

Article

# Water Treatment Facilities as Civil Engineering Heritage from Guardian of Urban Sanitation to Symbol of Urban Colonial Modernity, in the Case of Ttukdo (Seoul) Water Purification Plant

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**Abstract:** Ttukdo Water Purification Plant, built in 1908, is the first modern waterworks facility in Seoul and the first waterworks industrial heritage in Korea. Modern waterworks were established in order to resolve insanitary conditions of the city as a part of modernization projects; however, it had been developed with discrimination and colonial domination under Japanese occupation. This paper investigates how Ttukdo Water Purification Plant, a product of colonial modernity, became the representative modern waterworks heritage in both aspects of a colonial and civil engineering heritage. Based on archival research, this study analyzes the transformation process of Ttukdo Water Purification Plant, and the changing meaning and value with the historical background. As a result, Ttukdo Water Purification Plant has been characterized by the universal features of water industry heritage, continuity as a facility to produce clean water, and symbolic meaning as the guardian of urban sanitation. On the other hand, Ttukdo plant is regarded as a monument which was conceived under complicated historical conditions—at the confluence of modernization, colonial rule, and emergent urban needs.

**Keywords:** modern waterworks; water industry heritage; colonial heritage; civil engineering heritage; Ttukdo water purification plant

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## 1. Introduction

### 1.1. Background and Purpose of Research

Industrial heritage is presently regarded as a positive resource for economic and social development in areas that have been affected by deindustrialization. However, the concept of heritage has expanded to embrace industrial heritage only recently, during the last three decades of the twentieth century—and this expansion was largely limited to the Western world [1]. In July 2003, the International Committee for the Conservation of Industrial Heritage (TICCIH) signed the Nizhny Tagil Charter for the Industrial Heritage in Russia. In this charter, industrial heritage is defined as “the remains of industrial culture which are of historical, technological, social, architectural or scientific value” [2]. These remains “consist of buildings and machinery, workshops, mills and factories, mines and sites for processing and refining, warehouses and stores, places where energy is generated, transmitted and used, transport and all its infrastructure, as well as places used for social activities related to industry such as housing, religious worship or education” [2].

Civil engineering heritage sites—buildings and infrastructure including railways, bridges, waterworks, and the like—therefore constitute one type of industrial heritage. In contrast to Western countries, where the concept of industrial heritage has been recognized for decades, South Korean

cultural heritage conservation has only recently expanded to include industrial heritage. This expansion can be seen in the launch of the Registered Cultural Property System in 2001, which was designed to protect modern buildings and civil engineering facilities from indiscriminate destruction [3]. In addition, the successful renewal of Seonyudo Ecological Park (formerly the Seonyu Water Purification Plant) has changed public perceptions of industrial heritage by shifting the government's focus from waste disposal to recycling. There are 42 civil engineering heritage sites among the 524 registered cultural heritage buildings designated by the South Korean government between 2001 and July 2019. Among these are nine water treatment facilities, 10 railway water towers, and three agricultural pumping facilities [4]. All in all, water-related facilities (broadly referred to as waterworks throughout) account for half of South Korea's total civil engineering heritage sites and therefore represent a large part of the country's civil engineering heritage. According to Dongjin Kang, waterworks have a high value of original form; thus, they can be used as industrial heritage sites, which maintains their original function and space if they are well-maintained [5].

Waterworks were cores of urban infrastructure when they were first installed in present-day South Korea in the beginning of the twentieth century. To safeguard cities' water quality, many of these facilities have not been open to the public for much of their history. Beside the Ttukdo and Gui Water Purification Plants in Seoul, which house a museum and exhibition halls, most of Korea's water industry heritage has remained unused after being closed without heritagization. Recently, the Daebong Service Reservoir of Daegu city was selected as part of the 2018 Urban Renewal New Deal Project and will be developed into a cultural park and youth artist space as part of a broader project to regenerate the area around the reservoir. However, there is no plan to renovate or reuse the Daebong Service Reservoir under the auspices of industrial heritage, as has been done with other waterworks in South Korea. These projects demonstrate how the authenticity of civil engineering heritage sites such as waterworks is tied to their continued operation. Because these sites are often abandoned after their service life has expired, it is necessary to develop a better understanding of how to continue to utilize and update old water facilities while maintaining their authenticity as civil engineering heritage sites.

This paper examines the Ttukdo (Seoul) Water Purification Plant, the first waterworks industrial heritage site in South Korea, as a colonial and civil engineering heritage site through its transformation process. According to precedent Korean studies, Korean waterworks have been regarded as a colonial legacy, providing evidence of discrimination and colonial domination under Japanese occupation; however, this approach often overlooks the technical aspects of modern water supplies as a civil engineering heritage for urban sanitation [6–8]. Thus, I will trace the formation and expansion process of the Ttukdo Water Purification Plant in the first half of the twentieth century according to both colonial legacy and modern infrastructure. This will reveal its complex colonial modernity, which can be analyzed using post-colonial theory, which links colonialism and modernity in non-European countries [9–11]. In addition, this study examines the transformation process of the Ttukdo Water Purification Plant to determine the meanings that have been selected for their heritage implications using the perspective of heritagization, or "making heritage". Through the twentieth century and into the first decades of the twenty-first, the meaning and value of the Ttukdo Water Purification Plant has changed over time against a wider historical backdrop in which waterworks were first regarded as guardians of urban sanitation and then redefined as symbols of urban colonial modernity. This changing meaning and value is analyzed in three stages according to its historical background.

### *1.2. Literature Review, Research Materials, and Methods*

In Korean studies, modern waterworks have been regarded as the products of colonial rule and its inherent discrimination against the colonized. Backyoung Kim pointed out that waterworks of colonial Korea were sites of colonial power in which the Japanese colonial government displayed both discrimination and hypocrisy in dealing with urban sanitation crises [6]. In a similar way, Dongbin Joo identified colonial power relations and discrimination in the implementation of Korea's residential water metering system during the 1920s [8]. Yongmi Kim argued that the enforced belief that tap water

was safe made the everyday lives of Seoul's residents subject to the operation and policies surrounding the city's waterworks [7]. Meanwhile, studies dealing with waterworks in specific regions of Korea focuses on Japanese settlements in Korea before colonization. Seung Kim examined the installation of Busan's waterworks during the late nineteenth and early twentieth centuries by the Japanese colonial government [12]. Yeonkyung Lee focused on the private water supply facilities of colonial Japanese settlements in Seoul [13]. These precedent studies deal with how Korean waterworks were formed and managed by colonizers in the first half of the twentieth century using a historical and sociological perspective. While urban historians and sociologists have given attention to modern waterworks, historians of technology have seldom dealt with waterworks development [14,15]. Therefore, this study deals with the transformation process of Korean waterworks in technological terms of urban sanitation, based on the precedent studies. In other words, this paper will examine the modern waterworks of Korea using the perspective of colonial modernity by analyzing how modern technology works within the colonial context and how modern waterworks acquires its significance as a meaningful heritage.

