D.T2.7.1 FINAL SELF-EVALUATION REPORT

Subtitle

Version 1

MM YYYY

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1. Background and objectives

1.1. Challenges and solutions

Water over-abstraction is one of the main threats to EU water environment. Water reuse thus presents a great opportunity. Globally, industrial uses already present 19% of water reuse for this purpose (EU-level instruments on water reuse, 2016), while industrial users of drinking water are one of the biggest single users of water in Europe. So industrial usability of rainwater and purified wastewater could achieve a large benefit in reducing the use of drinking water for industrial purposes. Water requirements in the EU for industrial sector are diverse in terms of quality and quantity, but offer plenty of opportunities for potential cost savings. However, technologies and services addressing the specific needs of the industry sectors have yet to be developed (EC, Water Reuse in Europe, 2014).

The purpose of the pilot was to define the usability of rainwater and purified wastewater for production of secondary raw material-based (SRM) construction materials for use on public infrastructure and surfaces. The quality of water and of end products was shown, proving that using recycled water is suitable. The pilot is built up in a way to be easily transferrable to other regions/countries.

The pilot action demonstrated the usability of purified wastewater and rainwater for the purpose of production of secondary raw materials -based construction products. Rainwater is harvested and stored in a reservoir and used in the production process, whereas purified wastewater is transported from the nearby wastewater treatment plant. Materials produced are used for road maintenance works and for revitalisation of degraded areas by Nigrad, d.o.o., a public company, owned by the Municipality of Maribor and is the concessionaire for public road maintenance. MBVOD showed that purified wastewater combined with harvested rainwater is suitable to be used in the production process.

The pilot shows strong synergies with the Horizon 2020, Circ-01-2016-2017, Cinderela project, in which MBVOD is a stakeholder, that aims to produce new construction materials from different types of wastes. However, it considers only the production process from the view of input/output materials, not taking into account using different types of recycled water for production. Thus, there is no funding in Cinderela's budget for the use of recycled water and no risk of double financing.

Within the current pilot, quality of products produced with purified wastewater and rainwater was monitored and suitability of use proven.

2. Experience of the pilot implementation

2.1. Lessons learned from the planning phase

To successfully implement the pilot action, it is necessary to properly plan the project.

The planning process is also described in the documents D.T2.4.1 - Common guide for piloting process and WPT2 Checklist, which were very helpful during the planning and early implementation phase. The templates for the documents were provided by PP11-FBR and adapted for specific pilot I3 by PP-5 MBVOD.

Planning can be divided into sub-phases1:

Preparatory phase:

The pre-planning has already started in 2019 with Nigrad, d.o.o., who are also stakeholders in this project and concessionaire for public road maintenance and will use the harvested rainwater and recycled purified wastewater for production of secondary raw materials-based construction products. Because the pilot shows strong synergies with Horizon 2020, Circ-01-2016-2017, Cinderela project, in which MBVOD is a stakeholder, that aims to produce new construction materials from different types of wastes (more detailed info in 1.1. Tackled challenges), we decided this is the perfect opportunity to combine the two projects and the perfect implementation area.

Preliminary planning phase:

In 2020 we started to prepare the Pilot concept (more detailed info in D.T2.4.2 Pilot concept) and have been in constant contact with PP-11 FBR, who provided us with technical assistance.

The planning started with some basic data analysis (water balance in location of the pilot, seasonal fluctuation, backup water supply…). We worked out a planning concept with a rough dimensioning of all major systems and examined alternative solutions under the same requirements. We examined three construction options, which are presented in the Pilot concept. A schematic diagram was prepared for the optimal option.

The most important part of planning is the dimensioning of the equipment, as the wrong dimensions of equipment can greatly affect the results of the pilot. When dimensioning the capacity of storage tanks, D.T2.4.1 - Common guide for piloting process (basic data list) was extremely helpful. We determined water saving measures, water balance on site, water quality requirements, and especially factors affecting rainwater harvesting and storage design. We analysed annual rainfall quantity and pattern over a year and checked the dimensions of collection surface area. Considering this data combined with runoff coefficient, we calculated storage capacity of storage tanks. Detailed description of dimensioning is described in D.T2.4.2 Pilot concept.

Next step was to clarify what kind of permits we needed for the pilot. Building and other permits have been granted (included in D.T2.4.4 – Investment preparation package) and were obtained by the publicly owned company Nigrad, d.o.o., (stakeholders in this project), who are responsible for on-site planning and construction and will be operating the production plant (Cinderela project). We have obtained the Permission to carry out the pilot from the land owner (included in D.T2.4.4 – Investment preparation package).

Once we had the preliminary information we worked on cost estimation. The cost estimation is described in Section 4: Costs of this document.

[1] Based on D.T2.4.1 Common guide to piloting process, prepared by PP-11 FBR, adapted for specific pilot action I3 by PP-5 MBVOD

Detailed planning phase:

During the detailed planning phase we worked with PP-6 E-Zavod in preparing D.T2.3.1 Thematic Catalogue 1, smart assessment tools for potentials mapping of urban water use, where a cost-benefit assessment of the pilot action and multi-criteria benefits analysis of the pilot was conducted.

