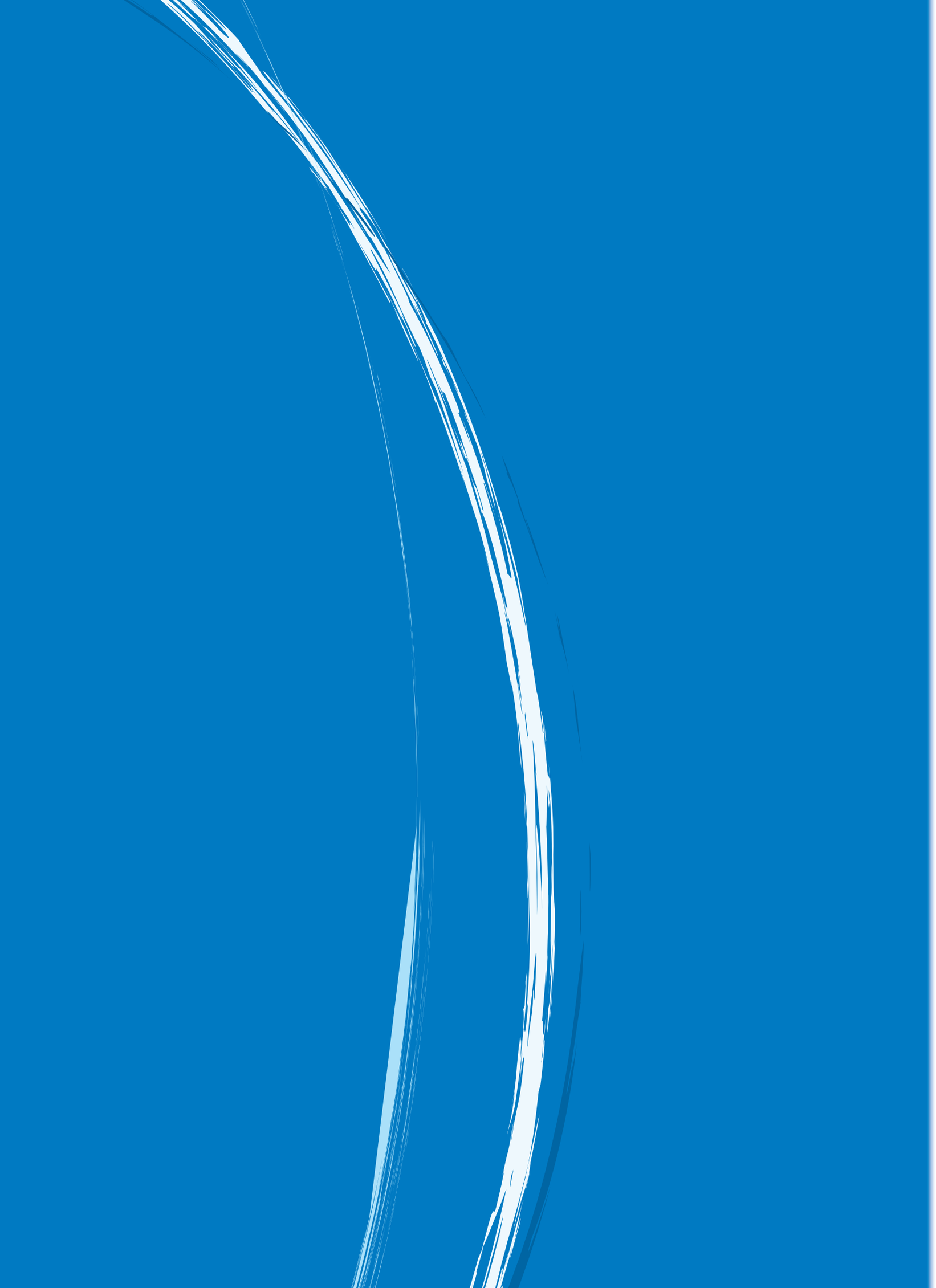

Water has no taste, no color, no odor;
it cannot be defined, art relished while ever mysterious.
Not necessary to life,
but rather life itself.

ANTOINE DE SAINT-EXUPERY,
Wind, Sand, and Stars, 1939

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Written by: PhD Brigita Jamnik | **Schematic drawings:** Milan Praznik

Photography:
JP Vodovod-Kanalizacija archive, Historical archive Ljubljana, Domen Pal, Branko Čeak, Jože Maček, David Badovinac, Anže Godec

Full page photographs:
JP Vodovod-Kanalizacija administrative building on Vodovodna ulica. | *Anže Godec*
Hercules' fountain in front of Stična mansion, reconstructed in 1991 to celebrate the 101st anniversary of Ljubljana water distribution system | *Domen Pal, Branko Čeak, Jože Maček*
Supporting construction with water pipes crosses the river Ljubljanica at Črna vas. | *Domen Pal, Branko Čeak, Jože Maček*
The water pipe crossing the river Ljubljanica at Črna vas | *Domen Pal, Branko Čeak, Jože Maček*
Interior of the medieval fountain on Kongresni trg square | *Domen Pal, Branko Čeak, Jože Maček*

Spread image:
The streets of Ljubljana carefully hide a multitude of underground passages. | *Domen Pal, Branko Čeak, Jože Maček*

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Ljubljana, July 2012

About public company JP Vodovod-Kanalizacija

In terms of the number of users of the public supply of drinking water and the wastewater draining and treatment services, JP Vodovod-Kanalizacija is the largest company in Slovenia. Both municipal services are provided in the City Municipality of Ljubljana and for the municipalities of Brezovica, Dobrova - Polhov Gradec, Dol pri Ljubljani and Škofljica. We also provide wastewater drainage and treatment services in Horjul and Medvode municipalities. The public company JP Vodovod-Kanalizacija is a wholly owned subsidiary of Public Holding Ljubljana and is one of the four companies that compose the holding. The company was established in 1890 and used a number of organizational structures. The last change was implemented in 1994, when the company structured itself as a limited liability company.

Water is our responsibility. Our modern water system delivers drinking water to our customers in compliance with legislation and the latest water supply standards. The drinking water we supply meets the health requirements and the supply of water is uninterrupted and safe.

Municipal wastewater treatment plants utilize the latest mechanical and biological processes to remove solid waste and organic nutrients and perform nitrification. These processes ensure that wastewater complies with the prescribed threshold parameters before it is released into the environment.

