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D1.4 - COMPREHENSIVE PORTFOLIO OF INNOVATIVE NBS 3

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Date: 27/03/2023
Deliverable ID: D1.4.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003765.

Project details			
Project acronym	NICE	Start / Duration	01/06/2021 60 months
Topic	SC5-27-2020	Call identifier	H2020-SC5-2020-2
Type of Action	RIA	Coordinator	CETIM
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Deliverable details				
Number	D.1.4			
Title	Comprehensive portfolio of innovative NBS 1			
Work Package	WP1			
Dissemination level	Public		Nature	Report
Due date (M)	M57		Submission date (M)	M58
Deliverable responsible	CETIM	Contact persons	Magdalena Gajewska – mgaj@pg.edu.pl	

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Document History			
Date	Version	Name	Changes
19.04.2024	0.1	D.1.2. v 1	
05.05.2024	0.2	D1.2 v 2	Corrected with project Reviewer's comments part 1
15.07.2024	0.3	D1.2 v 3	Corrected with project Reviewer's comments part 2
20.11.2024	0.4	D1.2 v 4	Corrected according to report no 2 Reviewer's suggestions
02.03.2026	0.1	D1.4 v 1	Added section: "URL portfolios from NICE project"
20.03.2026	0.2	D1.4 v 2	Corrected with project Reviewer's comments

Abbreviations

ATW Aerated Treatment Wetland
CSO Combined sewer overflow
DAFAST Dissolved Air Flotation Unit
FRB French Reed Bed- working in series vertical subsurface bed
FTW Floating Treatment Wetland
FWI Floating Wetland Islands
FWS-TW Free Water System Treatment Wetland- ponds with different depths
GR Green Roofs
GW Green Walls
HDPE High-density polyethylene
HSSF or HF Horizontal Subsurface Flow Treatment Wetland
HRAP High Rate Algae Pond
HRT Hydraulic Residence Time
HTW Hybrid Treatment Wetland
LW Living Walls
NBS Nature Based Solution
NH4-N Ammonium Nitrogen
p.e. Personal Equivalent
PO4-P Orthophosphate
PVC Polyvinyl Chloride
RBF Reed Bed Filters
RG Rain Garden
TKN Total Kjeldahl Nitrogen (Norganic +NH4-N)
TN Total Nitrogen (Norganic +NH4-N +NOx-N)
TP Total Phosphorus
TSS Total Suspended Soils (Volatile and mineral suspended solids)
TW Treatment Wetland (former Constructed wetland)
VSSF or VF Vertical Subsurface Flow Treatment Wetland
WW Wastewater
WWTP Wastewater Treatment Plant
STRB Sludge Treatment Reed Beds

WHY WE ELABORATE PORTFOLIO:

Extensive research carried out over the recent decades indicates that the globe's freshwater resources are limited, and human activity contributes to their further degradation and impoverishment.

Additionally, rapid climate change caused by human activity results in unexpected events such as uneven distribution of precipitation causing torrential rains and their consequences, i.e. flash floods or long periods of no rainfall causing droughts.

The consequences of these changes are becoming increasingly felt, both in urban and rural areas. Thus saving water and treatment of various types of wastewater to recycle its use or retention, becomes a top priority of water and wastewater management. Currently available technologies of purification, allow to remove variety, almost all, of contaminants from wastewater. However, the basic limitation is the necessary energy input and connected carbon and water footprint and thus associated treatment costs.

Due to rising energy prices, especially in the last two decades, low-energy technologies are gaining popularity and importance. In addition, the adoption by the EU of the circular economy rewards technologies such as nature-based solutions (NBS) in water protection and recovery. The European Commission describes them as "Nature-inspired and nature-supported solutions that are economical, offer environmental, social, and economic advantages, and contribute to resilience. These solutions introduce a greater variety of natural elements and processes into urban areas, landscapes, and marine environments through interventions that are locally tailored, resource-efficient, and systemic. Therefore, nature-based solutions must enhance biodiversity and support the provision of various ecosystem services. The advantage of NBS, apart from the low energy consumption is their low emissivity. Characteristic is no secondary sludge production during treatment wastewater, and it is possible to design systems with "0-emission" or even with additional production, e.g. biomass (for energy purposes) or water production for different urban purposes.

It should be underlined that NBS also perfectly fulfills four functions of ecosystems: supply (clean water and biomass), supporting (biodiversity, habitat creation, support for water circulation and matter and others), regulatory (regulation of flooding, temperature, water production) and cultural (recreation, education, aesthetics).

Therefore, NBSs are not only an alternative to conventional ones such as e.g. the activated

sludge method but a solution providing undeniable benefits.

So far, the primary argument against the widespread use of the NBSs was their high-level space requirements, in comparison with conventional systems. In many cases, this is not a real limitation, all the more so because it can use different combinations of NBSs, which are characterized by lower demand for space. At the same time, the space dedicated to NBS should be treated as a type of compensation for a degraded environment providing ecosystem service.

Now is the time to provide you with the definition. One of them given by EC is “Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural

features and processes into cities, landscapes, and seascapes, through locally adapted, resource-efficient and systemic interventions."[1]

In the NICE portfolio, You will be provided with such information as main dedication, some technical data about construction and operation, the location of the facility, or its ecological potential as well as ecosystem services (ES) and urban circularity challenges (UCC) . The portfolios present various uses of different types of Nature-Based Solutions (NBS) in a user-friendly way, taking into account the types of medium treated among others like wastewater, industrial wastewater, or surface runoff. The NICE portfolio has been foreseen as a tool mainly for politicians and decision-makers and thus provides a basis for finding a tailored solution. The NICE portfolio stands out from existing NBS by focusing specifically on some basic technical data, efficiency, ecological potential, urban circularity challenges, and ecosystem services as core components of each object, emphasizing sustainable urban resource cycles built up on the application of NBS.

[1] https://research-and-innovation.ec.europa.eu/research-area/environment/nature-based-solutions_pl

GRAPHICAL GUIDE OF PORTFOLIO:

The font and color used in the portfolio are as suggested in the NICE Style guide. The first step of creating the portfolio was choosing background colors for the different types of treated media. The backgrounds are derivatives of the original color scheme depending of the media color. Next step consisted of choosing the correct icons from the Flowchart. The icons are placed on the front page of the portfolio for easy recognition of the type of NBS There are 8 categories and they present in Table 1.

Icons are also placed on the top part of the portfolio for facilities such as rain gardens, green roofs, and vegetated walls (Table 2).

Table 1. Type of medium with corresponding portfolio color

Type	Color
NBS for domestic wastewater	
NBS for industrial wastewater	
NBS for greywater / greywater + direct rainfall	
NBS for direct rainfall	
NBS for surface runoff	
NBS for surface water	
NBS for sewage sludge	
NBS for landfill leachate	
NBS for combines sewer overflow	

Table 2. Different types of NBS with corresponding portfolio icons

Type of NBS	Icon
Horizontal Subsurface Flow Treatment Wetland (HSSF or HF) Vertical Subsurface Flow Treatment Wetland (VSSF or VF) Free Water Surface Treatment Wetland (FWS-TW) Hybrid Treatment Wetland (HTW) French Reed Bed (FRB) Aerated Treatment Wetland (ATW) High Rate Algal Pond (HRAP) + Treatment Wetland (TW) One-stage Treatment Wetland Treatment Wetland (TW) Floating Treatment Wetland (FTW) Floating Wetland Island (FWI) Sludge Treatment Reed Bed (STRB) Bioremediation Cells	
Green Roofs (GR)	
Living walls/green walls (LW/GW)	
Rain garden (RG)	
In-stream restoration (buffer zones) Water storage systems (reservoir)	
NBS with ensure reuse of treated medium	

The first page consists of basics including a short description and information such as construction year, costs, and operators as well as a table with ecosystem service provided by the NBS. Moreover, location and climate information can be found there, according to World Map Koppen-Geiger Climate Classification (Figure 1). A few pictures of the facility are placed on the front page.

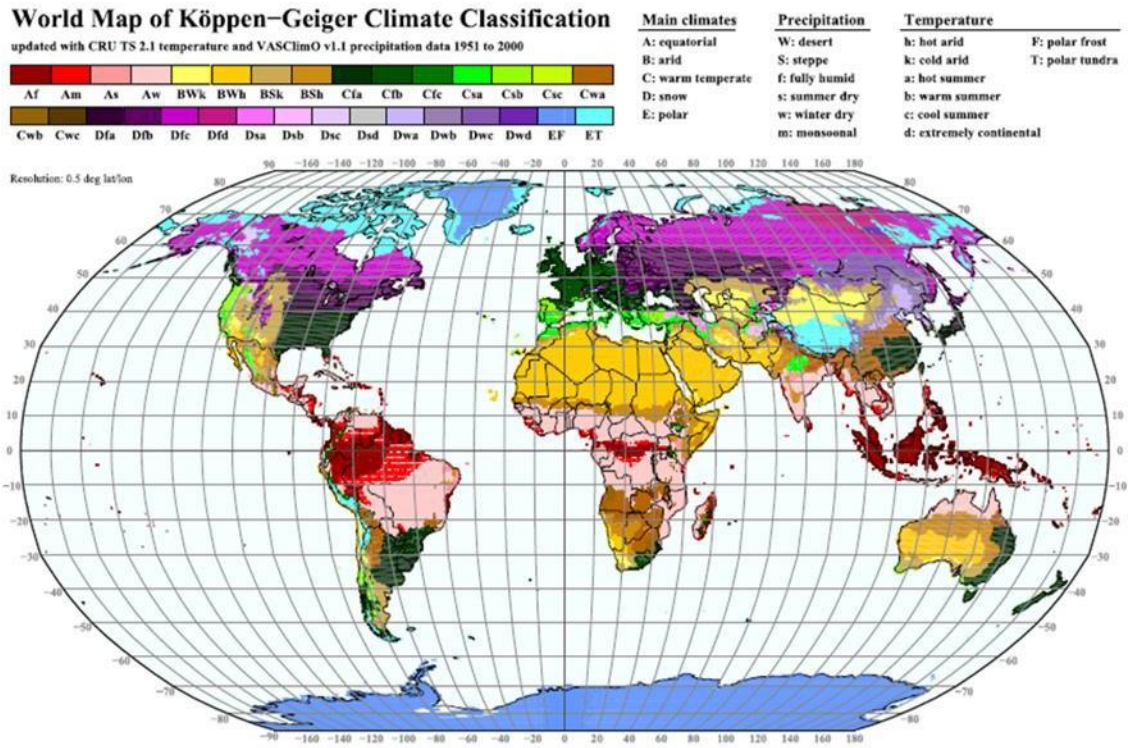


Figure 1. World Map of Köppen-Geiger climate classification[2].

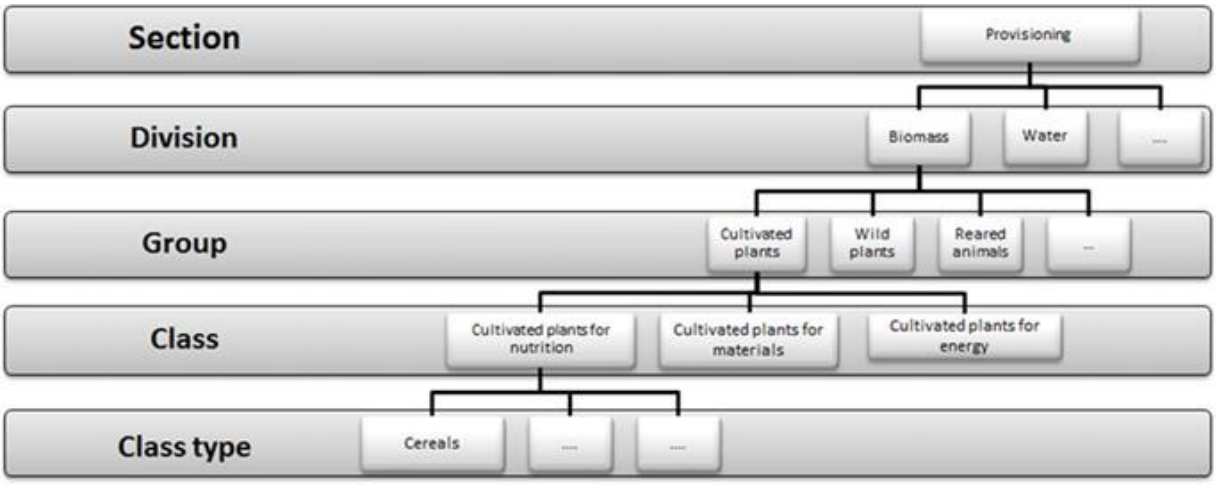
The back page of the portfolio consists of more technical data. The disadvantages and advantages of the particular object can be found there. A section was also devoted to ecological potential - how the facility helps improve the ecological situation of the area. The back page has a designated spot for technical drawings. If none are available, more pictures are placed there. Information about the European framework and author is placed on the back page of the portfolio.

[2] Kottek, M., Grieser, J., Beck, C., Rudolf, B., & Rubel, F. (2006). World Map of the Köppen-Geiger climate classification updated. Meteorologische Zeitschrift, 15(3), 259–263. DOI: 10.1127/0941-2948/2006/0130

ECOSYSTEM SERVICES:

Ecosystem services are the benefits people obtain from ecosystems. The portfolio describes ecosystem services using the Common International Classification of Ecosystem Services (CICES) methodology. CICES is a structured framework developed to categorize and describe the various benefits that ecosystems provide to humans. CICES aims to classify the contributions that ecosystems make to human well-being that arise from living processes. Although biotic ecosystem outputs remain the focus in CICES, feedback from the user community to broaden the classification to cover abiotic outputs has been addressed. The CICES allows users to select only those ecosystem services that depend on living systems (i.e. biodiversity in its broadest sense) or to include the non-living parts of ecosystems that can also contribute to human well-being[33].

Figure 2. The hierarchical structure of CICES V5.1, illustrated with reference to a provisioning service 'cultivated plants' which at Group level has no end-use associated with it[3]



[3] Haines-Young, R. and M.B. Potschin (2018): Common International Classification of Ecosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure. www.cices.eu

Table 3. Definition and background notes on the three major Sections in CICES V5.1[3]

Provisioning	• **This Section covers all nutritional, non-nutritional material and energetic outputs from living systems as well as abiotic outputs (including water).** • The Division level makes a distinction between biomass-based (biotic) provisioning services and the aqueous and non-aqueous abiotic ecosystem outputs. *In the full CICES 5.1 Table, the entries for water have been labelled Provisioning (abiotic) as opposed to Provisioning (biotic), and so they may be excluded or included in the listing of ecosystem services as users require. Given that in V5.1 abiotic ecosystem outputs can now be viewed alongside those arising from living systems, users can display the full listing by selecting 'CICES' and 'CICES extended' using the filter provided with any other filters switched off.*
Regulation and Maintenance	• **All the ways in which living organisms can mediate or moderate the ambient environment that affects human health, safety or comfort, together with abiotic equivalents.** • The Division level therefore covers (i) the 'transformation of biochemical or physical inputs to ecosystems' in the form of wastes, toxic substances and other nuisances; and (ii) the 'regulation of physical, chemical, biological conditions, which categorizes the various ways in which living systems can mediate the physico-chemical and biological environment of people in a beneficial way. • *In the full CICES 5.1 Table, the entries for regulating and maintenance that cover the contributions that living systems make to human well-being are labelled 'biotic'. However, given that in V5.1 abiotic ecosystem outputs can now be viewed alongside those arising from living systems, users can display the full listing by selecting 'CICES' and 'CICES extended' using the filter provided with any other filters switched off.*
Cultural	• **All the non-material, and normally non-rival and non-consumptive, outputs of ecosystems (biotic and abiotic) that affect physical and mental states of people.** • Cultural services are primarily regarded as the environmental settings, locations or situations that give rise to changes in the physical or mental states of people, where the character of those settings is fundamentally dependent on living processes; they can involve individual species, habitats and whole ecosystems. • The settings can be semi-natural as well as natural settings (i.e. can include cultural landscapes) providing the characteristics being considered are dependent on *in-situ* living processes. • In the classification we make the distinction between cultural services that are enabled as a result of direct or indirect interactions of people and living systems. • *In the full CICES 5.1 Table, the entries for cultural services that cover the contributions that living systems make to human well-being are labelled 'biotic'. However, given that in V5.1 abiotic ecosystem outputs can now be viewed alongside those arising from living systems, users can display the full listing by selecting 'CICES' and 'CICES extended' using the filter provided with any other filters switched off.*

Table 4. Example ecosystem services assessment for treatment wetland for domestic wastewater in Kniewo (Poland)

ECOSYSTEM SERVICES ACCORDING TO CICES			
Section	Provisioning	Regulation & Maintenance	Cultural
Class	**BIOTIC:** -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) **ABIOTIC:** -Surface water used as a material (non-drinking purposes)	**BIOTIC:** -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration **ABIOTIC:** -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	**BIOTIC:** -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

NBS IN CIRCULARITY:

In the contras to linear management of resources (water, food, materials, energy) the circular economy (CE) model is proposed in 2015 by EU, provides economic growth without increasing the consumption of new resources and reducing the impact on the environment[4].

Multifunctionality makes NBS an important concept for cities to achieve resource management according to the CE principles.

The concept, relating urban challenges with NBS, was developed within the COST Action CA17133 Circular City investigating the hypothesis that 'A circular flow system that implements NBS for managing nutrients and resources within the urban biosphere will lead to a resilient, sustainable and healthy urban environment'[5]

[4] Atanasova, N., Castellar, J.A.C., Pineda-Martos, R., Nika, C.E., Katsou, E., Istenič, D., Pucher, B., Andreucci, M.B., Langergraber, G., 2021. Nature-based solutions and circularity in cities. Circ. Econ. Sustain. 1, 319–332. https://doi.org/10.1007/s43615-021-00024-1.

[5] Langergraber, G., Pucher, B., Simperler, L., Kisser, J., Katsou, E., Buehler, D., ... & Atanasova, N. (2020). Implementing nature- based solutions for creating a resourceful circular city. Blue-Green Systems, 2(1), 173-185. https://doi.org/10.2166/bgs.2020.933

The following Urban Circularity Challenges (UCCs) for shifting to circular management of resources can be addressed with NBS have been defined 7 UCC and shown in Figure 2 and Table 5[4,5,6]:

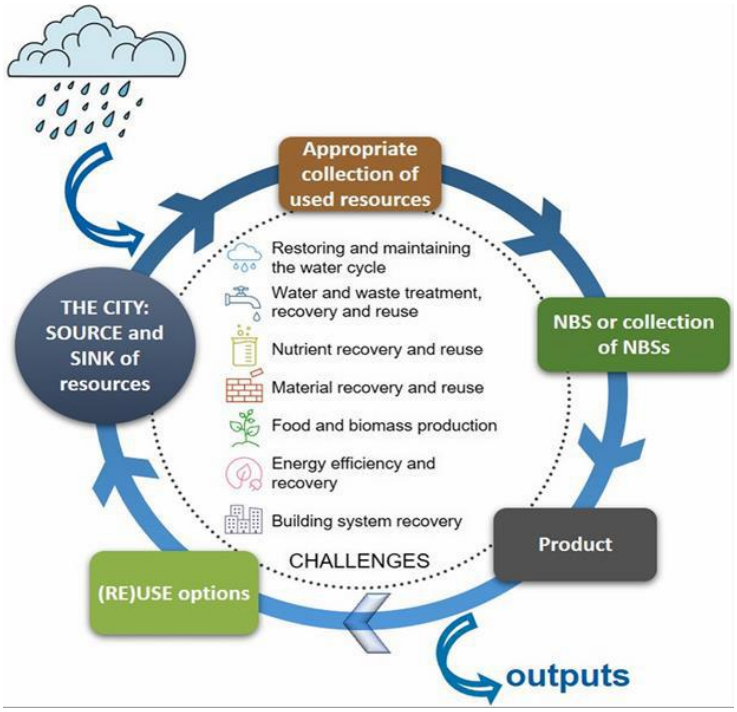


Figure 3. Urban circularity challenges for shifting to circular management of resources that can be addressed with NBS[4]

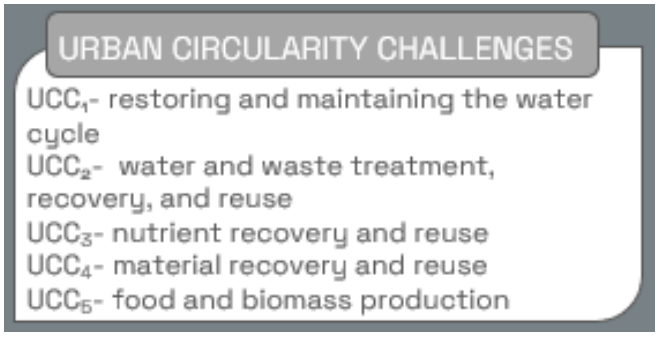
[6] Kasprzyk M., Szpakowski W., Poznańska E., Boogaard F.C., Bobkowska K., Gajewska M., 2022. Technical solutions and benefits of introducing rain gardens – Gdańsk case study, Science of The Total Environment, 835, 155487, https://doi.org/10.1016/j.scitotenv.2022.155487

Table 5. Descriptions of challenges related to urban circularity and the role of NBS[4,5,6]

URBAN CIRCULARITY CHALLENGES	
UCC_1	restoring and maintaining the water cycle
UCC_2	water and waste treatment, recovery, and reuse
UCC_3	nutrient recovery and reuse
UCC_4	material recovery and reuse
UCC_5	food and biomass production
UCC_6	energy efficiency and recovery
UCC_7	building system recovery

For each object presented in portfolio an individual assessment of urban circularity challenges was elaborated (Table 6).

Table 6. Exemplary assessment of urban circularity challenges for treatment wetland for domestic wastewater in Kniewo (Poland).



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PORTFOLIO

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003765.

The 24 cases was found for domestic wastewater, 13 for industrial wastewater, 7 for greywater / greywater + direct of rainfall, 11 for direct of rainfall, 14 for surface runoff, 7 for surface water, 5 for sewage sludge, 5 for landfill leachate and reject water, 4 for combined sewer overflow.
URL portfolios from the NICE project have also been added at the end of the document and it contains 9 cases.

Medium category	Type of object	Location	Name
Domestic wastewater ∑=24	Horizontal Subsurface Flow Treatment Wetland (HSSF or HF) ∑=2	Stężyca (Poland)	HORIZONTAL SUBSURFACE FLOW TREATMENT WETLAND FOR WASTEWATER < 50 PE
		Gorgona (Italy)	2 STAGE HORIZONTAL SUBSURFACE FLOW TREATMENT WETLAND FOR IRRIGATION, <500 PE
	Vertical Subsurface Flow Treatment Wetland (VSSF or VF) ∑=2	Bolwerk (Poland)	VERTICAL SUBSURFACE FLOW TREATMENT WETLAND+POND FOR <50 PE
		Lesvos (Greece)	VERTICAL SUBSURFACE FLOW TREATMENT FOR WASTEWATER REUSE AND RESOURCE RECOVERY
	Free Water Surface Treatment Wetland (FWS-TW) ∑=3	Eskiltuna (Sweden)	FREE WATER SURFACE TREATMENT WETLAND AS A TERITARY TREATMENT
		Hasseleholm (Sweden)	FREE WATER SURFACE TREATMENT WETLAND AS A TERITARY TREATMENT
		Caraglio (Italy)	FREE WATER SURFACE TREATMENT WETLAND AS A TERITARY TREATMENT
	Hybrid Treatment Wetland (HTW) ∑=11	Kniewo (Poland)	HYBRID TREATMEMT WETLAND >50 PE
		Borucin / Łączyno (Poland)	HYBRID TREATMENT WETLAND + POND < 50 PE
		Almeria (Spain)	HIGH RATE ALGAE POND + TREATMENT WETLAND
		Agramon (Spain)	HIGH RATE ALGAE POND + TREATMENT WETLAND
		Chiuso Di Pesio (Italy)	FRENCH REED BEDS + HORIZONTAL SUBSURFACE FLOW TREATMENT WETLAND FOR WASTEWATER, 80 PE
		Jougar (Tunisia)	HYBRID TREATMENT WETLAND FOR WASTEWATER
		Casteluccio Di Norcia (Italy)	INNOVATIVE – FRB + VSSF + FWS-TW FOR GROUND WATER RECHARGE
		Chorfech (Tunisia)	MULTISTAGE TREATMENT WETLAND FOR AGRICULTURAL REUSE
		Del Mar (USA)	MULTISTAGE FREE WATER SURFACE TREATMENT WETLAND, 50 – 1000 PE
		Haderselev (Denmark)	ELECTORATIVE BACTERIA BASED SYSTEM
		Maharashtra (India)	HYBRID TREATMENT WETLAND FOR WASTEWATER REUSE IN URBAN HOSTEL
	French Reed Bed (FRB) ∑=4	Ohrei (Moldavia)	FRENCH REED BEDS FOR RAW WASTERWATER TREATEMNT, 20 000 PE
		Macouria (France)	FRENCH REED BEDS WITH RECIRCULATION LOOP
		Les Halles (France)	FRENCH REED BEDS
		Misilya Jarba (Palestine)	FRENCH REED BEDS AND DISINFECTION POND
	Aerated Treatment Wetland (ATW) ∑=2	Tarcenay (France)	AERATED TREATMENT WETLANDS
		Bas-en-Basset (France)	AREATED TREATMENT WETLAND AND SLUDGE TREATMENT REED BEDS
Industrial wastewater ∑=13	Horizontal Subsurface Flow Treatment Wetland (HSSF or HF)	Candidoni (Italy)	HORIZONTAL SUBSURFACE FLOW TREATMENT PLANT FOR DAIRY WASTEWATER

	∑=1		
	Hybrid Treatment Wetland (HTW) ∑=7	Jesi (Italy)	HYBRID TREATMENT WETLAND FOR WASTEWATER AND REUSE IN INDUSTRY
		Nimr (Oman)	HYBRID TREATMENT WETLAND D FOR OIL WASTEWATER
		Embetsu (Japan)	HYBRID TREATMENT WETLAND FROM DAIRY INDUSTRY
		Castellina in Chianti (Italy)	HYBRID TREATMENT WETLAND FOR WINERY WASTEWATER
		Bolgheri (Italy)	HYBRID TREATMENT WETLAND FOR WINERY WASTEWATER
		Santa Tome (Argentina)	HYBRID TREATMENT WETLAND FOR EFFLUENT FROM METALLURGICAL INDUSTRY
		New Boston (USA)	HYBRID TREATMENT WETLAND FOR AGRICULTURAL LEACHATE
	One-stage Treatment Wetland ∑=1	Vidigueira (Portugal)	TREATMENT WETLAND FOR TREATMENT AND REUSE OF WINERY WASTEWATER
	Aerated Treatment Wetland (ATW) ∑=1	San Rocoo di Piegara (Italy)	VERTICAL SUBSURFACE FLOW TREATMENT WETLAND FOR AGROINDUSTRY
	Bioremediation Cells ∑=1	Riyadh (Saudi Arabia)	BIOREMEDIATION CELLS
	Floating Treatment Wetland (FTW) ∑=1	Sialkot (Pakistan)	FLOATING TREATMENT WETLAND FOR TANNERY WASTEWATER
	Free Water Surface Treatment Wetland (FWS-TW) ∑=1	Bologne (Italy)	TREATMENT WETLAND FOR AGRICULTURE
Greywater / Greywater + Direct of rainfall ∑=7	Green roofs (GR) ∑=3	Makandusi (Tanzania)	ROOFTOP HORIZONTAL SUBSURFACE FLOW TREATMENT WETLAND FOR GREYWATER REUSE
		Oregon (USA)	ROOF HYBRID FOR GREYWATER
		Richmond (USA)	GREEN ROOF AS A WASTEWATER TREATMENT PLANT FOR GRWYWATER
	Living walls/green walls (LW/GW) ∑=4	Beiru (Lebanon)	LIVING WALLS FOR GREYWATER REUSE
		Ferla (Italy)	LIVING WALL FOR GREYWATER REUSE
		Amman (Jordan)	LIVING WALLS FOR GREYWATER REUSE
		Marina di Ragusa (Italy)	LIVING WALLS FOR GREYWATER REUSE
Direct rainfall ∑=11	Rain garden (RG) (basin, bioretention swale) ∑=3	Albuquerque (USA)	RAIN GARDEN
		Gdańsk, 9 Ugory Street (Poland)	RAIN GARDEN FOR ROOFTOP RUNOFF
		Gdańsk, Kaczeńce Street (Poland)	RAIN GARDEN FOR ROOFTOP RUNOFF
	Green roofs (GR) ∑=5	Buffalo (USA)	GREEN ROOF AND RAIN GARDEN FOR WATER REUSE IN IRRIGATION
		Manhattan (USA)	GREEN ROOF AT A SLOPE
		Washington (USA)	GREEN ROOF AS A RECREATIONAL SPACE
		New York (USA)	ROOFTOP FARM FOR REUSE OF RAINWATER
		Copenhagen (DENMARK)	GREEN ROOF
	Living walls/green walls	Valladolid (Spain)	HYDROPONIC SYSTEM
		Paris (France)	LIVING WALL

	(LW/GW) ∑=3	Kalisz, John Paul II Square (Poland)	GREEN BUS STOP
Surface runoff ∑=14	Rain garden (RG), green roofs (GR) (meadow, basin, bioretention swale, tree pits), Treatment Wetland (TW) ∑=10	Gdańsk, 3maja Street (Poland)	RAIN GARDEN FOR MAIN ROAD RUNOFF
		Wrocław, courtyard among Jedności Narodowej, Rychtalska and Ustronie Street (Poland)	POCKET PARK
		Wrocław (Poland)	TREE PITS
		Wrocław, Gwiaździsta Street (Poland)	WILDFLOWER MEADOW FOR RUNOFF PURIFICATION
		Kalisz, Podgórze 6 Street (Poland)	RAIN GARDEN FOR URBAN RUNOFF
		Gdańsk, Goszczyńskiego Street (Poland)	RAIN GARDEN FOR STREET RUNOFF
		Syracuse (USA)	RAINGARDEN AND BIOSWALE FOR STREET RUNOFF
		Gdańsk, O'Rourke Street (Poland)	RAIN GARDEN FOR PARKING LOT RUNOFF
		Gdańsk, Stryjewskiego Street (Poland)	RAIN GARDEN FOR PARKING & STREET RUNOFF
		Toronto (Canada)	GREEN PARK
	Water storage systems (reservoir) ∑=1	Mściwojów (Poland)	RETENTION RESERVOIR
	Treatment Wetland (TW) ∑=1	Gidy (France)	BUFFER POND AND TREATMENT WETLAND
	Horizontal Subsurface Flow Treatment Wetland (HSSF or HF) ∑=2	Zalenieki (Latvia)	HORIZONTAL SUBSURFACE FLOW TREATMENT FOR RAINWATER FROM FARMYARD
		Bogota (Colombia)	HORIZONTAL SUBSURFACE FLOW TREATMENT WETLAND IN BOGOTA
Surface water ∑=7	Floating Wetland Island (FWI) or Floating Treatment Wetland (FTW) ∑=3	Durham (USA)	FLOATING WETLAND ISLANDS
		Fairfax (USA)	FLOATING TREATMENT WETLAND
		London (England)	FLOATING TREATMENT WETLAND
	In-stream restoration (buffer zones) ∑=4	Charlottesville (USA)	IN-STREAM RESTORATION - BUFFER ZONES
		Dublin-CA (USA)	IN-STREAM RESTORATION - BUFFER ZONES
		Aarhus (Denmark)	RESTORATION OF NATURAL WETLAND
		Aarhus (Denmark)	RESTORATION OF NATURAL WETLAND
Sewage sludge ∑=5	Sludge Treatment Reed Beds (STRB) ∑=5	Gniewino (Poland)	SEWAGE SLUDGE TREATMENT REED BED
		Al Awir (United Arab Emirates)	SEWAGE SLUDGE TREATMENT REED BED
		Helsinge (Denmark)	SEWAGE SLUDGE TREATMENT REED BED
		Negrepelisse (France)	SLUDGE TREATMENT REED BEDS & FRENCH TREATMENT WETLAND
		Paslieres (France)	FRENCH TREATMENT WETLAND & SLUDGE TREATMENT REED BEDS
Landfill leachate and reject water (LL and rejected water)	Treatment Wetland (TW) ∑=5	Burnie (Australia)	LANDFILL LEACHATE TREATMENT WETLAND SYSTEM
		Copping (Australia)	LANDFILL LEACHATE TREATMENT WETLAND SYSTEM
		Tianjin (China)	LANDFILL LEACHATE TREATMENT WETLAND SYSTEM
		Sydney (Australia)	POST-INDUSTRIAL LEACHATE TREATMENT WETLAND SYSTEM

∑=5		Lunan Tangshan (China)	POST-INDUSTRIAL LEACHATE TREATMENT WETLAND SYSTEM
Combined sewer overflow (CSO) ∑=4	French Reed Bed (FRB) ∑=1	Challex (France)	FRENCH REED BED FOR COMBINED SEWER OVERFLOW
	Hybrid Treatment Wetland (HTW) ∑=2	Gorla Maggiore (Italy)	MULTISTAGE TREATMENT FOR COMBINED SEWER OVERFLOW
		Carimate (Italy)	MULTISTAGE TREATMENT FOR COMBINED SEWER OVERFLOW
	Treatment Wetland (TW) ∑=1	Bergheim (Germany)	TREATMENT WETLAND FOR COMBINED SEWER OVERFLOW
URL portfolios from NICE project ∑=9			
Domestic wastewater ∑=2	Hybrid Treatment Wetland (HTW) ∑=1	Aarhus (Denmark)	HYBRID TREATMEMT WETLAND
	Vertical Subsurface Flow Treatment Wetland (VSSF or VF) ∑=1	Talavera de ls Reina (Spain)	VERTICAL SUBSURFACE FLOW TREATMENT WETLAND
Greywater / Greywater + Direct of rainfall ∑=4	Vertical Subsurface Flow Treatment Wetland (VSSF or VF) ∑=1	Algeciras (Spain)	VERTICAL SUBSURFACE FLOW TREATMENT WETLAND
	Hybrid Treatment Wetland (HTW) ∑=1	Madrid (Spain)	HYBRID TREATMENT WETLAND
	Living walls (LW) ∑=2	Turin (Italy)	LIVING WALL FOR GREYWATER REUSE
		Benalmádena (Spain)	LIVING WALL FOR GREYWATER REUSE
Surface runoff ∑=1	Rain Garden (RG) ∑=1	Gdańsk (Poland)	RAIN GARDEN 2.0 FOR STREET RUNOFF
Surface water ∑=1	Hybrid Treatment Wetland (HTW) ∑=1	Cairo (Egypt)	HYBRID TREATMENT WETLAND
Combined sewer overflow (CSO) ∑=1	Treatment Wetland (TW) ∑=1	Lyon (France)	TREATMENT WETLAND FOR COMBINED SEWER OVERFLOW

www.nice-nbs.eu

NBS FOR DOMESTIC WASTEWATER

Type of object	Location	Name
Horizontal Subsurface Flow Treatment Wetland (HSSF or HF) ∑=2	Stężyca (Poland)	HORIZONTAL SUBSURFACE FLOW TREATMENT WETLAND FOR WASTEWATER < 50 PE
	Gorgona (Italy)	2 STAGE HORIZONTAL SUBSURFACE FLOW TREATMENT WETLAND FOR IRRIGATION, <500 PE
Vertical Subsurface Flow Treatment Wetland (VSSF or VF) ∑=2	Bolwerk (Poland)	VERTICAL SUBSURFACE FLOW TREATMENT WETLAND+POND FOR <50 PE
	Lesvos (Greece)	VERTICAL SUBSURFACE FLOW TREATMENT FOR WASTEWATER REUSE AND RESOURCE RECOVERY
Free Water Surface Treatment Wetland (FWS-TW) ∑=3	Eskiltuna (Sweden)	FREE WATER SURFACE TREATMENT WETLAND AS A TERITARY TREATMENT
	Hasseleholm (Sweden)	FREE WATER SURFACE TREATMENT WETLAND AS A TERITARY TREATMENT
	Caraglio (Italy)	FREE WATER SURFACE TREATMENT WETLAND AS A TERITARY TREATMENT
Hybrid Treatment Wetland (HTW) ∑=11	Kniewo (Poland)	HYBRID TREATMEMT WETLAND >50 PE
	Borucin / Łączyno (Poland)	HYBRID TREATMENT WETLAND + POND < 50 PE
	Almeria (Spain)	HIGH RATE ALGAE POND + TREATMENT WETLAND
	Agramon (Spain)	HIGH RATE ALGAE POND + TREATMENT WETLAND
	Chiuso Di Pesio (Italy)	FRENCH REED BEDS + HORIZONTAL SUBSURFACE FLOW TREATMENT WETLAND FOR WASTEWATER, 80 PE
	Jougar (Tunisia)	HYBRID TREATMENT WETLAND FOR WASTEWATER
	Casteluccio Di Norcia (Italy)	INNOVATIVE – FRB + VSSF + FWS-TW FOR GROUND WATER RECHARGE
	Chorfech (Tunisia)	MULTISTAGE TREATMENT WETLAND FOR AGRICULTURAL REUSE
	Del Mar (USA)	MULTISTAGE FREE WATER SURFACE TREATMENT WETLAND, 50 – 1000 PE
	Haderselev (Denmark)	ELECTORATIVE BACTERIA BASED SYSTEM
	Maharashtra (India)	HYBRID TREATMENT WETLAND FOR WASTEWATER REUSE IN URBAN HOSTEL
French Reed Bed (FRB) ∑=4	Ohrei (Moldavia)	FRENCH REED BEDS FOR RAW WASTERWATER TREATEMNT, 20 000 PE
	Macouria (France)	FRENCH REED BEDS WITH RECIRCULATION LOOP
	Les Halles (France)	FRENCH REED BEDS
	Misilya Jarba (Palestine)	FRENCH REED BEDS AND DISINFECTION POND
Aerated Treatment Wetland (ATW) ∑=2	Tarcenay (France)	AERATED TREATMENT WETLANDS
	Bas-en-Basset (France)	AREATED TREATMENT WETLAND AND SLUDGE TREATMENT REED BEDS

HORIZONTAL SUBSURFACE FLOW TREATMENT WETLAND FOR WASTEWATER < 50 PE

OBJECT INFORMATION

Name: 4 single family treatment wetlands with pre-filter and HSSF
Type of facility: HSSF
Treated medium: domestic sewage
Description of the solution: Domestic wastewater from the building flows through a PVC sanitary pipe (Ø160mm) into the sedimentation tank, then moves to the pump. The wastewater undergoes mechanical and partial biological treatment as it circulates through a concrete ring structure. A pre-filter, placed in the sump, receives the wastewater at regular intervals, delivering it at an angle and distributing it evenly over the filter. The treatment pond is built within a trench and is insulated from the ground with a 1mm HDPE membrane.



BASIC INFORMATION

Construction year: 2009
Constructor: Investor under GUT's guidance
Source of financing: Co-financed Ministry of Science and Higher Education, European Economic Agency Financial Mechanism and the Norwegian Financial Mechanism
Total cost: 2300 €
Facility operator: individuals
Maintenance cost: 250 € / year
Contact person: Magdalena Gajewska (mgaj@pg.edu.pl)

GEOGRAPHICAL COORDINATES

Latitude: 54° 17' 01" N
Longitude: 17° 55' 19" E

LOCATION

Country: Poland
City: Stężyca
Type of climate: Cfb
Average temperature: 8°C
Sum of precipitation: 759 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production





Source: M. Gajewska

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 40m^2
Volume: 24m^3
Efficiency and effectiveness: removal effectiveness of TN varied from 22.4 to 84.2% (loadings from 8.5 to 34.0 kg/ha·d) BOD removal varied from 25.6 to 99.1% (loadings from 11.2 to 115 kg/ha·d.)
Operating experience: good treatment effectiveness BOD 64.0-92.0%, TN 44.0-77.0%, TP 24.0-66.0%

ECOLOGICAL POTENTIAL

The application of TW for single-family effluent is an effective and sustainable solution for WW treatment in the rural areas. The monitoring results of the single family NBSs indicated that the one stage HSSF facilities working at the second stage of sewage treatment provided effective removal of BOD_5 and COD as well as TSS.

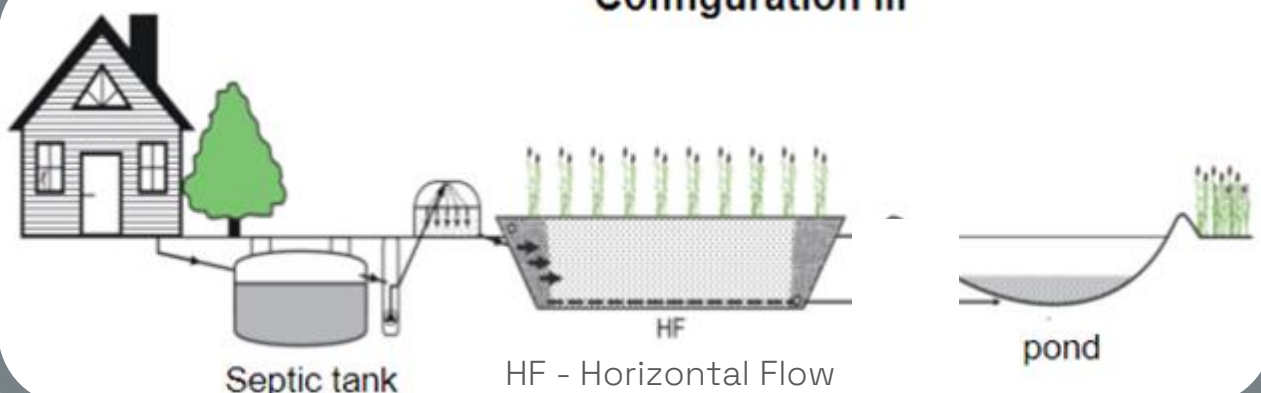
ADVANTAGES

1. During post-vegetation period (after two years of operations of the systems) the quality of the effluent improved significantly and in many cases meet the above mentioned requirements.

DISADVANTAGES

1. A long construction and development process (about 2 years) without full operational efficiency.

Configuration III



HF - Horizontal Flow

Source: M. Gajewska

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

2 STAGE HORIZONTAL SUBSURFACE FLOW TREATMENT WETLAND FOR IRRIGATION, <500 P.E

OBJECT INFORMATION

Name: Treatment wetland for wastewater treatment and reuse on Gorgona Island
Type of facility: HSSF
Treated medium: urban wastewater
Description of the solution: Gorgona plant consists of a primary treatment system (grid and Imhoff tank) and of a secondary treatment system with HSSF disposed in two by two in parallel and followed in series by a wet grassland functioning as filter between treatment system and environment. During summer water can be taken for irrigation aims after basins 3 and 4 or after the wet grassland. The facility treats 20–80m^3/day of wastewater produced by the Gorgona penitentiary, which can host up to 400 people.



GEOGRAPHICAL COORDINATES

Latitude: 43° 25' 51.50" N
Longitude: 9° 54' 13.43" E

BASIC INFORMATION

Construction year: 1996
Constructor: IRIDRA
Source of financing: partially funded by the Italian Ministry of Justice
Facility operator: unskilled personnel
Total cost: 490 834 €
Maintenance cost: 2000 € annually
Contact person: Anacleto Rizzo (rizzo@iridra.com)

LOCATION

Country: Italy
City: Isle of Gorgona
Type of climate: Csa
Average temperature: 15.8 °C
Sum of precipitation: 953mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production





Source: R. Bresciani et al. „Horizontal subsurface flow system for Gorgona penitentiary, Italy"

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 1350 m^2
Volume: 1080 m^3
Primary design factor: Inflow rate 20–80 m^3 /day; Population equivalent 400 p.e.; Population equivalent area 3.3 m^2 /p.e.
Efficiency and effectiveness: After 24 years of operation (from 1996 to 2020) of operation, the four horizontal subsurface flow cells were still working properly, complying with the "proper treatment" concept required by Italian law for treatment plants serving less than 2,000 p.e. (DL 152/06).

ECOLOGICAL POTENTIAL

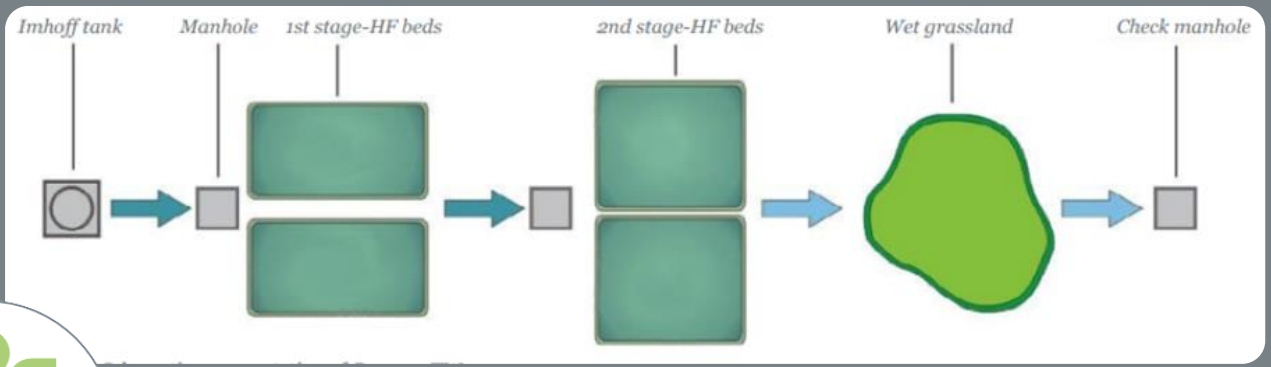
Includes services such as nutrient cycling, primary production, soil-formation, habitat provision. These make it possible for the ecosystems to continue providing services such as food supply, flood regulation and water purification.

ADVANTAGES

1. System on Gorgona Island is highly appreciated as a result of the low cost and simple maintenance of the TW. Moreover, the prisoners always feel confident in reusing the treated wastewater without any concerns for safety.

DISADVANTAGES

1. The lifespan of a nature-based solution using a subsurface flow TW is often strongly affected by clogging. Guidelines and textbooks sometimes report that filling media should be refurbished after 8–10 years because of clogging.



