

# Tap Water Supply: Safe, Tasty Tap Water for the Residents of Seoul

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## Writer

Seoul Metropolitan Government

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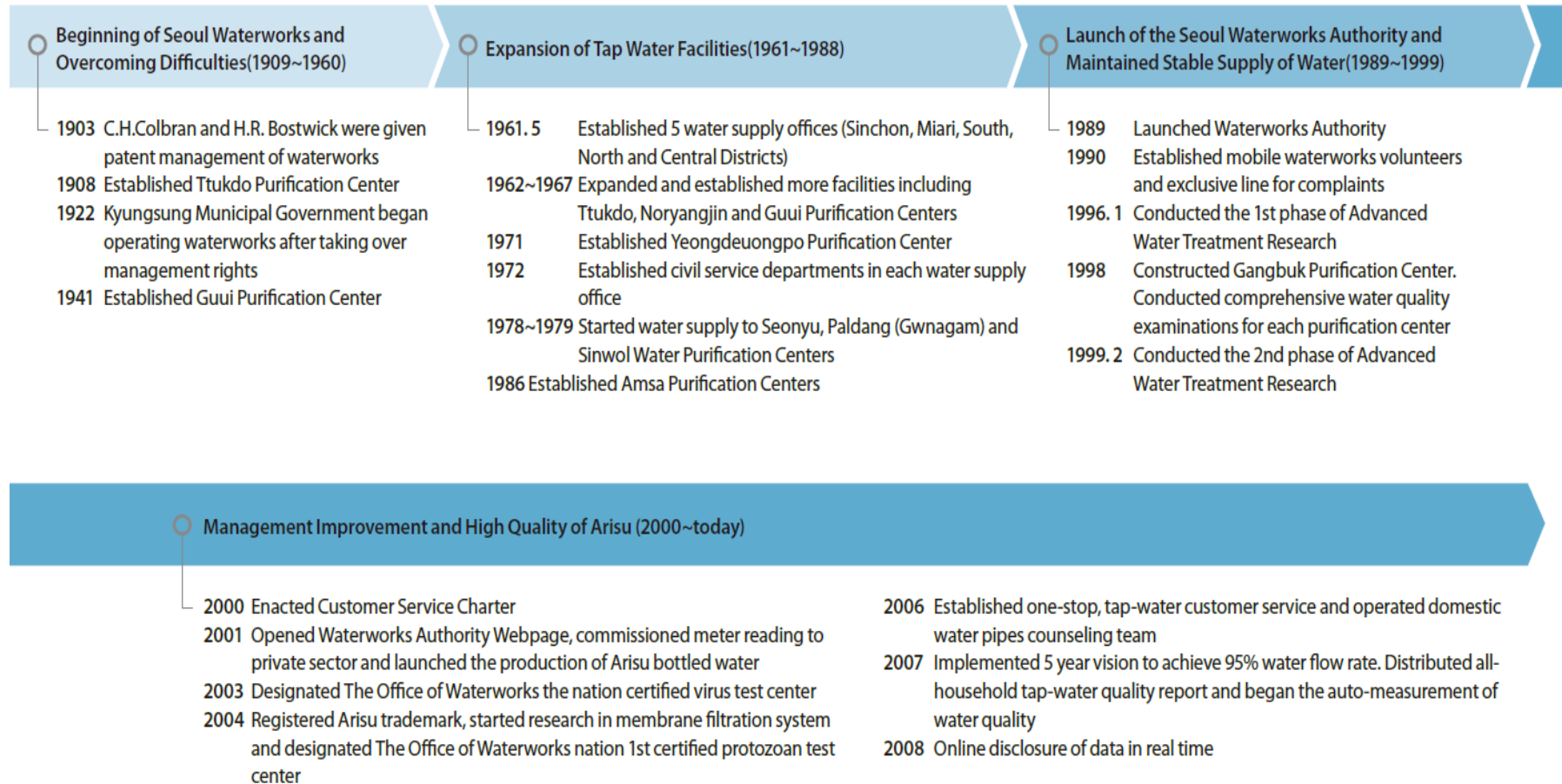
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## Introduction

The word 'Arisu' is the name of Seoul's tap water brand, but it used to be the name for the Han River, which flows through the heart of Seoul. In fact, the word is a combination of an old Korean word 'Ari', meaning big, and 'Su', which means water. Having had more than 100 years of tap water management policies and evolving throughout that time, Seoul's water supply policy today is recognized as one of the best in the world.