Managing both municipal systems requires a lot of experience and knowledge on our part and future generations will be able to testify to their efficiency. Daily activities we perform on both distributed networks, facilities and equipment include monitoring system operations and health status, timely detection and elimination of malfunctions, and regular as well as unscheduled maintenance. As a good manager we ensure that systems operate safely, efficiently and without interruptions in accordance with regulations and customer expectations.

Far left:
Administrative building of the Kleče water plant

***Left**:*
Aerial photograph of the central wastewater treatment plant Ljubljana

Public company JP Vodovod-Kanalizacija prepares long-term strategies for developing both municipal systems and designs project solutions for water supply and sewage. We also collaborate on the preparation of expert groundwork and projects for land use and changes to legislation and run awareness and informational campaigns. Our daily tasks also include providing consent in the procedures for acquiring building and operating permits, connecting facilities to both municipal systems and preparing documentation for reconstructions and new constructions. We also maintain

the cadastral register, store and process large amounts of data and report to competent national authorities. We replace, calibrate and read water meters, collect samples and perform laboratory tests of drinking and wastewater. We accept sludge from septic tanks and from smaller municipal treatment

Right:
Hydrant

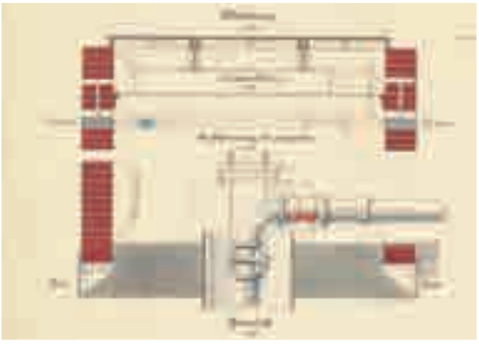
Far right:
A drinking fountain on Pogačarjev trg

plants and maintain and monitor their operations, inspect utility connections, and clean sand traps and oil separators on public surfaces.

In 1998, we were one of the first municipal companies in Slovenia to receive the ISO 9001 quality management system certificate. Our decision to implement a quality management system was driven by our need for efficient operations as the standard requires us to maintain the quality of our business processes. The quality management system supports our goals as we are continuously driving the efficiency of our operations by systematically documenting and analyzing our business. The principle of personal responsibility motivates employees to improve productivity and exposes mutual dependence of processes to improve communication among employees. The result is increased trust from all of our stakeholders – customers, owners, employees and suppliers. Protection of the environment is also an important and recognizable part of our long-term mission. We are striving for excellence and the highest levels of social and environmental responsibility.

Important information about drinking water systems managed by the public company JP Vodovod-Kanalizacija (31 December 2011)

Parameter	**Scope**
Length of the water distribution system	1,115 km
Number of water connections	40,484
Number of reservoirs	31
Volume of reservoirs	23,542 m^3
Number of water supply facilities in the central water distribution system	5
Number of local water supply facilities	8
Number of pumping stations	11
Number of booster pumping stations	20
Annual volume of water sold	21,535,120 m^3



Up:
A sign on the Rožnik reservoir marks the beginnings of the public water supply system

Far left:
Roman well from the 2nd century CE
Photo: David Badovinac

Left:
Plans for a water distribution system in Ljubljana from the end of the 19th century

Right:
Old well pump
Photo: Domen Pal/Branko Čeak/Jože Maček

Far right:
The mouth of the well on Grajski grič with a windlass and a wooden wheel to lift water
Photo: Domen Pal/Branko Čeak/Jože Maček

History

Roman Emona

In Roman Emona, public water supply in the area of modern Ljubljana was already developed. The inhabitants of Emona found sources of drinking water in the hills around their homes and wastewater was drained to the river Ljubljanica through collection channels.

1881

The city committee on health adopted the proposition to build a water distribution network that was drawn up by engineer Rudolph Wagner.

1882

A committee for a water distribution system was founded. It was headed by Ivan Hribar, who later became the city's mayor.

Period from 1888 to 1890

The city authorities entrusted the first plans for a public water distribution system to machine engineer Oskar Smreker (1854-1935). At the time, he was among the most prominent European designers and builders of water distribution systems and an important researcher. Later, Oskar Smreker oversaw the construction of the water distribution system.

1 April 1890

Ljubljana city council adopted the Rules on provisioning water equipment in and in front of houses in Ljubljana and the Provision for supplying water from the Ljubljana water system.

Middle ages, modern period and the majority of the 19th century

There was no progress in public water supply during this period. The aqueduct that ran from Golovec to Mestni trg since the Roman times was used for several centuries and some sources claim that it was used until the earthquake in 1511. In the areas, now occupied by Podutik, Dravlje and Koseze suburbs, Romans had built a water distribution system that carried water from the Zlatek spring, which was used until 1737. In the medieval period, the city inhabitants got their water from streams and village wells. It was carried to the city in jugs and then disposed of into nearby ditches and gardens.

The sewerage system was built gradually at the beginning of the 19th century.

17 May 1890

The 27-kilometer long water distribution system delivered drinking water to 606 of the 900 houses in Ljubljana for the first time.

29 June 1890

This date marked the opening ceremony of the water distribution system that included the Kleče water plant with four steam-powered pumps and the capacity of 3,384 m^3/day, primary pipes measuring 27,326 meters in length, and the Rožnik reservoir with the capacity of 3,030 m^3. Construction costs of 484,486 guldens were covered by a lottery loan.

1899

The earthquake in 1885 dramatically changed the face of Ljubljana. Jan Vladimir Hrasky, professor at the Prague Technical University, submitted a design for the sewage system that accompanied the urban plan for Ljubljana reconstruction.

1905

The first parts of the modern public sewage system were built on Lipičeva ulica.

1908–1910

The capacity of Kleče water plant was increased to 9000 m^3/day. A 5.2-kilometer pipe with the diameter of 400 mm was built to connect the Kleče plant to the Rožnik reservoir. In 1910, there were 1368 houses connected to the water system.

1916

The first stage of the sewage collector on the left bank of the river Ljubljanica in the city center was constructed.

1928

The capacity of the Kleče water plant was increased to 27,000 m^3/day and the total length of the water distribution network increased to 127 kilometers.

1933

The first stage of the sewage collector on the right bank of the river Ljubljanica in the city center was constructed.

1940

Steam boilers in the Kleče water plant were turned off and pumps were connected to the electrical grid.

1945

A new reservoir with the capacity of 2,162 m^3 was built on Rožnik.

1951

The company Kanalizacija Ljubljana was founded.

1953

Water plant in Hrastje was opened.

1955

Šentvid water plant was opened.

The first ordinance on protecting the quality of groundwater (Ordinance on the protection zone) was adopted.