Source: R. Bresciani et al. „Horizontal subsurface flow system for Gorgona penitentiary, Italy"
Source: K. Ćwik / Agencja – wyborcza.pl

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

VERTICAL SUBSURFACE FLOW TREATMENT WETLAND+POND FOR < 50 PE

OBJECT INFORMATION

Name: Single family treatment hybrid
Type of facility: VSSF + pond
Treated medium: domestic WW
Description of the solution: The adopted WW treatment technology provides for multi-stage WWTP processes in mechanical and biochemical processes. The treatment processes take place both in the mechanical part (sedimentation tank) and in the biological part (hydrophyte bed and polishing pond). The biological process of WW treatment is carried out in a single wetland bed with a VF of WW, and then it is polished in a pond.



BASIC INFORMATION

Construction year: 2009
Constructor: Investment under GUT's guidance
Source of financing: Co-financed Ministry of Science and Higher Education,
Total cost: 2300 €
Facility operator: individuals
Maintenance cost: 250 € / year
Contact person: Magdalena Gajewska (mgaj@pg.edu.pl)

GEOGRAPHICAL COORDINATES

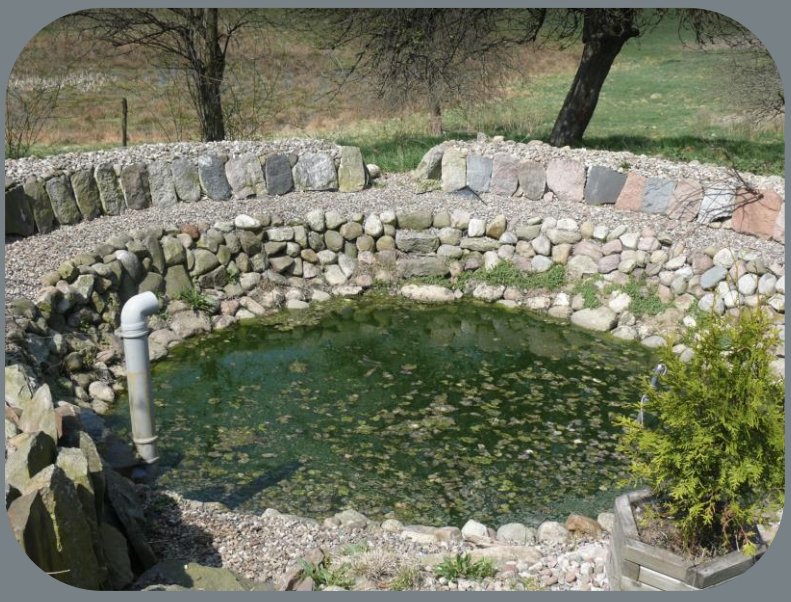
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Longitude: 17° 55' 45" E

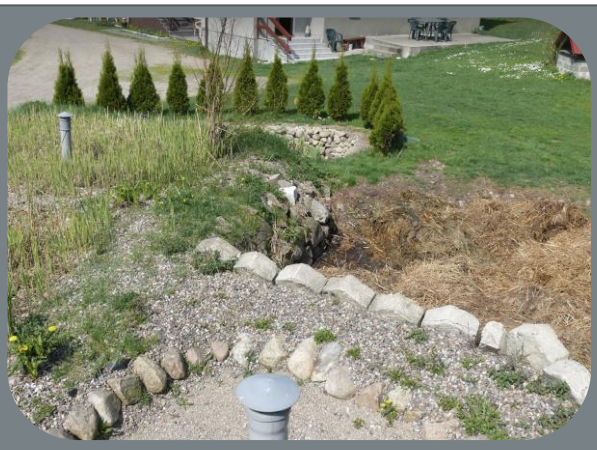
LOCATION

Country: Poland
City: Bolwerk
Type of climate: Cfb
Average temperature: 8°C
Sum of precipitation: 759 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production





Source: M. Gajewska

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 16 m^2
Volume: 12 m^3
Efficiency and effectiveness: pollution removal efficiency - BOD_5 = 90%, COD = 85%, TN = 50%,
TP =50%
Operating experience: The wastewater treatment plant using the hydrophyte method of wastewater treatment reaches full efficiency after about 3 years of operation.

ECOLOGICAL POTENTIAL

The application of treatment wetlands for single-family effluent is an effective and sustainable solution for wastewater treatment in the rural areas. The removal of pollutants is high without using additional chemicals. In addition, this facility has low energy consumption.

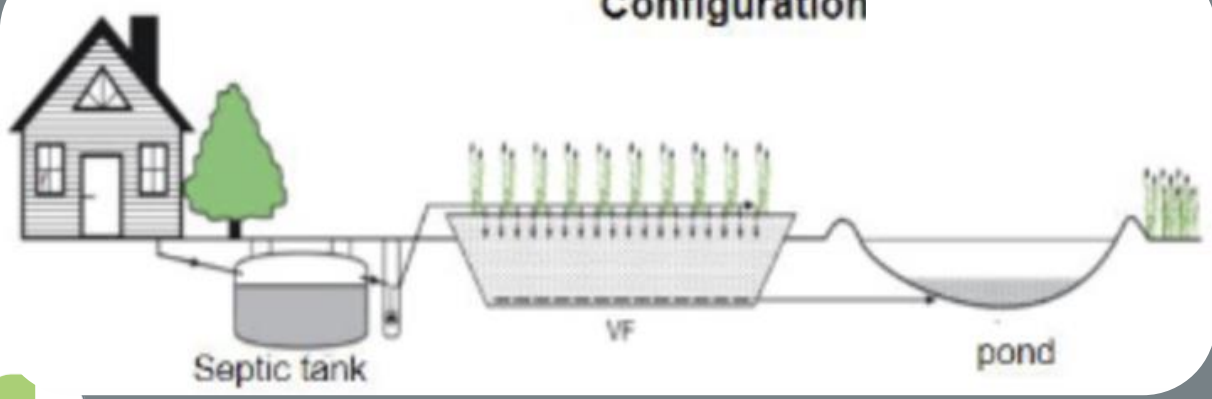
ADVANTAGES

1. No formation of secondary (biological) sewage sludge.

DISADVANTAGES

1. As a result of transpiration, the amount of sewage discharged in the summer period may be significantly reduced even up to 50% of the initial volume.

Configuration



Source: M. Gajewska

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

VERTICAL SUBSURFACE FLOW TREATMENT FOR WASTEWATER REUSE AND RESOURCE RECOVERY

OBJECT INFORMATION

Name: Water cycle: the Lesvos experiment in the HYDROUSA project
Type of facility: VSSF
Treated medium: domestic sewage
Description of the solution: The domestic wastewater produced by the town of Antissa is treated both to produce an effluent suitable for reuse in irrigation and to recover resources, such as nutrients and energy, that can be exploited elsewhere. The TW is designed with 4 types and consists of 4 VF beds. One VF bed has dimensions of 18,0x8,5m, which is about 150m^2. The entire vegetation area on the facility is 600m^2.



GEOGRAPHICAL COORDINATES

Latitude: 39° 16' 27" N
Longitude: 26° 16' 40" E

BASIC INFORMATION

Construction year: 2010
Constructor: project HYDROUSA
Source of financing: Horyzont 2020 funds
Facility operator: HYDROUSA
Total cost: 136 000 €
Maintenance cost: 12 000 € / year
Contact person: Fabio Masi (masi@iridra.com)

LOCATION

Country: Greece
City: Lesvos
Type of climate: Csa
Average temperature: 17.6 °C
Sum of precipitation: 739mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production



Source: F. Massi "Economia circolare nel ciclo delle aque e sicurezza alimentare: l'esperimento di lesbo nel progetto hydrousa"



Source:S. Prost-Boucle; N. Wepierre et al.. "Wastewater treatment in island locations"

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
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TECHNICAL DATA

Area of the facility: 950m^2
Volume: 100m^3
Inflow:
10 m^3/d winter
100 m^3/d summer
Efficiency and effectiveness: BOD<10mg/l, TSS<10mg/
Dominant plant species: *Phragmites Australis, Typha latifolia, Iris pseudacorus, Carex spp, Scirpus lacustris*

ECOLOGICAL POTENTIAL

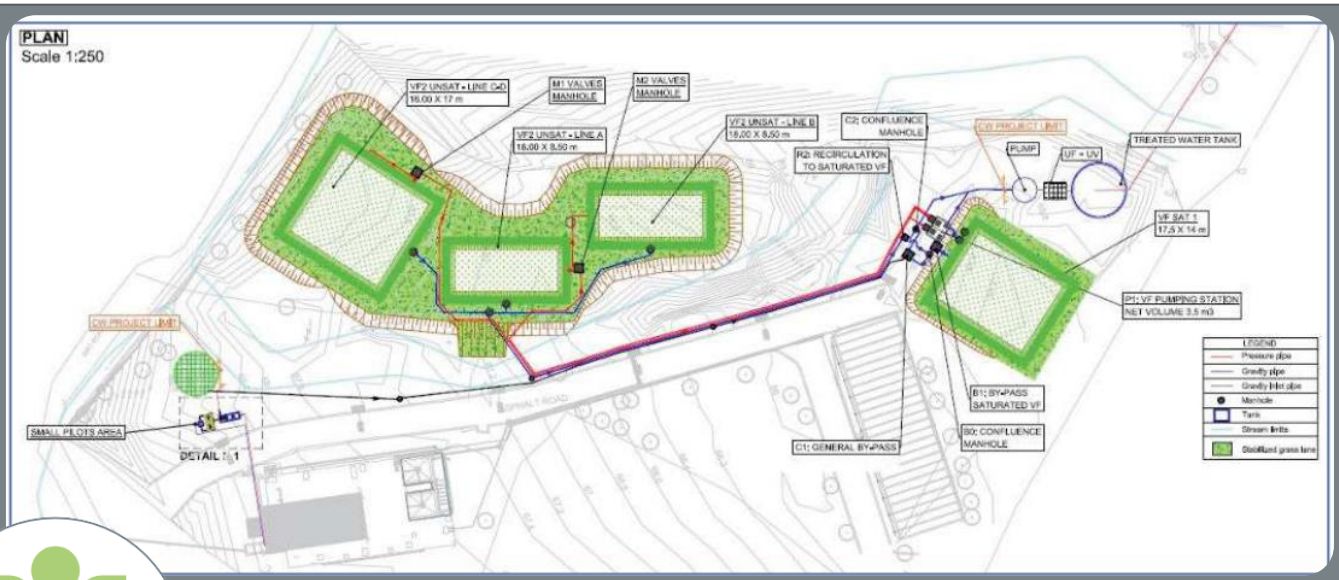
This system delivers higher performance than activated sludge treatment, for less than 1/3 of the investment cost. The agri-forestry area produces more than 3 tons of vegetables, fruit, cereal grains and herbs per year.

ADVANTAGES

1. The facility is able to remove 90% of pathogenic bacteria and 70% of TSS.

DISADVANTAGES

1. Poor levels of nitrogen removal.



Source: F. Massi "Economia circolare nel ciclo delle aque e sicurezza alimentare: l'esperimento di lesbo nel progetto hydrousa"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

FREE WATER SURFACE TREATMENT WETLAND AS A TERITARY TREATMENT

OBJECT INFORMATION

Name: Ekeby FWS-TW
Type of facility: FWS-TW
Treated medium: domestic WW
Description of the solution: Ekeby wetland is situated on arable land consisting of a 5-15m layer of fine clay. The wetland area including canals is 300 000 m^2 and the wetland area is 280 000 m^2. It receives tertiary treated WW from the WWTP and the total volume is 300 000 m^3 divided into eight ponds. The incoming water flows passively and it is distributed into a canal leading the water into five parallel ponds. The water is then collected in another distribution canal and enters subsequently three parallel ponds. Finally, the water is collected in a distribution canal and then released into the river Eskilstunaån.



GEOGRAPHICAL COORDINATES

Latitude: 59° 23' 18" N
Longitude: 16° 27' 33" E

LOCATION

Country: Sweden
City: Eskiltuna
Type of climate: Cfb
Average temperature: 6.8 °C
Sum of precipitation: 626 mm

BASIC INFORMATION

Construction year: 1999
Constructor: NCC
Source of financing: local funds
Total cost: 2 200 000 €
Facility operator: Eskilstuna Energi & Miljö
Maintenance cost: 19 200 € / year
Contact person: Sylvia Waara (sylvia.waara@iridrhh.se)



URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production

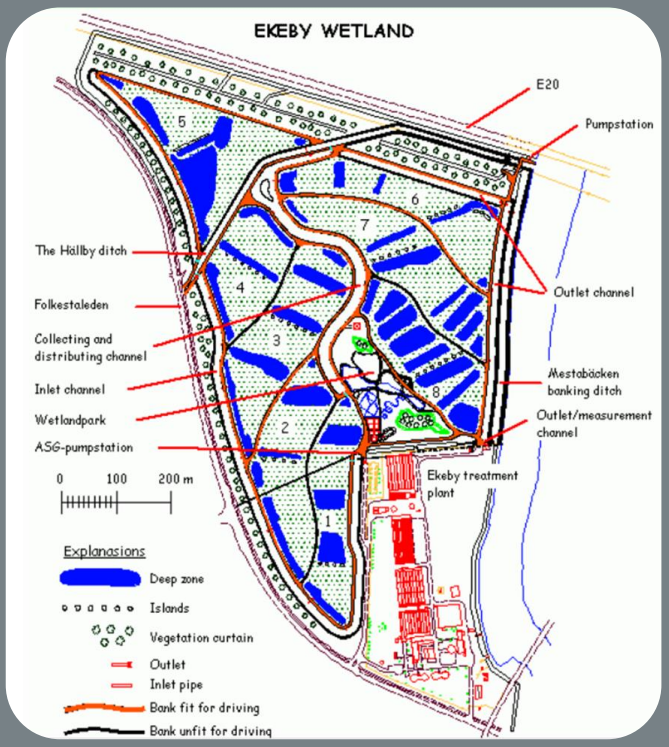
Source: S. Waara

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that that enable activities promoting health, recuperation or enjoyment through active or immersive interactions -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

ECOLOGICAL POTENTIAL

The wetlands attract diverse bird fauna. The facility allows for eco-tourism as the paths are equipped with information boards, observation towers for iwatchers and a designated area with picnic tables. Moreover, the facility cleans sewage and air through the plant species found in Eskeby.



TECHNICAL DATA

Area of the facility: 400 000m^2
Volume: 300 000 m^3
Primary design factor: Inflow rate 43 200 m^3/day; P.E.= 108 424; Population equivalent area 3.1 m^2/ PE
Efficiency and effectiveness:
Most of the nitrogen was removed during April–October but 0–30% was also removed during November–March.
Dominant plant species: *Phragmites Communius, Glyceria Maxima, Ceratophyllum Demersum*

ADVANTAGES

1. The wetland in Eskilstuna is very cost-efficient plant for the reduction of nitrogen, phosphorus and bacteria.
2. The wetland has fairly low investment cost and operation expenses.

DISADVANTAGES

1. Plants used in the TW need about 3-4 times higher investment cost, that is 4500 - 6000 € since an external source of coal must be added, too, the running expenses will be much higher (about 10 times) than for a wetland.

Source: S. Waara

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

FREE WATER SURFACE TREATMENT WETLAND AS A TERITARY TREATMENT

OBJECT INFORMATION

Name: Magle FWS-TW
Type of facility: FWS-TW
Treated medium: domestic WW
Description of the solution: Magle FWS-TW was treatment in 1995 and is situated on land consisting of forest, meadow and a peat bog. Treated waste water is pumped 1.5 km to the inlet of the wetland and then flows by gravity. The water first runs into a long distribution pond, then passes through one of four parallel ponds from where it ends in a collecting pond. It passes flow metering and a sampling point and is discharged into a ditch and transported to the lake Finjasjön. The average depth is 0.5 m, but in some places along the sides of the ponds the water depth is up to 2.5 m. The deep zones were treatment to improve denitrification and the more shallow zones designed to improve phosphorus retention and keep some areas oxygenated and vegetated.



GEOGRAPHICAL COORDINATES

Latitude: 44° 15' 2" N
Longitude: 7° 49' 50" E

BASIC INFORMATION

Construction year: 1995
Constructor: Hassleholms Vatten
Source of financing: no data available
Total cost: 1 000 000€
Facility operator: Hassleholms Vatten
Maintenance cost: 22 000 € / year
Contact person: Sylvia Waara (sylvia.waara@iridrhh.se)

LOCATION

Country: Sweden
City: Hassleholms
Type of climate: Cfb
Average temperature: 9.0 °C
Sum of precipitation: 652 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production



Source: S. Waara

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that that enable activities promoting health, recuperation or enjoyment through active or immersive interactions -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

ECOLOGICAL POTENTIAL

The wetlands attract diverse bird fauna. Magle is located in the outskirts of the city and has been designed to include opportunities for recreation and education. They enable inhabitants to understand the water cycle and the importance of an efficient wastewater treatment.



TECHNICAL DATA

Area of the facility: 90 000m^2
Volume: 26 000 m^3/day
Primary design factor: inflow rate- 12 000 m^3/day; P.E.- 31 000; P.E. area- 9.7 m^2/P.E.
Hydraulic Load: 57 mm/day
Detention Time: 7-8 days
Efficiency and effectiveness:
The removal of total nitrogen during 1996–2009 in Magle was on average 24%, equivalent to 1,066 kg/ha/year. A slightly higher value, 30%, was obtained during 2015–2017.

ADVANTAGES

1. Facility enables inhabitants to understand the water cycle and the importance of an efficient wastewater treatment.
2. For visitors, odors are rarely a problem, nor are mosquitos.

DISADVANTAGES

1. *Cladophora* cells are released, in the spring and summer, and enter the effluent, resulting in an increase of BOD_7, COD and suspended solids.

Source: S. Waara

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

FREE WATER SURFACE TREATMENT WETLAND AS A TERITARY TREATMENT

OBJECT INFORMATION

Name: TW for the tertiary treatment of WW from the municipality of Caraglio
Type of facility: conventional + NBS (FWS, SBR)
Treated medium: domestic wastewater
Description of the solution: The WWTP of Caraglio municipality (10 000 PE) treats the wastewater with a secondary activated sludge system (SBR). In order to guarantee a more constant removal efficiency of the WWTP under time variable influent loads, a tertiary stage with FWS TW was designed. The FWS treats an average wastewater flow of 720 m^3/day and has a surface area of 2100 m^2. The FWS was designed with different water depths (from 0.4 to 1.2 m), creating environments suitable for the placement of different types of vegetation.



GEOGRAPHICAL COORDINATES

Latitude: 44° 24' 56" N
Longitude: 7° 25' 54" E

LOCATION

Country: Italy
City: Caraglio
Type of climate: Cfb
Average temperature: 9. 7°C
Sum of precipitation: 1635 mm

BASIC INFORMATION

Construction year: 2017
Constructor: IRIDRA
Total cost: 1 500 000 €
Facility operator: Azienda Cuneese dell' Acqua
Maintenance cost: 5 000-7 500 € / year
Contact person: Anacleto Rizzo (rizzo@iridra.com)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse





Source: IRIDRA

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 2100 m^2
Volume: 1050 m^3
Primary design factor: 10 000 P.E., average daily flow rate: 720 m^3/day
Efficiency and effectiveness:
Removal rates for SBR :
TSS – 94%, BOD_5 – 97%, COD – 95%, TN – 83%, TP – 78%.
Operational experience: Reduction of the quantity of sludge extracted from biological reactors from 15 to 9 m^2 per day.

ECOLOGICAL POTENTIAL

Potentials include: water supply (groundwater supply, drinking and irrigation use), use of plants present in wetlands (e.g. raw materials for food, cosmetics etc.), presence of free animals such as migratory birds. It is a great contribution to biodiversity. Also, there is possibility of carrying out recreational and educational activities.

ADVANTAGES

1. The facility can be utilized in rural areas where access to land is typically better than in urban areas.

DISADVANTAGES

1. FWS TWs are reportedly employed less frequently due to the significant risk of human and animals exposure to pathogens.



Source: IRIDRA

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HYBRID TREATMEMT WETLAND >50 PE

OBJECT INFORMATION

Name: Hybrid treatment wetland in Kniewo
Type of facility: VSSF + HSSF
Treated medium: domestic sewage
Description of the solution: HTW was designed for 60 PE and consists of VSSF bed followed by HSSF bed. The assumed technology of the treatment wetland in Kniewo provides WW treatment in mechanical processes (sedimentation, flotation) and biochemical processes (microbiological decomposition of contaminants in oxidation and reduction processes as well as absorption and adsorption). The treatment processes take place both in the mechanical part (three chamber sedimentation tank with 3 days retention time) and in the biological part – HTW. After the HTW treated effluent is discharged to drainage system. As filling material in both beds (SSVF and SSHF) gravel of granulation 2–8 mm was used. Beds were planted with local species of common reeds (*Phragmites australis*) with density 4 pcs/m^2.



GEOGRAPHICAL COORDINATES

Latitude: 54° 39' 50" N
Longitude: 18° 07' 12" E

BASIC INFORMATION

Construction year: 2018
Constructor: Salesian Youth Center in Kniewo
Source of financing: private funds
Facility operator: Salesian Youth Center in Kniewo
Total cost: 10 000 €
Maintenance cost: 1 000-1 500 € / year
Contact person: Magda Kasprzyk (magkaspr@pg.edu.pl)

LOCATION

Country: Poland
City: Kniewo
Type of climate: Cfb
Average temperature: 8.7°C
Sum of precipitation: 771 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production



Source: M. Kasprzyk

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility:
VSSF bed - 72 m^2
HSSF bed - 48 m^2
Efficiency and effectiveness: TSS – 68%, COD – 94%, turbidity – 94%, NH_4-N – 96%, PO_4-P – 84%
Operating experience: Facility works properly. After 4 years of operation over 90% of area is cover by reed.
Dominant plant species: *Phragmites australis*
Type of substrate: gravel of granulation 2–8 mm

ECOLOGICAL POTENTIAL

Wetlands are the habitat of various plants and microorganisms, creating favorable conditions for various microbiological processes. High biodiversity is conducive to wastewater treatment processes and at the same time ensures their natural course. An additional advantage of using the technology of wetlands for wastewater treatment is the lack of secondary (biological) sewage sludge formation.

ADVANTAGES

1. Simple construction and operation process.
2. Overall low energy consumption.
3. No formation of secondary (biological) sewage sludge.

DISADVANTAGES

1. Improper construction can cause operational problems.
2. Requirement for a constant wastewater flow and usage of energy.





Source: M. Kasprzyk

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HYBRID TREATMENT WETLAND + POND
< 50 PE

OBJECT INFORMATION

Name: Single family TW in Borucin and Łączyno
Type of facility: VSSF I + VSSF II + pond
Treated medium: domestic sewage
Description of the solution: The adopted technology enables multi-stage WW treatment processes in mechanical and biochemical processes. The purification processes take place both in the mechanical and biological parts. The biological process of WW treatment is carried out in wetlands with VF, then the treated wastewater is purified in a pond. Purification in vertical beds takes place thanks to the processes of filtration, sorption, and biochemical oxidation and reduction reactions.



GEOGRAPHICAL COORDINATES

Borucin:
Latitude: 54° 17' 1" N
Longitude: 17° 58' 14" E
Łączyno:
Latitude: 54° 16' 7" N
Longitude: 18° 0' 22" E

BASIC INFORMATION

Construction year: 2009
Constructor: Investment under GUT's supervision
Source of financing: Co-financed by Ministry of Science and Higher Education,
Total cost: 2300 €
Facility operator: individuals
Maintenance cost: 250 € / year
Contact person: Magdalena Gajewska (mgaj@pg.edu.pl)

LOCATION

Country: Poland
City: Borucin / Łączyno
Type of climate: Cfb
Average temperature: 7,9 °C
Sum of precipitation: 759 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production





Source: M. Gajewska

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 18,5 m^2
Volume: 15 m^2
Efficiency and effectiveness: pollution removal efficiency - BOD_5 = 90%, COD = 85%, TN= 50%, TP =50%
Operating experience: The wastewater treatment plant using the hydrophyte method of wastewater treatment reaches full efficiency after about 3 years of operation.

ECOLOGICAL POTENTIAL

The wetland sewage treatment plant ensures waste-free management of domestic wastewater generated on the territory of an individual farm, treated sewage will be transformed into full-value fertilizer. During the growing season, they are used for irrigation of greenery.

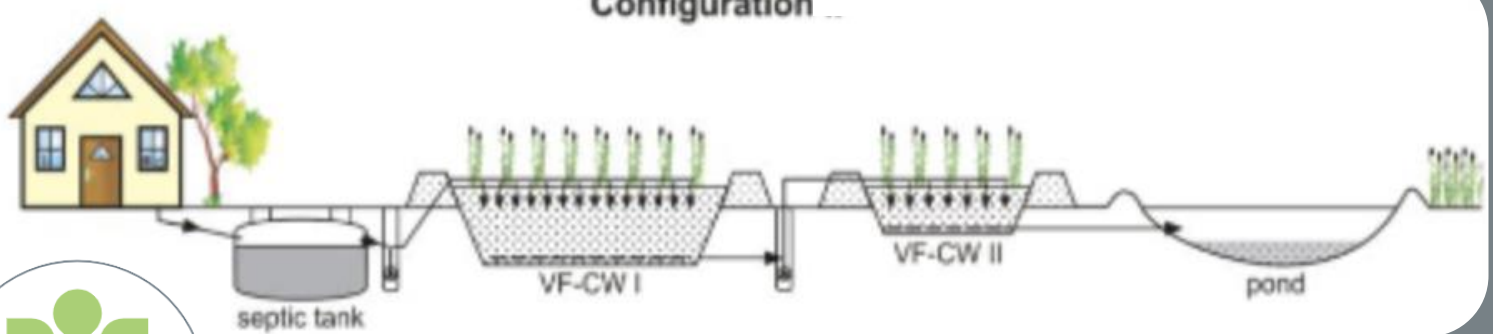
ADVANTAGES

1. No formation of secondary (biological) sewage sludge.

DISADVANTAGES

1. As a result of transpiration, the amount of sewage discharged in the summer period may be significantly reduced even up to 50% of the initial volume.

Configuration



Source: M. Gajewska

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HIGH RATE ALGAE POND + TREATMENT WETLAND

OBJECT INFORMATION

Name: HRAP for Almería Metropolitan Area – East
Type of facility: HRAP + TW
Treated medium: domestic sewage
Description of the solution: This experimental plant was installed at El Toyo WWTP, a medium-size plant located in the outskirts of Almeria (Andalusia, Spain). The projects aimed at comparing under real conditions a conventional WWTP with an hybrid alternative treatment that combines a semi extensive wastewater treatment systems such as HRAP, a Dissolved Air Flotation Unit (DAFAST) unit to separate algae biomass from treated wastewater and an extensive wastewater treatment systems such as SSVF.



GEOGRAPHICAL COORDINATES

Latitude: 36° 50' 28" N
Longitude: 2° 24' 41" W

BASIC INFORMATION

Construction year: 2018
Constructor: URCI consultores
Source of financing: LIFE BIOSOLWARE and H2020 SABANA project
Facility operator: General Secretariat for Water. GIASA Regional Government of Andalusia.
Total cost: 1 500 000 €
Maintenance cost: 5 000-8 000 € / year
Contact person: Raul Cano (raul.cano.herranz@fcc.es)

LOCATION

Country: Spain
City: Almeria
Type of climate: BSk
Average temperature: 17.4 °C
Sum of precipitation: 221mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production

Source: R. Cano



ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility:
Microalgae raceway pond - 3000m^2
Treatment wetland - 200m^2
Volume: 900m^3
Primary design factor: 50 000 PE capacity- 13,000 m^3/day
Efficiency and effectiveness: >90% COD, >65% TP, >60% TN (microalgae raceway pond); >90% TSS and Turbidity (TW)
Hydraulic load or HRT:
Microalgae pond->3.5-5 days
Treatment Wetland->80L/m^2/day

ECOLOGICAL POTENTIAL

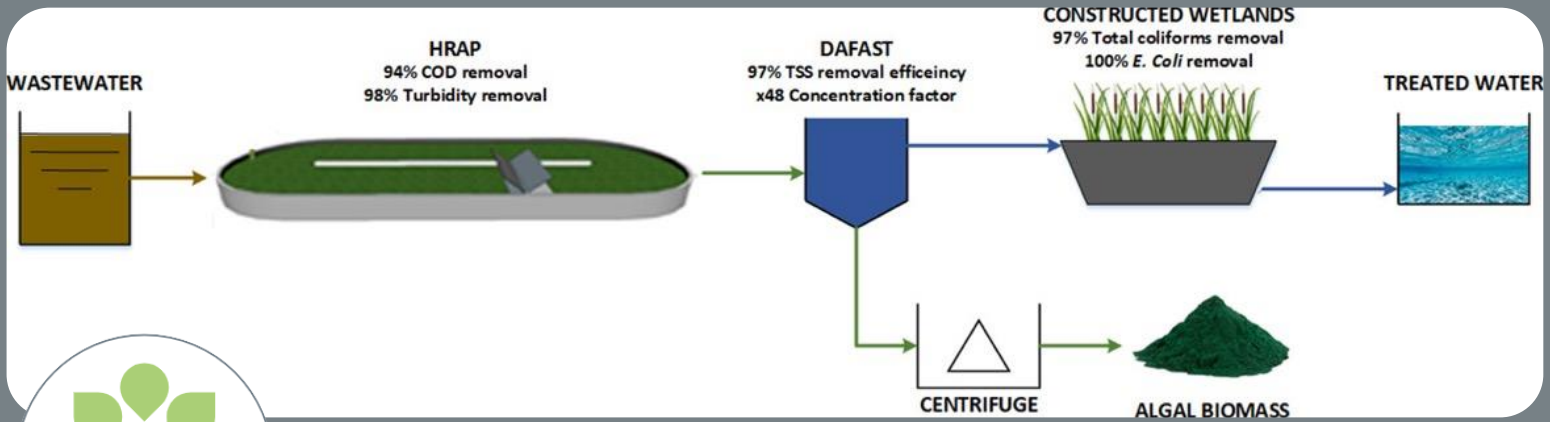
Allows treatment of wastewater that can be made available for reuse. It also helps recover nutrients in biomass and prevents eutrophication through wastewater treatment. It is a very energy efficient system in comparison to conventional wastewater treatment.

ADVANTAGES

1. Low energy consumption.
2. Simple maintenance and operation compared to conventional wastewater treatment technologies.
3. Production of algae biomass and biogas.

DISADVANTAGES

1. Larger carbon footprint than conventional wastewater treatment technologies.



Source: urciconsultores.com/en/new-wastewater-treatment-plant-in-almeria

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HIGH RATE ALGAE POND + TREATMENT WETLAND

OBJECT INFORMATION

Name: HRAP VSSF + TW in Agramon
Type of facility: HRAP+VSSF
Treated medium: domestic sewage
Description of the solution: Demonstrative plant built in the small town of Agramón (Hellín, Spain). The project aimed at building a demonstrative HRAP with Dissolved Air Flotation Unit (DAFAST) unit and VF used as clarifiers to separate algae biomass from treated wastewater. The HRAP demo plant consists of a 10 000 m^2 raceway with SSVF consisting of four 50 m^2 beds.



LOCATION

Country: Spain
City: Agramon / Albacete
Type of climate: Csa
Average temperature: 14.6 °C
Sum of precipitation: 379mm

GEOGRAPHICAL COORDINATES

Latitude: 38° 25' 18" N
Longitude: 1° 38' 17" W

BASIC INFORMATION

Construction year: 2022
Constructor: Aqualia FCC
Source of financing: H2020 SABANA project
Facility operator: Aqualia FCC
Total cost: 2 500 000 €
Maintenance cost: 6 000-13 000 € / year
Contact person: Angel Encinas (angel.encinas.bogeat@fcc.es)



URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production



Source: A.Encinas

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TECHNICAL DATA

Area of the facility:
Microalgae raceway pond - 10 000m^2
Treatment wetland - 200m^2
Volume: 3000m^3
Hydraulic load or HRT: 8 days (microalgae raceway pond) ;600 L/m^2/day (TW)
Operating experience: Simple maintenance and operation compared to conventional wastewater treatment technologies.

ECOLOGICAL POTENTIAL

Includes services such as water purification, carbon sequestration (algae) and reduced energy consumption (helping with climate regulation) and waste decomposition. This facility provides habitat for plants, insects and amphibians.

ADVANTAGES

1. Low energy consumption.
2. Simplicity of operation during first year of operation. Operational problems are limited to scarce mechanical equipment (pumps, valves, blowers).
3. Production of algae biomass and biogas.

DISADVANTAGES

1. Larger carbon footprint than conventional wastewater treatment technologies.



Source: A.Encinas

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

FRENCH REED BEDS + HORIZONTAL SUBSURFACE FLOW TREATMENT WETLAND FOR WASTEWATER, 80 PE

OBJECT INFORMATION

Name: Garelli shelter natural WWTP system (80 PE)
Type of facility: FRB + HSSF
Treated medium: domestic WW
Description of the solution: The system has five basins, arranged in two treatment stages: VSSF and then HSSF; it is designed to manage the treatment of the grey and black waters of the facility, without the need of pre-treatment systems, except for a screen for mechanical filtering. The "French style" scheme consist of:
(i) pre-treatment with manual screen/degreaser;
(ii) first stage with three parallel VSSF where the three basins work by rotation with cycles of 2-3 days use and 46 days rest;
(iii) second stage with two parallel HSSF
The system works completely by gravity with no energy, due to a self-activating siphon that feeds the FRB. The FRB were chosen to limit the extension of the system and to avoid the extraction and management of sludge, which is difficult and costly at high altitudes.



GEOGRAPHICAL COORDINATES

Latitude: 44° 15' 2" N
Longitude: 7° 49' 50" E

LOCATION

Country: Italy
City: Chiuso di Pesio
Type of climate: Cfb
Average temperature: 8.5 °C
Sum of precipitation: 1347 mm

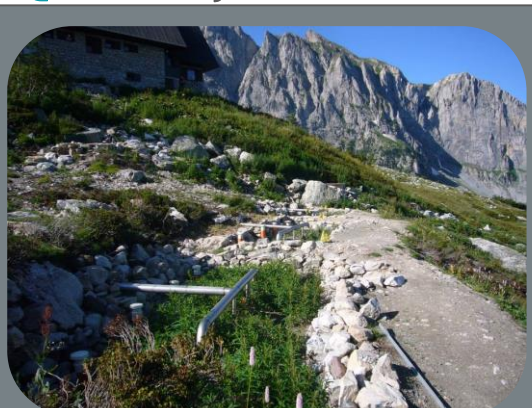
URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse

BASIC INFORMATION

Construction year: 2014
Constructor: IRIDRA Company, Sinbio
Source of financing: Interreg project ALCOTRA
Total cost: 58 000 €
Maintenance cost: 2 000-3 000 € / year
Contact person: Fabio Massi (massi@iridra.com)





Source: IRIDRA

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 85m^2; FRB - 45m^2 ; HF - 40m^2
Volume: 68m^3
Primary design factor: 80 PE; average flow: 2.9 (week) – 4.7 (weekend) m^3/d
Efficiency and effectiveness:
TSS – 89% BOD_5 – 89% TKN – 46%
Dominant plant species: for FRB: *Epilobium angustifolium, Carex rostrate;* for HF *Rumex alpinus and Deschampsia caespitosa*

ECOLOGICAL POTENTIAL

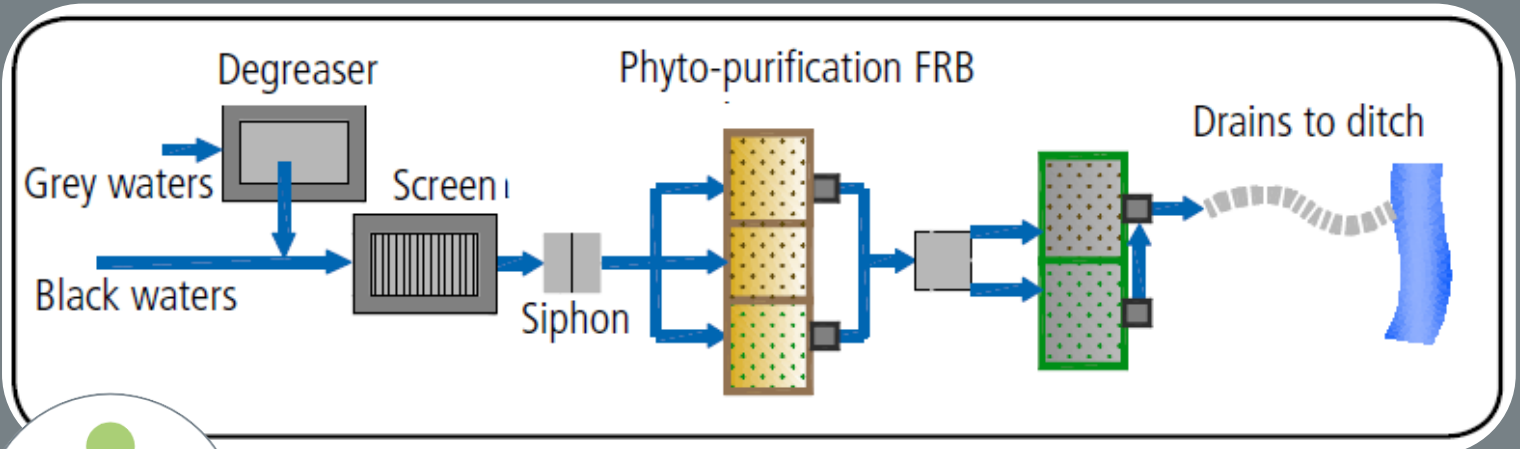
The use of plants present in wetlands allows for raw materials for food, cosmetics and medical products such as, fodder, wood, paper production, fertilizers. Moreover, it is a great contribution to biodiversity. It can serve as a possible energy source.

ADVANTAGES

1. The TW demonstrates that the lifespan of such facilities can be maintained even in high altitude in demanding environment.

DISADVANTAGES

1. The main disadvantage is that the facility had numerous design constraints.



Source: R.Bresciani et al. „Guidelines on constructed wetland for wastewater treatment in the alpine environment"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HYBRID TREATMENT WETLAND FOR WASTEWATER

OBJECT INFORMATION

Name: TW in Jougar
Type of facility: HTW
Treated medium: domestic WW
Description of the solution: A combined VSSF and HSSF TW systems, designed for rural domestic WW treatment and with theoretical HRT of 2 days and 3.6 days. Several water quality parameters including pH, BOD_5 , COD, TSS, TKN and TP, and fecal bacteria's number in both raw and treated wastewaters were monitored during a macrophyte life cycle.



LOCATION

Country: Tunisia
City: Jougar
Type of climate: BWh
Average temperature: 19.4 °C
Sum of precipitation: 196mm

GEOGRAPHICAL COORDINATES

Latitude: 36° 29' 34" N
Longitude: 9° 56' 55" E



Source: maps.google.com.pl

BASIC INFORMATION

Construction year: 2004
Constructor: Centre International des Technologies de l'Environnement de Tunis (CITET)
Source of financing: Tunisian government (SERST)
Facility operator: CITET
Total cost: 20 000 €
Maintenance cost: 600 € / year
Contact person: Soulwene Kouki (kouso2004@yahoo.fr)

URBAN CIRCULARITY CHALLENGES

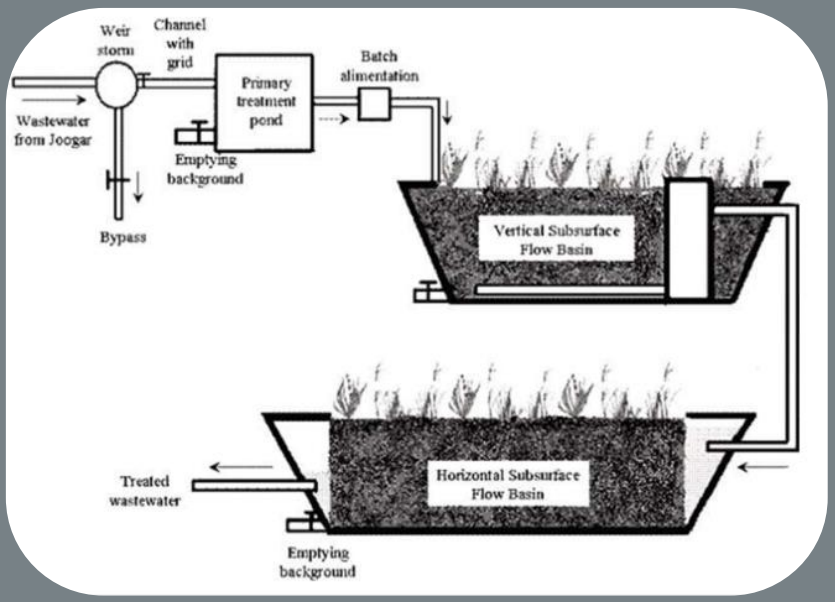
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UCC_3- nutrient recovery and reuse
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UCC_5- food and biomass production

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TECHNICAL DATA

Area of the facility: Sum -328m^2
VF -121m^2 HF - 207m^2
Volume: 492m^3
Catchment: 170 000m^2
Efficiency and effectiveness: The main treatment performance results showed the following average removal rates: BOD_5 (93 ± 2%), COD (89 ± 3%), TSS (98 ± 1.5%), TKN (38 ± 19%), TP (72 ± 16%).



ECOLOGICAL POTENTIAL

This facility is one of the pilot NBSs in Tunisia treating wastewater. Wetlands were used for researches that would enable the improvement of physicochemical and biological parameters of wastewater in the future.

ADVANTAGES

1. The facility serves a population of almost 1000 inhabitants, which equals to a one whole village.
2. TWs system had a good capacity to reduce BOD_5, COD, TSS and fecal bacteria.

DISADVANTAGES

1. The TWs system had a good capacity to reduce BOD_5 , COD, TSS and fecal bacteria, but only moderate removal efficiencies of total nitrogen and phosphorus were recorded during the monitoring period.

Source: S. Kouki „Performances of a constructed wetland treating domestic wastewaters during a macrophytes life cycle:"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

INNOVATIVE – FRB + VSSF + FWS-TW FOR GROUND WATER RECHARGE

OBJECT INFORMATION

Name: TW system for wastewater treatment in the village of Castelluccio di Norcia
Type of facility: FRB + VSSF + FWS-TW
Treated medium: urban wastewater
Description of the solution: The plant represents an innovation in the French system of purification. In the first stage ,in FRB, the solids accumulate on the surface. The second stage consists of two VSSF basins. The effluent is finally reused for groundwater recharge, by an infiltration area connected to a subirrigation trench.



LOCATION

Country: Italy
City: Casteluccio di Norcia
Type of climate: Cfb
Average temperature: 9.2 °C
Sum of precipitation: 1150mm

GEOGRAPHICAL COORDINATES

Latitude: 42° 49' 2.64" N
Longitude: 13° 12' 1.26" E

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse

BASIC INFORMATION

Construction year: 2012
Constructor: IRIDRA
Source of financing: region of Umbria
Facility operator: qualified personnel
Total cost: 395 000 €
Annual maintenance cost: 5531 €
Contact person: Fabio Masi (masi@iridra.com)





Source: IRIDRA „Treatment wetlands system for wastewater treatment in the village of Casteluccio Di Norcia"

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 3100 m^2
Volume: 2170 m^3
Catchment: 8.5 km^2
Primary design factor: water quality targets: COD 160 mg L^{-1};BOD_5 40 mg L^{-1};N-NH_4^+ 25 mg L^{-1}; TSS 80 mg L^{-1}
Efficiency and effectiveness: The effluent concentrations of the FRB WWTP of Castelluccio di Norcia were stable below the water quality targets, with high mean removal efficiencies for COD, BOD_5, TN, N-NH_4^+, TP and TSS.

ECOLOGICAL POTENTIAL

Includes services such as nutrient cycling, primary production, soil-formation, habitat provision. These make it possible for the ecosystems to continue providing services such as food supply, flood regulation and water purification.

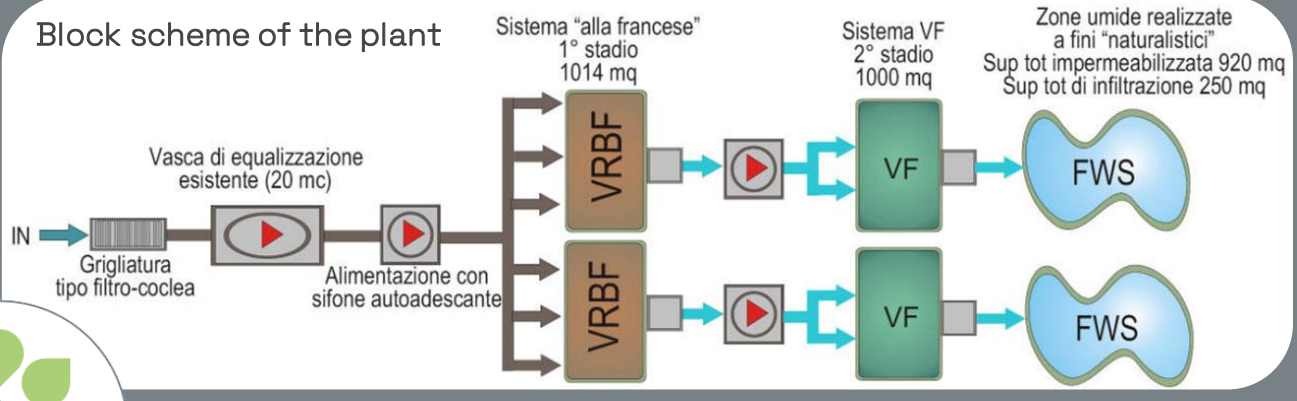
ADVANTAGES

1. Does not require the primary treatment system (septic tank or Imhoff tank). Consequently, FRB is an attractive solution to minimize the operational and maintenance costs of wastewater treatment from small settlement.

DISADVANTAGES

1. The FRB construction costs (364–394€ PE–1) were slightly high.
2. The choice of a treatment wetland system was dictated by strong fluctuation of the inhabitants, from a few dozen in the winter, to 1000 P E during summer and weekends.