## Waterworks Timeline



Century of Experience in Urban Water Supply

### **1908~1944, The First Urban Water Supply System**

Though Seoul was the first city in Korea to adopt a modern urban water supply system, the Korean War halted its continuing development, meaning that it was not until the 1960s that tap water technology truly took off. The foremost priority in water policy for Seoul at the time was hygiene. Water-borne diseases such as cholera and typhoid were rampant among those who used the untreated, unhygienic water from wells and spring water, costing the lives of many citizens. This dire situation called for a water supply that was both hygienic and stable.

The first modern water purification plant was built in 1908, and water began to flow through the pipes of the system to Seoulites every day. This system however, would inevitably displace many water peddlers whose livelihood relied on selling buckets of drinking water to each household. The operating agency of the time, Korea Works Company, hired these peddlers, to minimize residual damage during the transition to a modern water supply system.

### **1945~1960, Recovery of Purification Centers after the Korean War**

The 3-year Korean War, which broke out in 1950, destroyed most of Seoul's water supply facilities, including 30~90% of its purification stations. Despite the odds, officials did their best to continue operating a water supply system even during the war. A special law was passed that allowed funding for waterworks recovery projects, and timely foreign assistance also played an important role. From 1954 and for the following 5 years, thanks to the assistance of the central government and the UN, repair and maintenance projects could be undertaken. Water facility expansion took off in earnest in 1956 with Guui purification station plant 2, which was constructed without reliance on any foreign technical assistance. Since then, expansion and repair works have continued, resulting in a 3-fold increase in water service per capita from 59ℓ in 1945 to 163ℓ in 1960.

### **1961~1979, Water Facility Expansion**

The rapid economic growth of the nation in the 1960s resulted in industrialization, urbanization, and a surge in Seoul's population, which in turn inevitably caused an explosive demand for water. To address this, Seoul responded by expanding and upgrading existing purification facilities as well as constructing additional ones from 1961 to 1979, while laying out a 10-year plan (1972~1981) to build and expand

production facilities.

### **1980~1988, Stability in the Water Supply**

By the 1980s more than 90% of all residents were supplied with tap water, and the daily supply per person reached 400ℓ. As the supply itself stabilized, Seoul focused on building pressure stations or booster pump stations to be able to reach the population residing at higher altitudes, as well as upgrading old pipes to reduce leakage.

Water quality control was facilitated by a computer system which made automatic remote control possible. Seoul then began channeling its resources and efforts towards quality and established the Water Technology Institute and strengthened water quality standards, to deliver high quality tap water to as many people as possible.

### **1989~Present, Seoul's Tap Water Reborn as 'Arisu'**

Seoul's tap water is now known as Arisu. The quality of Arisu is maintained by testing for 163 substances, as recommended by WHO. All information, from water intake to supply, is disclosed to the public, ensuring public confidence in the safety and cleanliness of the water that they drink. Having achieved stability in production, Seoul pushed itself a step further to ensure a good taste to the water. To this end, Seoul is adopting an advanced water purification system in all of its purification centers, which will be in place by the end of 2015.