1956

The wastewater treatment plant Brod began operations.

1966

The wastewater treatment plant Črnuče began operations.

1975

The capacity of the water plant in Hrastje was doubled.

1977

The Ordinance on water resources protection zones in Ljubljana and measures to protect water was adopted.

1994

With the foundation of the Holding mesta Ljubljana, a company for the management of public companies, the public company JP Vodovod-Kanalizacija d.o.o. began operations in its current legal form.

1981

Water plant Brest was opened.

1982

Water plant Jarški prod was opened.

1988

The Ordinance on protecting drinking water resources was adopted.

1989

The number of water wells in the Kleče water plant was increased to 16.

1991

Construction of the facilities for first stage treatment of wastewater in the Central wastewater treatment plant in Ljubljana.

1998

The company acquired the ISO 9001 quality management system certificate.

2001

The municipal wastewater treatment plant in Črnuče was reconstructed.

2003

Acquisition of the accreditation certificate No. LP-023 in accordance with SIST EN 17025 for chemical analysis.

2004

The Ordinance on the water protection area for the Ljubljansko polje aquifer was adopted. Acquisition of the accreditation certificate No. K-041 in accordance with SIST EN 17020 for the control of water gauges for cold water.

2005

A trial of the second stage of wastewater treatment at the Central wastewater treatment plant in Ljubljana began.

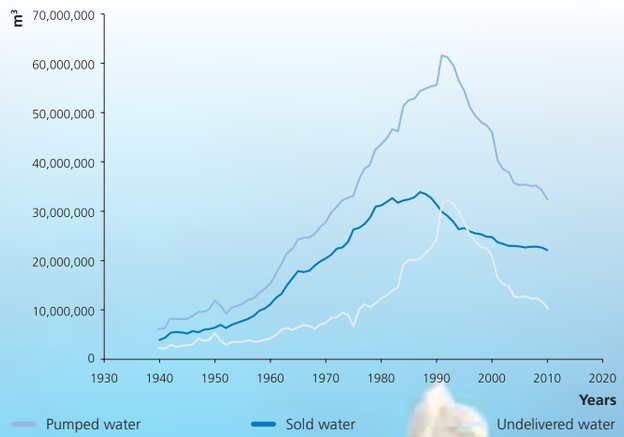
2007

The adoption of the Ordinance on the water protection area for aquifers on Ljubljansko barje and in Ljubljana surroundings.

2009

The company launched the project to improve the hydraulic operations of the sewerage system in Ljubljana by building three sewage retention tanks and collectors.

Pumped quantities of drinking water and sold and undelivered water in the period 1940-2011. The highest levels of water consumption were recorded in the late 1980s. The consumption of water is decreasing as are the volumes of undelivered water.



Water for Ljubljana

Drinking water supply – The indispensable part of our everyday lives

We manage the central water distribution system in the City Municipality of Ljubljana, which reaches beyond its borders to municipalities Brezovica, Dobrova - Polhov Gradec, Dol pri Ljubljani, and Škofljica. We also manage local water systems in Prežganje, Mali Vrh pri Prežganju, Lipoglav, and Šmarna gora. In municipalities Brezovica and Škofljica, we manage local water distribution systems Rakitna and Pijava Gorica, respectively.

Drinking water is our natural resource - priceless and indispensable. It is also our loyal companion. We use it every day for cooking and drinking and it has many other uses in households and the industry. Each resident of Ljubljana and its surroundings uses between 115 and 150 liters of drinking water per day. By taking into account industrial and other uses, the average usage is 200 liters per resident.

The central water distribution system and six local systems include: five water plants with 44 wells, 8 smaller local water plants and 1,100 kilometers of the water distribution network. The system has 40,500 connections that supply water to 315,000 users.

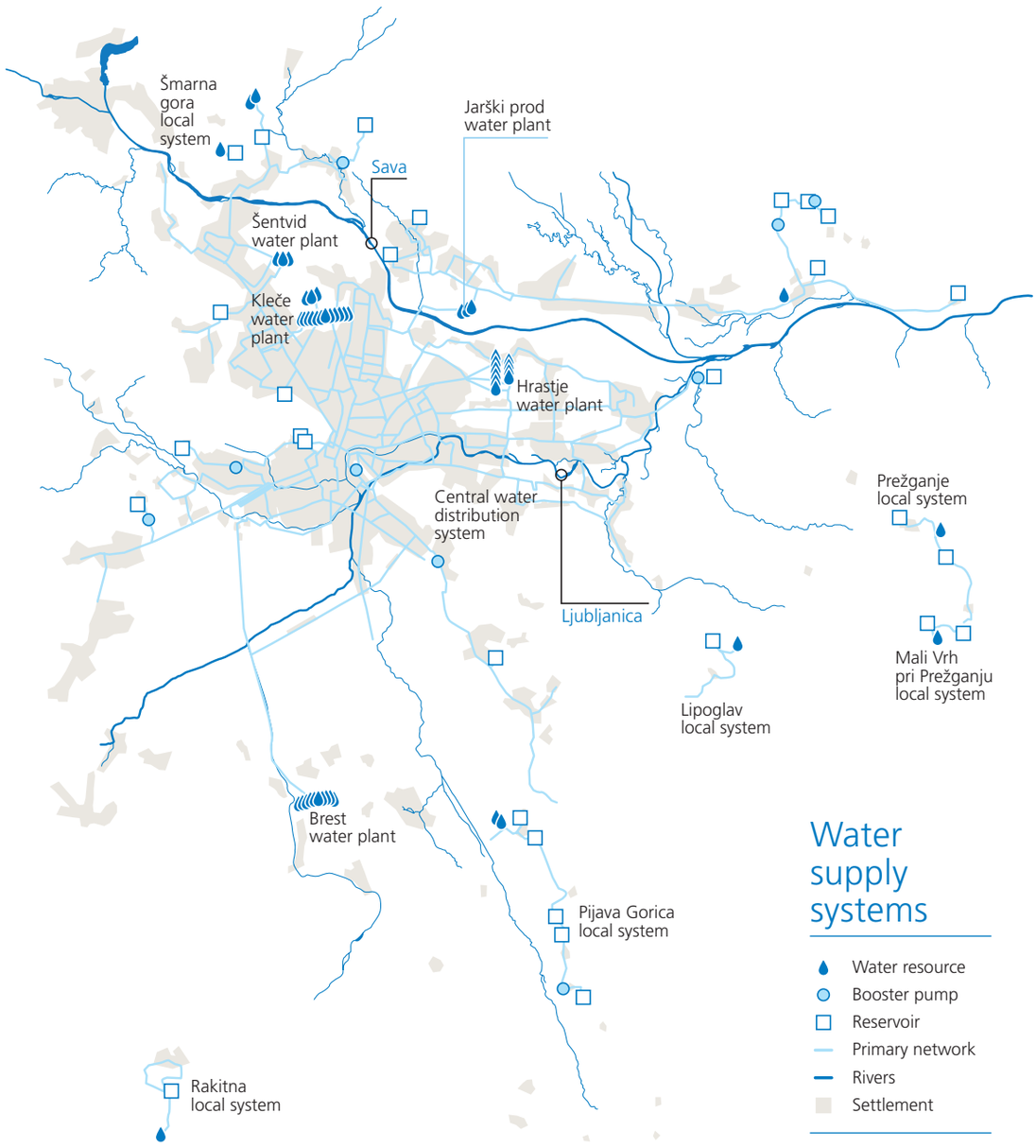
The source of water for the central water distribution network is the groundwater in sand and gravel aquifers on Ljubljansko polje and Ljubljansko barje. The groundwater is pumped in five water plants: Kleče, Hrastje, Jarški prod, Šentvid, and Brest. Local water distribution systems get their water from local water resources - either underground resources, such as springs or wells, or surface waters.