Block scheme of the plant



Source: IRIDRA „Constructed wetlands system for wastewater treatment in the village of Casteluccio Di Norcia"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

MULTISTAGE TREATMENT WETLAND FOR AGRICULTURAL REUSE

OBJECT INFORMATION

Name: WWTP for agricultural water reuse from Chorfech village
Type of facility: HTW
Treated medium: domestic WW
Description of the solution: The WW is primarily treated by an Imhoff tank in order to remove part of the solids to reduce the risk of clogging of the filter bed. The primary effluent is entering a hybrid TW system composed of three stages: HF wetland, VF wetland and finally a second HF wetland.

LOCATION

Country: Tunisia
City: Chorfech
Type of climate: Csa
Average temperature: 18.7 °C
Sum of precipitation: 444mm

GEOGRAPHICAL COORDINATES

Latitude: 36° 54' 59" N
Longitude: 10° 4' 43" E

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production

CHORFECH



BASIC INFORMATION

Construction year: 2008
Constructor: IRIDRA
Source of financing: European Commission and the national partners of the project
Facility operator: no data available
Total cost: 72000€
Maintenance cost: 1000€ / year
Contact person: Anacleto Rizzo (rizzo@iridra.com)

Source: iridra.eu



ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
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TECHNICAL DATA

Area of the facility: without the Imhoff tank about 1800 m^2
Volume: 1590 m^3
Efficiency and effectiveness:
Between May and June 2010, a monitoring campaign was carried out and the mean overall removal rates performed by the plant were respectively: 97% for TSS, 95% for COD and 97% for BOD_5, 71% for TN and 82% for TP.

ECOLOGICAL POTENTIAL

The WWTP implemented in Chorfech, is mainly meant as a demonstration of sustainable water management solutions (low-cost wastewater treatment).

ADVANTAGES

1. Increasing the available water for agricultural activities and solving the issue of uncontrolled wastewater discharge in the drainage channel nearby.

DISADVANTAGES

1. Clogging issues arise after the wine season.
2. Difficulties with calculating the issue of hydraulics in the facility.

1. Imhoff tank
2. 1st stage HF-TW
3. 2nd stage VF-TW
4. Reservoir
5. 3rd stage HF-TW
6. Outlet to drainage
7. Sludge bed



Source: A. Ghrabi et al.."A multistage constructed wetland for wastewater treatment of small rural agglomeration in Tunisia"

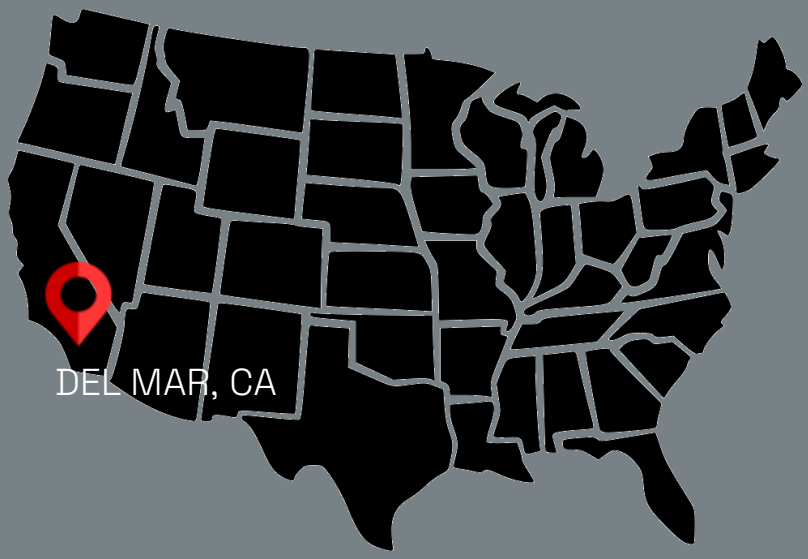
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This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

MULTISTAGE FREE WATER SURFACE TREATMENT WETLAND, 50 – 1000 PE

OBJECT INFORMATION

Name: Del Mar Fairgrounds TW
Type of facility: HTW
Treated medium: domestic WW
Description of the solution: The treatment facility includes backstretch conveyance infrastructure, lift stations, a settling (East) pond, a TW system (West Pond), and a WW treatment facility. Designing a TW system that features both VF and HF TWs in an optimal sequence was an ideal design solution given the limited space within the Fairgrounds. Combined with proper maintenance and plant harvesting, this treatment wetland system removes 50% - 75% of nutrients from effluent.



GEOGRAPHICAL COORDINATES

Latitude: 38° 55' 49" N
Longitude: 6° 24' 21" W

BASIC INFORMATION

Construction year: 2020
Constructor: Great Ecology
Source of financing: Start-up funding
Facility operator: 22nd District Agricultural Assosciation
Total cost: 1 500 000 €
Maintenance cost: 10 000-13 000 € / year
Contact person: info@greatecology.com

LOCATION

Country: United States of America
City: Del Mar, CA
Type of climate: Csc
Average temperature: 16.4 °C
Sum of precipitation: 379 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production





Source: greatecology.com

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 44 500 m^2
Volume: 65 000m^3
Efficiency and effectiveness: The facility fulfils the assumed infiltration and outflow functions.
Operational experience: Great Ecology was part of an interdisciplinary team led by Fuscoe Engineering to tackle the challenge of treating surface water runoff from the Del Mar Fairgrounds to meet Regional Board discharge requirements.

ECOLOGICAL POTENTIAL

The treatment wetlands system is visually appealing, which is important given its prominent location on the Del Mar racetrack. The content of water and plants have a positive effect impact on the microclimate.

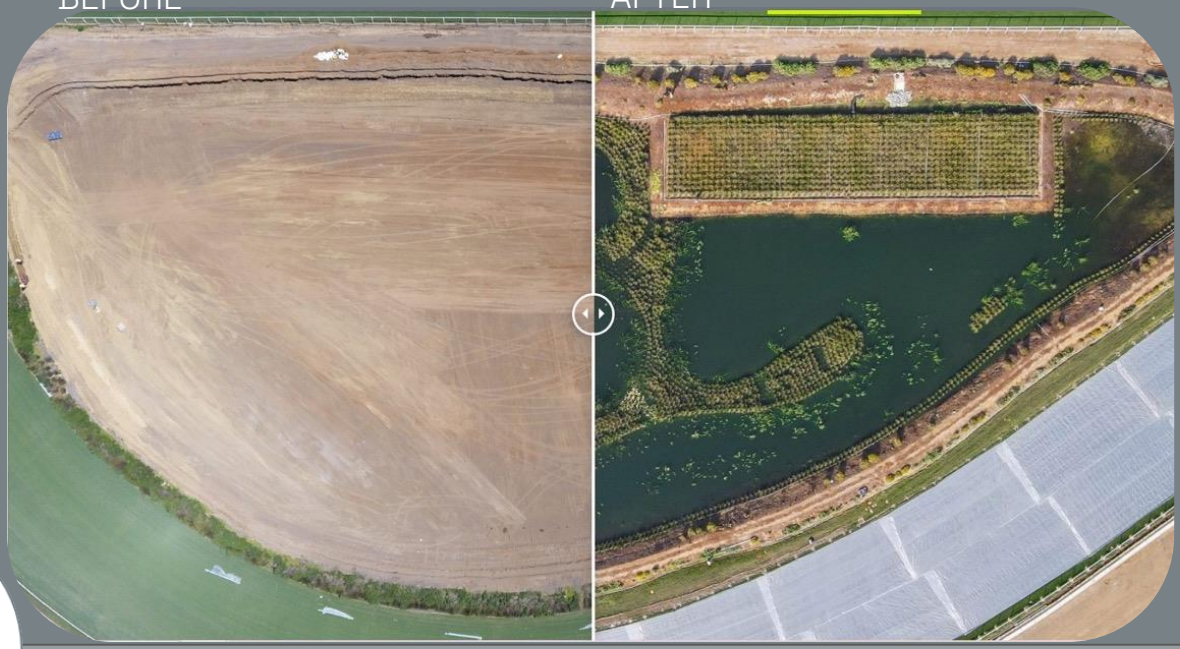
ADVANTAGES

1. Pre-treatment of water.
2.Providing a habitat for birds and small animals.
3. Absorbing air pollution and reducing heat in the summer.

DISADVANTAGES

1. Necessary operational works, ensuring i.e. patency of the inflow and proper development of plants.

BEFORE AFTER



Source: greatecology.com

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HYBRID TREATMENT WETLAND WITH ELECTORATIVE BACTERIA BASED SYSTEM

OBJECT INFORMATION

Name: Imetland system, Electroactive bacteria based system WWTP
Type of facility: HTW with electroactive bacteria based system
Treated medium: domestic wastewater
Description of the solution: The treatment system was designed to treat the wastewater produced by 200 p.e., in 2018 at Ørby, Haderslev in the rural area of Southern Denmark. The wastewater treatment plant receives primary treated waters from 40 households. Each house has its own sedimentation tank of at least 2m^3 capacity and all the wastewater generated by the houses is transported to the treatment plant in separate sewer, meaning that run off or surface runoff do not come into the sewers and therefore doo not reach the treatment plant. The wastewater is treated using a planted electroactive based system, of two parallel beds, followed by an anodic oxidation disinfection system to finally be disposed by infiltration.



GEOGRAPHICAL COORDINATES

Latitude: 55° 18' 18" N
Longitude: 9° 37' 40" E

LOCATION

Country: Denmark
City: Haderslev
Type of climate: Cfb
Average temperature: 9,2°C
Sum of precipitation: 814 mm

BASIC INFORMATION

Construction year: 2018
Constructor: Kilian Water ApS
Source of financing: H2020 EU project
Total cost: ca 300.000 € (incl. VAT)
Facility Operator: Local association
Maintenance cost: 500 € per year
Contact person: Carlos A. Arias (carlos.arias@bio.au.dk)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production



Source: Carlos A. Arias

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of facility: 120 m^2 in total
Two beds of of 40 m^2, filled with electro-conductive material working in parallel, fed by a pump on the surface, with equal volume.
Pumping well, anodic oxidation disinfection system, to dispose the water in a ground infiltration system.
Houses served: 40, ca 200 p.e.
Design flow 23 m^3/d, but daily flow can change according to houses occupation.
Efficiency and effectiveness of facility: pollution removal rates: BOD_5 = 99 %; COD = 92 %; TSS = 94 %; TKN =70 %; TN = 70 %; TP = 55 %
Operating experience: simple maintenance and operation, low energy requirement and online monitoring via Wi-Fi.

ECOLOGICAL POTENTIAL

The TW integrated to the landscape, important in rural areas. The system benefits the presence of pollinators and discharges disinfected water lowering health risks to nearby coastal waters. In addition, this facility has low energy demand that can even be optimize by the installation of solar panels.



ADVANTAGES

1. Using electro bacteria based systems reduces the footprint.
2. Very low energy consumption (only a pump for feeding pulses).
3. Disinfection using solar power technology.

DISADVANTAGES

1. Electro-conductive material can be hard to find and might be expensive.
2. If operated saturated, nitrification is limited, but can be overcome by operating unsaturated.

Source: Carlos A. Arias

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HYBRID TREATMENT WETLAND FOR WASTEWATER REUSE IN URBAN HOSTEL

OBJECT INFORMATION

Name: Wastewater Reuse in an Urban College Hostel in India
Type of facility: HTW
Treated medium: domestic WW
Description of the solution: Three treatment lines have been implemented at NBS facility:
The first line - 40 m³/d of domestic wastewater through an anaerobic primary treatment and then discharges the effluent to the sewer line.
The second line treats 40 m³/d of greywater through VSSF.
The third line treats 100 m³/d of domestic wastewater through an anaerobic primary and secondary treatment as well as three VSSF for tertiary treatment.



GEOGRAPHICAL COORDINATES

Latitude: 18° 31' 28" N
Longitude: 73° 49' 28" E

LOCATION

Country: India
City: Maharashtra, Pune
Type of climate: Aw
Average temperature: 24.3 °C
Sum of precipitation: 1200mm

BASIC INFORMATION

Construction year: 2015
Constructor: College of Engineering Pune
Source of financing: 7th Framework Programme of the European Commission and DST Government of India
Facility operator: College of Engineering Pune(staff trained by IRIDRA company)
Total cost: 160 000 €
Annual maintenance cost: 2 500 € / year
Contact person: Fabio Masi (masi@iridra.com)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production



Source: F. Massi et al. „College of engineering Pune hostel campus: an Indian experience of sustainable wastewater treatment and reuse"



Source: R. Bresciani „Case study of sustainable sanitation projects. Wastewater reuse in an Urban College Hostel Pune, Maharashtra, India"

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 538m^2
Volume: 511 m^3
Primary design factor:
WW - 1054 PE; HLR 252 l/m^2
Efficiency and effectiveness:
- OM and particulate have been sufficiently processed,
- nutrients have shown quite low performances

ECOLOGICAL POTENTIAL

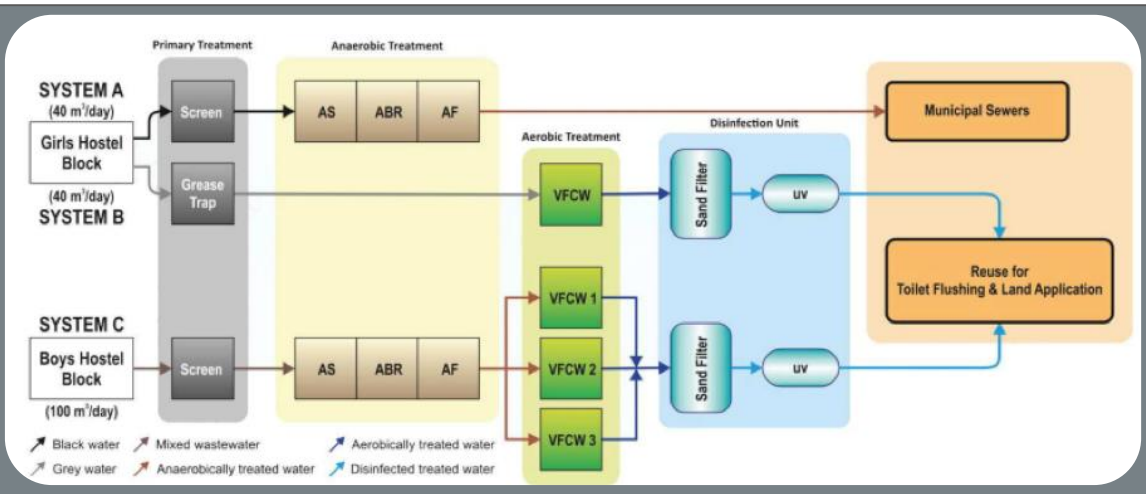
Includes services such as nutrient cycling, primary production, soil-formation, habitat provision. These make it possible for the ecosystems to continue providing services such as food supply, flood regulation and water purification.

ADVANTAGES

1. Can be operated by unskilled labor if properly trained on the functioning of the plant.
2. No need of any chemicals for the process and no parameters have to be controlled during operation, except the periodical analysis on the inlet and outlet.

DISADVANTAGES

1. To limit odors and mosquitoes, the distribution pipes are laid under a thin gravel layer.
2. To reduce the excavation volumes, the basins are partially over ground, surrounded by a brick wall that can also constitute a sitting arrangement for students but it is used without proper safety measures.



Source: F. Massi et al. „College of engineering Pune hostel campus: an Indian experience of sustainable wastewater treatment and reuse"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

FRENCH REED BEDS FOR RAW WASTERWATER TREATEMNT, 20 000 PE

OBJECT INFORMATION

Name: French VSSF beds in Orhei municipality
Type of facility: FRB
Treated medium: raw domestic WW
Description of the solution: Facility settled for the following treatment scheme:
1. A mechanical screw screen and grit.
2. A removal chamber, a flow equalization and pre-aeration tank.
3. A wetland system, divided in four lines, each of them composed of two stages in series: the first stage is a system with a FRB for raw sewage and a classical VSSF system for the second stage.
4. A final disinfection pumping system for discharge into Raut river.



GEOGRAPHICAL COORDINATES

Latitude: 47° 22' 15" N
Longitude: 28° 46' 49" E

LOCATION

Country: Moldova
City: Orhei
Type of climate: Cfa
Average temperature: 10.9 °C
Sum of precipitation: 575mm

BASIC INFORMATION

Construction year: 2012-2013
Constructor: World Bank, Global Environment Facility Project – P.I.U. Moldova Government
Source of financing: local and UE funds
Facility operator: untrained personnel
Total cost: 85 000 € / year
Contact person: Anacleto Rizzo (rizzo@iridra.com) or Fabio Masi (masi@iridra.com)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production





Source: F.Massi et al. „Large scale application of French reed beds: municipal wastewater treatment for a 20 000 inhabitant town in Moldova."

ECOSYSTEM SERVICES ACCORDING TO CICES

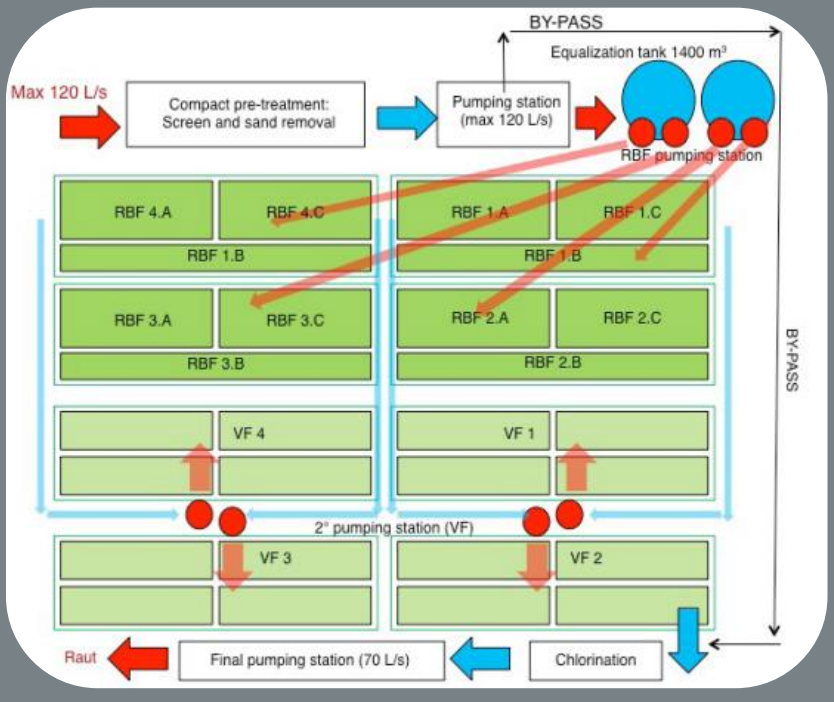
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ADVANTAGES

1. The facility is a great example of a solution that can be implemented in a medium or even a large scale.
2. The medium to large scale of the Orhei facility makes these co-benefits of high potential impact.

DISADVANTAGES

1. Higher investment costs to locate the treatment system in proximity of the reuse site.
2. Higher land occupation to meet local disinfection standards for reuse.



Source: F.Massi et al. „French vertical-flow treatment wetland in Orhei municipality, Moldova"

ECOLOGICAL POTENTIAL

Includes services such as nutrient cycling, primary production, soil-formation, habitat provision. These make it possible for the ecosystems to continue providing services such as food supply, flood regulation and water purification.

TECHNICAL DATA

Area of the facility: 34 948 m^2
Volume: 36900 m^2
Catchment: 50 000 m^2
Efficiency and effectiveness: The Orhei French VSSF was able to meet the effluent water quality standards under very low temperatures (minimum registered temperature during the monitoring was −27°C), showing constant efficient removal of TSS, COD, and BOD5 independent of the different seasons and only a partly inhibited nitrification in winter.

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

FRENCH REED BEDS WITH RECIRCULATION LOOP

OBJECT INFORMATION

Name: Bois d'Opale II
Type of facility: FRB with recirculation loop
Treated medium: domestic wastewater
Description of the solution: This treatment system was designed to treat the wastewater of a 480 p.e. residential area with a single stage composed of two cells of VF filters with water recirculation.



BASIC INFORMATION

Construction: 2011
Constructor: SEVEA;
Designer : Ecobird;
Source of financing: local founds
Total cost: 286 440 € (incl. VAT)
Maintenance cost: 4 816 € per year
Contact person: Stéphane Troesch (s.troesch@ecobird.fr)

GEOGRAPHICAL COORDINATES

Latitude: 4°58'08.5"N
Longitude: 52°27'08.9"W

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production

LOCATION

Country: France (Guyane)
City: Macouria
Type of climate: Af
Average temperature: 26,2°C
Sum of precipitation: 2560 mm





Source: S. Troesch

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
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TECHNICAL DATA

Area of facility: 392 m^2
Catchment area: 1 200 m^2
Volume: 235 m^3
Hydraulic data: Dry weather 72 m^3/d
Efficiency and effectiveness of facility: guaranteed pollution removal rates: BOD_5 = 60 %; COD = 60 %; TSS = 50 %
Operating experience: simple maintenance and operation

ECOLOGICAL POTENTIAL

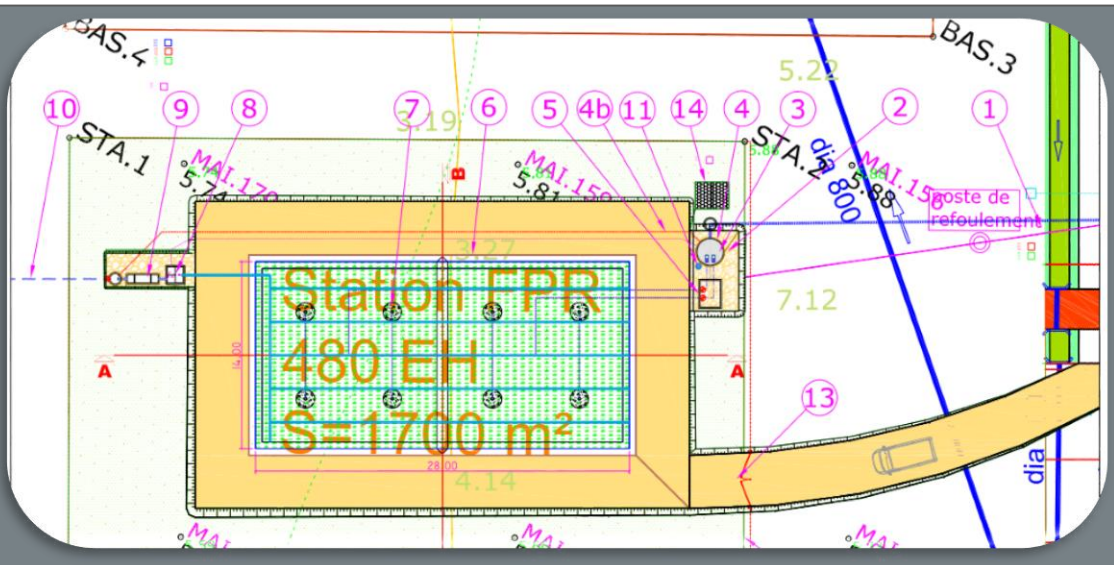
The TW provides as water purification, nutrient cycling, habitat for insects and aesthetic value by being consistent with the surrounding landscape.

ADVANTAGES

1. This type of treatment system allows the application of raw wastewater directly without pretreatment.
2. Recirculating the water on the filter allows relevant efficiencies for a single stage.

DISADVANTAGES

1. Energy consumption due to water recirculation.
2. Plants must be removed more than once a year (tropical climate).



Source: S. Troesch

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

FRENCH REED BEDS

OBJECT INFORMATION

Name: Les Halles WWTP
Type of facility: FRB
Treated medium: domestic wastewater
Description of the solution: This treatment system was designed to treat the wastewater of 800 p.e. in such a way that the treatment of phosphorus and nitrogen is achieved without electricity. For this purpose, a succession of TW was implemented and consist in: a BiHofilter®, VF, trickling filters, filtering ditches and an apatite filter (P removal).



BASIC INFORMATION

Construction year: 2013
Constructor: SAVEA
Source of financing: local funds / Water Agency
Total cost: 884 442 € (incl. VAT)
Facility operator: Communauté de communes des Monts du Lyonnais
Maintenance cost: 5 000 € per year
Contact person: Stéphane Troesch (s.troesch@ecobird.fr)

GEOGRAPHICAL COORDINATES

Latitude: 45°42'45.0"N
Longitude: 4°26'12.5"E

LOCATION

Country: France
City: Les Halles (district: Auvergne-Rhône-Alpes)
Type of climate: Cfb
Average temperature: 10°C
Sum of precipitation: 830 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production





Source: S. Troesch

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

ECOLOGICAL POTENTIAL

The TW provides water purification, nutrient cycling and aesthetic value by being consistent with the surrounding landscape. In addition, this facility has no energy consumption and provides a habitat for insects.

TECHNICAL DATA

Area of facility (filtration): 2 031 m^2 in total BiHofilter®: 961 m^2; VF: 400 m^2; VF saturated: 420 m^2; Trickling filter: 15 m^2; Filtering ditch: 92 m^2; Trickling filter: 15 m^2; Filtering ditch: 74 m^2; Apatite filter: 54 m^2
Catchment area: 9 600 m^2
Volume of filtration: 2 234 m^3 in total BiHofilter®: 1 009 m^3; VF: 360 m^3; VF saturated: 567 m^3; Trickling filter: 17 m^3; Filtering ditch: 102 m^3; Trickling filter: 17 m^3; Filtering ditch: 74 m^3; Apatite filter: 89 m^3
Hydraulic data: Dry weather: 154 m^3/d; Wet weather: 339 m^3/d
Efficiency and effectiveness of facility: pollution removal rates: BOD_5 = 99 %; COD = 96 %; TSS = 99 %; TKN = 97 %; TN = 83 %; TP = 91 %
Operating experience: simple maintenance and operation



ADVANTAGES

1.This type of treatment system allows the application of raw wastewater directly without pretreatment .
2. Energy-saving wastewater treatment plant operating without electricity with high removal efficiencies.

DISADVANTAGES

1. A station without electricity requires a large footprint and a sloping site

Source: S. Troesch

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

FRENCH REED BEDS AND DISINFECTION POND

OBJECT INFORMATION

Name: The Misilya-Jarba WWTP
Type of facility: FRB and disinfection pond
Treated medium: domestic wastewater
Description of the solution: This treatment system was designed to treat the wastewater of 3600 p.e. using VF treatment filters (BiHofilter® configuration combining unsaturated and saturated layers within a single stage) followed by a disinfection lagoon before the treated water is infiltrated.



BASIC INFORMATION

Constructor: JV Brothers co/Arabia CC/SAVEA
Designer: Ecobird
Source of financing: AFD
Total cost: 1 900 000€ (incl. VAT)
Facility operator: Maythaoun Joint Water and Sanitation Service Council
Maintenance cost: 7 544 €/y
Contact person: Stéphane Troesch (s.troesch@ecobird.fr)

GEOGRAPHICAL COORDINATES

Latitude: 32°23'31.3"N
Longitude: 35°17'35.3"E

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production

LOCATION

Country: Palestine
City: Misilya-Jarba (district: West Bank)
Type of climate: Csa
Average temperature: 21°C
Sum of precipitation: 540 mm



Source: S. Troesch

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of facility: 9 855 m^2 in total; VF: 4325 m^2; Pond: 5530 m^2
Catchment area: 34 190 m^2
Volume: 9 680 m^3 in total ; VF: 6 900 m^3; Pond: 2780 m^3
Hydraulic data: Dry weather: 267 m^3/d; Wet weather: 320 m^3/d
Efficiency and effectiveness of facility: guaranteed discharge levels: BOD_5 = 20 mg/L; TSS = 30 mg/L; TN: 50 mg/L
Operating experience: simple maintenance and operation

ECOLOGICAL POTENTIAL

The FRB provides water purification, nutrient cycling, habitat for insects and aesthetic value by being consistent with the surrounding landscape.



ADVANTAGES

1. This type of treatment system allows the application of raw wastewater directly without pretreatment.
2. The unsaturated and saturated VF filter ensure 50% of TN removal within a single recirculated stage.
3. The lagoon allows a disinfection of the water before infiltration with energy consumption.

DISADVANTAGES

1. Disinfection with a lagoon requires a large footprint.
2. Energy consumption (solar panel) for recirculation loop of treated water on the 1st stage.

Source: S. Troesch

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

AERATED TREATMENT WETLANDS

OBJECT INFORMATION

Name: ATW in Tarcenay, France
Type of facility: ATW
Treated medium: domestic wastewater
Description of the solution: ATWs are an advanced type of TWs, which allow more efficient removal of contaminants from wastewater owing to the higher availability of oxygen. This subsurface flow system is aerated mechanically from below, with an appropriate distribution system of air. This system is ideal for treating wastewater with high organic matter loads and for minimizing the land footprint of the TW. The WWTP (old pond) needed to be up-scaled and retrofitted while respecting higher outlet requirements. The Rhizosph'air process (patented by Syntea, Naturally Wallace and Rietland) involves two components: a vertical unsaturated filter receiving raw wastewater, followed by a horizontal saturated filter with forced aeration.





GEOGRAPHICAL COORDINATES

Latitude: 47° 16' 41" N
Longitude: 6° 10' 05" E

LOCATION

Country: France
City: Tarcenay
Type of climate: Cfb
Average temperature: 10.6°
Sum of precipitation: 1230mm

BASIC INFORMATION

Construction year: 2016
Constructor: Municipality of Tarcenay
Source of financing: municipality funds
Total cost: 830 000 €
Facility operator: Municipality of Tarcenay
Maintenance cost: 14 000 €
Contact person: Pascal Molle (pascal.molle@inrae.fr)

ECOLOGICAL POTENTIAL

Owing to the simplicity of the operation, the community can manage the treatment plant.
Consequently, they use it for educational and visionary purposes related to green infrastructure. Sheep are used to maintain the green areas.

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production

Source: Nature-Based Solutions for Wastewater: A series of factsheets and case studies

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

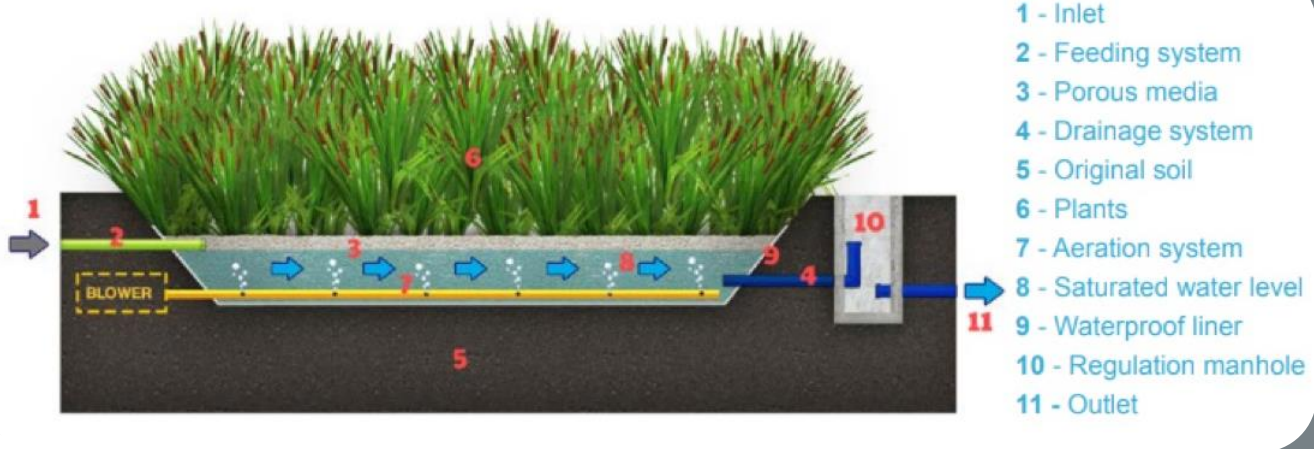
Area of the facility: 1400 m^2
Volume: 112 m^3
Hydraulic load: 0,28 m^3/day
Forced Aeration: 3 hours/day, divided into four phases during the day
Primary design factor: 1400 P.E.; inflow rate 293 m^3/day; population equivalent area 1 m^2 / P.E.
Operating experience: Operation and maintenance approaches for this case are similar to French VFTWs. They include two visits per week for treatment system inspection and control (screening and batch feeding system, alternation of filters, etc.). Once a year, plants (*Phragmites australis*) need to be harvested and once every 10–15 years the organic deposit layer needs to be removed to be used in agriculture by land application. The fact that the system is compact (1 m^2/PE) translates to less harvesting time per year than a standard system.

ADVANTAGES

1. The facility requires less land than other NBS solutions.

DISADVANTAGES

1. Usage of delicate technology that entails extra energy consumption.



Source: Anacleto Rizzo

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

AREATED TREATMENT WETLAND AND SLUDGE TREATMENT REED BEDS

OBJECT INFORMATION

Name: Bas-en-Basset WWTP
Type of facility: ATW & STRB (Rhizosph'air) and STRB for P sludge
Treated medium: domestic wastewater
Description of the solution: This treatment system is designed to treat the wastewater of 4500 p.e. The low nitrogen and phosphorous outlet consent are 10 mg/L in TKN, 15 mg/L in TN and 2 mg/L in TP. For the treatment of organic and more specifically nitrogen a Rhizosph'air® (aerated TW) was implemented. The treatment of phosphorus is done by ferric chloride and completed by STRB for the phosphorous sludge management.



GEOGRAPHICAL COORDINATES

Latitude: 45°18'32.3"N
Longitude: 4°06'52.9"E

BASIC INFORMATION

Construction year: 2019
Constructor: SAVEA
Source of financing: local funds
Total cost: 1 752 560 € / 2 103 000 € (incl. VAT)
Facility operator: Syndicat des eaux Loire Lignon
Maintenance cost: 40 000 € / year
Contact person: Stéphane Troesch (s.troesch@ecobird.fr)

LOCATION

Country: France
City: Bas-en-Basset (district: Auvergne-Rhône-Alpes)
Type of climate: Cfb
Average temperature: 11°C
Sum of precipitation: 544 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production





Source: S. Troesch

ECOSYSTEM SERVICES ACCORDING TO CICES

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ECOLOGICAL POTENTIAL

1. Wastewater treatment and sewage sludge management using natural methods.
2. Effective removal of biogenic compounds from wastewater.
3. Recovery of biogenic compounds from sewage sludge.



TECHNICAL DATA

Area of facility: Rhizosph'air®: 4 568 m^2; STRB: 440 m^2
Volume: Rhizosph'air®: 7 537 m^3; STRB: 242 m^3
Hydraulic data: Dry weather: 875 m^3/d; Wet weather: 1275 m^3/d
Efficiency and effectiveness of facility: guaranteed discharge levels: BOD_5 = 10 mg/L; COD = 60 mg/L; TSS = 15 mg/L; TKN = 10 mg/L; TN = 15 mg/L; TP = 2 mg/L
Operating experience: plant performing better than expected with outlet concentrations lower than consent threshold.

ADVANTAGES

1. Treatment of raw sewage directly on TW without pretreatment.
2. The Rhizosph'air® can reach very low concentrations of nitrogen at the outlet (15 mg N/L) through sequential aeration within the same stage.
3. The addition of ferric chloride allows to reach very low TP concentration.
4. Compactness of the system in comparison with extensive TW.
5. A reliable phosphorous sludge management with STRB.

DISADVANTAGES

1. The energy consumption, due to the Rhizosph'air®, is more important than a classic TW solution but still 3 to 4 times lower then an activated sludge plant.
2. Additional maintenance due to blowers, and aeration networks.

Source: S. Troesch

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

www.nice-nbs.eu

NBS FOR: INDUSTRIAL WASTEWATER

Type of object	Location	Name
Horizontal Subsurface Flow Treatment Wetland (HSSF or HF) ∑=1	Candidoni (Italy)	HORIZONTAL SUBSURFACE FLOW TREATMENT PLANT FOR DAIRY WASTEWATER
Hybrid Treatment Wetland (HTW) ∑=7	Jesi (Italy)	HYBRID TREATMENT WETLAND FOR WASTEWATER AND REUSE IN INDUSTRY
	Nimr (Oman)	HYBRID TREATMENT WETLAND D FOR OIL WASTEWATER
	Embetsu (Japan)	HYBRID TREATMENT WETLAND FROM DAIRY INDUSTRY
	Castellina in Chianti (Italy)	HYBRID TREATMENT WETLAND FOR WINERY WASTEWATER
	Bolgheri (Italy)	HYBRID TREATMENT WETLAND FOR WINERY WASTEWATER
	Santa Tome (Argentina)	HYBRID TREATMENT WETLAND FOR EFFLUENT FROM METALLURGICAL INDUSTRY
	New Boston (USA)	HYBRID TREATMENT WETLAND FOR AGRICULTURAL LEACHATE
One-stage Treatment Wetland ∑=1	Vidigueira (Portugal)	TREATMENT WETLAND FOR TREATMENT AND REUSE OF WINERY WASTEWATER
Aerated Treatment Wetland (ATW) ∑=1	San Rocoo di Piegara (Italy)	VERTICAL SUBSURFACE FLOW TREATMENT WETLAND FOR AGROINDUSTRY
Bioremediation Cells ∑=1	Riyadh (Saudi Arabia)	BIOREMEDIATION CELLS
Floating Treatment Wetland (FTW) ∑=1	Sialkot (Pakistan)	FLOATING TREATMENT WETLAND FOR TANNERY WASTEWATER
Free Water Surface Treatment Wetland (FWS-TW) ∑=1	Bologne (Italy)	TREATMENT WETLAND FOR AGRICULTURE

HORIZONTAL SUBSURFACE FLOW TREATMENT PLANT FOR DAIRY WASTEWATER

OBJECT INFORMATION

Name: HSSF for WW from agricultural cooperative firm fattoria della Piana
Type of facility: HSSF
Treated medium: dairy wastewater
Description of the solution: The plant is composed of diversified primary treatments, set on the basis of wastewater typology: equalization of milk production wastewater, a common three-chambered tank where all wastewaters is discharged, after which wastewaters is sent into an HF system with 4 tanks in parallel for a secondary treatment. The effluent is discharged back into Mammella Torrent creek.



BASIC INFORMATION

Construction year: 2011
Constructor: Cooperative Fattoria della Piana Agricultural firm
Facility operator: Cooperative Fattoria della Piana Agricultural firm
Total cost: 200 000€
Maintenance cost: 4000€ / year
Contact person: Anacleto Rizzo (rizzo@iridra.com)

GEOGRAPHICAL COORDINATES

Latitude: 38° 31' 8.94" N
Longitude: 15° 58' 22.82" E

LOCATION

Country: Italy
City: Candidoni
Type of climate: Csa
Average temperature: 17.2 °C
Sum of precipitation: 607mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production



Source: IRIDRA "Constructed wetland for treatment of wastewater from agricultural cooperative firm Fattoria Della Piana"



Source: fattoriadellapiana.it

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 2280m^2
Volume: 1824 m^3
Catchment: 2600000m^2
Hydraulic load or HRT: On average, the daily wastewater quantity is 85m^3/d. The wastewater comes from a number of sources: houses and a restaurant (maximum 12 residents and 100 restaurant users), the milk cooling plant (average 20m^3/d), the dairy (20 tons per day of processed milk, which produces 20m^3/d of wastewater) and milking (200 livestock, which produce 20m^3/d);

ECOLOGICAL POTENTIAL

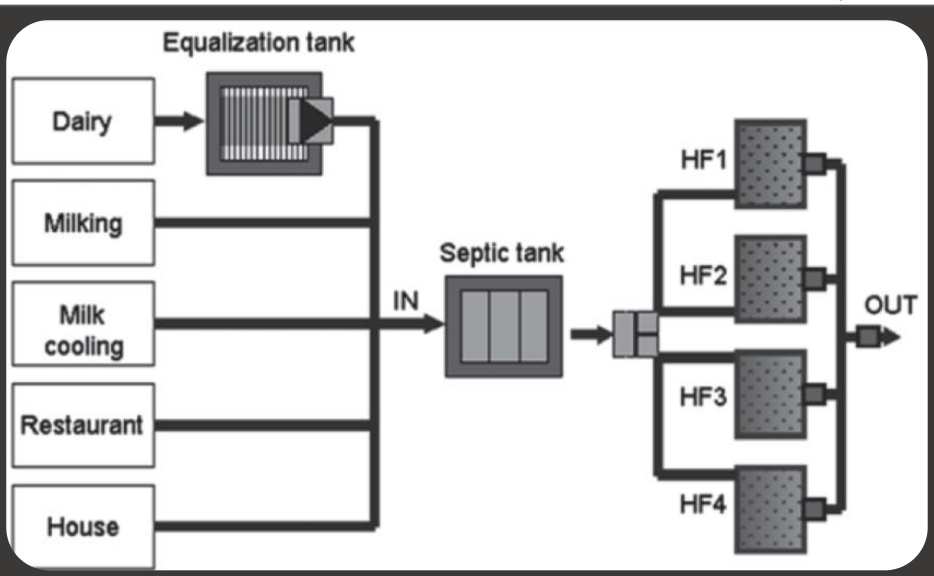
The dairy HSSF is a place, where biogas is produced, which is used to create energy. The facility purifies wastewater and air. Here, sewage with a high nutrient load is decomposed. This facility was a pilot project in which wastewater with such large differences in pH and content (fats, proteins) was treated.

ADVANTAGES

1. Utilization of wastewater for energy production at the same time treatment of wastewater.

DISADVANTAGES

1. Problems with working on wastewater with different pH levels.



Source: F. Massi et al. " Dairy Wastewater Treatment by a Horizontal Subsurface Flow Constructed Wetland in Southern Italy"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HYBRID TREATMENT WETLAND FOR WASTEWATER AND REUSE IN INDUSTRY

OBJECT INFORMATION

Name: Hybrid HSSF-FWS TW in a large-scale wastewater treatment plant in Jesi, Italy
Type of facility: HSSF+ FWS-TW, SDRB
Treated medium: domestic wastewater
Description of the solution: The whole system treats about 18 000 m^3/d (around 60 000 PE) and a part of the effluent is reused in a nearby industrial area. All the new sections have been provided with an online monitoring system, in order to reduce as much as possible the energy consumption for the denitrification process leaving more role to the final wetland whenever it obtains sufficient performances. The hybrid TW system consists in a first sedimentation pond with a volume of 5000 m^3, a 1ha HSSF and a 5ha FWS-TW. The accumulated sludge in the sedimentation basin are periodically pumped in a wet woodland planted with *Populous alba*.



GEOGRAPHICAL COORDINATES

Latitude: 43° 21' 10" N
Longitude: 13° 15' 43" E

LOCATION

Country: Italy
City: Jesi
Type of climate: Cfa
Average temperature: 15.6 °C
Sum of precipitation: 681mm

BASIC INFORMATION

Construction year: 2003
Constructor: Multiservizi Spa
Source of financing: private
Facility operator: Multiservizi Spa
Total cost: 1 774 685 €
Maintenance cost: 12 000-17 000 € / year
Contact person: Anacleto Rizzo (rizzo@iridra.com)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production





Source: globalwettech.com/references/14-jesi-municipal-wwtp-teritary-treatment

ECOSYSTEM SERVICES ACCORDING TO CICES

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ADVANTAGES

1. High treatment efficiencies in terms of organic and nutrient loads.
2. No or almost negligible energy consumption.
3. Simple construction and maintenance.

DISADVANTAGES

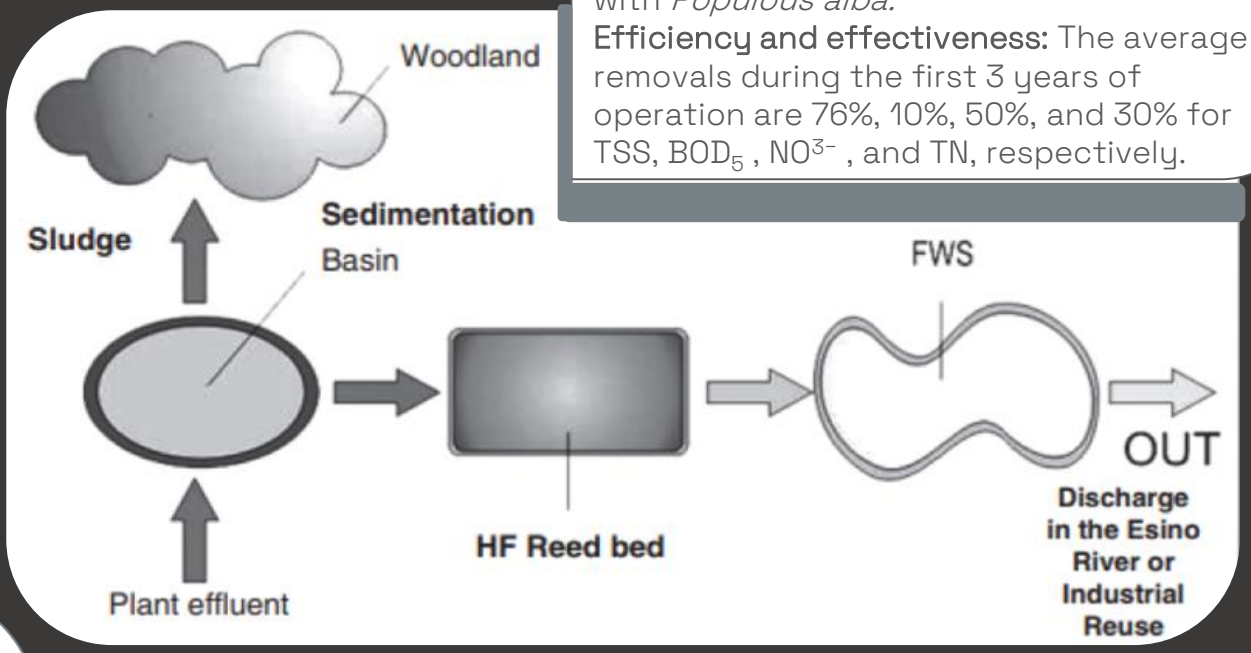
1. Huge undertaking in terms of land needed.
2. Many hydraulic calculations needed.

ECOLOGICAL POTENTIAL

Includes services such as nutrient cycling, primary production, soil-formation, habitat provision, capturing carbon compounds. These make it possible for the ecosystems to continue providing services such as food supply, flood regulation, water and air purification, researches on large scale NBS facilities.