Lastly, we have designed three construction options and after comparison, decided on the optimal option (presented in D.T.2.4.2 Pilot concept).

Approval planning phase:

Approval planning was already done in the preliminary planning phase.

Implementation and tender planning phase:

We worked through the planning concept step by step taking into consideration all technical requirements and made preliminary construction plan. The concept was presented to the stakeholders, especially Nigrad, d.o.o., who are heavily involved in the project, and to other partners of the CWC project at the Partner meetings. Once we got the confirmation from stakeholders, PP-11 FBR and other CWC partners on the pilot concept, we collected offers for land works and main equipment to be used in the pilot. We decided that the optimal solution is that some installation works would be done by MBVOD staff, because of the vast experience in installation works for drinking supply system. Some equipment to be installed was taken from the public procurement, from which we already have an ongoing contract. The budget is described in Section 4: Costs of this document.

2.2. Lesson learned from the procurement phase

Planning is the most important phase of any construction project. Proper planning of the budget, resources and tender conditions ensured that the procurement process was completed without any problems.

2.3. Lessons learned from the construction/installation phase

Technical lessons learned:

- It is necessary to ensure that the equipment is installed according to the manufacturer's instructions.
- If possible, the storage tank and pump manufacturer/provider/representative should install the equipment or be present at the construction site during installation to exercise control over construction/installation.
- The area, where the pumps and electrical cabinet are installed, should be well waterproofed, unless submersible pump is used. Hydro-insulation was necessary in our case, because the pumps and electrical cabinet with automatics are installed in an underground shaft.

Practical lessons learned:

- First phase of operation: As two pilot actions (CWC pilot I3 and Cinderela – Horizon 2020 Circ-01-2016-2017) are being carried out on the same construction site and both pilot actions are interdependent, there have been some difficulties in scheduling/coordination of activities. While the construction and installation of planned equipment went smoothly, some problems occurred at a late stage of construction. We intended to collect rainwater from the roof of facility (laboratory and presentation building), which is currently in a very early construction phase. As it seemed unlikely the facility would be built in time (due to extension of Cinderela project deadline), we only stored and used purified wastewater for production process during the first phase of operation. A decision made in consultation with PP-11 FBR.

- Second phase of operation: A drainage was built around the foundation concrete plateau, where the production of concrete materials is taking place. A large amount of (recycled) water is being used for production process. Excess water, along with rainwater, that would otherwise sink into the ground, is being gathered via drainage in the catchment area and then directed with pipelines to one of the reservoirs, where it is being stored for re-use in the production process. In between we have built three sedimentation shafts to eliminate small and large particles and sand. A filter was also installed to eliminate fine particles. As a result, both storage tanks are active, one for storing and use of treated wastewater and the other for storing and use of rainwater mixed with discharged industrial wastewater from construction. While during the first phase of the operation we were experiencing a long period of draught, the collection part was built just in time when there were a few extensive periods of rain and we were able to harvest enough of rainwater mixed with discharged industrial wastewater from construction to perform monitoring.
- Latter part of operation: As the facility (laboratory and presentation building) will be constructed, rainwater from the roof will also be harvested, stored and used in the production process. The gutters from the roof will lead rainwater to the catchment area and then diverted through pipelines and filter to one of the storage tanks.

Specific lessons learned:

Installation of PE underground storage tanks:

According to manufacturer's instructions[2] special attention needed to be placed with:

- Transport of the tanks
- Handling the tanks at the construction site
- Temporary storage at the construction site
- Dimensions of the construction pit
- Filling material
- Anchoring the tanks
- Foundation slab
- Traffic load

According to manufacturer's instructions[1] there are four installation methods depending on specific cases:

- Simple underground installation – non traffic surface (method used in the pilot)
- Underground installation with ground water

[2] Applies only to specific types of PE underground storage tanks that were installed in the Pilot action (Roto RoTerra 16000). Other types of PE underground storage may have slightly different or similar requirements. Manufacturers instructions: https://roto-group.eu/media/wysiwyg/Vprasalniki/navodila-vkop-EN.pdf

- Installation below traffic surfaces
- Installation deep below the ground
-

Example 1: SIMPLE UNDERGROUND INSTALLATION – NON TRAFFIC SURFACE

- The external sizes of the construction pit should be 60 - 100 cm larger than the tanks external length and width. If the characteristics of the terrain allow it, the walls of the construction pit should be dug as vertically as possible (a safe angle of excavation should be considered and work safety rules respected).
- Construction pit planum layer should be straight, fortified and hard. If the soil has a lower bearing capacity, a 40 cm thick layer of gravel material or concrete should be made. The layer should be fortified to the compaction rate of 60 MPa.
- A 15 cm thick sand bedding should be put on top of the prepared layer. The sand layer should be levelled out.
- Carefully place the tank on to the sand bedding (placement with appropriate mobile crane or excavator) and level the sand out using a level measuring tool. Using the coil, adjust the telescopic elevation to the final level of the terrain.
- The construction pit is then filled up with 4-16 mm gravel fraction to the tank height of 30 cm, measured from the bottom of the tank, while the tank is simultaneously being filled up with water up to the height of 30 cm measured from the bottom of the tank (make sure all chambers are filled). Please make sure that the curved parts of the tank are well filled with the fraction from all outer sides. Simultaneous filling of the pit with fraction and the tank with water should be made in 30 cm steps, until the pit is completely filled (up to 25 cm below the level of the lid).
- The inflow and the outflow are then connected to the tank
- Across the entire area of the tank, geotextile must be laid.
- The top 25 cm are filled in with soil(200 g/m2 geotextile should be laid prior to filling). Please make sure that the tank lid remains uncovered. Attach the tank lid to the tank neck with supplied screws.
- Maximum height of gravel and soil above the tank is 70 cm.
- If the surrounding terrain is impermeable, the drainage should be made around the tank.