Far left:
Šmartno water plant
Photo: Domen Pal/Branko Čeak/Jože Maček

Left:
Water supply facility equipment
Photo: Domen Pal/Branko Čeak/Jože Maček

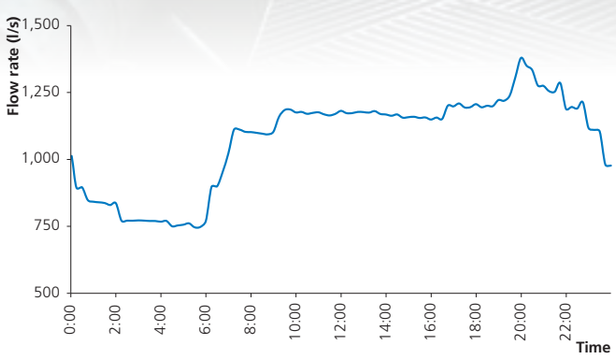
In the central water distribution system some settlements are supplied with water from a single water plant, while some receive water from two or more facilities, depending on the volume of consumed water and pressure conditions.

Water plants and catchments are highly secure areas, enclosed by a protective fence, marked with warning signs and under constant security surveillance.



Direct access to water plants is possible only when accompanied by an authorized person. Personnel are only constantly present in the Kleče water plant.

Pipes with larger diameters connect catchments and water plants to other facilities such as reservoirs and pumping stations. Together, they form the primary water supply network. Pipes with smaller diameters connect users to the primary network. These smaller pipes are connected in the dense network of the secondary water supply network. Pipe diameters are between 50 and 800 mm.



Quantities of drinking water pumped for the central water supply system Ljubljana on 28 March 2012. The consumption of drinking water begins to increase in the morning and reaches its highest point in the evening. It then decreases until morning.

The water that reaches users in Ljubljana comes from a natural environment, does not undergo technical treatments and is only chlorinated occasionally. On the other hand, local water systems do treat their water before supplying it to their users. On its journey from water plants to users, water never stays in the water supply network for more than a couple of hours. Additional equipment is required to ensure that water reaches high-lying areas, such as the Castle Hill, as the pressure within the network is too low to lift the water. Pumping stations or booster pumps are added to the water supply network to solve this issue.

Delivery of drinking water

There are 11 pumping stations that pump water to reservoirs. Their operation is regulated by the water level in reservoirs, which then deliver water to users. Booster pump station is a device that ensures that the network that follows the station has stable pressure conditions, which depend on the requirements of elevated buildings. There are 20 booster pumps installed on the network.

Pressure reducing stations play the opposite role to pumping stations. They reduce the pressure in specific parts of the network to the levels that are acceptable to the user.

Right:
Rožnik reservoir from 1945
Photo: Domen Pal/Branko Čeak/Jože Maček

Far right:
Instrument chamber in reservoir Pržan
Photo: Domen Pal/Branko Čeak/Jože Maček

Reservoirs are partially dug in reinforced concrete objects with one or two water cells. Water is delivered to reservoirs either directly or by pumping stations. When the consumption of water in the network is reduced (for example, at night), excess water is pumped to reservoirs. When the consumption

increases, the network is supplied by water plants as well as reservoirs. Reserve capacities in reservoirs ensure a more reliable and secure drinking water supply. In the event of a sudden failure of water plants, water needs in the network could be temporarily met by the water from reservoirs. The 19 reservoirs in Ljubljana water supply system have the total volume of 21,000 m^3, while the local systems are served by 12 reservoirs with the total capacity of 2,500 m^3. Ljubljana surroundings are hilly, so reservoirs are located on hillsides around Ljubljana. Ljubljana does not use water towers that are used in cities on flat plains to ensure appropriate pressure in the water supply network.

The water supply network also includes more than 9,600 hydrants. These are points in the water supply network that enable direct access to water in the event of a fire. The water supply network also includes innumerable other elements: gate valves, dampers, vents and silt disposals. We inspect water supply components visually or by using audio monitoring devices that are installed on individual segments of the network. Equipment for automated measuring of flow and pressures in the network provides the data for analyses that are used to optimize the system, perform preventive measures, such as replacing damaged components, and design damage remediation plans.

Ljubljana water supply system uses steel and cast iron pipes, polyethylene and polyvinyl chloride pipes, ductile iron pipes and asbestos cement pipes. The oldest part of the system is more than 120 years old. Ductile iron pipes are most commonly used in reconstruction projects while households are most commonly connected to the network with polyethylene pipes.

The central control center is used to manage and monitor the operation of the water supply system. All data about the operation of individual objects is delivered to the center. Equipment for pumping

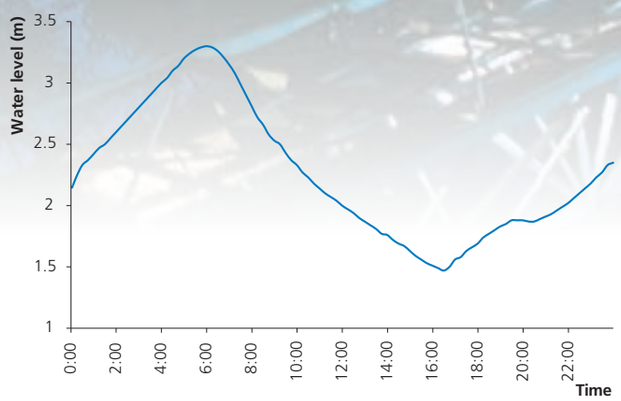
Far left:
Water supply network maintenance

Left:
Water meter

and storing water is automated and controlled remotely. Controllers use input data to automatically manage pumping processes and transmit data to the control center by using radio stations. We are constantly upgrading our software to keep up with modern development practices.