TECHNICAL DATA

Area of the facility: 65 000m^2 in total sedimentation pond - 5000 m^2, HF - 10 000m^2, FWS - 50 000m^2
Volume: 42 000m^3
Primary design factor: 60 000 PE, WW inflow 13 000-19 000 m^3/day
Dominant plants species: HF planted with *Phragmites australis*. Wet woodland planted with *Populous alba.*
Efficiency and effectiveness: The average removals during the first 3 years of operation are 76%, 10%, 50%, and 30% for TSS, BOD_5 , NO^{3-} , and TN, respectively.



Source: F. Massi "Enhanced Dentrification by a Hybrid HF-FWS Constructed Wetland in a Large-Scale Wastewater Treatment Plant"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HYBRID TREATMENT WETLAND FOR OIL WASTEWATER

OBJECT INFORMATION

Name: Nimr Water Treatment Plant
Type of facility: HTW
Treated medium: water from oil exploration and production
Description of the solution: In the middle of a desert landscape in Oman, the world's largest commercial reed bed treatment plant for the cleaning of polluted water from oil production has been operating since 2008. The technology used is: passive hydro-cyclones for oil in water separation, FWS wetland for water polishing and hydrocarbons breakdown and evaporation ponds for treated effluent disposal (zero-discharge system). Also, partial reuse of the treated effluent for irrigation of crops with market value has already started. By using natural flow processes, no energy-intensive pumps are required to treat the polluted water throughout the system. The water is then distributed by gravity into 4 terraces.



GEOGRAPHICAL COORDINATES

Latitude: 18° 34' 19" N
Longitude: 55° 49' 45" E

LOCATION

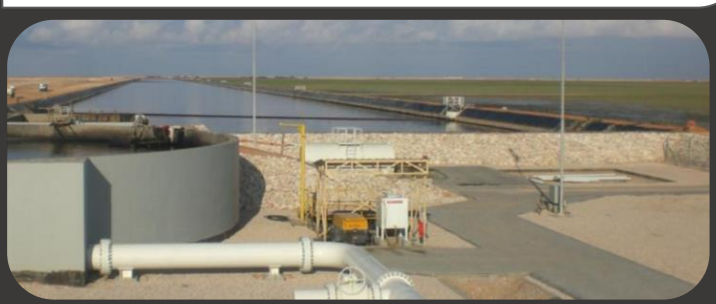
Country: Oman
City: Nimr
Type of climate: Bsh
Average temperature: 25.4°C
Sum of precipitation: 173 mm

BASIC INFORMATION

Construction year: 2011-2044
Constructor: Bauer resources and Petroleum Development Oman
Operator: Petroleum Bauer Resources
Source of financing: Governmental sources
Total cost: about 100 000 000 $
Contact: Dr. Roman Breuer (roman.breuer@ecosys-wetlands.com)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse





Source: wetsystems.com.au/portfolio-items/nimr-water-treatment-plant-oman

ECOSYSTEM SERVICES ACCORDING TO CICES

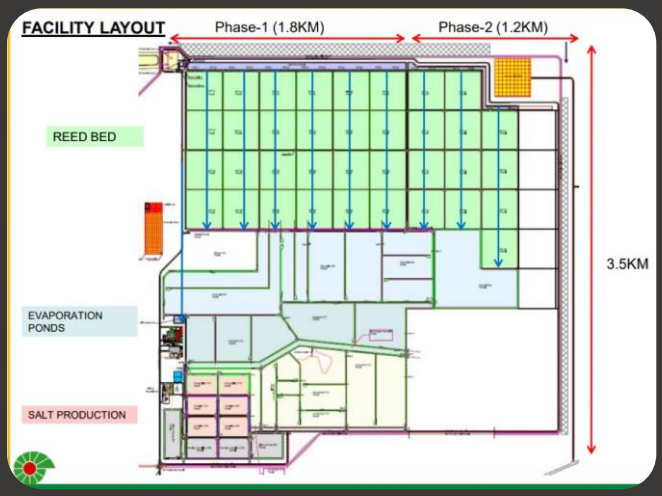
Section	Provisioning	Regulation & Maintenance	Cultural
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TECHNICAL DATA

Area of the facility: 13.5 km^2
Primary design factor: treatment capacity of 175 000 m^3/day
Efficiency and effectiveness: The oil content in the produced water is reduced from 500 mg/l when entering the NWTP to less than 0.5 mg/l when leaving the wetland system. Treatment efficiency >99.9%).
Dominant plant species: *Phragmites australis*

ECOLOGICAL POTENTIAL

The facility enables the production of table salt in the process of evaporation from tanks intended for this purpose. Plant species growing within the wetlands are a source of building material that can be used as biomass fuel. The oil-infused water is detoxified and purified, and the recovered oils are used as a full salable product.



ADVANTAGES

1. This facility enables access to fresh water for a population of 80 000 people.
2. The system operates with minimum external power. Overall it allows to save 15% of treatment cost and 60% of CO_2 emissions.

DISADVANTAGES

1. Multi-branch investment requiring advanced knowledge in the field of hydraulics, environmenta protection, chemistry.
2. Risk of clogging of the hydraulic system due to many organic components from fuel extraction.

Source: wetsystems.com.au/portfolio-items/nimr-water-treatment-plant-oman

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HYBRID TREATMENT WETLAND FROM DAIRY INDUSTRY

OBJECT INFORMATION

Name: Hybrid TW in northern Hokkaido-Japan
Type of facility: HTW
Treated medium: milking parlor WW
Description of the solution: A hybrid TW was designed and constructed in November 2006 at Embetsu. It consists of three beds (VF-VF-HF) constructed in series . VF beds were designed as per the design recommendations of Paul Cooper. Facility works in seasonal variations on the purification and removal efficiencies of hybrid sub-surface TW system (VF-VF-HF).



LOCATION

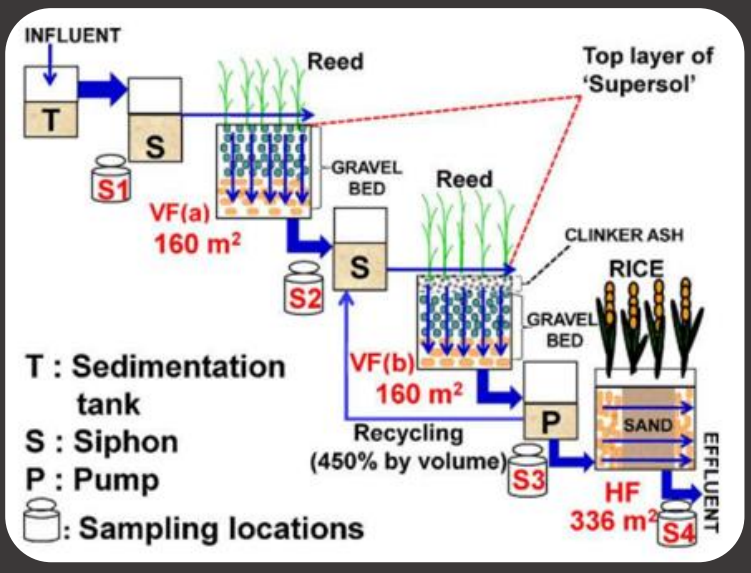
Country: Japan
City: Embetsu
Type of climate: Dfb
Average temperature: 7.2°C
Sum of precipitation: 1105 mm

GEOGRAPHICAL COORDINATES

Latitude: 44° 45' 00" N
Longitude: 141° 48' 00" E

BASIC INFORMATION

Construction year: 2006
Constructor: Graduate School of Agriculture
Source of financing: grants by Research Council of Ministry of Agriculture, Forest and Fisheries
Total cost: 40 000$
Maintenance cost: 600$ / year
Contact person: Pradeep Kumar Sharma (pradeep2910@gmail.com)



URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse

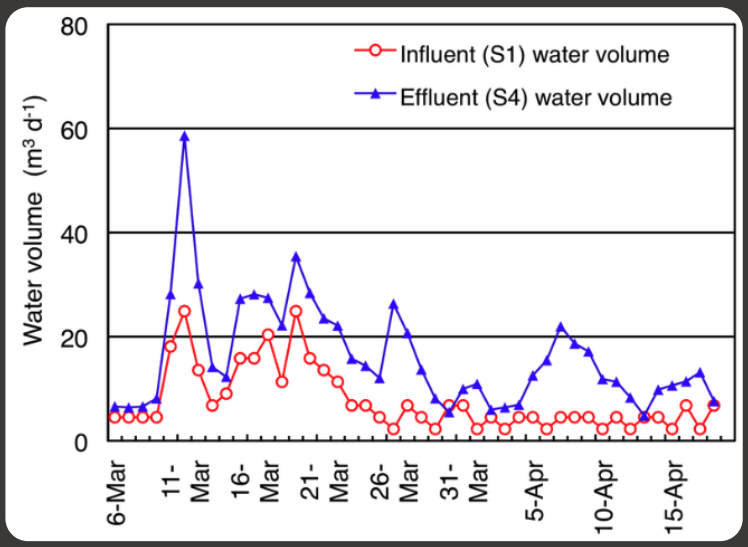
Source: P. K. Sharma et al. "Seasonal efficiency of a hybrid sub-surface flow constructed wetland system in treating milking parlor wastewater at northern Hokkaido"

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
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TECHNICAL DATA

Area of the facility: 656m^2
Volume: 460m^3
Catchment: Parlor milking water and some precipitation
Hydraulic loading rates: 7.9 and 7.3 mm/d were observed during cold and warm periods. It fluctuated from 4.7 to 17.4 mm/d during cold period and 1.8 to 14.2 mm/d during warm period



ECOLOGICAL POTENTIAL

Wastewater from the dairy is not transported to a receiver such as a river or the sea, but is used to grow cane and rice. The wastewater contains the nutrients necessary to ensure the proper life cycle of these crops.

ADVANTAGES

1. Regardless of extremely adverse climate conditions and high nutrient loads, hybrid sub-surface TWs can efficiently achieve higher purification and removal rates of >95% for TSS and total coliform, >89% for COD and BOD_5, >76% for TN and >72% for TP during both cold and warm periods.

DISADVANTAGES

1. These systems has limitations of relatively large area requirement, bad odor and are difficult to operate in extremely colder climates.

Source: researchgate.net, Pradeep Kumar Sharma

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HYBRID TREATMENT WETLAND FOR WINERY WASTEWATER

OBJECT INFORMATION

Name: Cecchi winery TW
Type of facility: HTW
Treated medium: industrial WW
Description of the solution: The winery WW has been treated with a multi-stage wetland system since 2001. The technology used is:
1st stage - a FRB wetland raw wastewater of 1,200m^2.
2nd stage - 4 parallel HFTW of 960m^2 (240m^2 each).
3rd stage - a single-bed FWS-TW of 850m^2; optional sand filter of 50m^2 before discharge into Gena River.



BASIC INFORMATION

Construction year: 2001
Upgraded: 2019
Constructor: Casa Vitivinicola Cecchi e.F- Dott.ssa Miria Bracali
Source of financing: Casa Vitivinicola Cecchi & F.
Facility operator: Winery employees
Total cost: 59 470 € / year
Contact person: Anacleto Rizzo (rizzo@iridra.com)

GEOGRAPHICAL COORDINATES

Latitude: 43° 25' 4.14" N
Longitude: 11° 13' 5.96" E

LOCATION

Country: Italy
City: Castellina in Chianti
Type of climate: Csa
Average temperature: 12.9°C
Sum of precipitation: 921 mm

TECHNICAL DATA

Area of the facility: 3060 m^2
Volume: 2750m^3
Catchment: 4000000m^2
Efficiency and effectiveness: Flow 100 m^3/d (mean value during peak vintage season) but average 70m^3/d (volumes changed in 2009 after upgrading)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse

Source: F. Massi et al. "Winery high organic content wastewaters treated by constructed wetlands in Mediterranean climate"



ECOSYSTEM SERVICES ACCORDING TO CICES

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ECOLOGICAL POTENTIAL

Includes services such as nutrient cycling, primary production, soil-formation, habitat provision. These make it possible for the ecosystems to continue providing services such as food supply, flood regulation and water purification.

ADVANTAGES

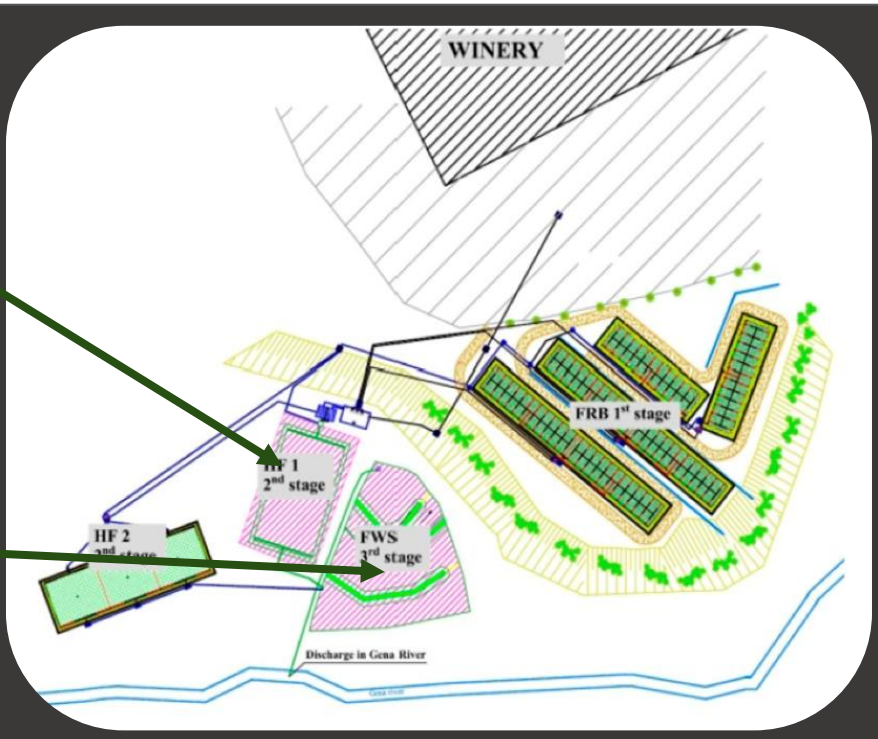
1. Low-cost, low-maintenance and energy saving technology shows it is an effective solution for winery wastewater.

DISADVANTAGES

1. Difficulties in calculating the issue of hydraulics in the facility.

Refurbished TW beds in horizontal subsurface flow systems.

Third stage recovered FWS from the original TW WWTP of 200



Source: A. Rizzo et al. "Online Monitoring of a Long-Term Full-Scale Constructed Wetland for the Treatment of Winery Wastewater in Italy"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HYBRID TREATMENT WETLAND FOR WINERY WASTEWATER

OBJECT INFORMATION

Name: Ornellaia and Masseto Winery
Type of facility: HTW
Treated medium: winery WW
Description of the solution: Project of TW for the wine producing firm "Tenuta dell' Ornellaia", Italy. The system consists of VSSF as a first stage followed by a second HSSF stage with recirculation to the first stage and then by a single FWS-TW. It treats wastewater from the company, which allows water to be reused for irrigation.



BASIC INFORMATION

Construction year: 2001
Constructor: IRIDRA company
Source of financing: private
Facility operator: winery employees
Total cost: 773 000 €
Maintenance cost: 2000 € / year
Contact person: Anacleto Rizzo (rizzo@iridra.com) or Fabio Masi (masi@iridra.com)

GEOGRAPHICAL COORDINATES

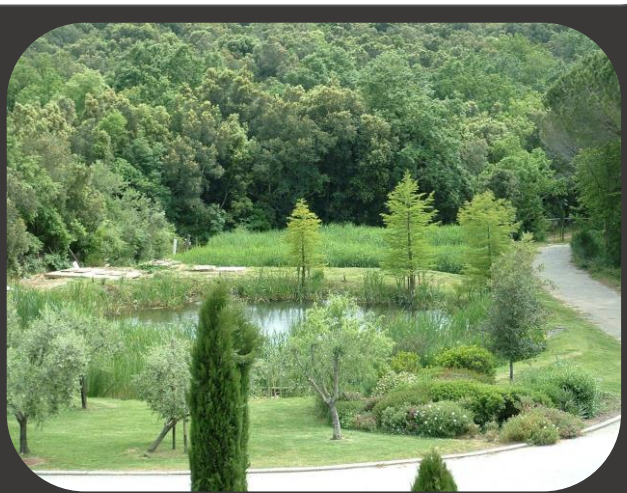
Latitude: 43° 12' 41.2" N
Longitude: 10° 36' 41.9" E

LOCATION

Country: Italy
City: Bolgheri, Leghorn province
Type of climate: Csa
Average temperature: 15.8 °C
Sum of precipitation: 953 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse





Source: F. Massi

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 1316m^2
Volume: about 568m^3
Catchment: 970 000m^2
Hydraulic load: organic loading rate (kg COD /ha/d): 236
The flow rate during the winemaking period is about 42m^3/d

ECOLOGICAL POTENTIAL

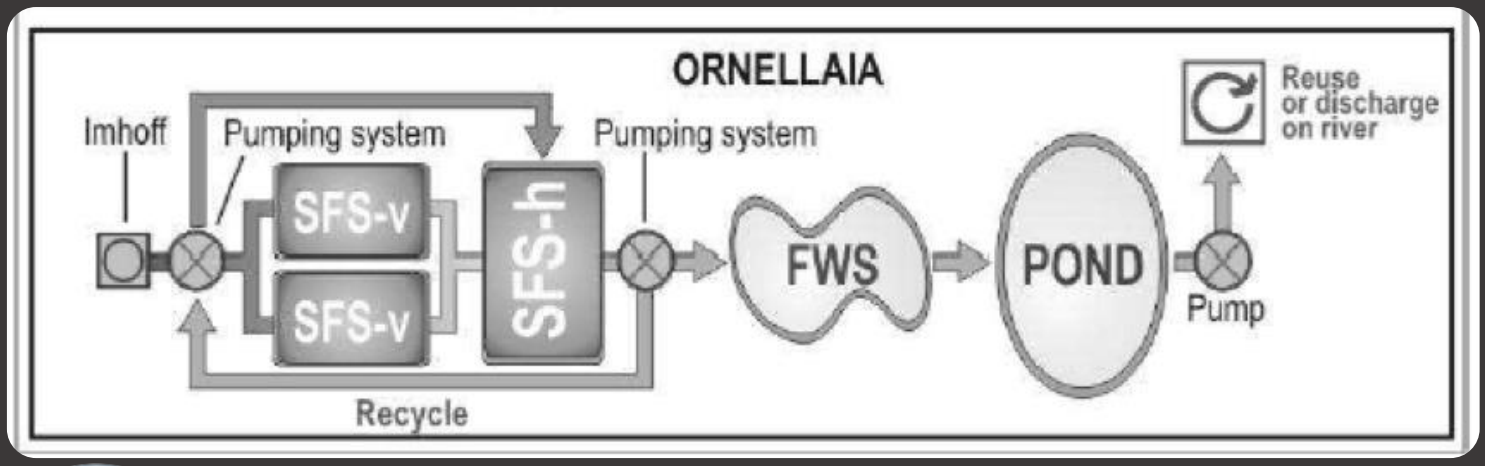
The facility enables waste decomposition. It is crucial as winery's sewage discharge is high in organic load. The facility supports biodiversity by planting various species. Nutrient cycling process can be observed.

ADVANTAGES

1. Easy maintenance of the facility.
2. Elevated improvement regarding economic, naturalistic and environmental aspects.

DISADVANTAGES

1. Difficulties with calculating hydraulics issue in the facility.
2. VSSF beds present light clogging problems after the season with black sludge layer.



Source: F. Massi „winery high organic content wastewaters treated by constructed wetlands in mediterranean climate"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HYBRID TREATMENT WETLAND FOR EFFLUENT FROM METALLURGICAL INDUSTRY

OBJECT INFORMATION

Name: Bhaco TW for effluent final polishing
Type of facility: HTW
Treated medium: metallurgical industry WW
Description of the solution: Bahco metallurgical industry for tool making needed an effluent final-stage treatment. A large land area was available in the factory facilities and costs for maintenance and operation of wastewater treatment are limiting factors in Argentina. In addition, sewage from the factory also required a final treatment. A FWS wetland was constructed. This type of TW was selected due to the efficiency in metal removal and the low costs for operation and maintenance. Although FWSs requires a large area, this is not a problem in this case. Industrial wastewater containing metals and sewage from the factory are treated together, both after a primary treatment (25 m^3/day of sewage + 75 m^3/day of industrial WW). Sewage improves the ability of macrophytes to take up heavy metals from wastewater



GEOGRAPHICAL COORDINATES

Latitude: 31° 67' 46" S
Longitude: 60° 76' 91" E

LOCATION

Country: Argentina
City: Santa Tome
Type of climate: Cfa
Average temperature: 19.1°C
Sum of precipitation: 1188 mm

BASIC INFORMATION

Construction year: 2002
Constructor: Bahco metallurgical industry
Operator: Bahco metallurgical industry
Source of financing: company funds
Total cost: 2 000 000 $
Maintenance cost: 8 000- 10 000 $
Contact person: M.A. Maine; message: https://www.researchgate.net/profile/Maria-Maine1



URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse

Source: M.A. Maine et al. „Case study 10 – bahco treatment wetland for effluent final polishing (Argentina)"

ECOSYSTEM SERVICES ACCORDING TO CICES

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ECOLOGICAL POTENTIAL

FWS-TW and the discharge pond provide an additional ecosystem service with a high diversity of macrophyte and have become the habitat for diverse wildlife, such as ducks, geese, coots, coypus, lizards, capybaras, turtles. The content of water and plants has a positive effect impact on the microclimate. The treatment wetlands system is also visually appealing.

TECHNICAL DATA

Area of the facility: 2 000 m^2
Volume: 1 000 m^3
Design flow: 100 m^3/day of WW
HRT: 7-10 days
Efficiency and effectiveness: Treated effluent meets the Argentinian law limits for discharge. FWS performance improved with wetland maturity.
Type of substrate: The wetland was rendered impermeable with 6 layers of compacted bentonite, in order to achieve a hydraulic conductivity of 10−7 m/s. A layer of 1 m of soil was placed on top of the bentonite layer. Several locally available macrophyte species were planted into the wetland.
Dominant plant species: *Typha domingensis*
Operational experience: Although this FWS wetland was faced with accidental events, it was capable of recovering its performance, demonstrating its robustness. FWS and the discharge pond provide an additional ecosystem service with a high diversity of macrophyte and have become the habitat for diverse wildlife, such as ducks, geese, coots, coypus, lizards, capybaras, turtles. The effluent, after passing through the wetland, was led to a 1.5 ha pond in the factory facilities. Phreatic water meters were placed around the wetland to monitor groundwater quality, as a security measure.

ADVANTAGES

1. The facility helps to reduce run-off. It absorbs air pollution and serves as a pretreatment of water.

DISADVANTAGES

1. The main disadvantage is that the facility needs many operational works such as ensuring the patency of inflow.

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HYBRID TREATMENT WETLAND FOR AGRICULTURAL LEACHATE

OBJECT INFORMATION

Name: Crosswinds Marsh Wetland Interpretive Preserve
Type of facility: HTW
Treated medium: post agricultural leachate
Description of the solution: One of the largest self-sustaining wetland mitigation projects in the USA, Crosswinds Marsh in New Boston, Michigan is also a recreational park and wildlife refuge that is part of the Wayne County Park system. The park was created to allow Detroit Metropolitan Wayne County Airport (DTW) to meet environmental regulations during a major airport expansion sited on top of an existing wetland. By remediating nearby land that was historically wetland that has been converted to primarily agricultural use, the park far exceeds requirements and accommodates multiple public uses, including passive recreation, fishing, and environmental learning opportunities.



GEOGRAPHICAL COORDINATES

Latitude: 42° 05' 38" N
Longitude: 83° 26' 27" W

LOCATION

Country: United States of America
City: New Boston, MI
Type of climate: Dfa
Average temperature: 10.0 °C
Sum of precipitation: 922mm

BASIC INFORMATION

Construction year: 1995
Constructor: ABC Paving; W.H. Canon, Inc. L. Lawyer Construction
Source of financing: governmental funding
Total cost: 18 100 000 €
Maintenance cost: 15 000- 20 000 €
Facility operator: SmithGroup, Department of City Detroit Parks & Recreation
Contact person: Cassie Goodwin (smithgroup.com/people/cassie-goodwin)

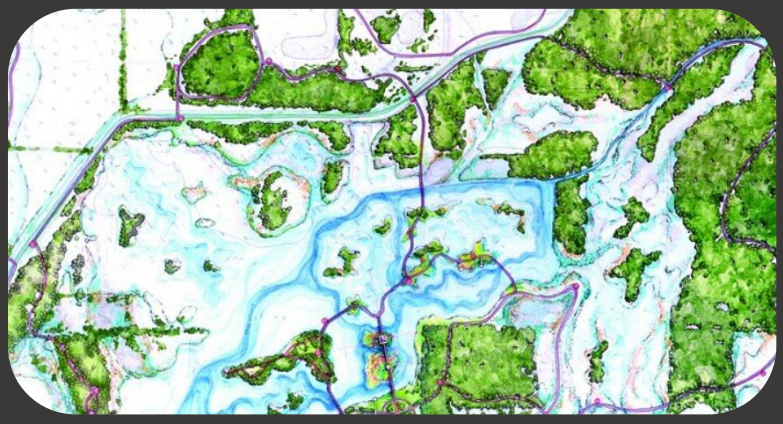


URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse

Source: landscapeperformance.org/case-study-briefs/crosswinds-marsh-wetland-interpretive-preserve

ECOSYSTEM SERVICES ACCORDING TO CICES			
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TECHNICAL DATA

Area of the facility: 4.25 km^2
Efficiency and effectiveness: The facility captures runoff waters that may pose a risk of flooding nearby villages. Moreover, the system filters surface runoff water from the city and airport, improving its quality.
Operating experience: Continuous yearly monitoring and an aggressive management plan to control invasive species are critical to the success of habitat restoration.

ECOLOGICAL POTENTIAL

The site allows for the capture and treatment of surface runoff water that comes from the city, as well as the purification and use of gray sewage for watering plants. The park is home to many native species of animals and birds, whose numbers are constantly monitored. In addition, this facility is a meeting place for residents and a destination for tourists.

ADVANTAGES

1. Decreased upstream and downstream flooding.
2. Restored over 4.25km^2 of historical wetland habitat that had been drained for agriculture and residential use.

DISADVANTAGES

1. The constant need to monitor the hydrological situation, including the occurrence of flooding, as well as chemical and biological monitoring of the inflowing water bodies.

Source: landscapeperformance.org/case-study-briefs/crosswinds-marsh-wetland-interpretive-preserve

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

TREATMENT WETLAND FOR TREATMENT AND REUSE OF WINERY WASTEWATER

OBJECT INFORMATION

Name: TW in Vidigueira
Type of facility: one-stage TW
Treated medium: winery WW
Description of the solution: A facility that treats industrial WW from Vidigueira wineries with high saturation of organic components. The sewage is initially cleaned mechanically by separating the grapes on the grates. Then passes through the reed beds system. Treated sewage is directed to the tank. It can be used for watering crops. It can be classified as a one-stage TW.



VIDIGUEIRA

LOCATION

Country: Portugal
City: Vidigueira
Type of climate: Cfb
Average temperature: 17.6°C
Sum of precipitation: 1100 mm

BASIC INFORMATION

Construction year: 2001
Ampliation: 2012
Constructor: Wine factory
Source of financing: private
Facility operator: Wine factory
Total cost: 200 000 €
Maintenance cost: 2500 € / year
Contact person: Herdade Cortes de Cima (www.cortesdecima.com)

GEOGRAPHICAL COORDINATES

Latitude: 38° 09' 39.7" N
Longitude: 7° 43' 27.3" E

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse





Source: cortesdecima.com

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 1900 m^2
Volume: 1900 m^3
Catchment: 135000 m^2
Efficiency and effectiveness:
NH_4^+ *< 10mg/l, TP< 10 mg/l ,* NO_3- *< 50 mg/l*
Operating experience: Simple to build, needs space that is not lacking in agricultural areas.

ECOLOGICAL POTENTIAL

Includes services such as circulation of nutrients primary production, soil formation, habitat provision. These enables the ecosystems to continue providing services such as food supply, flood regulation and water purification.

ADVANTAGES

1. Low construction and maintenance cost.
2. Use of energy-saving technologies.

DISADVANTAGES

1. Difficulties in calculating the hydraulics parameters of the facility.





Source: cortesdecima.com

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

VERTICAL SUBSURFACE FLOW TREATMENT WETLAND FOR AGROINDUSTRY

OBJECT INFORMATION

Name: VSSF for swine WW in San Rocco di Piegara
Type of facility: VSSF
Treated medium: swine WW
Description of the solution: The SSVF TW treats the swine WW produced by the pig farm situed in San Rocco di Piegara (Roverè Veronese). The NBS consists the FBA™ (Forced Bed Aeration™) technology to aerate the 5 VF beds, increasing the treatment efficiencies and reducing the requested area. The facility is designed to treat the swine WW produced by 3 000 pigs (WW flow 38 m^3/d).



SAN ROCCO DI PIEGARA

BASIC INFORMATION

Construction year: 2017
Constructor: S.A.S.A. – Societa' Allevamento Suini Di Saviola Luca E C. S.N.C.
Source of financing: private
Facility operator: S.A.S.A.
Total cost: 250000€
Maintenance cost: 5000€ / year
Contact person: Anacleto Rizzo (rizzo@iridra.com)

GEOGRAPHICAL COORDINATES

Latitude: 45° 33' 41.16" N
Longitude: 11° 4' 31.46" E

LOCATION

Country: Italy
City: San Rocoo di Piegara
Type of climate: Cfa
Average temperature: 14.1°C
Sum of precipitation: 1101 mm



URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse

ECOLOGICAL POTENTIAL

The pig farm is a facility where two products: biogas (used as a source of energy) and compost (used as a natural fertilizer) are obtained at the same time. Solution (aerated SSVF TW) implemented in the pig farm is dedicated to the treatment of swine WW.



Source: A. Rizzo et al.. "Aerated constructed wetlands for swine wastewater treatment: experiences from the start-up of a full scale system in Italy"

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 2240 m^2
Volume: 2000 m^3
Catchment: 43000 m^2
Efficiency and effectiveness: The TW has shown high average removal efficiencies: TSS 66.3%; COD 90.7%; NH_4^+ 89.5%; TKN 82.8%; TN between 64.3% and 70.9%; TP 77.2%. Moreover, the aerated SSVF TW of San Rocco di Piegara is an example of the system capable of reproducing conditions similar to the best results reported in the literature.



ADVANTAGES

1. Aerated VSSF TW allows to propose a full scale system to treat swine WW in condition of limited available area.

DISADVANTAGES

1. Very high TSS, COD, nutrient load and salinity make calculations difficult.

Source: A. Rizzo et al.. "Aerated constructed wetlands for swine wastewater treatment: experiences from the start-up of a full scale system in Italy"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

BIOREMEDIATION CELLS

OBJECT INFORMATION

Name: Riyadh Bioremediation Facility
Type of facility: Bioremediation Cells
Treated medium: industrial WW
Description of the solution: The facility is the largest of its kind in the world. The previously derelict site is an integral component of the environmental restoration of the Wadi Hanifah watershed, where large quantities of untreated industrial and urban wastewater had constituted a public health hazard and jeopardized downstream wetland ecosystems. The facility is primarily composed of 134 bioremediation cells organized into 3 main groups. It relies on a food-chain-based approach in which primary producers (algae and higher-order plants) and consumer organisms (fish, birds, insects, etc.) break down urban wastewater components. A low-tech, eco-centric infrastructure of bioremediation cells, weirs, pools, riparian planting and complementary features provide the habitat required to support this ecosystem. The treated effluent augments the hydrological regime of the wadi or is recycled to accommodate other urban functions, including a new city-wide river park system.



GEOGRAPHICAL COORDINATES

Latitude: 24° 35' 27" N
Longitude: 46° 42' 21" E

LOCATION

Country: Saudi Arabia
City: Riyadh
Type of climate: BWH
Average temperature: 26.2°C
Sum of precipitation: 66m

BASIC INFORMATION

Construction year: 2009
Constructor: Badan Agricultural and Contracting Company
Source of financing: local funding
Total cost: 32 000 000$
Facility operator: Arriyadh Development Authority
Maintenance cost: 600 000$ / year
Contact person: Jean Trottier (jean.trottier@umanitoba.ca)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse



Source landscapeperformance.org/case-study-briefs/wadi-hanifah-comprehensive-development-plan

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
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TECHNICAL DATA

Area of the facility: 1 km in length
Catchment area: 4000m^2
Primary design factor: The designed flow rate is approximately 2.4m^3/s with a retention time of approximately 31 hours. The biocells currently process an average of 350 000m^3 of wastewater per day.
Operating experience: Removes an average of: 33% of TP, 13.5% of TN, 89% of fecal coliforms, 79% of total coliforms, 94% of total suspended solids.

ECOLOGICAL POTENTIAL

The facility is inhabited by creatures that can be collected and used for handcraft purposes. The structure cleans sewage and the surrounding air, aerates sewage, eliminates harmful pathogens from black sewage.
It provides food, indirectly due to the source of water it is for crops.

ADVANTAGES

1. Saves around $27 million per day, the cost of 253,000 barrels of oil that would be required for desalinization and reduces reliance on seawater as a water source.

DISADVANTAGES

1. May pose a threat to humans and reveal the fauna due to the pathogens collected from feces discharged from the city to the bioremediation facility.





Source landscapeperformance.org/case-study-briefs/wadi-hanifah-comprehensive-development-plan

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

FLOATING TREATMENT WETLAND FOR TANNERY WASTEWATER

OBJECT INFORMATION

Name: Treatment of tannery WW Wastewater in a FTW
Type of facility: FTW
Treated medium: tannery WW
Description of the solution: The Sialkot discharges millions of gallons of untreated effluent into drains each day. In order to devise a cost-effective system for the treatment of tannery WW, a FTW was established to treat the effluent using local plants through phytoremediation. The efficiency of the FTW was tested with three different plant species. Wastewater from a tannery drain was pumped into the FTW tank with a flow of 0.5 liter per minute and was given a retention time of six days.



GEOGRAPHICAL COORDINATES

Latitude: 32° 35' 12" N
Longitude: 74° 23' 30" E

BASIC INFORMATION

Construction year: 2018-2019
Constructor: Adeel Younas
Source of financing: WWF-Pakistan
Total cost: 20 000 €
Facility operator: Adeel Younas
Maintenance cost: 600-1 000 €/ year
Contact person: Love Kumar, e-mail: (lovekumar@ufl.edu)

LOCATION

Country: Pakistan
City: Sialkot
Type of climate: Cwa
Average temperature: 23.4°
Sum of precipitation: 1004 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment,





Source: A.Youns and J.Shafiq

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
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TECHNICAL DATA

Area of the facility: 5m^2
Volume: 4.31m^3
Primary design factors: wastewater flow: 0.72 m^3/day, detention time: 6 days
Dominant plant species: water hyacinth water lettuce, *Typha latifolia*
Operating experience: Each of plants were grown separately and operating for three months in the FTW tank.

ECOLOGICAL POTENTIAL

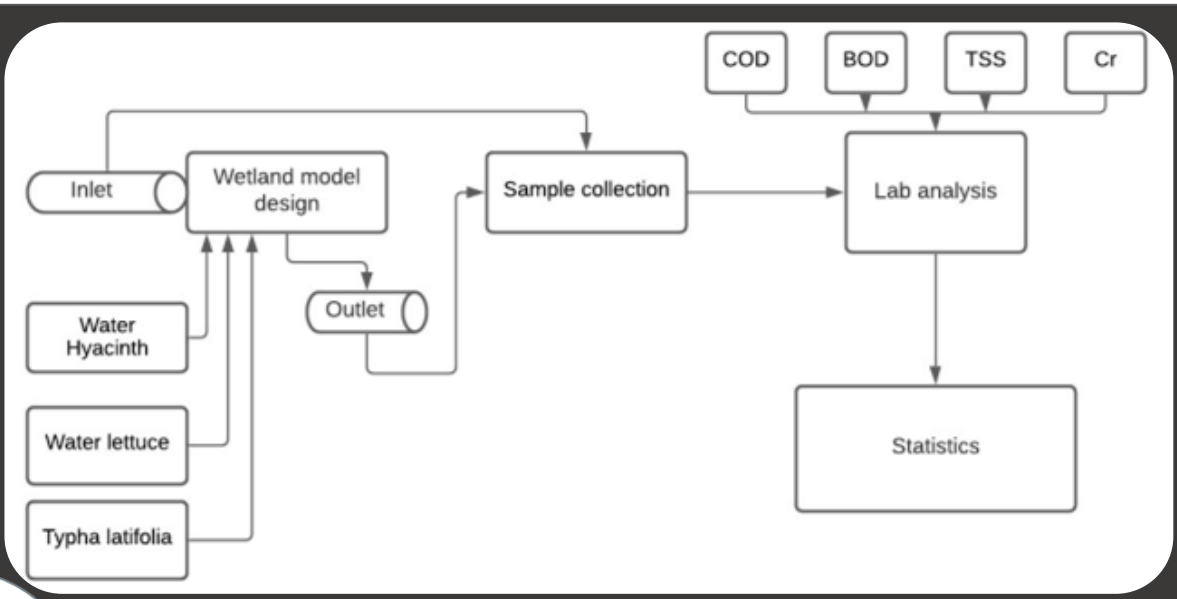
The described system exhibits significant ecological potential by utilizing phytoremediation for the cost-effective treatment of tannery wastewater. By employing local plant species, the system can improve water quality while promoting biodiversity. Its scalability and adaptability to local environments make it an eco-friendly solution for industrial effluent management.

ADVANTAGES

1. A cost-effective way and an alternative to expensive treatment methods.

DISADVANTAGES

1. High impact of solid particles introduced with the WW. High probability of clogging the hydraulic system.



Source: A.Youns and J.Shafiq „Treatment of Industrial Wastewater in a Floating Treatment Wetland: A Case Study of Sialkot Tannery"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

TREATMENT WETLAND FOR AGRICULTURE

OBJECT INFORMATION

Name: TW Treating Agricultural Drainage Water in Northern Italy
Type of facility: FWS
Treated medium: agricultural runoff
Description of the solution: The study was carried out on a non-waterproofed pilot scale TW located on an experimental agricultural farm of the Canale Emiliano Romagnolo. The NBS treats tile drainage water coming from a 12.5 ha experimental farm that grows different crops eg. fruit trees, vegetables, and cereals. The area of the FWS represents around 3% of the total farm surface, and it is divided into four 8–10 m wide meanders that create a 470-m-long water course.



GEOGRAPHICAL COORDINATES

Latitude: 44° 34’ 22” N
Longitude: 11° 31’ 44” E

BASIC INFORMATION

Construction year: 2001
Constructor: Green4Water
Source of financing: Ministry of Education, University and Research in Italy
Total cost: 100 000 €
Facility operator: Canale Emiliano Romagnolo
Maintenance cost: 7 000 € / year
Contact person: Stefano Anconelli (anconelli@consorziocer.it)

LOCATION

Country: Italy
City: Bologne
Type of climate: Cfa
Average temperature: 14.3 °C
Sum of precipitation: 825 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse



Source: I. Braschi et al. „Miglioramento della qualita dell’acqua tramite fitodepurazione delle acque dei reticoli pormiscui”



Source: S.Lavarnic et al. „Long-Term Monitoring of a Surface Flow Constructed Wetland Treating Agricultural Drainage Water in Northern Italy”

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 5850 m^2
Catchment: 125 000 m^2
Volume: 1500 m^3
Dominant plant species: *Phragmites australis, Typha latifolia, T. angustifolia, Salix alba, Populus alba*
Operating experience: The operation of the SFTW depends mostly on the frequency and volume of precipitation.

ECOLOGICAL POTENTIAL

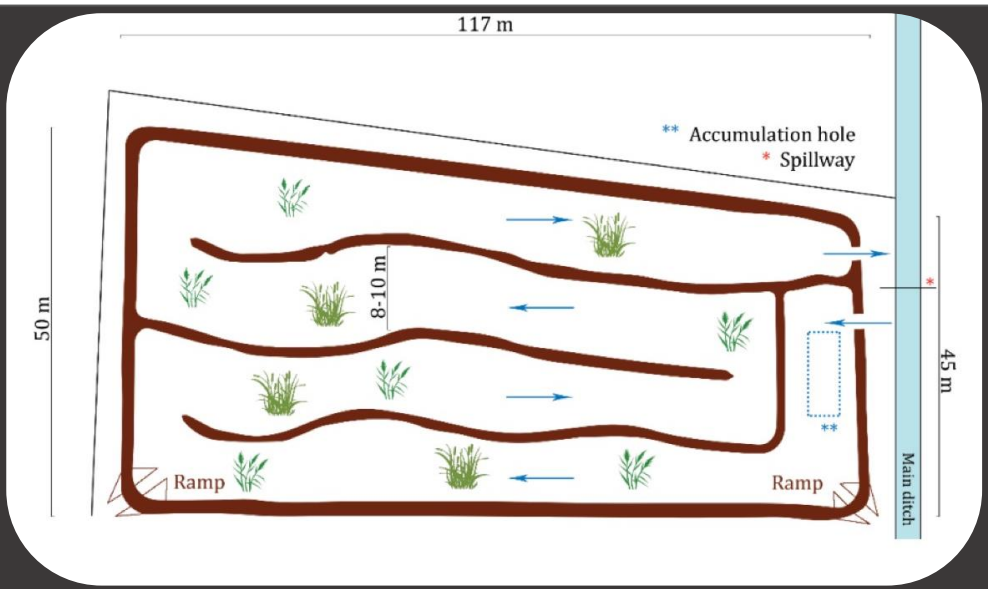
Wastes from the facility are used to grow plants. Moreover, the planted species of reeds help the biodiversity. The facility improves the microclimate of the environment and captures biogenic and carbon compounds.

ADVANTAGES

1. The water flow in the system is gravitational and therefore operating costs are low, especially since only occasional maintenance works are needed every few weeks.

DISADVANTAGES

1. Two pumps convey water from the ditch towards the inlet once water in the ditch reaches a certain level. Probability of clogging the pumps.



Source: I. Braschi et al. „Miglioramento della qualita dell'acqua tramite fitodepurazione delle acque dei reticoli pormiscui"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

www.nice-nbs.eu

NBS FOR GREYWATER / GREYWATER + DIRECT OF RAINFALL

Type of object	Location	Name
Green roofs (GR) ∑=3	Makandusi (Tanzania)	ROOFTOP HORIZONTAL SUBSURFACE FLOW TREATMENT WETLAND FOR GREYWATER REUSE
	Oregon (USA)	ROOF HYBRID FOR GREYWATER
	Richmond (USA)	GREEN ROOF AS A WASTEWATER TREATMENT PLANT FOR GRWYWATER
Living walls/green walls (LW/GW) ∑=4	Beiru (Lebanon)	LIVING WALLS FOR GREYWATER REUSE
	Ferla (Italy)	LIVING WALL FOR GREYWATER REUSE
	Amman (Jordan)	LIVING WALLS FOR GREYWATER REUSE
	Marina di Ragusa (Italy)	LIVING WALLS FOR GREYWATER REUSE

ROOFTOP HORIZONTAL SUBSURFACE FLOW TREATMENT WETLAND FOR GREYWATER REUSE

OBJECT INFORMATION

Name: Rooftop wetland for greywater treatment and its agricultural reuse
Type of facility: GR
Treated medium: greywater
Description of the solution: The company IRIDRA designed a rooftop wetland for the treatment and reuse of the greywater from the Singita Sasakwa Lodge for agricultural purposes. The system was designed as a HF wetland of a surface area of 23m^2 and with an estimated treatment capacity of 4m^3/d in order to treat the greywater produced by all the activities of the resort (bathrooms, kitchen, pool, etc.).



BASIC INFORMATION

Construction year: 2015
Constructor: IRIDRA/Singita Sasakwa Lodge
Source of financing: private
Facility operator: Singita Sasakwa Lodge
Total cost: 5300 €
Maintenance cost: 500 €
Contact person: Fabio Masi (masi@iridra.com)

GEOGRAPHICAL COORDINATES

Latitude: 3° 5' 15.5" S
Longitude: 34° 29' 30.271" E

LOCATION

Country: Tanzania
City: Makandusi, Serengeti
Type of climate: Aw
Average temperature: 26.1°C
Sum of precipitation: 1114 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery

TECHNICAL DATA

Area of the facility: 23 m^2
Volume: 10.35 m^3
Catchment: 130 m^2
Primary design factor: wastewater capacity 4m^3/day
Hydraulic retention time: 0.8 day
Type of substrate: LECA® (Light Expanded Clay Aggregates)

ROOFTOP BASIN



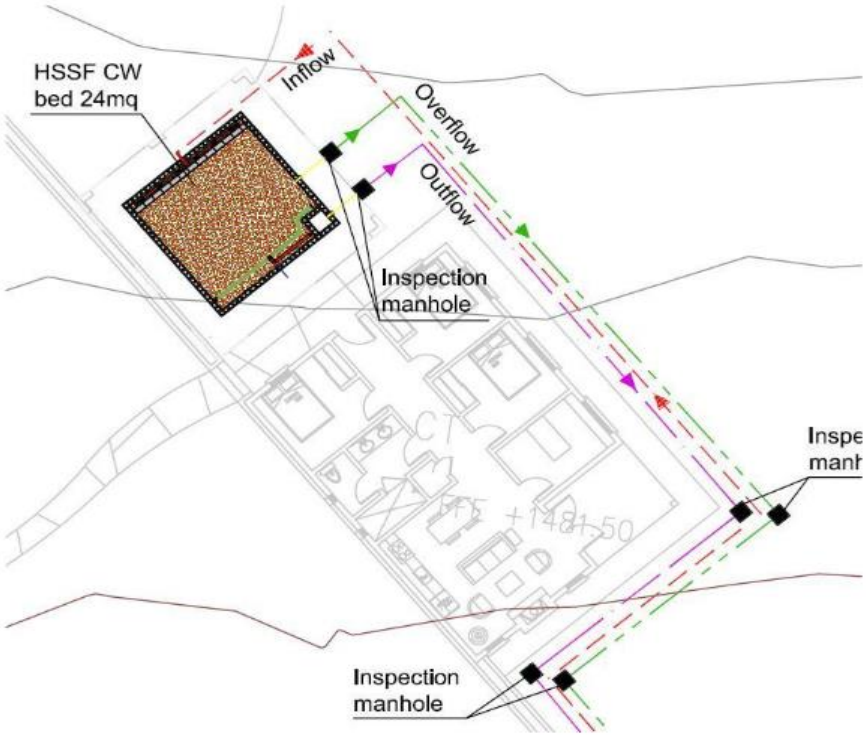
LECA FILLING



Source: F. Massi et al.."Green architecture and water reuse: examples from different countries"

ECOSYSTEM SERVICES ACCORDING TO CICES			
Section	Provisioning	Regulation & Maintenance	Cultural
Class	ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific -Characteristics of living systems that enable education and training investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable aesthetic experiences

Resort in Grumenti community, Serengeti (Tanzania)



ECOLOGICAL POTENTIAL

Includes services such as nutrient cycling, primary production, soil-formation, habitat provision. These make it possible for the ecosystems to continue providing services such as food supply, flood regulation and water purification.

