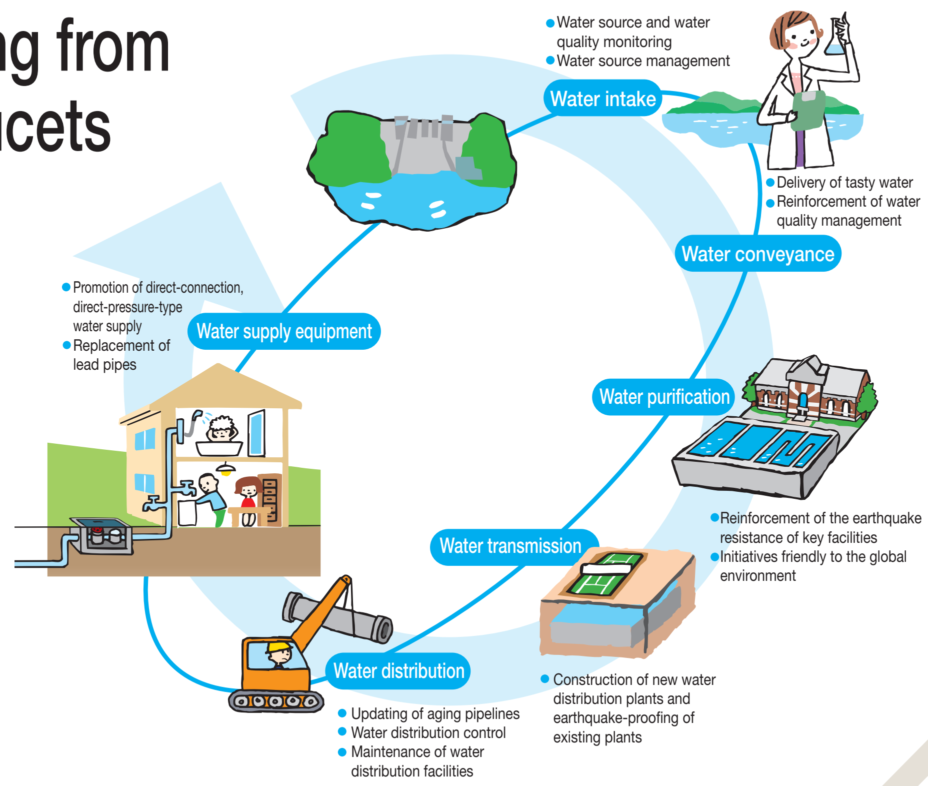
Specialized information magazine to help deepen understanding of waterworks technology

2023



Waterworks Technology Supporting Osaka's Total System, Covering from Water Sources to Faucets

For over 120 years since its founding in 1895, the Osaka City Waterworks Bureau has worked toward the stable supply of water in terms of both quality and quantity by establishing a total system covering from water sources to faucets. In recent years, however, the environment surrounding waterworks business has been becoming increasingly stringent as a result of successive revisions to water quality standards, the enhancement of water quality inspection, the advent of the time of large-scale facility renewal, and the promotion of environmental protection. In order to ensure stable and sustainable water supply services to meet the needs of the times, Osaka is faced with the necessity for efficiently taking continuous improvement measures for the existing waterworks system with consideration of a new philosophy for the future, new technologies, and customer needs from a contemporary point of view.



Working according to Waterworks Grand Design

In view of the situation, Osaka formulated a waterworks master plan named the Osaka City Waterworks Grand Design in April 2006 in order to respond to the challenges that the Waterworks Bureau was facing as well as medium- to long-term challenges. This master plan sets the social role and responsibility of Osaka's waterworks as its Vision and Mission in pursuit of developing a waterworks suitable to mature communities where residents and visitors conduct lively urban activities.

Osaka is promoting a variety of measures based on the Grand Design, including projects for improving water purification facilities and distribution pipes.

VISION

•Deliver safe, high-quality water stably to customers at reasonable and fair charges.

•Contribute to the development of Japan's water supply business.

CONCEPT

Connect and combine Grand Design measures and action plans based on the strategies, and incorporate them into the basic system to establish new waterworks that will achieve the universal vision and mission.

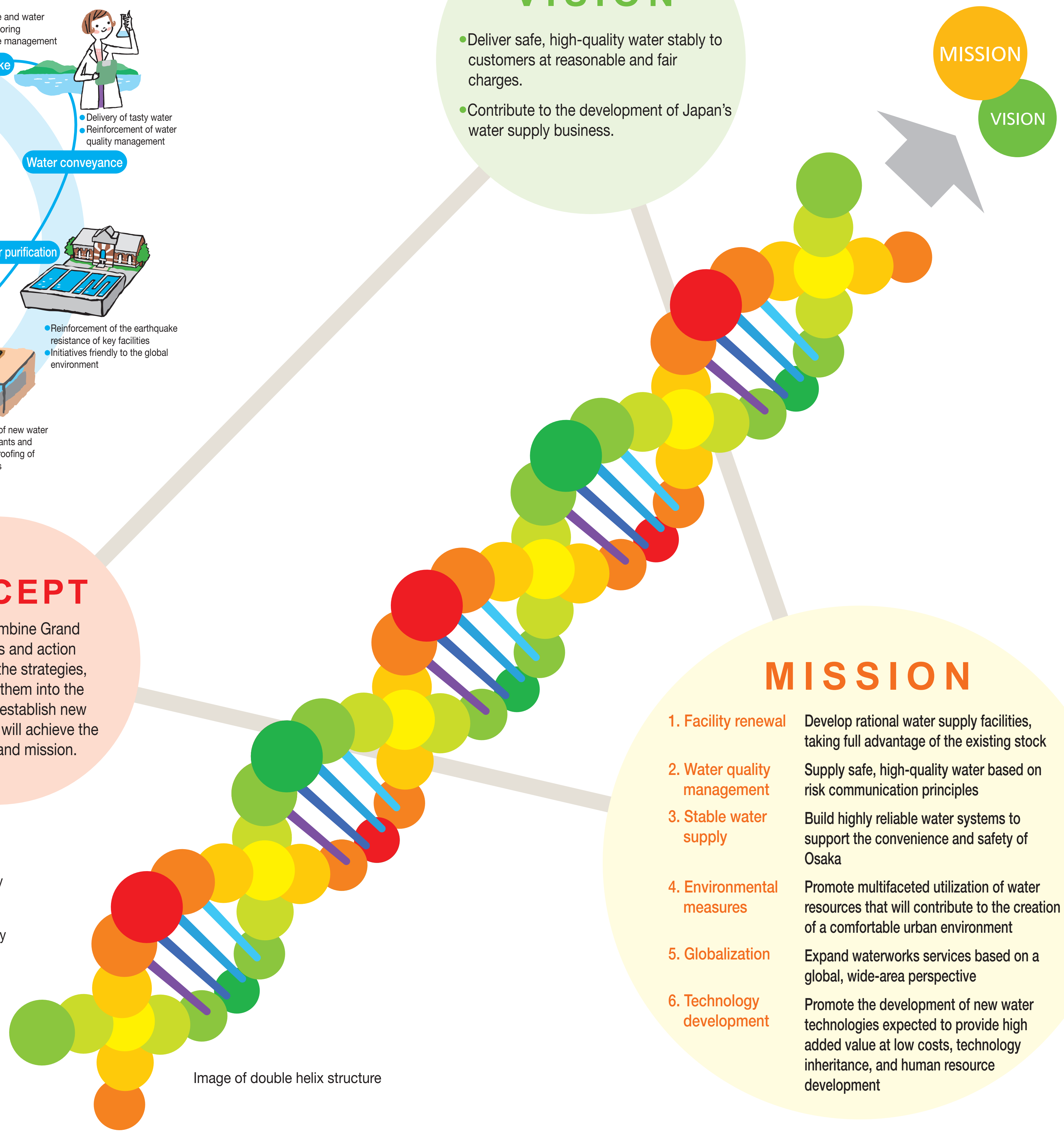


Image of double helix structure

MISSION

1. Facility renewal	Develop rational water supply facilities, taking full advantage of the existing stock
2. Water quality management	Supply safe, high-quality water based on risk communication principles
3. Stable water supply	Build highly reliable water systems to support the convenience and safety of Osaka
4. Environmental measures	Promote multifaceted utilization of water resources that will contribute to the creation of a comfortable urban environment
5. Globalization	Expand waterworks services based on a global, wide-area perspective
6. Technology development	Promote the development of new water technologies expected to provide high added value at low costs, technology inheritance, and human resource development

CONTENTS

Further improvement of safe and tasty water

Further improvement of safe and tasty water

The Waterworks Bureau sets its own goal for the improvement of safety and palatability of tap water, toward which it promotes study on water treatment technology and works to raise the level of tap water safety and quality management.

Acquisition of ISO 22000 certification

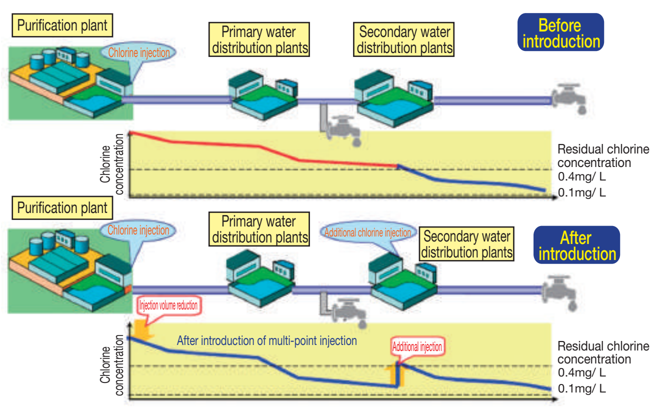
In pursuit of the stable supply of safer and higher-quality tap water, the Waterworks Bureau integrated its water safety planning and safety and quality management efforts based on ISO 9001 for water treatment, established its unique Water Safety Management System, and acquired ISO 22000 certification, an international standard for food safety management. (December 2008, for the first time in the world as a public water supply business entity)

Elimination of chlorine smell

The Waterworks Bureau works toward the homogenization and reduction of the residual chlorine concentration, which is one of the major factors of customers' dissatisfaction with tap water, while ensuring the safety.

Reduction and homogenization of residual chlorine

The Waterworks Bureau promotes a shift from the conventional chlorine injection system mainly applied to water purification plants to a distributed chlorine injection system centered in the major water distribution plants of Osaka City, thereby conducting well-balanced residual chlorine control and achieving the reduction of chlorine smell.



Water Resources and Water Quality Conservation

- Working to secure stable quantity and quality of water -

Tap water source - Yodo River

The water supply of Osaka completely depends on the Yodo River, one of the largest rivers in Japan. The Katsura River, the Uji River, and the Kizu River merge into the Yodo River, which flows down to Osaka Bay through the Osaka Plain. The Katsura River, the Uji River, and the Kizu River are different from one another in flow characteristics, but they mutually compensate and contribute to the stability of the flow of the Yodo River.
Lake Biwa, in particular, which is Japan's largest lake located upstream of the Uji River, plays a major role in adjusting the flow rate of the Yodo River.

Water Source Development

Since early on, the City of Osaka has endeavored to secure water sources in Lake Biwa and the Yodo River systems in response to an increasing demand for water.
Osaka started its First-phase Project of Yodo River Water Control in 1943, and it completed the reconstruction of the Nagara Movable Weir (the present Great Yodo River Weir), the construction of the Takayama Dam, and the construction of the Shorenji Dam in 1963, 1969, and 1970, respectively. Osaka took part in the Shorenji Water Resource Project and the Lake Biwa Development Project as well, which were completed in 1971 and 1991, respectively. Osaka has thus secured a total flow rate of 30.976 m^3/s (approximately 2,676,000 m^3/day) to respond adequately to its future water demand.

Lake Biwa Comprehensive Development Project

The Lake Biwa Comprehensive Development Project consisted of two projects. That is, the Lake Biwa Development Project (fiscal 1968 to 1991), which was planned to maintain a flow rate of 40 m^3/s in response to the Hanshin area's new demand for water and to ensure the flood control of Lake Biwa, and the Regional Development Project (fiscal 1972 to 1996), which was planned for the development and maintenance of Lake Biwa and its surroundings.
The Lake Biwa Comprehensive Development Project started in compliance with the Act on Special Measures concerning Lake Biwa Comprehensive Development, which was enacted in 1972, and took 25 years for completion (from fiscal 1972 to 1996) at a total project cost of 1,907,400 million yen.

■ Development of water resources

■ Water resources development by Osaka City (Unit: m^3/sec.)

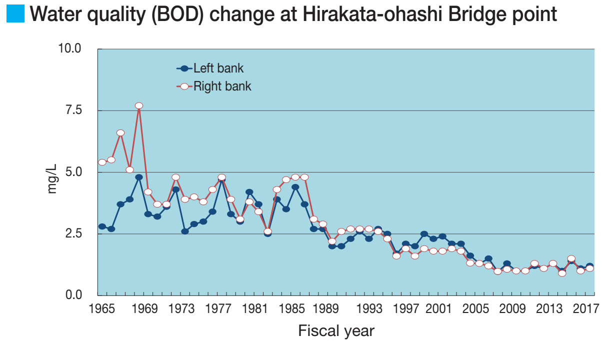
	Before the first phase of river water control	The first phase of river water control	Nagara*	Takayama	Seirenji	Shorenji	Lake Biwa	Total
Domestic water	10.600	6.000	1.420	2.249	1.035	2.187	7.485	30.976
Industrial water		1.200	1.690			0.655		3.545

* Current Great Yodo RIver Weir

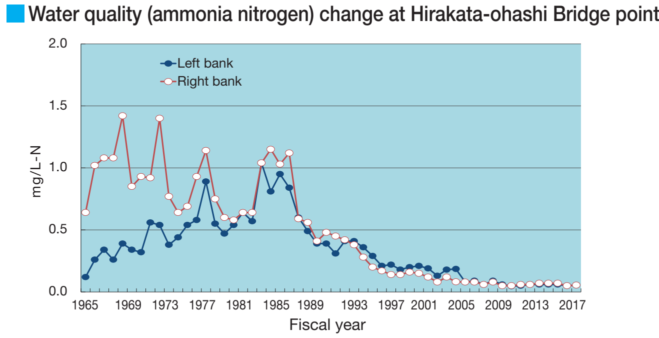
Changes in and Conservation of Water Quality

Originating from Lake Biwa, the largest lake in Japan, the Yodo River is blessed with a large amount of water at a stable flow rate. Cities of various sizes, including Kyoto, are located in the upper and middle reaches of the river, and urban wastewater of these cities flows into the Yodo River water system. It is therefore very important for water supply entities that take water downstream of the Yodo River to maintain the water quality of the Yodo River system.
The Yodo River had a high biochemical oxygen demand (BOD) as an organic pollution index from the latter part of the 1950s through the latter part of the 1960s. With the development of sewers in the upper and middle reaches, however, there has been a considerable reduction in the value. In addition, the concentration of ammonia nitrogen (NH_3-N) increased from the latter part of the 1960s to the 1970s, but it has been declining in recent years.
The Yodo River Water Quality Consultative Committee was founded in August 1965 in order to maintain the water source quality of the Yodo River, and it currently consists of nine water utilities taking raw water from the Yodo River (Osaka, Moriguchi, Hirakata, Suita, Amagasaki, Itami, Nishinomiya, the Osaka Water Supply Authority, and the Hanshin Water Supply Authority). The Committee has been proactively conducting activities for the maintenance of water source quality, including the measurement and inspection of water source quality, and making requests addressed to organizations concerned with water quality maintenance.
Furthermore, six prefectures and three ordinance-designated cities in the Kinki region located along the Yodo River system (Kyoto Prefecture, Osaka Prefecture, Mie Prefecture, Shiga Prefecture, Nara Prefecture, Hyogo Prefecture, Kyoto City, Osaka City, and Kobe City) established the Lake Biwa-Yodo River Water Quality Preservation Organization in September 1993. The Organization has been conducting a variety of projects for the purpose of research and development concerning water purification technology for the water in the Lake Biwa and Yodo River water systems.

■ Water quality (BOD) change at Hirakata-ohashi Bridge point



■ Water quality (ammonia nitrogen) change at Hirakata-ohashi Bridge point



* Prepared based on the results of surveys by the Yodo River Water Quality Consultative Committee

Outline of Water Purification Plants

Outline of water purification plants

Osaka City has three water purification plants: Kunijima, Niwakubo and Toyono. These purification plants are located in balanced formation between the upper and lower reaches of the water source, the Yodo River, so that there is a fixed reaching time sufficient to implement necessary emergency measures between their intake points in the event of a sudden raw water quality accident.

■ Kunijima Purification Plant (1-3-14 Kunijima, Higashiyodogawa-ku, Osaka)

The second Waterworks Expansion Project resulted in the launch, from February 1914, of water transmission by a slow-filtration facility with a water supply capacity of 151,800 m³/day from the Kunijima Water Purification Plant, which is the oldest of the existing water purification plants in Osaka City. Subsequently, the fourth Waterworks Expansion Project established Rapid Sand Filtration Plant No. 1, while the fifth Waterworks Expansion Project produced Rapid Filtration Plant No. 2. In addition, the ninth Waterworks Expansion Project commenced in 1969 and resulted in the abolition of the slow-filtration facility and the installation of Rapid Sand Filtration Plants Nos. 3 and 4, covering a site area of approximately 462,000 m², to provide a water supply capacity of 1,180,000 m³/day today. The upper and lower systems are located at the upper and lower reaches of the Yodo River respectively, and raw water is taken in a natural down-flow from the right bank of the Yodo River in Kunijima, Higashi Yodogawa-ku, and also at the Hitotsuya Intake Station on the right bank of the Yodo River in Hitotsuya, Settsu City, and conveyed by pressure pumping. After purification treatment, water is supplied to the central, northern and northwestern areas of Osaka through 13 trunk lines, including the western trunk line, by pressure pumping.

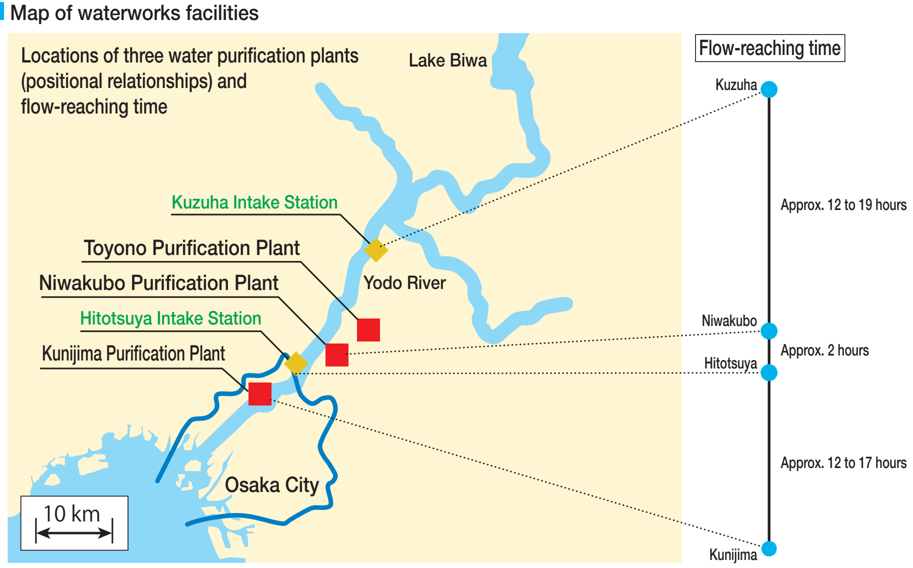
■ Niwakubo Purification Plant (11-31, Yodoe-cho, Moriguchi City)

The sixth Waterworks Expansion Project resulted in the launch, from November 1957, of partial water transmission with a water supply capacity of 120,000 m³/day, and the Niwakubo Water Purification Plant became the second water purification plant in Osaka City, providing full water transmission with a water supply capacity of 240,000 m³/day from July 1958. The plant adopted a rapid filtration system from its inception. Subsequently, the seventh and eighth Waterworks Expansion Projects resulted in a current water supply capacity of 800,000 m³/day and a site area of approximately 220,000 m². Raw water is taken in through natural down-flow from the left bank of the Yodo River down from Dainichi-cho and Oba-cho in Moriguchi City, and after purification processing, water is transmitted to the Oyodo and Tatsumi Water Distribution Plants. Water is then supplied by pressure pumping from the Oyodo Water Distribution Plant through the Naniwa and Taisho trunk lines to central and western areas of Osaka City while water is supplied from the Tatsumi Plant through the Sumiyoshi, south, and new south trunk lines to the southern areas of Osaka City. The Niwakubo Purification Plant was the first in Osaka City to adopt the centralized management system.