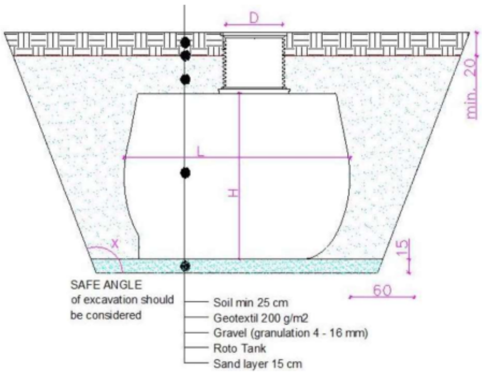

Figure 1: Manufacturers special instructions for simple underground installation of storage tanks - non traffic surface (method used in the pilot) (Source: https://roto-group.eu/media/wysiwyg/Vprasalniki/navodila-vkop-EN.pdf)

2.4. Lessons learned from operation

When the construction phase was completed, we started preparing for the operation phase. The most important part was the test run of the pumps.

The test run was successful in July 2021 and the device was ready for operation.

After the successful test run the operation phase started and everything went smoothly. From July 2021 until March 2022, only treated wastewater was used. After the drainage around the concrete production plateau was built along with sedimentation tanks and inlet pipelines in March 2022, we managed to launch the second phase of operation which included, along with the use of treated wastewater, also the use of rainwater mixed with discharged industrial wastewater from construction.

Since the second phase of operation was launched later than expected, thus providing us with a short period of operation, no problems have occurred in this short space of time. While during the first phase of the operation we were experiencing a long period of draught, the collection part was built just in time when there were a few extensive periods of rain and we were able to harvest enough of rainwater mixed with discharged industrial wastewater from construction to perform monitoring. Some lessons could be learned in the future when the device will be in full operation for a longer period of time, after the CWC project is finished.

3. Timeline and responsibilities

Activity	*Start Date*	*End date*	*Status*	*Responsible (person/dept. or org.)*	*Involved people / stakeholder*	*Comment*
1. FUA-level pilot concept	January 2020	September 2020	Done	MBVOD		
2. Permission to carry out the pilot from the land owner	May 2020	May 2020	Done	MBVOD/Nigrad d.d.	Nigrad d.d. Municipality of Maribor	
3. Bidding - collecting offers for equipment & infrastructure works	June 2020	July 2020	Done	MBVOD		
4. Decision on optimal offers	September 2020	September 2020	Done	MBVOD		
5. Orders for equipment & infrastructure works	October 2020	October 2020	Done	MBVOD		
6. Investment preparation package	September 2020	March 2021	Done	MBVOD		
7. Landworks and installation of equipment	November 2020	June 2021	Done	MBVOD & contractors		
8. Intermediate self-evaluation report	February 2021	March 2021	Done	MBVOD		
9. Test run	July 2021	July 2021	Done	MBVOD		
10. Additional installation works - drainage, sedimentation tanks, filters - for harvesting rainwater mixed with discharged industrial wastewater from construction	February 2022	March 2022	Done	Contractors - Nigrad d.d.		

10. Monitoring	July 2021	May 2022	Ongoing	MBVOD, Deltaplan, National laboratory for Health, Food & Environment, Nigrad d.o.o.		
11. Results	July 2021	May 2022	Ongoing	MBVOD, Deltaplan, National laboratory for Health, Food & Environment		
12. Reports	September 2021	May 2022	Ongoing	MBVOD		

4. Costs

Cost type (e.g. planning, construction, etc.)	Description of cost (what is included into the contract, what was delivered, etc.)	Planned amount in AF (EUR)	Real amount (based on contract) (EUR)	Description (e.g.: *how well the prices were estimated, any problems that came up, what changes needed etc)*
Construction	Pumps	3.000,00 (Renting)	3.176,00	Justification below**
Construction	2 underground storage tanks (16 m^3) and filters	24.000,00	5.272,00	
Construction	Transport of purified wastewater	12.500,00 (Suitable vehicle)	3.609,60	
Construction	Land work (preparation work, landwork, concrete laying & unexpected costs)	5.000,00 (landworks) + 1.500,00 (pipeline)	9.269,02	
Construction	Shaft	/	3.850,00	
Planning Construction Supervision	Staff cost	1.500,00 (only pipeline)	9.200,00	
Total cost		43.500,00	34.376,70	

***Subject to change. More staff cost will be allocated for supervision of operation and monitoring, if allowed**

****Justification of differences:**

Renting pumps is not an effective option for this project. We have decided on installing hydro booster station with two pumps with automatics for 3.176,00€, while reservoirs with filters cost less than predicted budget (4720,00€+552,00€). Landscaping works have cost 9.2269,02€, while transport of purified wastewater will cost 3.609,60€ and concrete shaft needed to be installed for pumps and other equipment (3.850,00€). Staff cost - including overhead (9.200,00€ - installation works done by MBVOD staff). Decisions on the optimal options and bids has been made in relation to the cheapest offer. All costs considered we are still well within AF predicted budget.

