D.T3.3.4 MARIBOR FUA-LEVEL STRATEGY ON INTEGRATED CIRCULAR URBAN WATER MANAGEMENT INCLUDING TARGETED ACTION PLAN

Subtitle

Version 1

12 2021

PREPARED BY

CONTENT

INTRODUCTION

Summary of chapters 1-5. The description of stage of local strategies on circular urban water management preparation covering vision creation, goal and objectives setting.

1. Determination of the territory covered by the strategy

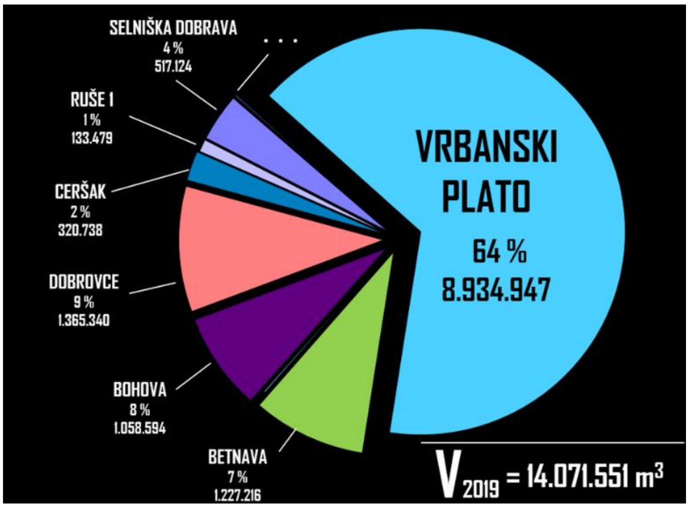

Figure 1: Shares of water resources in the system.

Water supply is not something that goes without saying. Mariborski vodovod, public company d.d. manages the water supply system, which supplies more than 166,000 users from 212 settlements from 16 municipalities in the northeastern part of Slovenia. With an annual volume of 14 million m3 of pumped water, Mariborski vodovod manages the largest water supply system in the country. The length of the main water supply pipeline in IOM alone is 595 km, supplying 103,352 (98.2%) IOM residents. The data refer to the situation in 2019.

According to the location of the pumping stations, the water supply system is divided into 16 water supply areas. Of these, 10 water sources after location of pumping stations and 6 catchments, these represent in the overall structure only 0.3% share or 38.8 thousand m3 of water and are intended for the supply of small completed systems supplied from these water sources prior to management by the company. The structure of catches includes larger catches; Areh catchment, Mariborska koča catchment and the capture of Pivola.

Compared to previous periods, today almost 30% less water is pumped into the network than 20 years ago. Most water was taken from water sources in the period from 1980 to 2000. After that year, we record a decline in water abstraction. In 2020, a total of 13.9 million m3 of water was pumped, which is almost 2% less than in the previous year. The largest aquatic source The Vrban plateau has 15 wells, where 67% of all pumped water is pumped into the system. 2020 was the most active pumping from well 9, where 11% of all pumped water was taken. This was followed by well 19 (9%) and well 18 (8%). 10% less water was taken from the wells in Betnava than last year, and 36% from the Bohova well less. In other water sources, the amount of pumped water remained at the level of the previous year or. there were no major ones changes. Among the catchments, the pumping from the Mariborska koča catchment increased the most, representing 21.8 % of all catchment waters

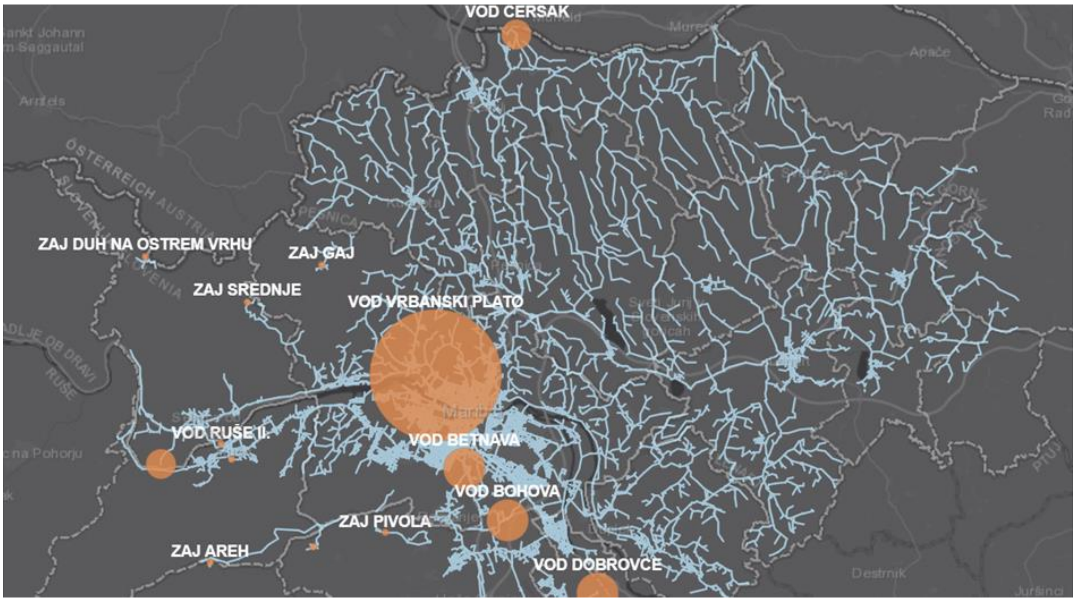

Figure 2: Water sources by amount of water pumped.

2. Stakeholder involvement

MBVOD’s stakeholders’ engagement strategy has followed the five-tier process from the start:

(i) gathering and sharing information,
(ii) dealing with concerns and grievances,
(iii) assessing the impact and importance of different stakeholder groups,
(iv) communicating back and forth through various methods, and
(v) building conclusions together.

2.1. The Municipality of Maribor

The territory of the Municipality of Maribor covers 147,5 km2 with population of 110.871 inhabitants, measured in 2018. In recent years, the Municipality of Maribor has proven that even a municipality burdened with a difficult economy and various other social challenges can successfully direct its development path towards a brighter future. Since 2014, MOM has been planning a comprehensive urban system that would include the integrated management of all waste and water generated in the region, based on a circular economy policy, efficient and sustainable use of energy and water, and the use of recycled waste and water as new resources. At the same time, the system would incorporate the fundamental principles of a collaborative economy with the involvement of civil society, which is being pursued by both the European Commission and the United Nations.

2.2. Nigrad – Sewage Management Utility Company

Water discharged in the sewage system is water which, after use or as a result of precipitation, is discharged into water directly or through sewage and appropriate treatment. Municipal wastewater is generated in households, public facilities, production and service activities, where the quality of wastewater is similar to domestic wastewater. Industrial wastewater is generated in industry, craft, economic, agricultural activities and after its generation is not similar to municipal wastewater, as it is polluted with various pollutants depending on the type of activity. Rainwater wastewater as a result of precipitation flows from paved surfaces or other material-covered surfaces directly into the water or is discharged into the public sewer. Publicly owned company Nigrad d.o.o. is responsible for management, operation and maintenance of the sewerage system. High seasonal precipitations can cause mixing of stormwater, rainwater and wastewater resulting in overflow of parts of the sewage system. Nigrad is actively trying to encourage citizens to reroute their stormwater and rainwater arising from their surfaces away from the sewage into private rainwater barrels or to ensure sinkholes intended to recharge the aquifers. As part of the public utility service, Nigrad performs drainage and treatment of municipal wastewater and rainwater, maintenance of sewerage network of all profiles, maintenance and management of treatment plants, penetration and cleaning of clogged sewer pipes of all profiles, pumping and removal of sewage sludge and small municipal sewage treatment plants all diameters and flow measurements.