■ Toyono Purification Plant (1-1 Uzumasa Takatsuka-cho, Neyagawa City)

The eighth Waterworks Expansion Project provided partial water transmission at the rate of 200,000 m³/day from July 1968, and the Toyono Water Purification Plant, the newest plant in Osaka City, began water transmission at the rate of 400,000 m³/day in September 1969. Subsequently, the ninth Waterworks Expansion Project designed to enhance water supply led to a current water supply capacity of 450,000 m³/day and a site area of approximately 180,000 m². Raw water is taken in by the Kuzuha Intake Station, which is located on the left bank of the Yodo River down from Kuzuha Nakanoshiba in Hirakata City approximately 15 km from the Toyono Water Purification Plant, and transmitted by pressure pumping. After purification treatment, water is transmitted by natural down-flow to the Joto Purification Plant (with an elevation difference of approximately 37 m), and it is transmitted by a combination of natural down-flow and pumping through the Semba, Nagahori and Shin-Imamiya trunk lines to the central and eastern areas of Osaka City. Computer-employed control has been adopted from its inception, and remote computer control has been implemented from the central control room.

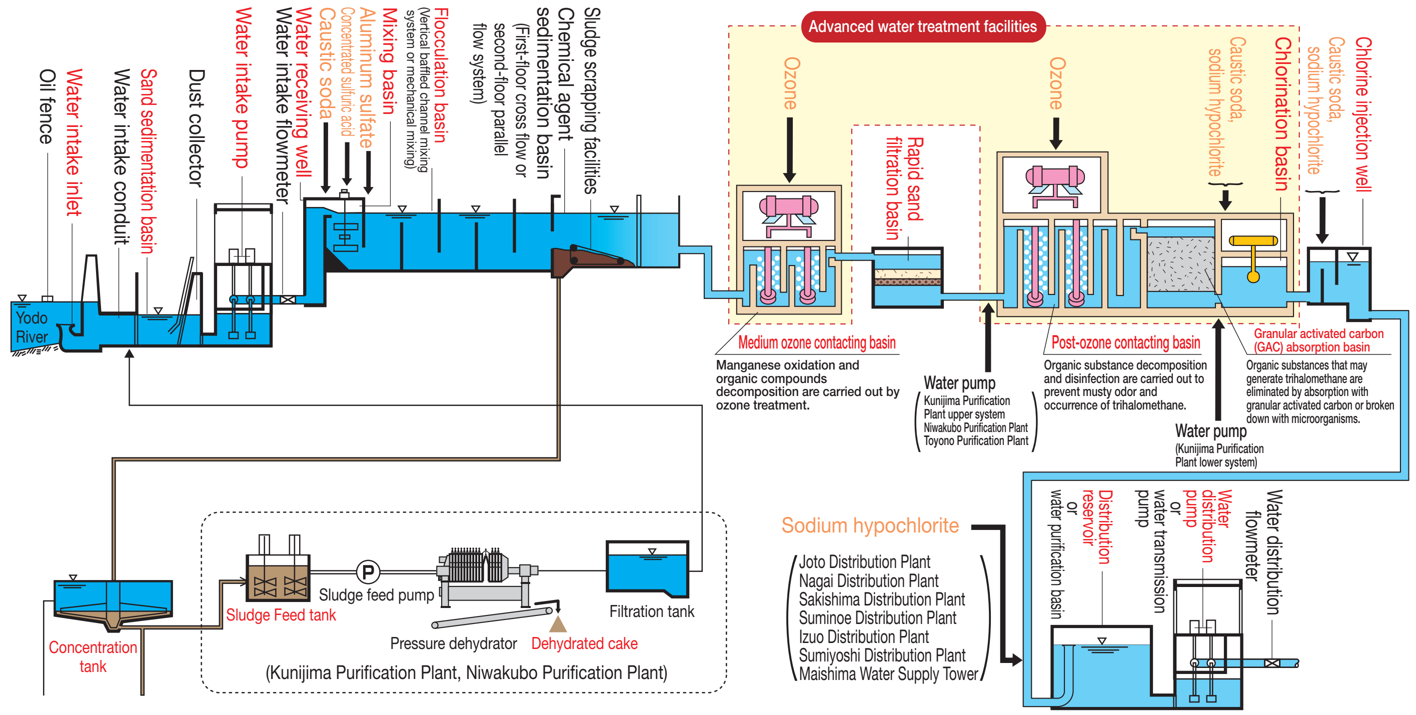
■ Map of waterworks facilities



Water purification treatment system

With the aim of improving general tap water quality in Osaka City by measures such as the removal of mold-like and other unpleasant odors and the reduction of trihalomethane, the Osaka Municipal Waterworks Bureau has introduced an advanced water treatment system, which is based on conventional purification processing that adopts sedimentation basins and rapid sand filtration with the addition of ozone and granular activated carbon treatment.

■ Treatment systems at purification plants



Advanced water treatment

Advanced water treatment is the product of the Advanced Water Purification Facility Improvement Project undertaken from 1992 to 1999 with the aim of realizing the supply of safer, higher-quality water. As a result, advanced water purification facilities for ozone processing and granular activated carbon processing were installed at all purification plants. Then water transmission started to the downstream system of the Kunijima Purification Plant in March 1998, the Niwakubo Purification Plant in March 1999, and the upstream system of the Kunijima Purification Plant and the Toyono Purification Plant in March 2000. The total project cost was 75.3 billion yen.

○ Reasons that advanced water treatment was necessary

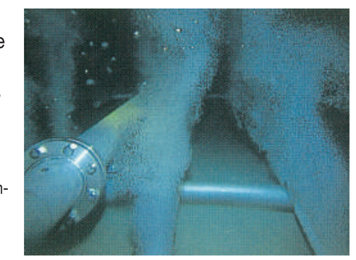
Raw water from Lake Biwa, the water source for Osaka City, produced a mold-like odor more or less every year beginning in 1981, and this caused unpleasant odors in tap water taken from Lake Biwa and the Yodo River system. When the unpleasant odor became strong, the approaches taken included the injection of powdered activated carbon and interim chlorination, which failed to adequately remove the unpleasant odors.
In addition, some of the chlorine used in the purification processes and some organic substances present in raw tap water reacted to produce trihalomethane. Although total trihalomethane density at city water faucets was within water quality standards, it became necessary to reduce these levels in order to ensure a safer water supply.
Meanwhile, it was difficult to remove chemicals and small quantities of various organic substances present in rivers by using conventional sedimentation reservoirs and rapid filtration methods mainly applied to the removal of constituents causing cloudiness.
Against this background, with the aim of improving tap water quality, including the removal of unpleasant odors and reduction of trihalomethane, the City introduced advanced water treatment using ozone and granular activated carbon.

○ Outline of advanced water treatment

• Ozone treatment

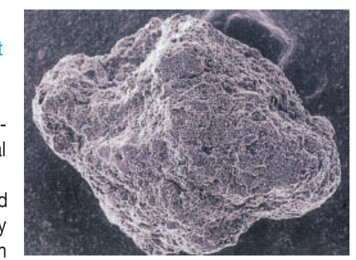
Artificially produced ozone is formed into minute bubbles and diffused to react with target substances in the water to achieve purification. Ozone, which has the second most powerful oxidizing and sterilizing properties after fluorine, is generated from air and electricity alone and there is no need for the transportation and storage of raw materials.
In addition, ozone ensures ease of inverter-controlled adjustments for the amount produced to match the state of raw water. Moreover, ozone returns to oxygen after the reaction, leaving no residual impurities.

* Ozone (O_3), a highly oxidized substance that combines three oxygen atoms, is effective in breaking down organic and other substances that cause mold-like odors, thereby eliminating unpleasant odors. Ozone also serves to oxidize manganese present in water and to disinfect water.


Ozone contact reservoir

• Granular activated carbon treatment

Granular activated carbon, which is a multi-porous substance with a total internal particle space surface area of approximately 2,000 m²/g, removes material such as organic substances dissolved in the water that cause a mold-like odor and trihalomethane-generating substances by adherence to its pores and by breakdown of substances that adhere to its surface into microorganisms.


Granular activated carbon viewed through an electron microscope

Planned maintenance of water supply facilities

Formulation of Osaka city water supply facility infrastructure reinforcement plan

The business environment surrounding the water supply business is in a situation where drastic measures are required, such as the increasing urgency of earthquake countermeasures following the revision of damage assumptions for the Nankai megathrust earthquakes, while demand for water remains sluggish.

The "New Waterworks Vision" compiled by the Ministry of Health, Labour and Welfare in March 2013 sets forth the basic principle of "Waterworks that Brings Trust Together with Local Communities for the Future," and describes the ideal image of waterworks from these three perspectives: "robust" to ensure a reliable water supply by making facilities earthquake-proofing, "safe" to ensure tap water safety through advanced water purification and quality management, and "sustainable" to ensure sustainability of supply system by thorough asset management.

Subsequently, in October 2019, the revised Waterworks Law came into effect, which aims to strengthen the infrastructure of waterworks while promoting wide-area cooperation and public-private partnerships, after clarifying the roles of the national government, prefectures, and waterworks utilities in addressing the issues facing the waterworks industry. The revised law stipulates that water service providers must strive to strengthen the infrastructure of their business and systematically renew water supply facilities from a long-term perspective. In addition, the "Basic Policies for Strengthening the Infrastructure of Waterworks" (Ministry of Health, Labor and Welfare Notification No. 135 of 2019) based on the revised Waterworks Law states that it is important to take actions for "strengthening waterworks," "ensuring safe waterworks," and "appropriate asset management" as items related to the maintenance and systematic renewal of water facilities.

In addition, from the perspective of maintaining the functions of critical infrastructure, etc. that support the national economy and daily life, the "Three-year Emergency Measures for Disaster Prevention and Disaster Mitigation and Toughening the Land" (FY2018-2020) and the subsequent "Five-year Acceleration Measures for Disaster Prevention and Disaster Mitigation and Toughening the Land" (FY2021-2025) approved by the Cabinet in December 2018 also list measures to strengthen disaster resistance of water facilities (such as water treatment plants) and to improve earthquake resistance of water pipelines as priority measures to be addressed.

In March 2018, the Osaka City Waterworks Bureau compiled the "Osaka City Waterworks Management Strategy (2018-2027)" (hereinafter referred to as "Management Strategy"), a medium- to long-term basic plan to ensure sustainability by clarifying investment plans and various measures in the future, and formulated the "Urgent 10-year Plan for Improving Earthquake Resistance of Pipelines implemented" and "Water Purification and Distribution Facilities Enhancement Plan Implemented" as implementation plans for water supply facility improvement based on the Management Strategy. However, the management strategy was revised in FY2021, taking into account the expected impact on future water demand and water supply revenue forecasts due to the spread of new coronavirus infection from FY2020 onward, and the fact that the "Osaka City Waterworks PFI Pipe Renewal Project, etc." (hereinafter "PFI Pipe Renewal Project") under the Public Facilities Operating Right, which was being worked toward introducing to significantly promote pipe line renewal, became difficult to implement due to the decline of applicants.

In the management strategy after this review, the seismic maintenance of pipelines in the waterworks business was revised as follows: The PFI pipeline renewal project has become difficult to implement, and it has become necessary to reduce the planned project volume by narrowing down the renewal target. Therefore, we will work together with the water purification and distribution facilities to ensure that we will be able to supply the water necessary for the immediate future even in the event of a Nankai megathrust earthquakes, which has been pointed out as an imminent threat and for which countermeasures are urgently needed. The project aims to reduce the risk of wide-area water outages in the event of such an earthquake in cooperation with the water purification and distribution facilities.

Therefore, along with the review of the management strategy, the ""Urgent 10-year Plan for Improving Earthquake Resistance of Pipelines implemented" and "Water Purification and Distribution Facilities Enhancement Plan Implemented", which are the implementation plans for water supply facility improvement based on the management strategy before the review, are also to be reviewed. In March 2022, the "Water supply Facility Infrastructure Enhancement Plan" was formulated as a new implementation plan for the improvement of water supply facilities, integrating the plans for the improvement of water purification and distribution facilities and pipelines, in order to improve coordination between water purification and distribution facilities and pipelines, and to make the water supply process from water intake and purification to distribution clearer and more integrated. The plan was revised in March 2023.

In order to ensure a stable supply of safe and reliable tap water to citizens and customers in the future, we will steadily implement facility improvements based on this plan.

Concept of Facility Equipment

(1) Building a resilient waterworks system

① Earthquake Countermeasures

The Osaka City Regional Disaster Prevention Plan (Earthquake and Wind/Flood Disaster Prevention Plan) assumes various disaster risks, including earthquakes caused by inland active faults such as the Uemachi Fault Zone earthquake, trench-type (plate boundary) earthquakes such as the Nankai megathrust earthquakes, and river flooding and storm surges caused by wind and flood damage.

In particular, the Nankai megathrust earthquakes is expected to occur within the next 30 years with a high probability of 70-80% (as of January 1, 2021), and its occurrence is becoming increasingly imminent. In the event of a Nankai Trough earthquake, the largest of which is expected to occur, a wide area on the Pacific Ocean side from Kanto to Kyushu is expected to be hit by strong tremors with an intensity of 6 to 7 on the Japanese seismic scale and a huge tsunami.

In addition, weather disasters have become more severe and frequent in recent years due to the effects of climate change. Therefore, there are concerns that windstorms and floods may cause large-scale power outages and wide-area water outages due to damage to water supply facilities and flooding, resulting in the shutdown of water supply facilities and a prolonged period of time until restoration is completed.

In order to achieve the objective of stable supply even in the time of disaster, it is important to view facilities such as "intake facility," "water pipelines," "purification facility," "transmission pipe," "distribution facility," and "distributing pipes" as a series of tiered waterworks systems and to develop them so that each facility can establish a route that functions continuously even in the event of a disaster.

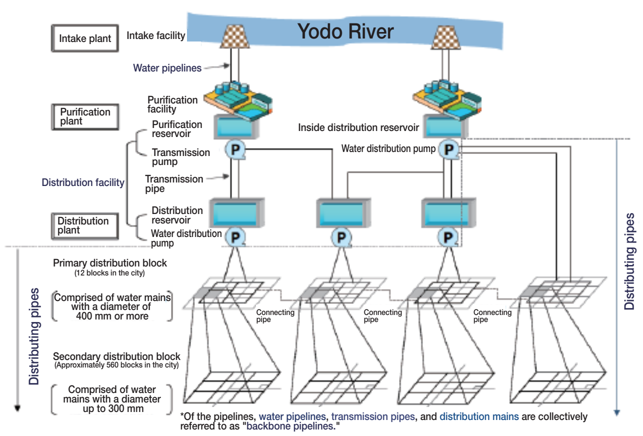


Figure　Hierarchical structure of water supply facilities

Specifically, we aim to achieve the following future vision.

◆Even in the event of the Uemachi Fault Zone earthquake, which is the largest earthquake expected to hit the city, damage to water supply facilities will be kept to a minimum, and the city was able to continue supplying water at the required level.

◆The city will be able to avoid water outages in the city even during long-term, widespread, large-scale power outages.

◆Even in the event of the largest windstorm and flood damage that could be expected, damage to water supply facilities will be kept to a minimum, and the city was able to avoid water cutoffs due to river flooding and internal flooding.

(2) Appropriate scale of facility level

While the total facility capacity in Osaka City is 2.43 million ㎥ per day, the maximum daily water supply in FY2020 was 1.18 million ㎥, and the ratio of maximum daily water supply to facility capacity (maximum operating ratio) is low at 48.5%.

The long-term water demand forecast conducted by the Waterworks Bureau in FY2021 estimates that water demand will continue to decline in the future. Therefore, in future facility development, while considering the stability of water supply, it will be necessary to optimize the maintenance level from the viewpoint of efficient business operation based on future water demand trends.

Specifically, even if one of the water treatment systems were to be shut down due to various risk events such as accidents and disasters after the earthquake-proofing of the water treatment facilities, or planned renewal and maintenance work, we estimated the reserve capacity necessary to continue to stably supply future water demand (assumed to be about 1.15 million ㎥ per day), and we also estimated the benefits of the decentralized arrangement of three water treatment plants and the current water supply network. From the perspective of utilizing the current water supply and distribution network for stable supply, the future maintenance level is set at 0.7 million ㎥ for the Kunijima Water Treatment Plant, 0.48 million ㎥ for the Niwakubo Water Treatment Plant, and 0.45 million ㎥ for the Toyono Water Treatment Plant, for a total facility capacity of 1.63 million ㎥.

(3) Maintenance and improvement of facility functions to ensure a stable daily water supply

Water utilities are lifelines that support the affluent lives of citizens and advanced urban activities, and are expected to continue to provide a stable supply of safe, high-quality water into the future.

Therefore, we will continue to maintain and improve facility functions through appropriate maintenance and renewal to ensure that the soundness of the facilities responsible for supplying such water does not deteriorate, and we will further strengthen our safe, high-quality waterworks system.

Plan overview and key objectives

(1) Outline of the plan

○ Plan period: FY 2018 - 2027
○ Total project cost: approx. 260 billion yen (including tax)
○ Project scope: Water supply facilities (intake, purification, distribution facilities and pipelines)
○ Basic measure: Strengthening of core facilities
Reinforcing safe, high-quality waterworks system
Maintaining and improving facility functions

(2) Main objectives

	2017(H29) year-end	2020 (R2) year-end	2027 (R9) year-end
Facility capacity to withstand a major Nankai megathrust earthquakes	240,000 m³/day	240,000 m³/day	1.09 million m³/day
Drainage facilities that are earthquake resistant against a Nankai megathrust earthquakes	9 facilities	9 facilities	12 facilities
Primary water distribution block where block-wide water outage was avoided in the event of Nankai megathrust earthquakes	0 block	0 block	3 block
Facility capacity with in-house power generation equipment for facility operation	0 m³/day	240,000 m³/day	1.09 million m³/day
Assumed storm and flood damage patterns that can avoid water outages in the city	—	2 patterns	5 patterns

*The city's regional disaster prevention plan envisions a total of six patterns of flooding: internal flooding, external flooding (four patterns: Yodo River, Yamato River, Kanzaki River, and Neya River), and storm surge; by the end of FY2027, it is expected that the city will be able to avoid water outages for five patterns except storm surge.
Actual results as of 2017 could not be calculated because some damage assumptions had not yet been published.