Michael Cotte wrote of the cultural heritage of water, proposing to categorize it into six types: (1) the acquisition, management, and control of water to make it available for human use; (2) the various types of water use; (3) the management of constraints and the control of natural water; (4) water and health, water quality, and the associated representations; (5) water-related knowledge, knowhow, myths, and symbols; and (6) the cultural landscape of water [16] (pp. 15–16). In 2018, TICCIH published James Douet's thematic study, *The Water Industry as World Heritage* [15]. In his study, Douet [15] defined the water industry as "the infrastructure built for the management of drinking water during the industrial period (the late eighteenth to early twentieth century)"—therefore, waterworks belong to the first category of Cotte's six definitions [16]. According to Douet, no modern waterworks had been designated as a UNESCO World Heritage Site; the only designated property or landscape that contains a modern drinking water system is the metal mining complex Tarnowskie Gory, Poland, which features an underground water management system [15] (pp. 14–18).

Douet pointed out "an outstanding human value (an important interchange of human values, illustrative of a significant stage in human history) of water industry heritage was in solving the sanitary crisis which imperiled urban life during the second part of the nineteenth century" [17] (p. 94). In addition, he argued that the distinguished feature of water industry heritage is its continuity: many water facilities not only are still used for their original purpose but also are renewed, updated, and maintained [15] (pp. 63–67). Jongchul Ahn investigated the placeness of four closed purification plants in Seoul from the perspective of a functional system. According to his definition, "a functional system includes a social and an internal function—the former refers to how the system responds to its own purpose and meaning as industrial facility, and the latter refers to how we can represent its processes and mechanisms" [18]. Ahn defined the placeness of a water purification plant as consisting in whether it is used as a place related to water industry, such as a waterworks museum, or a place including water-related functions, such as gardens of aquatic plants. In a broader sense, the placeness defined by Ahn is included in the concept of continuity suggested by Douet. This paper will analyze the remarkable characteristics of the Ttukdo Water Purification Plant as a water industry heritage site using the two aspects of urban sanitation and continuity, based on Douet's analysis. Additionally, this research will examine this heritage within the colonial context of East Asian countries and broaden the concept of water industry heritage.

This study is based on archival research to analyze the historical development of Korean waterworks during the twentieth century and examines how the waterworks responded to and developed alongside the emergence of new technologies and new norms in modern hygiene. The following historical manuscripts and construction documents are representative of the sources that were reviewed for this paper: Chosensodofu 1913, hereafter JGGK (the Japanese Government General of Korea) 1913 [19]; Chosensodofu 1937, hereafter JGGK 1937 [20]; Chosensodofukeikido 1919, hereafter JGGK 1919 [21]; Keijobu 1928a, hereafter CGS (city government of Seoul) 1928a [22]; Keijobu 1928b, hereafter CGS 1928b [23]; Keijobu 1928c, hereafter CGS 1928c [24]; and Keijobu 1933, hereafter CGS

1933 [25]. To identify the distinguishing characteristics of modern Korean waterworks, I attempt to undertake a comparative study between modern Korean waterworks and both modern British and Japanese waterworks. To analyze the present situation of waterworks facilities in South Korea and elsewhere, we also utilized data from the Korean Cultural Heritage Administration's list of registered cultural heritage sites and designated cultural heritage sites. These data were statistically analyzed and represented through maps to examine the current situation by region. Newspaper articles and museum display explanations were also analyzed to assess people's perceptions of modern waterworks systems and facilities.

## 2. Background: Installation and Modification of Korean Modern Waterworks

### 2.1. What Are Modern Waterworks?

It is commonly written that the Romans had the first urban society to impound rivers for water supply—the Aqua Appia, the first Roman aqueduct, was constructed in 312 BC. In many Roman towns, raised water from rivers was delivered by aqueducts, stored in vaulted stone cisterns on the edges of towns, and distributed to public fountains, baths, and some private houses by both pipes and artisanal water carriers [15] (pp. 26–27).

In ancient China, a water supply system equipped with underground pipelines existed in Yangcheng, a city during the Eastern Zhou dynasty (770–256 BC). The clay pipelines transferred water into the city from outside and predate the Roman aqueduct. Chang'an, the capital of the Han dynasty, had a water supply system to carry water from the Kunming Reservoir Water to the city with water channels. Beijing also implemented a water supply system after the Three Kingdom Period (220–280 AD). Generally, these ancient water supply systems had no treatment facilities because the water was unpolluted; however, several cities, including Chengdu during the Northern Song Dynasty, adopted a purifying method using sedimentation [26].

In Japan, the Koishikawa water supply system was installed in 1590 under the order of Tokugawa Ieyasu and gradually expanded to cover the whole city of Edo [27] (pp. 10–12). In England, the New River Company began to supply water to the city of London, which had a nearly 63 km-long channel bringing spring water from Hertfordshire to Islington, in 1613. In the second half of the eighteenth century, as the population grew, London required more water. In response to this demand, private companies such as Chelsea Waterworks Company were established, and many of them drew water from the River Thames [28] (p. 35). At that time, it was believed that water drawn from natural environments far from the cities themselves would be safe to drink because Koch's and Pasteur's germ theory had not been popularized [29] (p. 139).

However, the rapid urbanization, population growth, and industrialization that occurred during the nineteenth century created unsanitary conditions in many cities, which in turn caused frequent outbreaks of water-related diseases and thus spawned public health crises. To resolve these crises, it was necessary to improve water supply systems via filtration. In 1804, the first experimental sand filter was constructed in Scotland, and in 1829, the first public slow filters were installed in London's waterworks. Around this time, cast iron pipes were introduced in various European cities [15] (p. 26). In 1855, filtration systems were made mandatory across England; however, slow sand filters saw only limited use in England and North America [15] (p. 45).

By the late nineteenth century, water filtration had been introduced to Japan. Yokohama, the first open port Japanese city, adopted British filtration technology and developed their own modern water supply system in 1887. The cities of Hakodate and Nagasaki began to use water filtration systems in 1889 and 1891, respectively, and Japan's major cities of Tokyo, Osaka, and Nagoya installed water filtration systems in the same period [30] (p. 118). In Tokyo, discussions about introducing modern waterworks and water filtration systems took place as early as 1874, but the implementation of these systems were delayed because of the cost of updating the city's existing public water supply system, which dated back to the Edo period [31] (p. 154). However, cholera outbreaks in 1882 and 1886 made

water filtration an important public issue, and the pressure generated by these outbreaks eventually led to the installation of the modern systems described above. Tokyo's water supply system was designed by the British civil engineer William K. Burton; construction began in October 1893 and was completed in November 1898 [32] (pp. 230–231).

