

Case	Water Quality Management		
Water utility	Bureau of Waterworks Tokyo Metropolitan Government		
General information of the utility (as of October 1, 2018 unless otherwise specified)			
Operation type	Public	Service area (km ²)	1,239
Population served	13.50 million	Distribution (m ³ /d)	421
Service coverage (%)	100.0	Pipe length (km)	27,195
NRW (%)	3.25 (water loss) ¹	Number of staff	3,747 ²
Number of water sources	Surface water (5), Groundwater (279), Others (Subsoil water x 8)* ²		
Water rates (JPY)	2077.2 ³	(in case of 10m ³ of water use per month for residential customers)	
Summary	Water supply service is an important lifeline that supports our daily lives and urban activities. The quality of tap water is required to meet the drinking water quality standards based on the Waterworks Act, and the Bureau of Waterworks Tokyo Metropolitan Government is making every effort for water quality management to maintain a stable supply of safe, refreshing, high-quality tap water. This paper presents the water quality management at the Bureau, which supplies water to approximately 13.5 million people in the 23 wards and 26 cities and towns in the Tama area, and how the utility addresses emerging water quality issues.		
Current Status & Challenges	1. Water quality inspection system The Waterworks Act stipulates 51 parameters for drinking water quality standards, 26 parameters for water quality management targets, and 47 parameters for which further consideration is required, as well as the parameters for daily inspections. At the Bureau of Waterworks Tokyo Metropolitan Government (Bureau), the Water Quality Center is playing a central role in improving the utility’s water quality inspection capabilities in terms of both technology and equipment, and is responsible for ensuring an appropriate inspection system is in place.		

¹ water loss (%) is listed instead of NRW

² as of August 1, 2020

³ budget for FY2019; calculated from the unit selling price for 1m³ for a month

(1) Acquisition of the international standard certification

The Bureau has obtained accreditation for its water quality inspections under an international standard (ISO/IEC17025), which objectively guarantees a reliability of inspection results, and has been implementing water quality inspections on its own. The Water Quality Center obtained certification for metals in March 2004, and later for volatile organic compounds in March 2007. The Water Quality Testing Laboratory at the Tama Water Supply Reform Promotion Division also obtained certification for metals and volatile organic compounds in March 2007.

(2) Water quality inspection plan

In the utility's "Water Quality Inspection Plan for FY2019" published in March 2019, test points were set at 131 locations in Tokyo where automatic water quality meters had been installed, as well as at the entrance and exit of water treatment plants (stations). The plan also determined an appropriate inspection frequency depending on the characteristics of the water quality of different water sources. The inspection plan and inspection results have been published on the utility's website.

2. Water quality management from source to tap

(1) Water quality management of water sources

The main water source of the Bureau is surface water, which is derived from almost the entire Kanto region, including the Tone River, Arakawa River, Edogawa River, Tama River, and Sagami River. Subsoil water and groundwater are also used as a water source, mainly in the Tama area. To understand the water quality of such a wide range of water sources, and to use that information for water quality management in reservoirs and for proper water treatment, and for water quality conservation of the water sources, as well as for an early detection of water quality anomalies and prompt and appropriate response in case of pollution incidents, the following measures are being implemented.

- Periodic water quality inspections at about 70 survey points
- Patrol monitoring of water quality via water testing vehicles, etc.
- Establishment of an emergency contact network and coordination in case of water quality incidents as well as the investigation on the incidents
- Proper management of water source forests and concluding agreements with upstream areas of the Ogouchi reservoir and with surrounding towns and villages
- Collecting information on the water discharged from factories and other constructions in the water source catchment area and requesting

cooperation for pollution prevention

(2) Water quality management at water treatment plants (stations)

At the water treatment plants (stations), water is treated by rapid filtration (coagulation, sedimentation and sand filtration), slow filtration, and membrane filtration processes. In addition to rapid filtration, the treatment plants use, depending on the water quality conditions, powdered activated carbon and advanced water treatment process that combines ozonation and biological activated carbon process. Also, since October 2013, all the water abstracted from the Tone River system has undergone advanced water treatment.