Additional budget justifications:

The pilot project is implemented in collaboration with another investment – Horizon 2020, Circ-01-2016-2017, Cinderela project, in which MBVOD is stakeholder, that aims to produce new construction materials from different types of wastes (described in 1.1 Challenges and sollutions). However, Cinderela project considers only the production process from the view of input/output materials, not taking into account using different types of recycled water for production. Thus, there is no funding in Cinderela's budget for the use of recycled water meaning there is no risk of double financing.

Cinderela's investment is described in the Building permit project (part of D.T2.4.4. - Investment preparation package), where predicted location of reservoirs can be seen. However, no financing for recycled water is provided in Cinderela project.

ADDITIONAL COSTS – AFTER PROJECT EXTENSION

Cost type (e.g. planning, construction, etc.)	Description of cost (what is included into the contract, what was delivered, etc.)	Planned amount (JS approved) (EUR)	Real amount (based on contract) (EUR)	Description (e.g.: *how well the prices were estimated, any problems that came up, what changes needed etc)*
Construction	Land works and installation works for rainwater harvesting	4.500,00	3.973,05	

5. Results

Two underground storage tanks, each with a capacity of 16 m3, have been installed, one for storing treated wastewater, which is transported from wastewater treatment plant in Dogoše, Maribor, and one for storing rainwater.

A shaft was built in front of the two storage tanks to provide space for hydro-booster station and other equipment (water meters, valves etc.), which provides water for the construction process of SRM based construction products.

A supply line (PEHD RC DN90) was installed from hydro-booster station to the connection point next to the concrete plateau, used for production process of SRM based construction products. The only connection point is an above-ground hydrant, which is equipped with a “non-potable water” sign.

The catchment shaft for the collection of rainwater mixed with discharged industrial wastewater from construction was built next to concrete plateau along with drainage around the plateau to collect the excess water used in the production process, along with rainwater – water that would otherwise sink into the ground. A pipeline was built from the catchment area to the storage tanks, where it is being stored for re-use in the production process. In between three sedimentation shafts were built to eliminate small and large particles and other foreign matter. A filter was also installed to eliminate fine particles.

In that way we are re-using the water multiple times.

The results of the pilot implementation are summarized in Figures 2,3,4,5,6.

<u>System operation:</u>

The shaft has a built-in hydro booster station with two pumps, both pumps are frequency controlled – control is set to maintain constant pressure in the pressure system. Two probe modules are installed in the energy cabinet for each pump separately. As long as both reservoirs are full, both pumps are running, each approx. 50%. If one of the reservoirs is emptied, associated pump is not running until the water reaches the pre-set level. An additional dose is mounted with two switches for remote switching on and off for each station separately. The energy cabinet contains fuses for each pump separately, fid switch, power switch, two probe modules with six probes included, additional fuse for light in the shaft, manual-automatic switch for each pump separately. Drain cocks for water sampling are installed on the pressure side after each pump. An additional cabinet with pump control is located outside the shaft in a dedicated space. In addition, pumps should are automatically shut down, if they run dry, in order to avoid damage to them.

<u>Hydro booster station with two pumps:</u>

Type: Lowara VaFHP 2 / 11 / 10SV03 (2 x 1,1 kW, 3 x 400v, 50 Hz)
Each pump 3,5 l/s at dH = 20 m VS (2 b)
At 3,9 l/s = 1,6 b

Figure 2: Storage tanks, equipment shaft and pipeline during installation works before backfill

Figure 3: Pumps and electrical cabinet with automatics inside the shaft

Figure 4: Connection points for rainwater and purified wastewater (hydrant) and drinking water (PVC shaft)

Figure 5: Storage tanks and equipment shaft after most of the land works

Figure 6: Drainage and the collection shaft for collection of rainwater mixed with discharged industrial wastewater from construction (during construction)

6. Mentoring visit

The online mentoring visit took place on 21st of October 2021 (10:00 – 11:20).

Attendees:
Matej Levstek and Aleš Erker (MBVOD – Municipality of Maribor)
Tadej Žurman (Deltaplan d.o.o.)
Nuša Lazar and Tomislav Ploj (Nigrad d.d.)
Erwin Nolde and Norma Khoury-Nolde (fbr)

Agenda:

- Introductory presentation (with discussion)
- Pilot film made by MBVOD showing different construction phases of pilot implementation https://www.youtube.com/watch?v=Yv9qDQLBEn0&t=121s
- Introduction to the Cinderela Project and pilot synergies (Nuša Lazar, Tomislav Ploj and Tadej Žurman)
- Live on-site video (with discussion)

The online mentoring visit proceeded well. Due to internet problems there were short interruptions. During the walk-through on pilot site some problems were encountered in the audio recording due to the prevailing weather conditions (windy weather). During the mentoring visit, the pilot plant was not in operation due to a software modification related to the addition of a new silo for SRM material in the production line.