Water meters are used to measure the consumption of drinking water in buildings connected to the public water supply. Before installation, each water meter is verified in our own water meter control laboratory, which is accredited in accordance with SIST EN ISO/IEC 17020 requirements. To ensure that water consumption measurements are reliable and correct, all installed water meters are replaced every five years and larger meters are replaced every three years. Currently, there is a project underway to ensure remote reading of water consumption and automated transmission of data into our databases.

Connecting a building to the water supply and sewage systems.



Water level fluctuations in the Pržan reservoir on 28 March 2012. During nighttime, the water is supplied to the reservoir and then released to the network, when the consumption increases in the morning.

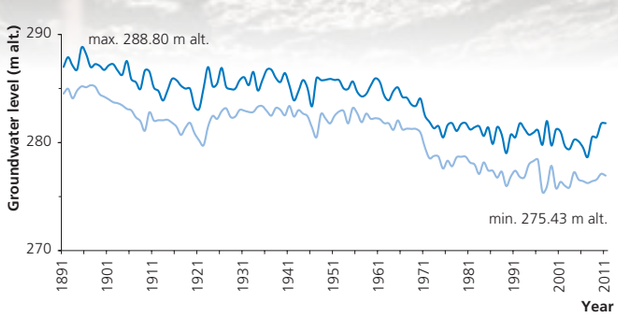
Water supply safety

We place water supply safety before everything else. Drinking water affects human health and our users are right to expect the highest quality. The responsibility of our employees towards their work and the equipment, facilities and the network we manage ensure that our drinking water complies with regulatory and health requirements.

Every day, drinking water is delivered to users in Ljubljana and its surroundings. It complies with health regulations that are harmonized with European requirements. The water we drink and use does not contain microorganisms, parasites or their developmental stages that are harmful to people's health. It also does not contain any substances that would be harmful either on their own or in combination with other substances.

Right:
Marking signs

Far right:
Manhole cover



Highest and lowest levels of groundwater in water plant Kleče throughout its lifetime. The decrease during the first decades of operation is a result of increased pumped volume. Later decreases are a result of interventions in the Sava riverbed.

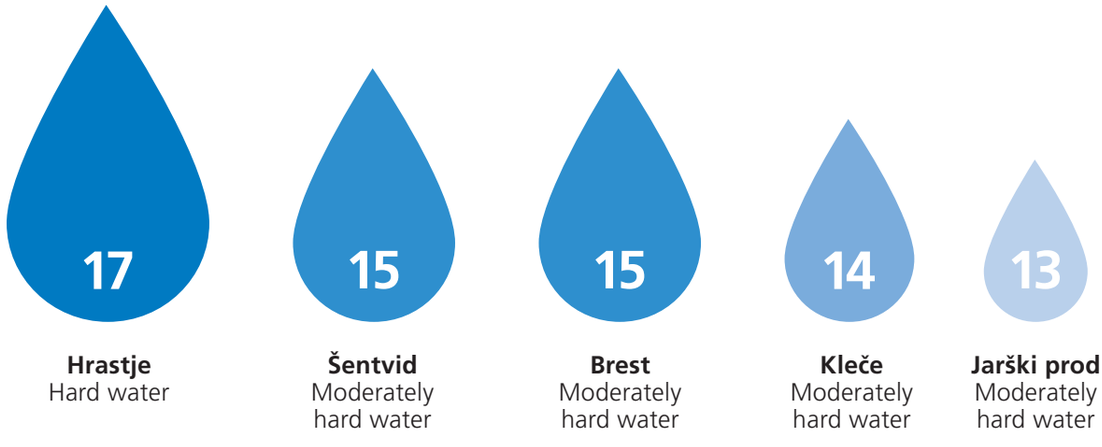
Drinking water – Highly regulated food

Procedures, related to pumping, storing and transporting drinking water, are compliant with the SIST ISO 9001 standard.

Internal control of drinking water is performed in accordance with a mandatory plan that is based on HACCP (Hazard analysis and critical control points) system principles. It enables us to control the entire system and recognize any microbiological, chemical and mechanical parameters that may represent a risk to people's health.

Our modern laboratory for microbiological and chemical testing of samples (accredited and compliant with SIST EN ISO/IEC 17025) and professional staff enable us to monitor the parameters of drinking water at all stages: at our customers, in the network and water supply facilities, water plants and catchments. The compliance of drinking water with health and regulatory requirements is verified by us and the ministry, responsible for health. Public drinking water supply is also carefully monitored by the Health Inspectorate of the Republic of Slovenia.

Graphical representation of water hardness by individual water stations [°N]



°N = German scale (°dH is also used) – 1°N is equivalent to 10 mg CaO/liter.
Hardness scale: 0–8 °N: Soft water; 8–15 °N: Moderately hard water; 15–21 °N: Hard water; above 21 °N: Very hard water

Protecting water resources

In Ljubljana and its surroundings, the supply of drinking water depends on protecting water resources with water protection areas that are defined with relevant regulations. In these areas any activity or intervention that would endanger the quality or quantity of water resources is forbidden.

In the immediate vicinity of water plants restrictions are very strict. The restrictions are less severe in areas further removed from these facilities. Measures are intended to reduce the dangers and risks, posed by existing and any future activities.

Water protection areas are an important factor in protecting water resources. At the same time, they restrict development of a number of activities, which causes disagreements among users. This is why the protection of water resources is a hard task that never ends. As a water supply system manager we are actively participating in these processes as their success and efficiency are what ensures the safety of our water supply.

Far left:
Facility for monitoring the levels and quality of groundwater

Left:
Road sign marks the entry to a water protection area

Mission, vision and concluding thoughts

Public company JP Vodovod-Kanalizacija has decades-long tradition of responsibly realizing its mission. Our creative and experienced employees, whose guiding principle is the respect for others and the environment, help us ensure that drinking water supply is safe and reliable and that draining and treating wastewater is performed in accordance with environmental standards. In this way, we contribute to creating a more secure, creative, healthier and cleaner environment and ensure the satisfaction of our customers.