### **Clean Water for Everyone in Seoul**

Seoul's purification capacity and service population both jumped to astonishing levels: From 1908 to 2013, the purification capacity jumped 348 times from 12,500 tons to 4.35 million tons per day, while its service population jumped by 83 times, from 125,000 to 10.39 million people. In fact, the total amount of water used in 2013 was 1,164,636,000 tons in cumulative terms, or 3,191,000 tons as a daily average. This astonishing progress was made possible by continuous efforts to upgrade existing facilities and build new ones, which helped resolve the water shortage and ensure supply stability since 1998.

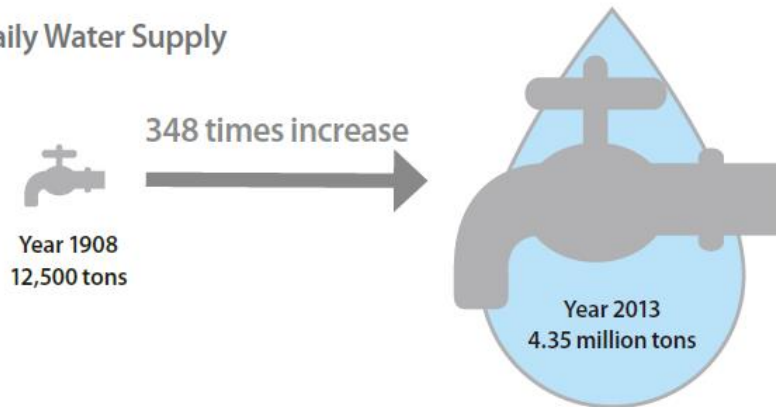
Having achieved production stability, the Office of Waterworks at Seoul Metropolitan Government then shifted its focus to water quality. To this end, Seoul has adopted an environment-friendly, advanced purification system which uses ozone and GAC (Granular activated carbon). This system was first introduced to Yeongdeungpo Arisu Center in 2010 and is expected to be adopted in all purification centers in Seoul during 2015.

## Status of Seoul Waterworks

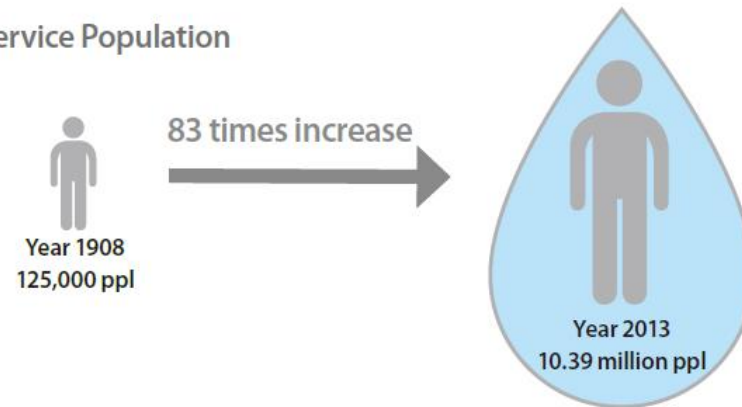
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Category	2001	2002	2003	2004	2005	2006	2007	2008	2012
Production cost per m <sup>3</sup>	242.12	234.12	481.43	213.22	220.41	231.16	224.22	260.22	630
Unit cost of sales per m <sup>3</sup>	480.62	202.92	207.01	210.61	214.40	212.93	217.42	217.01	261.22
Increase rate	14.90%				freeze				9.00%
Charge	90.30%	94.70%	102.30%	99.20%	97.20%	99.00%	93.40%	92.30%	88.90%

### Daily Water Supply



### Service Population



## Best Water Production Facilities

### Around-the-clock Water Quality Monitoring

Since Seoul utilizes surface water from the Han River as its source water, it is paramount that the city work closely with the municipalities

near the river to most effectively protect this water from contamination. To this end, Seoul operates the Han River Watch Group which guards against illegal waste dumping and indiscriminate development in the area. Seoul's efforts are complemented by the central government, manifested by the fund created by the Ministry of Environment. Created in 1999, the Han River source water management fund (KRW 3.9804 trillion as of 2011) is used to monitor and improve water quality as well as to support community activities.