ADVANTAGES

1. The subsurface flow avoided the development of odors and mosquitoes and allowed the public to access and visit the wetland area.
2. Lightweight clay aggregates used to reduce weight of the system for both building materials and filling media.

DISADVANTAGES

1. The facility relies on pumping system.
2. The location of the wetland on the roof is dangerous - system failure and torrential rains may violate the load-bearing capacity of the building.

Source: F. Massi et al.."Green architecture and water reuse: examples from different countries"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

ROOF HYBRID FOR GREYWATER

OBJECT INFORMATION

Name: Tri-City wastewater treatment plant
Type of facility: GR
Treated medium: greywater
Description of the solution: The Tri-City Water Pollution Control Plant uses physical, biological and chemical treatment to clean approximately 32 000 m^3 of wastewater per day, created by the cities of Gladstone, Oregon City and West Linn. Following the treatment process, clean water is released into the Willamette River. The roofs are irrigated with greywater, and the water treatment personnel monitor the water quality of the runoff from the roofs.

BASIC INFORMATION

Construction year: 2010
Constructor: American Hydrotech Inc.
Source of financing: government project
Total cost: 10 000 000 $
Facility operator: Tri-City service district
Maintenance cost: 10 000-15 000$/year
Contact person: Green roofs company (aramis@greenroofs.com)

TECHNICAL DATA

Area of the facility: 1 319 m^2
Volume: 235 m^3
Daily WW inflow: 32 000 m^3 per day
Dominant plant species: succulents
Operating experience: The green roof is irrigated from air conditioning condensate, which prevents this water from entering the wastewater system and provides an additional cooling benefit to the building.

OREGON CITY, OR



GEOGRAPHICAL COORDINATES

Latitude: 45° 37' 68.3" N
Longitude: 122° 58' 98.2" W

LOCATION

Country: United States of America
City: Oregon City, OR
Type of climate: Csb
Average temperature: 11.3°C
Sum of precipitation: 1486 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery



Source: LiveRoof Texas

ECOSYSTEM SERVICES ACCORDING TO CICES			
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ECOLOGICAL POTENTIAL

Green roofs improve the quality of greywater such that it can subsequently be reused for irrigation of ornamental plants or can be drained to existing sewer lines. Green roofs can mitigate direct rainfall quantity and improve its quality. In addition, they facilitate the provision of a sustainable built urban environment.



Source: LiveRoof Texas

ADVANTAGES

1. Green roofs reduce urban heat island effect.
2. Green roof provides an additional insulation in the winter and during the summer reduces heat load to the building.

DISADVANTAGES

1. Necessary operational works, ensuring i.e. patency of the inflow and proper development of plants.

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

GREEN ROOF AS A WASTEWATER TREATMENT PLANT FOR GRWYWATER

OBJECT INFORMATION

Name: Green roof at Richmond wastewater treatment plant
Type of facility: hybrid GR
Treated medium: greywater sewage
Description of the solution: Richmond's wastewater treatment plant serves approximately 58 000 customers in the city and is the largest of its kind in Virginia. Located along the south bank of the James River, the plant can treat up to 265 000 m^3 a day of sanitary sewage and directed rainfall before returning it to the river.



BASIC INFORMATION

Construction year: 2011
Constructor: International Roofing
Source of financing: government project
Facility operator: RIVERBEND NURSERY
Total cost: 80 000 $
Maintenance cost: 3 000-5 000$
Contact person: Green roofs company (aramis@greenroofs.com)

GEOGRAPHICAL COORDINATES

Latitude: 37° 31' 12.7" N
Longitude: 77° 25' 23.2" W

LOCATION

Country: United States of America
City: Richmond, VA
Type of climate: CfA
Average temperature: 14.8 °C
Sum of precipitation: 1122mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery





Source: greenroofs.com/projects/richmond-waste-water-treatment-plant-effluent-filtration-building

ECOSYSTEM SERVICES ACCORDING TO CICES			
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TECHNICAL DATA

Area of the facility: 557.4 m^2
Daily WW inflow: 265 000 m^3 / day
Dominant plant species: sedum, alliums, and euphorbia
Operating experience: The next goal is to install a green roof on the new Ultraviolet Disinfection Facility, a 2,000 square foot surface, for an estimated cost of $35,000.



ECOLOGICAL POTENTIAL

Green roofs improve the quality of greywater so that it can subsequently be reused for irrigation of ornamental plants or can be drained to existing sewer lines. Green roofs can mitigate direct rainfall quantity and improve its quality. In addition, they facilitate the provision of a sustainable built urban environment.

ADVANTAGES

1. Green roofs reduce urban heat island effect.
2. Green roof provides an additional insulation in the winter and during the summer reduces heat load to the building.

DISADVANTAGES

1. Necessary operational works, ensuring i.e patency of the inflow and proper development of plants.

Source: greenroofs.com/projects/richmond-waste-water-treatment-plant-effluent-filtration-building

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

LIVING WALLS FOR GREYWATER REUSE

OBJECT INFORMATION

Name: LW for greywater treatment and reuse in Jewet Hall
Type of facility: LW
Treated medium: greywater from a dormitory
Description of the solution: The project for the LWs for Jewett Hall regards the construction of LWs and GFs, designed with the aim of treating and reusing light greywater (from showers and washbasins) produced by the dormitory, and is reused for toilet flushing. The LWs are divided into the East Living Wall, and the West Living Wall, for a total surface area of approximately 80 m^2 , while the GF covers a surface area of approximately 105 m^2. Therefore, the NBS of Jewett Hall is expected to treat up to 2.9 m^3/d of greywater, about 1060 m^3/year.



GEOGRAPHICAL COORDINATES

Latitude: 33° 54' 02" N
Longitude: 35° 29' 09" E

BASIC INFORMATION

Construction year: 2021-2022
Constructor: IRIDRA
Source of financing: NAWAMED project, EU ENI CBC MED program
Total cost: 10 000€
Facility operator: American University of Beirut (AUB)
Maintenance cost: 1 000-2 000€
Contact person: Anacleto Rizzo (rizzo@iridra.com)

LOCATION

Country: Lebanon
City: Beirut
Type of climate: Csa
Average temperature: 20.5°C
Sum of precipitation: 845 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery



Source: enicbcmed.eu/nawamed-introduces-cutting-edge-solutions-greywater-treatment-lebanon

ECOSYSTEM SERVICES ACCORDING TO CICES			
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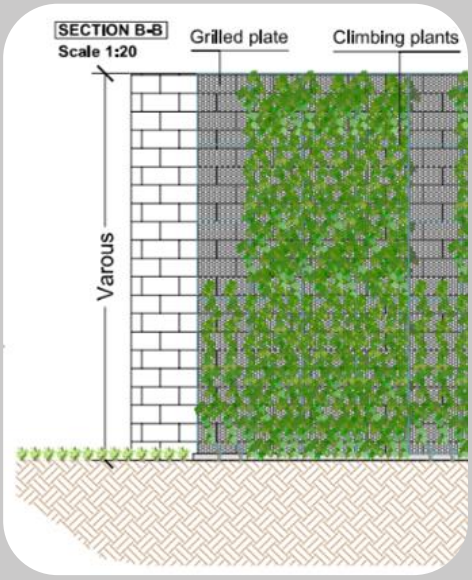
TECHNICAL DATA

Area of the facility:
GF– 105 m²;
LW– 84 m²
Primary design factors:
LW - OTR: - 17 g O_2/m²*d; HLR: 100–700 l/m²*d; OLR: 50 g COD/m²/d;
GF - OTR: 30 gO_2/m²d; HLR: 80 l/m²*d; OLR: 30 g COD/m²/d
Average daily hydraulic load: 2.9 m³/d
Efficiency and Effectiveness:
Expected outlet concentrations:
BOD_5 < 15 mg/l;
COD < 100 mg/l

ECOLOGICAL POTENTIAL

LWs have zero or reduced energy consumption, making the costs for consumed energy almost negligible. Moreover, the facilities provide excellent environmental integration. They provide additional benefits typical of living walls such as thermal insulation, improvement of air quality and building aesthetics.





ADVANTAGES

1. LWs are ideal for treating slightly polluted water in situ and reusing it for activities that do not require drinking water.

DISADVANTAGES

1.High possibility of clogging the hydraulic network supplying greywater to the facility.

Source: IRIDRA

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

LIVING WALL FOR GREYWATER REUSE

OBJECT INFORMATION

Name: LW for the treatment of greywater for the Valle dell'Anapo comprehensive state institute
Type of facility: LW
Treated medium: greywater from a school
Description of the solution: The project is to construct a LW for the treatment and reuse of the greywater at a middle school. The treatment of greywater from the school sinks is carried out through a LW adapted to provide TW processes, and the treated water is accumulated in an underground deposit. To avoid any hygienic-sanitary problem, a U.V. disinfection chamber was installed. The water is then reused for toilet flushing and irrigation.

BASIC INFORMATION

Construction year: 2022
Constructor: IRIDRA
Source of financing: NAWAMED project, EU ENI CBC MED program
Total cost: 59 000€
Facility operator: Ferla municipality
Maintenance cost: 8 000-10 000€/year
Contact person: State Institute in the Municipality of Ferla, Sicilia (svimed.nawamed@gmail.com)





GEOGRAPHICAL COORDINATES

Latitude: 37° 07' 07" N
Longitude: 14° 56' 12" E

LOCATION

Country: Italy
City: Ferla
Type of climate: Csa
Average temperature: 16.0°C
Sum of precipitation: 621 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery



Source: IRIDRA

ECOSYSTEM SERVICES ACCORDING TO CICES			
Section	Provisioning	Regulation & Maintenance	Cultural
Class	ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific -Characteristics of living systems that enable education and training investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable aesthetic experiences

ECOLOGICAL POTENTIAL

The plant species hosted by the pots promote bacterial biodiversity and allow the water to distribute itself evenly in the pots, guaranteeing purifying efficacy and having an aesthetic and cooling function.



TECHNICAL DATA

Area of the facility: 30 m^2
Primary design factors: OTR: 17 gO_2/m^2*d; HLR: 100 – 700 l/m^2*d
Hydraulic load: 1.3 m^3/d
Operating experience: The system involves the collection of water (mostly from washbasins) in a small tank, followed by a pumping system to feed the GW. The water percolates through the pots through a piping system, and a tank collects it for subsequent reuse.

ADVANTAGES

1. The structure is an integral part of the building's facade. Protection of the external parts of the wall and reduction of heating of the interior of the building under the LW.

DISADVANTAGES

1. The facility is exposed to supplying water only through rainfall (uncertainty of occurrence, which may damage the green wall or tap water.

Source: IRIDRA

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

LIVING WALLS FOR GREYWATER REUSE

OBJECT INFORMATION

Name: Pilot installation for greywater treatment and reuse in Univeristy of Jordan
Type of facility: LW
Treated medium: greywater from a dormitory
Description of the solution: The project aims at implementing the real scale pilot installations for greywater rainwater treatment and reuse, including GW. The technique that is used for the treatment of the greywater in GWs derives from the treatment wetlands technology. The NBS are divided in three different areas, providing a green wall surface of about 218 m^2, and treating and recovering a total greywater flow rate equal to about 4.2 m^3/d, the reusable greywater amounts to about 1000 m^3/year.



GEOGRAPHICAL COORDINATES

Latitude: 32° 00' 58" N
Longitude: 35° 52' 10" E

BASIC INFORMATION

Construction year: 2022/2023
Constructor: IRIDRA
Source of financing: NAWAMED project, EU ENI CBC MED program
Total cost: 134 805€
Facility operator: University of Jordan
Maintenance cost: 2 000€ / year
Contact person: Anacleto Rizzo (rizzo@iridra.com)

LOCATION

Country: Jordan
City: Amman
Type of climate: BSk
Average temperature: 17.2°C
Sum of precipitation: 187 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery



Source: encibcmed.eu/nawamed-presents-water-management-pilots-implemented-jordan

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific -Characteristics of living systems that enable education and training investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 218 m²
Type od substrate: 10 mm round, washed gravel; sand 0.2-5 mm , (D_{60}= 1 mm)
Efficiency and Effectiveness:
Category - toilet flushing
BOD_5 < 15 mg/l; COD < 100 mg/l
Category - parking and lawn irrigation
BOD_5 < 30 mg/l; COD < 100 mg/l

ECOLOGICAL POTENTIAL

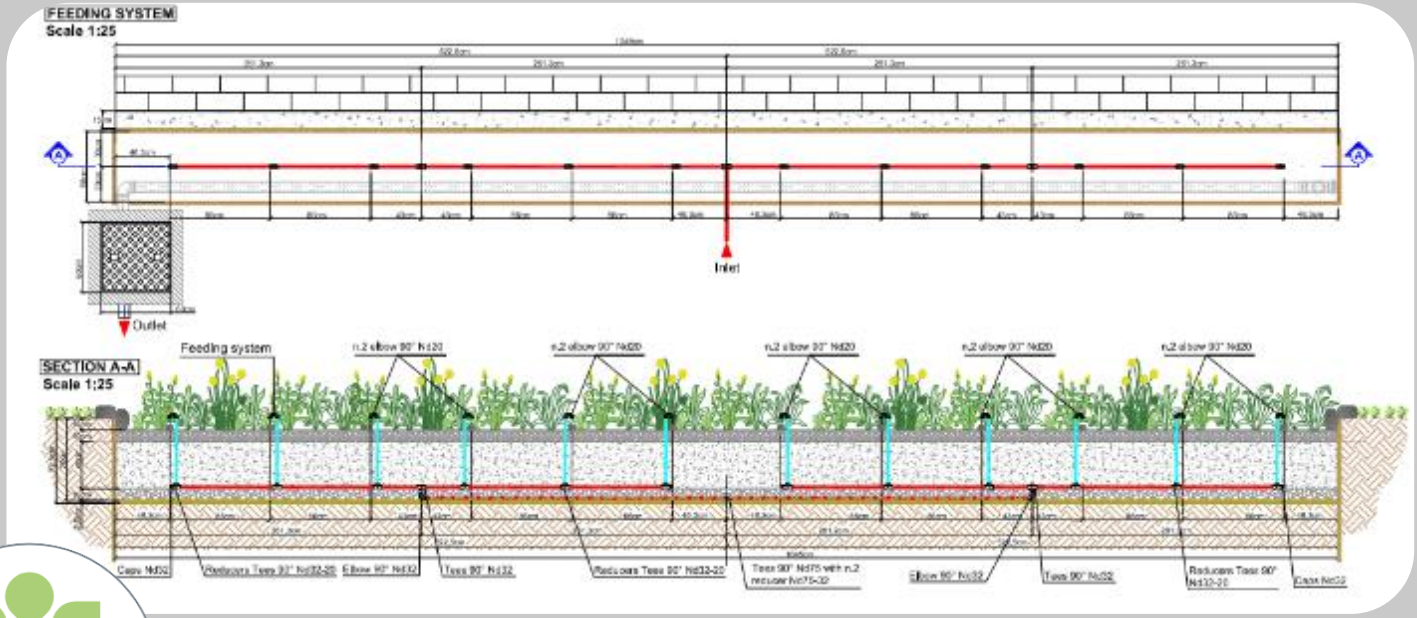
LWs have zero or reduced energy consumption, making the costs for consumed energy almost negligible. Moreover, the facilities provide excellent environmental integration. They provide additional benefits typical of green roofs such as thermal insulation, improvement of air quality and building aesthetics.

ADVANTAGES

1. LWs are ideal for treating slightly polluted water in situ and reusing it for activities that do not require drinking water.

DISADVANTAGES

1. High possibility of clogging the hydraulic network supplying greywater to the facility.



Source: IRIDRA

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

LIVING WALLS FOR GREYWATER REUSE

OBJECT INFORMATION

Name: Living walls at Marina di Ragusa
Type of facility: LW
Treated medium: greywater
Description of the solution: The LW for greywater treatment and reuse system has been developed as demonstration project. The aim was environmental and economic sustainability obtained through the purification of grey water, and recovery and reuse for fit-for-purpose uses such as toilet flushing or irrigation produced by the showers of Margarita Beach. The LW aims to save about 350 litres of drinking water per day.



BASIC INFORMATION

Construction year: 2018
Constructor: AConsumelessMed project
Source of financing: private and initiative co-funded by the European Regional Development Fund
Total cost: 10 000€
Facility operator: unskilled personnel
Maintenance cost: 200€ / year
Contact person: Anacleto Rizzo (rizzo@iridra.com)

GEOGRAPHICAL COORDINATES

Latitude: 36° 46' 54.98" N
Longitude: 14° 33' 31.06" E

LOCATION

Country: Italy
City: Marina di Ragusa, Sicily
Type of climate: Csa
Average temperature: 16.5°C
Sum of precipitation: 541 mm

URBAN CIRCULARITY CHALLENGES

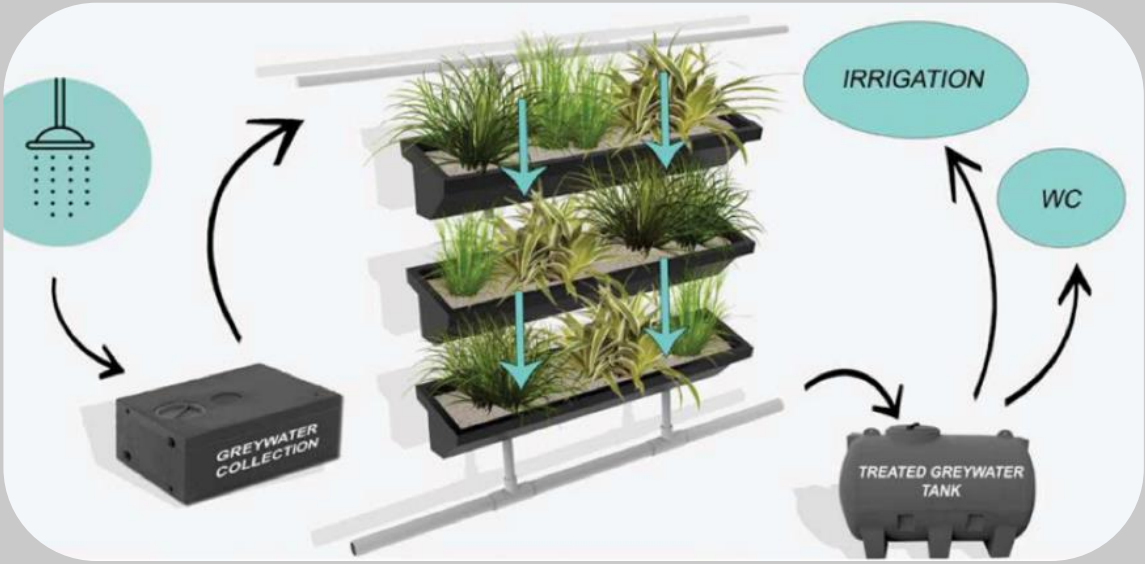
UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery





Source: A. Rizzo et al.."Living walls at Marina Di Ragusa, Italy"

ECOSYSTEM SERVICES ACCORDING TO CICES			
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TECHNICAL DATA

Area of the facility: 9 m²
Volume: 4.5 m³
Flow: 350 l/day
Primary design factor: 3m² /PE
Operating expierience: No monitoring campaign was established. On the other hand, the treated greywater was successfully reused throughout the tourist summer season of 2018, highlighting proper treatment.

ECOLOGICAL POTENTIAL

The LW was designed to be hotspot of biodiversity in the urban environment. Evapotranspiration of plants placed in the NBS supports the reduction of the urban heat island effect. Moreover, the facility purifies air. The installation of a construction was an occasion to renew the aesthetics, as well as to increase the green and sustainable image of the beach resort.

ADVANTAGES

1. The facility is relatively cheap and fulfils the assumed functions.
2. It does not take up much horizontal area in the city (in comparison to wetlands).

DISADVANTAGES

1. Further tests should be carried out to obtain in depth knowledge out treatment processes in the facility.

Source: A. Rizzo et al.."Living walls at Marina Di Ragusa, Italy"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

www.nice-nbs.eu

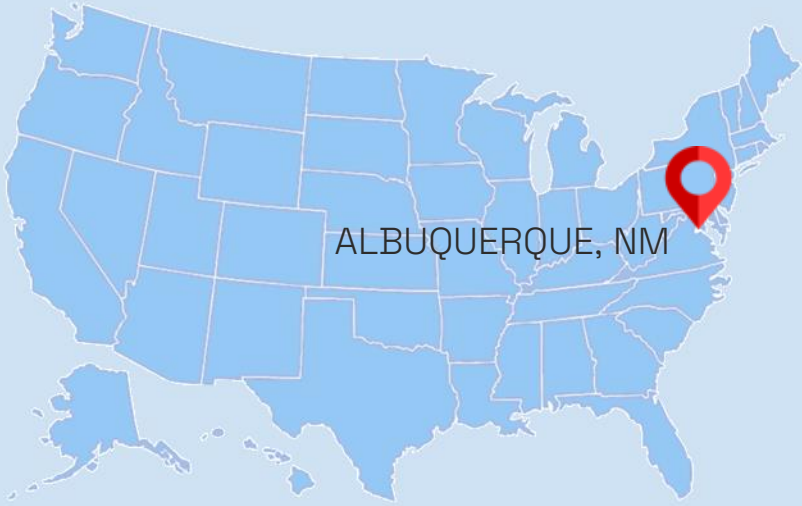
NBS FOR DIRECT RAINFALL

Type of object	Location	Name
Rain garden (RG) (basin, bioretention swale) ∑=3	Albuquerque (USA)	RAIN GARDEN
	Gdańsk, 9 Ugory Street (Poland)	RAIN GARDEN FOR ROOFTOP RUNOFF
	Gdańsk, Kaczeńce Street (Poland)	RAIN GARDEN FOR ROOFTOP RUNOFF
Green roofs (GR) ∑=5	Buffalo (USA)	GREEN ROOF AND RAIN GARDEN FOR WATER REUSE IN IRRIGATION
	Manhattan (USA)	GREEN ROOF AT A SLOPE
	Washington (USA)	GREEN ROOF AS A RECREATIONAL SPACE
	New York (USA)	ROOFTOP FARM FOR REUSE OF RAINWATER
	Copenhagen (DENMARK)	GREEN ROOF
Living walls/green walls (LW/GW) ∑=3	Valladolid (Spain)	HYDROPONIC SYSTEM
	Paris (France)	LIVING WALL
	Kalisz, John Paul II Square (Poland)	GREEN BUS STOP

RAIN GARDEN

OBJECT INFORMATION

Name: Pete V. Domenici U.S. Courthouse Landscape Retrofit
Type of facility: RG
Treated medium: direct rainfall
Description of the solution: The facility reconnects the site with its historical and geographic context through an evocative and sustainable design. Located in the downtown district, the design converts a water-intensive turf landscape into one that enhances environmental efficiency while providing a dignified setting for court operations. Design strategies include rainwater harvesting, energy-efficient lighting, solar panels, native and drought-tolerant plants, and extensive use of repurposed materials.



LOCATION

Country: United States of America
City: Albuquerque, NM
Type of climate: BWk
Average temperature: 14.4°C
Sum of precipitation: 211 mm



GEOGRAPHICAL COORDINATES

Latitude: 35° 05' 30" N
Longitude: 106° 38' 58" W

BASIC INFORMATION

Construction year: 2013
Constructor: AIC General Contractor Inc.
Source of financing: U.S. General Services Administration
Total cost: 2 800 000$
Facility operator: U.S. General Services Administration
Maintenance cost: 25 000-35 000$
Contact person: Chris Martin (chris.martin@asu.edu)



URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_7- building system recovery

Source: landscapeperformance.org/case-study-briefs/pete-v-domenici-us-courthouse-landscape-retrofit

ECOSYSTEM SERVICES ACCORDING TO CICES			
Section	Provisioning	Regulation & Maintenance	Cultural
Class	ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific -Characteristics of living systems that enable education and training investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 18 600 m^2
Operating experience: Generates an estimated 43,100 kWh of solar power annually, 99% of the net energy needed for outdoor lighting. **Efficiency and effectiveness:** Reduces potable water use for irrigation by 86% compared to an established baseline.

ECOLOGICAL POTENTIAL

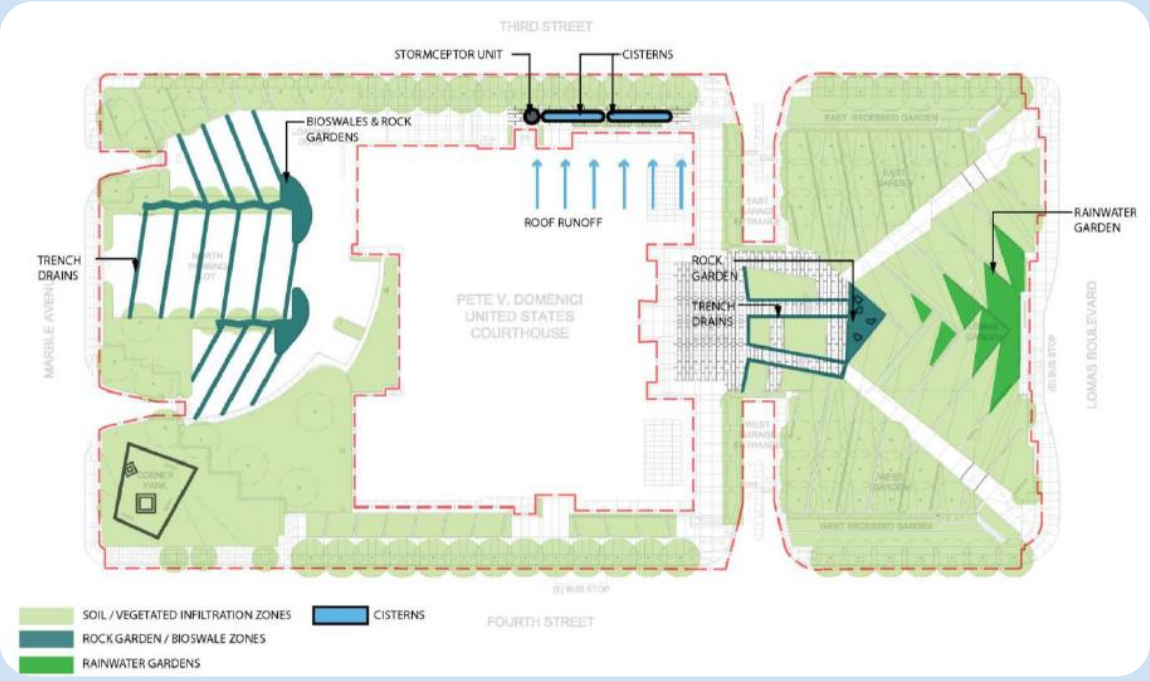
The main task of the facility is to manage rainwater in such a way as to reduce the shortage of water used to water plants around the facility. In addition, plants purify the incoming water and recharge groundwater.

ADVANTAGES

1. Irrigation water is supplemented by rainwater collected from the roof and stored in 2 underground cisterns (60 m^3).

DISADVANTAGES

1. Grass, which is demanding in care, was partially sown as part of the facility's vegetation.



Source: landscapeperformance.org/case-study-briefs/pete-v-domenici-us-courthouse-landscape-retrofit

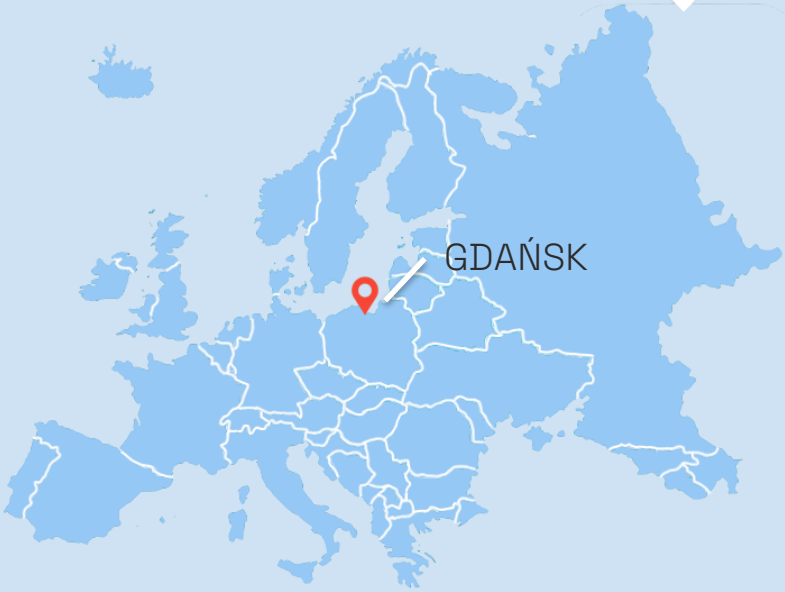
Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

RAIN GARDEN FOR ROOFTOP RUNOFF

OBJECT INFORMATION

Name: Box rain garden eMOCja center (9 Ugory Street)
Type of facility: RG
Treated medium: direct of rainfall
Description of the solution: The rain garden consists of three box gardens connected with cascades, it is fed by rainwater collected from the roof surface. In the last of the containers there is an emergency overflow. Excess water is directed to a nearby street. The facility collects rainwater, which relieves the municipal rainwater drainage system, has a positive effect on the microclimate. Next to the boxes there is a bench with an adjacent container for decorative greenery.



GEOGRAPHICAL COORDINATES

Latitude: 54° 21' 51.61'' N
Longitude: 18° 41' 57.57'' E

BASIC INFORMATION

Construction year: 2020
Constructor: Gdańskie Wody
Source of financing: urban investment
Total cost: 1 750€
Facility operator: Gdańskie Wody
Maintenance cost: 100€
Contact person: Magdalena Gajewska (mgaj@pg.edu.pl) or Agnieszka Kowalkieiwcz (a.kowalkiewicz@gdanskieowdy.pl)

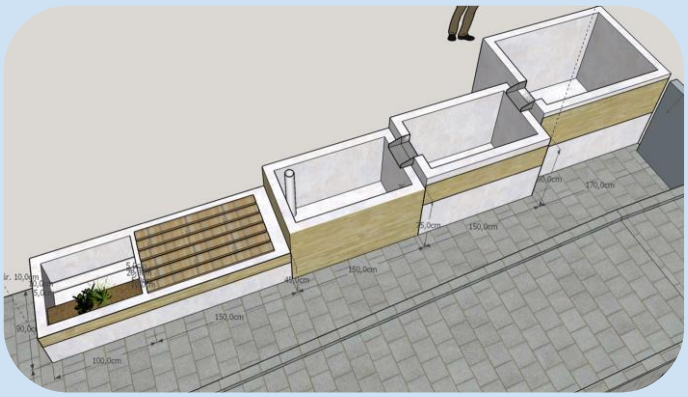
LOCATION

Country: Poland
City: Gdańsk
Type of climate: Cfb
Average temperature: 9 °C
Sum of precipitation: 420 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_7- building system recovery





Source: Gdańskie Wody sp. z o.o.

ECOSYSTEM SERVICES ACCORDING TO CICES			
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TECHNICAL DATA

Area of the facility: 5 m^2
Volume: 2,3 m^3
Catchment: Polder area, pumping station to Martwa Wisła river
Efficiency and effectiveness: The facility fulfils the assumed functions

ECOLOGICAL POTENTIAL

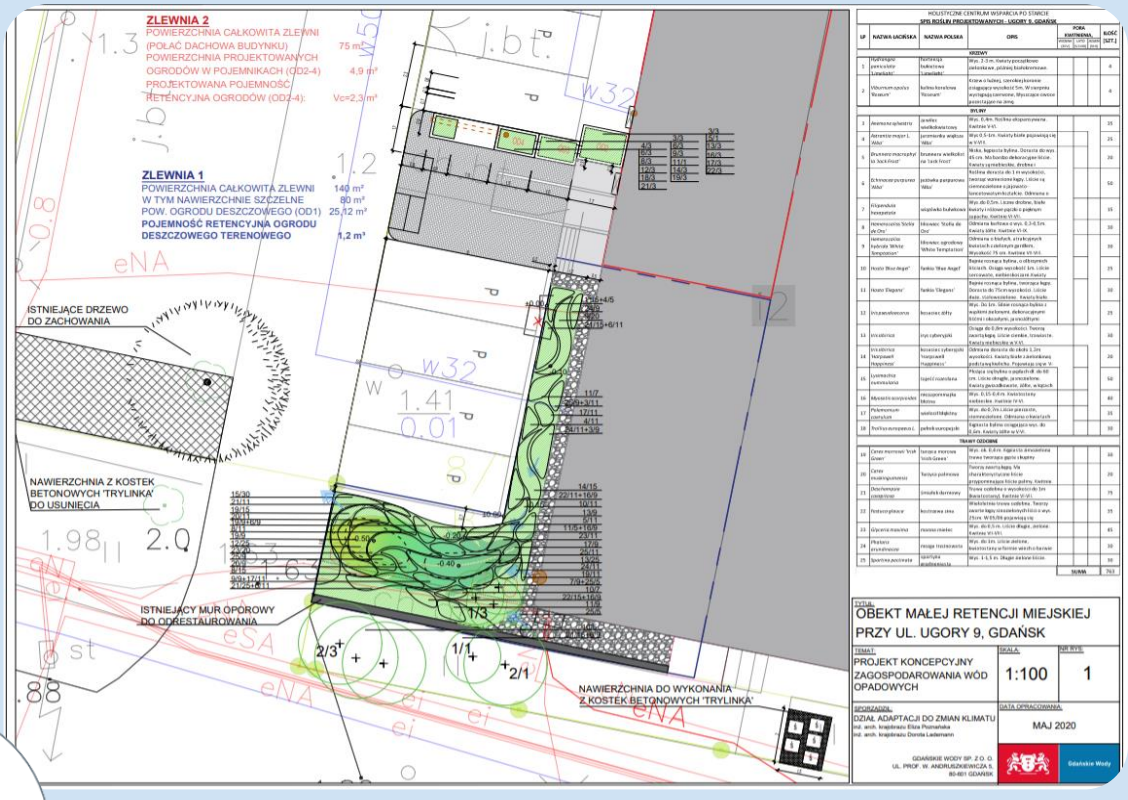
The regulatory function of the garden is cleaning the surface runoff and delaying the outflow from the catchment. The supporting function is providing habitats. It has a positive effect on the biodiversity.

ADVANTAGES

1. Due to the location of the garden at the medical center, it can have a therapeutic function.
2. Rainwater retention in the landscape.
3. Increase in flood protection of the city.

DISADVANTAGES

1. Necessary operational works, ensuring i.e patency of the inflow and emergency overflow and plant care.



Source: Gdańskie Wody sp. z o.o.

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

RAIN GARDEN FOR ROOFTOP RUNOFF

OBJECT INFORMATION

Name: Rain garden at Kaczeńce Street
Type of facility: RG
Treated medium: direct of rainfall
Description of the solution: The rain garden consists of many basins connected with an overflow. It is powered by runoff collected from the surface roofs' surface. The facility collects and infiltrates rainwater, which relieves the municipal rainwater drainage system, has a positive effect on biodiversity and microclimate. Excess water is directed by an emergency spillway to rainwater sewer network.



BASIC INFORMATION

Construction year: 2018
Constructor: Gdańskie Wody
Source of financing: urban investment
Total cost: 85 000€
Facility operator: Gdańskie Wody
Maintenance cost: 400€
Contact person: Magdalena Gajewska (mgaj@pg.edu.pl)
or Agnieszka Kowalkiewicz (a.kowalkiewicz@gdanskieowdy.pl)

GEOGRAPHICAL COORDINATES

Latitude: 54° 21' '51.61" N
Longitude: 18° 41' '57.57" E

LOCATION

Country: Poland
City: Gdańsk
Type of climate: Cfb
Average temperature: 9 °C
Sum of precipitation: 420 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_7- building system recovery





Source: gdmel.pl

ECOSYSTEM SERVICES ACCORDING TO CICES			
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TECHNICAL DATA

Area of the facility: 449m^2
Volume: 224,5m^3
Catchment: Polder area, pumping station to Martwa Wisła
Efficiency and effectiveness: The facility fulfils the assumed functions of flood protection and drainage

ECOLOGICAL POTENTIAL

Relieving the rainwater drainage system increases flood protection. The moistening of the soil increases, which improves the microclimate. The rain garden helps with sustainable rainwater management.

ADVANTAGES

1. Retention of rainwater in the landscape.
2. Preliminary treatment of water and relieving rainwater drainage.
3. Aesthetic value for residents of nearby housing estate.

DISADVANTAGES

1. Necessary operational works, ensuring i.e patency of the inflow and proper development of plants.



Source: gdanskiewody.pl

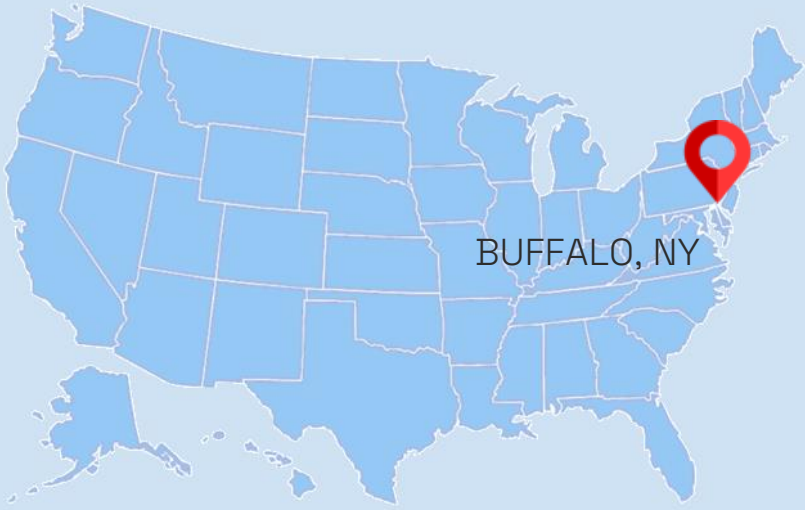
Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

GREEN ROOF AND RAIN GARDEN FOR WATER REUSE IN IRRIGATION

OBJECT INFORMATION

Name: Green roof and rain garden at the McKinley High School
Type of facility: RG & GR
Treated medium: rainwater
Description of the solution: A wide variety of green infrastructure tools were incorporated into the school renovation to support its onsite rainwater management program. Importantly, these attractive features also are accessible green spaces which function as outdoor learning laboratories for the students. The green infrastructure solution features two main components: GR, a 219m^2 extensive green roof with 138m^2 of vegetative area and four inches of growing medium and RG, a 158m^2 RG along the outside of the courtyard.



GEOGRAPHICAL COORDINATES

Latitude: 42° 93' 73" N
Longitude: 78° 87' 88" W

BASIC INFORMATION

Construction year: 2012
Constructor: LP Ciminelli Inc., Joseph A Sanders & Sons Inc.
Source of financing: program of Education Building
Total cost: 30 000 000$
Facility operator: Vegtal I.D.
Maintenance cost: 600 $ / year
Contact person: Green roofs company (aramis@greenroofs.com)

LOCATION

Country: United States of America
City: Buffalo, NY
Type of climate: Dfa
Average temperature: 9.4 °C
Sum of precipitation: 1087 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery





Source: landscapeperformance.org/case-study-briefs/buffalo-public-school-305-mckinley-high-school

ECOSYSTEM SERVICES ACCORDING TO CICES			
Section	Provisioning	Regulation & Maintenance	Cultural
Class	ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific -Characteristics of living systems that enable education and training investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 377 m^2
Catchment: 377 m^2
Type of substrate: rubber form recycled rubber paver tiles
Efficiency and effectiveness: The facility fulfils the assumed functions of infiltration and outflow. 100m^3 reduced run-off provided by the GR.



ECOLOGICAL POTENTIAL

Permeable pavements and a 11.5 m^3 rainwater harvesting system allow water to be collected to support the courtyard water feature and can be re-used for irrigation of the school's extensive landscaping.

ADVANTAGES

1. GRs reduce urban heat island effect.
2. GR provides an additional insulation in the winter and during the summer reduces heat load to the building.
1.RG provides retention of rainwater in the landscape.
2. Preliminary treatment of water and relieving rainwater drainage.
3. Aesthetic value for residents of nearby housing estate.

DISADVANTAGES

1. Necessary operational works, ensuring i.e patency of the inflow and proper development of plants.

Source: landscapeperformance.org/case-study-briefs/buffalo-public-school-305-mckinley-high-school

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

GREEN ROOF AT A SLOPE

OBJECT INFORMATION

Name: Kansas State University Memorial Stadium Green Roof
Type of facility: GR
Treated medium: direct rainfall
Description of the solution: These roofs are semi-intensive GRs with sandy substrates — the sandy soil or growing media — laid at depths of circa 15cm over insulated, steeply sloped surfaces up to 40%. The facility's substrates are held in place by a durable plastic geo-web system, which is secured to the upper part of each roof via stainless steel cables attached to eye-bolts at the top of each. The east roof substrate consists of expanded shale to reduce its weight. Both were seeded and planted with mostly species native to the Flint Hills ecoregion.



GEOGRAPHICAL COORDINATES

Latitude: 39° 11' 14" N
Longitude: 96° 35' 01" W

BASIC INFORMATION

Construction year: 2015-2016
Constructor: Blueville Nursery
Source of financing: foundations:
- the Mary K. Jarvis Endowment (K-State landscape architecture program),
- Jeffrey L. Bruce & Company LLC, the K-State Green Action Fund,
- the Pollinator Partnership, the Garden Club of America, Buildex,
- the Landscape Architecture Foundation (LAF)

Total cost: 2 500 000$
Facility operator: City of Syracuse
Maintenance cost: 3 000$ – 8 500$/year
Contact person: Lee R. skabelund

LOCATION

Country: United States of America
City: Manhattan, KS
Type of climate: Cfa
Average temperature: 13.2 °C
Sum of precipitation: 1045 mm



URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery



Source: landscapeperformance.org/case-study-briefs/Kansas-state-University-memorial-stadium-gr

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 4 000m^2
Volume: 600m^3
Efficiency and effectiveness: Created a healthy soil ecosystem. GR soil biomass increased from an average of 49.5 nanomoles per gram of substrate in 2017 to 77.4 nanomoles per gram in 2019. Organic matter increased from an average of 1.1% in 2017 to 1.65% in 2019.

ECOLOGICAL POTENTIAL

The facility captures the precipitation directly at the point where it is extracted. The surface runoff from the roof is reduced providing relief of the sewage system. Moreover, it acts as an insulator.

ADVANTAGES

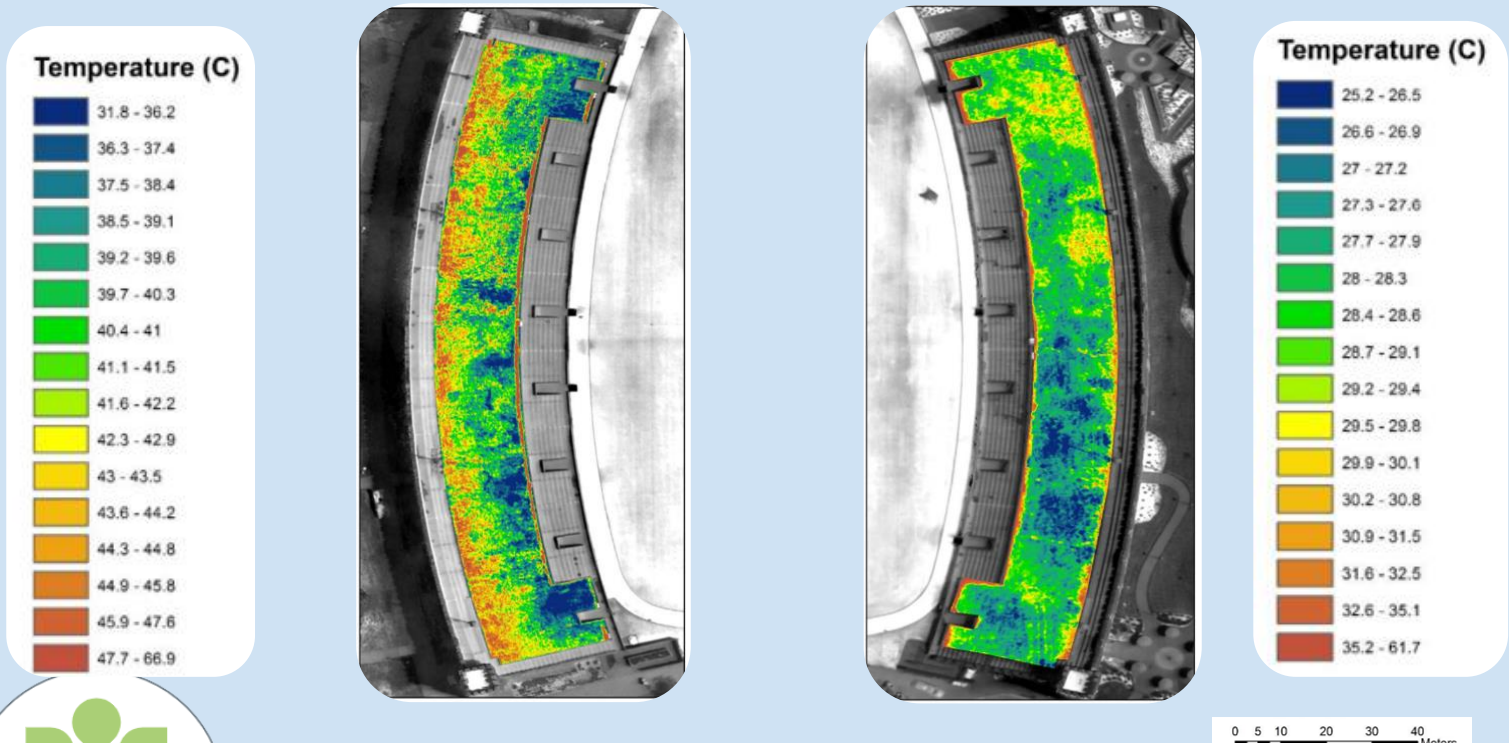
1. The facility allows : reduction in expenses for gardeners, using drinking water for watering, lowering electricity bills. The green roof acts as an insulator.