Main Initiatives

(1) Strengthening of core facilities【approx. 95 billion yen】

(1) Measures against earthquakes

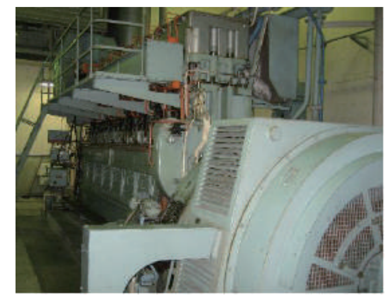
・Seismic improvement of water treatment facilities
・Seismic improvement of water distribution facilities
・Reinforcement of water supply and distribution network
・Seismic maintenance of pipelines


Earthquake-proofing of water purification facilities (coagulation sedimentation tank at Toyono Water Purification Plant)


Earthquake-proofing of water pipes (Tatsumi No. 1 water pipe)

(2) Promotion of power outage countermeasures

・Maintenance of private power generation equipment for facility operation


Private power generation equipment for facility operation (Tatsumi water distribution plant)

(3) Promotion of storm and flood countermeasures

・Water resistance of facilities

(2) Maintenance and improvement of facility functions【approx. 150 billion yen】

・Renewal and maintenance of intake, purification, and distribution facilities
・Renewal and maintenance of water distribution branch pipes

(3) Reinforcement of safe, high-quality waterworks system【approx. 15 billion yen】

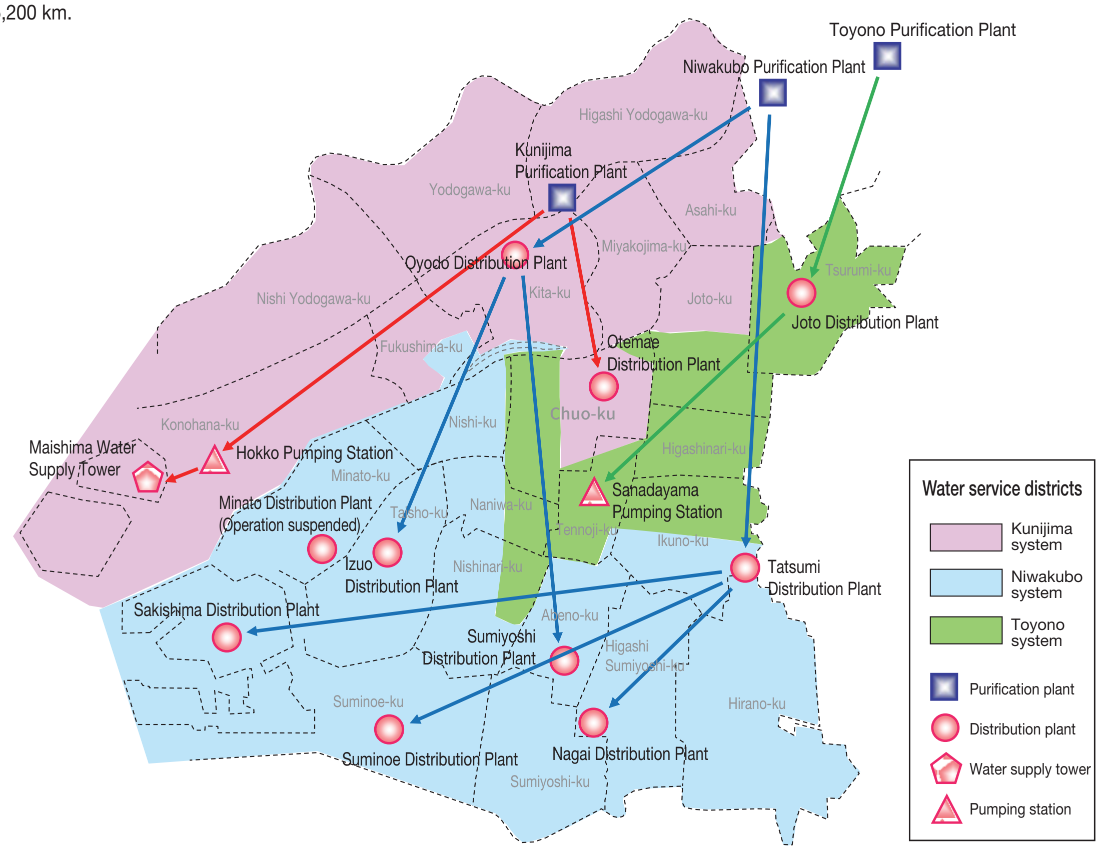
・Preparing for water quality accident risks
・Reinforcement of monitoring system


Installation of powdered activated carbon injection facilities (Niwakubo water purification plant)

Outline of Distribution Facilities

Water Distribution Facilities

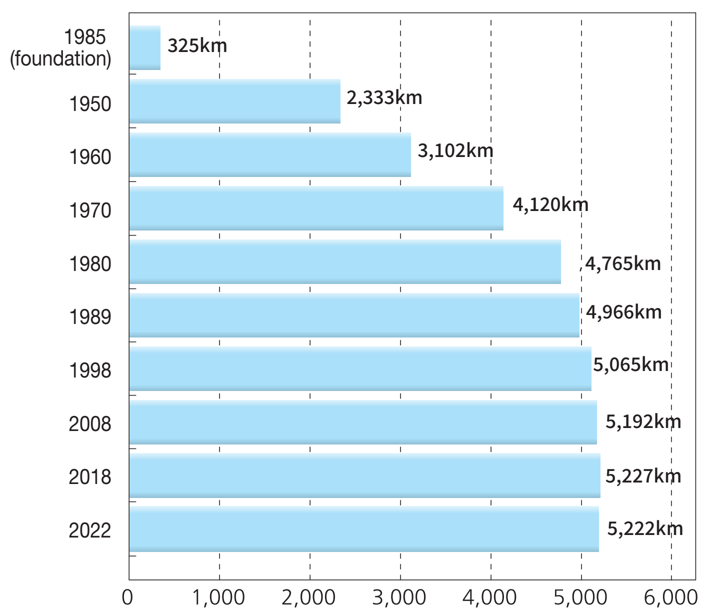
The area of Osaka City is mostly flat and therefore pressure pumps are used for water distribution. The Kunijima Water Purification Plant downstream system uses three water distribution pumping stations located inside the Plant, along with the secondary water distribution facilities of the Otemae Water Distribution Plant, the Hokko Pressure Pumping Station, and the Maishima Water Supply Tower, to distribute water. The Niwakubo Water Purification Plant downstream system uses the Tatsumi and Oyodo Water Distribution Plants, along with the secondary water distribution facilities of the Sumiyoshi, Suminoe, Sakishima, Nagai, and Izuo Water Distribution Plants, to distribute water. The Toyono Water Purification Plant downstream system uses the Joto Water Distribution Plant and the Sanadayama Pressure Pumping Station to distribute water.
The total capacity of the water purification and distribution reservoirs is 789,700 m³, and the total length of the aqueducts, water supply pipes, and water distribution pipes is approximately 5,200 km.



■ Capacity of water purification and distribution reservoirs (as of the end of FY2022)

Kunijima Purification Plant system	Niwakubo Purification Plant system	Toyono Purification Plant System
Distribution reservoir for Kunijima Purification Plant No. 1 Distribution Pumping Station 112,400 m³	Distribution reservoir for Niwakubo Purification Plant 33,400 m³	Distribution reservoir for Toyono Purification Plant 75,300 m³
Distribution reservoir for Kunijima Purification Plant No. 2 Distribution Pumping Station 55,000 m³	Tatsumi Distribution Plant 100,900 m³	Joto Distribution Plant 67,000 m³
Distribution reservoir for Kunijima Purification Plant No. 3 Distribution Pumping Station 124,000 m³	Oyodo Distribution Plant 55,000 m³	
Otemae Distribution Plant 33,700 m³	Sumiyoshi Distribution Plant 12,000 m³	
Maishima Water Supply Tower 500 m³	Suminoe Distribution Plant 27,300 m³	
	Sakishima Distribution Plant 30,000 m³	
	Nagai Distribution Plant 42,000 m³	
	Minato Distribution Plant 15,000 m³	
	Izuo Distribution Plant 24,000 m³	
Total 325,600 m³	Total 339,600 m³	Total 142,300 m³

■ Total lengths of aqueducts, and water supply and distribution pipes



Maintenance and Management of Pipelines

Pipeline information management system

The pipeline information management system utilizes computer mapping for the information management of water supply and distribution pipelines, thus replacing conventional water management diagrams, ledgers, and construction drawings.
The introduction of this system, which came into full-fledged operation in fiscal 2000, has enabled speedier operations, improved resident services, advanced utilization of data, homogenization of duties, and saving of space and resources.
Furthermore, functions to assist various operations have been developed, with the aim of facilitating more effective use of the system.

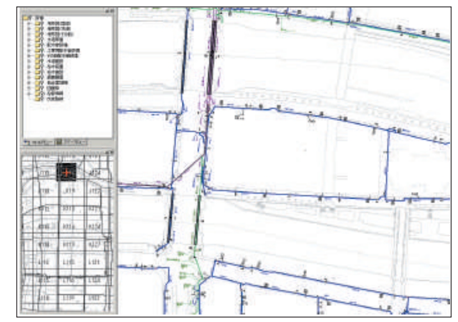
[Major functions]

○Mapping
Function to digitalize water supply equipment information (pipeline graphic data and attribute information) to be managed on terrain data

○Filing
Function to associate construction completion drawings of water distribution pipes and water supply pipes with water supply equipment information, and save them in PDF format to be available for reference and output.

○Work assist
The mapping function is customized for the operations below:
- Receiving requests for leakage repair
- Setting priorities for aging pipes to be improved
- Management of water control valve opening and closing (valve ledgers)
- Identifying the range of water stoppage (displaying the suspending pipelines and number of affected house-holds), etc.

Mapping screen (basic function)



Maintenance management of aqueducts, water supply pipes and distribution pipes

Regarding the maintenance management of aqueducts, water supply pipes, and water distribution pipes to ensure a stable supply of high-quality water, Osaka City conducts the followinga:
(1) Maintenance management

○Waterworks facility repair work (maintenance, such as repairing leaks in pipelines)
In addition to repairing leaks in pipelines and replacing faulty ancillary equipment (valves, pneumatic valves, etc.), planned repairs such as water pipe bridge repainting are carried out based on the results of daily inspections of the water distribution system.

○Pipeline patrols (prevention of accidents) and survey (prevention of accidents caused by other construction work)
(Pipeline patrols)
Prevent accidents from occurring by regularly patrolling buried conduits and visually checking for road subsidence and abnormalities in the iron covers of ancillary equipment, etc.
・Routes covered Backbone conduits such as conduit and water pipes, trunk and branch pipes and branch lines, aqueducts and conduits in communal ditches.
・Work description Visual patrols to check for leaks, rattling of steel covers and other irregularities.
(Survey)
Actively and systematically patrolling the construction sites of other works (including pipeline burial works of other companies) to prevent accidents involving water pipes.

○Pipe leakage surveys (planned leakage surveys, mobile inspection and maintenance work)
(Planned leakage surveys)
Underground leakage surveys are carried out systematically in order to prevent leakage incidents by detecting underground leaks at an early stage and to reduce the costs associated with leaks.
(Mobile inspection and maintenance work)
Leakage surveys of pipelines and inspection of ancillary equipment before secondary rehabilitation of the pavement is constructed at the construction site of other works.

○Maintenance work on trunk line valves (maintenance management of accessory equipment of trunk lines)
Conducting regular inspections and maintenance for accessory equipment that will play a particularly important role (in preventing the expansion of the impact range, etc.) in the event of an accident on a trunk line or switching of the water distribution system, which always needs to be maintained in good condition.

○Pipe investigation
To investigate the physical properties of the deteriorated conduits and the impact of soil on the conduits in order to determine the causes of conduit accidents and to study conduit asset management. Conduct soil surveys (visual and detailed) around pipelines subject to leakage repair works, etc.

Water leakage investigation

■ Figure: Trunk line patrol

(Reference)
Pipe investigation for the entire City (soil and pipe investigations to identify the cause of leakage accidents)
Investigation targets: Ductile cast iron pipes
Steel pipes
Other serious accidents (medium- or large-diameter pipes, etc.)

History of water supply facility development to date

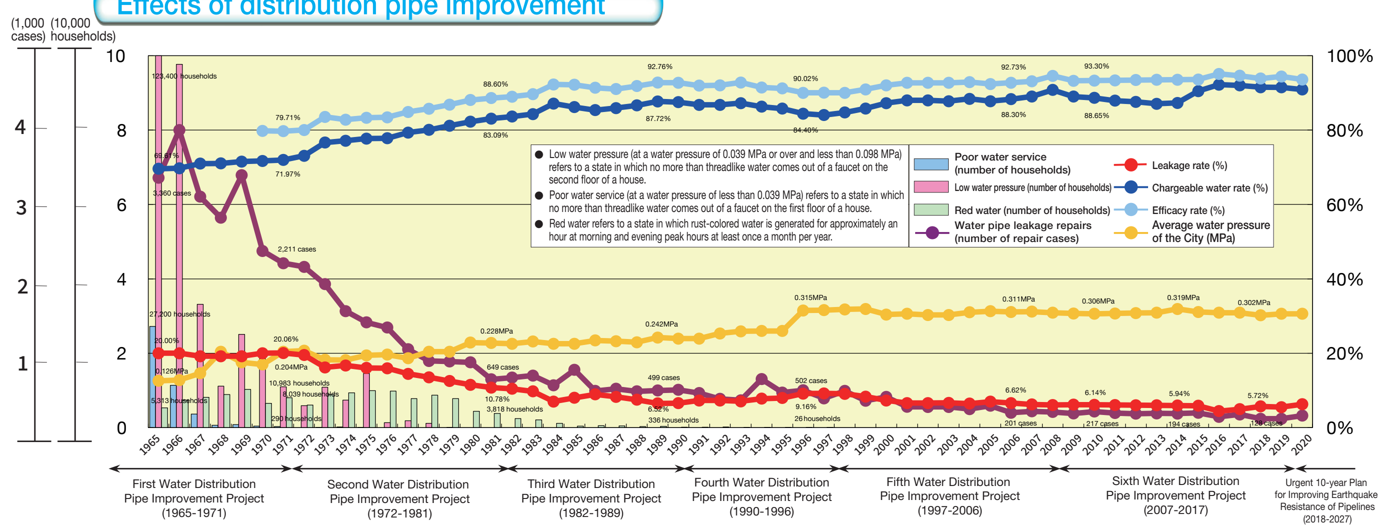
History of water purification facility development to date

Item \ Project	First Water Purification Facility Development Project	Second Water Purification Facility Development Project	Third Water Purification Facility Development Project	Fourth Water Purification Facility Development Project
Business year	1979 - 1991	1992 - 1996	1997 - 2006	2007 - 2017
Project cost	32.3 billion yen	34.4 billion yen	76.1 billion yen	49.4 billion yen
Project contents	• Measures for aging and deteriorating facilities • Measures to modernize facilities • Disaster and security measures • Measures for monitoring of water quality By promoting the above measures, ensure the safety and reliability of water purification and distribution plants and facilities as a whole.	• Planned renewal of aging equipment • Reinforcing backup functions for an emergency • Introducing advanced water purification management systems • Improving water purification facilities • Reinforcing water quality monitoring systems By promoting the above basic measures, and in relation to the reform of the water purification and treatment systems associated with the introduction of the advanced water treatment system, improve and stabilize the entire water intake, purification and distribution systems toward the next generation.	To establish highly reliable water intake, purification, and distribution systems by improving the facility standards through expanding and enhancing earthquake-proofing measures, while continuing to follow the principles of the Second Water Purification Facility Improvement Project • Planned renewal of aging equipment • Reinforcement of the earthquake resistance of key facilities • Reinforcing backup functions, along with the ensuring of water supply and distribution bases • Introducing advanced water purification and distribution management systems • Modernization of water purification facilities • Reinforcement of water quality monitoring systems	In line with the principles of the Osaka City Waterworks Grand Design, develop medium- to long-term scenarios, taking into consideration various reform factors, and implement efficient renewal and earthquake resistance reinforcement of water purification facilities by employing waterworks asset management that takes advantage of the characteristics of multiple systematization. Also, effectively reinforce system functions by introducing cutting-edge technologies in view of the next-generation waterworks systems, and establish highly reliable water purification and distribution systems that will achieve goals such as low-cost risk management. • Reform and improvement of aging facilities based on asset management • Reinforcement of the earthquake resistance of key facilities • Expansion and reinforcement of life-spot functions • Establishing next-generation water purification and distribution management systems • Sophistication of water purification and water quality management
Project effects	• Water purification and distribution reservoirs [(43,000 m³) secured 2.43 million m³/day base Sufficient for 5.4 hours → 5.8 hours] • Reinforcement of earthquake resistance of water distribution reservoirs [Otemae, Sumiyoshi] • Doubling of power-receiving lines [Sumiyoshi, Sanadayama] • Construction of new water pumping station No. 1 • Installation of rotation speed control equipment [Kunijima Distribution Plant 3, Joto, Oyodo, Tatsumi] • Renewal and improvement of aging electrical and mechanical equipment • Installation of remote water quality monitoring device	• Water purification and distribution reservoirs [(105,000 m³) secured 2.43 million m³/day base Sufficient for 5.8 hours → 6.8 hours] • Sophistication of management systems [Kunijima, Niwakubo, Toyono] • Introduction of sodium hypochlorite [Toyono] • Modernization of water purification facilities associated with introduction of advanced water treatment • Renewal and improvement of aging electrical and mechanical equipment	• Water purification and distribution reservoirs [(75,000 m³) secured 2.43 million m³/day base Sufficient for 6.8 hours → 7.6 hours] • Installation of in-house generator for facility operation [5 purification and distribution plants] • Earthquake-proofing of water purification facilities [7 control towers and pumping stations] • Introduction of advanced water distribution management systems [Otemae, Sanadayama, Sumiyoshi, Suminoe] • Renewal and improvement of aging electrical and mechanical equipment • Installation of additional remote water quality monitoring devices	• Reinforcement of the earthquake resistance of key facilities [Niwakubo No. 1 system purification facilities (Earthquake-proofing rate: 0.0% ⇒ 9.9%) Earthquake-proofing of buildings (pumping stations, etc.)] • Water purification and distribution reservoirs (24,000 m³) secured 2.43 million m³/day base Sufficient for 7.6 hours → 7.8 hours • Installation of in-house generator for facility operation [4 distribution plants] • Integration and sophistication of water purification and distribution management systems • Shift to a distributed chlorine injection system • Renewal and improvement of aging electrical and mechanical equipment

History of water distribution pipe maintenance to date

Item \ Project	First Water Distribution Pipe Improvement Project	Second Water Distribution Pipe Improvement Project	Third Water Distribution Pipe Improvement Project	Fourth Water Distribution Pipe Improvement Project	Fifth Water Distribution Pipe Improvement Project	Sixth Water Distribution Pipe Improvement Project
Business year	FY 1965-1971	FY 1972-1981	FY 1982-1989	FY 1990-1996	FY 1997-2006	FY 2007-2017
Project length	1,072 km	1,835 km	384 km	349 km	630 km	742 km
Project cost	16.1 billion yen	80.7 billion yen	52.1 billion yen	74.5 billion yen	137.6 billion yen	126.5 billion yen
Project contents	• Improving poor water service resulting from a rapid increase in water demand and the insufficient water supply capacity of old pipes • Repairing fire hydrants, gate valves and the like	• Eliminating poor water service, low water pressure, and pipes that frequently cause red water or water leakage • Repairing or replacing old pipes, mainly small-diameter pipes (300 mm or less)	• Focusing on large- and medium-diameter pipes (400 mm or over), eliminating red water and improving pipeline functions (water supply capacity, joints, etc.) and safety	• Promoting systematic renewal of aging pipelines • Reinforcing trunk line networks • Enhancing mutual water supply between water distribution systems • Introduction of advanced water distribution management systems	• Systematic renewal of aging pipelines • Reinforcing reliability of pipeline systems • Introduction of advanced water distribution management systems	• Strategic renewal of aging pipelines • Reinforcing lifeline system functions • Projects related to urban development
Project effects	• Sharp decrease in the number of households with poor water service in summer FY1965: 27,200 FY1971: 290 • Rise in average water pressure of the City 1.55 kg/cm² ⇒ 2.10 kg/cm² • Improvement in efficacy rate FY1964: 72.5% FY1971: 79.7%	• Poor water service was mostly eliminated by FY1976. • Low water pressure was mostly eliminated by FY1980. • Reduction in the number of households suffering red water FY1971: 8,039 FY1981: 3,818 • Improvement in efficacy rate FY1971: 79.7% FY1981: 88.6%	• Reduction in the number of households suffering red water FY1989: 336 • Improved earthquake resistance of water distribution pipes (Earthquake-proofing rate) FY1981: 75% FY1989: 79% • Improvement in efficacy rate FY1981: 88.6% FY1989: 92.8%	(Earthquake-proofing rate of pipelines*) FY1990: 80% FY1996: 83% * Rate of cast iron pipes, ductile cast iron pipes and steel pipes with mechanical joints	(Earthquake-proofing rate of pipelines*) FY1996: 75% FY2006: 84% * Rate of ductile cast iron pipes and steel pipes	(Earthquake-proofing rate of pipelines*) FY2006: 14% FY2017: 29% * Rate of ductile cast iron pipes and steel pipes with a separation prevention function

Effects of distribution pipe improvement



Operation Management

General Water Operation Center

Operations of the waterworks facilities owned by the City of Osaka (three purification plants and 14 distribution plants (pumping stations), and industrial water facilities (one purification plant and four distribution plants (pumping stations)) are under around-the-clock integrated remote control by the General Water Operation Center, which started operation in November 2019.

[Major functions of General Water Operation Center]

○Standardizing and optimizing operation management

○Water purification and distribution operation management in accordance with ISO 22000

○Mitigating and preventing accident risks
Promptly responding to an emergency by flexibly employing mutual support between purification/distribution systems

○Knowledge management
Promoting concentration, development and succession of know-how related to water purification and distribution

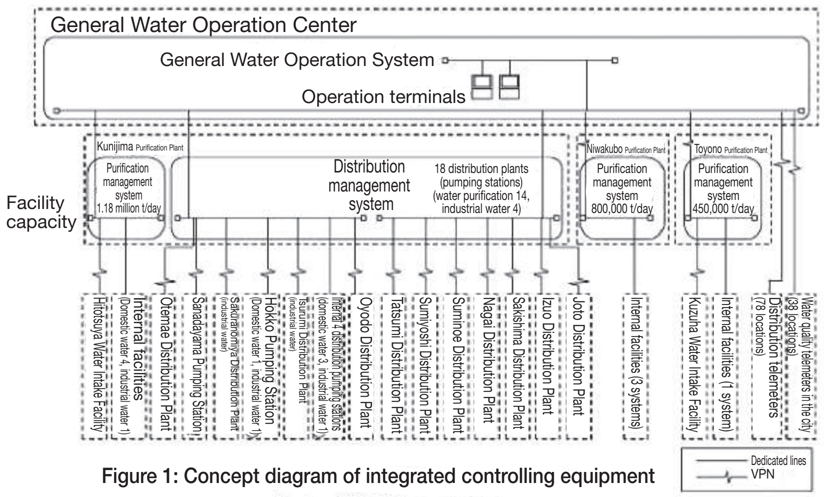


Figure 1: Concept diagram of integrated controlling equipment

■ Water Distribution Information Center

■ Water Distribution Information System

The Water Distribution Information Center monitors the status of water distribution using the water distribution telemeters (flowmeters, water pressure gauges) placed on distribution pipes of the entire City area, which are used in examination of water service stoppage and resumption, etc. at normal times and formulation of emergency water distribution plans in an emergency, such as an accident or disaster.