Seoul constantly monitors and guards its source water from contamination through methods such as regularly testing for 41 substances at 31 source water points, and 142 substances at 6 intake points. In addition, an automatic water quality meter checks the algae and phenol levels 24/7. The intake stations are also equipped with a biological alert system that detects microorganisms, algae, water fleas, and fish. Seoul is also investing in devices that help prevent oil leaks from seeping into the intake stations. An algae alert system issues a warning when the water temperature exceeds 20°C or when odor-causing materials (geosmin or BIM Level 2) are detected in the purification facilities.

### **Guideline for Healthy and Tasty Water**

To meet the growing demand for safe, tasty tap water, Seoul has introduced new guidelines which include 3 categories addressing health concerns and 6 categories concerning the taste of tap water.

### **Quality Testing for 163 Substances**

Today, Arisu undergoes tap water quality tests for 163 substances, as recommended by WHO. The water in purification centers is tested daily while faucet water also undergoes stringent monthly testing at 860 points. In addition, water at 120 water supply sites is tested on a quarterly basis. At purification centers, an automatic water quality monitoring system is in place to check the level of 6 substances. This multilayered monitoring keeps Arisu clean and safe.

### **Advanced Purification System**

To deliver upgraded, premium quality tap water that satisfies standards for cleanliness, safety, health and even taste, Seoul has adopted the Advanced Water Purification System, which strengthens the current purification method by incorporating ozone and granular activated carbon (GAC, or charcoal). These two materials completely remove any unpleasant taste and/or odor caused by algae, disinfection by-

products and micro-organic matter. With the introduction of the Advanced System, Seoul can now deliver cleaner, safer water in which the minerals are retained.

### Membrane Filtering Purification System

The Ministry of Environment, Seoul Metropolitan Government, and private companies joined forces to install an advanced type of filtering system, the membrane filtering purification system (or membrane integrity test).

Replacing traditional sand filters, the new system removes contaminant particles in water more thoroughly, contributing to better quality and better-tasting water for end users. This cutting edge, eco-friendly method also reduces the need for chemicals by 50% and simplifies management, which in turn, saves money. Seoul's membrane filters, which are made 100% by Korean technology, are the first of their kind to be used in Korea.



## Chlorine Re–dispersion Facility

Although chlorine plays an essential role in reservoirs as a disinfectant, it does have an unpleasant odor, driving many citizens away from drinking it. To minimize the odor, a small amount of chlorine is dispersed at multiple points; first at the purification plants, and then at the water supply reservoirs, instead of concentrating all the chlorine at the purification plants.

### Guideline for Healthy and Tasty Water

Category	Substances	Unit	Drinking Water Quality Standards	Guidelines	Description
Health Related Items	Mineral(Ca, Mg, Na, K)	mg/L	-	20 ~ 100	Essential for elements for the human body
	TOC (Total organic carbons)	mg/L	5.0(Inspected Items)	1.0 less	Beneficial for health thanks to tightened standards for by-products of antiseptics
	Turbidity	NTU	0.5	0.3 less	Beneficial for health due to elimination of microorganisms (e.g. protozoans, viruses)
Flavor Related Items	Residual Chlorine	mg/L	4	0.1 ~ 0.3	Disinfection (of) odors
	2-MIB	ng/L	20(Inspected Items)	8.0 less	Substances that cause mold-like odor
	Geosmin	ng/L	20(Inspected Items)	8.0 less	Substances that cause soil-like odor
	Copper	mg/L	1	0.05 less	Pure water producing substance
	Iron	mg/L	0.3	0.05 less	Red water producing; brass
	Temperature	°C	-	4 ~ 15	Suitable for Drinking with refreshing sensation

## Safety and Stability of Tap Water

### Large Reservoirs Ensure an Emergency Water Supply and a Constant Water Supply Free of Outage

A reservoir is an important facility in urban water usage because it serves to ensure a stable water supply without outages as well as



providing water in times of emergency. At one time, a direct water supply system was used, through which pressure stations or purification centers supplied water directly to households. However, because the direct system came with many disadvantages such as waste and instability in supply, Seoul saw the need to shift to an indirect system whereby water is supplied through reservoirs. Understanding the importance of reservoirs, Seoul built large-scale reservoirs through which water could flow naturally to the service area. Since 1999, Seoul also turned the upper parts of some of the reservoirs into recreational facilities for residents.