Since the nineteenth century, new waterworks systems using modern technology have been installed in cities across the world. Most often, these systems draw water from rivers with high-pressure pumping engines, purify the water, and then deliver it to cities via cast iron pipes. Water filtration technology has evolved in the twenty-first century—for instance, rapid filtration systems have replaced slow sand filter systems. However, one thing has not changed: modern waterworks' main prerogative to provide clean water for urban sanitation. This is what Douet calls the “outstanding universal value” of the modern water industry, grounded in the industry's response to the crises of urban sanitation that defined industrialization in many places [15] (p. 132).

## 2.2. Modern Korean Waterworks in the First Half of the Twentieth Century

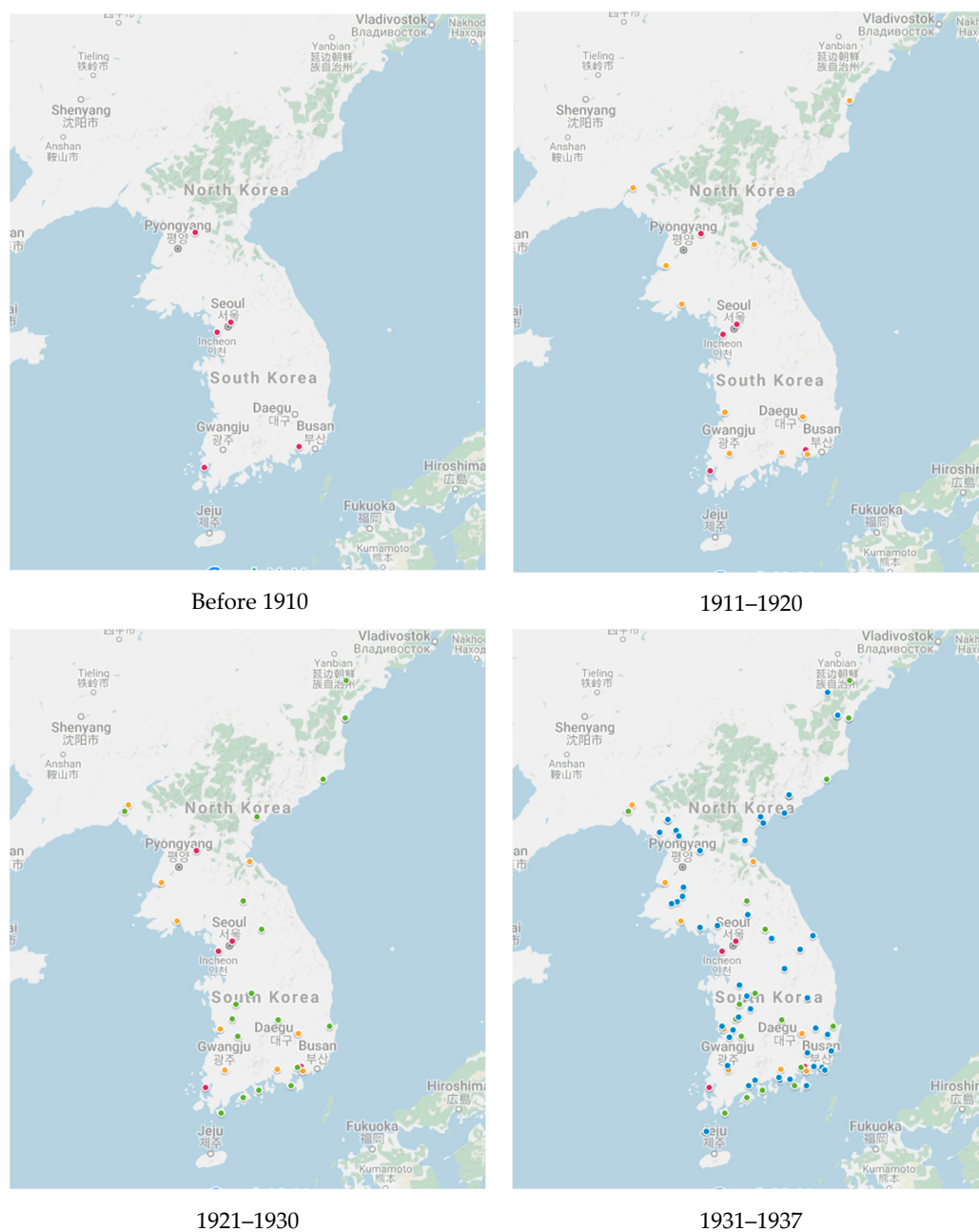
Like other Asian cities, Korean cities struggled with urban population growth and outbreaks of epidemics throughout the nineteenth century [33] (p. 57). Korea's first water supply system was installed in the Japanese settlement of Busan in 1880 [12] (pp. 240–241), and Japanese settlers near Seoul installed waterworks in their village located at the city's southern edge in 1903 [13] (pp. 218–219). However, these waterworks' operations were limited to the private dwellings of Japanese settlers and utilized a small-scale water supply network using distant gravity supply methods and a natural filtration system.

Construction of Korea's first water supply system outfitted with modern filtration technology began in 1906. The waterworks were located in Seoul, designed by a British civil engineer, funded by two American businessmen, and took two years to complete. In 1906, the Bureau of Waterworks was established under the Residency-General. One year later, the bureau began to construct waterworks in Incheon and Pyeongyang, which were completed in 1910. Busan's waterworks had been improved and expanded in 1894 and again in 1908. Except in Seoul, where the waterworks were constructed by a Western engineering company, waterworks construction was led by Japanese civil engineers. Before 1910, only five cities were integrated into Korea's waterworks network: Seoul, Busan, Incheon, Pyeongyang, and Mokpo. While Busan, Incheon, and Pyeongyang were open port cities with high populations of Japanese colonists, Seoul and Pyeongyang were two traditional cities with higher populations of Koreans [19].

After 1910, modern waterworks were constructed in many Korean cities. Eleven cities installed waterworks in the 1910s alone; nine of these were primary cities (*fu*, 府) or provincial capitals, and the remaining two (Jinhae and Nanam) were military cities. In the 1920s, waterworks were installed in 17 more cities, including Sinuiju and Masan, two of Korea's primary cities. Others were open port cities, military towns, or railway cities. Some of these expansions happened as a direct result of epidemic outbreaks: for example, Goheung, a small town located in the far south of the peninsula, installed waterworks in 1921 in response to a 1918 typhoid outbreak that killed hundreds of people. In the 1930s, water supply facilities were rapidly expanded to 52 additional cities. During this period in particular, many of the newly installed waterworks were built to provide water for industry [20] (See Figure 1).