In order to further improve water quality management, the Bureau formulated the "TOKYO Advanced Quality Program (Tokyo Metropolitan Government's Water Safety Plan)" for its water treatment plants and started implementing it in 2008. This program aims to achieve a higher level of water quality management by integrating the following three components: the risk management based on the Water Safety Plan proposed by the World Health Organization (WHO); advanced quality management at the water treatment plants based on ISO9001; and the highly accurate water quality inspections guaranteed by ISO/IEC17025. The water quality management at each treatment plant is as follows.

- Elaborate checking on the status of water treatment via water quality meters and water quality tests
- Conducting water quality tests for each parameter at an appropriate frequency, such as daily, weekly, or monthly
- Quality inspection of chemicals used in water treatment
- Constant monitoring using a fish-based water monitoring tank
- Other investigations and researches regarding water quality management

(3) Water quality management at faucets

To confirm the safety of water supply at the point of faucets, water quality inspections are conducted periodically at the 131 designated locations in Tokyo for each water distribution network. The details on the water quality management at each faucet are as follows.

- Automatic water quality meters are installed at all the 131 locations to continuously monitor the color, turbidity, and residual chlorine whose measurement is required by the Waterworks Act once a day.
- Water quality inspections are conducted at different frequencies ranging from once to 12 times a year including for the 51 parameters of drinking water quality standards, those for water quality management targets and

	<p>those for which further consideration is required.</p> <p>In addition, the Bureau has set its own "Water Quality Targets for Refreshing Water," which are at a higher level than the national standards, and is implementing comprehensive measures to achieve those targets. The figure below shows the eight targeted parameters, whose values are being measured at the 131 faucets.</p> <p>(4) Irregular inspections in case of anomaly water quality detection</p> <p>Irregular water quality inspections are conducted when there is a risk of non-compliance with the drinking water quality standards because of an anomaly water quality or facility contamination detected somewhere from source to tap. Irregular inspections are implemented in cooperation with relevant departments and municipalities to investigate the cause and find its solution.</p> <p>(5) Water quality inspections by request of customers</p> <p>Inquiries from customers regarding water quality and their requests for water quality inspections are handled, in the wards, through a cooperation of the Customer Center, branch offices and the Water Quality Center, and in the Tama area, through a cooperation of the Tama Customer Center, service stations, and the Tama Water Supply Reform Promotion Division.</p>
Measures & Solutions	<p>To further enhance water quality management at the Bureau, considering the current situation in which the pollution of water sources is becoming more complex and diverse, the utility is striving to acquire the latest analytical techniques and develop water treatment technologies, as well as to conduct various researches and experiments.</p> <p>(1) Responses to radioactive materials</p> <p>The Great East Japan Earthquake of March 11, 2011 caused the Fukushima Daiichi Nuclear Power Plant incident, which led to radioactive materials having been detected in the tap water of the Bureau. The Bureau studied methods to remove radioactive materials and implemented effective water treatment. As a result, the utility confirmed that radioactive iodine can be removed by a combination of appropriate chlorination and powdered activated carbon treatment, and that radioactive cesium can be removed by coagulation and sedimentation.</p> <p>In terms of inspections, radioactive materials in water supply are measured daily at five water treatment plants that represent the utility's each water source, and also measured periodically at other water treatment plants as</p>

well as at the water treatment stations in the Tama area. The measurement results are published on the Bureau's website. Radioactive iodine has never been detected since mid-April 2011, and radioactive cesium has never been detected since its measurement started on March 22, 2011.

(2) Responses to the formaldehyde water quality incident

In May 2012, a major water quality incident took place that led to the suspension of water intake and water supply in wider areas including Tokyo. The incident resulted from the amount of formaldehyde exceeding the drinking water quality standards having been detected in the tap water from water treatment plants using the Tone River system. At the Bureau, water intake was suspended at the Misato water treatment plant. The incident was caused by a certain substance that had not been regulated as a hazardous substance having been discharged into the Tone River system without proper treatment and afterwards having reacted with chlorine used for disinfection at water treatment plants to produce formaldehyde. In the immediate aftermath of the incident, the Bureau cooperated with water utilities in the Tone River basin and investigated the origin of the water discharge while reinforcing the monitoring of its water qualities.