DISADVANTAGES

1. Instead of sowing plants that do not need a lot of water, it was decided to irrigate vegetation that can die without constant watering.

Common roof

Green Roof



Source: landscapeperformance.org/case-study-briefs/Kansas-state-University-memorial-stadium-green-roofs

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

GREEN ROOF AS A RECREATIONAL SPACE

OBJECT INFORMATION

Name: ASLA headquarters Green Roof
Type of facility: GR
Treated medium: direct rainfall
Description of the solution: The 280 m^2 green roof was installed in May of 2006. It is one of seven green roofs demonstration projects in the Anacostia River Watershed of DC. ETEC monitored water quality and quantity on this roof for 5 rain events in the fall of 2006 and the spring of 2007. The sampling and monitoring of the green roof was performed in accordance with the standard operations for collection and measurement promulgated by the U.S EPA. The location of the project in an urban area that faces significant issues related to combined sewer outflows and a degraded watershed makes the demonstration value of the project.



GEOGRAPHICAL COORDINATES

Latitude: 38° 59' 03" N
Longitude: 77° 01' 17" W

LOCATION

Country: United States of America
City: Washington, D.C.
Type of climate: Cfa
Average temperature: 13.0°C
Sum of precipitation: 1198 mm

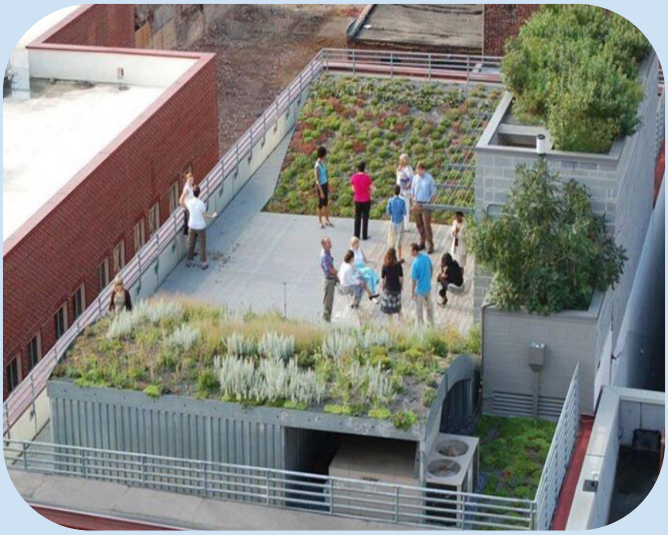
BASIC INFORMATION

Construction year: 2006
Constructor: Blueville Nursery
Source of financing: Chesapeake Bay Foundation, National Fish and Wildlife Foundation, U.S. Environmental Protection Agency Chesapeake Bay **Program. Total cost:** 350 000 $
Facility operator: American Society of Landscape Architects
Maintenance cost: 5 000-8 000$
Contact person: Michael Van Valkenburgh Associates
website: https://www.mvvainc.com/

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery





Source: landscapeperformance.org/case-study-briefs/asla-headquarters-green-roof

ECOSYSTEM SERVICES ACCORDING TO CICES			
Section	Provisioning	Regulation & Maintenance	Cultural
Class	ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific -Characteristics of living systems that enable education and training investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 280 m^2
Catchment area: 280 m^2
Dominant plant species: the sedums, the phloxes, *Silene caroliniana*
Efficiency and effectiveness: The most effective is to reduce runoff from the rooftop and catch the precipitation where it occurs. Facility allows for reduction of ammonia, nitrates, as well as the content of dissolved content in the effluent.

ECOLOGICAL POTENTIAL

The green roof enables the production of nutrients. Plants purify rainwater and air. The temperatures measured between the traditional roof and the green roof differ from each other - the green roof reduces the surface heating temperature.

ADVANTAGES

1. Keeps the roof surface temperature as much as 6.5°C degrees cooler than on neighboring conventional black roofs on the hottest summer days.

DISADVANTAGES

1. Require irrigation the plants several times a week to maintain their beauty.



Source: landscapeperformance.org/case-study-briefs/asla-headquarters-green-roof

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

ROOFTOP FARM FOR REUSE OF RAINWATER

OBJECT INFORMATION

Name: Javits Center expansion rooftop farm
Type of facility: GR
Treated medium: direct of rainfall
Description of the solution: The project includes a one-acre green roof farm, all-season greenhouse, a 929 m^2 orchard and food forest with dozens of fruit-bearing trees, and 1302 m^3 underground cistern for recovering and recycling rainwater runoff. Economic activity generated includes: 4,000 full time jobs; 2,000 part time jobs; 3,100 construction jobs; 200,000 more hotel room nights a year; and $393 million in new economic activity a year.



BASIC INFORMATION

Construction year: 2021
Constructor: Lendlease Construction LMB Inc. & Turner Construction
Source of financing: Commercial Buildings
Total cost: 1 500 000 000 $
Facility operator: Brooklyn Grange
Maintenance cost: 2 000 000 $
Contact person: Green roofs company (aramis@greenroofs.com)

GEOGRAPHICAL COORDINATES

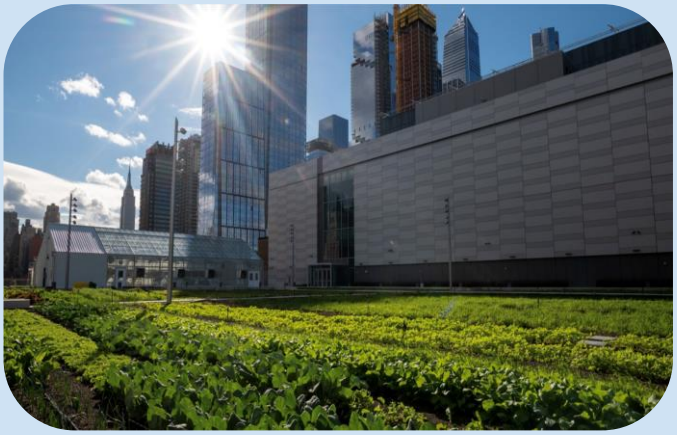
Latitude: 40° 45' 27.87" N
Longitude: 74° 00' 11.98" W

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery

LOCATION

Country: United States of America
City: 11th Avenue, New York
Type of climate: Cfa
Average temperature: 11.9°C
Sum of precipitation: 1139 mm





Source: greenroofs.com/projects/javits-center-expansion-rooftop-farm

ECOSYSTEM SERVICES ACCORDING TO CICES			
Section	Provisioning	Regulation & Maintenance	Cultural
Class	ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific -Characteristics of living systems that enable education and training investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 19 403 m^2
Efficiency and effectiveness: Designed to reduce runoff by 25% and remove 80% of total suspended solids from water.
Operational experience: There are five honeybee hives on the green roof and four hives at The Farm. Two underground tanks with a 1 300 m^3-holding capacity capture and treat rainwater to irrigate all of the plants on the rooftop, reducing the need for potable water for irrigation by at least 50%.

ECOLOGICAL POTENTIAL

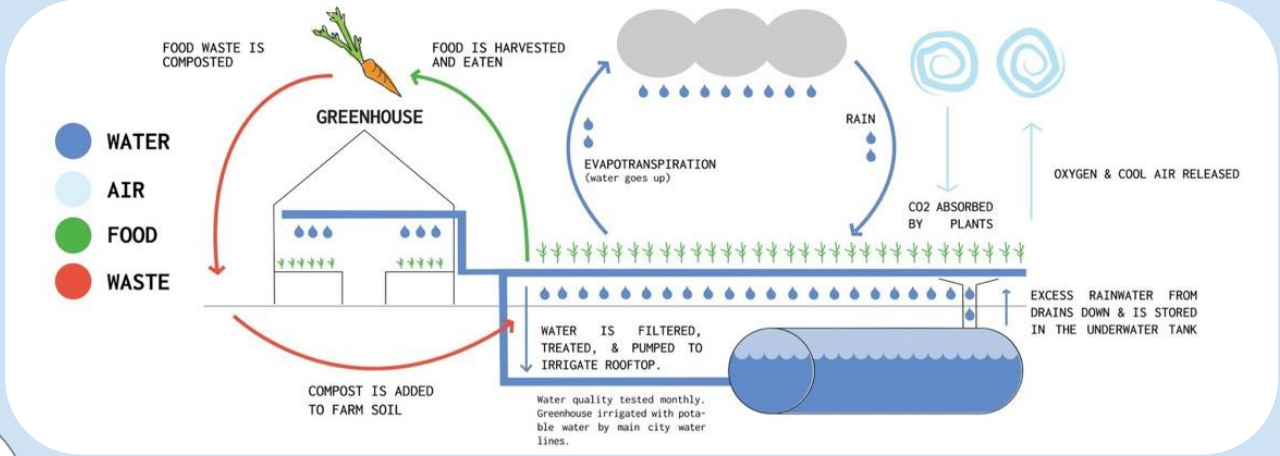
After being filtered, the harvested rainwater from the cisterns will be used to irrigate crops and trees. Roof and sealed surfaces have light-colored materials that comply with the Solar Reflectance Index to reduce urban heat island effect. The facility provides a natural habitat for birds and other small animals.

ADVANTAGES

1. This facility reduces rainwater runoff and absorbs air pollutants.

DISADVANTAGES

1. Constant maintenance works are necessary to ensure patency of the inflow and proper development of plants.



Source: greenroofs.com/projects/javits-center-expansion-rooftop-farm

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

GREEN ROOF

OBJECT INFORMATION

Name: CopenHill – green roof
Type of facility: GR
Treated medium: direct of rainfall
Description of the solution: Copenhill Urban Mountain is a public space on the site of the incinerator building. SLA's design of a green rooftop park for Copenhagen's new waste-to-energy plant combines hiking trails, playgrounds, vantage points, climbing walls and runoff fitness – along with a 500 meter ski slope designed by BIG. All of it created within a wild mountain nature with plants, rockscapes, 7 000 bushes and 300 trees.



BASIC INFORMATION

Construction year: 2019
Constructor: BJARKE INGELS GROUP, SLA, ZINCO GMBH
Source of financing: govermental funds
Total cost: 670 000 000 $
Facility operator: Amager Resource Center, Copenhagen Municipality
Maintenance cost: 600 000- 800 000$ / year
Contact person: info@zinco-greenroof.com

GEOGRAPHICAL COORDINATES

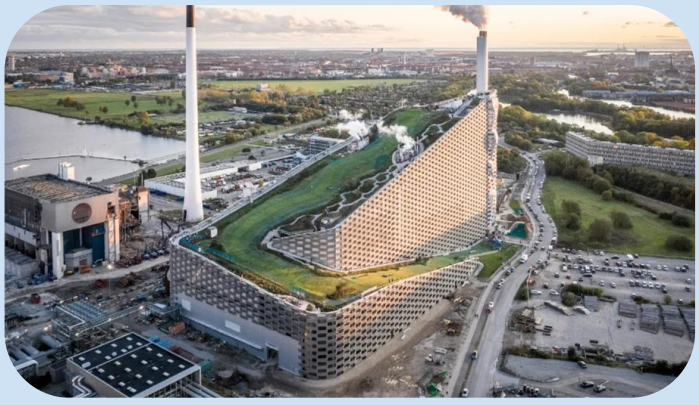
Latitude: 55° 41' 5" N
Longitude: 12° 37' 13" E

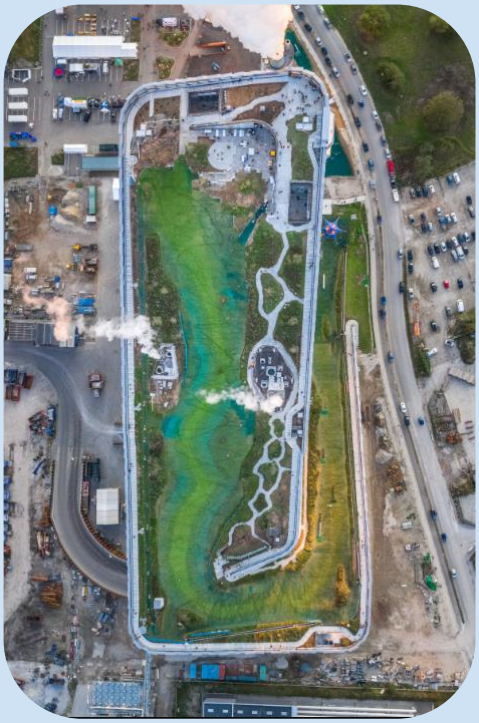
LOCATION

Country: Denmark
City: Copenhagen
Type of climate: Cfb
Average temperature: 8.9°C
Sum of precipitation: 728 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_7- building system recovery





Source: wwwgreenroofs..com/projects/copenhill

ECOSYSTEM SERVICES ACCORDING TO CICES			
Section	Provisioning	Regulation & Maintenance	Cultural
Class	ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific -Characteristics of living systems that enable education and training investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 10 000 m^2
Catchment area: 10 000 m^2
Operating experience: Whirring furnaces, steam, and turbines convert 440,000 tons of waste annually into enough clean energy to deliver electricity and district heating for 150,000 homes.

ECOLOGICAL POTENTIAL

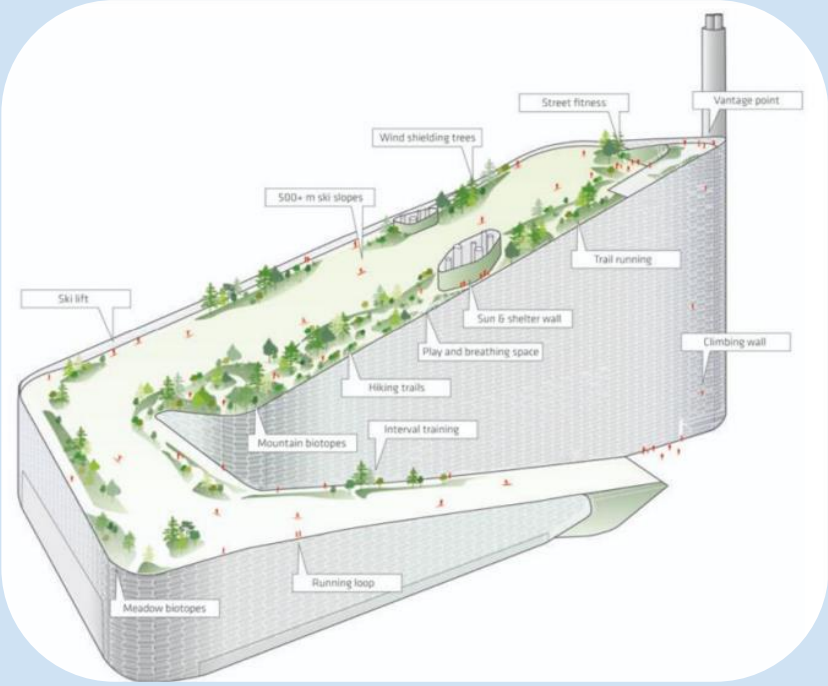
Copenhill Urban Mountain is a public space on the site of the incinerator building. In summer, the structure is expected to guarantee biodiversity and become a refuge for birds and insects.

ADVANTAGES

1. Its primary function is to harvest rainwater while at the same time rewilding a biodiverse landscape while absorbing heat, removing air particulates and minimizing rainwater runoff.

DISADVANTAGES

1. Probability of frequent device failures. They consume a significant amount of energy production.
2. The need to employ highly qualified staff, which is costly.



Source: www.greenroofs.com/projects/copenhill

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HYDROPONIC SYSTEM

OBJECT INFORMATION

Name: GreenShades
Type of facility: hydroponic system
Treated medium: direct of rainfall
Description of the solution: Green Shades is a hydroponic system that allows the installation of vegetated awnings or tensile structures covered in vegetation. The water supply and return pipes as well as the electrical cables are routed along the structure. Each plant canopy is fitted with two drip pipes that form the terminals for the irrigation system. Water is collected in an installation room. A disused kiosk was used for the installation of the irrigation system equipment. One irrigation pipe runs from the kiosk to the awnings and another runs parallel to it, but in the opposite direction, returning to the installation.



VALLADOLID

GEOGRAPHICAL COORDINATES

Latitude: 41° 64' 96" N
Longitude: 72° 88' 46" W

BASIC INFORMATION

Construction year: 2021
Constructor: SingularGreen
Source of financing: Urban GreenUp Project (Horizon2020)
Total cost: 344 605€
Facility operator: Tierra Ingenieria y Paisajismo
Maintenance cost: 2 000-5 000€ / year
Contact person: info@singulargreen.com

LOCATION

Country: Spain
City: Valladolid
Type of climate: CSa
Average temperature: 12.5°C
Sum of precipitation: 490 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery





Source: singulargreen.com/en/green-shades-valladolid

ECOSYSTEM SERVICES ACCORDING TO CICES			
Section	Provisioning	Regulation & Maintenance	Cultural
Class	ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific -Characteristics of living systems that enable education and training investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 21m x 4m long triangular textile vegetal canopy
Catchment area: 145 m^2
Efficiency and effectiveness: cooling power of 112 frigories/m^2
Operating experience: 1m^2 of vegetated surface generates the oxygen required by a person throughout the year, and filters harmful gases,. It absorbs NO_X and CO_2.

ECOLOGICAL POTENTIAL

This system opens up a new range of possibilities and benefits for urban landscaping. It brings added value to increasingly urbanized cities. It reduces the temperatures by 2°C in and therefore improves the environment.

ADVANTAGES

1. It generates shadows for the enjoyment of the public space without taking away space from the users.

DISADVANTAGES

1. Carrying out all the necessary maintenance work: start-up and monthly maintenance of the irrigation system, pest control, pruning.

THE SCHEME OF HYDROPONIC SYSTEM



Source: singulargreen.com/en/green-shades-valladolid

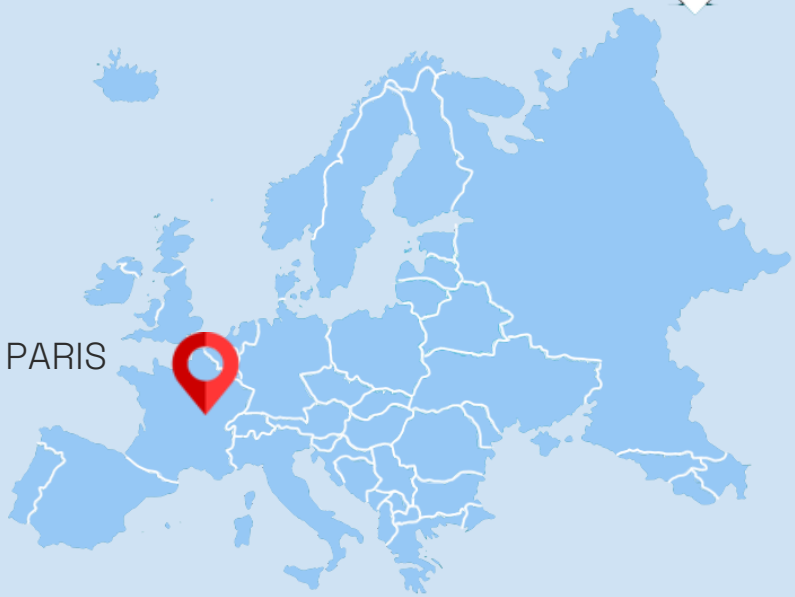
Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

LIVING WALL

OBJECT INFORMATION

Name: Musee de quai branly LW
Type of facility: LW
Treated medium: direct of rainfall
Description of the solution: There are plants that grow on damp rock walls. The plants are established without soil, in a layer of recycled polyamide felt that acts as a growing medium for the roots and carries a dilute nutrient solution from drip irrigation tubes at the top edge of the wall. The felt is attached to sheets of expanded PVC hung on a tubular steel frame that separates the vegetated surface from the building facade. A gutter along the bottom of the wall catches and recycles the irrigation water.



GEOGRAPHICAL COORDINATES

Latitude: 48° 51' 39" N
Longitude: 2° 17' 52" E

BASIC INFORMATION

Construction year: 2005
Constructor: Greenroofs.com LLC
Source of financing: public funding
Total cost: 640 000 €
Facility operator: Musee de quai Branly
Maintenance cost: 6 000-10 000€ / year
Contact person: Linda Velazquez (linda@greenroofs.com)

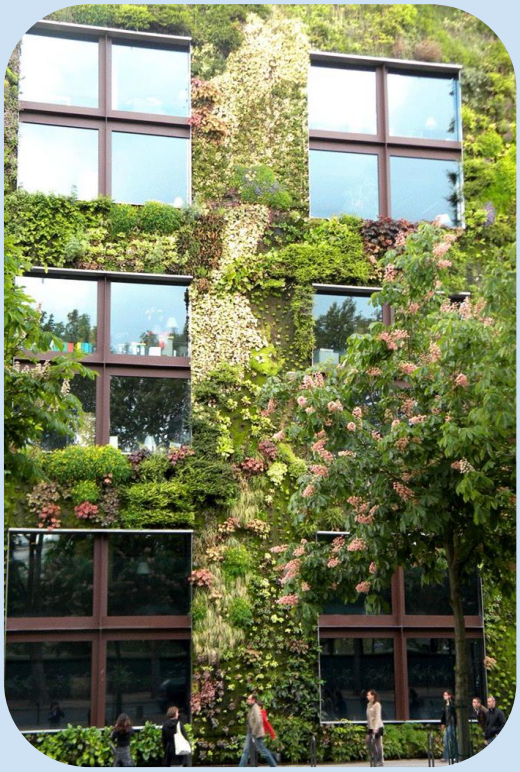
LOCATION

Country: France
City: Paris
Type of climate: Cfb
Average temperature: 11.7 °C
Sum of precipitation: 720 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery





Source: greenroofs.com/projects/musee-du-quai-branly-greenwall

ECOSYSTEM SERVICES ACCORDING TO CICES			
Section	Provisioning	Regulation & Maintenance	Cultural
Class	ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific -Characteristics of living systems that enable education and training investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 799 m^2
Volume: 300 m^3
Primary design factor: V_{water}=350l/day
Type of substrate: The climbing and crawling plants coming from humid regions, do not grow in the soil. Instead, they develop in the foam-rocks, tree trunks or creek pebbles, where they anchor their roots.
Operating experience: The technique of vertical culture overcomes weight problems and is suitable for all walls, regardless of their height.

ECOLOGICAL POTENTIAL

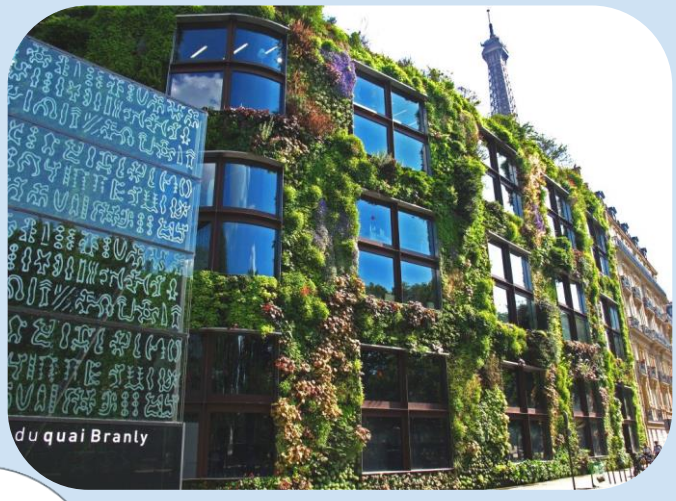
The LW is a popular place in Paris, which is a marketing point for the city. Plants help to increase biodiversity. Moreover, the installation contributes to reducing the heat-stress effect. Plants clean the polluted air in the city.

ADVANTAGES

1. The use of vertical space in the city is a great idea to develop the urban fabric (an ergonomic solution that does not require the use of horizontal surfaces, i.e. roads, sidewalks, squares, etc.).

DISADVANTAGES

1. Rainwater is not enough to irrigate the LW - tap water is needed, which generates costs and consumes drinking water unnecessarily.





Source: greenroofs.com/projects/musee-du-quai-branly-greenwall

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

GREEN BUS STOP

OBJECT INFORMATION

Name: Green bus stop at John Paul II Square in Kalisz
Type of facility: green bus stop
Treated medium: direct of rainfall
Description of the solution: It is one of six such facilities in the city. The investment is carried out thanks to the activity of the residents who submitted the task to the Civic Budget. This bus stop is located in a highly sealed environment. Arrangement of objects: one pot with plants at the two shorter edges of the stop, from the back - planting plants in the ground. The frame on the back wall enables to surround the stop with climbing plants.



GEOGRAPHICAL COORDINATES

Latitude: 51° 45' 52.2" N
Longitude: 18° 5' 33.0" E

BASIC INFORMATION

Construction year: 2020
Constructor: Department of Municipal Management and Environmental Protection, Kalisz City Hall
Source of financing: local funds- participatory budgeting
Total cost: 290€
Facility operator: Department of Municipal Management and Environmental Protection, Kalisz City Hall
Maintenance cost: 50€ / year
Contact person: Izabela Grześkiewicz (igrzeskiewicz@um.kalisz.pl)

LOCATION

Country: Poland
City: Kalisz
Type of climate: Cfb
Average temperature: 9.6°C
Sum of precipitation: 666 mm



URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery

Source: I. Grześkiewicz

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific -Characteristics of living systems that enable education and training investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 8m^2
Volume: 2m^3
Primary design factor: P_{macx}=30mm
Dominant plant species: *Hemerocallis 'Stella de'oro'; Miscanthus sinensis 'Zebrinus'; Campsis radicans 'Flamenco'; Parthenocissus tricuspidata*

ECOLOGICAL POTENTIAL

Green bus stops clean the air through the vital activities of plants planted in the facility. The green area causes the local air temperature reduction around the bus stop.

ADVANTAGES

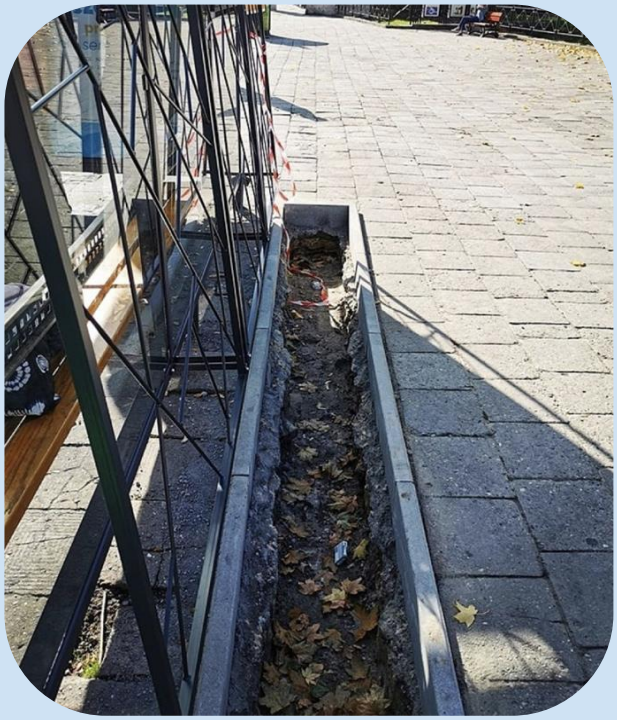
1. Simplicity of structure design.
2. Relatively cheap solution.
3. It is a perfect way to arrange bus shelters. They do not need to be replaced with new and expensive ones, but it is enough to green them with a green support frame.

DISADVANTAGES

1. In periods of long shortage of rainwater, the facility must be watered with tap water.
3. Every 6 months (in spring and autumn), gardening is necessary, e.g. additional plantings, checking the condition of plants.

PROBLEMS

The execution of the ground-level part of the green stop (back of the facility) is ineffective in terms of supplying it with surface runoff. The curb is above the concrete level. It should be located at the ground level or slightly lower so that the water can flow freely to the ground. In this situation, the water stops in front of the curb and flows by gravity to the drain.



Source: I. Grześkiewicz

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

www.nice-nbs.eu

NBS FOR SURFACE RUNOFF

Type of object	Location	Name
Rain garden (RG), green roofs (GR) (meadow, basin, bioretention swale, tree pits), Treatment Wetland (TW) ∑=10	Gdańsk, 3maja Street (Poland)	RAIN GARDEN FOR MAIN ROAD RUNOFF
	Wrocław, courtyard among Jedności Narodowej, Rychtalska and Ustronie Street (Poland)	POCKET PARK
	Wrocław (Poland)	TREE PITS
	Wrocław, Gwiaździsta Street (Poland)	WILDFLOWER MEADOW FOR RUNOFF PURIFICATION
	Kalisz, Podgórze 6 Street (Poland)	RAIN GARDEN FOR URBAN RUNOFF
	Gdańsk, Goszczyńskiego Street (Poland)	RAIN GARDEN FOR STREET RUNOFF
	Syracuse (USA)	RAINGARDEN AND BIOSWALE FOR STREET RUNOFF
	Gdańsk, O'Rourke Street (Poland)	RAIN GARDEN FOR PARKING LOT RUNOFF
	Gdańsk, Stryjewskiego Street (Poland)	RAIN GARDEN FOR PARKING & STREET RUNOFF
	Toronto (Canada)	GREEN PARK
Water storage systems (reservoir) ∑=1	Mściwojów (Poland)	RETENTION RESERVOIR
Treatment Wetland (TW) ∑=1	Gidy (France)	BUFFER POND AND TREATMENT WETLAND
Horizontal Subsurface Flow Treatment Wetland (HSSF or HF) ∑=2	Zalenieki (Latvia)	HORIZONTAL SUBSURFACE FLOW TREATMENT FOR RAINWATER FROM FARMYARD
	Bogota (Colombia)	HORIZONTAL SUBSURFACE FLOW TREATMENT WETLAND IN BOGOTA

RAIN GARDEN FOR MAIN ROAD RUNOFF

OBJECT INFORMATION

Name: Rain garden at 3 Maja street, Gdańsk
Type of facility: RG
Treated medium: urban runoff
Description of the solution: The RG consists of three independently supplied basins connected by cascades. It is powered by rainwater collected from the surface of the roadway. Three inlets in the curb allow to discharge rainwater surface runoff to the facility, where it is collected and transported through the root systems of planted vegetation.



BASIC INFORMATION

Construction year: 2020
Constructor: Gdańskie Wody
Source of financing: city funds
Total cost: 55 500 €
Facility operator: Gdański Zarząd Dróg Zieleni
Maintenance cost: 1 500 €
Contact person: Magdalena Gajewska (mgaj@pg.edu.pl); Agnieszka Kowalkieiwcz (a.kowalkiewicz@gdanskiewody.pl)

GEOGRAPHICAL COORDINATES

Latitude: 54° 20 ´55.3" N
Longitude: 18° 38 ´31.2" E

LOCATION

Country: Poland
City: Gdańsk
Type of climate: Cfb
Average temperature: 9 °C
Sum of precipitation: 449 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_7- building system recovery





Source: Gdańskie Wody

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific -Characteristics of living systems that enable education and training investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 758,7m^2
Volume: 98,2m^3
Primary design factor: P_{max} (p=10%, t=45min) = 30mm
Efficiency and effectiveness: The facility fulfills the assumed functions of flood protection and drainage.

ECOLOGICAL POTENTIAL

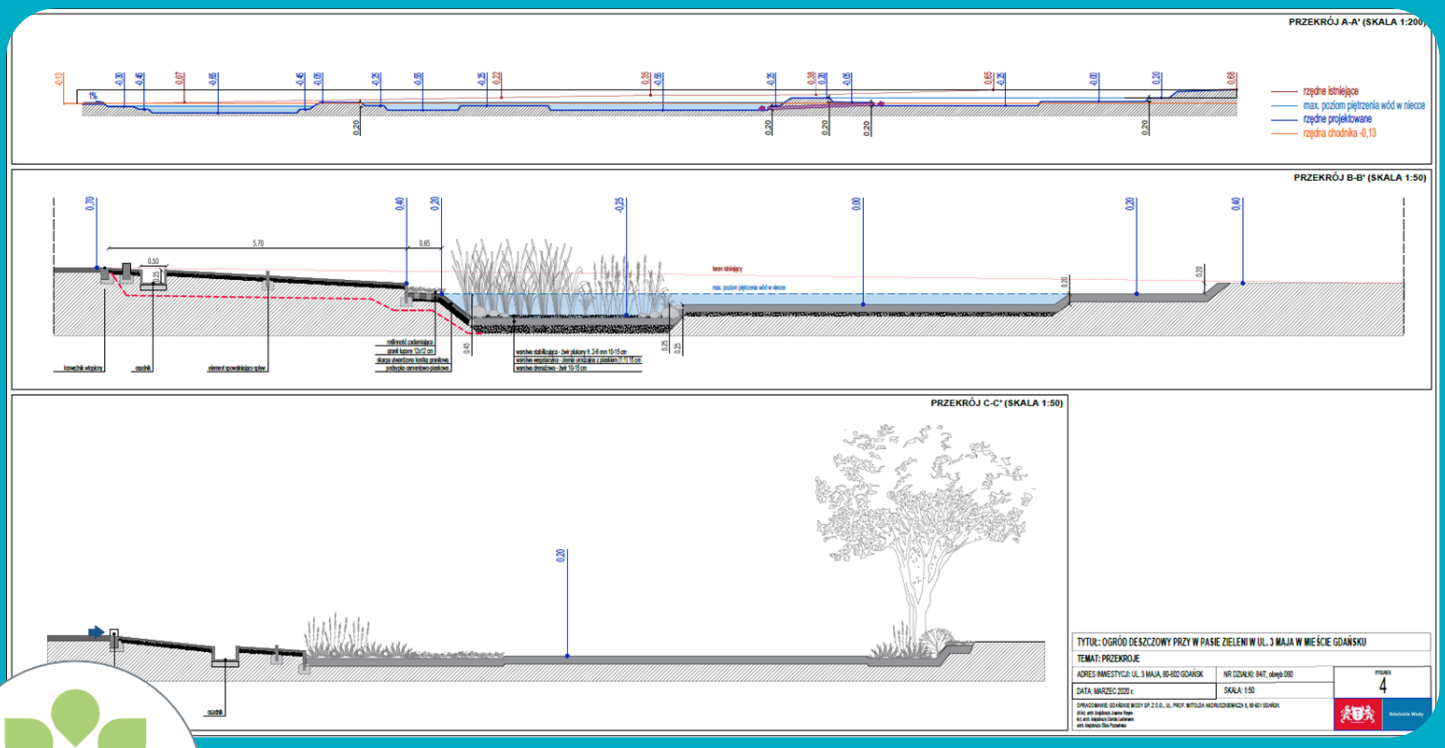
The infiltration process taking place in the basins improves the state of soil moisture, which affects the cooling of the nearby environment, which is especially desirable during the increasingly frequent heat, which is the result of climate change.

ADVANTAGES

1. Flood protection of communication routes.
2. Pre-treatment of water and relieving rainwater drainage.
3. Integration of retention facilities with urban greenery.

DISADVANTAGES

1. Necessary operational works, ensuring the patency of the inflow and proper development of plants.
2. Road salts used in winter can destroy vegetation.



Source: Gdańskie Wody

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

POCKET PARK

OBJECT INFORMATION

Name: Pocket Park - courtyard among Jedności Narodowej, Rychtalska and Ustronie street
Type of facility: pocket park
Treated medium: urban runoff
Description of the solution: The pocket park was created in line with the GrowGreen project in cooperation with the city of Wrocław, financed from the EU budget of the HORIZON2020 project. The analyzed area is located in a district with an intense downtown development. The park was built in consultation with the habitants. The solutions proposed under construction are comprehensive. The investment was created in the "design and build" mode, avoiding many complexities related to the construction law. Monitoring conducted by the Wrocław University of Environmental and Life Sciences.



GEOGRAPHICAL COORDINATES

Latitude: 51° 7' 37.2" N
Longitude: 17°2' 53.6" E

LOCATION

Country: Poland
City: Wrocław
Type of climate: Cfb
Average temperature: 10°C
Sum of precipitation: 700 mm

BASIC INFORMATION

Construction year: 2019
Constructor: GrowGreenWRO
Source of financing: UE HORIZON2020 Project
Total cost: 230000€
Facility operator: City Hall in Wrocław
Maintenance cost: 3000€ / year
Contact person: GrowGreenWRO@um.wroc.pl

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_7- building system recovery





Source: K. Ćwik / Agencja – wyborcza.pl

ECOSYSTEM SERVICES ACCORDING TO CICES			
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TECHNICAL DATA

Area of the facility: 1356 m^2
Volume: Bioswale - 3 m^3
Raingarden - 1.5 m^3
Catchment: 3750 m^2
Efficiency and effectiveness: high level of both due to visible changes

ECOLOGICAL POTENTIAL

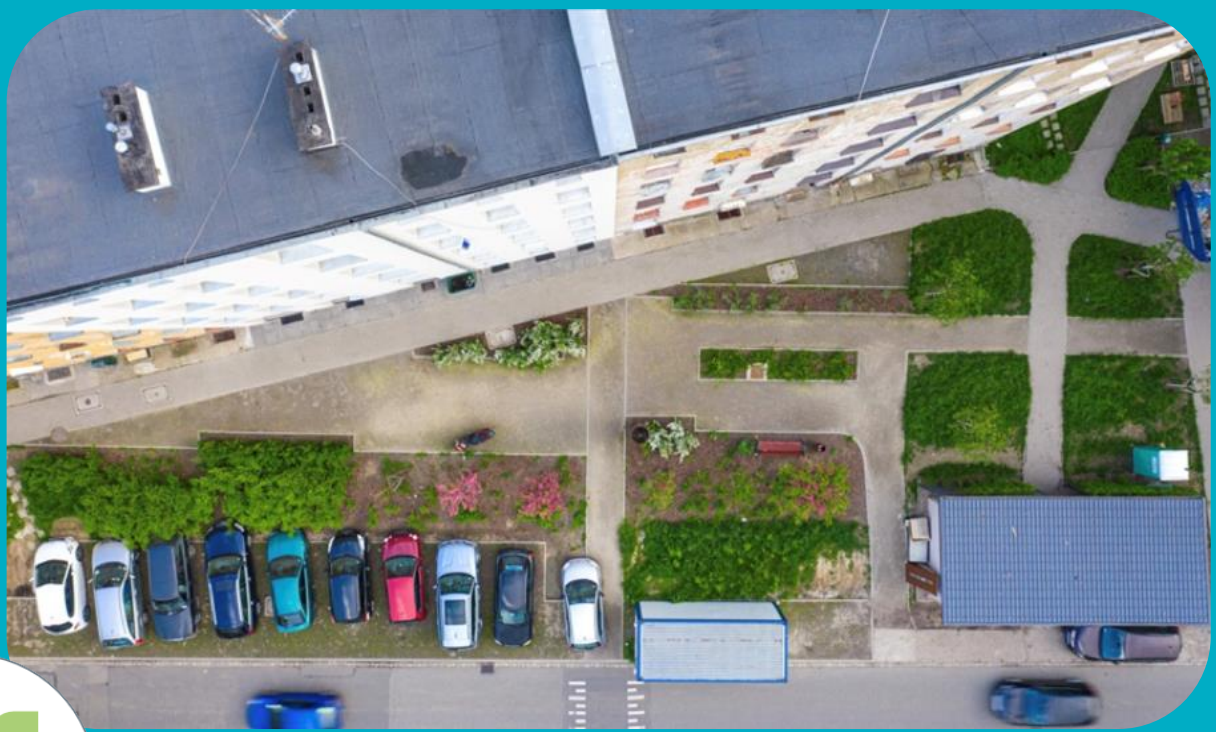
The pocket park captures and purifies the surface runoff water. It improves the microclimate by reducing evaporation from the surface of the area. The facility reduces drought by infiltrating the deeper layers of soil.

ADVANTAGES

1. Short time of constructing the object.
2. Visible positive changes in the environment and functioning of the estate.
3. Pocket parks allow for comprehensive activities in land development.

DISADVANTAGES

1. The need for multi-sector cooperation.
2. No consistent slope of the terrain taking into account the direction of surface runoff into the basins of the facility.



Source: K. Ćwik / Agencja – wyborcza.pl

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

TREE PITS

OBJECT INFORMATION

Name: Tree pits in Wrocław
Type of facility: tree pits
Treated medium:, urban runoff
Description of the solution: Water storage systems around trees are specialized substrates structural or additional modules (usually made of plastic) with a specialized substrate selected for them, built in the vicinity of trees. From these systems, there is water after rainfall is absorbed (soaked up) by tree roots under control of the system. A properly functioning system should have a positive effect on the system root of plants: reduce the problem of water stress, excessive soil compaction and its too small volume in relation to the roots' need.



GEOGRAPHICAL COORDINATES

Latitude: 51° 05' 58.2" N
Longitude: 17° 02' 12.1" E

BASIC INFORMATION

Construction year: 2013
Constructor: Green City Life
Total cost: 46000€
Facility operator: PKP S.A. Spatial Development Department in Wrocław
Maintenance cost:4000€ / year
Contact person: Head of the Department of Spatial Development - Agnieszka Stopyra (agnieszka.stopyra@pkp.pl)

LOCATION

Country: Poland
City: Wrocław
Type of climate: Cfb
Average temperature: 10°C
Sum of precipitation: 700 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_7- building system recovery





Source: gcl.com.pl

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
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TECHNICAL DATA

Area of the facility: 2000m^2
Volume: 128m^3(only tree pits)
Catchment: 10000m^2
Retention capacity: 200l/m^2
Efficiency and effectiveness: Water's pollutants removal - high efficiency

ECOLOGICAL POTENTIAL

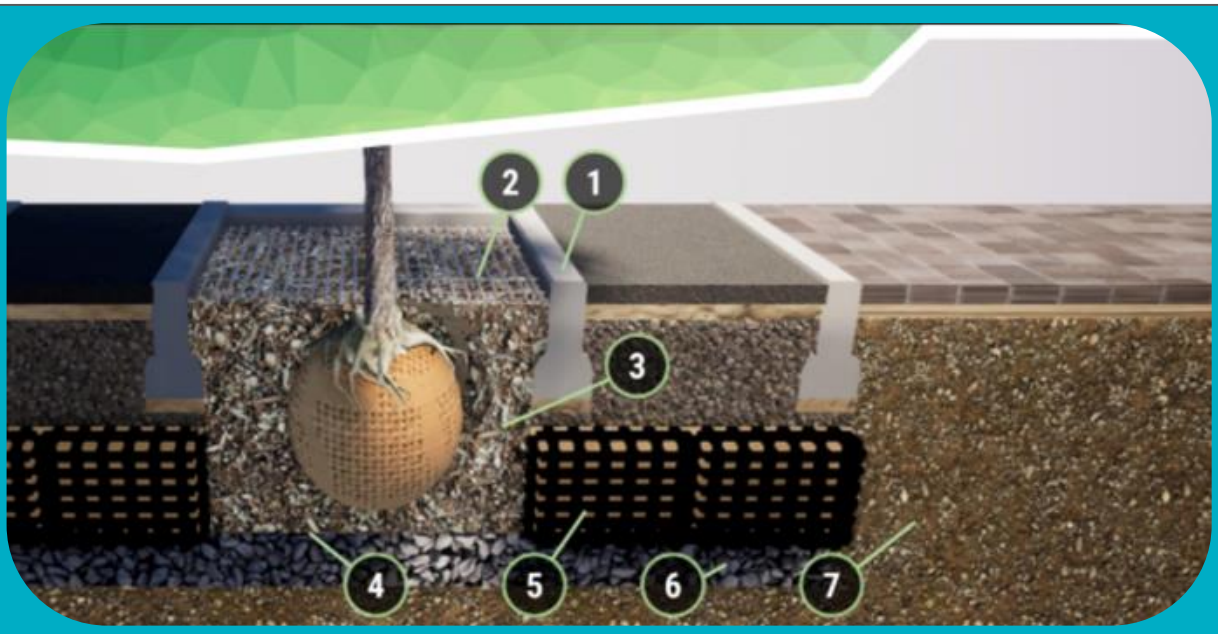
Tree pits intercept rainwater and surface runoff, retaining it in the soil. For effective infiltration, high-permeability fillings are used, which allows water to be drained into the underground reservoir and reused.

ADVANTAGES

1. Quick and easy installation - no hardware repair required.
2. Limitation of fees for drainage of rainwater.
3. Compensation modules made of recyclable polypropylene.
4. Possibility of dismantling gratings around trees enabling to maintain system.

DISADVANTAGES

1. The use of elements of modular systems increases the cost of investment.
2. The average age of trees growing in the vicinity of built-up surfaces will be estimated at 7 years, while trees growing in green belts live on average 4 times longer.



General cross-section through pit:
1. concrete 2. metal grate 3. fertile soil 4. geotextile
5. anti-compression module 6. drainage layer 7. natural soil

Source: K. Lejuć et al. „Katalog Dobrych Prkatyk – drogi"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

WILDFLOWER MEADOW FOR RUNOFF PURIFICATION

OBJECT INFORMATION

Name: Wildflower meadow at Gwiaździsta street in Wrocław
Type of facility: wildflower meadows
Treated medium: surface runoff
Description of the solution: A flower meadow was created on the initiative of the residents of the estate. Annual and perennial plants have been sown. An alternative to classic grass lawns.