Evaluations and conclusions of the mentoring visit are written in section 9 (Pilot upscaling plans) – 9.2 (Online mentoring visit).

7. Monitoring activites and results

Quality of rainwater and purified wastewater

The aim of Maribor pilot is to show the usability of rainwater and recycled black water from local wastewater treatment plant for production of secondary raw material-based products. Since Maribor doesn't have separate wastewater and rainwater/stormwater system, the quality of incoming wastewater mixed with stormwater differs based on the season and precipitation. Thus, the National Laboratory of Health, Environment and Food has suggested 2 monitoring periods based on the changing weather conditions. Two sampling and analyses have already been done showing that the wastewater is appropriate to be used in production of construction materials.

Quality of produced materials

Water for construction products must comply with the provisions of the SIST EN 1008 standard. This standard states that municipal water may not be used in concrete, but treated water can no longer be considered as municipal water, but the provisions for industrial wastewater have been complied with. Such water should not contain oils and fats more than in traces, any foam as a result of detergents should disappear within two minutes after vigorous shaking. The colour of the water can be at palest yellow or cloudy. 100 ml of water may have a maximum of 4 ml of sediment if tested according to point 6.1.1 of the SIST 1008 standard. The water must not have an odour other than that which is permissible for drinking water. The pH of the water should be less than 4. After the addition of NaOH, the colour is assessed as yellowish brown or cloudy. The chloride content must be less than 1000 mg / l for reinforced concrete and less than 500 mg / l for pre-stressed concrete, or the chloride content in the concrete must not exceed the value specified in the standard SIST EN 206-1: 2000. The sulphate content in water, determined in accordance with point 6.1.3 of the SIST EN 1008: 2003 standard shall not exceed 2000 mg / l. If alkaline reactive aggregates are expected to be used, the sodium oxide equivalent content must not exceed 1500 mg / l.

Analysis of a recycled water sample for the preparation of composites

As part of the Cinderela project sampling and analysis of a recycled water sample was performed on 4th April 2022 by Laboratory of Nigrad to assess whether it is suitable for use in the preparation of composites.

Manual sampling was performed on site of the Cinderela and CWC pilot project. Water analyzes were performed in two parallels.

Analysis was performed for oils and fats, detergents, color, sedimental substances, suspended substances, smell, pH, Chlorine content and Sulphate content.

"Based on the stated results of the analyzes, we believe that the analyzed recycled water is suitable for the preparation of composites"

The monitoring report in Slovenian language is attached to this document.

Monitoring of quantity of recycled water used in production/Quantity of saved potable water

One of the main outputs of the pilot is quantity of recycled water used in production process. For this purpose, two water meters have been installed on the outflow from reservoirs. One reservoir serves for storing purified wastewater, the other serves for storing harvested rainwater. Thus, one water meter has been installed for measuring the amount of purified wastewater used and the other for measuring the amount of harvested rainwater used in the production process.

Water is one of the main resources in production of construction materials. Since the aim of the pilot is to show usability of rainwater and purified wastewater in production process, quantity of recycled water used in production will thus be equal to the quantity of saved potable water and also the energy (electricity) savings for energy used for abstraction and distribution of potable water that has been replaced

The results for now have been inconclusive since the operation phase of the pilot has only just started.

8. Indicators

Indicators	Description	Baseline	Achieved so far	Target value	Measurement/ monitoring method	Regularity of measurement
Output 1	Number of storage tanks installed	2	2	2	N/A	Once
Output 2	Number of hydro-booster stations with pumps for harvested rainwater and recycled water installed	2	2	2	N/A	Once
Output 3	Quantity of harvested rainwater and recycled water used in production	0 m^3	48 m^3	30 m^3/month	Water meters will be installed in the outflow from reservoirs. One water meter for rainwater and one water meter for recycled purified wastewater. MBVOD will be responsible for	Monthly/Yearly/End of project

					measurement/monitoring of water meters.	
Result 1	Quantity of saved potable water	0 m^3	48	30 m^3/month	Water meters will be installed in the outflow from reservoirs. One water meter for rainwater and one water meter for recycled purified wastewater. MBVOD will be responsible for measurement/monitoring of water meters.	Monthly/Yearly/End of project
Result 2	Quality reports on purified wastewater (that is used for production)	0	2	2 reports	The National Laboratory of Health, Environment and Food has suggested 4 monitoring periods based on the changing weather conditions. Two sampling and analyses have been done showing that the wastewater is appropriate to be used in production of construction materials.	Biannually