In summary, Korean waterworks were largely installed during the first half of the twentieth century. These installations were constructed in large cities with large populations of Japanese residents first, and then happened in provincial capitals and medium-sized cities. By the 1930s, waterworks were being installed in small- and medium-sized cities across Korea, and industry-specific water supply systems were installed in the country's developing industrial cities. In short, waterworks installation projects began in order to provide clean water to urban residents, prevent epidemics, and improve urban health, but after Korea began industrializing in the 1930s, the focus of these waterworks projects shifted toward providing water to industrial facilities in abundance.





**Figure 1.** Distribution of waterworks facilities in the first half of the twentieth century. (Waterworks installed before 1910 (red), between 1911 and 1920 (yellow), between 1921 and 1930 (green), and between 1931 and 1937 (blue), Drawn by author with the data from Chosendobokujigyousi [20]).

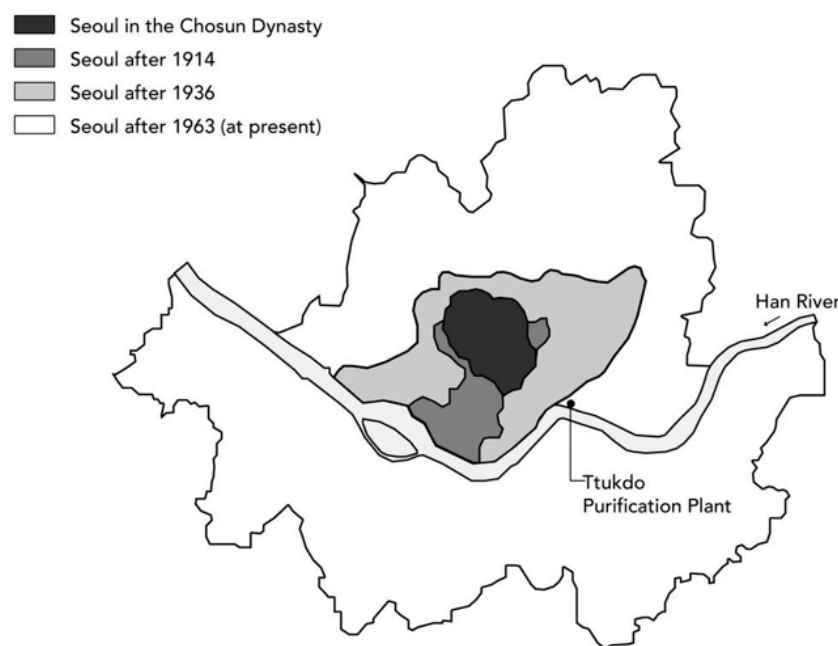
Among the waterworks facilities that were installed before 1945, the water supply system in Seoul has unique characteristics. First, it was the first one with modern filtration technology and the largest one in Korea. Furthermore, it was the only waterworks facility that was designed by a non-Japanese engineer; moreover, it showed the Korean government's will to modernize its capital city before colonization. Before the twentieth century, there was no modern water supply system in Seoul. Instead, residents drew water from nearby rivers or wells. In 1902, the city suffered a cholera epidemic, and one year later, preparation of the water supply system was inaugurated. Two American businessmen, C.H. Colbran and H.R. Bostwick, obtained the license to construct and operate Seoul's waterworks from the then-ruling Daehan Empire. In 1905, Colbran and Bostwick transferred the waterworks concession to Korea Waterworks Limited, an international syndicate founded by British civil engineer Hugh Garrat

Foster Barham. From this point onward, Colbran and Bostwick took responsibility for the construction of Seoul's waterworks. Construction began in August 1906 with the installation of slow sand filter beds and was completed in August 1908 [19,20].

### 3. Establishment and Modification of the Ttukdo Water Purification Plant in Seoul

#### 3.1. Introduction of Modern Waterworks in Seoul

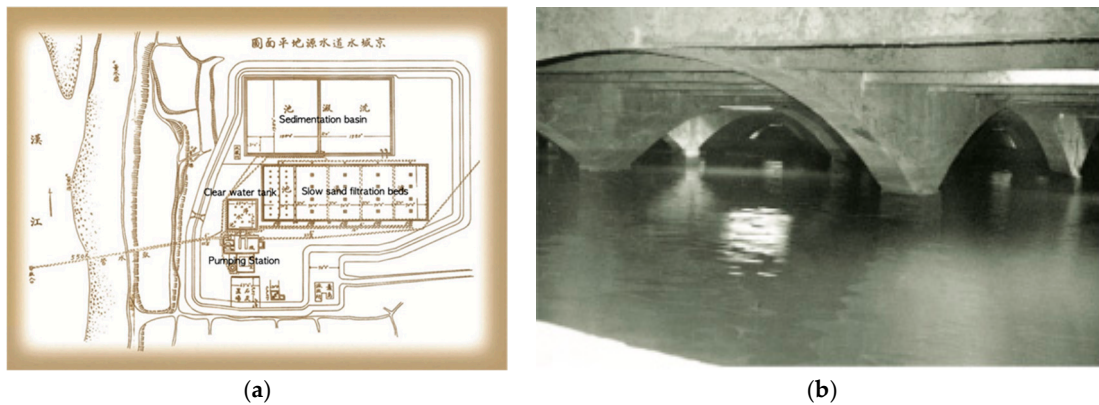
The water purification plant of the Seoul waterworks was installed at Ttukdo Island, which is located on the upper stream of the Han River, on the eastern outskirts of Seoul (See Figure 2). This water purification plant had one pumping station, two sediment basins, five filter beds, and one clear water tank. Raw water was pumped by steam engine from the upstream of the Han, sent to the first sedimentation basin, and then continuously sent to the second basin. After sedimentation, water flowed into the slow sand filter beds. Filtered water was stored in a clear water tank, was directed into the water pumping room, and was eventually sent to the service reservoir at Daehyun mountain (See Figure 3). The purified water was delivered from the service reservoir to the city by gravity via a cast iron pipeline. The main pipeline from Daehyun reservoir passed through the Gwanghuimun gate (the southeastern gate of old Seoul) and was divided into four lines at the Chungryung Bridge near Euljiro fifth street. The four pipelines supplied the city's eastern, southern, northern, and Yongsan quarters, respectively (See Figure 4). The capacity of the Seoul waterworks was about 13,607 m<sup>3</sup>. The waterworks were expected to provide 111 L per person per day for 122,250 people [19] (p. 26). When construction was completed in 1908, the population of Seoul was 217,391, so the water supply rate should have been 57 percent. However, in 1912, the water supply population was only 78,442 compared to the total population of 302,686 [34]. In short, the actual water service rate was only 26 percent.