#### **94.4% Revenue Water Rate (RWR)**

Revenue water rate (RWR) refers to the percentage of supplied water that is not lost due to leakage or other factors. A high RWR means higher revenue earned from the total water produced by the city. To raise RWR, Seoul introduced various measures, one of which was replacing old pipes, which have traditionally caused water contamination. In fact, by 2013, 13,668km (95.4%) out of 13,034km of old pipes past their life cycle were replaced. The remaining 634km of pipes are set to be replaced in 2015. Besides replacement, Seoul also built an additional 1,663km of pipe sized 400~2,800mm.

Seoul also successfully divided its complex water pipeline network into 2,037 small blocks and 100 middle-sized ones, making overall operation very easy and maintenance/repair more effective. With this subdivided system, only a very limited area would be affected by an incident of leakage. In addition, emergency water supply and recovery became far easier. Dividing a complicated network into smaller units even made it easy to detect which block was experiencing leakage and the precise number of leaks, increasing RWR even further. Seoul also applies scientific and systematic detection, examples of which include checking the minimum flow level at night when usage is minimal, and multi-point leak detection.

Seoul is also equipped with a scientific, real time water flow monitoring system which enables early detection of leaks by checking water volume and pipe pressure on a real-time basis at 443 locations, including pipes, pressure stations, and reservoirs.

Such measures helped Seoul achieve a level of RWR on a par with advanced nations in the field of tap water, and recorded a 94.4% RWR in 2013; a 39.2% jump from 55.2% in 1989, which translated into a cost reduction of KRW 4.6 trillion.

#### **Water Supply Geographic Information System**

In the past, location and property information concerning water facilities was hand-marked on paper maps. This resulted in unintentional

omissions and incorrect entry of data, compromising the accuracy which directly affects analysis, while increasing overall costs in time and energy. To address this issue, Seoul created the Water Supply Geographic Information System, utilizing GIS technology to create a digital database of location and property information for water pipes, supporting components, and other urban facilities in general. GIS is an information system comprised of hardware, software, and an application which enables input, output, and analysis of data. Today, GIS is applied to 13,841km of water pipes, 260,000 valves, 1,991,000 water meters, and 301 reservoirs and pressure stations. A survey method with satellite-based GPS and the latest tools is employed, using absolute coordinates based on the World Geodetic System.

## Case Study

# The Arisu Total Service

The Seoul Metropolitan Government launched the Arisu Total Service for the first time in the country. The Arisu Total Service takes a proactive, integrated approach to complaint handling to enhance citizen's satisfaction in tap water service. Issues that can be handled by the citizen-centered, comprehensive system include leakage, water shortage, meter replacement, water quality testing among many others. One of the main features of the service is its proactive response system which allows administrators to predict the potential complaints so that the city government can proactively respond to them even before such complaints are lodged. Second, with the comprehensive, integrated service packages, staff not only responds to the particular issue that is raised, but also asks citizens to see if they are any other issues that may potentially cause inconvenience. The one-stop service contributed to reducing water-related complaints by 36.2% compared to the previous year.



Production of Arisu Water



Water Quality Test by The Office of Waterworks, Seoul Metropolitan Government

# Scientific Operation of Water Supply

## **Cheapest Water Bills**

Seoul strives to rationalize its business practices so as to push the water bill down, which would alleviate a financial burden on its citizens. To this end, the city began outsourcing water metering operations, such as meter reading, to private enterprise. The city government also rearranged agencies working under SMG to streamline the administrative staff and work process while digitizing as much of the work process as possible, including billing and accounting. These efforts contributed to placing Seoul's water bills at one of the lowest rates in the world.