Impact 1 Impact 2	"Assessment report on determination of suitability/operational appropriateness of rainwater and recycled purified wastewater for production process" which in turn provide baseline for "Better water management in production process, especially with concrete and products used for road maintenance"	0	0	1 assessment report	The quality of different types of water will be tested for the purpose of determining if rainwater and recycled purified wastewater is suitable/unsuitable to be used in the production process. MBVOD along with Deltaplan will be responsible for monitoring, which will be done by National laboratory of Health, Food and Environment. The quality of materials will be tested and determined if recycled water is appropriate for use in the production of construction products.	Once, at the end of the project
Impact x	Amount of funds leveraged based on project achievements THIS IS A PROJECT LEVEL INDICATOR, SO PLEASE ADD YOUR SHARE TO THIS.	0		2 900 000 euro	CWC foresees weighty leverage of funds for spin-off projects. Largest investment (at least 1 M EUR) foreseen is a closed-loop recycled water system in Maribor (if recycled water proves to be usable for different purposes e.g. snowmaking, washing of buses). Bydgoszcz intends to introduce decentralized RW utilization for public purposes (e.g. for watering parks, cleaning streets,	once, at the end of the project

					supplying ponds), Turin aims to roll-out green roofing and Zugló plans to replicate its pilot in other kindergartens.	

9. Pilot upscaling plans

9.1. Online peer-review visit

The online peer-review visit in Maribor, Slovenia, took place on Friday, 19 November 2021.

All project partners were invited, Poland and Hungary were the required countries that had to participate. From each country we invited:

- 2 National PPs
- Relevant FUA stakeholders
- Facilitators of the local SMGs (recommended).

Agenda of the online visit:

- Part 1: Pilot action presentation
  - 9.00-9.15 Welcome (Anja EZVD)
  - 9.15-10.15 Pilot action presentation – videos (Aleš, Matej – MBVOD, Nuša Lazar – Nigrad, Tadej Žurman – Deltaplan)
  - 10.15-10.30 Coffee break / collection of questions
  - 10.30-11.00 Q&A session related to the pilot action

- Part 2: Preparation of assessment

  Interactive workshop

  - 11.00-12.00 Breakout rooms (Slovenia, Poland and Hungary): answering evaluation questions
  - 12.00-13.00 Presentation of the breakout rooms answers and discussion
  - Wrap up of the online peer-review visit

The links to the relevant documents about the pilot action in Maribor for the preparation of the peer-review visit were provided before the meeting, such as amateur video of the pilot, online mentoring visit report and video (D.T2.4.3), pilot concept (D.T2.4.2), intermediate self-evaluation report (D.T2.6.3), water quality analysis.

In the second part people were divided into three breakout rooms.

- Hungarian
- Polish
- International

Several questions were discussed in breakout rooms which provided the platform for collective discussion.

- Which of the achieved pilot objectives are important in your FUA? Do you think a similar action would be an effective way to reach those objectives (or others) in your FUA?
- What is the most important information about the idea and the expected results of the pilot action for your FUA?
- Would a similar action be feasible in your FUA?

The discussion took place with the following conclusions:

- Budapest (HU):
  - Single municipality in a large city, wastewater is managed by the city.
  - Nearly 100% of wastewater is treated in Budapest.
  - A lot of possibilities to use treated wastewater, especially in construction industries.
  - Economic feasibility of building a secondary pipeline network for reuse of treated wastewater is questionable.
  - Similar pilot in Budapest – usage of rainwater and greywater.

- Bydgoszcz (PL):
  - Similar objectives with Bydgoszcz pilot.
  - Priority is using rainwater.
  - WWTPS's outside the city – difficult to transport WW.
  - 5 factories – concrete blocks.
  - 2 factories – silicate bricks (higher temperature – requires better quality of water – rainwater more suitable).
  - Treated wastewater would be useful for street cleaning.

- International - Split (HR):
  - Limitations – a lot of fresh drinking water even for industrial purposes
  - In this point in time it is not feasible to implement a similar project – maybe in the future
  - Questions about the beneficiaries, investors – private or public institutions

Summary and recommendations from the peer-review visit:

Everyone agreed a similar action could be done in their FUA but with certain limitations. Budapest team would be focused on using rainwater. Treated wastewater would be useful for street cleaning.

Everyone agreed that it is important that mechanisms must be put in place in the future to protect the drinking water sources, increase the reuse of water where it is possible and educate people on efficient water use and reuse of water.

Everyone agreed that it is important that mechanisms must be put in place in the future to protect the drinking water sources, increase the reuse of water where it is possible and educate people on efficient water use and reuse of water.

9.2. Online mentoring visit

State of the pilot at the time of the mentoring visit:

At the time of the mentoring visit, the two reservoirs and all equipment and construction material related to the investment were completely installed and functionality tested in April 2021. The mobile pilot production plant (Cinderela) went into operation initially in September 2020, using backup water supply from public drinking water supply system at the beginning. Since September 2021 the plant already produced SRM-based construction products using treated wastewater. The rainwater reservoir remained empty since no rainwater could be collected at that time. However, the rainwater part has since been updated, with the drainage, collection points, sedimentation shaft and inlet pipeline being built.

Evaluation of the pilot action by FBR:

FBR noted at the time that “If rainwater from the paved traffic surfaces is also used, in addition to rainwater from roof surfaces, which is certainly advantageous, it is advisable to have a filter/sieve (or a sedimentation stage) before it enters the rainwater reservoir”. We have since built a drainage around the concrete plateau, which is used for production of SRM based products. A collection point in the corner of the plateau and a pipeline, which leads the collected water to the storage tanks. In between three sedimentation shafts have been built and a filter for fine matter has been installed before the water enters the reservoir to eliminate foreign matter.