The data gathered and processed at the Water Distribution Information Center are available for viewing on terminals of the water distribution information system or the disaster information system of each staff in charge, water purification plants, waterworks centers, water examination centers, and facility maintenance centers.

For the key water distribution telemeters, such as the telemeters installed at the guiding station for distribution pump operation, uninterruptible power systems and duplex communication lines have been introduced as earthquake-proofing measures.

At distribution plants and pumping stations, in order to stabilize the water pressure of distribution pipes as much as possible, pumping operation is automatically controlled so that the water pressure of the guiding station for distribution telemeters placed around the City is always at a certain level.

Number of water distribution telemeters installed (as of the end of fiscal 2021)	104
(Reference) Industrial water supply system Number of water distribution telemeters installed (as of the end of fiscal 2021)	7

Water supply equipment

Water Supply Equipment Improvement Project

Osaka City basically considers water supply equipment as personal property. However, from the viewpoints of preventing water leakage and improving customer service, the City replaces water supply pipes on or under roads at the expense of the Waterworks Bureau under certain criteria set by the City.

In the third and fourth Water Supply Equipment Improvement Projects from fiscal 2002 through fiscal 2013, priority was given to the replacement of lead water supply tubes that had been used for an extended period of time, while Osaka City promoted the prevention of water leakage, elimination of poor water service, improvements in earthquake resistance, and replacement of water pipes. Since fiscal 2014, though the Project was completed, Osaka City has continued the efforts to eliminate lead water pipes.

Project / Item	First Water Supply Equipment Improvement Project	Second Water Supply Equipment Improvement Project	Third Water Supply Equipment Improvement Project	Fourth Water Supply Equipment Improvement Project
Business year	FY1993-1996	FY1997-2001	FY2002-2006	FY2007-2013
Project cost	13.3 billion yen	27.0 billion yen	26.3 billion yen	40.5 billion yen
Major project contents	• Prevention of water leakage • Elimination of poor water service	• Prevention of water leakage • Elimination of poor water service • Improvement in the earthquake resistance of water supply equipment • Improvement in maintenance of water supply pipes to eliminate hindrance in maintenance control	• Prevention of water leakage • Elimination of poor water service • Improvement in the earthquake resistance of water supply equipment • Improvement in maintenance of water supply pipes to eliminate hindrance in maintenance control • Promoting replacement of lead water supply pipes	

Replacement of lead water supply pipes

Seeing water supply standards for lead becoming increasingly stricter, Osaka City considered countermeasures and formulated basic policies from the viewpoints of both hardware and software.

• Suppress lead elution by adjusting pH of water

• Survey on all households concerning the use of lead water supply pipes according to the construction completion drawings of water supply equipment

• Provide customers with information by direct mail

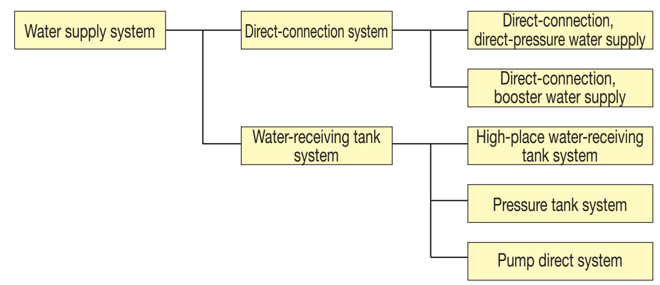
Along with the above initiatives, Osaka City advanced the Water Supply Equipment Improvement Project as its fundamental approach against lead water supply pipes. Osaka City has attached priority to and already completed the replacement of lead water supply pipes at kindergartens, nursery schools, and other similar institutions based on the knowledge that lead has a particularly adverse effect on the health of infants.

Replacement of lead water supply pipes

Expanding the range of direct water supply

In response to the Ordinance of the Ministry of Health, Labour and Welfare, which was promulgated in 2002 for partial amendments to the Waterworks Law Enforcement Regulations of the Waterworks Law, Osaka City revised the municipal ordinance on water supply on March 31, 2003. Since then, the City has enhanced efforts to educate those installing water-receiving tanks concerning the hygienic management of water-receiving tanks. And the City has been working to expand the range to which the direct water supply system without using water-receiving tanks is applicable, with the aim of eliminating hygienic problems resulting from inappropriate management of water-receiving tanks, especially small tanks.

At present, the range to which the direct water supply system is applicable is as shown below. Currently, Osaka City's water supply systems are classified into the direct-connection type that utilizes the water pressure on water distribution pipes and the water-receiving tank type that stores water once in water-receiving tanks before supplying water.



○Direct-connection, direct-pressure water supply

(System to supply water directly with the water pressure on water distribution pipes)

At present, direct-connection, direct-pressure water supply is available in Osaka City if the conditions below are satisfied.

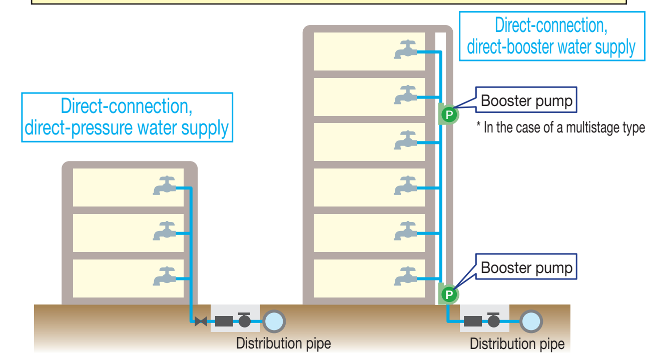
> ○Direct-connection, direct-pressure water supply is available when:
> • the meter diameter is 75 mm or less,
> • maximum water supply height is 8.0 m, and
> • water supply is possible according to a hydrologic calculation.
> Even when the water supply height is over 8.0 m, direct water supply is available if it satisfies certain conditions for urban environment improvements.

*Since October 1, 2007, direct-connection, direct-pressure water supply has been applicable to four- or five-story buildings in areas with high pressure on water distribution pipes under certain conditions.

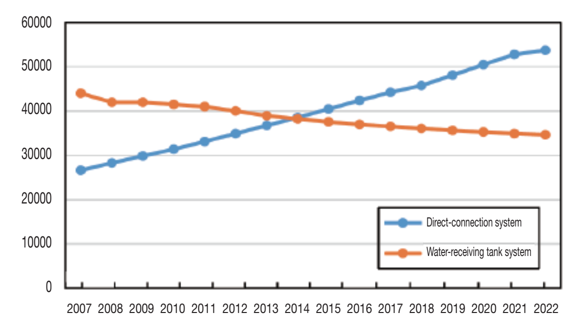
○Direct-booster water supply (System to supply water using booster pumps)

It is possible to supply water directly from water distribution pipes to buildings with 200 households by using booster pumps in addition to the pressure on the distribution pipes. At present, direct-connection, direct-booster water supply is applicable if the conditions below are satisfied.

> ○Direct-booster water supply is available when:
> • the meter diameter is 75 mm or less,
> • the maximum instantaneous flow rate is 666 L/min.,
> • water can be supplied with a booster pump with a maximum operating pressure of 0.75 MPa, and
> • the building has no segments of which the purpose of use is unclear at the time of application.
> The above conditions are subject to a hydraulic calculation for confirmation.



■ Numbers of facilities with direct-connection system and facilities with water-receiving tank system



Water Quality Tests

History of Water Quality Testing Laboratory

Established on April 5, 1949 as the first self-testing entity for tap water quality in Japan, the Osaka Municipal Waterworks Bureau's Water Quality Testing Laboratory boasts a history that spans more than half a century. To date, the Laboratory has accomplished countless achievements in the field of tap water quality management. Its achievements include the introduction of water quality inspection for the Lake Biwa and Yodo River basins, the source of raw water for Osaka City, and breakpoint pre-chlorination technology, the development of methods of analysis of trihalomethane and malodorous substances, studies into micro-organic substance treatment technology, and the introduction of advanced water purification technology.
Branch offices to carry out water quality management of water purification and other processes were established at the Niwakubo Water Purification Plant on August 1, 1957 and at the Toyono Water Purification Plant on June 17, 1968.

Acquisition of waterworks GLP certification

The Laboratory was Japan's first institution that acquired Good Laboratory Practice certification for waterworks (Waterworks GLP) and has been working to ensure precision in water quality inspections and tests, thereby communicating the highly reliable results of water quality inspections to customers. (Certification acquired on December 26, 2005)

JWWA-GLP001
Water GLP-certified laboratory

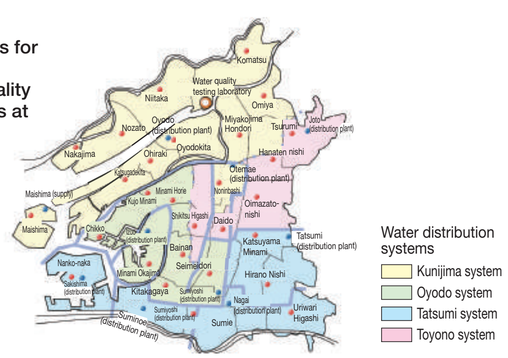
Water quality inspections at faucets

(Daily inspections) Inspection of water quality at faucets is carried out using remote water quality inspection devices installed at a total of 38 locations in each water distribution system, monitoring and measuring the color, cloudiness, toxicity and residual effects of disinfection continuously around the clock. (Fig. 3)

Details of daily inspection at faucets

Inspection name	Number of measuring locations	Number of measuring items	Remarks
Water quality inspection plan (daily inspection)	38 locations determined in Osaka City (marked with ●●)	3 items	Inspection conducted at least once a day on color, cloudiness, toxicity and residual effects of disinfection (Item 1 (a), Paragraph 1, Article 15 of Waterworks Law Enforcement Regulations)
		3 items	Water temperature, pH value, electrical conductivity

Fig. 3
Water intake points for daily inspections (Remote water quality monitoring devices at 38 locations)



Water quality management at purification plants

The purpose of water quality management is to ensure that water transmitted to Osaka City from water purification plants conforms to water quality standards and that water purification is properly implemented.
In addition, extraordinary water quality inspections are conducted when raw water has become highly cloudy due to heavy rain, when there is an abnormal water shortage, when a raw water contamination accident has occurred, or when irregularities are discovered in water purification processes, and the results are promptly reflected in water purification treatment.

Details of water quality inspections at water purification plants

Inspection name	Number of measuring items	Number of measuring items	Measuring frequency
Purification plant water quality management plan	Water purification processes at each water purification plant (raw water to purified water)	Water quality standard items, water quality management target items, etc. (over 200 items, including 94 items and agricultural chemicals)	Once a day to once a year

Osaka City Waterworks and Water Quality Management Plan

To ensure the safety of tap water, it is necessary to conduct appropriate water quality measurement in all processes, from raw water to each faucet, on a process-by-process basis. In this respect, the Water Quality Testing Laboratory studies the characteristics of water quality fluctuations in each process for each water quality item, and it formulated a plan on water quality management that designates the items of comprehensive water quality measurement spanning all processes, water intake locations, and measurement frequency. As shown below, the water quality management plan comprises four plans, including the Water Quality Inspection Plan, which each waterworks entity is required to formulate under Paragraph 6, Article 15 of the Waterworks Law Enforcement Regulations.

Fig. 1 Structure of Water Quality Management Plan

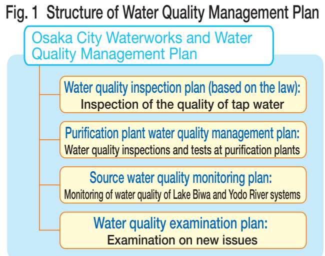
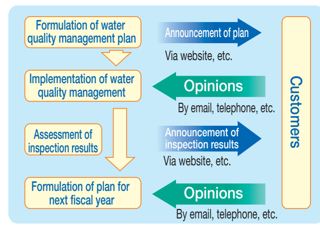


Fig. 2 Announcement of Water Quality Management Plan



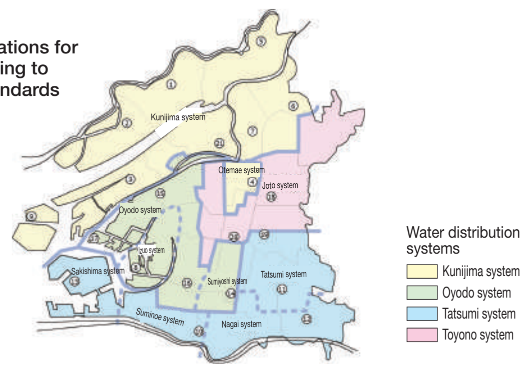
Water quality inspections relating to water quality standards

<Water quality inspections relating to water quality standards> Apart from daily inspections, to check representative water quality for each distribution system, Osaka City has designated a total of 21 water taps and conducts inspections at each such location. Together with the inspections it conducts at exits of purification plants, the City conducts inspections on all the water quality standard items. (Fig. 4) In addition, of the water quality management target items, inspection is also conducted on items associated with the possibility of fluctuations in density in water distribution and supply systems, along with the water quality standard items.

Details of water quality inspections relating to water quality standards at water supply taps

Inspection name	Number of measuring locations	Number of measuring items	Measuring frequency	Remarks
Water quality inspection plan (water quality inspections relating to water quality standards)	21 locations designated in Osaka City (①～㉑)	56 items, including water quality standard items and water quality management target items	Once a month to once every 3 months	Water quality inspections to check for compliance with water quality standards under Article 4 of the Waterworks Law

Fig. 4
Water intake locations for inspections relating to water quality standards (21 locations)



Source water quality monitoring

The Lake Biwa and Yodo River basins, the sources of raw water for Osaka City, are monitored to grasp the condition of water quality while surveys are conducted in order to contribute to the prediction of future water sources and raw water quality. The Water Examination Laboratory works in collaboration with other waterworks entities that also use Lake Biwa and the Yodo River as water sources to monitor, investigate and research* water quality. In addition, Osaka City conducts independent surveys on industrial waste water released into the Uji and Yodo River basins. In the event of a raw water accident occurring at the source, the established liaison structure is used to promptly acquire accurate information and to put measures in place at water purification plants.

Details of periodic inspections concerning water source quality monitoring

Inspection name	Number of measuring locations	Number of measuring items	Measuring frequency
Lake Biwa survey*	5	30 items	Once a month to once every 2 months
Yodo River mainstream survey*	8	62 items and 110 types of agricultural chemicals	Once a month to once every 2 months
Yodo River tributary survey*	5	52 items and 110 types of agricultural chemicals	Once every 2 months to once every 3 months
Industrial waste water survey	9	58 items	Once every 3 months to once every 6 months

Fig. 5 Source water rivers and industrial waste water intake locations

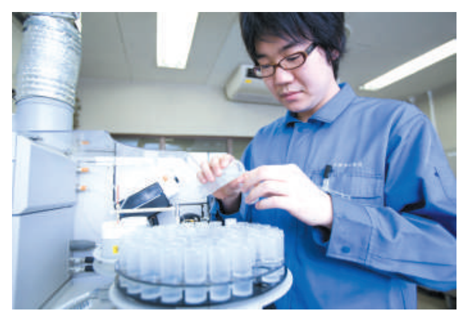
Water quality testing of industrial water

Water quality is tested to check that industrial water supplied for use to industries in Osaka City is of appropriate quality. Regular testing is carried out at the Higashi Yodo River Water Purification Plant (daily and monthly).

Other tests

Various other tests and inspections are conducted, including tests on water purification maintenance and management and on chemicals, materials and equipment related to safety of tap water.

- Quality testing of waterworks chemicals (aluminum sulfate, caustic soda, sodium hypochlorite, concentrated sulfuric acid, etc.)
- Quality testing of materials and equipment (granular activated carbon, filtration sand, gravel, etc.)
- Testing of waste water from specific water purification plants (waste water testing pursuant to Clean Water Act and Sewage Act, etc.)
- Water flow testing at waterworks facilities, such as distribution reservoirs
- Testing for leakage (judging whether the water is tap water)
- Contracted testing (commissioned testing based on the Osaka City Waterworks Bureau Contracted Water Quality Testing Handling Regulations)
- Water quality testing in response to customer inquiries



Research on tap water quality

To ensure the safety of tap water both at present and in the future, concerning substances contained in raw water for tap water with a minute concentration and substances that may be generated as byproducts in the processes of purification treatment or water distribution/supply, Osaka City gathers and examines information on their impact on the health and convenience of people. For items that require additional research, the City works to establish measuring methods and formulate measures to grasp the status of their presence and reduce them.

Major research target items	Research method
Microorganism indicators	• Gathering information • Development and application of measurement methods • Understanding the status of presence of target items (identifying the presence and concentration in raw water, etc.) • Understanding behavior in advanced water purification processes, etc. • Establishment of reduction measures • Verification of tap water safety
Infectious microorganisms	
Endocrine disruptors (environmental hormones)	
Agricultural chemicals	
Residual organic pollutants	
Organic synthetic compounds	
Disinfection byproducts	
Items requiring examination of water quality standards	

List of major precision analysis devices owned by the Water Quality Testing Laboratory

Analysis device name	Target substance	Number of units owned
Inductively coupled plasma mass spectrometer	Metals, including lead	3
Gas chromatographer mass spectrometer	Agricultural chemicals and organic substances including disinfection byproducts	2
Purge trap gas chromatograph mass spectrometer	Chloroform and other volatile organic substances	1
Head space gas chromatograph mass spectrometer	Chloroform and other volatile organic substances	5
Liquid chromatograph mass spectrometer	Agricultural chemicals and organic substances including environmental hormones	5
Atom light absorption photometer	Metals including iron	3
Mercury meter	Mercury	3
Gas chromatograph	Organic chlorine substances such as PCB	1
High-speed liquid chromatograph	Anionic surfactant and non-ionic surfactant	2
Post column high-speed liquid chromatograph	Organic substances including agricultural chemicals	1
Post column ion chromatograph	Negative ion types including bromates and chlorides	3
Post column ion chromatograph	Cyan, etc.	2
Full organic carbon meter	Organic substances quantities	3
Full organic halogen analyzer	Organic halogen quantities	2
Scanning-type electron microscope	Solids	1
Epi-illumination fluorescent microscope	Microorganisms such as cryptosporidium	2
ATP meter	Total bacteria content	1
Infrared spectrometer	Plastics	1
PCR device	Microorganism	2
Full-automatic solid phase extraction device	Organic substances such as agricultural chemicals	8
Total nitrometer	Total nitrogen	1
Micro-plate reader	Bioassay such as environmental hormones	1

Earthquake Countermeasures

Osaka City Waterworks and Earthquake-resistance Measures Reinforcement Plan 21 (Basic Concept)

This master plan is a basic concept for systematically and strategically promoting measures to strengthen earthquake countermeasures for the city's water supply system in general. It is compiled with the aim of building a crisis-resistant water supply system that can continue to supply water even in the event of a major Nankai Trough earthquake, which is certain to occur in the near future, or an earthquake in the Uemachi Fault Zone, which is expected to cause the greatest damage to the city.

Therefore, this plan is a compilation of measures related to the strengthening of earthquake disaster countermeasures from all the administrative projects implemented by the city's waterworks system. Specifically, we will continue the basic policy principles of the initial plan, including measures to improve the earthquake resistance of core facilities in conjunction with the maintenance of aged facilities such as intake, purification, and distribution plants and distribution pipes, measures to improve mutual compatibility between distribution systems, and measures to strengthen backup functions in conjunction with the expansion of water distribution reservoirs, etc. In addition, we will review, expand, and strengthen various measures for facility development, including the promotion of projects to strengthen the infrastructure of intake, purification, and distribution facilities and to promote earthquake resistance of pipelines, while taking into account various factors from a contemporary perspective. The project also promotes the reinforcement of earthquake disaster countermeasures from a comprehensive viewpoint of both software and hardware.

Basic measures

(1) Reinforcement of the earthquake resistance of key facilities

We will build a water supply system that can continue to supply water even in the event of an earthquake by strengthening the earthquake resistance of intake, purification, and distribution plants and pipeline facilities, which are the core of water supply facilities, and by systematically upgrading aging facilities.

(2) Establishment of supply and distribution bases network

We will make maximum use of the water purification/distribution plants and other facilities that have been developed to date, and expand the necessary functions as emergency response activity yards that will serve as a wide-area front line for support and reinforcement, as well as establish new emergency water supply bases at water supply centers and other facilities to respond to dispersed evacuations.