2.3. Waste Water Treatment Company

Wastewater treatment is a process through which wastewater is treated to such an extent that it meets environmental and other quality standards. Wastewater treatment may include (depending on the required treatment standards) mechanical, chemical or biological processes and combinations thereof. The public service provider does not use chemicals or other aggressive substances to treat wastewater. In order to monitor the implementation of measures to reduce water pollution and achieve emission limit values, monitoring of this wastewater is necessary. Private company Aquasystem is responsible for wastewater treatment plant with capacity of 190.000 PE but is operating now at the capacity of 136.000.

Purified water is of good quality, which is confirmed by regular testing. Maribor's FUA currently has no return-pipeline system for reuse of purified wastewater, thus there are currently very limited possibilities for reusing it – purified wastewater currently flows into the Drava river.

2.4. Key CE Stakeholders

MBVOD has defined as key stakeholders several CE actors that were present at all stakeholder group meetings and have presented their vision of water circularity in cities. Mainly, the Institute Wcycle Maribor – Institute for Circular Economy (IWM) and the company Deltaplan, d.o.o., have been very active in presenting viable (and possibly feasible) options for targeted implementation that could bring about significant changes in circular water management. To implement circular economy in Maribor, five publicly owned companies, which are exclusively owned by the municipality of Maribor, established the Wcycle Maribor Institute (IWM) in April 2017. The IWM is the umbrella organization responsible for implementing projects arising from start-ups, citizens themselves or private entities. The presentation of the Wcycle Maribor project was carried out as part of the European Week of Cities and Regions in October 2016 in Brussels with the support of former European Commissioner dr. Janez Potočnik, and was presented to the citizens of Maribor in November 2016. The concept was then unanimously supported by the City Council, which in March 2017 blessed the further development and establishment of IWM. As of September 2021, IWM has been universally taken over and merged with the Regional Development Agency Podravje – Maribor, which has replaced IWM as the CWC stakeholder offering an even broader knowledge scope and wider reach in terms of their regional coverage of almost 40 municipalities.

3. Baseline assessment

3.1. Quality of Supplied Water

The compliance and safety of drinking water was ensured by the Maribor Waterworks in 2020 by implementing internal control according to the prepared HACCP plan or by controlling the processes from the abstraction of groundwater, its treatment (disinfection), pumping to the distribution of water to the taps of users. Compliance and safety of drinking water monitored at pumping stations and catchments, during distribution on the network (in water supply facilities) and at final users (mostly in primary schools and kindergartens and partly in catering facilities). According to the proclamation epidemic and the closure of most public facilities took place between 17 March and 1 July and from 26 October to 31 December, sampling of drinking water at hydrants closest to the collection points where usually takes samples.

Sampling and analysis of drinking water as part of internal control was performed by the National Laboratory for Health and the Environment and food (hereinafter NLZOH). In total, they were taken away during the implementation of internal control in 2020 2,164 samples for microbiological testing. A further 103 samples were taken for chemical testing. Same time 2,196 field measurements (temperature, redox potential, pH and electrical conductivity) were performed. Sampling and analysis of samples was also performed in the system of enrichment and active protection of the Vrbanski pumping station plateau, however, these results are not included in the present report as they do not represent the state of the water it distributes Maribor Waterworks to users (so-called "raw water"). They are also not included in the report samples taken smoothly even if the pumping station was not in operation (example: no results taken into account samples taken from the Ruše 2 well, as water from this well has not been pumped into the network since 2005 due to exceedances of pesticide limits; the samples taken at the pumping station are also not taken into account Bohova 2 after the pumping station was decommissioned on 25 June 2020).

According to the results of microbiological investigations, the NLZOH estimates that the Maribor Waterworks provided users with drinking water water that met the requirements of the Drinking Water Regulations, with the exception of individual samples at individual sites sampling.

Discrepancies in microbiological parameters in 2020 amount to 3.65%. The percentage of non-compliant samples is in lower than last year. The reduction in percentage is mainly due to sampling on hydrants and not on user taps. As we have repeatedly established (and proven), the cause of most discrepancies is inadequate condition of internal house installations (installation of unsuitable materials, inadequate maintenance or non-maintenance, water stagnation, etc.). Most samples were inconsistent due to indicator parameters or the presence of coliforms bacteria and a minority due to the increased total number of microorganisms at 37 ° C. The presence of Escherichia Coli was confirmed in 2 samples, and in 1 sample, in addition to Escherichia coli, the presence of enterococci was also confirmed. The presence of Clostridium perfringens was confirmed in 1 sample.

Due to the confirmed presence of Escherichia coli and enterococci, it was necessary to impose a measure once in 2020 compulsory boiling of water in the local system Srednje (Municipality of Maribor). There was water it is necessary to cook in this area from 15 June to 30 June. The measure of compulsory boiling of water was pronounced due to increased water turbidity and the consequent presence of microorganisms of fecal origin. The identified non-compliances can be attributed to the inadequate condition of water supply facilities, more precisely to the intrusion meteoric waters into catchments and consequently into the water supply system.

In its annual report for 2020, the NLZOH notes that the operator has taken appropriate measures to protect health drinking water users. The effectiveness of the measures was demonstrated by control samples at the same sampling points.

All control samples were in accordance with the provisions of the Rules on Drinking Water. Preventive disinfection of the entire drinking water supply system (including areas, as disinfection is not implemented) was carried out once in 2020, in the period from 13 May to 27 May 2020 and coincided with the release of measures following the declared epidemic.

The results of physico-chemical investigations show that they were taken from the entire system of the Maribor plumbing for various tests 103 samples. 1 discrepancy was recorded and that was a nonconforming sample that was taken at the Betnava 3 pumping station. This sample was non-compliant due to the limit value being exceeded pesticide bentazone. At the same time, samples were taken on the network. Only - they were compliant since the limit was exceeded values were not detected. From this we can conclude that the mentioned discrepancy did not affect the health of the users.

Results of microbiological and physico - chemical testing in the framework of internal control in 2020 confirm that the drinking water, with the exception of individual samples at certain sampling points, complies with the Rules about drinking water. Water sources that do not meet the required regulations have been eliminated not from the drinking water supply system. As can be seen in the conclusion of the Annual Report on the Health Adequacy of Drinking Water of the Maribor Waterworks, which made by NLZOH, drinking water is tested in all municipalities in accordance with the provisions of the Rules on Drinking Water. Z the implementation of internal control according to the principles of HACCP ensured safe and healthy drinking water.

3.2. State of the Water Supply Network

At the end of 2020, a total of 237 fractures and 599 interventions were recorded on the connecting lines in the water supply system network. The number of fractures decreased by 21% compared to the previous year, the number of interventions corrected to connecting lines increased by 37% compared to the previous year.

The highest number of fractures was recorded in the Municipality of Maribor (103), in the Municipality of Hoče - Slivnica (34) and in the Municipality Duplex (31). According to the length of the water supply network, they had the most breaks per 10 km of water supply network Municipality of Hoče - Slivnica (4.64), Municipality of Duplek (3.05), and the Municipality of Maribor (1.73); on average on the system 1.43.

According to the recorded data, the most fractures in PVC water pipes compared to the length of the network after individual types of material. The fewest fractures in terms of the length of the water supply network are on the pipelines from steel and cast iron.

A common reason for fractures is the increased pressure on critical sections due to the expansion of the water supply network. networks. The cause of water losses can also be attributed to the poor water supply network in the city center municipality of Maribor, where water seeps into groundwater and therefore it is difficult to determine the critical location of the pipeline, as on some sections the water pipelines were installed a hundred years ago and have long since expired. The Municipality of Maribor has 13.1 km of water supply network older than 100 years. The system covers 102 km or 6% of the entire water supply network, which is more than 50 years old. They are a priority all asbestos cement (AC) pipelines, the oldest thin-walled plastic pipelines and inadequate elasticity, where the problem of material aging is greatest, and other pipelines of inadequate characteristics (PVC, TPE, PC, SPE). PVC pipes of larger profiles are also critical because they are plastic and practical all larger than Fi 150.

Almost half of the water supply network (47%) has a diameter of between 50 and 100 mm. It is on this dimension of pipelines also 62% of all fractures. Older steel (JE) and cast iron pipelines (LZ) of larger ones are also a big problem profiles (above Fi 300), as they are the oldest from 1901 and would need to be replaced. The same goes for connectors and connecting water in this part. They record higher energy and water losses at the connections. According to the cause of fractures, 36% of all fractures can be attributed to the deterioration of pipelines.