BASIC INFORMATION

Construction year: 2019
Constructor: Łąki Kwietne Business
Source of financing: local funds
Total cost: 5000 €
Facility operator: Housing Association of Wrocław-Południe
Maintenance cost: 1000€ / year
Contact person: Grzegorz Walkiewicz
grzegorz.walkiewicz@laka.org.pl

GEOGRAPHICAL COORDINATES

Latitude: 51° 05' 50'' N
Longitude: 17° 01' 18'' E

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_7- building system recovery

LOCATION

Country: Poland
City: Wrocław
Type of climate: Cfb
Average temperature: 10°C
Sum of precipitation: 700 mm



Source: tuwroclaw.com

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 1000m^2
Dominant plant species: Malva mauritiana, Calendula, Centaurea, Papaver, Coreopsis
Type of substrate: fertile brown soil

ECOLOGICAL POTENTIAL

A flower meadow increases a retention of the estate area. It cleans water and air through the presence of certain plant species. The flowers attract insects that pollinate plants.

ADVANTAGES

1. It does not require professional or demanding care.
2. Low financial cost.
3. The facility increases the retention capacity of the area.

DISADVANTAGES

1. Necessary watering from the water supply system during periods of drought.



source: tuwroclaw.com

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

RAIN GARDEN FOR URBAN RUNOFF

OBJECT INFORMATION

Name: Rain garden on Podgórze 6 street
Type of facility: RG
Treated medium: urban runoff
Description of the solution: The main purpose of the facility is to redirect the road and roof slope runoff from the drainage system to the designed construction. The runoff is directed through the downpipe from the front part of the roof through the green area separated by the existing road elements. This treatment relieves the city sewage system.



BASIC INFORMATION

Construction year: 2020
Constructor: Factory of water construction and land improvement BUDWIM
Source of financing: local funds
Total cost: 3600€
Facility operator: City Administration of Residential Buildings in Kalisz
Maintenance cost: 100€
Contact person: Izabela Grześkiewicz, e-mail:igrzeskiewicz@um.kalisz.pl

GEOGRAPHICAL COORDINATES

Latitude: 51° 45' 33.1" N
Longitude: 18° 4' 49.2" E

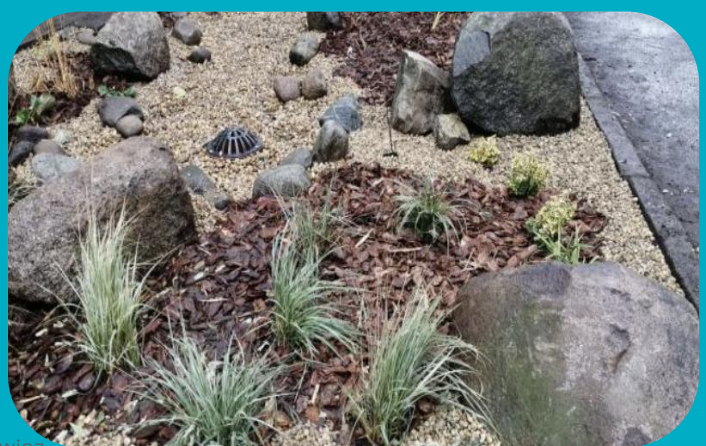
LOCATION

Country: Poland
City: Kalisz
Type of climate: Cfb
Average temperature: 9.6 °C
Sum of precipitation: 666 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_7- building system recovery





Source: supervisor of the Office of the Kalisz city Revitalization Izabela Grześkiewicz

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 52m^2
Volume: about 15.6m^3
Catchment: 200m^2
Primary design factor: P_{max}=60mm lub volume of runoff 0.2/m^2
Type of substrate: gravel, pebble, wood chips(soil-making processes)

ECOLOGICAL POTENTIAL

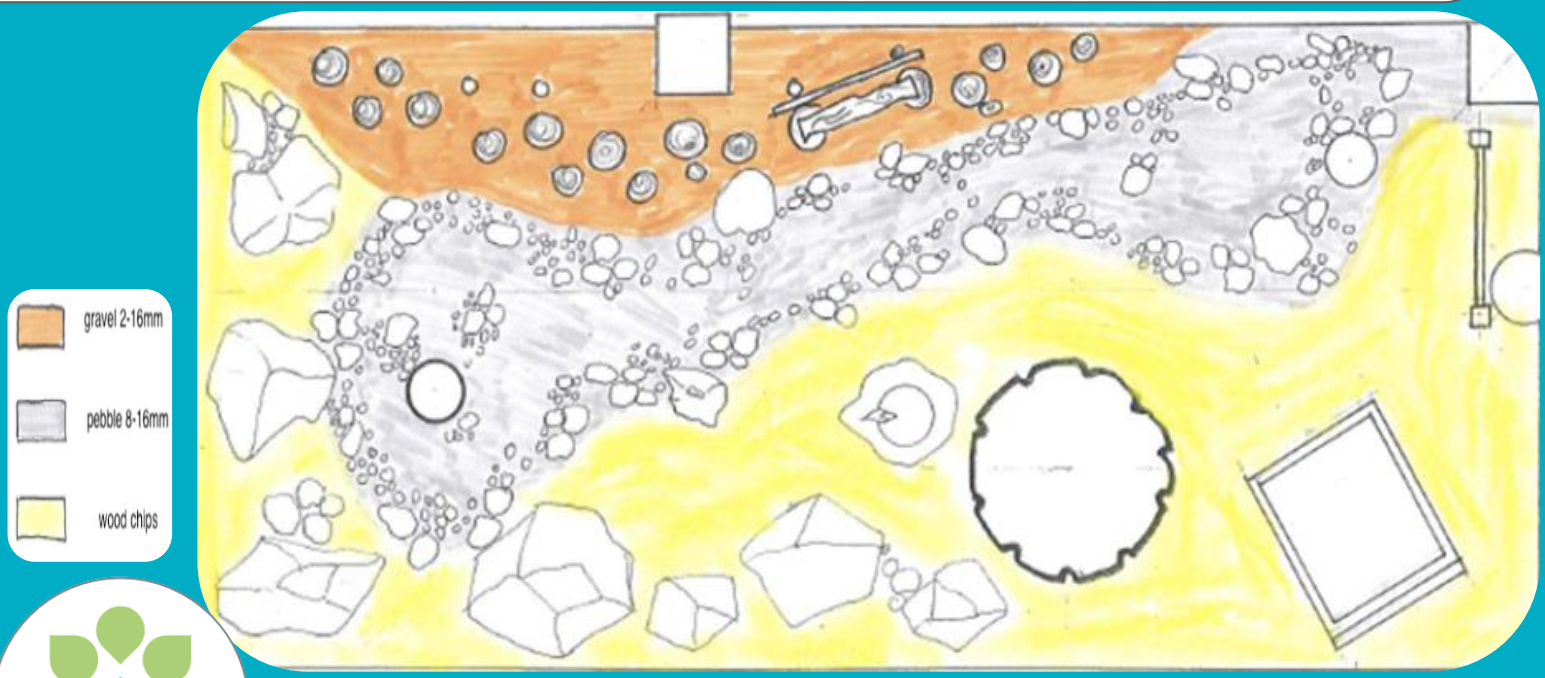
The rain garden captures and purifies the surface runoff water. It improves the microclimate of the area by reducing evaporation from the surface of the area. The garden reduces drought by infiltrating the deeper layers of soil.

ADVANTAGES

1. Small area of investment. Costs are relatively low but change is valid.
2. The rain garden was made by people who had never done this type of projects before and manage it.
3. Limitation of fees for drainage of rainwater.

DISADVANTAGES

1. Lack of accurate calculations, i.e. volume of runoff, catchment area.
2. Lack of laboratory and scientist correlation to make some researches in chemistry, hydrologic, hydraulic and economic topics.



Source: supervisor of the Office of the Kalisz city Revitalization Izabela Grześkiewicz

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

RAIN GARDEN FOR STREET RUNOFF

OBJECT INFORMATION

Name: Rain garden at the intersection of Goszczyńskiego and Zakopiańska Street
Type of facility: RG
Treated medium: urban surface runoff
Description of the solution: The rain garden consists of seven cascades, it is fed by rainwater collected from the surface of the roadway. Three inlets in the curb allow surface runoff of rainwater to the facility, where it is collected and taken up by the root systems of planted plants. The inlets are in the form of a depression in the curb, a concrete drain trough, a curb with a drainage channel. On the road of the fortified inlet from the roadway there are transverse troughs, acting as a preliminary settling tank.



LOCATION

Country: Poland
City: Gdańsk
Type of climate: Cfb
Average temperature: 9 °C
Sum of precipitation: 511 mm

GEOGRAPHICAL COORDINATES

Latitude: 54° 20' 57.50" N
Longitude: 18° 36' 51.8" E

BASIC INFORMATION

Construction year: 2021
Constructor: Gdańskie Wody
Source of financing: urban investment
Total cost: 45 500€
Facility operator: Gdański Zarząd Dróg i Zieleni
Maintenance cost: 1000€ / year
Contact person: Magdalena Gajewska (mgaj@pg.edu.pl) or Agnieszka Kowalkiewicz (a.kowalkiewicz@gdanskieowdy.pl)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_7- building system recovery





Source: trojmiasto.pl

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 412 m^2
Volume: 82,3 m^3
Catchment: 8,5 ha
Efficiency and effectiveness: The facility fulfills the assumed functions of flood protection and drainage
Dominant plant species: *Acorus calamus, Typha, Iris sibirica, Carex*

ECOLOGICAL POTENTIAL

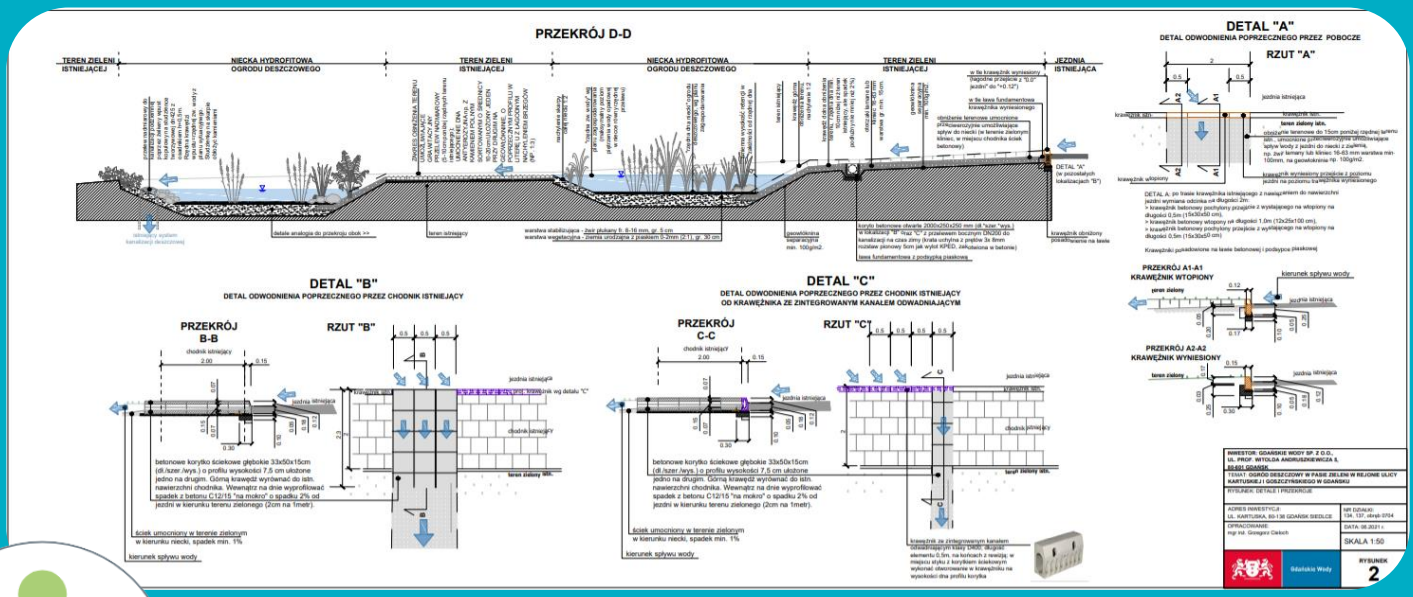
The garden provides habitats by increasing biodiversity. Flowering plants, butterflies and birds inhabiting the garden perform an aesthetic function. The regulatory function of the garden consists in cleaning the surface runoff (vegetation, settling tank) and delaying the outflow from the catchment.

ADVANTAGES

1. Effective delay of runoff from the catchment.
2. Preliminary treatment of water and relieving rainwater drainage.
3. Aesthetic values for residents of nearby housing estates.

DISADVANTAGES

1. Necessary operational works, ensuring patency of the inflow and proper development of plants.
2. Low probability of supplying all basins due to the large volumes of captured water in the first depressions in the facility.



Source: Gdańskie Wody Sp. z o.o.

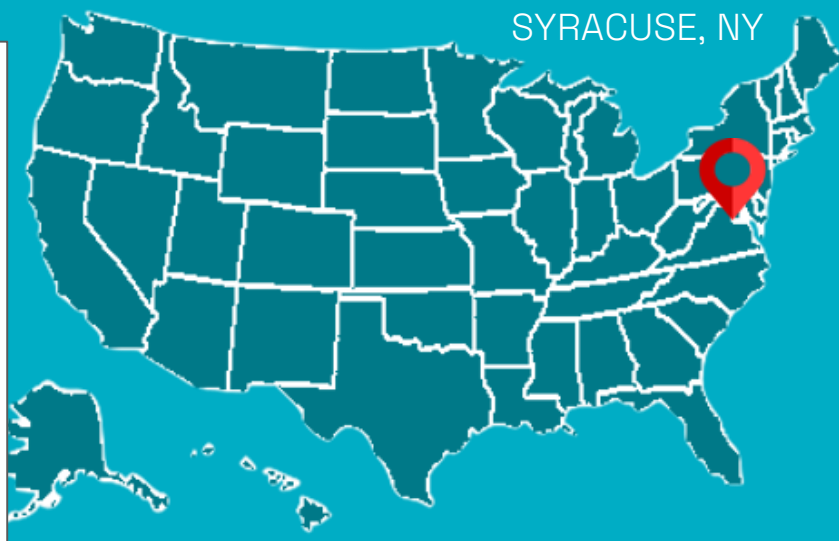
Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

RAINGARDEN AND BIOSWALE FOR STREET RUNOFF

OBJECT INFORMATION

Name: Rain Garden and bioretention basin in Syracuse, NY
Type of facility: RG & bioswale
Treated medium: surface runoff
Description of the solution: The bioretention basin is situated between the sidewalk and existing tree line on the vacant lot parcel and is designed to capture surface runoff from West Newell Street via existing catch basins. The drainage area extends on West Newell Street from Vale Street to Baldwin Avenue. The bioretention area is planted with native plants and serves as a community beautification feature as well as rainwater management.



BASIC INFORMATION

Construction year: 2017
Constructor: D.E. Tarolli Inc, J&J Landscaping, LLC
Source of financing: Commercial Building
Total cost: 93 645$
Facility operator: City of Syracuse
Maintenance cost: 1000$ / year
Contact person: Project Coordinator (jedwalsh@ongov.net)

GEOGRAPHICAL COORDINATES

Latitude: 43° 01' 62.2" N
Longitude: 76° 15' 57.3" W

LOCATION

Country: United States of America
City: Syracuse, NY
Type of climate: Dfb
Average temperature: 8.6 °C
Sum of precipitation: 1254 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_7- building system recovery





Source: savetherain.us

ECOSYSTEM SERVICES ACCORDING TO CICES			
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TECHNICAL DATA

Area of the facility: 320 m^2
Volume: 250 m^3
Catchment: 1913 m^2
Efficiency and effectiveness: The facility fulfils the assumed functions of infiltration and outflow. Runoff reduction of 602 m^3/year.

ECOLOGICAL POTENTIAL

The bioretention area serves as a community beautification feature as well as rainwater management. Five apple trees were also planted. All runoff from the block stretch of West Newell Street is drained into a green infrastructure practice, instead of the combined sewer system.

ADVANTAGES

1. Flood protection of communication routes nearby.
2. Integration of retention facilities with urban greenery.

DISADVANTAGES

1. Necessary operational works, ensuring i.e patency of the inflow and proper development of plants.



Source: savetherain.us

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

RAIN GARDEN FOR PARKING LOT RUNOFF

OBJECT INFORMATION

Name: Rain garden at O'Rourke Street
Type of facility: RG
Treated medium: surface runoff (from the nearby surfaces)
Description of the solution: The rain garden consists of 2 flow basins. It is fed by rainwater collected from the surface of sidewalks, parking lots and streets. The facility collects and infiltrates rainwater, which relieves the municipal rainwater drainage system. It has a positive effect on biodiversity, microclimate and protects nearby residential buildings from flooding.



BASIC INFORMATION

Construction year: 2018
Constructor: Gdańskie Wody
Source of financing: city funds
Total cost: 21 200 €
Facility operator: Gdański Zarząd Dróg i Zieleni
Maintenance cost: 1500 € / year
Contact person: Magdalena Gajewska (mgaj@pg.edu.pl); Agnieszka Kowalkiewicz (a.kowalkiewicz@gdanskieowdy.pl)

GEOGRAPHICAL COORDINATES

Latitude: 54° 22' ′58.96" N
Longitude: 18° 37' 32.44" E

LOCATION

Country: Poland
City: Gdańsk
Type of climate: Cfb
Average temperature: 9 °C
Sum of precipitation: 517 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_7- building system recovery





Source: Gdańskie Wody

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 200,86m^2
Volume: 56,3m^3
Primary design factor: P_{max}(p=10%, t=45min)= 30mm
Efficiency and effectiveness:
The facility fulfills the assumed functions of flood protection and drainage.

ECOLOGICAL POTENTIAL

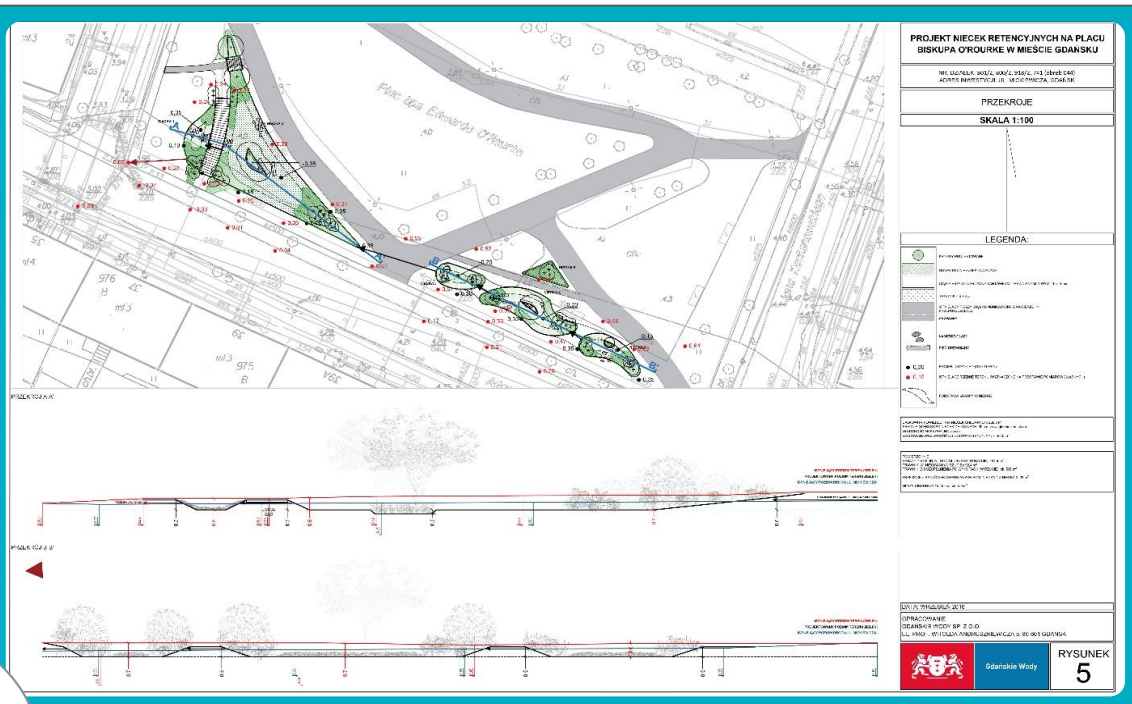
Reduced evaporation resulting from decrease in ambient temperature has a positive effect on the water balance. The load of pollution from surface runoff is taken over by the small retention object, and the water is subjected to sub-purification process.

ADVANTAGES

1. Infiltration of the rainwater into the ground.
2. Preliminary treatment of water and relieving rainwater drainage.
3. Reduction of the temperature of the environment during summer months (improving microclimate).

DISADVANTAGES

1. Necessary operational works, ensuring eg. patency of the inflow and proper development of plants.
2. Road salts used in winter can destroy vegetation.



Source: Gdańskie Wdoy

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

RAIN GARDEN FOR PARKING & STREET RUNOFF

OBJECT INFORMATION

Name: Rain garden on Stryjewskiego Street
Type of facility: RG
Treated medium: surface runoff
Description of the solution: The rain garden consists of a depression in the terrain with plantings of properly selected plants. It is sustained with rainwater collected from the surface of the parking lot. It does not have an emergency spillway to the rainwater drainage. The facility collects and purifies rainwater, which relieves the urban rainwater drainage system.



BASIC INFORMATION

Construction year: 2018
Constructor: Gdańskie Wody
Source of financing: city funds
Total cost: 12 600 €
Facility operator: Gdański Zarząd Nieruchomości Komunalnych
Maintenance cost: 1 500 € / year
Contact person: Magdalena Gajewska (mgaj@pg.edu.pl); Agnieszka Kowalkiewicz (a.kowalkiewicz@gdanskiewody.pl)

GEOGRAPHICAL COORDINATES

Latitude: 54° 21' ´35.65" N
Longitude: 18° 42' 29.94" E

LOCATION

Country: Poland
City: Gdańsk
Type of climate: Cfb
Average temperature: 9 °C
Sum of precipitation: 420 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_7- building system recovery





Source: Gdańskie Wody

ECOSYSTEM SERVICES ACCORDING TO CICES			
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TECHNICAL DATA

Area of the facility: 150 m^2
Volume: 35 m^3
Primary design factor: P_{max}(p=10%, t=45min)= 30mm
Efficiency and effectiveness:
The facility fulfils the assumed functions of flood protection and drainage.

ECOLOGICAL POTENTIAL

The load of pollution from the runoff on the surface of the parking lots is taken over by the low retention facility. The water is subjected to the process of sub-purification. Vegetation can contribute to increasing infiltration and reducing evaporation.

ADVANTAGES

1. Effective drainage of the parking lot.
2. Preliminary treatment of water and relieving rainwater drainage.
3. Aesthetic value for residents of a nearby housing estate.

DISADVANTAGES

1. Necessary operational works, ensuring i.e patency of the inflow and proper development of plants.
2. Road salts used in winter can destroy vegetation.





Source: Gdańjskie Wody

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

GREEN PARK

OBJECT INFORMATION

Name: University of Toronto Scarborough Campus Valley Land Trail
Type of facility: green park
Treated medium: surface runoff
Description of the solution: It is a 500m long trail that provides safe and easy access to the Highland Creek watershed. The trail balances environmental and social responsibility through universally accessible and inclusive design. Also it provides opportunity for engagement and study, serving as a foraging site for the university's culinary program and a living laboratory for natural science programs. Deemed an environmentally unique habitat by the Toronto Regional Conservation Authority.



BASIC INFORMATION

Construction year: 2019
Constructor: Brown&Company Engineering
Source of financing: University funds
Total cost: 2 500 000$
Facility operator: University of Toronto Scarborough Campus
Maintenance cost: 30 000 – 50 000$
Contact person: Jenny Hill (researchgate.net/profile/Jenny-Hill-2)

GEOGRAPHICAL COORDINATES

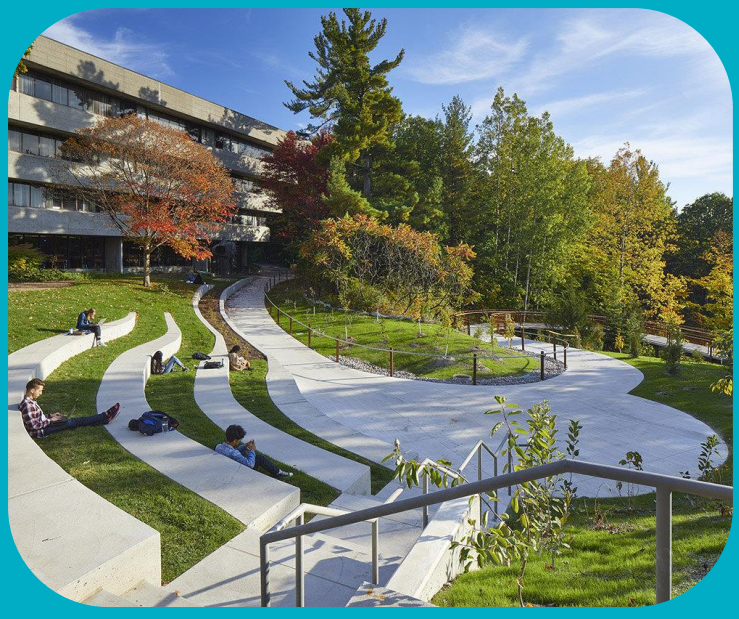
Latitude: 43° 47' 05" N
Longitude: 79° 11' 19" W

LOCATION

Country: Canada
City: Toronto
Type of climate: Dfb
Average temperature: 8.7 °C
Sum of precipitation: 845 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_7- building system recovery





Source: landscapeperformance.org/case-study-briefs/UTSC-trail

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific -Characteristics of living systems that enable education and training investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 20 000 m^2
Dominant plant species:
trees*: Aspen, White Oak;*
bushes*: native fruit shrubs*
Operating experience: Projected to intercept over 6 800 m3 of rainwater over the next 20 years (from 2019)

ECOLOGICAL POTENTIAL

Edible plant species can be found in the park. Through many planted trees and shrubs, the facility captures large amounts of CO2 and constitutes a flood barrier for the campus. The facility is a habitat for many species of wild animals, which increases species diversity.

ADVANTAGES

1. Park serve as havens for various plant, animal, and insect species, fostering biodiversity in urban areas
2. Plants in the park absorb carbon dioxide (CO2) and other pollutants from the air.

DISADVANTAGES

1. Park require regular maintenance, including landscaping, irrigation, and waste management
2. Large park areas on university campuses may limit available space for infrastructure expansion



Source: landezine.com/university-of-toronto-scarborough-valley-land-trail-by-schollen-and-company

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

RETENTION RESERVOIR

OBJECT INFORMATION

Name: Mściwojów Reservoir
Type of facility: Retention and flood control tank with biological water purification function
Treated medium: Floodplain waters from the Wierzbak and Zimnik rivers, surface runoff waters from the catchment
Description of the solution: The water reservoir in Mściwojów was built on the Wierzbiak and Zimnik rivers. There is a unique self-purification system on a European scale, consisting in the creation of natural backwaters overgrown with special vegetation, which filter the water of the pre-reservoir flowing into the reservoir.



GEOGRAPHICAL COORDINATES

Latitude: 51° 01' 40"N
Longitude: 16° 16' 35"E

BASIC INFORMATION

Construction year: 1991
Constructor: "BUDEX" s.c in Lublin
Source of financing: local funds
Total cost: 6 000 000 €
Facility operator: Polish Waters; branch of the Legnica Catchment Board
Maintenance cost: 6 000-10 000€ / year
Contact person: Jan Kazak UPW (jan.kazak@upwr.edu.pl)
Agnieszka Najdecka - Polish Waters (agnieszka.najdecka@wody.gov.pl)

LOCATION

Country: Poland
City: Mściwojów
Type of climate: Cfb
Average temperature: 10 °C
Sum of precipitation: 700 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse





Source: J.Dąbrowska „Mściwojów Reservoir – study of small retention reservoir with an innovative water self-purification system"

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that that enable activities promoting health, recuperation or enjoyment through active or immersive interactions -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 345900 m^2
Volume: maximum 1.35 million m^3
Catchment: 47 km^2
Average Hydraulic Retention Time: 65 days
Operating experience: Wide range of works during operation (periodic and commission inspections, maintenance, current repairs, overhauls).

ECOLOGICAL POTENTIAL

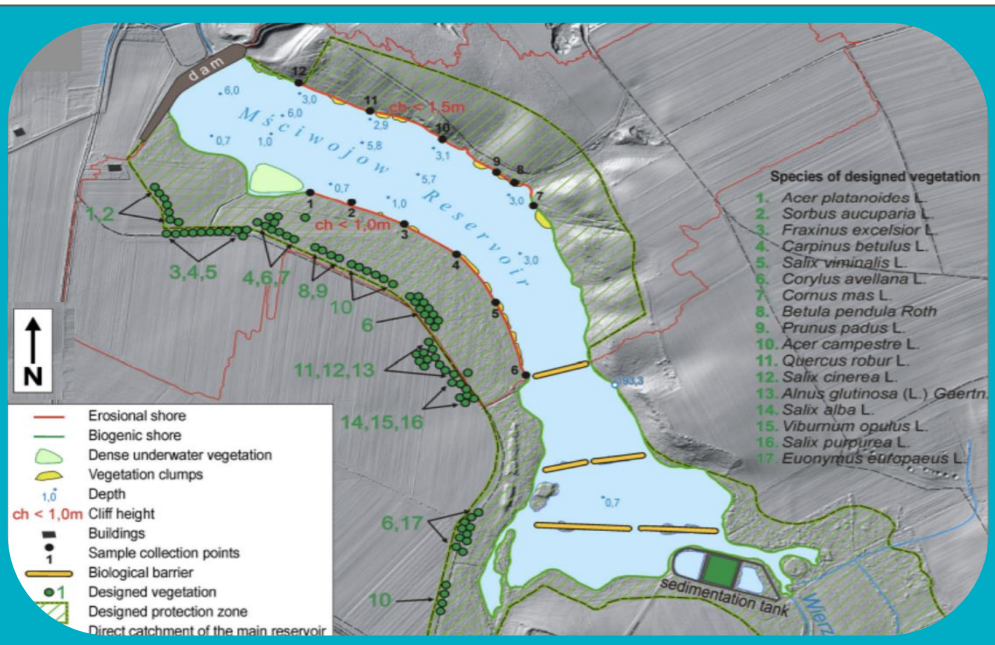
It treats the contaminated waters and municipal sewage, which will go to the surface runoff and the ground through the infiltration process. Due to the agricultural purpose of the land near and the possibility of fishing in this area, the reservoir "produces" food.

ADVANTAGES

1. The building purifies water from heavy metals, biogenic compounds and others by filtration in the ground.
2. Increasing soil retention in areas directly adjoined to the reservoir, and stabilizing the depth of the water table in up to 50m from the reservoir.

DISADVANTAGES

1. Complex design - large technical parameters of the tank (cubic capacity, size of the catchment, etc.).
2. A difficult aspect of maintaining the stability of the building - ensuring safety against flooding of nearby areas.



Source: J. Dąbrowska „Shore zone in protection of water quality in agricultural landscape – the Mściwojów Reservoir , southwestern Polandc

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

BUFFER POND AND TREATMENT WETLAND

OBJECT INFORMATION

Name: The Servier Laboratories WWTP
Type of facility: Buffer pond and TW
Treated medium: surface runoff
Description of the solution: This treatment system was designed to treat rainwater (12 000 m^3) using a buffer pond followed by a vertical flow treatment wetland for the treatment of runoff water before discharging it in the receiving body.



BASIC INFORMATION

Construction year: 2013/2014
Constructor: SOGEA Nord Ouest;
Designer: EcoBIRD
Source of financing: Servier laboratories
Total cost: 900 000 € (excl. VAT)
Facility operator: The Servier Laboratories
Maintenance cost: < 8 000 € per year (incl. VAT)
Contact person: Stéphane Troesch (s.troesch@ecobird.fr)

GEOGRAPHICAL COORDINATES

Latitude: 47°58'36.3"N
Longitude: 1°50'52.6"E

LOCATION

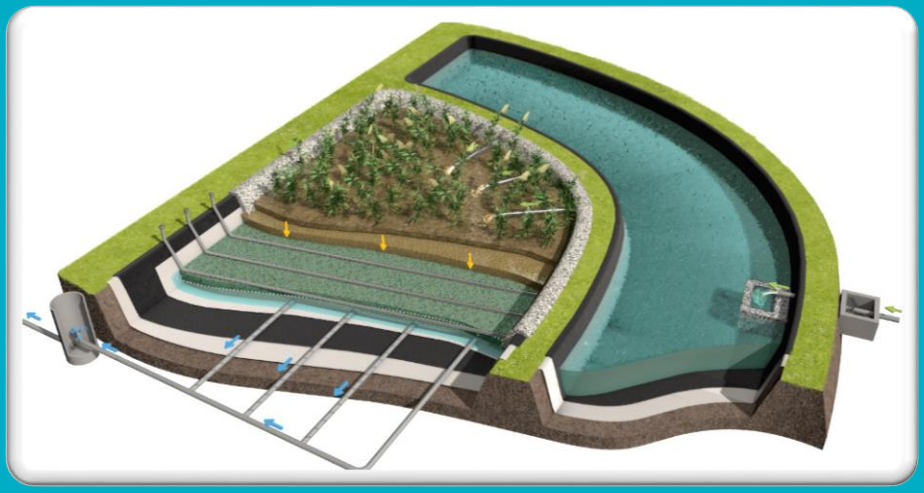
Country: France
City: Gidy (district: Centre-Val de Loire)
Type of climate: Cfb
Average temperature: 11°C
Sum of precipitation: 645 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse

ECOLOGICAL POTENTIAL

The treatment system provides ecosystem services such as water purification, nutrient cycling, habitat for insects and aesthetic value.



Source: S. Troesch

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of facility: 13 600 m^2 in total
Pond: 11 000 m^2; VF TW: 2 600 m^2
Catchment area: 23 000 m^2
Volume: 24 340 m^3 in total
Pond: 22 000 m^3; VF TW: 2 340 m^3
Water flow : Treatment of 100-year rainfall: 12000 m^3
Efficiency and effectiveness of facility: guaranteed discharge levels and removal rates: BOD_5 = 7 mg/L or 70 %; COD = 30 mg/L or 65 %; TSS = 25 mg/L or 90 %; TN = 3 mg/L; TP = 0.7 mg/L; Pb = 1 mg/L or 65 %; Total hydrocarbons = 1 mg/L or 70 %
Operating experience: simple maintenance and operation





ADVANTAGES

1. Simple and efficient surface water runoff management and treatment.
2. Limited Maintenance constraints and costs.

DISADVANTAGES

1. Land availability.

Source: S. Troesch

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HORIZONTAL SUBSURFACE FLOW TREATMENT FOR RAINWATER FROM FARMYARD

OBJECT INFORMATION

Name: Treatment wetland in Mezaciruli
Type of facility: HSSF
Treated medium: surface runoff
Description of the solution: A pilot-scale HSSF was installed at the farm Mezaciruli to improve rainwater quality collected from the farmyard and demonstrate applicability of TW as a convenient treatment option for contaminated surface runoff. The system consists of a sedimentation pond as a pretreatment plant, a water pump, a water distribution well, and a horizontal subsurface flow TW with the surface area of 160 m^2.



BASIC INFORMATION

Construction year: 2014
Constructor: farm Mezaciruli
Source of financing: Project NUTRINFLOW (Interreg Central Baltic Programme 2014-2020)
Total cost: 240 000 €
Facility operator: farm Mezaciruli
Maintenance cost: 5 000 € / year
Contact person: Juris Cirulis (www.celotajs.lv)

GEOGRAPHICAL COORDINATES

Latitude: 56 34' 27.7" N
Longitude: 23° 29' 38.9" E

LOCATION

Country: Latvia
City: Zalenieki county, Jelgava region
Type of climate: Dfb
Average temperature: 6.8 °C
Sum of precipitation: 671 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse





Source: J. Cirulis

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 4000 m^2
Catchment: 74000 m^2
Volume: 5400 m^3
Hydraulic and hydrological data: Average concentration of suspended solids at the inlet was 83.36 mg/L.
Effectiveness and efficiency: Color and turbidity of the incoming water visually differs from the water leaving the wetland, which are the parameters that indicate a better quality of the treated medium.

ECOLOGICAL POTENTIAL

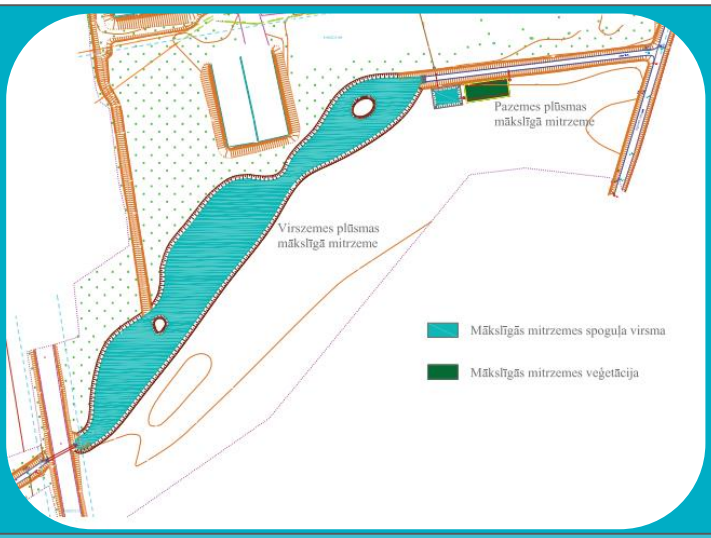
This facility cleans the water of solid particles and purifies the air through the presence of dense flora. It also absorbs nitrogen and phosphorus compounds and is a storehouse for silt. Moreover, it delays the peak of the flood wave. The site is a habitat for many animal species (mainly birds and insects).

ADVANTAGES

1. Contributes to the reduction of plant nutrients and suspended matter in runoff from agricultural lands.
2. The facility reduces the risk of flooding as it receives a significant part of surface runoff.

DISADVANTAGES

1. Dredging the bottom of the reservoir once a year results in high costs, large logistics and projects.
2. For water supply in the case of construction of an underground flow wetland the use of a water pump may be necessary, which causes additional operating expenses.



Source: L. Grinberga

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HORIZONTAL SUBSURFACE FLOW TREATMENT WETLAND IN BOGOTA

OBJECT INFORMATION

Name: TW in Bogota
Type of facility: HSSF
Treated medium: urban runoff
Description of the solution: This project stays within the framework of the University's (Facultad de Ingeniería, Pontificia Universidad Javeriana) environmental management plan of its physical resources office. To gauge the system's performance (its hydraulic attenuation), it is monitored by means of two triangular sharp-crested weirs, a series of piezometers and ultrasonic level sensors. The location of the weirs is: the entrance of settling tank and the exit of the facility. Initial results showed that the TW delays runoff hydrographs between 11 and 53 minutes, outflow runoff peaks vary between 37% and 78% of those observed for inflow. The facility retains up to 46% of total rainfall volume.



GEOGRAPHICAL COORDINATES

Latitude: 4° 35' 56" N
Longitude: 74° 04' 51" E

LOCATION

Country: Colombia
City: Bogotá
Type of climate: Am
Average temperature: 13.1°C
Sum of precipitation: 797 mm

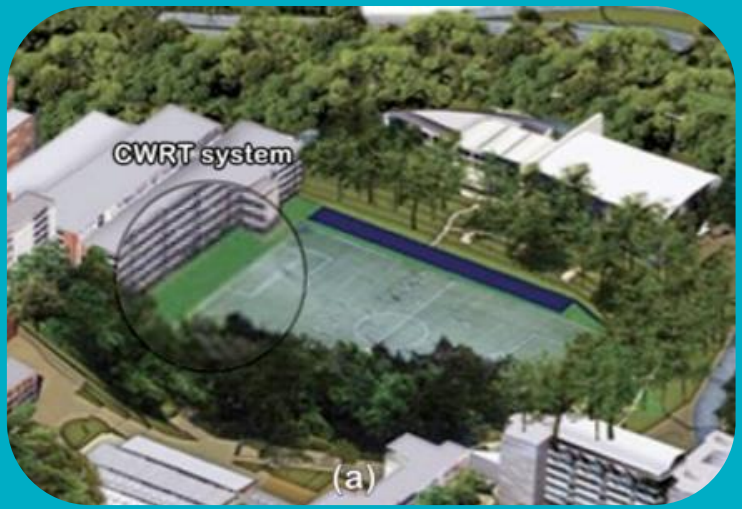
BASIC INFORMATION

Construction year: 2013
Constructor: INDRACOL S.A.S
Source of financing: internal funds
Facility operator: Ponitifica Universidad Javeriana
Total cost: 315 569 $
Maintenance cost: 619 $
Contact person: Maria Angelica Suarez (m.suarezj@javeriana.edu.co)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse





Source: S.Galarza-Molina et al. „Constructed-Wetland/Reservoir-Tank system Used for Rainwater Harvesting in Bogota, Colombia"

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
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TECHNICAL DATA

Area of the facility: 85 m^2
Volume: 145 m^3
Catchment: 18 942 m^2
Efficiency and effectiveness: At the outlet of the TW/RT there is evidence of a decrease in turbidity SST and BOD_5, however, no changes have been found for chlorides and TDS.

ECOLOGICAL POTENTIAL

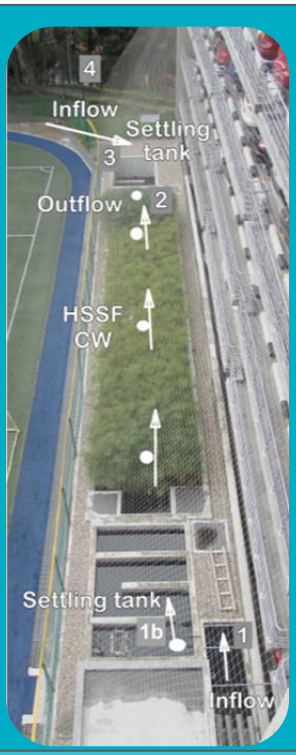
Making researches about: wastewater inflow and outflow, efficiency of the NBS. Increasing biodiversity by planting some plants where a lot of creatures have good living conditions. The facility improves the microclimate of the environment and captures biogenic and carbon compounds. It purificates the runoff.

ADVANTAGES

1. The outlet water meets the requirements to be used for washing surfaces.

DISADVANTAGES

1. The water that arrives from the soccer field does not have the expected quality.





Source: S.Galarza-Molina et al. „Constructed-Wetland/Reservoir-Tank system Used for Rainwater Harvesting in Bogota, Colombia"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

www.nice-nbs.eu

NBS FOR SURFACE WATER

Type of object	Location	Name
Floating Wetland Island (FWI) or Floating Treatment Wetland (FTW) ∑=3	Durham (USA)	FLOATING WETLAND ISLANDS
	Fairfax (USA)	FLOATING TREATMENT WETLAND
	London (England)	FLOATING TREATMENT WETLAND
In-stream restoration (buffer zones) ∑=4	Charlottesville (USA)	IN-STREAM RESTORATION - BUFFER ZONES
	Dublin-CA (USA)	IN-STREAM RESTORATION - BUFFER ZONES
	Aarhus (Denmark)	RESTORATION OF NATURAL WETLAND
	Aarhus (Denmark)	RESTORATION OF NATURAL WETLAND

FLOATING WETLAND ISLANDS

OBJECT INFORMATION

Name: FWI in Durham(NC), USA
Type of facility: FWI
Treated medium: surface water
Description of the solution: FWIs are hydroponic systems that fully vegetated are essentially wetlands that float on the surface of open water. To test whether FWIs provide a benefit for nutrient and TSS removal, two ponds in Durham. In late March 2010, FWIs were installed as retrofits at both the “Museum “ pond and “DOT” pond. FWIs act as a hydroponic system, with the plants and microbes that inhabit the plant roots taking nutrients from the surface water.



GEOGRAPHICAL COORDINATES

Latitude: 36° 02’ 93” N
Longitude: 78° 89’ 94” W

BASIC INFORMATION

Construction year: 2010
Constructor: NCDENR – Division of Water Quality
Source of financing: partly NCDENR – 95 000$, governmental funds- rest
Total cost: 182 355 $
Facility operator: The North Carolina Department of Environmental Quality
Maintenance cost: 2 000 $
Contact person: Ryan J. Winston (winston.201@osu.edu)

LOCATION

Country: United States of America
City: Durham, NC
Type of climate: Cfa
Average temperature: 15.7°C
Sum of precipitation: 1136m

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse





Source: William F. Hunt et al. „Evaluation of Floating Wetland Islands (FWIs) as a Retrofit to Existing Stormwater Detention Basins”

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 370 m^2(FWIs); 3600 m^2 (FWIs + surface water)
Volume: 92 m^3
Catchment area: 15 500 m^2
Hydraulic load: 45 l/day
Operating experience: The museum pond with FWI has significantly reduced concentration of all pollutants studied.
Dominant plant species: *Carex stricta, Juncus effusus, Spartina pectinata*

ECOLOGICAL POTENTIAL

The facility improves the above-water ecosystem, while the roots provided submerged habitat. Also the systems take up excess agricultural nutrients. Minimizing algal blooms and dead zones. Research suggests they can be used to reduce manmade contaminants that persist in the environment.

ADVANTAGES

1. No need for additional land to be used for treatment.
2. Do not detract from the required storage volume.

DISADVANTAGES

1. Prior water quality tests must be carried out.
2. The efficiency of the facility is based on appropriated plant choice.

Museum Pond



DOT Pond



Source: William F. Hunt et al. „Evaluation of Floating Wetland Islands (FWIs) as a Retrofit to Existing Stormwater Detention Basins"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

FLOATING TREATMENT WETLAND

OBJECT INFORMATION

Name: FTW in Fairfax, Virginia
Type of facility: FTW
Treated medium: surface water
Description of the solution: This project adapted a standard water quality retrofit of a wet pond on Ashby Road in Fairfax, Virginia to incorporate evaluation of FTWs as a potential new treatment technology. FTWs improve water quality by removing nutrients through plant uptake, microbial uptake, and increased sedimentation. Four treatments with three replicates following a completely randomized block design were installed to evaluate effects of the floating mats and different plant species in the FTW mesocosm system. The four treatments included control, un-vegetated floating mat, pickerelweed, and softstem bulrush.