FBR noted at the time that “Supply lines of the hydrant and taps which are not fed with drinking water must be properly designated and clearly marked with “non-potable water” signs”. We have since equipped the hydrant with a sticker marked with a “non-potable water” sign, seen on the picture below.

Figure 7: Hydrant with a "non-potable water" sign while "rainwater mixed with dischargeed industrial wastewater from construction" drainage and collection area is being built

FBR noted at the time that from the two samples which were investigated for physico-chemical parameters: “the Biochemical Oxygen Demand (BOD_5) of < 5 mg/l meets the requirements for service water for toilet flushing, which also correspond with the service water quality requirements in Germany. In general, the water quality on site, i.e. in the reservoirs, is decisive. The storage of treated wastewater over a longer period of time and its impact on the quality of water withdrawn for the production process should not be ignored. Further samples for analysis should be taken at the point of use. Due to the considerable turbidity which is still measured in the treated wastewater (6 - 8 mg/l), and which is presumably of biodegradable nature, it can be assumed that odour nuisances cannot be ruled out with time. In addition, if suspended solids in the treated wastewater deposit on in-house installations, it can be expected that the function of the toilet flush units will be impaired after some time. This can be excluded, if turbidity values below 1 NTU are achieved. However, occasional slightly exceeding values (1 - 2 NTU) can be uncritical. On the other hand, this will probably not be of significance, if the water is used for the production of recycled building material. Therefore, it is generally recommended to investigate the stored treated wastewater quality (later also the rainwater) more closely over a longer monitoring period."

FBR also noted at the time that "in Germany, it is recommended that service water for use in buildings meets the hygienic/microbiological requirements of the EU Bathing Water Directive[3]. In case of *E. coli*, this would be < 1,000 CFU/100 ml. Since significantly higher *E. coli* concentrations were detected in the treated wastewater used for the above production purposes, namely 66,000 CFU/100 ml, this should be discussed with the local health authorities."

Upgrading and fine tuning of pilot concept:

FBR noted: "Whether the installation of the inlet pipes for rainwater harvesting will be concluded before the end of the project remains an open question at the present time. However, the reuse of rainwater for the production of recycled construction material will have an added value on the whole pilot measure in terms of sustainability, economic as well as environmental benefits."

For additional uses such as indoor reuse of treated wastewater and rainwater for toilet flushing, the local water quality regulations for non-potable water use in buildings have to be followed.

9.3. Possible spin-offs

1. Harvested rainwater and purified wastewater connection to the facility (laboratory and presentation building) being built as part of Cinderela project.

Preliminary talks have taken place to build a sanitary connection (used for toilets) for harvested rainwater and purified wastewater to the facility (laboratory and presentation building) as part of Cinderela project. The construction of the facility is currently in an early stage and is foreseen to be completed by the end of 2022.

2. Distribution system of recycled urban water as part "Strategy for the transition to circular economy in the Municipality of Maribor"

As part of city's "Strategy for the transition of the city of Maribor to circular economy", Municipality of Maribor, together with Mariborski vodovod and the Wcycle Institute, focus their funds in order to explore the possibilities of implementing the distribution system for the recycled water in the city with a goal to later implementation. As systemic implementation is currently not economically feasible due to the abundance of fresh water, projects like CWC can serve as springboard for above mentioned organizations to cooperate with local, national and international and European institutions in the preparation of the necessary documents, which would allow for appropriate incentive measures on the demand side. Moreover, energy demand implications for abstraction and distribution of potable water should also be considered.

[3] https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=CELEX%3A32006L0007

The designed distribution system of recycled urban water is based on the idea of maximum reuse (of over 7.0 million m^3) 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 hauliers (Magna, ERM Airport, …).

Figure 8: Distribution system of recycled urban water plan as part "Strategy for the transition of the city of Maribor to circular economy in the Municipality of Maribor"

10. Project follow-up

Wastewater overload and water over-abstraction are one the main problems EU is facing in the future and is already being faced with today in some regions. Industry sector are one of the main users of the drinking water. The pilot action addresses this topic with an integrated circular economic approach, showing that reused water can be used in construction industry and can be used along with other recycled materials, circularly closing the material loop.

The implementation of the pilot action has demonstrated the usability of rainwater and purified wastewater for production of secondary raw material based (SRM) construction production and has therefore achieved the goals set at the start of the project,

FUA Maribor with Municipality of Maribor and surrounding municipalities has gained the experience and know-how in water reuse within the construction industry. Pilot action was presented in various local, national and international events and has therefore reached the dissemination objectives, communicating the results to stakeholders, local authorities and construction industry sector. As the project is transferable, we hope that similar projects can be implemented in the future, especially if EU, national and local measures could make similar projects economically more viable. Similarily, utilities sector could use the purified wastewater and rainwater for road maintanance works.

The implementation of the two projects, CWC and Cinderela, is a perfect example of how material flows can be closed into loops. The synergies were evident early on in the preparation phase of the two projects. While Cinderela is using recycled materials as raw material for construction products and water being critical to production, CWC provides the whole process with recycled water. Therefore we have a whole cycle of material reuse. Produced concrete blocks have been tested for hardness with results showing the same or similar characteristics as non-recycled construction materials.