<u>The main challenges in providing access to drinking water to all citizens of IOM and other municipalities that are part of the water supply system managed by the Public Company Mariborski vodovod are:</u>

1. Ensuring public supply of drinking water in sufficient quantity and quality to all residents.
2. Providing sufficient capacity (human resources) to repair and improve infrastructure.
3. Balanced investment of funds for regular maintenance, replacement and upgrading of infrastructure, which would also make a key contribution to reducing water losses.
4. Program and perform regular maintenance of wells to prevent sediment accumulation.
5. Increase users' confidence in the public supply of drinking water and find leverage to control the adequacy of internal installation systems.

3.3. State of Groundwater

The main source of drinking water in IOM is groundwater. In the future, increased pressure and greater variability of groundwater resources (water content, quality) are expected, which poses risks to water supply. The water body of the Drava Basin is statistically characterized by a negative trend (decrease) of groundwater level. The share of granted water rights in this area is between 75% and 100% depending on the available water quantities. Due to the current situation, a sufficient amount of water is provided in the area of the Vrban plateau due to the damming of the Drava River and the implementation of the first phase of active protection with artificial enrichment. However, due to constant pressures on groundwater (increased water consumption, reduced capacity of wells, more environmental interventions that could affect the direction of groundwater flow or groundwater pollution, etc.), there may be a lack of sufficient water in the future. . Due to the above, it is necessary to build II. active protection phase.

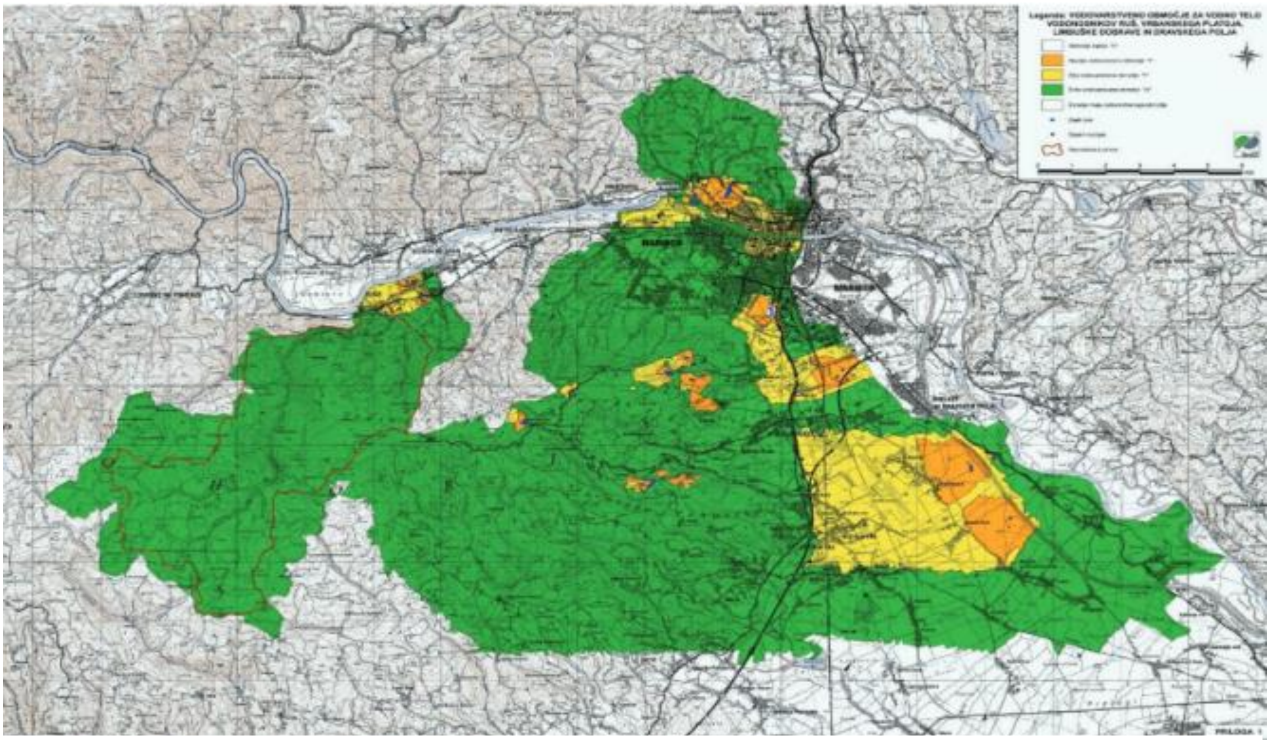

Figure 3: Pumping stations and water protection areas.

The Groundwater Regulation defines the procedure for determining the threshold value for groundwater quality, chemical and quantitative status parameters, groundwater quality standards, groundwater quality threshold values, conditions for good quantitative and chemical status, criteria for identifying and turning relevant and continuous increasing pollution trends, criteria for determining the load of groundwater body when it is necessary to start implementing measures due to the failure to achieve the objectives related to groundwater and additional requirements for the preparation of a program of measures for groundwater.

Groundwater as a source of drinking water in the IOM area and surrounding municipalities is especially protected by a decree defining water protection areas and water protection regime, namely the Decree on the water protection area for the water body of the Ruše aquifers, Vrbanski plateau, Limbuška dobrava and Dravsko polje.

The state of groundwater quality is implemented in the entire water protection area of the Maribor water supply pumping stations at 18 collection points. The state of groundwater is evaluated according to the Decree on the state of groundwater (Official Gazette of the Republic of Slovenia, Nos. 25/09, 68/12 and 66/16). For a more detailed presentation in this document, we chose the analysis of the groundwater status at the measuring point KP 2, which is located in the city center.

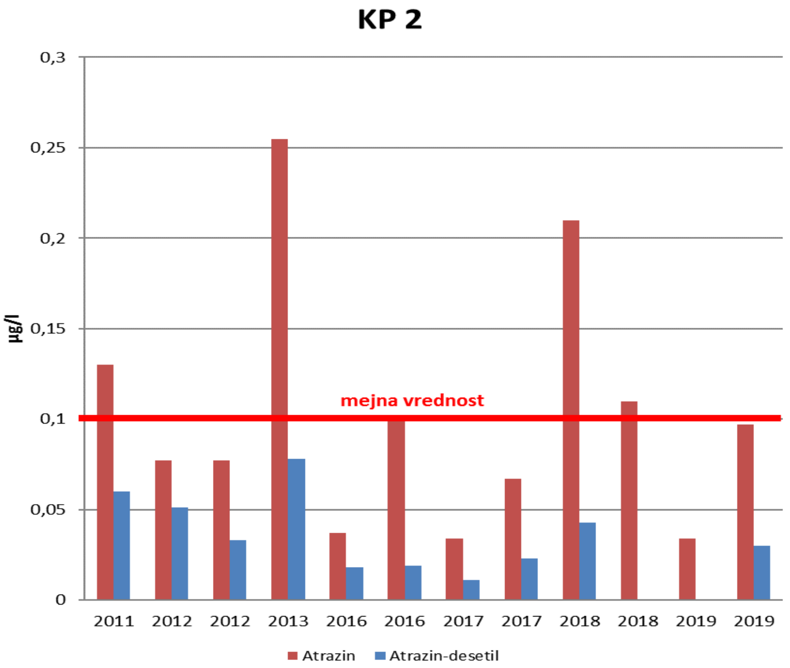

Figure 4: Content of atrazine and its degradation product (µg / l) at the KP-2 collection point in the years 2011-2019

Groundwater analyzes performed as part of immission monitoring in the IOM do not show significant deviations if we compare the values measured in 2019 with the previous year. With regard to the content of plant protection products (pesticides) in groundwater, a marked trend of decreasing concentrations is observed. Among the pesticides whose presence has been confirmed in groundwater, atrazine and its degradation product desethyl-atrazine occur in the largest cases. The limit value set by the Groundwater Regulation was not exceeded in any sample. Other pesticides (bentazone, metolachlor and its metabolites) were found only at certain measuring points and only in individual years. At the KP 2 measuring point, in the measurement period from 2011 to 2019, the largest fluctuations in the concentrations of atrazine and desethylatrazine were observed in comparison with other measuring points. In 2019, the limit value of 0.1 µg / l was not exceeded.