## **Arisu Integrated Information Center**

The Arisu Integrated Information Center monitors and analyzes all necessary information from water intake, purification, storage, distribution, and faucet quality management, contributing to the production and delivery of a stable supply of clean water to Seoulites. This system is capable of collecting and analyzing operational information for the entire water supply system on a real-time basis (6 purification stations and 8 branch offices), all of which used to be managed separately. With the center, Seoul is able to respond more effectively in cases of outage and shortage.

## **Seoul Water Now System**

The Seoul Water Now System is a real-time, automatic water quality assessment and online data disclosure service. The system analyzes water-related data (pH, turbidity, residual chlorine, etc.) in 9 categories; the data comes from automatic readers installed throughout 186 facilities (6 water intake points, 6 purification stations, 84 reservoirs, 13 pressure stations, and 77 faucets). The system issues an alert or warning depending on how far the existing situation exceeds or falls short of the permissible level. Most importantly, the system allows the public to access up-to-date information on water quality via Seoul's website (<http://arisu.seoul.go.kr>) or a phone call (Seoul Mobile Portal Service), etc.

## **Arisu Quality Verification Service**

Many citizens trusted the safety of the water produced in the purification centers, yet they were hesitant to drink tap water mainly because of the questionable condition of pipes or water tanks. To eliminate this hesitancy, Seoul adopted the Arisu Quality Verification System, which provides free checkup services for citizens who request an inspection agent to visit their house to verify the water quality in their faucets. Households receive a free on-the-spot water quality assessment on 5 indicators (turbidity, pH, iron, copper, and residual chlorine). Faucets that have passed the standard are provided a certificate. If the test results are not satisfactory, 7 additional items such as bacteria and colon bacterium are tested for, to identify the underlying cause. This information is then relayed to the operators to recommend cleaning the water tank, old pipe replacement, etc.

### **Eco-friendly Energy and Renewable Energy**

Committed to creating purification centers that pursue low carbon and green growth, Seoul set up a geothermal heating and cooling system at 3 purification centers (Yeongdeungpo, Gwangam, Amsa) and set up additional PV facilities at the Yeongdeungpo and Amsa purification centers. Seoul is currently developing a technology that will turn sludge to green energy, in order to cut waste treatment costs while enhancing efficiency.

### **Waterworks Research Institute**

In its efforts to find the best ways to make tap water safe and tasty, the Waterworks Research Institute conducts in-depth testing on 163 substances recommended by WHO and publishes the results online on a regular basis. It operates in line with the government's low carbon, green growth initiative by focusing on technological development. Another main responsibility of the institute is fostering experts, which it facilitates through 16 different training programs.

The Institute has achieved outstanding outcomes, some of which include membrane separation technology, an eco-friendly ozone process, and anti-rust pipes, among many others. So far 8 patents have been awarded to the Waterworks Research Institute. This leading institute is at the forefront in sharing its accumulated knowledge and insight to help other businesses within the water sector.

### **Bottled Tap Water**

Seoul began producing bottled water in May 2001. The decision was made to promote Arisu to the wider public by making it more