(3) Enhancing mutual water supply between water distribution systems

In order to enable emergency and flexible water distribution operations after the earthquake, we will improve interconnectivity among water distribution systems by strengthening the trunk line network through the construction of new pipelines.

(4) Countermeasures against power failures

To ensure stable power supply essential for intake, purification, and distribution plant operations even in the event of prolonged power outages, we will promote power outage countermeasures such as the installation of private power generation facilities.

(5) Maintaining the system to procure materials

We will continue to ensure that we have the necessary equipment and materials for emergency water supply and for emergency restoration so that a push-type emergency water supply system can be established to provide a normal level of water supply even in areas where water has been cut off.

(6) Reinforcement of water supply stability in the bay area

The construction of a waterway bay area network integrating Sakishima, Maishima, Yumeshima, and the conventional waterfront area through the installation of pipelines, etc.

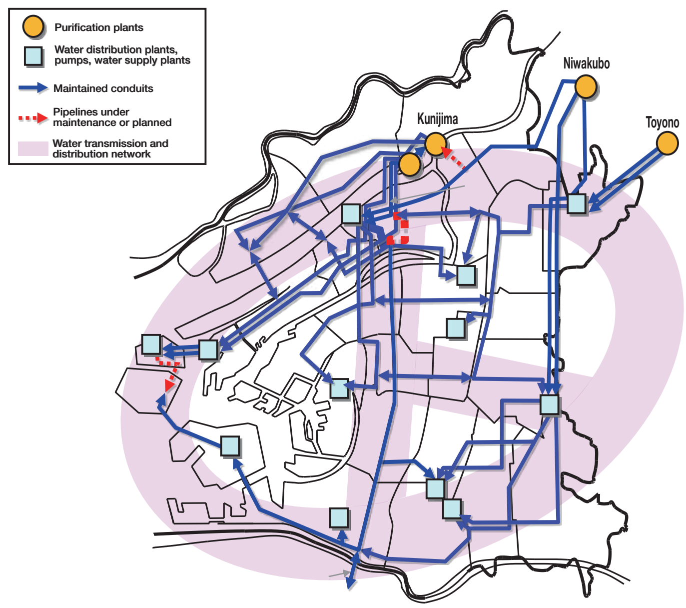
(7) Reinforcing reliability of information and communication systems

We will ensure an information and communication system that will facilitate a series of emergency priority operations, such as promptly activating and functioning an organized immediate response system based on the Business Continuity Plan (BCP) for the city's water supply system after an earthquake, and quickly ascertaining the operational status of water supply facilities, etc.

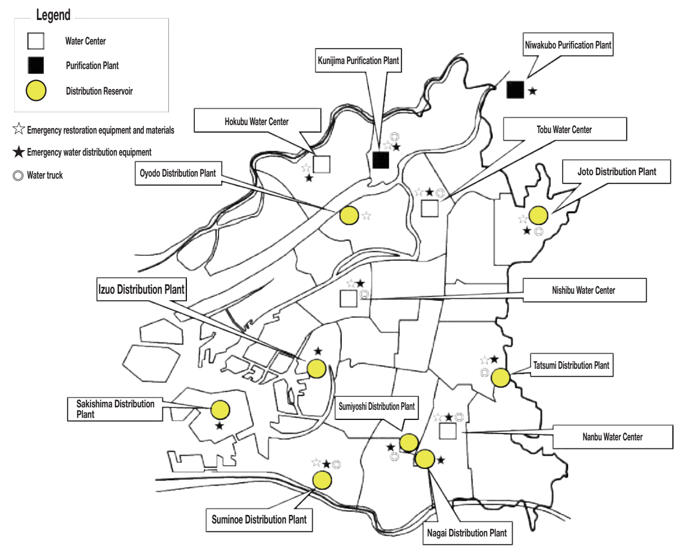
(8) Reinforcement of earthquake resistance of headquarter facilities related to earthquake countermeasures

The headquarter facilities will be systematically maintained and renewed based on asset management, and will be enhanced in terms of both software and hardware, including the expansion of remote functions.

Enhancing mutual water supply between water distribution systems



■ Maintaining the system to procure materials



Waterworks Bureau Disaster Information System

The Waterworks Bureau's Disaster Information System was reconstructed in fiscal 2015 as part of its initiative to enhance the reliability of its information and communications system. The System uniformly manages the City's disaster-related information, including information on damage, restoration activities and the status of emergency water supply in the event of an earthquake or other disaster, so as to support the prompt and precise understanding of the situation, decisions on countermeasures, and implementation of activities.

The Disaster Information System can collect information promptly and smoothly by sharing data with other systems, such as the Water Distribution Information System and the Pipeline Information Management System.

Information terminals used for regular work operations can access the System. In the event of a disaster, each staff member of the Bureau may enter disaster-related information into the System, which can be communicated to and shared with other members, facilitating emergency restoration activities and emergency water supply activities.

Enhancing crisis management systems

The Waterworks Bureau has a disaster response manual for prompt emergency restoration and emergency water supply, and it strives to build a broad-area mutual support system by concluding mutual support agreements with large cities, such as government-designated cities, Japan Water Works Association's Kansai Branch, neighboring cities, and organizations concerned. The Waterworks Bureau has been enhancing the emergency response system by participating in joint drills with these organizations and disaster drills of each ward in which many citizens participate. Furthermore, aiming to build an organization capable of continuing or quickly resuming the water supply service even in the event of a large-scale earthquake, the Bureau has been endeavoring to improve its crisis management capabilities by formulating a business continuity plan to promote capacity development of its staff through disaster response education and training and by continuously reviewing the plan.

Emergency water supply system in the event of a disaster in the city

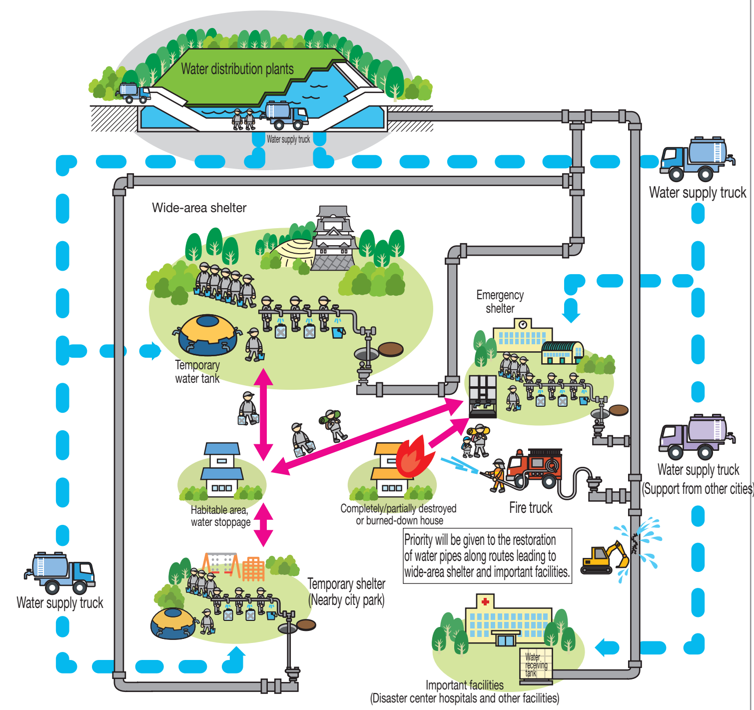
The Water Bureau's has an emergency water supply system in place to ensure that, in the event of an earthquake or other disaster that disables the water supply, citizens are provided with the necessary quantities of water for drinking and domestic use, depending on the situation at the time.

1 Securing drinking water, etc.

Securing drinking water and other resources after a disaster is based on the following approach.

1 Immediately after the disaster	2 From post-disaster to completion of recovery	3 After completion of restoration
Drinking water is secured through stockpiles Medical water is secured through transported water supply systems	Water requirements are secured through the base water supply system and the transported water supply system.	Normal quantities secured (up to 3 weeks after disaster)

2 Emergency water supply in times of disaster



▼What is the base water supply system?
Water trucks make rounds to temporary water tanks set up in disaster shelters and other locations to supply water, which is then drawn from the temporary tanks.

▼What is the transported water supply system?
This method involves water trucks supplying water directly to the receiving tanks of important facilities, including disaster base hospitals.

Check point: Securing emergency water supply equipment and materials

At material storage facilities in the city, the following materials and equipment for emergency restoration are stockpiled for the repair of water pipes and for emergency water supply.

Water Truck These vehicles are used to transport water to temporary water tanks set up in evacuation centres and other important facilities such as hospitals.

Temporary water tank It is installed in evacuation centres and other places where water is cut off in order for citizens to receive water.

Temporary hydrant Installed as a tap when the main pipe is running.

Check point: Emergency water stations in times of disaster

If water is cut off during a disaster, emergency water stations will be set up as appropriate at wide-area evacuation centres, disaster shelters and temporary shelters.

Wide evacuation area

Evacuation sites in the event of a major fire and the spread of fire, such as large parks that are safe from fire. There are 34 such parks in Osaka, nine of which have 400 ㎥ earthquake-resistant water tanks underground.

Disaster refugee center

School gymnasiums and other facilities where citizens who cannot live in their own homes due to flooding or collapse take shelter. About 560 locations, including primary and secondary schools in the city.

Temporary shelter

There are about 1,420 such places in the city, which are temporary shelters in case of earthquakes, e.g. parks, squares and school playgrounds.

Environment-friendly Initiatives

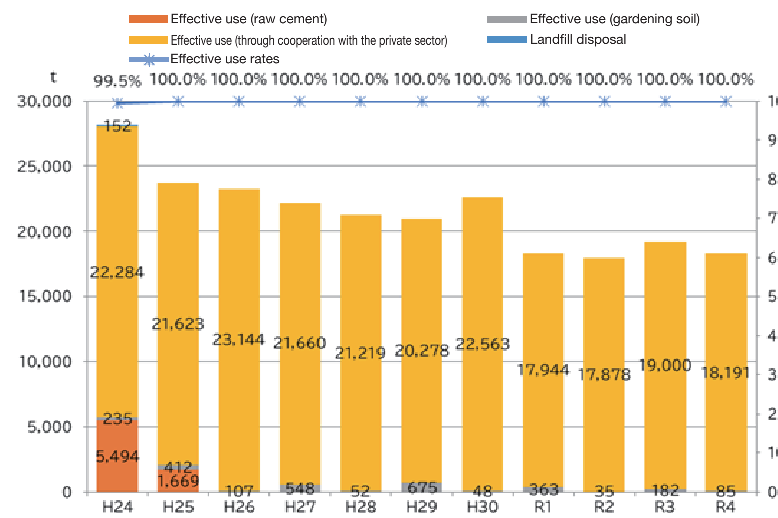
Effective use and recycling of sludge from water purification

The Kunijima Water Purification Plant and the Niwakubo Water Purification Plant use pressure dehydrators, and the Toyono Water Purification Plant uses solar drying reservoirs to perform wastewater treatment.
Since sludge from water purification is classified as industrial waste, the City has promoted the effective use of the sludge and the reduction of the amount of sludge generated.
Until fiscal 2010, sludge from water purification was mainly used as cement raw material, gardening soil and water-retaining pavement material, with the effective utilization rate staying around 50%. Starting from fiscal 2011, in order to raise the effective utilization rate and reduce the cost for disposal, the City established partnerships with the private sector to adopt their technologies and ideas, such as reusing the sludge as backfill soil, and has achieved a utilization rate of 100% by fiscal 2013.
The City will continue to promote more stable and effective use of sludge from water purification in cooperation with the private sector, thereby maintaining the utilization rate of 100%.


Pressure dehydration system (Niwakubo Purification Plant)


Solar drying system (Toyono Purification Plant)

Percentage and breakdown of effective use of sludge from water purification



Construction of the environment-friendly administrationbuilding of Kunijima Purification Plant

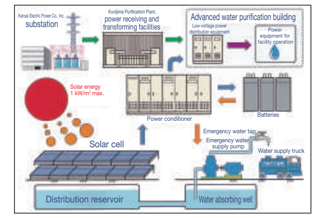
The administration building of the Kunijima Water Purification Plant was constructed in March 2007 as the facility to conduct comprehensive management of the Kunijima Water Purification Plant.
This building is designed to be environmentally friendly, featuring rooftop gardening, cooling with cool tubes, water spraying to shading louvers and outdoor air-conditioner units to reduce air-conditioning load. The surrounding roads are paved with water retaining material.

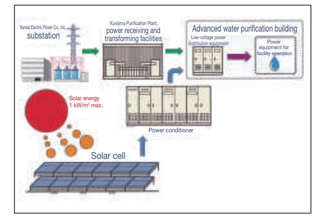
Solar power generation systems

To promote use of energy friendly to the global environment, the City has introduced solar power generation systems at the Kunijima Water Purification Plant and four waterworks centers.

[Overview of solar power generation system at Kunijima Water Plant]

The Plant normally uses a part of the generated electric power for the operation of its advanced water treatment facilities. The power generator installed above the purification reservoir is furnished with power storage equipment and emergency water supply equipment, which enable temporary water supply to water trucks in the event of a power outage for a long time.
(1) Above distribution reservoir (installed in March 1999)
Maximum output: 150 kW
Power generation capacity: Approx. 160,000 kW per hour/year (as of fiscal 2021)
(equivalent to the amount of power used by 36 general households)
Carbon dioxide reduction: Approx. 54 tons/year (as of fiscal 2021)
(2) Rooftop of lower system advanced water treatment building (installed in March 2011)
Maximum output: 250 kW
Power generation capacity: Approx. 300,000 kW per hour/year (as of fiscal 2021)
(equivalent to the amount of power used by 70 general households)
Carbon dioxide reduction: Approx. 106 tons/year (as of fiscal 2021)



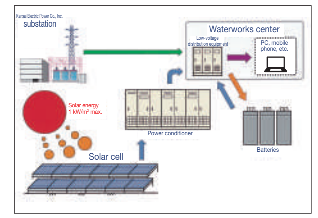


[Overview of solar power generation system at waterworks centers]

The generated power is normally used inside each waterworks center. The power storage equipment furnished enables the centers to secure a certain amount of

Solar power generation systems at waterworks centers

Location	Maximum output	Time of installation
East Waterworks Center	10 kW	March 2016
West Waterworks Center	5 kW	March 2016
South Waterworks Center	10 kW	December 2016
North Waterworks Center	10 kW	March 2016



Total power generate at each waterworks center: Approx. 42,000 kW per hour/year (as of fiscal 2021)
(equivalent to the amount of power used by 10 general households)
Total amount of carbon dioxide emissions reduced at each waterworks center: Approx. 16

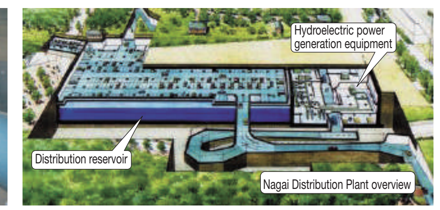
Hydroelectric power generation equipment

As one of its environment-friendly initiatives for energy saving and utilization of unused energy, Osaka City has introduced hydroelectric power generation systems that utilize the residual hydraulic pressure of water flowing into water distribution reservoirs. The hydroelectric power generation systems that the Osaka Waterworks Bureau has introduced are as follows:

[Overview of hydroelectric power generation equipment at Nagai Distribution Plant]

All the generated power is used as part of the electric power for the operation of water distribution pumps and other equipment of the plant.
Installation: November 2004
Type: Horizontal axis Francis turbine
Maximum output: 253 kW
Power generation capacity: Approx. 1.50 million kW per hour/year (as of fiscal 2021)
(equivalent to the amount of power used by 347 general households)
Carbon dioxide reduction: Approx. 710 tons/year (as of fiscal 2021)

Hydroelectric power generation equipment at Nagai Distribution Plant



[Overview of hydroelectric power generation equipment at Izuo Distribution Plant]

The electricity generated at the Plant is all for sellhjhh.
Installation: March 2013
Type: pump-reversing turbine
Maximum output: 110 kW
Power generation capacity: Approx. 470,000 kW per hours/year (as of fiscal 2021)
(equivalent to the amount of power used by 109 general households)

Hydroelectric power generation equipment at Izuo Distribution Plant

[Overview of hydroelectric power generation equipment at Sakishima Distribution Plant]

All the generated power is used as part of the electric power for the operation of water distribution pumps and other equipment of the plant.
Installation: February 2019
Type: pump-reversing turbine
Maximum output: 43 kW
Power generation capacity: Approx. 240,000 kW per hours/year (as of fiscal 2021)
(equivalent to the amount of power used by 55 general households)
Carbon dioxide reduction: Approx. 91 tons/year (as of fiscal 2021)

Hydroelectric power generation equipment at Sakishima Distribution Plant

Energy saving for pumping facilities, etc.

Water intake, purification and distribution facilities consume a large amount of electric power in the water treatment and distribution processes. At these facilities, focused measures have been implemented for the pumping equipment, which consume the largest amount of electricity.
The City has adopted, for the pumping equipment that is easily affected by demand fluctuations, a rotation speed controller that enables constant, highly efficient operation while replacing impellers of some pumps with optimum ones, thereby reducing power consumption.

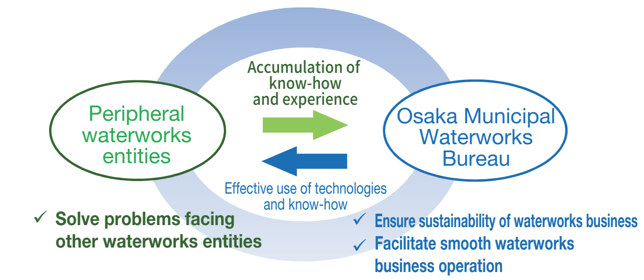
Promotion of Wide-area or International Collaborations, and Passing Down of Waterworks Technologies

Promotion of Wide-area or International Collaborations by Osaka Municipal Waterworks Bureau

[Wide-area collaborations with other waterworks entities]

Starting from fiscal 2006, the Osaka Municipal Waterworks Bureau has promoted wide-area collaborations with other waterworks service entities in both software and hardware aspects by utilizing the technology and human resources it has accumulated.

[Objectives of wide-area collaborations]



○Accepting consigned technological services

The Bureau undertakes consigned technical operations in response to the needs of other waterworks service entities, such as water quality testing and various other analyses, preparation of water safety plans and risk management manuals, and design and construction surveillance for facility renewal.

○Mutual support in a disaster

The Bureau works to establish mutual support systems for emergency restoration and emergency water supply in the event of a disaster, etc. and holds joint disaster drills.

○Human resources development

The experience-based training center that opened in 2010 is used as a "wide-area training base" for training of human resources, including not only the staff members of Osaka City but also those who are engaged in waterworks services in other municipalities both in Japan and overseas.

○Installation of connecting pipes for emergency

The Bureau, jointly with neighboring waterworks entities, has installed emergency connecting pipes to be used for mutual support water supply in an emergency or a disaster.

○Survey and research on water purification technologies

Since fiscal 2008, with the aim of contributing to the development of waterworks technology through technological collaborations, the Bureau has been engaged in joint research using optimum cutting-edge treatment technology testing facilities (new testing facilities). In fiscal 2018, the Bureau compiled an assessment of the hybrid membrane filtering system and an outlook for the future. After that, exchange of information has been continued on a periodic basis.

[Overseas deployment of water supply service]

The Osaka Municipal Waterworks Bureau has been promoting overseas deployment of water supply service business based on public-private collaboration by effectively using the technologies and know-how owned by the Bureau and for the purpose of helping the development of waterworks business in Asia, revitalizing the economy of Osaka and the Kansai region, and improving technological capabilities of its staff members.

○Technology exchange with Ho Chi Minh City waterworks

Challenges facing the waterworks of Ho Chi Minh City, Vietnam, are inevitable for a city that is in the process of development. Believing that the technologies and know-how of Osaka City, which has experienced and overcome similar challenges, will help Ho Chi Minh overcome them, the Osaka City Waterworks Bureau concluded a memorandum on technological exchange with the Ho Chi Minh municipal waterworks operator, or Saigon Water Corporation (SAWACO), on December 9, 2009 (updated on November 18, 2015 and December 3, 2018), aimed at the promotion of a friendly relationship and mutual development, thereby establishing a G-to-G collaboration system. Based on this memorandum, the Bureau has accepted staff members from SAWACO since fiscal 2010.

Signing ceremony for the memorandum with SAWACO
(December 13, 2018)

○Initiatives based on public-private cooperation

The Bureau has participated in and implemented the national government's research projects together with public-private cooperation.

(1) Research project for improvement of water distribution plants
The Bureau conducted a research project for the improvement of water distribution networks of the city of Ho Chi Minh in collaboration with private companies.