A pilot demonstration facility is currently being built with the produced recycled materials a spart of the Cinderela project at the CWC/Cinderela pilot site. The facility along with the whole pilot site can be used in the future as a circular economy hub, showcasing the results and synergies of CWC and other connected and similar projects can to local, national and international organizations, general public, potential public and private investors. This could provide a springboard for initiatives for similar projects for years to come.

ATTACHMENT 1:

Analysis of a recycled water sample for the preparation of composites

Name of the document:

Analiza vzorca reciklirane vode za pripravo kompozitov 0404.2022.pdf*

*The document is in Slovenian language.

<u>**Executive summary:**</u>

As part of the Cinderela project sampling and analysis of a recycled water sample was performed on 4th April 2022 by Laboratory of Nigrad to assess whether it is suitable for use in the preparation of composites.

Manual sampling was performed on site of the Cinderela and CWC pilot project. Water analyzes were performed in two parallels.

Analysis was performed for oils and fats, detergents, color, sedimental substances, suspended substances, smell, pH, Chlorine content and Sulphate content.

Conclusion:

“Based on the stated results of the analyzes, we believe that the analyzed recycled water is suitable for the preparation of composites”

Nigrad, komunalno podjetje, d.o.o.
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ANALIZA VZORCA

Cinderela

Analiza reciklirane vode za pripravo kompozitov

april 2022

Naslov: Analiza vzorca:
Analiza reciklirane vode za pripravo kompozitov

Izvajalec: Nigrad, komunalno podjetje, d.o.o.
Oddelek Laboratorij
Zagrebška cesta 30
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Tel.: (02) 45 00 300
Fax: (02) 45 00 360

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Naročnik: Cinderela
Zagrebška cesta 30
2000 Maribor
Tel.: (02) 45 00 300
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http:/www.nigrad.si/

Oznaka poročila: voda 0404.2022

Datum poročila: 04. 05. 2022

Vodja laboratorija:

Tonka ČUK

Nigrad, komunalno podjetje, d.o.o.
Zagrebška cesta 30, 2000 Maribor

Rok za pritožbe: 15 dni po prejemu poročila o preskušanju.

1. UVOD

V okviru projekta Cinderela smo izvedli vzorčenje in analizo vzorca reciklirane vode, da bi ocenili ali je primerna za uporabo pri pripravi kompozitov.
Izvedli smo ročno vzorčenje. Mesto vzorčenja je določil naročnik. Analize vode smo opravili v dveh paralelkah.

2. PODATKI O VZORCU

Vrsta vzorca:	trenutni vzorec reciklirane vode iz cisterne
Uporabljena oprema:	ročno vzorčenje
Količina vzorca :	6 l
Sprejem vzorca:	04. 04. 2022
Vzorčenje izvedel:	Iztok Jevšnikar
Opombe k vzorčenju:	ni

Vzorec je bil od sprejema v laboratorij do izvedbe analiz hranjen v hladilniku na 4°C.

3. REZULTATI ANALIZ

Vse analize vzorca smo izvedli v dveh paralelkah.
Pri naboru parametrov za analizo smo si pomagali z določili standarda SIST EN 1008: 2003 »Voda za pripravo betona – Zahteve za vzorčenje, preskušanje in ugotavljanje primernosti vode za pripravo betona, vključno z vodo, pridobljeno iz procesov v industriji betona«

3.1 OLJA IN MAŠČOBE:

- V vzorcu ni opaznih sledi olja ali maščob.

3.2 DETERGENTI

- Vzorec se ne peni niti po tresenju.
- Spektrometrično določeni neionski tenzidi v vzorcu s kivetnim testom po HM-5: 2018: < loq
- Spektrometrično določeni anionski tenzidi v vzorcu s kivetnim testom po SIST ISO 7875-1: 1997 / AC1 (mod.): 2004: < loq

3.3 BARVA

- Vzorec vode je prosojen in ni obarvan.
- Tudi po dodatku 3% NaOH se vzorec ni obarval.

3.4 USEDLJIVE SNOVI

- Rezultat določitve usedljivih snovi v vzorcu po DIN 38409-9 (2): 1980 po 30 minutah: < 0,1 ml/l
- Rezultat določitve usedljivih snovi v vzorcu po DIN 38409-9 (2): 1980 po 120 minutah: < 0,1 ml/l

3.5 SUSPENDIRANE SNOVI

- Rezultat določitve suspendiranih snovi v vzorcu po SIST ISO 11923: 1998: < 0,2 mg/l

3.6 VONJ

- Analiziran vzorec vode je brez vonja.

3.7 pH

- pH = 7,1

3.8 VSEBNOST KLORIDOV

- Koncentracija kloridov v vzorcu: < loq

3.9 VSEBNOST SULFATOV

- Spektrometrično določena koncentracija sulfata s kivetnim testom po SIST ISO 9280 (mod.): 1996v vzorcu: < loq

4. MNENJE

Glede na navedene rezultate analiz menimo, da je analizirana reciklirana voda primerna za pripravo kompozitov.