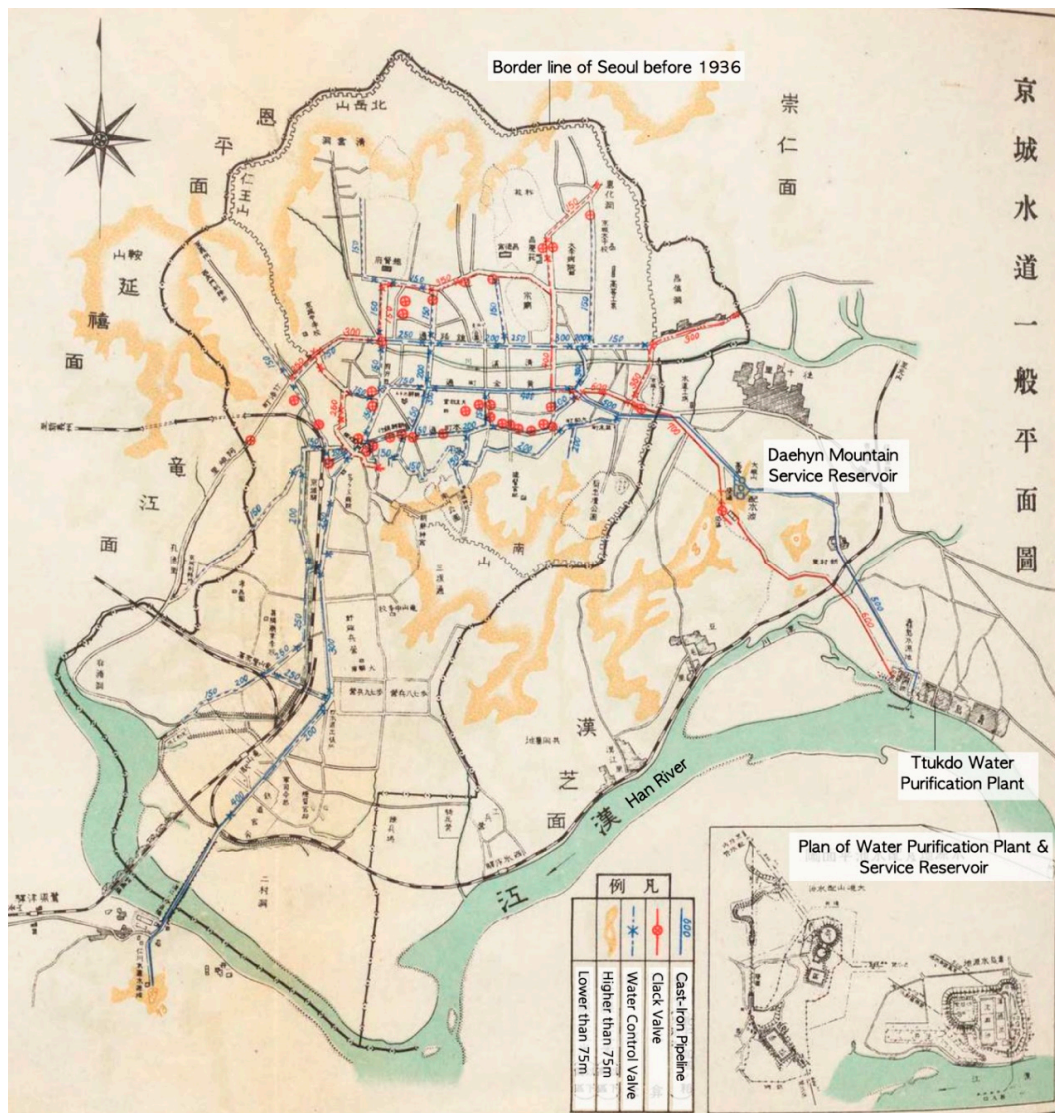
**Figure 2.** The location of Ttukdo Water Purification Plant (source: author).

A major reason why it was difficult for the water supply system to supply the city's residents with sufficient amounts of purified water was owed to the limits of the filtration technology. As noted above, Seoul's waterworks was designed by a British engineer and used British technology in its early stages, including a British-made steam-pumping engine and slow sand filtration technology, also called "British filtration" in Korea and, as it was used for the Tokyo waterworks as well, in Japan [21] (p. 60). The waterworks adopted sand slow filtration by gravity that admitted water to the space above the fine sand through the sedimentation process and flowed downward by gravity. Compared

to rapid filtration technology, slow sand filtration is slower and requires more space and resources for its operation [35] (pp. 16–17).



**Figure 3.** (a) Site plan of the Ttukdo Water Purification Plant ca. the 1910s. (b) Slow sand filter bed at the Ttukdo water purification plant. (Source: Seoul waterworks Authority, 2008 [36]).



**Figure 4.** A map of Seoul’s waterworks ca. the 1930s. (Source: JGGK 1937 [20]).



### 3.2. Improvement and Enlargement of Seoul's Water Treatment Facilities

After Japan annexed Korea in 1910, Seoul's water services were set to be managed by the Shibusawa Company beginning on 24 January 1911. However, two months later, the Japanese colonial government bought the right to manage Seoul's waterworks from the company, and the Kyungsungbu (city government of Seoul) became responsible for managing the waterworks. The Kyungsungbu continuously improved and expanded the purification plant to increase its service capacity. Between 1912 and 1915, one filter bed and one service reservoir were added to the city's waterworks. Between 1928 and 1933, Ttukdo Water Purification Plant underwent a large expansion and received a modern intake system, sedimentation and filtration basin, and an additional service reservoir. This modernization of Seoul's water treatment facilities featured a fundamental change of purification techniques with introduction of rapid filtration, chlorination, and intake of riverbed water [21–23].

Rapid filtration is 40 times faster than slow sand filtration because it agglomerates impurities with aluminum sulfate before filtration and requires only a quarter of the filtration bed area. Thus, it was available to increase the amount of serviced water. Additionally, agglomeration with aluminum sulfate makes it possible to purify water even when the raw water is turbid [37]. Chlorination, which was introduced in 1928, can effectively prevent water-borne infectious diseases such as cholera and dysentery by removing bacteria and viruses that cannot be removed through filtration. Water drawn via the infiltration gallery from the riverbed is of better quality than surface water; thus, Seoul's water supply system began to work with better-quality raw water in this period.