(2) Project for improvement of construction technology related to water supply equipment
In collaboration with private companies based in Osaka, the Bureau conducted a project for improvement of construction technology for the installation of water supply equipment to eliminate water leakages of the Ho Chi Minh City waterworks system.

On-site survey

Passing Down of Waterworks Technologies

Osaka City is supported by waterworks technologies that have been accumulated over the 120 years of history since the foundation of waterworks. The City has led the waterworks industry nationwide by incorporating in business the technological achievements it has obtained through many surveys and research activities and putting them into practice to date.

To ensure sustained and effective waterworks services, not to mention a stable supply of safe, high-quality water, to meet the demand of the times at a high standard level, the maintenance and development of waterworks technologies is important. It is therefore necessary to ensure that waterworks technologies of Osaka City will be passed down to subsequent generations by such means as establishing a practical research and study structure for the development of waterworks technologies and an efficient technical training system and promoting technical exchanges both inside and outside Japan.

Through our tireless endeavors in developing cutting-edge technologies and research frameworks through technical research committees and departmental R&D programs, as well as seeking wide-reaching cooperation with industrial, governmental, and academic sectors, we established the Advanced Water Treatment Technology Laboratory in 2009 to stay in the forefront of Japan's waterworks industry.. The Waterworks Bureau has opened an experience-based training center, where trainees can learn technologies related to construction of water supply/distribution pipes, water treatment, etc. through hands-on experience of the processes, thereby enabling the valuable technologies it has developed and accumulated to be effectively and efficiently handed down to subsequent generations. Through these initiatives, technological exchanges not only within the Bureau but also with other waterworks business entities both in Japan and overseas have been promoted, contributing to the succession of waterworks technologies.

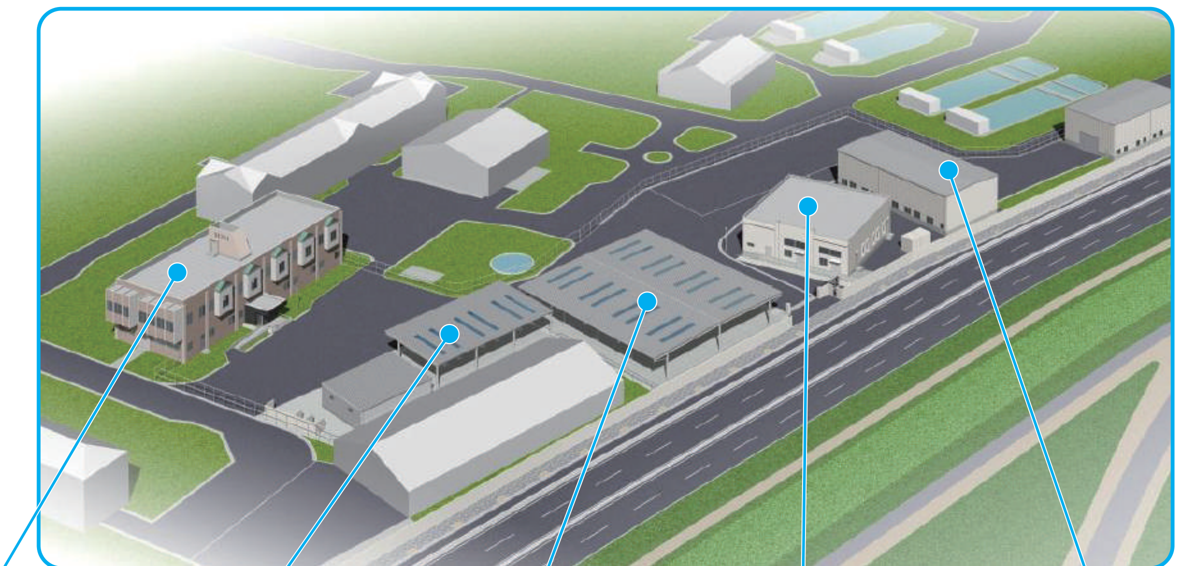
Optimum cutting-edge technology testing facilities

	Objectives, remarks
Enrichment of the research and study structure	
Osaka Municipal Water Bureau Technical Research Committee	Improvement of waterworks technology and study and consideration of items relating to development (Launched in 1970. Themes to date: advanced water purification, acquisition of ISO9001 accreditation, etc.)
Sectoral R&D programmes	Research and studies on immediate to medium- and long-term issues to be considered in each sector of the water supply industry, as well as efforts to improve technical capacity
Osaka Municipal Water Bureau Technical Development Joint Research Review Board	Joint implementation of research, study, and tests relating to waterworks technology with personnel from outside the Bureau (Launched in July 2001)
Establishment of efficient technology training structure	
Technical training by the specialized field at the Bureau (New, basic, applied)	Training technical staff and improving technical standards by providing lectures and hands-on technical training
Promotion of technical exchanges	
Technical consultations	Presentation of various expert opinions and technical achievements accumulated so far to contribute to improvement of the technical skills of personnel (Launched in 1950, held 216 times as of July 2023)
Reiwa Academy	Forum for human resources development and technical succession through lectures based on academic expertise of staff members
Waterworks business research	Implementation of waterworks business management and technical research with the aim of promoting and improving practical work guidance and abilities of bureau personnel (First issued in 1949)
Participation in international conferences and workshops, including IWA international meetings	Technical exchanges between staff members and skill improvement

Experience-based training center - Base for passing down of technologies and wide-area training -

This is a comprehensive education and training facility where trainees can learn the know-how of the total operation of waterworks, from water intake to water supply. It opened the seminar building and the water supply facility building in fiscal 2010, the water distribution facility building in fiscal 2011, and the mechanical and electrical building and the water purification facility building in 2012. The center offers effective training programs consisting of lectures and hands-on exercises in each field relevant to waterworks service. It is used as a forum for training of human resources, including not only the staff members of Osaka City but also those who are engaged in waterworks service in other cities in Japan and overseas.

■ Experience-based training center facility map

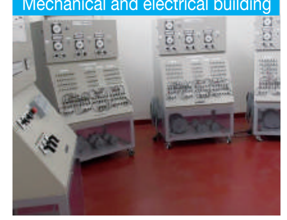


Seminar building

Water supply facility building

Water distribution facility building

Mechanical and electrical building



Water purification facility building

■Information on technical training and facility leasing for waterworks business operators

Osaka Municipal Waterworks Bureau website
Application for Technical Trainees: http://www.city.osaka.lg.jp/suido/page/0000125043.html
Leasing of experience-based training center facilities: http://www.city.osaka.lg.jp/suido/page/0000266607.html

Industrial Water Supply

Business summary

As a part of the measures for the prevention of ground subsidence, Osaka City started constructing industrial water supply in March 1951 for the purpose of supplying water to replace underground water for industrial use. Osaka City started supplying water to some areas of Konohana Ward and Fukushima Ward in 1954. Later, four expansion projects were implemented in response to restrictions on pumping up groundwater for industrial use and changes in the quantity of water in demand. As a result, the water supply capacity reached 575,300 m³/day in 1967, and industrial water has been playing a role of important infrastructure to support industrial activities in Osaka.

However, abnormal drought in the summer of 1973, the recession caused by the oil shocks, and the penetration of water-saving awareness forced factories to improve their recovery rate, which resulted in a substantial decrease in demand. In order to respond to these demand trends and to improve management efficiency, the water supply capacity was 151,000 m³/day and the length of distribution pipes was approximately 292 km at the end of FY 2008 as a result of the gradual consolidation of intake, purification and distribution plant facilities and capacity reviews in line with demand. Since April 2022, it has been operated by Miotsukushi Industrial Water Concession Co. as the "Osaka City Industrial Water Supply Specific Operation Project".

Quality of industrial water

Unlike drinking water, industrial water supply of Osaka City is not treated through filtration or chlorination, but the City controls the water quality so that it can be used as industrial water appropriate for most of the usages, such as for cooling, for cleaning and as materials.

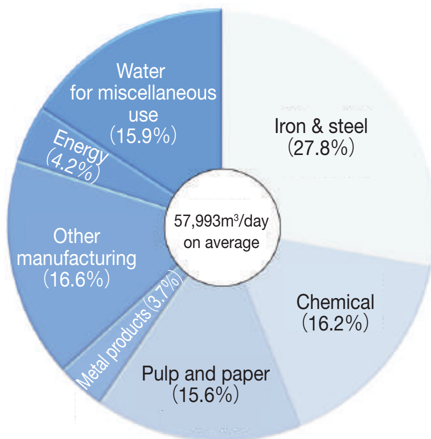
Since the required quality of industrial water varies depending on the intended use, users may need to conduct purification treatment by themselves if they use industrial water for applications that require water of high quality, such as for boilers and dyeing.

Water supply areas

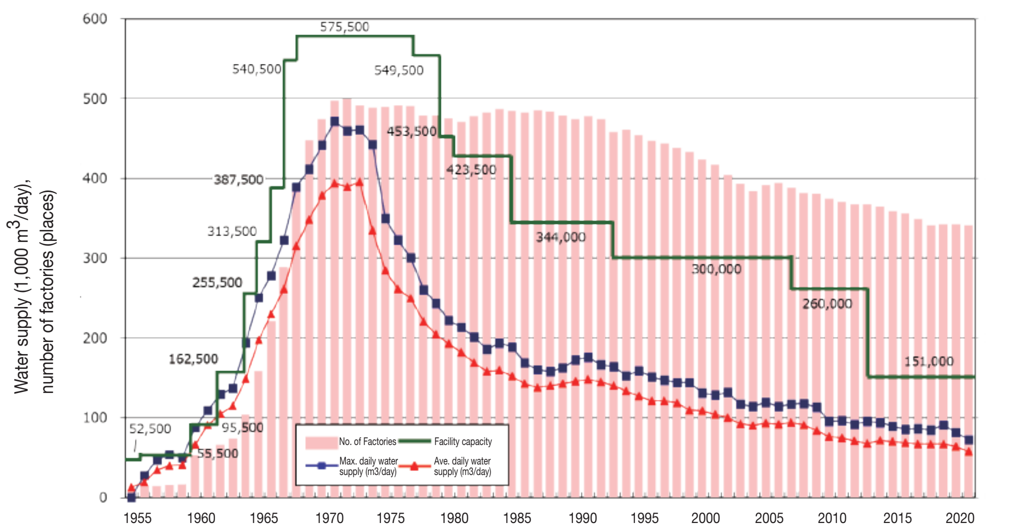
Industrial water is supplied from the Higashi Yodogawa Purification Plant to the following 19 areas.

All areas of Miyakojima, Fukushima, Konohana, Minato, Taisho, Naniwa, Nishi Yodogawa, Higashi Yodogawa, Yodogawa, Higashinari, Asahi, Tsurumi, Joto, and Nishinari and some areas of Kita, Ikuno, Suminoe, Hirano, and Higashi Sumiyoshi

Water consumption by business type (FY2021)

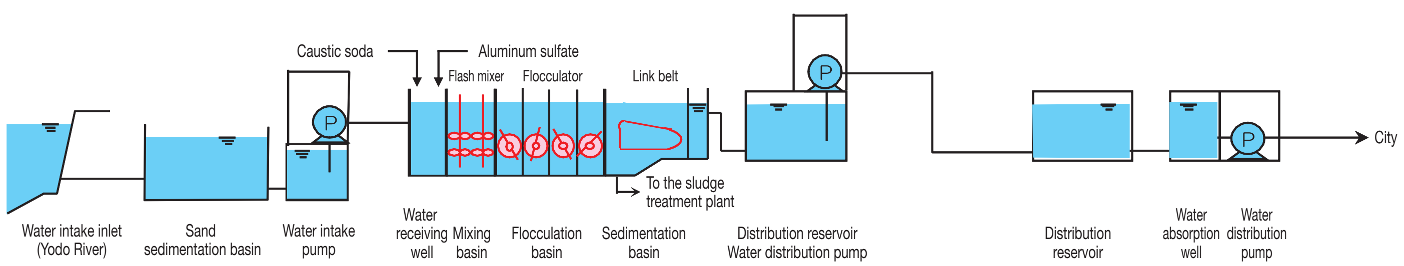


Changes in demand

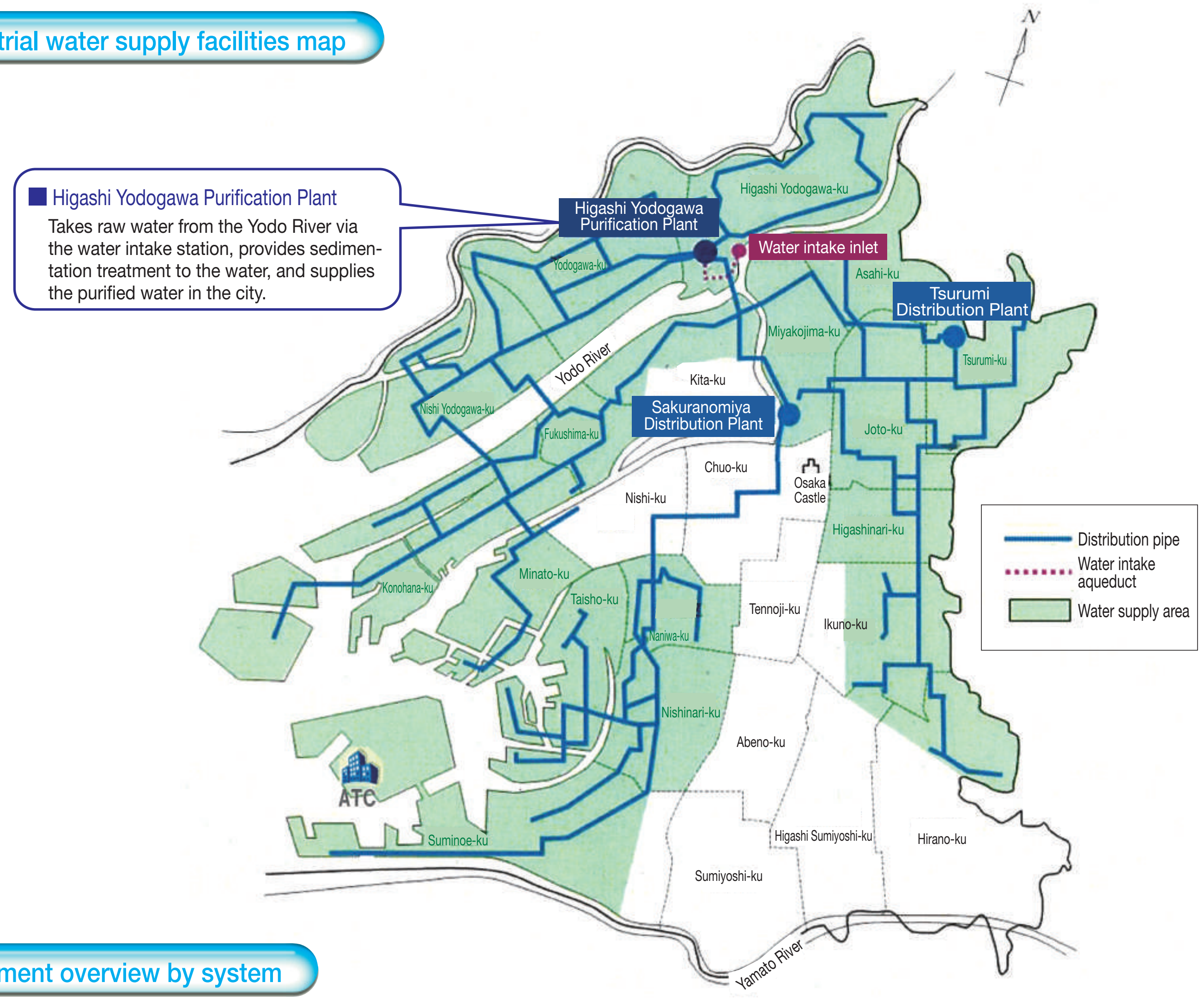


Note: The facility capacity indicates the capacity of facilities in actual operation, and it does not necessarily coincide with the officially reported water supply capacity

Industrial water supply treatment flow chart



Industrial water supply facilities map



Equipment overview by system

Type / Purification plant			Higashiyodogawa Purification Plant
Facility capacity (m³/day)			151,000
Water intake facilities	Water intake	Type	Water intake inlet
		Place, etc.	Kunijima Water Intake Point shared with the Hanshin Waterworks Project Group
	Intake pipe		φ1,100 to 1,200, two streams
	Settling basin		2 basins
	Water intake pump station		1 building
	Water intake pump		4 sets
Water conveyance equipment	Aqueduct		–
Purification equipment	Receiving well		1 (4 flash mixers)
	Chemical injection equipment		Aluminum sulfate, caustic soda and sodium hypochlorite
	Sedimentation basin	Type	Horizontal flow type (with flocculator basin)
		Number of basins	3
	Sump		Shared with waterworks facilities
	Drainage pump		
Distribution equipment	Distribution reservoir	Number of basins	Distribution reservoir on the premises: 2
			Sakuranomiya Distribution Plant: 2
		Capacity	Distribution reservoir on the premises: 3,460 m³
			Sakuranomiya Distribution Reservoir: 1,950 m³
	Water distribution pumping rooms		Distribution plant on the premises: 1 building
			Sakuranomiya Distribution Plant: 1 building
	Water distribution pump		Distribution plant on the premises: 6 sets
			Sakuranomiya Distribution Plant: 3 sets
Effluent treatment facilities	Concentrator		Shared with water supply facilities
	Dehydrator		
	Solar drying reservoir		–
Water supply start (year)			1963

Major pump specifications

Usage	Installation location	Diameter (mm)	Total pump head (m)	Discharge amount (m³/hour)	Electric motor output (kW)	Number of sets
Water intake	Higashiyodogawa Purification Plant	500×400	20	1,600	130	2
		700×600	20	3,300	270	2
Water distribution	Higashiyodogawa Purification Plant	350×250	55	750	170	2
		500×300	**40**	2,000	315	1
		600×350	**40**	2,000	**315〜68**	3
	Hokko Pumping Station	125×100	34	111	22	2
	Tsurumi Distribution Plant	500×350	55	1,500	310	2
		700×500	55	3,000	620	2
		700×500	39	2,300	310	1
	Sakuranomiya Distribution Plant	450×300	45	1,560	280	2
		500×350	45	1,560	280	1

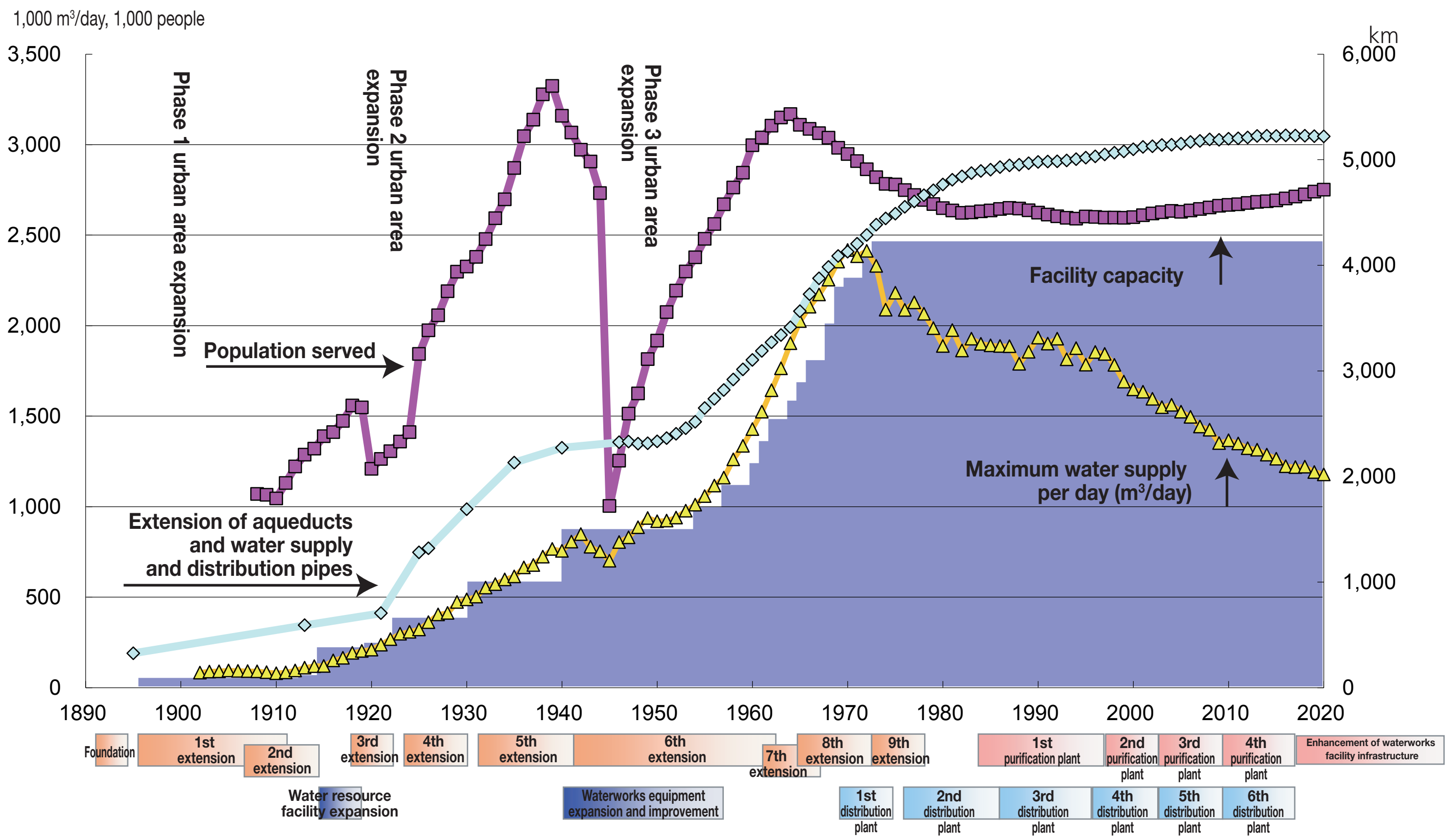
Data

Water supply population and history of expansion projects

The Osaka Municipal Waterworks Bureau was born in November 1895 as the fourth largest modern waterworks following facilities in Yokohama, Hakodate, and Nagasaki, and the Bureau celebrated 120 years of water supply in 2015.
The water supply population at the time the facility was established was 610,000, with a maximum water supply capacity of 51,240 m^3/day. The water purification plant was located at Sakuranomiya on the left bank of the Yodo River, and this plant transmitted water purified by slow filtration to a water distribution reservoir at Osaka Castle, from where it was supplied to Osaka City by natural down-flow through water distribution pipes totaling 325 km in length. The total operational budget was 2.4 million yen (three times the city budget at the time).
Subsequently, as the city developed, a growing water demand made it impossible for the Sakuranomiya water resource to satisfy needs, and this resulted in the implementation of an expansion project nine times, including the construction of the Kunijima Water Purification Plant in 1914 during the second waterworks expansion project.
A huge water demand in Osaka City after the war, in particular, led to the construction of the Niwakubo Water Purification Plant in 1957 during the sixth waterworks expansion project and the Toyono Water Purification Plant in 1968 during the eighth waterworks expansion project.
In addition, to address problems in the deteriorating quality of the water in the Yodo River and a growing water demand volume, the ninth waterworks expansion project was undertaken in 1969. This resulted in acceleration of the slow filtration equipment at the Kunijima Water Purification Plant (601,000 m^3/day), an increase of 198,000 m^3/day and an increase of 50,000 m^3/day at the Toyono Water Purification Plant system, giving Osaka City a water supply capacity of 2,430,000 m^3/day in 1973.
However, water demand peaked at a maximum daily volume of 2,417,700 m^3/day in 1970, leveling out from the growth trend up to that point and beginning to decrease.