Significant fluctuations are observed in chloride values, which have ranged between 27 and 130 mg / l in the last 6 years. Fluctuations in chloride concentrations occur due to environmental influences (impact of wastewater, winter salting of roads). Considering the location of the KP-2 collection point, we find that the impact of settlements and asphalted areas is particularly pronounced here. The limit value for nitrates 50 mg / l was not exceeded. However, a marked trend of declining or increasing nitrates is not observed.

The monitoring of more modern pollutants, such as residues of pharmacologically active substances (FAS) and perfluorinated substances, etc., is becoming an increasingly established approach for monitoring groundwater quality. Due to its persistence in nature, it is estimated that the trend in concentrations will increase over the years, so more and more attention will need to be paid to this.

The narrower area of the city of Maribor is characterized by a marked change in the composition of groundwater. Groundwater in the city center is highly mineralized, and the share of sodium and chloride in the mineral composition itself is increased. The first reason for this is the built-up and asphalted surfaces, resulting in less groundwater supply with rainwater. Another reason is the salting of asphalt surfaces. Sodium and chloride concentrations fluctuate considerably throughout the year.

In any case, the main challenges in ensuring the continuous quality of groundwater are:

1. Reducing the use and intrusion of pollutants into groundwater.
2. Special emphasis should be placed on the implementation of green infrastructure solutions among the existing grey infrastructure to ensure rainwater drainage.
3. Promoting organic farming to prevent leaching of nitrates and pesticides into the soil.
4. Reduction of pharmacologically active substances (drug residues as waste) in wastewater.
5. Supplementing the results from national monitoring with data and results from immission monitoring of the local community.
6. Informing and raising awareness of the population about what is being drained into the municipal system and what is not.

3.4. State of Surface Waters

The Drava River and its tributaries are key surface water bodies of the IOM. Tributaries and the Drava River play an important role in groundwater recharge, so their quality and share of infiltration are very important. A good chemical standard has been established for most water bodies in Slovenia, including the Podravina water bodies. However, problematic mercury content in excess of environmental standards has been detected in most of these water bodies. Exceedances are due to diffuse sources of immissions (chemicals, consumer goods, fossil fuels). The ARSO assesses the ecological condition of the Drava River between Maribor and Ptuj as good. However, in the Drava river basin more than half of the water bodies do not achieve good ecological status. The leading reasons for this are hydromorphological alteration and general degradation together with nutrient loading from intensive farming.

In the IOM area, general parameters of water pollution are monitored, such as: undissolved substances, nitrogen compounds, oxygen conditions, organic matter load and total phosphorus. The latest report on the state of the environment states that phosphorus loads stand out in the case of surface water pollution, which indicates the burden of municipal wastewater. Prevention of direct discharges of wastewater into surface waters is one of the measures that would certainly improve the chemical and microbiological condition (Vinarski potok, Radvanjski potok and the Drava river). Vinarski and Polanski potok are the busiest. Recent analyzes also show an excessive load of surface water with ammonia, which indicates the pollution of surface water from wastewater, agriculture (livestock and fertilizers) and other pollutants, such as leaching of water from gray infrastructure, inflows of industrial water, etc. It is characteristic of the Drava River that the number of faecal bacteria in the Maribor area is significantly increasing. The Drava River is exposed to hydromorphological pressures due to the use of water energy, and changes are also caused by flood defenses.

Therefore, the main challenges for improving surface water status are the following:

1. Identifying the causes of the presence of individual pollutants in water.
2. Ensuring sustainable maintenance of water and coastal lands.

3. Minimization of discharges of untreated wastewater into surface water bodies.

3.5. State of Wastewater

Drainage and treatment of wastewater in IOM is performed by Nigrad, a utility company, d.o.o. and the company Aquasystems d.o.o. 94% of MOM wastewater is treated at the central treatment plant. In IOM, the sewerage system is managed by a concessionaire owned by the municipality, i.e. Nigrad. In the area of MOM Nigrad operates 485,284 m of sewerage network, 3323 pumping facilities, 61 major unloaders and 35 pumping stations. As part of the concession, Nigrad discharges municipal wastewater and stormwater, maintains sewerage network of all profiles, maintains and manages sewage treatment plants, penetrates and cleans clogged sewage pipes of all profiles, pumps and removes sludge from septic tanks and small municipal sewage treatment plants, removes sewage pipes of all diameters. and flow measurements.

More than 60% of the IOM area is located in a water protection area, which means that the regulation of wastewater disposal in these areas is a priority. The Rules on the Discharge and Treatment of Municipal Waste and Rainwater set out the requirements for the provision of services of the obligatory local public utility service for the discharge and treatment of waste and rainwater. Sewerage system maintenance is one of the activities of Nigrad d. d., and the operator of the central treatment plant is the company Aquasystems d.o.o. Analyzes of treated water at the outlet show that in 2004-2019 all outflow parameters were in accordance with the requirements of the environmental permit. In the period from 2007 to 2016, several events were detected when wastewater was at the inflow of the WWTP due to unpredictable extraordinary pollution of inadequate quality (fuels, acids, detergents, extraordinary sudden amount of mechanical waste).

Drainage of rainwater from public areas and drainage and treatment of rainwater discharged into public sewers from roofs, if it is not possible to ensure compliance with the regulation governing the emission of substances and heat when discharging wastewater into water and public sewerage is a service of a public service provider. This service is not charged, but is listed on the monthly statements of the public drainage service provider only as a status notification, while on the back it informs users about the drainage rules by arranging the drainage in accordance with the rules, i.e. exclusion from the public sewerage system. Nigrad is carrying out activities related to the elimination of rainwater from the public sewerage system because climate change is causing torrential rains of greater intensity than anticipated in sewerage planning. Abundant rainwater in the sewer causes many inconveniences, such as. flooding of facilities, inability to discharge wastewater to treatment systems and significantly stronger abrasion of the network. This is a serious issue, which is regulated in the Slovenian legal system by legal and executive regulations in the field of emissions of substances in wastewater disposal and by-laws in the field of public environmental protection services. The Decree on the Drainage and Treatment of Municipal Wastewater stipulates that the planning, construction, reconstruction or maintenance of facilities in the agglomeration must ensure that measures are planned and implemented to reduce the amount of rainwater discharged into public sewers. Article 17 of the Decree on the Emission of Substances and Heat in the Discharge of Wastewater into Water and Public Sewerage also regulates this issue, which states that the owner of the facility must discharge rainwater from the roof directly or indirectly into the water when this is technically feasible, unless it uses this water as an additional source of water for purposes where there is no need to ensure drinking water quality (eg rinsing, washing, watering). Smooth flow of wastewater disposal or. Adequate sewage flow can be ensured in strict compliance with all regulations, so it is necessary to remove rainwater from the sewer system and thus contribute to normal operation.

We should also not overlook the measures provided for in Article 87 of the Real Property Code (Official Gazette of the Republic of Slovenia, Nos. 87/02 and 91/13) regarding the use of meteoric waters, where the provision on meteoric water applies, namely: Drainage of meteor showers: "The owner of the property must do everything necessary to prevent meteor showers from draining from his building or falling on foreign property." Economic public infrastructure, ie public sewerage, is undoubtedly foreign property owned by the public sewerage service leased from the IOM, so it is correct that rainwater does not flow into the public sewerage system.

In the IOM area, a mixed sewer system is mostly built, which means that Relieved rainwater is discharged through unloaders into streams and then into the Drava, while wastewater is led through the main reservoirs to the central treatment plant in Dogoše. Due to the dilapidation of unloaders or their undersizedness according to today's needs, polluted waters often overflow and pollute streams or. arresters. An example of such an environmental burden is present in the area of Radvanje and the area of Stražuna. Along the Stražunski channel / stream, e.g. there are as many as 11 relief facilities that no longer meet the requirements of the sewerage network, as they are undersized in relation to rainwater inflows. Due to the increased amount of rainwater and waste meteoric water, which additionally burden the unloaders, polluted water often overflows and pollutes the canal / stream.