The results of our work reflect a company that is responsible to its employees, owners and other shareholders. Our work is based on responsible and deliberate planning and execution of investment projects and development projects, founded on expertise. We pay special attention to long-term planning of the operations of both municipal systems and efficiently responding to everyday challenges that arise in the course of our work. We are proving our social responsibility by managing both municipal systems efficiently and sustainably. We also follow the principles of sustainable water resource use, which will enable us to utilize them in the coming decades.

We fulfill the expectations of our owners with efficient and transparent operations and by achieving measurable goals. We provide professional development and a safe working environment to our employees. The expert public recognizes us from our participation in research and development activities with Slovenian and foreign partners.

In the future, we wish to build on the results of our research and development work and professional growth to develop into a company that will have a permanent positive impact on our environment through our recognizable social image and performance of environment projects. With environment-friendly focus and care we wish to ensure that future generations will recognize us as a municipal system manager that efficiently and economically administered the two systems to achieve measurable results and improve the quality of life for the inhabitants of Ljubljana and its surroundings.

Through our work, expertise and experience that is carried from one generation to another, Public company JP Vodovod-Kanalizacija measures up to large municipal companies at the European level. That makes us worthy of the attention and trust from the expert and general public.

If you could tomorrow morning make water clean in the world,
you would have done, in one fell swoop, the best thing you could have done
for improving human health by improving environmental quality.

WILLIAM C. CLARK,
Racine, Wisconsin, 1988

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Full page photographs:
JP Vodovod-Kanalizacija administrative building on Vodovodna ulica. | *Anže Godec*
We manage more than 1,100 kilometers of sewerage networks in Ljubljana and its surroundings | *Anže Godec*
An aerial view of the Central wastewater treatment plant Ljubljana.

Spread image:
The streets of Ljubljana carefully hide a multitude of underground passages. | *Domen Pal, Branko Čeak, Jože Maček*

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Ljubljana, July 2012


KANALIZACIJA

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Administrative building of the Kleče water plant

***Left**:*
Aerial photograph of the central wastewater treatment plant Ljubljana

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Far right: *Sewerage network underground hides beneath urban surfaces*

Right: *Sewers are inspected visually and with cameras*

plants and maintain and monitor their operations, inspect utility connections, and clean sand traps and oil separators on public surfaces.

In 1998, we were one of the first municipal companies in Slovenia to receive the ISO 9001 quality management system certificate. Our decision to implement a quality management system was driven by our need for efficient operations as the standard requires us to maintain the quality of our business processes. The quality management system supports our goals as we are continuously driving the efficiency of our operations by systematically documenting and analyzing our business. The principle of personal responsibility motivates employees to improve productivity and exposes mutual dependence of processes to improve communication among employees. The result is increased trust from all of our stakeholders – customers, owners, employees and suppliers. Protection of the environment is also an important and recognizable part of our long-term mission. We are striving for excellence and the highest levels of social and environmental responsibility.

Important information about sewerage systems managed by the public company JP Vodovod-Kanalizacija (31 December 2011)

Parameter	**Scope**
Sewerage network length	1,134 km
• Combined sewers – network length	487.180 km
• Urban wastewater sewers – network length	329.130 km
• Stormwater sewers – network length	318.270 km
Number of sewerage connections	27,138
Number of municipal wastewater treatment plants	12
Capacity of Central wastewater treatment plant Ljubljana	360,000 PE
Capacity of local municipal wastewater treatment plants	19,750 PE
Number of pumping stations	48
Number of retention basins	3
Annual volume of drained wastewater	19,971,321 m^3

Up and left:
Sewerage construction on Šmartinska cesta in 1929

Far left:
Sewerage was built from bricks

Right:
Sewerage was discharged into the river Ljubljanica

Far right:
Longitudinal section of the sewer on Študentovska ulica from 1823

Milestones in the history of Ljubljana sewerage system

The seeds of the public sewerage system in Ljubljana were planted during the times of Roman Emona. Under perpendicular Emona streets larger sewers ran in the West-East direction to discharge wastewater into the river Ljubljanica. With the decline of the Roman Empire, the knowledge about the importance of public sewerage for public health was also forgotten. Centuries passed before a modern sewerage system was beginning to be built.

The sewerage system was built gradually at the beginning of the 19th century. After water was used, inhabitants continued to dispose of it into nearby ditches and gardens. City wells were polluted and inhabitants suffered from intestinal diseases.

The earthquake in 1885 dramatically changed the face of Ljubljana. In 1899, Jan Vladimir Hrasky, professor at the Prague Technical University, submitted a design for a sewerage system that accompanied the urban plan for Ljubljana reconstruction. The first parts of the modern public sewerage system were built on Lipičeva ulica in 1905. Year 1916 saw the building of the first part of the sewage collector on the left bank of the river Ljubljanica in the center of the city. Another collector on the right bank was added 17 years later, in 1933.

The company Kanalizacija Ljubljana was founded in 1951. In 1956 the wastewater treatment plant Brod began operations and was joined ten years later by the wastewater treatment plant Črnuče. First stage of wastewater treatment at the Central wastewater treatment plant in Ljubljana began operating in 1991.

With the foundation of the Holding mesta Ljubljana, a company for the management of public companies, the public company JP Vodovod-Kanalizacija d.o.o. began its operations in its current legal form.

In 2001 the wastewater treatment plant in Črnuče underwent reconstruction and in 2005, a trial of the second stage of wastewater treatment at the Central wastewater treatment plant in Ljubljana began.

Between 2009 and 2011 two sewage collectors and three retention tanks were built as part of the Project for improving the hydraulic performance of the sewerage system in Ljubljana.


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Draining the wastewater

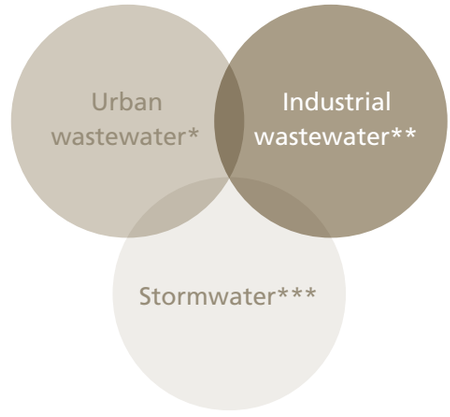
Draining and treating wastewater for a safe and quality living environment

The sewerage system is an integral part of the infrastructure that reduces the human impact on the environment, improves safety and quality of life and reduces risks to the health of the inhabitants of the capital city and its surroundings.