Against this background, construction for the additional 450,000 m^3/day planned for the Toyono Water Purification Plant during the ninth waterworks expansion project was suspended in 1975, marking the transition from the period of facility expansion that had continued up to that point to an era of facility maintenance and management.
At present, with the aim of building an infrastructure to support a rich life for citizens and advanced urban activities in the 21st Century, there is a need for an even more stable and highly reliable waterworks system, marking the transition from the era of facility maintenance and management to the era of facility restructuring.
In particular, learning from the lessons of the Hanshin Awaji earthquake that struck in January 1995, the Osaka City Waterworks Bureau Earthquake Resistance Measures Reinforcement Plan 21 (Basic Concept) was formulated (March 1996) with regard to disaster prevention measures and with the aim of improving waterworks system functions capable of withstanding envisaged earthquakes, including near-field types. Then measures were systematically implemented from a comprehensive perspective, including both pre/post-measures, such as prevention planning, emergency recovery planning and enhancement of the reliability of emergency response systems. Furthermore, on the water quality front, while undertaking raw water quality maintenance activities, the Advanced Water Purification Facility Improvement Project was promoted from 1992. This resulted in the supply of water, which had undergone advanced purification, throughout the city in March 2000, and has helped achieve the City's initial objectives, such as the removal of mold-like and other odors and the reduction of trihalomethane. In addition, Osaka City has been reinforcing the measures to deal with contaminating organic chemical substances, such as agricultural chemicals and environmental hormones that have been becoming increasingly prominent in recent years as well as cryptosporidium and other infectious organisms, with a view to providing even safer, high-quality water.

Changes in the Osaka City water supply population, water supply volume, water supply capacity, and extension of aqueducts and water supply and distribution pipes



Changes in matters related to water treatment

Year	Month	Matters	Remarks
1892	August	Beginning of project for establishment of waterworks	
1895	November	Completion of waterworks establishment project, birth of Sakuranomiya water resource	Water supply capacity: 51,240 m^3/day (slow filtration equipment)
1925	August	Beginning of work on first rapid filtration equipment in Osaka City (Fourth Waterworks Expansion Project) (Completed in 1930)	Water supply capacity: 577,000 m^3/day, including lime injection equipment (First rapid system)
1930	February	Start of work on chlorination	
	April	Start of first chlorine injection of 0.1 – 0.2 mg/L into slow and rapid filtration reservoirs	
1931	June	Pre-chlorination of rapid filtration system (Optional)	Water supply capacity: 862,000 m^3/day (Second rapid system)
1933	November	Start of work on rapid filtration equipment expansion (Fifth waterworks expansion project) (Completed in 1940)	
1934	–	Installation of new slow filtration lime injection equipment	
1948	January	Post-chlorination raised to 0.7 mg/L (Set)	
1951	January	Post-chlorination raised to 1.5 mg/L (Set)	City terminal: 0.4 mg/L residue (target)
1952	June to August	Start of pre-chlorination of first and second rapid systems	
1953	June	Post-chlorination injection at Kunijima Purification Plant changed to 1.2 mg/L	
1955	August	Pre-chlorination injection of first and second rapid systems changed to 0.5 mg/L at Kunijima Purification Plant	
1958	June	Rapid system pre-chlorination injection increased (0.5- 2.7 mg/L)	Black turbidity in raw water
	June	Start of slow system pre-chlorination injection (0.3 mg/L)	Excluding winter
1960	February	Start of chemical flocculation reservoir and pre-chlorination in the slow filtration system	
	February	Hand processing normally used for slow filtration, soda ash used for alkali agent (previously lime)	
	September	Slow filtration reservoir remodeled into chemical sedimentation reservoir	
1962	October	Kunijima first rapid system changed to discontinuous point chlorination	
	December	Kunijima second rapid system changed to discontinuous point chlorination	
1963	July	Start of pre-chlorination and discontinuous point chlorination at Niwakubo Purification Plant	
1964	April	Start of work on improvements to Kunijima Purification Plant purified water equipment as measure to deal with raw water quality contamination for the time being (3 years)	
	June	Due to increased chromaticity of filtered water from slow filtration, 5 mg/L of metaphosphoric acid soda was injected as countermeasure	
	June	Slow system intake stopped due to raw water quality contamination caused by water shortage	
	–	Completion of lime injection equipment and start of pH value adjustment	
1965	June	Aeration equipment installed at slow filtration reservoir at Kunijima Purification Plant	
1966	November	Testing of free chlorination started in slow system	
1967	December	Start of use of slaked lime as alkali agent (Niwakubo Water Purification Plant)	Use of soda ash discontinued

Year	Month	Matters	Remarks
1968	February	Start of test injection of polyaluminum chloride as flocculation agent (Kunijima Purification Plant)	
	May	Liquid aluminum sulfate used (Niwakubo Purification Plant)	Water storage concentration changed from 6% to 8%
1969	December	Start of testing red water prevention by pH value adjustment (Kunijima)	
1970	January	Chlorine injection of 42 mg/L recorded at Kunijima Purification Plant (38 mg/L at Niwakubo Water Purification Plant)	Black turbidity in raw water due to rainfall in abnormal turbid water
1971	May	Chlorine injection equipment capacity at Niwakubo Water Purification Plant changed (25–50 mg/L)	
	June	Powdered activated carbon injected (Kunijima, Niwakubo)	
	August	Start of pH adjustment processing as red water countermeasure (Niwakubo, Tatsumi systems)	pH target value: 7.5
	December	Polyaluminum chloride used at low water temperatures (Kunijima)	
1972	June	Use of liquid aluminum sulfate and caustic soda started (Kunijima)	
	June	Part of slow filtration equipment at Kunijima Purification Plant suspended	Complete suspension on September 24, 1974
	August	Ozone processing testing started (Kunijima)	
1973	February	Caustic soda injection equipment completed (Niwakubo)	
	June	Use of slaked lime high-concentration equipment started (Kunijima)	Approx. 15% concentration
1975	August	Ninth waterworks expansion project suspended	
1980	March	Emergency shutdown valve used on chlorination equipment (Kunijima)	
	March	Raw water toxic substance monitoring equipment completed at Kunijima Purification Plant (water quality test laboratory)	
1982	January	Advanced water purification test plant constructed (Kunijima)	Processing capacity: 60 m^3/day
1986	–	Interim chlorine injection equipment installed (Kunijima third system, Niwakubo first and second systems)	
	–	Advanced water purification verification plant constructed (Kunijima)	Processing capacity: 2,000 m^3/day
1988		Interim chlorine injection equipment installed (Kunijima fourth system)	
	–	Interim chlorine injection equipment installed (Kunijima second system, Niwakubo third system)	
1989	June	Powdered activated carbon injection equipment installed (Toyono)	
1990	–	Interim chlorine injection equipment installed (Kunijima first system, Toyono)	
1992		Advanced water purification equipment construction project started	
1998	March	Water transmission by the Kunijima Purification Plant lower system advanced water purification facility initiated	
1999	March	Water transmission by the Niwakubo Purification Plant advanced water purification facility initiated	
2000		Water transmission by the Kunijima Purification Plant upper system advanced water purification facility initiated	
		Water transmission by the Toyono Purification Plant advanced water purification facility initiated	
2010	September	Oxygen injection equipment installed (Kunijima)	
2010	November	Oxygen injection equipment installed (Toyono)	
2011	February	Oxygen injection equipment installed (Niwakubo first and second systems)	
2011	March	Oxygen injection equipment installed (Niwakubo third system)	

Data

Outline of water purification facilities by the purification plant type

Type			Kunijima Purification Plant*1				Niwakubo Purification Plant			Toyono Purification Plant
Facility capacity			1,180,000 m^3/day				800,000 m^3/day			450,000 m^3/day
Water intake facilities	Intake port, sedimentation reservoir		Kunijima Purification Plant: 3 water intake towers, 6 sedimentation reservoirs Hitotsuya Water Intake Station: 1 water intake tower, 8 sedimentation reservoirs (8 reservoirs in Osaka City x (200÷1,030))				2 water intake ports, 6 sedimentation reservoirs			Kuzuha Water Intake Station: 2 water intake ports, 4 sedimentation reservoirs
	Intake pump system		Hitotsuya water intake pumping station	First water intake pumping station	Third water intake pumping station	Second water intake pumping station	Water intake pumping station	Second water intake pumping station (2nd system)	Second water intake pumping station (3rd system)	Water intake / Water pumping
	Intake pump	Number of units	4	5	4	4	4	5	5	4 / 3
Water purification facilities	Water purification system		System 1	System 3	System 2	System 4	System 1	System 2	System 3	
	Mixing reservoir	Number of reservoirs	1 reservoir	2 reservoirs	1 reservoir	2 reservoirs	1 reservoir	1 reservoir	4 reservoirs	6 reservoirs
		Mixing method	Top to bottom flow system	Flush mixer	Flush mixer	Overflow distribution type	Flush mixer	Flush mixer	Flush mixer	Top to bottom flow system
	Flocculation reservoir	Number of reservoirs	2 reservoirs	6 reservoirs	4 reservoirs	6 reservoirs	4 reservoirs	4 reservoirs	4 reservoirs	6 reservoirs
		Flow direction	Top to bottom flow system	Perpendicular direct flow system	Top to bottom flow system	Perpendicular direct flow system	Top to bottom flow system	Top to bottom flow system	Top to bottom flow system	Top to bottom flow system
		Stirring device	Flow blocking board	Flocculator	Flow blocking board	Flocculator	Flow blocking board	Flow blocking board	Flow blocking board	Flow blocking board
	Sedimentation reservoir	Number of reservoirs	3 reservoirs	6 reservoirs	8 reservoirs	6 reservoirs	4 reservoirs	4 reservoirs	4 reservoirs	6 reservoirs
		Method	Lateral flow system	Lateral flow system	Lateral flow system	Lateral flow system	Lateral flow system	Lateral flow system	2-level parallel flow system	2-level parallel flow system
		Desludging method	Atmospheric pressure system	Link belt type	Link belt type	Link belt type	Link belt type	Running type Meader type	Link belt type	Link belt type
	Med-ozone contact reservoir	Number of reservoirs	3 reservoirs	4 reservoirs	4 reservoirs	4 reservoirs	4 reservoirs	4 reservoirs	8 reservoirs	4 reservoirs
		Method	Contrary flow distributed air piping system	Contrary flow distributed air piping system	Contrary flow distributed air piping system	Contrary flow distributed air piping system	Contrary flow distributed air piping system	Contrary flow distributed air piping system	Contrary flow distributed air piping system	Contrary flow distributed air piping system
		Contact time	5 min.	5 min.	5 min.	5 min.	5 min.	5 min.	5 min.	5 min.
		Number of contact stages	2 stages	2 stages	2 stages	2 stages	2 stages	2 stages	3 stages	2 stages
	Rapid filtration reservoir	Number of reservoirs	12 reservoirs	24 reservoirs	24 reservoirs	20 reservoirs	20 reservoirs	20 reservoirs	24 reservoirs	28 reservoirs
		Filtration area	80 m^2	126 m^2	108 m^2	126 m^2	116 m^2	116 m^2	127 m^2	126 m^2
		Filter layer thickness	75 cm	60 cm	75 cm	60 cm	75 cm	75 cm	70 cm	60 cm
		Gravel layer thickness	35 cm	26 cm	35 cm	26 cm	35 cm	35 cm	44 cm	20 cm
		Water collection method	Wheeler type	Porous block type	Wheeler type	Porous block type	Porous block type	Wheeler type	Wheeler type Porous block type	Porous block type
		Surface washing method	Fixed type	Fixed type	Fixed type	Fixed type	Fixed type	Fixed type	Fixed type	Fixed type
		Backwashing method	Direct pump transmission		Direct pump transmission		Direct pump transmission	Direct pump transmission	Direct pump transmission	Direct pump transmission
	Lift pump	Units	5		6		6			4
	Post-ozone contact reservoir	Number of reservoirs	3 reservoirs		3 reservoirs		3 reservoirs			4 units
		Method	Contrary flow distributed air piping system		Contrary flow distributed air piping system		Contrary flow distributed air piping system			U tube system
		Contact time	5 min.		5 min.		5 min.			4.2 min.
		Reaction time	5 min.		5 min.		5 min.			
		Number of contact stages	2 stages		2 stages		2 stages			—
	Granular activated carbon absorption reservoir	Number of reservoirs	12 reservoirs		14 reservoirs		16 reservoirs			10 reservoirs
		Area	101.4 m^2/reservoir		112.7 m^2/reservoir		116.9 m^2/reservoir			109.6 m^2/reservoir
		Layer thickness	2.1 m		2.1 m		2.1 m			2.1 m
		Water collection device	Porous plat type		Porous plat type		Porous plat type			Porous plat type
	Chlorine contact reservoir	Number of reservoirs	2 reservoirs		2 reservoirs		2 reservoirs			2 reservoirs
		Contact time	15 min.		15 min.		15 min.			15 min.
	Purification reservoir	Number of reservoirs					2 reservoirs	2 reservoirs	2 reservoirs	5 reservoirs
		Total capacity					10,000 m^3	10,000 m^3	13,400 m^3	75,300 m^3
	Water transmission pump	Units					4	4	5	
Chemical injection equipment	Concentrated sulfuric acid	Storage tank	10 m^3 × 2 tanks		13 m^3 × 2 tanks		11 m^3 × 2 tanks		6 m^3 × 2 tanks	8 m^3 × 2 tanks
		Lift pump	2		2		2		2	2
		Small extraction tank	0.5 m^3 × 2 tanks		0.7 m^3 × 2 tanks		0.5 m^3 × 2 tanks		0.3 m^3 × 2 tanks	0.4 m^3 × 2 tanks
		Injector	4	4	4	4		4	4	5
	Aluminum sulfate	Storage tank	210 m^3 × 4 tanks		210 m^3 × 2 tanks		250 m^3 × 6 tanks			250 m^3 × 2 tanks
		Lift pump	2		2		5			2
		Small extraction tank	3.5 m^3 × 2 tanks		3.5 m^3 × 2 tanks		2.3 m^3 × 2 tanks		4 m^3 × 2 tanks	4 m^3 × 2 tanks
		Injector	3	6	3	3	3	3	3	4
	Caustic soda	Storage tank	210 m^3 × 2 tanks		225 m^3 × 2 tanks		200 m^3 × 5 tanks			100 m^3 × 3 tanks
		Lift pump	3		3		2			2
		Injector: Pre	2	2	2	2	2	2	2	3
		Injector: Post	5		5		5			6
		Small extraction tank	4.5 m^3 × 2 tanks		5.5 m^3 × 2 tanks		7.5 m^3 × 2 tanks			4.0 m^3 × 2 tanks
	Ozone: Mid	Ozone generator	8.8 kgO$_3$/h × 1 unit	17.5 kgO$_3$/h × 1 unit	7.5 kgO$_3$/h × 1 unit	7.3 kgO$_3$/h × 1 unit	5.3 kgO$_3$/h × 1 unit	5.3 kgO$_3$/h × 1 unit	3.5 kgO$_3$/h × 2 units	9.9 kgO$_3$/h × 1 unit
		Non-ozone processing equipment	3	2	2	2	2	2	4	2
	Ozone: Post	Ozone generator	11.2 kgO$_3$/h × 2 units + 17.5 kgO$_3$/h × 1 unit		14.7 kgO$_3$/h × 2 units		17.5 kgO$_3$/h × 2 units			9.9 kgO$_3$/h × 2 units
		Non-ozone processing equipment	4		3		3			3
	Sodium hypochlorite	Storage tank	27 m^3 × 4 tanks		65 m^3 × 5 tanks		27 m^3 × 4 tanks			22 m^3 × 6 tanks
		Lift pump	-		2		-			2
		Small extraction tank	-		13 m^3 × 2 tanks		-			5.5 m^3 × 2 tanks , 10
		Injector	Water injection pump 8		9		Water injection pump 9			-
	Powdered activated carbon	Storage tank	-				85 m^3 × 2 tanks			-
		Dissolution tank	102 m^3 × 2 tanks				1.2 m^3 × 2 tanks			56.25 m^3 × 2 tanks
		Water injection pump	3				4			2
Waste water treatment equipment	Concentration tank	Capacity/Number of tanks	3,000 m^3 × 4 tanks				1,500 m^3 × 4 tanks			700 m^3 × 1 tank 1,050 m^3 × 1 tank
	Pressure dehydrator	Area/Number of units	1,150 m^3 × 5 tanks 25 m^3 × 3 tanks				1,100 m^3 × 6 tanks			25 reservoirs
	Solar drying reservoir	Number of reservoirs / Total area								29,600 m^2

Note: The Kunijima Purification Plant uses part of the industrial water facilities.