<u>In the field of wastewater disposal, two main challenges arise, namely:</u>

1. Ensuring separate drainage of meteor and municipal wastewater to avoid overloading the sewerage network.
2. Improving municipal infrastructure (sewerage system) to avoid wastewater runoff into surface or groundwater.

3.6. Climate Change and Water Resources

The key water sources of public water supply in the IOM area are the Vrban plateau, Betnava, Bohova and Dobrovce. All these water sources are affected by the Drava River, hinterland waters from the peripheral hills and Pohorje, and the share of precipitation that falls in the catchment area and can infiltrate the subsoil. All elements of this water balance may be affected by climate change.

The aquifer of the Vrban plateau is largely dependent on the dammed Drava River in the city area. The inflow of backwaters and rainwater has been estimated, but has not yet been analyzed in detail. Artificial groundwater enrichment, the dammed Drava River and a relatively deep aquifer give the Vrban Plateau a certain stability in the face of climate change. However, it is necessary to be aware that the pumping infrastructure is installed at a certain height and it is not easy to change it quickly if necessary. In this area, it is important to maintain the infrastructure and regularly monitor trends in the aquifer and the Drava River in order to ensure possible timely technological adaptation of the pumping station. The pumping stations in the northern area of the Drava plain (Betnava, Bohova, Dobrovce) mainly depend on the inflow of hinterland waters from the Pohorje area and the precipitation in the catchment area. Thus, due to the reduction of this type of water balance, they are significantly more vulnerable to climate change.

In Maribor, we are recording a declining trend in the average annual precipitation. As the temperature rises, the potential for evapotranspiration (evaporation) increases. Due to sub-Pannonian climate characteristics, the difference between precipitation and potential evapotranspiration is greater in Maribor than in central Slovenia. During the months, all but December record negative water balance trends (the ratio of water inflow, evaporation and water outflow in a given area at a given time). The figure below shows the declining trend of the water balance in the Maribor area since the time of instrumental measurements, which also affects the situation in groundwater.

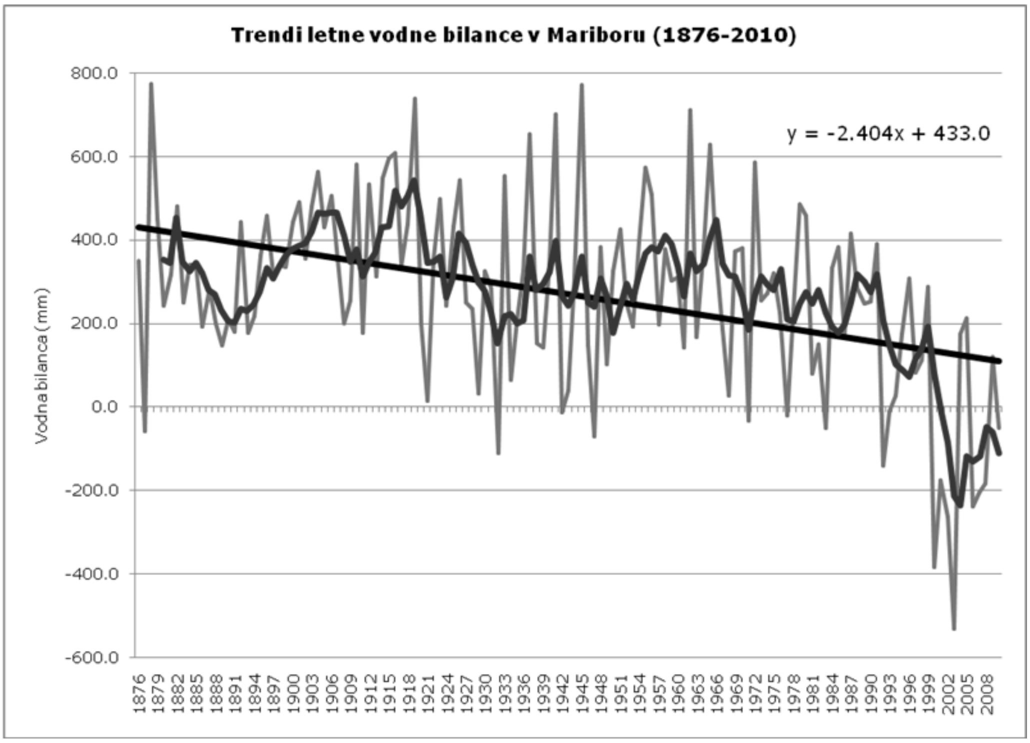

Figure 5: Trends in annual water balance in Maribor (1876-2010)

3.7. Key Challenges

- → Ensuring public supply of drinking water in sufficient quantity and appropriate quality to all residents.
- → Balanced investment of funds for regular maintenance, replacement and upgrading of infrastructure (water supply, sewerage).
- → Regular maintenance of wells.
- → Ensuring separate drainage of meteoric and municipal wastewater in order to avoid overloading the sewerage network (construction of a smart sewerage system).
- → Reducing the intrusion of pollutants into groundwater.
- → Determining the causes of the presence of individual pollutants in water.
- → Reduction of pharmacologically active substances (drug residues as waste) in wastewater.
- → Implementation of green infrastructure solutions among the existing gray infrastructure to ensure direct rainwater drainage.
- → Use of ecoremediation for sustainable restoration and protection of water protection areas.
- → Ensuring sustainable maintenance of water and coastal lands.
- → Informing and raising awareness of the population (promoting organic farming, using rainwater instead of drinking water, etc.).

3.8. Determined Potentials

3.8.1. Qualitative and spatial (location) identification of rainwater measures and investments

Identification of rainwater measures and investments for utilizations of potentials related to rainwater management:

- harvesting
- infiltration
- retention
- green roofs/facades
- evaporation
- landscape irrigation
- reuse in the households
- Non potable urban use (fire protection and air conditioning)
- Recreational/environmental uses (lakes and ponds, fisheries and snowmaking).

3.8.2. Assessment of potentials for improvement of existing knowledge, management and governance of rainwater management in Maribor FUA

Already in 2018, the Municipality of Maribor has adopted in an intensive co-creative process with all relevant stakeholders the Strategy for Transition of the City of Maribor into Circular Economy, where the chapter on water reuse and use of rainwater sets forth specific ambitions to be achieved by the FUA, the citizens and public utility companies in terms of partially replacing drinking water with rainwater and/or recycled wastewater. Moreover, in 2021, the Municipal Environmental Protection Plan of the Municipality of Maribor 2021 – 2030 is being adopted addressing circular water management as one of the key priorities in the city by 2030.

Therefore, the Municipality of Maribor, together with MBVOD, is concentrating its resources in order to try to explore the possibilities of implementing a distribution system for recycled water in the city with a view to later implementation. As systemic implementation is currently not economically feasible due to the abundance of fresh water, representatives of the above organizations are working with local, national, international and European institutions to prepare the necessary documents to provide appropriate incentives on the demand side.

3.8.3. Identification of potential FUA locations and description of needed rainwater MEASURES/ INVESTMENTS to improve utilization of rainwater in the FUA area

Proven water retention measures in urban areas include collecting rainwater (collecting rainwater from roofs, car parks, etc.) that brings many advantages, such as reducing strong rainfall effects and contributes to water conservation. Therefore, Maribor has chosen three different types of locations/buildings/neighbourhood, where the implementation of rainwater collection measures would be most easily implemented due to the nature of existing infrastructure already available in the areas considered.

1. Large levelled roofs of shopping centres and industrial complexes.

Figure 6: Potential for rainwater catchments on existing green roofs in Maribor. Number 1: Melje industrial zone. Number 2: Europark shopping center and University Clinical Hospital Maribor. Number 3: Tezno industrial zone and Leclerc/Rutar/Bauhaus shopping area. Number 4: Studenci industrial zone

2. Residential areas with large block-of-flats complexes with levelled roofs.

Figure 7: Examples: Regentova and adjacent streets (left), Goriška and adjacent streets (right).