Some of these new technologies were adopted because of a typhoid outbreak in 1928. Despite denial by the Kyungsungbu, there were public suspicions that Seoul's tap water had caused the outbreak [38,39]. According to a report published by the Donga newspaper on 13 November 1929, officials planned to install intake facilities with a borehole to enhance the quality of the raw water coming into the city's water supply system—in short, even officials recognized that filtration and chlorination were insufficient to get clean water delivered to the city. Thus, the introduction of rapid filtration techniques, chlorination, and intake of riverbed water played a decisive role in improving the quality of Seoul's tap water in the 1930s and increasing the city's water supply. Figures 5 and 6 show the Ttukdo Water Purification Plant's site plan and a schematic diagram that shows the planned improvement and expansion of facilities from 1928 to 1933. From these two images, we can see that infiltration galleries for collecting river-base water, a chemical mixing chamber, and rapid filter house were installed on the western side of the existing treatment facilities built in 1908. The introduction of new water purification technology led to the expansion of the purification plant.

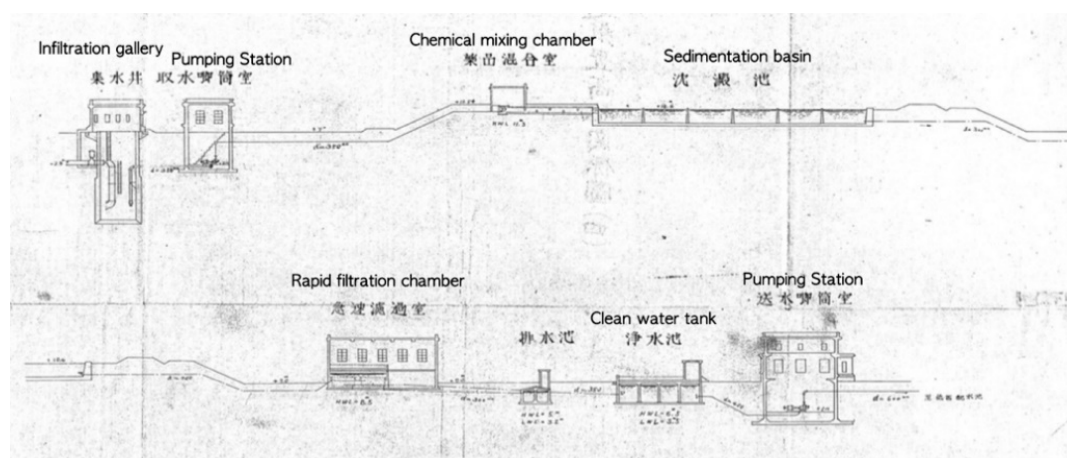


Figure 5. Schematic diagram of the Ttukdo Water Purification Plant ca. 1928. (Source: CGS 1928b [22]).

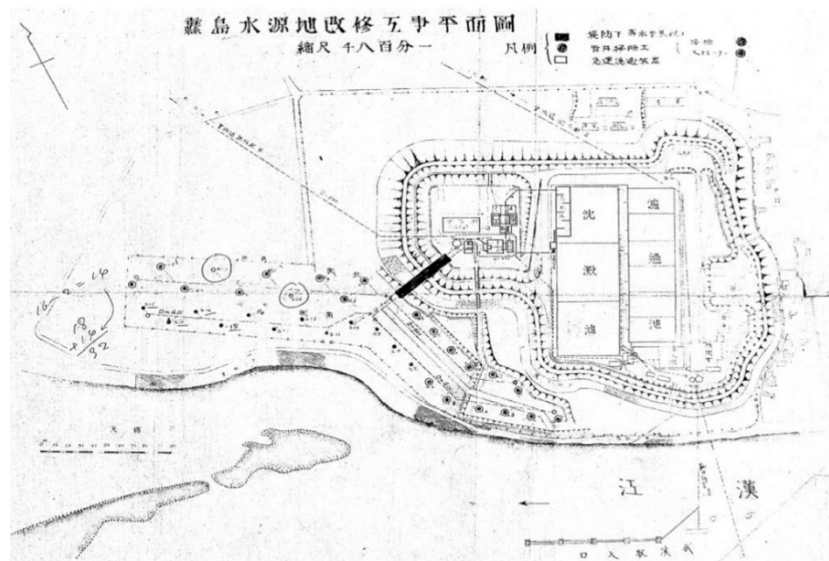


Figure 6. Site plan of the Ttukdo Water Purification Plant ca. 1928. (Source: CGS 1928a [21]).

#### 4. Transformation Process of Modern Waterworks into Civil Engineering Heritage

##### 4.1. Modern Waterworks Heritage in Korea

JGJK 1937 contains detailed information regarding the situation of waterworks in Korean cities at that time. The report indicates that Korea's water supply system in the 1930s operated as described above: water was drawn from rivers, purified in a reservoir via diverse filtration techniques, and then delivered to urban dwellers via cast iron pipes [20]. Waterworks facilities from this period can be divided into four categories based on their role in the water supply system at large: intake, treatment, collection and storage, and distribution. Water was collected either by gravity distance supply (i.e., by building upstream reservoirs to collect water from nearby rivers) or by pumping from a downstream river with a steam engine. In the early stages, Korean purification plants had sedimentation basins and filter beds. However, after plants began taking water from the underground, and chemical sedimentation was introduced, sedimentation basins were no longer necessary. Rapid filtration technologies, including chlorination processes, were introduced after the 1920s. The filtered water was stored in service reservoirs and delivered to cities via buried cast iron pipelines. Some pipelines in medium and small cities were ceramic or even soil, but most of the main pipelines were made with cast iron [20].

Although these modern water supply facilities were installed during the Japanese colonial period, some continued to be used after 1945. Many, however, were demolished during the Korean War. After the war, some of these facilities were restored, sometimes with the help of foreign powers. In the 1960s, seven cities (Seoul, Busan, Daegu, Gwangju, Incheon, Daejeon, and Cheongju) improved their water supply systems through foreign aid and state funds [40] (p. 182). However, the rate of water supply service in Korea remained at 22 percent throughout 1966. As Korea's waterworks continuously expanded and improved, this rate reached 35.3 percent in 1971, 42.4 percent in 1975, 54.6 percent in 1980, and 70 percent by 1987 [40] (pp. 167–180). At the same time, the waterworks facilities that had been installed in the early twentieth century were discarded; many were replaced with new facilities or demolished so that the land could be used for some other civic purpose. However, some have been preserved and reused as cultural heritage sites. At present, 11 modern waterworks facilities have been designated and registered as Korean cultural heritage sites.