			No. 1 Distribution Pumping Station	No. 2 Distribution Pumping Station	No. 3 Distribution Pumping Station	Otemae Distribution Plant	Hokko Pumping Station	Maishima Water Supply Tower	Tatsumi Distribution Plant	Oyodo Distribution Plant	Sumiyoshi Distribution Plant	Suminoe Distribution Plant	Sakishima Distribution Plant	Nagai Distribution Plant	Minato Distribution Plant	Izuo Distribution Plant	Joto Distribution Plant	Sanadayama Pumping Station
Distribution facilities	Distribution plants, water supply towers																	
	Distribution reservoir	Number of reservoirs	9 reservoirs	4 reservoirs	6 reservoirs	3 reservoirs	—	1 reservoir	8 reservoirs	4 reservoirs	2 reservoirs	2 reservoirs	2 reservoirs	3 reservoirs	2 reservoirs	2 reservoirs	6 reservoirs	—
		Total capacity	112,400 m^3	55,000 m^3	106,200 m^3	33,700 m^3	—	500 m^3	100,900 m^3	55,000 m^3	12,000 m^3	27,300 m^3	30,000 m^3	42,000 m^3	15,000 m^3	24,000 m^3	67,000 m^3	—
	Distribution pumps	Units	7	5	7	4	2		12	5	4	4	4	5	4	5	6	3
Disinfection equipment	Sodium Hypochlorite	Storage tank	—	—	—	—	—	0.2 m^3 × 2 tanks	0.3 m^3 × 2 tanks	0.3 m^3 × 2 tanks	1.3 m^3 × 3 tanks	2.0 m^3 × 3 tanks	1.5 m^3 × 2 tanks	4.5 m^3 × 2 tanks	—	0.8 m^3 × 3 tanks	1 m^3 × 3 tanks	—
		Injector	—	—	—	—	—	2	2	2	2	2	2	2	—	3	2	—

Changes in Osaka City water supply pipes (cast iron straight pipes)

Year	Name	Standard	Diameter	Type	Material	Joint shape	Interior coating	Remarks
1908-1930	Cast iron pipes for waterworks	Osaka City type	31/2” (89 mm) ~42” (1067 mm)		Ordinary cast iron	Socket	Tar	Imported and domestic products
1930-1932	〃	Clean Water Council type	75～1500 mm		〃	〃	〃	
1932-1933	〃	〃	〃		High-class cast iron	〃	〃	
1933-1954	〃	Japan Waterworks Association type	〃		〃	〃	〃	
1954-1958	Vertical-type cast iron straight pipes for waterworks	JIS G 5521	〃	Normal pressure pipe	〃	〃	Mortar lining	
〃	Centrifugal force dust-type cast iron pipes for waterworks	JIS G 5522	75～900 mm	〃	〃	〃	〃	
〃	Centrifugal force gold dust-type cast iron pipes for waterworks	JIS G 5523	75～250 mm	〃	〃	〃	〃	
1954-1955	Cast iron pipes with rubber joints	Osaka City type	1000～1500 mm	〃	〃	B type	Tar	Used on main Sumiyoshi line
1955-1962	Ductile cast iron pipes with rubber joints	〃	800～1500 mm	〃	Ductile cast iron	〃	Mortar lining	
1958-1966	Cast iron pipes with mechanical joints for waterworks	JWWA G 102	75～900 mm	〃	High-class cast iron	A type	〃	
1961-1965	Centrifugal force ductile cast iron pipes for waterworks	JWWA G 105	1200～1500 mm	Type 2 pipe	Ductile cast iron	B type	〃	
〃	〃	〃	800～1100 mm	〃	〃	A type	〃	
1963-1965	〃	〃	600～700 mm	〃	〃	〃	〃	
1964-1968	〃	〃	300～500 mm	〃	〃	〃	〃	
1965-1968	〃	〃	500～1100 mm	Type 3 pipe	〃	〃	〃	
1965-1987	〃	〃	300～350 mm	Type 1 pipe	〃	〃	〃	
1966-1987	〃	〃	75～250 mm	〃	〃	〃	〃	
1965	K-shaped centrifugal force ductile cast iron pipes	JDPA G 1001	1200～2200 mm	Type 2 pipe	〃	K type	〃	1974: JIS G 5526 1982: JWWA G 113 established
1965 onward	〃	〃	〃	Type 3 pipe	〃	〃	〃	Tar epoxy resin coating has been used on irregular-shaped pipes of 400 mm or more since about 1967.
1968 onward	〃	〃	500～1100 mm	〃	〃	〃	〃	
〃	〃	〃	400～450 mm	Type 2 pipe	〃	〃	〃	
1967 onward	U-shaped centrifugal force ductile cast iron pipes	Osaka City type	1000～2200 mm 1100～1500 mm	〃 Type 3 pipe	〃	U type	〃	1974: JIS G 5526 1982: JWWA G 113 established
1969 onward	T-shaped centrifugal force ductile cast iron pipes for waterworks	JWWA G 110	75～250 mm	Type 1 pipe	〃	T type	〃	Interior powder coating has been used in T type irregular-shaped pipes since 1975 (since 1977 in A type)
1977 onward	S-shaped centrifugal force ductile cast iron pipes	JDPA G 1019	500～2000 mm	Type 1-3 pipes	〃	S type	〃	1974: JIS G 5526 1982: JWWA G 113 established
1980 onward	SII-shaped centrifugal force ductile cast iron pipes	JDPA G 1021	100～450 mm	〃	〃	SII type	〃	〃
1982 onward	Ductile cast iron pipes for inner pipe insertion	OWMS G 1026 OWMS G 1027	300～1350 mm	Type 1-4 pipes 〃	〃	PI type PII type	〃	OMMS was abolished in 1995 and the transition was made to JWWA G 113 (PI and PII types). PIII-shaped types have been used for irregular-shaped pipes since 1968.
1987 onward	〃	JWWA G 113	75～350 mm	Type 1 pipe	〃	K type	〃	
1989 onward	Ductile cast iron pipes for waterworks	JWWA G 113	75～2600 mm	Type 1-4 pipes	〃	All types	〃	Transparent seal coating used, non-tar epoxy resin material used for exterior coating
1990 onward	〃	〃	〃	Type 1-4.5 pipes	〃	〃	〃	JWWA G 113 revised (transition to SI unit, etc.)
1992 onward	〃	〃	〃	〃	〃	〃	〃	JWWA G 113 revised (coating standards) JWWA K 139 established
1996 onward	NS-shaped ductile cast iron pipes	JDPA G 1042	75～250 mm	Type 1 & 3 pipes	〃	NS type	〃	JIS A 5314 transferred to JWWA G 113 in 2000.
2000 onward	Ductile cast iron pipes for waterworks	JWWA G 113	75～2600 mm	Type 1-4.5 pipes	〃	All types	〃	Leachability and leaching test method added
2003 onward	Ductile cast iron pipes for PN	Osaka City type	300～1500 mm	Type 1-4 pipes	〃	PN type	〃	PI and PII types used as improved pipes from 2003.
〃	Ductile cast iron pipes for waterworks	Osaka City type JWWA G 112	75～350 mm	Type 1 pipe	〃	All types	Interior surface epoxy resin powder	All bores targeted in Maishima and Yumeshima areas, etc.
2005 onward	NS-shaped ductile cast iron pipes	JDPA G 1042	300～450 mm	Type 1 pipe	〃	NS type	Interior surface epoxy resin powder Mortar lining	
2010 onward	NS-shaped ductile cast iron pipes	JDPA G 1042	500～1000 mm	Type S pipe	〃	NS type	Mortar lining	Bore expansion
2013 onward	GX-shaped ductile cast iron pipes	JDPA G 1049	75～250 mm	Type 1 pipe	〃	GX type	Interior surface epoxy resin powder	
2020 onward	GX-shaped ductile cast iron pipes	JDPA G 1049	300～400 mm	〃	〃	GX type	Interior surface epoxy resin powder	Bore expansion

Chronology

Chronology of water facilities

Year	Month	Matters relating to waterworks facilities	Water supply capacity
1892	August	Waterworks construction project starts	
1893	July	Water distribution reservoir at Osaka Castle completed	
1895	November	Waterworks construction project completed, birth of Sakuranomiya water resource	51,240 m^3/day
1897		First waterworks expansion project starts	
1908	January	Second waterworks expansion project and meter installation project starts	
1910	March	Meter installation project completed	
1912		First waterworks expansion project completed	67,200-91,650 m^3/day
1914	March	Second waterworks expansion project completed, birth of Kunijima water resource	219,000 m^3/day
1915	September	Suspension of operations at Sakuranomiya water resource	
1918	June	Kunijima water resource equipment supplementation project starts	
1919	March	Kunijima water resource equipment supplementation project completed	243,000 m^3/day
	September	Third waterworks expansion project starts	
1920	December	Abolition of Sakuranomiya water resource	
1922	March	Third waterworks expansion project completed	379,000 m^3/day
1925	August	Fourth waterworks expansion project starts	
1926	November	Water distribution pipe construction project starts	
1928	March	Water distribution pipe construction project completed	
1929	April	Highland water distribution equipment improvement project starts	
1930	February	Fourth waterworks expansion project completed	577,000 m^3/day
	October	Water distribution pipe expansion project starts	
1931	May	Highland water distribution equipment improvement project completed	
1932	March	Water distribution pipe expansion project completed	
1933	November	Fifth waterworks expansion project starts	
1935	November	Waterworks office building completed (operation launched on December 1)	
1939	May	Water supply equipment expansion and improvement project starts	
1940	April	Sixth waterworks expansion project starts	
	June	Fifth waterworks expansion project completed	862,000 m^3/day
1946	March	Water supply equipment expansion and improvement project suspension	
	March	Sixth waterworks expansion project suspension	
1948	September	Water supply equipment expansion and improvement project restarts	
1949	April	Water quality testing laboratory constructed	
1953	April	Water distribution pipe improvement project starts	
	June	Sixth waterworks expansion project restarts	
1954	August	Water supply equipment expansion and improvement project completed	982,000 m^3/day
1957	November	Birth of Niwakubo Water Purification Plant (sixth expansion project), partial passing water initiated (120,000 m^3 /day)	1,102,000 m^3/day
1958	July	Niwakubo Water Purification Plant completed (sixth expansion project)	1,222,000 m^3/day
		Full passing water transmission of 240,000 m^3/day	
		Seventh waterworks expansion project starts	
1960	March	Sixth waterworks expansion project completed	
1961	April	Separation and independence of industrial waterworks operations from waterworks operations	
	July	Partial passing water from Niwakubo Water Purification Plant (seventh expansion project) (120,000 m^3/day)	1,342,000 m^3/day
1962	April	Eighth waterworks expansion project starts	
	July	Niwakubo Water Purification Plant completed (seventh expansion project)	1,462,000 m^3/day
		Full passing water of 240,000 m^3/day	
1964	March	Seventh waterworks expansion project completed	1,562,000 m^3/day
	July	Niwakubo Water Purification Plant expanded (eighth expansion project), partial passing water launched (100,000 m^3/day)	
1965	April	5-year plan water distribution construction project starts (Phase 1)	1,662,000 m^3/day
	July	Niwakubo Water Purification Plant expansion (eighth expansion project), partial passing water launched (100,000 m^3/day)	1,782,000 m^3/day
1966	July	Niwakubo Water Purification Plant expansion (eighth expansion project) completed (120,000 m^3/day)	
		Full passing water of 320,000 m^3/day	1,982,000 m^3/day
1968	July	Toyono Water Purification Plant expanded (eighth expansion project), partial passing water launched (200,000 m^3/day)	2,182,000 m^3/day
1969	September	Toyono Water Purification Plant (eighth expansion project) completed (200,000m^3/day)	
		Full passing water of 400,000 m^3/day	
	September	Ninth waterworks expansion project starts	
1970	July	Toyono Water Purification Plant (ninth development project) partially completed (50,000 m^3/day)	2,232,000 m^3/day
1972	April	Phase 2 water distribution construction project implementation	
	July	Kunijima Water Purification Plant (ninth expansion project) completed (Fourth System, 108,000 m^3/day)	2,340,000 m^3/day
1973	July	Kunijima Water Purification Plant (ninth expansion project) completed (Third System 3, 90,800 m^3/day)	2,430,000 m^3/day
1975	August	Ninth waterworks expansion project suspended	
		Implementation continued as special construction project for remaining work	
1979	March	Special construction project completed	
	April	Phase 1 water purification facilities construction project implementation	
1982	April	Phase 3 water distribution pipe construction project implementation	
1990	April	Phase 4 water distribution pipe construction project implementation	
1992	April	Phase 2 water purification facilities construction project implementation	
		Advanced water purification facilities construction project implementation	
1995	November	100th anniversary of passing water (construction of waterworks memorial hall etc.)	
1997	April	Phase 3 water purification facilities construction project implementation	
		Phase 5 water distribution pipe construction project implementation	
1998	March	Kunijima Water Purification Plant lower system advanced water purification passing water	
1999	March	Niwakubo Water Purification Plant advanced water purification passing water	
2000	March	Kunijima Water Purification Plant upper system advanced water purification passing water	
		Toyono Water Purification Plant advanced water purification passing water	
2006	November	International water quality control standards for all water purification plants	
		ISO9001 accreditation acquired	
2007	April	Phase 4 water purification facilities construction project implementation	
		Phase 6 water distribution pipe construction project implementation	
2008	December	International foodstuffs safety control standard ISO22000 accreditation acquired	
2018	April	Urgent 10-year Plan for Improving Earthquake Resistance of Pipelines implementation	
		Water Purification and Distribution Facilities Enhancement Plan implementation	

Chronology of industrial water facilities

Year	Month	Matters relating to waterworks facilities	Water supply capacity
1951	March	Industrial waterworks construction project starts (Planned water supply volume: 52,500 m^3/day, construction of Fukushima Water Purification Plant, supply district: the whole of Konohana-ku and part of Fukushima-ku)	
1954	June	Start of partial supply water from the industrial waterworks construction project (Fukushima Purification Plant sedimentation water used)	52,500 m^3/day
	July	Ceremony to mark water transmission from the industrial waterworks construction project	
1955	July	Full volume water supply from the industrial waterworks construction project starts(Fukushima Water Purification Plant system: 52,500 m^3/day, filtration water used) Ceremony to mark completion of the industrial waterworks construction project	
	August	Mikuni waterproof waterworks used for industrial waterworks and water supply initiated (Planned water supply volume: 3,000 m^3/day, new Mikuni Water Distribution Plant constructed, water supply area: the whole of Higashi Yodogawa-ku)	55,500 m^3/day
1956	June	Industrial Water Law enacted	
1957	November	First industrial waterworks expansion project starts (Planned water supply volume: 40,000 m^3/day, Fukushima Water Purification Plant expanded to 17,000 m^3/day, Mikuni Water Distribution Plant expanded to 23,000 m^3/day, water supply area: the whole of Nishi Yodogawa-ku and Yodogawa-ku)	
1958	October	Industrial Waterworks Project Law enacted	
1959	April	Second industrial waterworks expansion project starts (Planned water supply volume: 160,000 m^3/day, construction of new Konohana Water Purification Plant: 67,000 m^3/day, construction of Higashi Yodogawa Water Purification Plant: 93,000 m^3/day, supply area: the whole of Fukushima-ku, Konohana-ku, Nishi Yodogawa-ku and Yodogawa-ku and part of Kita-ku and Higashi Yodogawa-ku)	
1959	May	Partial water supply form the first industrial waterworks project starts (Mikuni Water Distribution Plant system increased by 23,000 m^3/day)	78,500 m^3/day
	June	Ceremony to mark partial water transmission from the first industrial waterworks expansion project	
	November	Full water supply from the first industrial waterworks expansion project starts (Fukushima Water Purification Plant system increased by 17,000 m^3/day)	95,500 m^3/day
1960	February	First industrial waterworks expansion project completed	
1961	April	Separation and independence of industrial waterworks operations from waterworks operations	
	September	Partial water supply initiated from the second industrial waterworks expansion project (Konohana Water Purification Plant system: 67,000 m^3/day)	162,500 m^3/day
1962	April	Third industrial waterworks expansion project starts (Planned water supply volume: 225,000 m^3/day, construction of Joto Water Purification Plant: 153,000 m^3/day, Higashi Yodogawa Water Purification Plant increased by 58,000m^3/day, Fukushima Water Purification Plant increased by 14,000m^3/day, water supply area: the whole of Fukushima-ku, Higashinari-ku, Asahi-ku, Tsurumi-ku and Joto-ku and part of Kita-ku and Higashi Yodogawa-ku)	
1963	April	Full water supply from the second industrial waterworks expansion project starts (Higashi Yodogawa Water Purification Plant system: 93,000 m^3/day)	255,500 m^3/day
	April	The fourth industrial waterworks expansion project starts (Planned water supply volume: 95,000 m^3/day, construction of Nishinari Water Purification Plant: 60,000 m^3/day, Fukushima Water Purification Plant increased by 12,500 m^3/day, Konohana Water Purification Plant increased by 22,500 m^3/day, water supply area: in addition to the first specified area, the whole of Minato-ku, Taisho-ku, Naniwa-ku and Nishinari-ku and part of Ikuno-ku, Suminoe-ku, Hirano-ku and Higashi Sumiyoshi-ku)	
1964	November	Second industrial waterworks expansion project completed	
	October	Partial water supply from the third industrial waterworks expansion project starts	313,500 m^3/day
1965		(Higashi Yodogawa Water Purification Plant system increased by 58,000 m^3/day)	
	April	The fifth industrial waterworks expansion project starts	
	October	Partial water supply from the fourth industrial waterworks expansion project starts (Nishinari Water Purification Plant system: 60,000 m^3/day, by divided supply from Osaka Coastal Industrial Waterworks Union)	373,500 m^3/day
1966	March	Partial water supply from the third industrial waterworks expansion project starts (Water conveyed from the Joto Water Purification Plant system and Fukushima Water Purification Plant, Fukushima Water Purification Plant system increased by 14,000 m^3/day)	387,500 m^3/day
1967	February	Completion of the third industrial waterworks expansion project and commencement of full water supply from the third industrial waterworks expansion project (Joto Water Purification Plant system: 153,000 m^3/day)	540,500 m^3/day
	December	Full water supply from the fourth industrial waterworks expansion project starts (Fukushima Water Purification Plant system increased by 12,500 m^3/day, Konohana Water Purification Plant system increased by 22,500 m^3/day, water supply area: part of Ikuno-ku, Hirano-ku and Higashi Sumiyoshi-ku)	575,500 m^3/day
1968	February	Fourth industrial waterworks expansion project completed (Nishinari Water Purification Plant system: 60,000 m^3/day)	
	November	Fifth industrial waterworks expansion project suspension	
1976	May	Operations suspension at Mikuni Water Distribution Station (26,000 m^3/day) and Kunijima Water Transmission Pumping Station abolition (26,000 m^3/day)	549,500 m^3/day
1977	April	Mikuni Water Distribution Station abolition (26,000 m^3/day)	
1979	March	Operations at Fukushima Water Purification Plant suspension (96,000 m^3/day)	453,500 m^3/day
1980	March	Operations at Nishinari Water Purification Plant abolished and gratuitous transfer of jurisdiction to the sewage bureau effected (60,000 m^3/day)	423,500 m^3/day
	April	Installation of in-house industrial water at Osaka Coastal Industrial Waterworks Business Group and 30,000 m^3/day sub-distributed to Nishinari system for Osaka City	
1983	March	Fukushima Water Purification Plant abolition (96,000m^3/day)	
1984	March	Osaka Coastal Industrial Waterworks Business Group in-house industrial water expansion (Nishinari system: 30,000 m^3/day ⇒ 40,000 m^3/day)	433,500 m^3/day
	September	Operations at Konohana Water Purification Plant suspended (89,500 m^3/day) and moved as a water distribution station	344,000 m^3/day
1992	April	Konohana Water Purification Plant (89,500 m^3/day) and Kunijima Water Transmission Pumping Station (26,000 m^3/day) abolished and capacities of Joto Water Purification Plant and Nishinari system changed (Joto system: 153,000 m^3/day ⇒ 109,000 m^3/day)	300,000 m^3/day
1993	April	Industrial waterworks reconstruction project starts	
2000	April	Industrial waterworks reconstruction project starts (Phase 2)	
2004	March	Dissolution of the Osaka Coastal Industrial Waterworks Business Group	
	April	Industrial waterworks area expansion project starts Provisional launch of operations at Tsumori Water Purification Plant (Higashi Yodogawa Water Purification Plant system: 151,000 m^3/day ⇒ 146,000 m^3/day, Nishinari system: 40,000 m^3/day ⇒ 45,000 m^3/day)	
2007	March	Industrial waterworks area expansion project completed Tsumori Water Purification Plant abolished (Nishinari system: 45,000 m^3/day)	
	April	Higashi Yodogawa Water Purification Plant service area expanded to include Nishinari system and Nanko area (Higashi Yodogawa Water Purification Plant system: 146,000m^3/day ⇒ 151,000 m^3/day)	260,000 m^3/day
2009	March	Industrial waterworks reconstruction project (Phase 2) completed	
2013	February	Joto Water Purification Plant suspended (109,000 m^3/day)	151,000 m^3/day
2018	April	Joto Water Purification Plant abolished (Renamed Tsurumi Distribution Plant)	

Note 1) The operating water supply capacity shown in this paper indicates the actual operation capacity on those days, so it does not correspond with the capacity reported in the notification of business.
Note 2) The Nishinari Water Purification Plant has never been in operation. However, since the Nishinari system received water as raw water for the business group Tsumori Water Purification Plant, calculations are shown based on its water receiving capacity.

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The mobile-phone website of Osaka City Waterworks Bureau is available.

* Please read the QR code on the right if your phone is equipped with a camera.

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