3. Tabor Hall for sport events and concerts with large adjacent parking areas and the adjacent Ice Hall, which could also use the rainwater if properly collected and pre-treated.

3.8.4. Qualitative and spatial (location) identification of wastewater measures and investments

Identification of wastewater measures and investments for utilizations of potentials related to wastewater management:

- Treated wastewater in agriculture (crop irrigation, commercial nurseries)
- Treated wastewater in industry (cooling, boiler feed, process water, heavy construction)
- Groundwater recharge (ground water replenishment, salt water intrusion control)

3.8.5. Assessment of potentials for improvement of existing knowledge, management and governance of wastewater management

As noted, the Municipality of Maribor is following the city's Strategy for Transition of the City of Maribor into Circular Economy, where circular water management is noted as one of the key priorities in the city by the year 2030. Public service providers and municipality have to work together with stakeholders and local, national, international and European institutions to prepare the necessary documents to provide appropriate incentives on the demand side and to promote the safe use of recycled water.

3.8.6. Identification of potential FUA locations and description of needed wastewater measures/ investments to improve utilization of wastewater

Lack of water affects a third of the territory of the EU throughout the year. Although water scarcity is more pronounced in southern Europe, it is becoming increasingly important in other parts of the Union. Excessive water abstraction is one of the main threats to the EU's aquatic environment, not only in arid regions, but also in parts of Europe with high water levels. In addition, the sewerage networks in many countries are in a rather poor condition and the increasing number of extreme rainfalls, induced by climate change, often causes damage in the urban environment and groundwater pollution. The expansion of cities makes a major contribution to increasing the consumption of resources, such as, among other things, the consumption of water. This requires the adoption of water-saving measures to a much greater extent than current practices indicate.

Therefore, in 2018, Maribor has adopted The Strategy for the Transition to Circular Economy in the Municipality of Maribor with a special chapter dedicated to the reuse of recycled water and alternative water resources, thus establishing the framework for becoming a water smart city. Smart water economy and society should manage all available aquatic resources (*including water on the surface, underground water, wastewater and purified water*) in order to avoid water scarcity and pollution, increase resistance to climate change, manage water related risks appropriately and ensure that all useful substances, which can be obtained from waste water treatment processes or are integrated into water courses, are obtained. In a circular economy water reuse plays a key role, which brings significant environmental, social and economic benefits.

As systemic implementation in Maribor is currently not economically feasible due to the abundance of fresh water, representatives of different municipal organisations and utility companies have designed a future potential wastewater reuse system that would also ensure that wastewater would replace currently used fresh water for large consumers. The designed distribution system of recycled urban water is based on the idea of maximum reuse (*of over 7.0 million m3*) of purified and discarded water at the Central Wastewater Treatment Plant in at least 6 existing urban industrial zones, 4 central planned urban depots (urban gardens, urban greenhouses, energy planting zones, snowmaking) and an unspecified number of other potential large users, such as municipal transport company Marprom for their bus washing activities, municipal utility company for road cleaning and maintenance Nigrad, Magna car factory, ERM Airport.

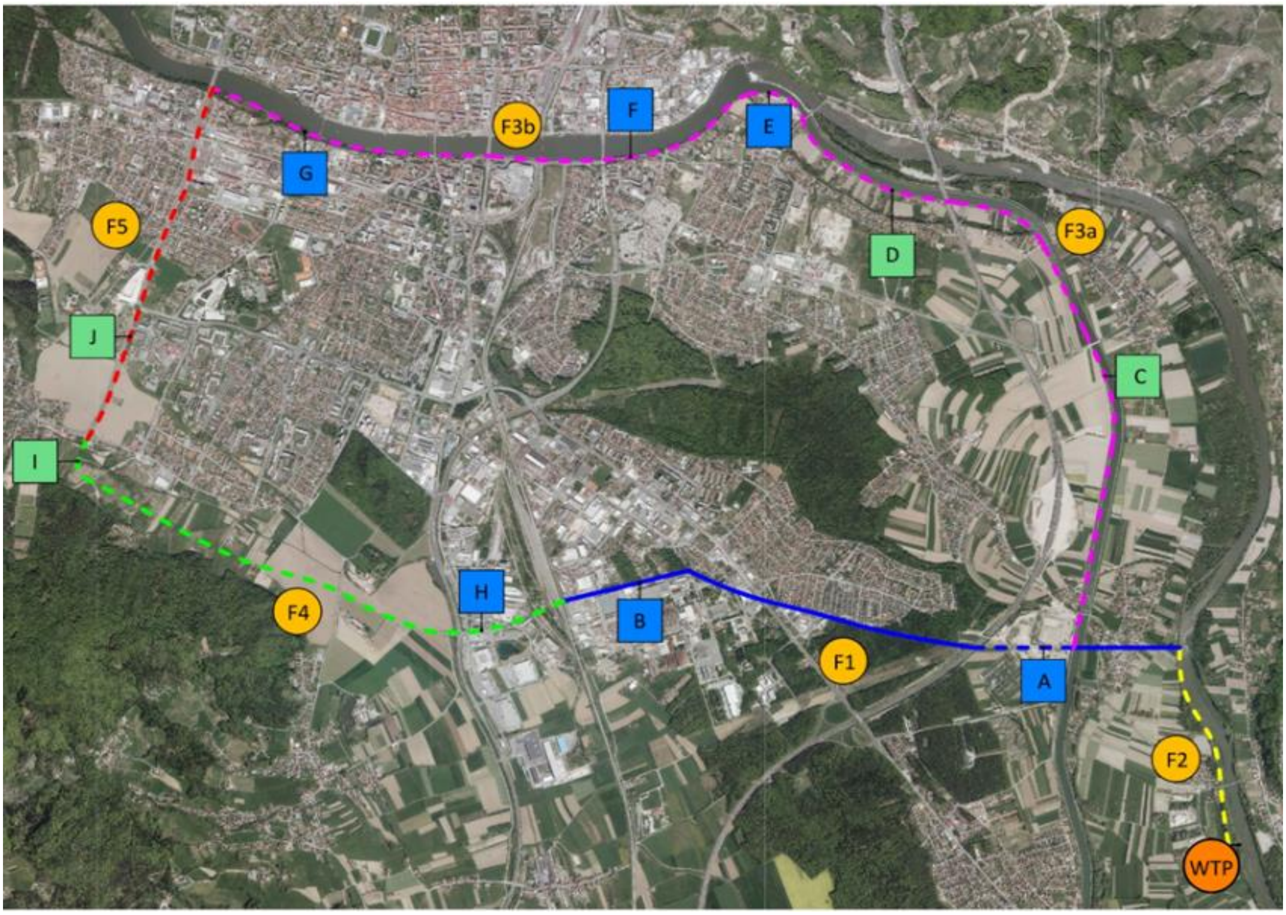

Figure 8: Ideated design of supply system with large users for reclaimed water distribution

4. Vision

The VISION of Maribor's FUA is focusing on particular stakeholders to promote reusing of purified wastewater within its own household or industrial process, encouraging the use of rainwater and stormwater to replace fresh water used for non-potable use, and to provide sustainable water supply and maintain and even increase the quality of water sources. In an intensive co-creation process, MBVOD and stakeholders have envisaged the following goals for integrated CUW management in Maribor FUA.

4.1. General Goals of the Vision

General Goal 1: Accessible (available) and sufficient quantities of healthy drinking water for every citizen for potable use.

General Goal 2: Protection of water resources against pollution and excessive use and elimination of water losses from (dilapidated parts) of the water supply network.

General Goal 3: Water is never waste.

General Goal 4: Elimination or remediation of existing sources of groundwater pollution (large 'point' sources and many diffuse small sources of pollution).

General Goal 5: Providing sufficient groundwater levels even during dry years / periods.

General Goal 6: Continuous monitoring of the chemical and quantitative status of groundwater.