The Ttukdo Water Purification Plant in Seoul and the valve house of Songhyun service reservoir at Incheon are two such designated cultural heritage sites. The other nine registered cultural heritages are located in Seoul, Busan (two sites), Gunsan, Masan, Ganggyeong, Daegu, Cheongju, and Tongyeong.

Most of these were registered as cultural heritage sites between 2005 and 2008, but the Ttukdo Water Purification Plant was designated a cultural heritage site in 1989, Incheon in 2003, and Ganggyeong in 2014. Three of the 11 are intake facilities, two are water purification plants, four are distribution facilities, and two are complexes that house filter beds and service reservoirs. Four of these waterworks facilities were built before 1910 (the first Ttukdo Water Purification Plant, Busan Seongjigok impounding reservoir, Bok Byeongsan service reservoir, and the Incheon Songhyun valve house), two in the 1910s (the Gunsan impounding reservoir and the Daegu service reservoir), two in the 1920s (the Ganggyeong service reservoir and filter beds and the Cheongju valve house), and three in the 1930s (the Masan impounding reservoir, Tongyeong service reservoir and filter beds, and Seoul Gui water purification plant). Currently, two purification plants located in Seoul (the Ttukdo and Gui plants) have been used as exhibition halls. The others do not have any specific designated use—instead, they remain vacant urban spaces and are used as public parks. Please see Table 1.

**Table 1.** List of waterworks heritage sites in Korea.

Types of Heritage	Location	Title	Original Function	Construction Date	Designation/Registration Date	Using as Waterworks	Current Usage	
City Designated Heritage	Seoul	The first Ttukdo Water Purification Plant	Purification plant	1908	1989	Not using	Museum	
Cultural Heritage Material	Incheon	Valve house of Songhyun service reservoir	Valve house	1910	2003	Not using	Public Park	
	Busan	Busan Seongjigok impounding reservoir	Impounding reservoir	1910	2008	Not using	Public Park	
	Busan	Bok Byeongsan service reservoir	Service reservoir	1910	2007	Not using	Public Park	
	Gunsan	The bank of first impounding reservoir	Impounding reservoir	1915	2005	Using		
	Daegu	Daebong service reservoir	Service reservoir	1918	2006	Not using	Public Park	
	Registered Cultural Heritage	Cheongju	Valve house of Dongbu service reservoir	Valve house	1923	2007	Not using	Public Park
		Ganggyeong	Chaewoonsan service reservoir	Filtration bed + Impounding reservoir	1924	2014	Not using	Not using
		Masan	Bongam impounding reservoir	Impounding reservoir	1930	2005	Not using	Public Park
		Tongyeong	Munhwadong impounding reservoir	Filtration bed + Impounding reservoir	1933	2005	Using	
		Seoul	Gui the first and second purification plants	Purification plant	1936/1959	2008	Not using	Exhibition hall & Education facilities

#### 4.2. Discarding and Finding Adoptive Uses for the Ttukdo Water Purification Plant

Seoul's rapid population growth and the expansion of its urban area demanded that additional water treatment facilities be established. In 1936, the Gui Purification Plant was built. This plant also adopted rapid filtration techniques, chlorination, and ran on the intake of riverbed water. The population of Seoul increased dramatically after the Korean War, so the water supply rate, which had reached 77 percent in 1945, fell to 57 percent by 1959. To meet this challenge, many existing waterworks were installed and expanded. For example, in 1948, the Yeongdeungpo purification plant for industrial

water was modified so that it could supply water to residential areas. In 1956, a third purification plant was added to the Ttukdo Water Purification Plant. Additional water purification plants were established at Bogwang, Gwangam, Seonyu, Amsa, and Gangbuk soon after.

However, since the 1990s, many of the old water purification plants have been abandoned or are no longer in use. The Noyangjin Water Purification Plant met this fate in 1998, as did the first and second plants at Gui in 2002, the first plant in Ttukdo in 2003, the Shinwol plant in 2003, and the Bogwangdong plant in 2005 [36]. Many of these plants were demolished after their closure, but some remained part of the urban landscape. For example, the Seonyu plant was used as a public ecological park after renovation, and Ttukdo's first plant and Gui's first two plants have been preserved as cultural heritage sites and are today used as museums and exhibition halls.

The Ttukdo Water Purification Plant, Seoul's first, is still in operation. There were six plants at the Ttukdo treatment facilities. The first was built in 1908, and its pumping-house, slow sand filter beds, and clear water tank were designated Tangible Cultural Asset No. 72 of Seoul Metropolitan City in 1989. Since 2008, the site has housed the city's waterworks museum. The city's second plant, which was constructed in 1928, was demolished in 1991 and replaced with a new plant. The city's third plant was built in 1956 via the ICA (International Cooperation Agency) foundation and closed in 1990. The fourth was built in 1970 and demolished in 1990, and the fifth was built in 1969 and renamed as the new first plant in 1990 [36] (pp. 248–267). The third and fourth plants remained in part and have been used as facilities for the experiential learning park of Seoul Forest.

The area of the first plant is currently being used as the waterworks museum. The pumping station, a red-brick, one-story masonry building built in 1907, has been remodeled for use as a main exhibition hall. The intake chamber is an annex hall, and the slow filtration basin, the oldest existing reinforced concrete building in Korea, has been restored to its original condition and is now open to the public (See Figure 7). The clean water tank is closed for preservation. Among these facilities, the pumping station and slow filtration basin are regarded as the core facilities of the Ttukdo Water Purification Plant because they demonstrate modern waterworks technology, filtration and pumping, and are well-preserved in their original forms. In the case of the third and fourth plants, the sedimentation basin has been transformed into Gallery Garden using the original structure, and the filtration basin has been used as a Butterfly Garden to raise aquatic plants and an insect garden inside a constructed glass pavilion in Seoul Forest. Additionally, the clean water tank has been used as an event space since the major structure of the building was demolished [18] (pp. 55–63).



**Figure 7.** (a) Former pumping station, now used as the main exhibition hall of Seoul's waterworks museum. (b) Former slow sand filter beds, now a display hall in the waterworks museum. (Photo taken by the author).

## 5. Historical Layers of Meaning in the Ttukdo Water Purification Plant

The Ttukdo Water Purification Plant provided clean water for urban dwellers for 83 years. It has since taken its rightful place as a cultural heritage site that introduces the historical and cultural value of Korea's modern waterworks to the public. Although the installation of water treatment facilities



between 1880 and 1950 was common all over the world, the Ttukdo Water Purification Plant holds more complicated historical meanings because it was built, expanded, and eventually operated in an extremely dynamic period that includes the rule of the Daehan Empire, Japanese colonial rule, both world wars, and the Korean War.