In addition to the central sewerage system that extends to municipalities Brezovica, Dobrova - Polhov Gradec, Medvode, and Škofljica, we also manage local sewerage systems with wastewater treatment plants Črnuče, Brod and Gameljne. In the municipality of Medvode we are managing the Pirniče sewerage system, and in Škofljica we are managing the Škofljica system. In the municipality of Dobrova - Polhov Gradec we administer Dobrova and Polhov Gradec sewerage systems. We also manage Horjul and Vrzdenec systems in Horjul, and Kamnik pod Krimom and Notranje Gorice systems in the municipality of Brezovica.

The central sewerage system in Ljubljana terminates with the treatment of water at the Central wastewater treatment plant Ljubljana, which has the capacity of 360,000 PE[1]. We also manage 11 local sewerage systems with corresponding wastewater treatment plants with the total capacity of 19,750 PE. The sewerage system has 27,100 connections and serves 31,600 buildings with 270,000 inhabitants and numerous industrial and commercial buildings. All sewerage systems terminate at wastewater treatment plants.

Wastewater types

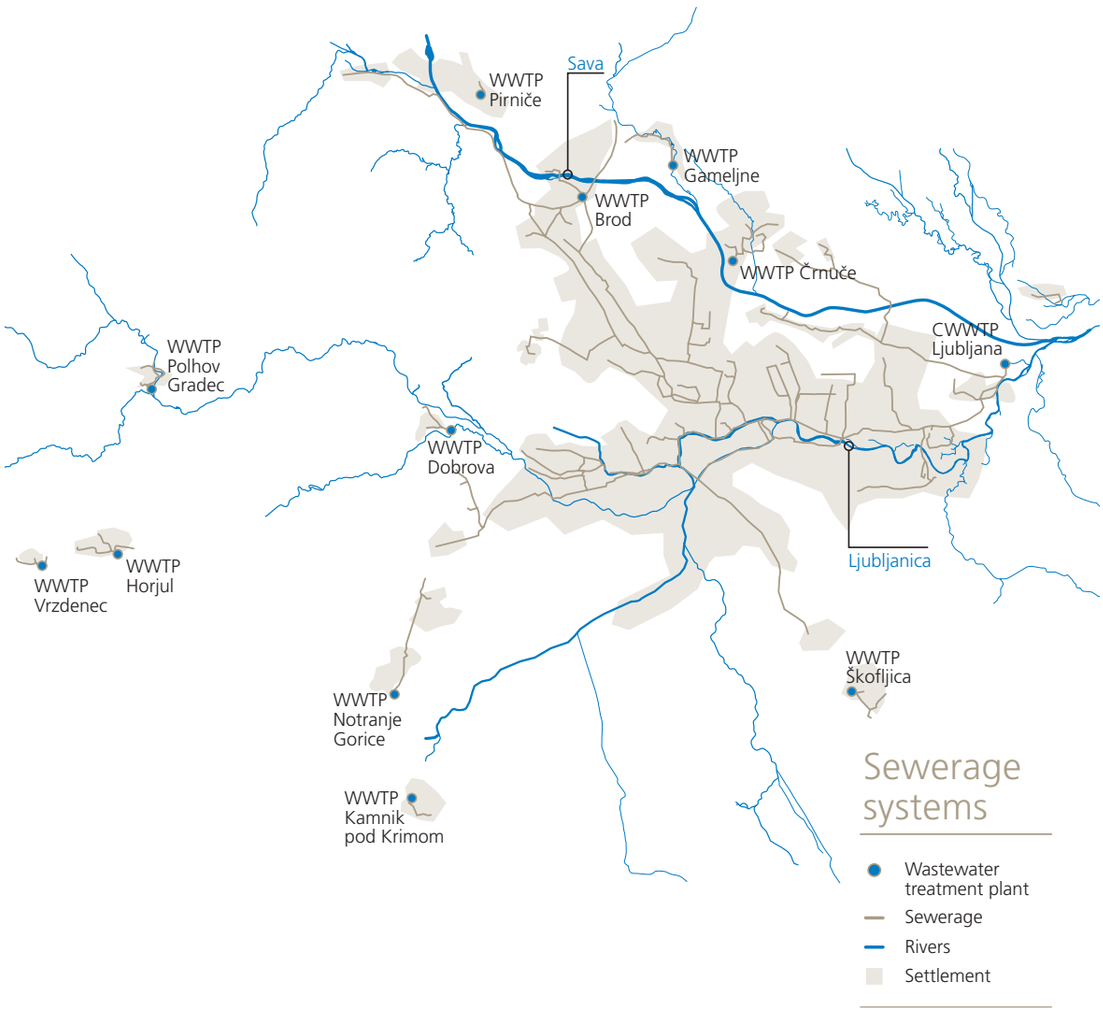


*** Urban wastewater**
occurs in households due to the use of water for sanitary purposes, cooking, washing and other household activities.

****Industrial wastewater**
is a result of water used in the industry and other commercial activities.

*****Stormwater**
is run-off rain water discharged from built up and paved surfaces and surfaces covered with other materials.

[1] The capacity of treatment plants is given in population equivalents (PE). PE is a unit for pollution load in household sewage produced by one person in a day.



How a sewerage system works

Immediately after it is used, drinking water becomes urban wastewater and is discharged into public sewerage along with industrial water and stormwater. We can only talk about regulated draining of wastewater once it is cleaned in a treatment plant before it is released into the environment. In a treatment plant, wastewater undergoes mechanical and biological treatment and is then released into the environment in a controlled fashion and in compliance with regulations.

Sewerage system consists of pipes of different diameters (25-240 centimeters) and a number of technological objects such as pumping stations, overflow facilities, retention basins, inspection chambers, oil separators, sand traps and treatment plants. In general, sewerage systems are gravity-based, which means that we take advantage of gravity to drain wastewater as it runs downhill. In flat areas and when crossing watercourses, wastewater needs to be pumped into higher main collectors, a task performed by a number of pumping stations. There are 48 pumping stations in the sewerage system and their total capacity is 7 million m^3 of wastewater.

In the areas, where wastewater needs to be pumped, the sewerage network is designed as a separate system: stormwater is left to drain into the soil, if the regulations and terrain allow it, or it is drained into the nearest drainage ditch. The central sewerage system and some of the systems in suburban municipalities are combined systems, which means that stormwater is drained together with urban and industrial wastewaters. In a separate system, wastewater is drained through two separate sewerage networks. This solution means that the sewers for urban wastewater and treatment plants are not burdened with large volumes of stormwater during rain. Collectors and retaining basins are used to relieve the burden on the combined sewerage system. These structures prevent excessive spillovers of wastewater from overflow facilities into the river Ljubljanica. The combined sewerage system is the better choice in the city center with numerous pipes under urban surface.