General Goal 7: Protection and conservation of groundwater as a source of drinking water.

General Goal 8: Implementation of anti-flood measures where flood events have been recorded in recent decades or it is clear from the flood maps that these are flood risk areas.

General Goal 9: Introduction of new standards in the field of urban infrastructure: integration of green solutions and sustainable solutions (water retention measures, nature-based solutions) to increase climate and ecosystem resilience.

General Goal 10: Prevention of run-off of untreated municipal wastewater and other types of polluted water into watercourses and existing surface waters.

General Goal 11: Creating conditions for good chemical and ecological condition of surface waters, so that they will be full of life, cleaned of micro pollutants, properly re-natured, able to perform ecological functions and ecosystem services.

General Goal 12: Waters, rivers, streams, lakes and ponds are valuable habitats!

General Goal 13: Promoting the system of water reuse: slightly polluted sanitary water (greywater) in households. rainwater can be used for watering gardens, washing cars, etc.

General Goal 14: Targeted orientation - water should stay (cycle) in the systems (natural/technical) for as long as possible and finally enter the ecosystems as clean as possible.

General Goal 15: Rainwater & Stormwater capture and release: rainwater and stormwater can be used for watering gardens, washing cars, road cleaning etc.

4.2. Defining Potentials for Rainwater and Wastewater Utilization

Presentation of current state of the art utilization of rainwater and wastewater in accordance with project goals:

- ✓ Recycle and reuse wastewater
- ✓ Increase efficiency in water use and distribution
- ✓ Guarantee good quality of water bodies
- ✓ Retain water as long as possible on site
- ✓ Promote multiple water use and water sustainability
- ✓ Preserve flow in water bodies

<u>And four main areas of intervention:</u>

Water Governance

Water efficiency & water loss reduction

Rainwater management

Grey water recycling

4.3. Realizing the Potentials of Rainwater Use (SWOT and PESTLE)

STRENGTHS	OPPORTUNITIES
• Reduction of the consumption of main water and the associated cost. • Reduction of the exploitation costs of water supply systems. • Reduction of the rainwater volume launched in wastewater and rainwater system, contributing to control the floods, the efficiency of WWTP and the discharge of water potentially polluted in receiving environment. • Decrease of the groundwater reserves dependence which exhaust when super-exploited. • Citizens' awareness about using rainwater for watering and to de-burden the sewage system is increasing.	• Technological innovations have been reducing the investment cost. • The market of rainwater harvesting has been increasing and a greater number of solutions are available. • In the context of climate change, the water availability decreasing reinforces, if not forces the need of this type of system. • Filling the regulatory gap that would increase the rainwater harvesting and use.
WEEKNESSES	**THREATS**
• Limitation of harvested rainwater quantity in the tank due to the temporal variability of the precipitation. • The system can implicate a significant initial investment. • Absence of national legislation that specifically regulates the rainwater harvesting. • Absence of local regulation that would financially penalise citizens that discharge the rainwater from their property into the municipal sewage system.	• General abundance of water in the area. • Moderately priced fresh water from the municipal water supply system. • If the solutions do not have a recognized quality and are not promoted as such, it can lead to loss of interest in the use of rainwater systems. • Lack of people information can lead to the no acceptance of this technique. • The concentration and the intensification of precipitation phenomena will require a greater transport capacity from catchment surface to the tank and a larger tank volume to face the dry periods which tend to be drier.

POLITICAL ISSUES	ECONOMIC ISSUES
• The level of administrative obstacles associated with the implementation of more demanding rainwater management systems (spatial limitations, longevity of the approval processes). • The promotion of sustainable solution applications for the drainage infrastructure by the local government. • Lack of coherent strategy for implementing rainwater management on city level. • Lack of coherent strategy for the implementation of sustainable development principles.	• Low level of recognition of benefits associated with the application of drainage infrastructure facilities. • High investment costs renovating and establishing new parts of the rainwater management and discharge systems. • Low level of investment expenditure for the construction of drainage systems. • Low level of subsidies for the construction of drainage systems.
SOCIAL ISSUES	**TECHNOLOGICAL ISSUES**
• The readiness for cooperation between groups of different participants in the decision-making process associated with investing in a drainage system model. • The level of awareness concerning the use of sustainable drainage systems. • The residents' safety level, which can be ensured thanks to the use of drainage infrastructure. • The level of social losses. • The susceptibility of the society to use innovative water management solutions.	• Ensuring enough capacity in the sustainable rainwater management systems. • The reliability of used drainage systems and the required maintenance frequency. • The level of experience in the operation of sustainable rainwater management systems. • The level of hydraulic overload of existing drainage systems.
LEGAL ISSUES	**ENVIRONMENTAL ISSUES**
• The preferences concerning the use of sustainable technologies in the field of public procurement. • The scope of regulations in the field of cooperation between local governments, industrial and scientific centres. • The cohesion and stability of legal provisions concerning rainwater management. • The range of requirements in applicable land development plans. • The scope of requirements in the field of drainage infrastructure impact on the environment.	• The level of legal protection of the environment and natural resources. • The level of capacity of drainage systems to supply underground water resources and an increase of biodiversity in urban areas. • The scale of how the drainage infrastructure impacts the environment. • The quality of rainwater, the water of the receiving reservoir and the drained area.

4.4. Realizing the Potentials of Wastewater Use (SWOT and PESTLE)

STRENGTHS	OPPORTUNITIES

• Even in periods of droughts, there is a supply of treated wastewater. • By reusing water, it reduces pressure on groundwater and surface water resources in the region. • The water quality of effluent water of the WWTP stays constant (predictable). • The knowledge and technology for further treatment of this water source to reach the set quality parameters is available. • Using reclaimed water during droughts decreases nitrate leaching. Less N and P from effluent in water streams.	• Demand of agricultural sector for the use of reclaimed water can lead to economies of scale. • The development of new and cheap technologies might enhance the cost-effectiveness and implementation. • EU regulation on reuse of water for irrigation offers framework for the use of reclaimed water in agriculture. • Increased drought occurrence will affect the urgency for reclaimed water sources.
WEEKNESSES	**THREATS**
• The price of the "classic" water resources is still very cheap, while the cost of treated wastewater is expensive (considering extra treatment, transport, storage, ...). • No distribution net available for water reuse (the cost of distribution network is expensive). • The legal framework restricts use of this water source or sets the same standards as for potable water although not used for drinking. • The use of reclaimed water will reduce the discharges in rivers and affecting the ecology. Risk for soil contamination with heavy metals. High energy consumption to deliver water resource.	• Weak interest to use reclaimed water. • Weak interest to provide reclaimed water. • Weak interest to distribute reclaimed water. • Uncertainty about effective treatment of emerging contaminants: nanoparticles, antibiotics, micro-plastic. • No integrated vision to implement this practice and fragmented policy.

POLITICAL ISSUES	ECONOMIC ISSUES
• Lack of unified standards. • Lack of political will to adopt appropriate enabling legislation. • Lack of political vision and supporting policies. • No strategical water priority plans. • Governance as bottleneck for implementation due to lack of knowledge.	• High investment costs to ensure ample treatment process. • Higher price of reclaimed wastewater in comparison with natural water sources. • Lack of market demand. • High investment costs to construct a reclaimed wastewater supply system.
SOCIAL ISSUES	**TECHNOLOGICAL ISSUES**
• Lack of trust in reclaimed wastewater. • Lack of public concern that would drive the demand and subsequent implementation. • Lack of education that would ensure trust in reclaimed wastewater. • Non-preparedness to pay additional/higher costs. • The use of reclaimed water might present a risk towards public health.	• Variable quality of reclaimed wastewater. • Lack of “alternative” water resource distribution system. • Question of the treatment intensity and technology assurance for technologies that needs to be implemented in order to achieve quality standards. • Large energy consumption for most of the available technologies.