We can consider the plant's major historical meanings in three stages. First, it was an urban infrastructural innovation that helped resolve the major challenges of mass urbanization. As discussed above, water treatment facilities were installed around the world to provide clean water to urban dwellers and prevent water-borne diseases in cities. Before preparing the construction of these waterworks, there was an outbreak of cholera, and Korean elites as well as foreign dwellers urged the installation of waterworks for sanitary living condition [41,42]. Additionally, Korea Water Works Limited advertised that drinking clean water would help prevent disease, combat fatigue, and improve mental health [43]. After the establishment of the Ttukdo Water Purification Plant, water quality has been managed regularly, and new purification technologies have been continuously introduced. These modern waterworks dramatically enhanced urban sanitary conditions: in 1919, tap water from the Seoul water supply system was proved to be cleaner than water from public wells or private old-fashioned waterworks in Japanese settlements—Seoul's tap water contained far less bacteria, settled solids, and organic materials [21] (pp. 25–28). In the case of Incheon, the death rate caused by cholera, typhus, and dysentery for four years after waterworks installation decreased from 104 to 10 per 10,000 people [21] (pp. 2–3).

Second, Seoul's waterworks were constructed under complicated interrelations among the Korean government, Western engineers and businessmen, and the Japanese colonial government. The waterworks were initially conceived by the will of Emperor Gojong of the Daehan Empire, who sought to modernize Korea by installing electric facilities, trams, and improving road conditions. However, given that they faced a lack of Korean civil engineers and a lack of government funds, the Korean government had to commission foreign engineers to carry out the project. Throughout the nineteenth century, many British civil engineers went to Asian cities for their business and played a role in constructing modern Asian cities. It means that at least, at the initial stage, Korea's waterworks industry was regarded as a profitable business for foreigners. After 1911, Seoul's waterworks was managed by Kyungseongbu, the municipal government and became a public utility. However, the public works of the colonial period inherently connote discrimination and domination. As previous researchers have indicated, the water supply zone expanded around a Japanese-dominated area, and discriminatory implementation of the water metering system made it difficult for Koreans to use tap water [6–8]. As a result, the sanitary conditions of Korean-dominated villages were far worse than those of Japanese villages. For example, Koreans, who had usually drawn water from wells, suffered more heavily than Japanese, who could get tap water during the 1916 cholera epidemic [21] (pp. 2–3).

Third, the Ttukdo Water Purification Plant has symbolic significance because it represents the beginning of modern Korean waterworks and was the first of the old waterworks facilities in Korea to be designated a cultural heritage site. The display of the waterworks museum emphasizes that these waterworks represent the beginning of modern civil engineering in Korea rather than foreign interventions, including the West and Japanese in a colonial context. The explanations of the Ttukdo Water Purification Plant provided by Seoul Metropolitan Government both at the site and on the official websites [44] focus both on the beginning stage, which was led by Western engineers and capitalists and Gojong, the emperor of the Daehan Empire, and on the renewal project of commemorating the 100-year anniversary of Seoul's waterworks, which strategically emphasize that the structures were built before Japanese occupation. In other words, the Ttukdo Water Purification Plant has been invested with its symbolic meaning as the pioneering waterworks according to a political strategy that designated it an essential site in Korea's cultural heritage.

## 6. Conclusion: Continuing Value of the Ttukdo Water Purification Plant: From Guardian of Urban Sanitation to Symbol of Urban Colonial Modernity

Designating the Ttukdo Water Purification Plant as a cultural heritage site in 1989 was extraordinary in the context of Korea, given that Korea did not consider industrial facilities as part of its cultural heritage until very recently. In addition, unlike other industrial heritage sites such as factories or railway facilities, this site tends not to be perceived as the product of colonization by South Korean citizens. This is because modern waterworks in Korea have several universal features, as described by Douet [15], and several unique features, as described above.

Douet pointed out that waterworks are distinct among industrial heritage sites because most of them are still in use for their original purposes. In addition, he described the water industry as “the manifestation of an immense intellectual, financial and technological effort during the nineteenth and the early twentieth centuries” [15] (pp. 63–65). Based on his analysis, the civil engineering heritage of the Ttukdo Water Purification Plant can be analyzed in the following two respects:

1. Continuity as a facility to produce clean water.
2. Symbolic meaning as the guardians of urban sanitation.

First, the Ttukdo Water Purification Plant is still used to supply clean water to Seoul despite its secondary functions as museums and exhibition halls. This is one of the unique features of water supply facilities compared to other types of industrial heritage, which are abandoned or outdated and thus no longer in use. This is possible because water purification plants’ operations are never obsolete, and the plants themselves are usually located in beautiful environments where they seldom produce pollution. Thus, it is possible for waterworks facilities to coexist with other public facilities. Because the site is still used for its original purpose, the Ttukdo Water Purification Plant has retained its authenticity as a civil engineering heritage site.

Second, Korea’s modern waterworks clearly have symbolic meaning as guardians of urban sanitation—this was the reason that they were built. Since its operations ceased, the purification plant has been remembered for its contribution to urban sanitation. The waterworks museum emphasizes the history of purification technology and processes, and the slow sand filter beds have been preserved to demonstrate how filtration was carried out in the early twentieth century.

In addition to these two aspects of Korea’s civil engineering heritage, the Ttukdo Water Purification Plant should be considered a monument conceived under complicated historical conditions—at the confluence of modernization, colonial rule, and emergent urban needs. The Ttukdo Water Purification Plant possesses several unique features as a modern industrial heritage site, especially given its Asian context. It was constructed with Western technology as part of a wider modernization program and has played a significant role in enhancing the lives of urban dwellers, even though it was built for foreign profit. The establishment of the waterworks required many resources: huge space, an immense amount of investment money, and advanced technologies—that these resources came together is a testament to the strength of the drive to modernize all aspects of all societies in this period. Although Korea’s modern waterworks have a colonial history, they also are distinct from other colonial modernization projects under Japanese rule. For instance, the first plant of Ttukdo Water Purification Plant was built with the help of Western powers and thus signifies the modernization and Westernization of the city—in this sense, it is not thought of as a colonial product on quite the same level as industrial infrastructure that was built for expressly Japanese purposes. However, the Ttukdo Water Purification Plant is also part of the colonial legacy in that unequal dissemination of waterworks through this plant eventually intensified racist perceptions that those who drank tap water were more civilized than those who did not. This led people to emphasize ethnic differences between the Japanese and Korean people and manifested some of the discriminatory policies of the colonial government. In short, the Ttukdo Water Purification Plant has a distinct historical significance as a symbol of urban colonial modernity.

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