(3) Responses to emerging chemical substances

In response to the formaldehyde water quality incident, the Ministry of Health, Labour and Welfare (MHLW) designated in March 2015 the substances that had not been subject to water discharge regulations but would produce a high amount of formaldehyde and other harmful substances as a result of the common water treatment process as the "substances difficult to treat with water treatment". The Bureau has carefully selected chemical substances, including the MHLW-designated ones, that can cause water source quality incidents, and established their inspection methods. These substances have been studied for their removability in water treatment, and the research results have been reflected in the TOKYO Advanced Quality Program.

(4) Measures against musty odor

In the past, musty odor in the Tama River and Sagami River was mainly caused by cyanobacteria generated within reservoirs located upstream of the rivers, but in recent years, musty odor originating from river waters themselves has become an issue. In the Tama River, musty odor has been a problem since 2011, and it has been detected in raw water above the level permitted by the water quality standards. This has been caused by cyanobacteria attached to stones on the riverbed, and the same type of

	<p>cyanobacteria has also been causing musty odor in the upstream portion of the Arakawa River since around 2012.</p> <p>The Bureau has been investigating the causes and status of cyanobacteria outbreaks, as well as conducting research and experiments on the sophistication of its water treatment process according to different raw water qualities, and studying the potential use of more optimal water treatment methods. At present, it is difficult to remove musty odor by the conventional water treatment process, therefore powdered activated carbon has been injected to address the issue at related water treatment plants, while ozonation has been reinforced at the treatment plants using advanced water treatment process.</p> <p>(5) Measures against cryptosporidium</p> <p>Cryptosporidium, which is a zoonotic pathogen, is difficult to kill completely by ordinary chlorination, but it can be removed by removing turbidity from raw water through appropriate water treatment process. Based on the MHLW's "Guidelines for Addressing Cryptosporidium in Water Supply" (published in March 2007 and revised in May 2019), the Bureau has set out how the utility addresses cryptosporidium in its "TOKYO Advanced Quality Program"</p> <p>(6) Measures against eutrophication in Ogouchi reservoir</p> <p>When high concentrations of nitrogen, phosphorus, and other substances contained in domestic wastewater flow into reservoirs, algae that use them as nutrients grow in mass quantities, causing odor and taste issues as well as filtration problems at the water treatment plants taking water from the related water sources. In the case of the Ogouchi reservoir, algae bloom (a phenomenon in which lake surfaces look like they are covered with blue powder due to algae growth) occurs mainly during summer in the upstream portion of the river. The Bureau has protected the reservoir's water quality by installing fences to prevent the spread of the bloom, in addition to the development of wastewater facilities.</p> <p>(7) Research and experiments</p> <p>Various researches and experiments to develop and improve water treatment technology have been conducted at the Training and Development Center and the Water Quality Center. The research results have been published on the utility's website.</p>
Future Plans	<p>The Bureau will continue to maintain a reliable water quality inspection system and elaborate water quality management structure from source to</p>

	<p>tap, and will also proactively address emerging water quality issues through various researches and experiments in order to supply safe and refreshing tap water to its customers.</p>
References	<p>The following three documents were referenced from the website of the Bureau of Waterworks Tokyo Metropolitan Government (https://www.waterworks.metro.tokyo.jp/).</p> <ul style="list-style-type: none"> - “Service Outline: FY2019.” September 2019. - “Water Supply of Tokyo.” September 2019. - “Water Quality Inspection Plan for FY2019.” March 2019. <p>Additional information on the types and number of water sources of the Bureau is as follows.</p> <ul style="list-style-type: none"> - Surface water: Tone River, Arakawa River, Edo River, Tama River, Sagami River - Groundwater: wells (including those currently suspended) - Subsoil water: Kinuta and Kinuta-shimo, Takatsuki, Hyuga-wada, Chigase No. 1 and No. 2, Futamatao, Sawai No. 1 and No. 2, Mitakesan, Nariki - When allocated by the number of water treatment plants (76): surface water (17), groundwater (48), subsoil water (11)