LEGAL ISSUES	ENVIRONMENTAL ISSUES
• Lack of national standards for wastewater reuse. • Lack of legal distinction between different use purposes related to different quality demands. • Lack of supportive pricing policies that would render using drinking water more expensive than reclaimed wastewater.	• The use of reclaimed water might present a risk towards soil contamination. • Lack of knowledge on the content of emerging contaminants in reclaimed water. • High energy consumption to treat and deliver water resource. • The use of reclaimed water will reduce the levels of recharging the aquifers.

5. Action Plan

Action 1: PREPARATION OF A STRATEGY FOR SUSTAINABLE WATER RESOURCES MANAGEMENT AND PROTECTION OF WATER RESOURCES	
Related Objective and background (challenge)	Objective 1: Decreasing Water Loses and Improving the Management of Water Resources
Description of the Action	The Strategy for Sustainable Water Resources Management is the core document necessary for Maribor and Maribor’s FUA to coherently address in an integrated manner al the particularities of water resources management (surface waters, groundwater, freshwater pumping locations).
Expected result	All-encompassing strategy that will provide the operational programme with measures, responsibilities and costs to achieve the optimal sustainable water resources management in Maribor’s FUA.
Responsible institution/s, organizations for implementation of the Action	JOINT INTER-MUNICIPAL ENVIRONMENTAL PROTECTION SERVICE
Other partner organization that needs to be involved	MUNICIPALITY OF MARIBOR, MBVOD, OTHER MUNICIPALITIES
Time scale	2022
Estimated costs and resources needed	Own resources
Target indicator	1 Strategy for Sustainable Water Resources Management

Action 2: IMPLEMENTATION OF THE PROGRAM OF CONSTRUCTION AND RECONSTRUCTION OF THE WATER SUPPLY NETWORK	
Related Objective and background (challenge)	Objective 1: Decreasing Water Loses and Improving the Management of Water Resources
Description of the Action	Implementation of the program of construction and reconstruction of the water supply network within the multi-year development plans will provide new and renovated water supply infrastructure.
Expected result	Decreased water loses, decrease events of breaks and leaks in the water supply system, increase the quality and stability of water supply.
Responsible institution/s, organizations for implementation of the Action	MUNICIPALITY OF MARIBOR
Other partner organization that needs to be involved	MBVOD, OTHER MUNICIPALITIES
Time scale	2025
Estimated costs and resources	5,5 million €

needed	
Target indicator	Investment program fully implemented.

Action 3: COORDINATION ACTION REGARDING THE MAINTENANCE OF WATER BODIES	
Related Objective and background (challenge)	Objective 1: Decreasing Water Loses and Improving the Management of Water Resources
Description of the Action	Management of water bodies in the river Drava basin is divided between the local communities, the city of Maribor being the largest, alongside the river and its riparian areas, between nationally publicly owned Drava Hydropower Plants Maribor company with regard to areas surrounding HPPs, and between the Slovenian Water Agency and its concession holder for management of the river Drava basin – the company VGP Drava. A targeted coordination action between the aforementioned stakeholders is necessary to symbiotically unify their various water basin management activities to achieve optimal results.
Expected result	A cohesive management approach for the Drava river basin contributing to surface and groundwater quality and to decrease the negative impacts of climate change (flooding) on people, nature and property.
Responsible institution/s, organizations for implementation of the Action	MUNICIPALITY OF MARIBOR
Other partner organization that needs to be involved	SLOVENIAN WATER AGENCY, DRAVA HYDROPOWER PLANTS MARIBOR, VGP DRAVA, OTHER RIPARIAN MUNICIPALITIES
Time scale	Continuous
Estimated costs and resources needed	170.000 € / year
Target indicator	Coordination Action Group with dedicated Integrated River Drava Basin Management Plan

Action 4: BEST-CASE PILOT FOR RAINWATER USE FOR URBAN GARDENING	
Related Objective and background (challenge)	Objective 2: Increasing Rainwater Use
Description of the Action	An on-site real-life pilot demonstration will be carried out to show how to capture and use rainwater for watering urban gardens at one location in Maribor (approx. 12.000 m^2 in size).
Expected result	Providing infrastructure and know-how to implement the demonstration pilot, actually providing rainwater to water approx. 12.000m^2 of urban gardens, demonstrating to citizens how-to and encouraging DIY (do-it-yourself).
Responsible institution/s,	MUNICIPALITY OF MARIBOR

organizations for implementation of the Action	
Other partner organization that needs to be involved	Citizens involved in urban gardening at demo location.
Time scale	2022
Estimated costs and resources needed	7.500 €
Target indicator	Demo pilot for rainwater capture and use for urban gardening.

Action 5: MUNICIPAL DECREE FOR SPECIAL DUTIES FOR DISCHARGING RAINWATER AND STORMWATER INTO THE SEWAGE SYSTEM	
Related Objective and background (challenge)	Objective 2: Increasing Rainwater Use Objective 3: Improving Water Use Efficiency
Description of the Action	Large amounts of rainwater and stormwater that are flowing from soil-sealed private surfaces present great pressure on public sewage system, especially in times of high precipitation, causing flash floods, and overflow of sewage water mixed with rainwater further pollutes groundwater, surface water and green (also agricultural) surfaces. Thus, regulatory measures must be taken in order to encourage private individuals and companies owning real-estate that causes such spillage of rainwater into sewage to act swiftly and ensure sinkage of rainwater into the ground.
Expected result	Decreased inflow of rainwater and stormwater from private soil-sealed real-estate and increase in resources from duties to be dedicated to improve sewage system.
Responsible institution/s, organizations for implementation of the Action	MUNICIPALITY OF MARIBOR
Other partner organization that needs to be involved	JOINT INTER-MUNICIPAL ENVIRONMENTAL PROTECTION SERVICE
Time scale	2023
Estimated costs and resources needed	Own resources
Target indicator	1 Municipal Decree

Action 6: SYSTEMIC STUDY OF POTENTIALS OF RECYCLED WASTEWATER USE	
Related Objective and background (challenge)	Objective 4: Increasing the Use of Recycled Wastewater
Description of the Action	Since the city of Maribor does not have a secondary recycled water supply system and the water treated at the municipal WWTP is discharged directly into the river Drava, a more initial approach is

	needed in order to assess the potentials of in-situ recycled water use (within industrial facilities, greywater for households) and ex-situ for future development (providing recycled water to end-users).
Expected result	A systemic strategy that will provide a future roadmap to develop an efficient system for reuse of recycled water on individual and collective level.
Responsible institution/s, organizations for implementation of the Action	MUNICIPALITY OF MARIBOR
Other partner organization that needs to be involved	JOINT INTER-MUNICIPAL ENVIRONMENTAL PROTECTION SERVICE, MBVOD
Time scale	2023
Estimated costs and resources needed	Own resources, 15.000€ for external expertise
Target indicator	1 Systemic Study of Potentials of Recycled Wastewater Use

Action 7: WATER MENU FOR CITIZENS TO ENCOURAGE UPTAKE OF TECHNOLOGIES FOR RAINWATER AND WASTEWATER REUSE ON INDIVIDUAL LEVEL	
Related Objective and background (challenge)	Objective 2: Increasing Rainwater Use Objective 3: Improving Water Use Efficiency Objective 4: Increasing the Use of Recycled Wastewater
Description of the Action	A special set of water saving and reuse micro-solutions that can be implemented on a single-home level will be developed as a guidance document on how to implement at least 11 different technologies in (*helophyte filters, rainwater harvesters, smart rain barrels, unit/small-scale water recycling, recycling showers, heat exchanging showers, biological water cleaning devices, automatic metering, aqua toilets, water storage, automated rinsing systems*). The Water Menu will present each technologies' environmental and economic benefits; the latter will be presented comparatively (current costs: investment cost – savings in a particular period of time) to motivate residents to take up the solutions.
Expected result	Significant increase in water menu's technologies on individual level.
Responsible institution/s, organizations for implementation of the Action	MUNICIPALITY OF MARIBOR
Other partner organization that needs to be involved	JOINT INTER-MUNICIPAL ENVIRONMENTAL PROTECTION SERVICE, MBVOD
Time scale	2023
Estimated costs and resources needed	Own resources, 10.000€ for external expertise
Target indicator	1 Water Menu