The sewerage network is usually located deeper than other municipal utility pipes. We are managing 329 kilometers of sewerage for urban wastewater, 318 kilometers of sewerage for stormwater and 487 kilometers of combined sewerage. To ensure unobstructed flow of wastewater, we need to regularly remove silt, sand and other deposits with modern cleaning equipment. For cleaning smaller and mid-size sewers (up to 1,100 millimeters) we use high pressure cleaning systems that utilize

Far left:
High-pressure water cleaning systems are used to clean sewers with the diameter of up to 1100 millimeters.

Left:
Sewer underground
Photo: Domen Pal/Branko Čeak/ Jože Maček

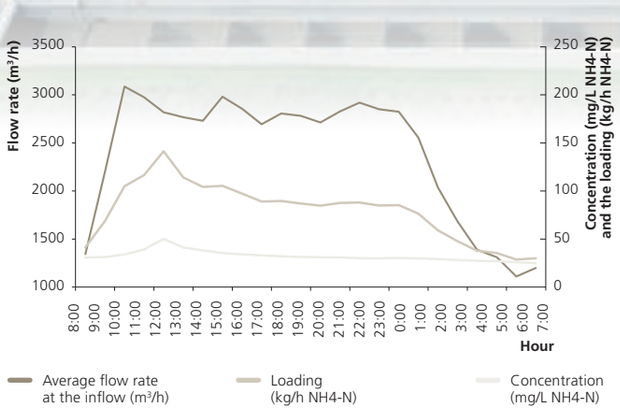
pressurized water to clean sediments from the bottom of the sewer and deposits on the sides of the pipe. The suspension then runs off to the neighboring sewerage shaft, where it is pumped into cleaning machines. The machines separate deposits from wastewater, part of which is returned to the sewerage system, while the other part of filtered wastewater is used for further cleaning. It is not possible to completely avoid manual cleaning of sewers with a larger diameter.

We regularly monitor the sewerage network, as leaking pipes may result in environment pollution. There is also risk of the opposite happening: groundwater may seep into the sewerage and represent a hydraulic burden on the system. Accessible parts of the sewerage network with pipes of large

diameters are inspected by our employees, while the inaccessible parts are recorded by cameras, attached to a robot that is remotely controlled from a vehicle equipped for just this purpose. Data on the sewerage system is important for making decisions on interventions and planning reconstruction works. We inspect 100 kilometers of sewerage networks annually.

Draining wastewater

All objects on sewerage systems are automated and controlled remotely from the central control center. Remote control is a precondition to ensuring that we are able to respond quickly and efficiently to any system malfunctions or errors. Data on operations that we receive periodically is the foundation for daily decisions about management and maintenance as well as for planning the development of sewerage system.



Flow rate at the inflow to CWWTP Ljubljana and the loading with ammonium nitrogen during the dry period between 22 August 2011 (8 a.m.) and 23 August 2011 (8 a.m.) Flow rates and the loading in wastewater increase in the morning and decrease during nighttime.

Central wastewater treatment plant in Ljubljana

The Central wastewater treatment plant in Ljubljana (CWWTP Ljubljana) treats 85% of all wastewater from Ljubljana and its surroundings. In addition to the city center and urban areas of Bežigrad, Šiška, Šentvid, Vič, Galjevica and Most, CWWTP Ljubljana also treats water from Medvode, Savlje, Tomačevo, Sneberje, Novo Polje, Zgornji Kašelj, Vevče, Kosovo polje, Majland on Tržaška cesta, Brdo, Vrhovci, Podutik, and Pržan.

CWWTP Ljubljana is a single-stage plant that uses physical and biological means to treat wastewater. It removes undissolved substances and carbon-based compounds and can also ensure nitrification. With the nominal capacity of 360,000 PE, CWWTP Ljubljana can treat between 80,000 and 100,000 cubic meters of wastewater per day, which substantially reduces pollution of Ljubljanica and Sava rivers and improves the quality of life for people living by both rivers. It also improves the quality of groundwater downriver from Ljubljana. Treated wastewater is the most important result of CWWTP Ljubljana operations. To ensure the efficiency of CWWTP Ljubljana, we continuously monitor and manage process parameters and regularly maintain the facilities, devices and equipment.

As it arrives to CWWTP Ljubljana, the wastewater from Ljubljana and its surroundings first undergoes mechanical treatment, followed by the biological treatment stage. During the first stage, stone trap and coarse and fine strainers are used to remove physical waste, larger than 6 millimeters. Oil skimmer and sand trap are then used to remove fats and sand. In total, this process removes approximately 1,200 tons of waste annually. During biological treatment, aeration tanks with the volume of 39,000 m^3 are pumped with compressed air and microorganisms in activated sludge decompose organic compounds that are dissolved in wastewater. During the next stage, settlers are used to separate

Right:
Stone trap

Far right:
Treated wastewater

activated sludge from treated water. Treated water is discharged into the river Ljubljanica. Part of the settled sludge is then returned to aeration tanks to ensure the required quantities of microorganisms, while excess sludge is further processed in digesters, where subsequent decomposition of organic substances in the sludge occurs.

From waste sludge to biodegradable waste

At the treatment plant, the waste sludge represents the largest share of total waste. With further procedures and appropriate treatment we turn it into dry, granular and sanitized waste in the form of pellets with the diameter of 2-4 millimeters, which is suitable for further use.

The goal of sludge treatment is to reduce the share of water in the sludge and to ensure its controlled decomposition. After gravity and mechanical thickening, sludge is then drained to digesters (total volume of 14,600 m^3). Here, the biological decomposition of organic substances takes place under anaerobic mesophilic conditions. This process is followed by mechanical dehydration of digested sludge by using a centrifuge and drying drum, until the share of dry matter exceeds 90 percent. On average, the process takes more than 25 days.

When organic matter decomposes in the digester, it produces biogas, which consists of methane and carbon dioxide, as well as hydrogen sulfide. Biogas is used in combination with natural gas as fuel to heat the sludge in digesters and to dry the sludge as it passes through the drying drum.

Far left:
A view of the sludge processing facilities

Left:
After treatment, waste sludge contains more than 90% of dry matter

The final product of the process is stable biodegradable waste, which is easy to transport and store due to its properties and volume. It is suitable as a complementary fuel in the industry. Annually, we produce approximately 8,000 tons of dewatered sludge.