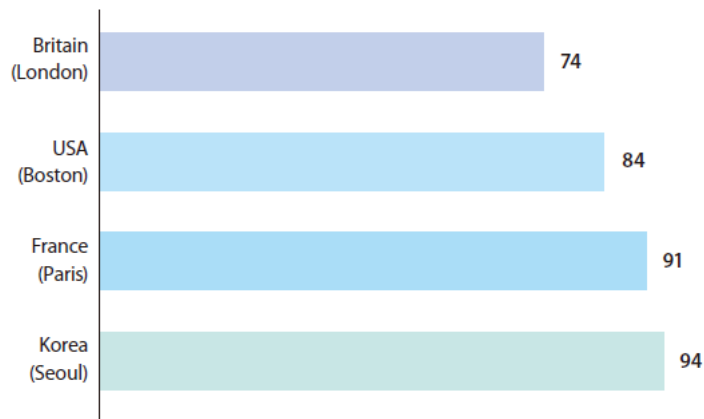
accessible, and to use it as a relief item in case of emergency. Currently, the production center for bottled Arisu is located in the Yeongdeungpo facility, which boasts a production capacity of 86,000 bottles per day. Since 2001, both demand and supply have grown for the bottled water; In fact, it has been particularly useful for those affected by droughts in Korea and other natural disasters that have hit many other parts of the world. For instance, Seoul offered bottled Arisu to victims of the 2008 earthquake in Sichuan, China, the typhoon in Kaohsiung, Taiwan in 2009, and the earthquake in Japan in 2011. In addition, Seoul also sent bottled Arisu to the Beijing Olympics. Seoul actively promoted Arisu to the global community in its own pavilion at the 2010 Shanghai Expo. Clearly, Arisu is becoming a well-known water around the world.

## Water Reservoir Construction Status

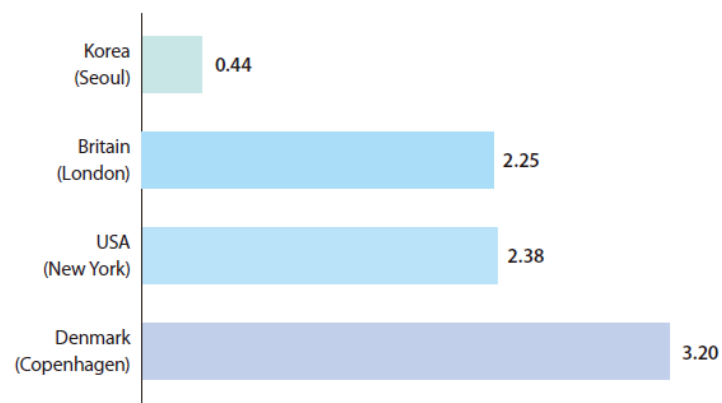
(Unit: 10,000 tons, hour)

Category	2000	2002	2007	2012	2013
Reservoir capacity	155	214	235	238	242
Storage period	5.1	12.5	13.5	13.9	15.6

Water Flow Rate of the World's Major Cities (Unit : %)



Water Utilities Bill of the World's Major Cities (Unit : USD/m<sup>3</sup>)



## Arisu, Recognized Globally

Winner of the United Nations Public Service Award, 2009

The United Nations Public Administration Network (UNPAN) awarded the Seoul Water Now System and the Arisu Quality Verification System the highest recognition for the transparency and reliability of its water supply. In particular, Seoul was recognized for its Seoul Water Now

System, an electronic water quality service that allows the citizens of Seoul to access up-to-date information on the quality of water supplied to their homes, as well as the Water Quality Verification System, a free inspection service available to households upon request.

#### **Global Water Industry Innovation Award, 2010**

The International Water Association (IWA), the world's largest water-related association, composed of 85 countries, awarded Seoul the Project Innovation Award in June 2010 and again in October 2010, for Seoul's premium tap water. It recognized Seoul's attainment of the highest RWR in the world, management improvement, and its focus on the taste of its water in addition to its safety.

#### **2010, International Business Award**

Seoul was chosen as the New product & Product Management and Product Development Department of the Year by Stevie Awards. Inc. in recognition of the business innovation, creativity and management that led to the world's highest RWR.

#### **2012 National Sanitation Foundation (NSF) Certification**

Seoul's Arisu acquired NSF certification for satisfactory water quality testing of all 167 substances recommended by WHO. This certification also demonstrates that Arisu qualifies as drinking water in the United States, proving the quality and reputation of Arisu worldwide.