GEOGRAPHICAL COORDINATES

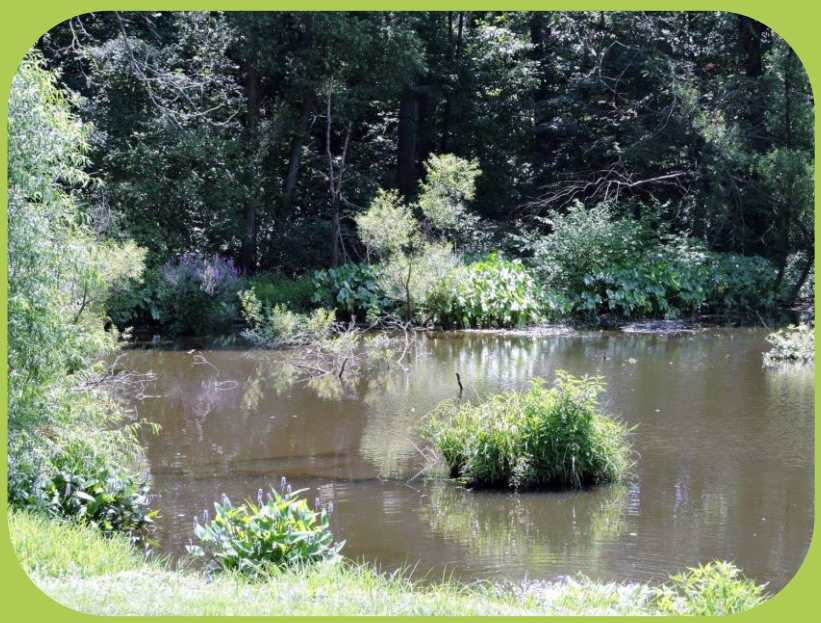
Latitude: 38° 50' 51" N
Longitude: 77° 17' 10" W

LOCATION

Country: United States of America
City: Fairfax, VA
Type of climate: Cfa
Average temperature: 13.6 °C
Sum of precipitation: 1075 mm

BASIC INFORMATION

Construction year: 2009-2013
Constructor: City of Fairfax Parks and Recreation
Source of financing: project – National Fish and Wildlife Foundation
Total cost: 330 000$
Facility operator: City of Fairfax Parks and Recreation
Maintenance cost: 3 500-5 000$ / year
Contact person: City of Fairfax Park and Recreation (fairfax.gov/government/park-recreation)



URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse

Source: nfwf.org/sites/1884_Final_Report

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 8000 m^2
Catchment: 566 560 m^2
Dominant plant species: *Pontederia cordata L.*, *Schoenoplectus* tabernaemontani
Efficiency and effectiveness: The values are less than the afforded credits for TP (50%) and TN (50%) currently assigned to wet ponds by the Virginia Stormwater BMP Clearinghouse (Virginia Department of Environmental Quality 2013).

ECOLOGICAL POTENTIAL

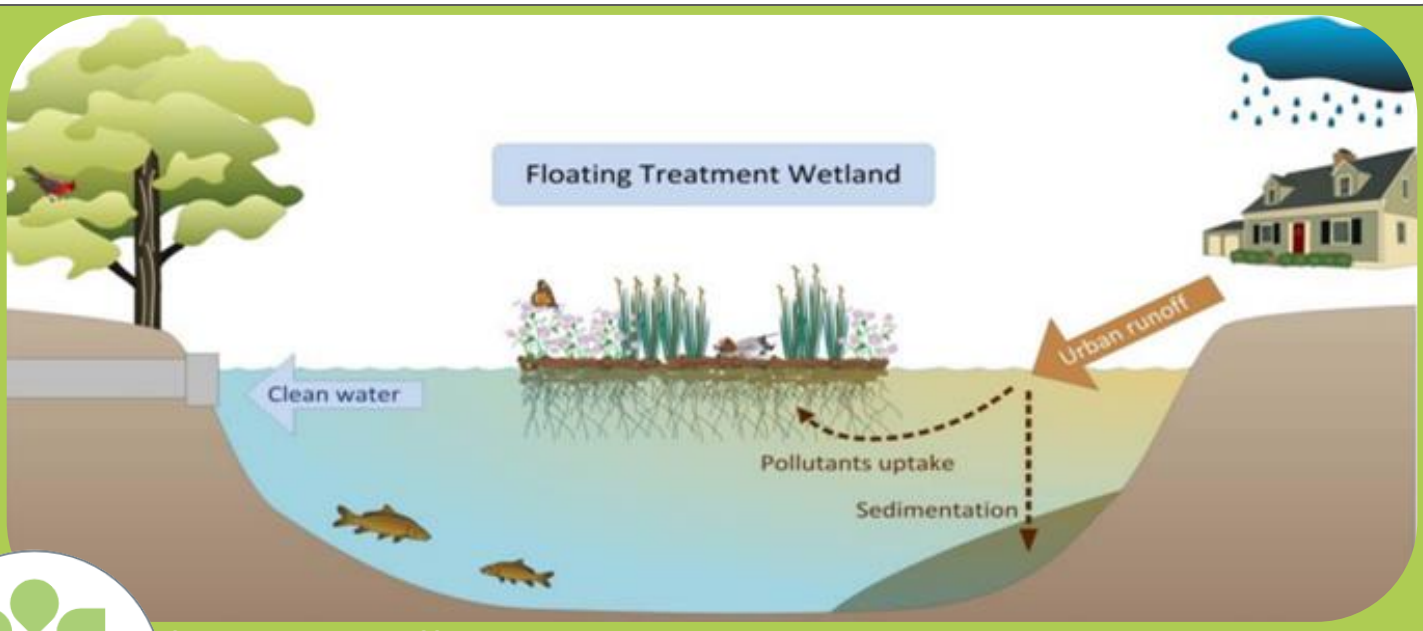
The floating treatment wetland allows for purification of water. Moreover, it is a great facility that increases the biodiversity of Fairfax city. It allows for ecotourism and recreation. Additionally, it is a great place for school excursions.

ADVANTAGES

1. Promising potential results – removal of 10 tons of sediment per year.

DISADVANTAGES

1. Low efficiency ratio leading to a disappointing performance of the facility.



Source: nfwf.org/sites/1884_Final_Report

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

FLOATING TREATMENT WETLAND

OBJECT INFORMATION

Name: BioHaven floating island at Hyde Park, UK
Type of facility: FTW
Treated medium: surface water
Description of the solution: As part of a programme of wildlife habitat improvements in the Royal Parks, a large FTW has been built on the Serpentine Lake in London's Hyde Park. Ecologists and landscapers worked with Salix bio-engineers to install a 200 m^2 island in the southern lake to clean the lake's water naturally. The FTW on the Serpentine will help to improve the water quality in a chemical free way and provide habitat and food for a variety of wildlife including insects, waterfowl and amphibians.



GEOGRAPHICAL COORDINATES

Latitude: 51° 30' 19" N
Longitude: 0° 10' 05" W

BASIC INFORMATION

Construction year: 2013
Constructor: Salix river & Wetland Services Ltd.
Source of financing: government funds
Total cost: 800 000 €
Facility operator: The Royal Parks
Maintenance cost: 3 000-5 000 € / year
Contact person: Leela O'Dea (leela@frogenvironmental.co.uk)

LOCATION

Country: England
City: London
Type of climate: Cfb
Average temperature: 10.8°
Sum of precipitation: 690m

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse





Source: salixrw.com/wetland-habitat-creation/royal-parks-serpentine-lake

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 200 m^2
Volume: 160 m^3
Dominant plants species: sedge, iris, rush, mint, purple loosestrife

ECOLOGICAL POTENTIAL

At the bottom of the chain, microscopic organisms will build-up naturally, becoming a biofilm on the surface of the island, cleaning the water and providing food for the zooplankton, micro and macro invertebrates like dragonfly nymphs and snails, and further up the chain, food for the fish. The root systems of the plants on the floating islands also process excess nutrients in polluted waters. This improves water quality and the wider aquatic habitat for insects and fish.

ADVANTAGES

1. The islands provide a beautiful and diverse habitat.
2. Recycling and reusing materials.

DISADVANTAGES

1. Prior water quality tests must be carried out.
2. Concern about water contamination with microplastics (referring to the latest research).





Source: salixrw.com/wetland-habitat-creation/royal-parks-serpentine-lake

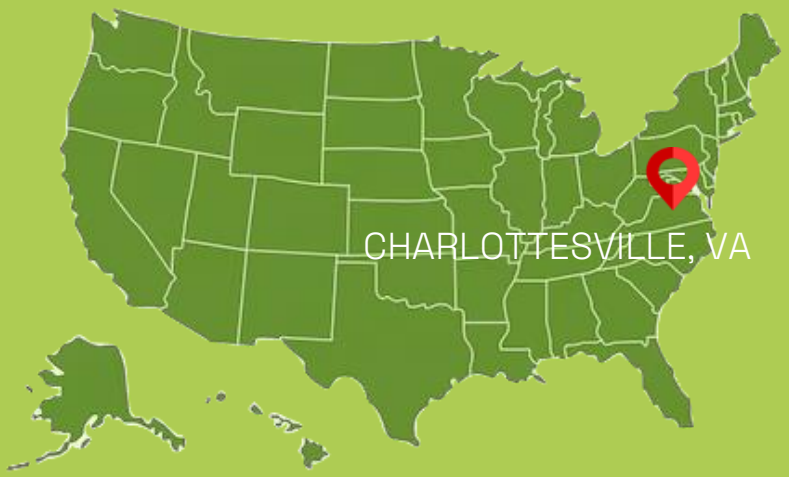
Funded by the Horizon 2020 Framework Programme of the European Union

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IN-STREAM RESTORATION - BUFFER ZONES

OBJECT INFORMATION

Name: Meadow Creek Stream Restoration
Type of facility: Buffer zone
Treated medium: Surface water
Description of the solution: The project consisted of 2.75 linear kilometers of stream restoration and the conservation of 300 000 m^2 as easement land, of which 160 000 m^2 are new public parkland. The main goals of this project are to: decrease sedimentation, improve stability, improve habitat, enhance surrounding forest, protect infrastructure, and create educational and recreational opportunities. The restoration design followed the natural channel approach to establish a dynamically meandering pattern to reconnect the stream with its flood plain and reduce bank erosion and sedimentation.



GEOGRAPHICAL COORDINATES

Latitude: 38° 03' 45" N
Longitude: 78° 29' 01" W

LOCATION

Country: USA
City: Charlottesville, VA
Type of climate: Cfa
Average temperature: 13.8°C
Sum of precipitation: 1047m

BASIC INFORMATION

Construction year: 2013
Constructor: Vanasse Hangen Brustlin, Inc. , Coastal Design and Construction, Inc.
Source of financing: Foundation- VIRGINIA The Nature Conservancy
Total cost: 4 000 000$
Facility operator: The City of Charlottesvile
Maintenance cost: 18 000-35 000$ / year
Contact person: Dana Kasler (kaslera@charlottesville.gov)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production





Source: landscapeperformance.org/case-study-briefs/meadow-creek-stream-restoration

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 300 000 m^2 as easement land; 2.75 linear kilometers of stream restoration
Catchment area: around 25 km^2
Efficiency and effectiveness : Bank Erosion Hazard Index(BEHI: method for assessing stream bank erosion potential)- sediment loading was reduced by 1 790 tons per year.

ECOLOGICAL POTENTIAL

The natural resources contained in the facility are the source of ornaments and decorations. The vegetation planted during the works purifies the air and increases the biodiversity of the area attracts bees that pollinate plants, the flora becomes a shelter for many animals.

ADVANTAGES

1. This project is improving the creek and forest health with better water quality.

DISADVANTAGES

1. No disadvantages have been noted during the operation of the plant.



Source: : landscapeperformance.org/case-study-briefs/meadow-creek-stream-restoration

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This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

IN-STREAM RESTORATION - BUFFER ZONES

OBJECT INFORMATION

Name: Tassajara Creek Restoration
Type of facility: Buffer zones
Treated medium: Surface water
Description of the solution: The project sought to stop chronic incision caused by years of grazing along a one-mile stretch of the creek in an area were significant development was anticipated. In 1998, after much consultation with the state-owned entities and geomorphologists, the Authority began construction of a compound channel with two reaches of low-flow channels and flood terraces planted with native vegetation for higher flows. The restored creek conveys 100-year flood waters, supports the local ecosystem, and serves as an amenity for the surrounding housing developments, sporting a mile-long trail that connects to local parks and the East Bay Regional Trail network.



GEOGRAPHICAL COORDINATES

Latitude: 37° 42' 31" N
Longitude: 121° 52' 46" W

LOCATION

Country: United States of America
City: Dublin, CA
Type of climate: Csc
Average temperature: 13.5° C
Sum of precipitation: 581mm

BASIC INFORMATION

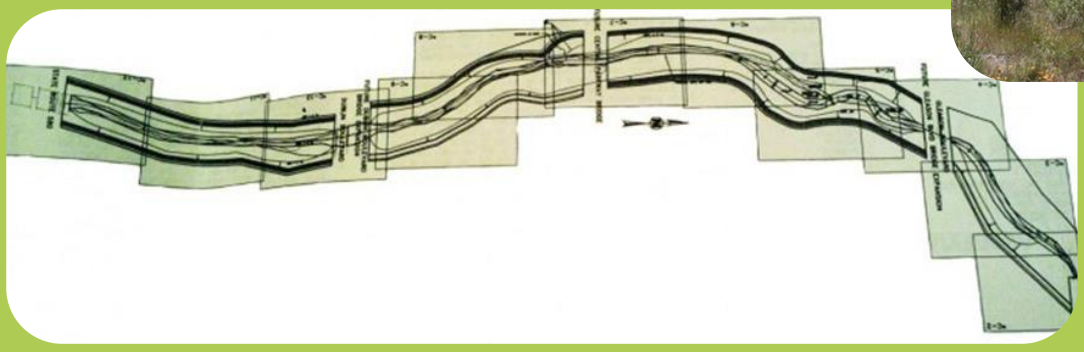
Construction year: 1999
Constructor: RGW Construction
Source of financing: project funds – Smith Group
Total cost: 5 000 000$
Facility operator: Alameda County surplus Property
Maintenance cost: 18 000 – 35 000$ / year
Contact person: Miw Lehrer (info@studio-mla.com)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production



Source: landscapeperformance.org/case-study-briefstassajaracreek-restoration



ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 14 000 m^2
Catchment area: 60 km^2
Primary design factor: Downstream reach: the entire channel was reconstructed with a low-flow channel designed to convey the 2-year flow (14-18 m^3/s) before overtopping onto the floodplain terrace designed to convey the 100-year flow.
Efficiency and effectiveness: The facility has been operating flawlessly since 1999. The assumptions made at the beginning of the project were 100% implemented.

ECOLOGICAL POTENTIAL

The purpose of the TW is to purify surface water from the urbanized and agricultural wasted district, which reduces the risk of bloom in the river. Moreover, it is a meeting place for natives, where they can rest and relax.

ADVANTAGES

1. Prevented 159 m^3 of concrete from entering a landfill by repurposing material from a former military bridge and a drop structure as buried riprap along the channel.

DISADVANTAGES

1. Miscommunication between project planners and those tasked with maintaining the site after project completion initially led to excessive trimming of riparian vegetation along the channel.



BEFORE



AFTER

Source: landscapeperformance.org/case-study-briefstassajaracreek-restoration

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RESTORATION OF NATURAL WETLAND

OBJECT INFORMATION

Name: Aarslev Restored Wetland
Type of facility: Restoration of Natural Wetland
Treated medium: surface water
Description of the solution: : The Aarslev wetland area has been cultivated and drained for agricultural purposes for over a century. Over time, cultivation of the fields became increasingly challenging due to soil flooding, making it politically and operationally acceptable to construct a natural wetland on the area. The purpose of reconstructing the wetland was to decrease the amount of nitrate reaching Aarhus Bay where oxygen depletion has caused several events of fish death. By stopping the agricultural activities and drainage, the meadows of the area were wetted and flooded and the site is now classified as a Nature 2000 and EU habitat area. The flooded meadows provide several ecosystem services by reducing the nutrient content of the water before reaching the bay, support of wildlife and function as recreational area outside the city. Birdwatching towers, paths for hicking and bikes, information boards and rest places have been installed along the banks to allow leisure activities.



GEOGRAPHICAL COORDINATES

Latitude: 56°08'29.9"N
Longitude: 10°04'08.6"E

LOCATION

Country: Denmark
City: Aarhus
Type of climate: Cfb /Dfb
Average temperature: 8.4 °C
Sum of precipitation: 897 mm

BASIC INFORMATION

Construction year: 2003
Constructor: Aarhus County, Municipality of Aarhus
Source of financing: Water plan II, Municipality of Aarhus
Total cost: 2,455,079.40 €
Contact person: Carlos A. Arias (carlos.arias@bio.au.dk)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production





Source: Carlos A. Arias

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
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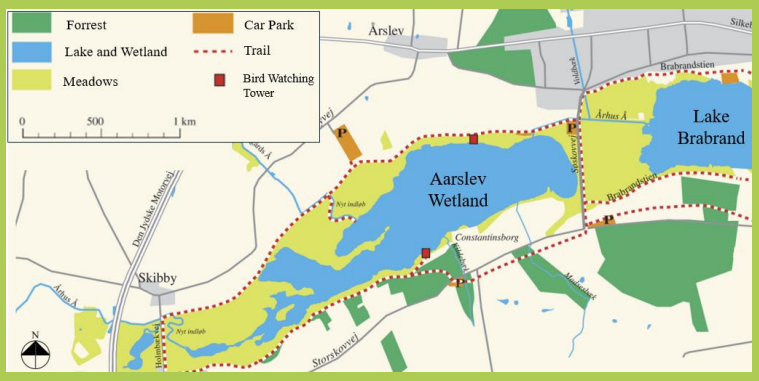
TECHNICAL DATA

Area of the facility: 117 ha wetland + 98 ha wet meadow, wetland to catchment ratio 0.8
Catchment area: 267.5 km^2
Volume: 584,290 m^3
Hydraulic data: Monthly loading: 102,446 10^{-3} m^3, Annual retention time: 2.1 days
Efficiency and effectiveness of facility:

Parameter	Inlet	Outlet	Retention	
	Kg yr^{-1}	Kg yr^{-1}	kg ha^{-1} yr^{-1}	%
NO_3^- - N	307,7	243,4	299	21
TN	365,8	309,7	261	15
PO_4^{3-} - P	6,115	3,267	13.2	47
TP	12,38	10,17	10.3	18

ECOLOGICAL POTENTIAL

1. Biodiversity, nesting of native bird species and resting spot for migrating birds.
2. Ecosystem services by treating stream water before discharging to downstream ecosystems.



ADVANTAGES

1. Decreasing the nutrient content of the catchment water before entering Lake Brabrand and preventing nutrients to reach and discharge in Aarhus Fjord.
2. Supporting wildlife, native species, and resting migrating birds.
3. Minimizing and mitigating Flood Risk
4. Recreation facilities

DISADVANTAGES

1. Flooding of the surrounding meadows has resulted in periodically negative effect on the fauna.
2. High predation and low survival rates of the trout stock in the narrow passage between Aarslev Restored Wetland and Lake Brabrand.
3. Frequent algae blooms in the wetland due to the high nutrient concentrations. However, this was expected given the motivation of the project.
4. High area demand

Source: : Carlos A. Arias

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RESTORATION OF NATURAL WETLAND

OBJECT INFORMATION

Name: Egaa Restored Wetland
Type of facility: Restoration of Natural Wetland
Treated medium: surface water
Description of the solution: : Egå Engsø was restored by re-flooding meadows on land previously drained in the 1950s for agricultural use. By the 1990s the water quality and natural ecosystem in and around the Egaa river, into which the site drained had declined in quality due to the effect of nitrate fertilizer and phosphorus through intensive farming in the area. In 2006 Aarhus Municipality, Aarhus County and the Danish Forest and Nature Agency decided to reestablished and construct a wetland and a lake as part of Action Plan for the Aquatic Environment II from 1998 to reduce this effect through biological denitrification. Another major reason for establishing the wetland and go ahead with the project, was the need for a strengthened defense and mitigate against the potential increasing rainfalls due to climate change.



GEOGRAPHICAL COORDINATES

Latitude: 56°13′17″N
Longitude: 10°13′54″E

LOCATION

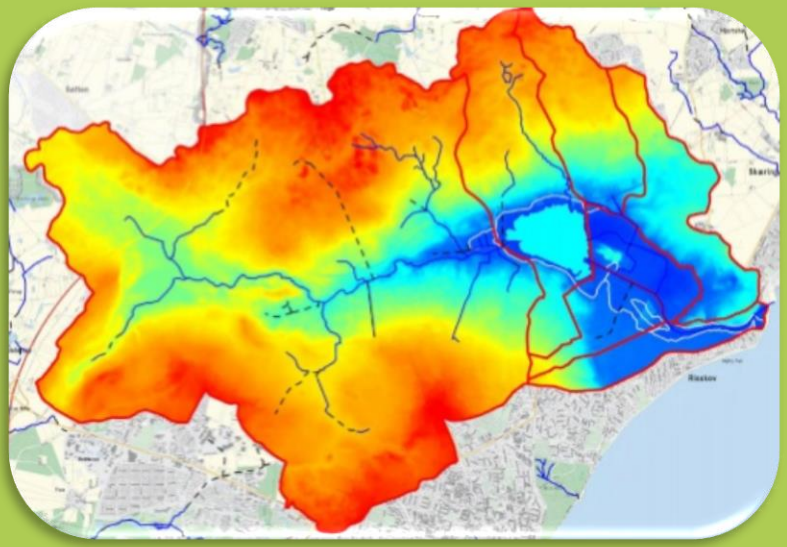
Country: Denmark
City: Aarhus
Type of climate: Cfb /Dfb
Average temperature: 8.43°C
Sum of precipitation: 703mm

BASIC INFORMATION

Construction year: 2006
Constructor: Aarhus County, Municipality of Aarhus
Source of financing: Municipality of Aarhus
Total cost: 418,575.95 €
Contact person: Carlos A. Arias (carlos.arias@bio.au.dk)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production



Source: Carlos A. Arias

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of facility: 115 ha + 100 ha reed beds and meadows, mean depth of 1.00 m
Catchment area: 47 km^2, 46% agriculture
Volume: 894,630 m^3
Hydraulic data: monthly loading depending on the precipitation in the catchment
Annual retention time: 160 days
Efficiency and effectiveness of facility: It is anticipated that the lake will contribute to a reduction in nitrogen emissions by approximately 33 t of N and 0.6 t of P annually. This reduction is estimated to represent 36% of the nitrogen discharge from Egå and nearly 6% of the TN discharge from Aarhus Municipality to the bay in 2006, which amounted to 556 t. However, a comprehensive assessment of the actual nitrogen retention within the wetland has not been conducted.
Operating experience: Bird management has been implemented to avoid invasive species nesting in the area.

ECOLOGICAL POTENTIAL

1. The wetland already holds several rare species, and some are even on the Danish Red List (IUCN Red List). The meadows surrounding Egaa Wetland are grazed by cattle during the summer months, creating ideal conditions for the emerging flora and fauna associated with wet meadows. This trend is expected to continue as the wetland ages.
2. Ecosystem services by treating stream water before discharging to downstream ecosystems.



ADVANTAGES

1. Using existing ecotypes for treatment purposes.
2. Low maintenance cost.
3. Decreasing the nutrient content form the catchment water and discharge to the bay.
4. Supporting wildlife, native species, and resting birds. Bird species are retuning to the area (e.g. sea eagles)
5. Minimizing flood risk.
6. Recreation facilities.

DISADVANTAGES

1. The decline in the number of trout smolts within the streams of the area. The trout is dependent on the streams for reproduction and with the establishment of the wetland, this ecotype was fragmented leading to a decrease in the abundance by 83%.
2. High area demand.

Source: : Carlos A. Arias

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

www.nice-nbs.eu

NBS FOR SEWAGE SLUDGE

Type of object	Location	Name
Sludge Treatment Reed Beds (STRB) ∑=5	Gniewino (Poland)	SEWAGE SLUDGE TREATMENT REED BED
	Al Awir (United Arab Emirates)	SEWAGE SLUDGE TREATMENT REED BED
	Helsinge (Denmark)	SEWAGE SLUDGE TREATMENT REED BED
	Negrepelisse (France)	SLUDGE TREATMENT REED BEDS & FRENCH TREATMENT WETLAND
	Paslieres (France)	FRENCH TREATMENT WETLAND & SLUDGE TREATMENT REED BEDS

SEWAGE SLUDGE TREATMENT REED BED

OBJECT INFORMATION

Name: Sludge treatment reed bed in Gniewino
Type of facility: STRB
Treated medium: sewage sludge
Description of the solution: Total area of the STRB is 2400 m^2 and it consists of six beds planted with reed. The time required to feed sludge to one bed is about 1 day. The facility treated surplus sewage sludge from biological part of WWTP for 15000PE. About 35% of wastewater supplied to the WWTP comes from the dairy and food industry and 17% of wastewater is delivered from septic tanks.



LOCATION

Country: Poland
City: Gniewino
Type of climate: Cfb
Average temperature: 9 °C
Sum of precipitation: 500mm

GEOGRAPHICAL COORDINATES

Latitude: 54° 42' 17" N
Longitude: 17° 59' 7.8" W

URBAN CIRCULARITY CHALLENGES

UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production

BASIC INFORMATION

Construction year: 2011
Modernization: 2018
Constructor: WWTP in Gniewino Municipality
Source of financing: own funds with support of Provincial fund for environmental protection
Facility operator: WWTP in Gniewino
Total cost: approx. 140 000 €
Maintenance cost: 1 000-2 000 €
Contact person: Katarzyna Kołecka (katkolec@pg.edu.pl) or Dariusz Rohde (dariusz.rohde@gpk-kostkowo.pl)





Source: K.Kołecka

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Regulation & Maintenance	Cultural
Class	BIOTIC: -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation) -Mediation of nuisances by abiotic structures or processes	BIOTIC: -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training

TECHNICAL DATA

Area of the facility: 6 reed beds about 2400m^2 in total
Hydraulic load: 70 kg of dry matter per 1m^{2}of beds
Operating experience: Due to errors in the design, construction and initial operation stages, operational problems appeared. For this reason, the facility has been modernized. Currently it works properly.

ECOLOGICAL POTENTIAL

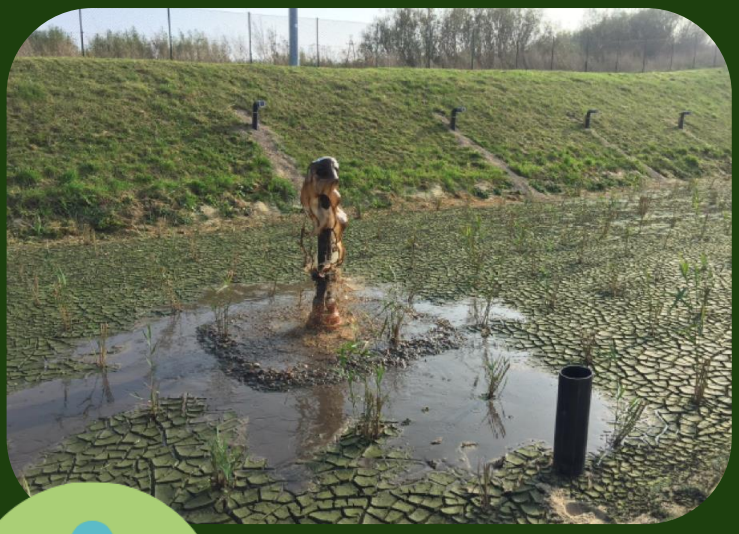
The STRBs treat sewage sludge using natural processes. They do not require additional chemicals and reduce energy consumption. This facility provides habitat for plants, insects and amphibians. The STRBs close the cycle of nutrients in the environment by converting waste into a product i.e. fertilizer, structure-forming material.

ADVANTAGES

1. The method is predicted for long-term management of sludge.
2. This is a low-energy method.
3.Simple construction and operation process.
4. Final product for reuse as a compost or soil amendment.

DISADVANTAGES

1. Even minor errors during construction and initial operation can cause serious operational problems.
2. The STRBs require a much smaller load in the start up period than in the regular operation one.





Source: K.Kołecka

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SEWAGE SLUDGE TREATMENT REED BED

OBJECT INFORMATION

Name: Waagner Biro Gulf
Type of facility: STRB
Treated medium: sewage sludge
Description of the solution: An aim of the NBS is to convert of conventional septic tank with soak away at Dubai Municipality (60 staff members). Use of septic tank as pretreatment conversion of soak away to a pump station and pumping of outflow to a 170 m² vertical flow sand filter reed bed for biological and tertiary treatment of pre-treated wastewater. Analyses proved sufficient quality for drip irrigation. Facility is treated by optional additional UV treatment of stored effluent with UV lamp in stainless steel pipe.



GEOGRAPHICAL COORDINATES

Latitude: 25° 08' 00" N
Longitude: 55° 14' 30" E

BASIC INFORMATION

Construction year: 2005/2006
Constructor: Waagner Biro Gulf
Source of financing: local funding
Facility operator: Respective owner in cooperation with Waagner Biro Gulf
Total cost: 40 500€
Maintenance cost: 450 €
Contact person: Jana Schlick (jana.schlick@planco.org)

LOCATION

Country: United Arab Emirates
City: Al Awir
Type of climate: BWh
Average temperature: 28.2°C
Sum of precipitation: 68mm

URBAN CIRCULARITY CHALLENGES

UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production





Source: Waagner Biro Gulf

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Regulation & Maintenance	Cultural
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TECHNICAL DATA

Area of the facility: 170 m^2
Hydraulic load: 170 m^3
Operating experience:
Daily tasks: Visual check of the system
Weekly tasks: Change of the distribution from one bed to another (opening and closing a valve); remove reed shoots from the service ways around the beds; visual check of the pump station.
Every three months: Discharge sludge from the pretreatment; flush distribution and drainage system, clean pump stations.

ECOLOGICAL POTENTIAL

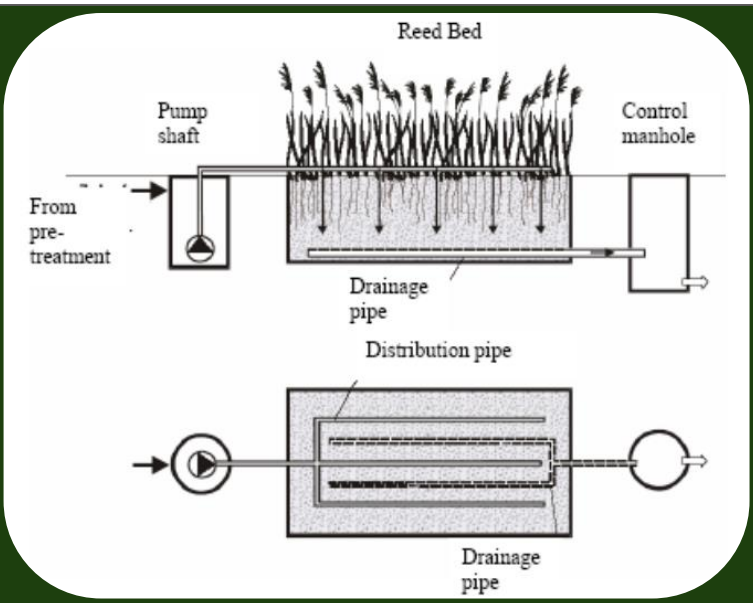
Storage of sewage sludge in an elevated tank and a pond for reuse for concrete mixing, soil watering, car washing and a fish ponds. Moreover, it enables sub-surface irrigation of different plants including tomatoes, melons, cucumbers, date palms, flowers, bushes and grass areas. Analyses of the plants have complied with WHO standards.

ADVANTAGES

1. Simple to operate without chemical additives or complex electronic controls.
2. Effects could be seen within one year by saving fresh water and tanker disposal cost.

DISADVANTAGES

1. An importance of proper sizing and dimensioning for sludge material, i.e., mixture of water with solids, to prevent clogging.



Source: entsorgungsverband.de/uploads/media/Vortrag-bleif.pdf

Funded by the Horizon 2020 Framework Programme of the European Union

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SEWAGE SLUDGE TREATMENT REED BED

OBJECT INFORMATION

Name: Sludge treatment reed bed in Helsinge
Type of facility: STRB
Treated medium: sewage sludge
Description of the solution: The surplus sludge from the activated sludge treatment systems to the left is pumped to fourteen reed beds in sequence. The water draining from the reed beds (reject water) is returned to the activated sludge tanks. When the beds are filled up with sludge after 8 to 12 years, the dewatered and partly mineralized sludge are used as a fertilizer in agriculture. The Helsinge system was established in 1996 with ten beds. The system was expanded with four extra beds in 2013.



GEOGRAPHICAL COORDINATES

Latitude: 54° 42' 17" N
Longitude: 17° 59' 7.8" W

BASIC INFORMATION

Construction year: 1996
Constructor: Orbicon company
Source of financing: local funds
Facility operator: Helsinge WWTP
Maintenance cost: about 10% of traditional methods of sludge treatment, cost of energy for pumps and control
Contact person: Katarzyna Kołecka (katkolec@pg.edu.pl)

LOCATION

Country: Denmark
City: Helsinge
Type of climate: Cfb
Average temperature: 9.1 °C
Sum of precipitation: 792 mm

URBAN CIRCULARITY CHALLENGES

UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production



Source: H. Brix "Sludge Dewatering and Mineralization in Sludge Treatment Reed Beds"



Source: globalwettech.com/references/sludgedewatering/item/87-helsinge-sludge-treatment-reed-bed-system

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Regulation & Maintenance	Cultural
Class	BIOTIC: -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation) -Mediation of nuisances by abiotic structures or processes	-Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training

TECHNICAL DATA

Area of the facility: 10 reed beds about 10 500m^2
Sludge volume: 7630 ton of dry matter per year
Efficiency and effectiveness: dewatering from 99% to about 25% dry matter content
Operating experience: Object has been working for a long time and serious problems with maintenance have not occurred.

ECOLOGICAL POTENTIAL

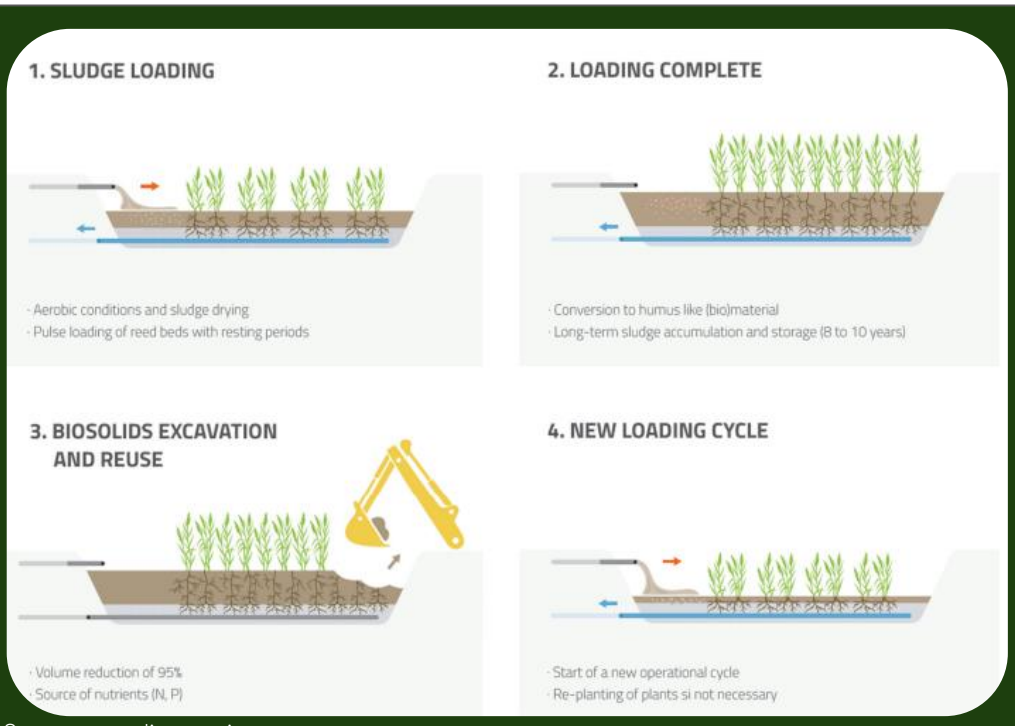
The STRBs treat sewage sludge using natural processes. They do not require additional chemicals and reduce energy consumption. This facility provides habitat for plants, insects and amphibians. The STRBs close the cycle of nutrients in the environment by converting waste into a product i.e. fertilizer, structure-forming material.

ADVANTAGES

1. The method is predicted for long-term management of sludge.
2. This is a low-energy method.
3.Simple construction and operation process.

DISADVANTAGES

1. Even minor errors during construction and initial operation can cause serious operational problems.
2. Facilities require relatively large area.



Source: www.limnos.si

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

SLUDGE TREATMENT REED BEDS & FRENCH TREATMENT WETLAND

OBJECT INFORMATION

Name: Nègrepelisse
Type of facility: STRB for septage treatment, French TW for leachtate treatment and short rotation coppice for effluent reuse
Treated medium: Septage
Description of the solution: This treatment system was designed to (1) treat septage (131 tons of TSS/year - 11 000 m^3/year) with sludge treatment beds, (2) treat leachates from sludge treatment beds with French VFTW and (3) reuse effluent by application on short rotation coppice in summer or (4) direct treated percolates to ponds in winter.



BASIC INFORMATION

Construction year: 2012
Constructor: SAVEA
Designer: EcoBIRD
Source of financing: local funds
Total costs: 1 382 104 € / 2 371 719 € (incl. VAT)
Facility operator: local municipality
Maintenance cost: 27 816 € per year (incl. VAT)
Contact person: Stéphane Troesch (s.troesch@ecobird.fr)

GEOGRAPHICAL COORDINATES

Latitude: 44°04'22.1"N
Longitude: 1°29'34.6"E

URBAN CIRCULARITY CHALLENGES

UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production

LOCATION

Country: France
City: Nègrepelisse (district Occitanie)
Type of climate: Cfb
Average temperature: 13,4°C
Sum of precipitation: 644 mm



Source: S. Troesch

ECOSYSTEM SERVICES ACCORDING TO CICES		
Section	Regulation & Maintenance	Cultural
Class	BIOTIC: -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation) -Mediation of nuisances by abiotic structures or processes	-Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training

TECHNICAL DATA

Area of facility: 2 700 m^2 in total
STRB: 2 600 m^2; VF TW: 100 m^2
Volume: 1 360 m^3
SDRB: 1 300 m^3; VF TW: 60 m^3
TSS flux: 50 kg TSS/m^2/y
Efficiency and effectiveness of facility: guaranteed discharge levels: COD = 1000 mg/L; TSS = 1000 mg/L
Operating experience: simple maintenance and operation

ECOLOGICAL POTENTIAL

The treatment system provides ecosystem services such as waste decomposition and detoxification as well as supporting services as nutrient cycling, primary production habitat for insects and aesthetic value by being consistent with the surrounding landscape.





ADVANTAGES

1. Low cost and efficient dewatering process.
2. High load variation acceptance
3. Sludge highly stabilized for agricultural land spreading.
4. Treated effluent is reused for the irrigation of wood (short rotation coppice) that is used as fuel for the municipal social housing heating system.

DISADVANTAGES

1. Need for a substantial land area.
2. Operation and maintenance requirement (half full time job).

Source: S. Troesch

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

FRENCH TREATMENT WETLAND & SLUDGE TREATMENT REED BEDS

OBJECT INFORMATION

Name: Paslières WWTP
Type of facility: FRB for domestic wastewater treatment and STRB for septage treatment
Treated medium: sewage (combined sewer) and septage
Description of the solution: This treatment system was designed to treat (1) the wastewater from 900 p.e. with French VF TW as well as (2) the septage from 900 septic tanks with sludge treatment beds. The leachate from STRB is treated on the TW.



BASIC INFORMATION

Construction year: 2016
Contstructor: **SAVEA**
Designer: EcoBIRD
Source of financing: local funds (Water agencies and Municipality)
Total cost: 790 334 € (incl. VAT)
Facility operator: Syndicat intercommunal Eau et Assainissement Rive Droite de la Dore
Maintenance cost: 6 840 € per year (incl. VAT)
Contact person: Stéphane Troesch (s.troesch@ecobird.fr)

GEOGRAPHICAL COORDINATES

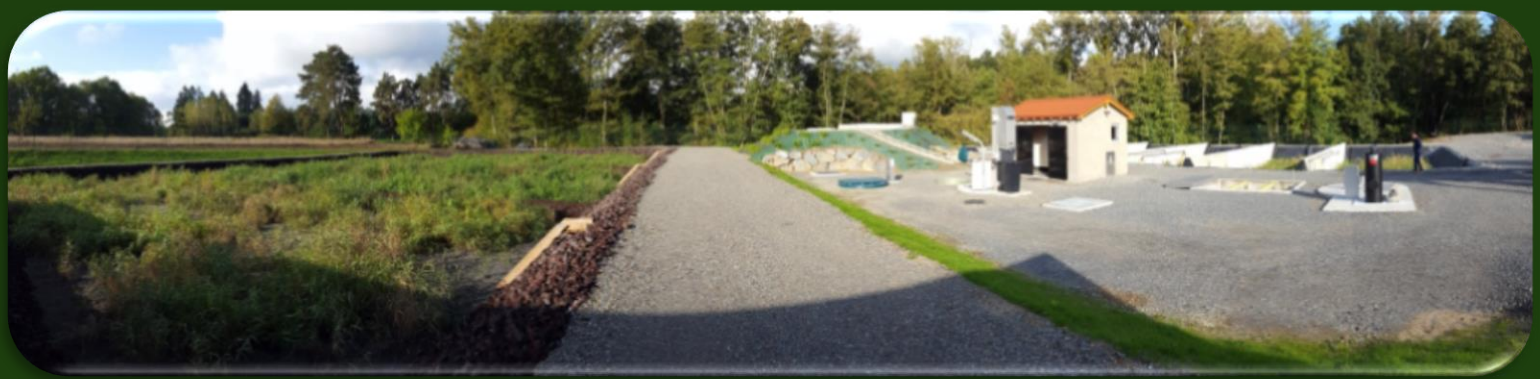
Latitude: 45°56'10.0"N
Longitude: 3°29'05.4"E

LOCATION

Country: France
City: Paslières (district: Auvergne-Rhône-Alpes)
Type of climate: Cfb
Average temperature: 11,5°C
Sum of precipitation: 644 mm

URBAN CIRCULARITY CHALLENGES

UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_5- food and biomass production



Source: S. Troesch

ECOSYSTEM SERVICES ACCORDING TO CICES		
Section	Regulation & Maintenance	Cultural
Class	BIOTIC: -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation) -Mediation of nuisances by abiotic structures or processes	-Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training

TECHNICAL DATA

Area of facility: 2 255 m^2 in total
VF TW (first stage): 1 085 m^2; VF TW (second stage): 720 m^2; STRB: 450 m^2
Catchment area: 6 750 m^2
Volume of filtration: 1 556 m^3 in total
VF TW (first stage): 705 m^3; VF TW (second stage): 648 m^3; STRB: 203 m^3
Water flow : Dry weather: 146 m^3/d; Wet weather: 246 m^3/d
Septage flow: 800 m^3/year
Efficiency and effectiveness of facility: guaranteed discharge levels and removal rates: BOD_5 = 20 mg/L – 85 %; COD = 90 mg/L – 75 %; TSS = 20 mg/L – 85 %; TKN = 15 mg/L – 70 %
Operating experience: simple maintenance and operation

ECOLOGICAL POTENTIAL

Facility provides water purification, nutrient cycling, habitat for insects and aesthetic value by being consistent with the surrounding landscape.



ADVANTAGES

1. This type of treatment system allows the application of raw wastewater directly without pretreatment.
2. Simple and highly efficient dewatering of sludge with SDRB.
3.Simple to operate.
4. No odor nuisance.

DISADVANTAGES

1. Availability of land area.

Source: S. Troesch

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

www.nice-nbs.eu

NBS FOR LANDFILL LEACHATE

Type of object	Location	Name
Treatment Wetland (TW) ∑=5	Burnie (Australia)	LANDFILL LEACHATE TREATMENT WETLAND SYSTEM
	Copping (Australia)	LANDFILL LEACHATE TREATMENT WETLAND SYSTEM
	Tianjin (China)	LANDFILL LEACHATE TREATMENT WETLAND SYSTEM
	Sydney (Australia)	POST-INDUSTRIAL LEACHATE TREATMENT WETLAND SYSTEM
	Lunan Tangshan (China)	POST-INDUSTRIAL LEACHATE TREATMENT WETLAND SYSTEM

LANDFILL LEACHATE TREATMENT WETLAND SYSTEM

OBJECT INFORMATION

Name: Burnie landfill leachate treatment wetland system
Type of facility: TW
Treated medium: landfill leachate
Description of the solution: Constructed on top of a recultivated landfill cell. The treatment process removes low level contaminants via a treatment train comprising a precipitation pond to remove metals, aerobic and anaerobic ponds for biological removal of ammonium nitrogen and nitrate by endemic plants, a polishing pond and final discharge to Cooee Creek via infiltration within a treatment wet eucalypt forest.



GEOGRAPHICAL COORDINATES

Latitude: 41° 6' 3" S
Longitude: 145° 51' 45" E

BASIC INFORMATION

Construction year: 2017
Constructor: SYRINX company
Source of financing: The Burnie Waste Management Centre (BWMC)
Total cost: 10 000 000 €
Maintenance cost: 10 000-20 000 € / year
Facility operator: SYRINX
Contact person: www.syrinx.net.au/contact

LOCATION

Country: Australia
City: Burnie
Type of climate: Cfb
Average temperature: 12.3 °C
Sum of precipitation: 910mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_6- energy efficiency and recovery





Source: syrnix.net.au/portfolio/burnie

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 258 000 m^2
Operating experience: The wetland system treats an average of 490 000 liters of landfill leachate per day. Flows have been successfully disconnected from the sewer network, reinstating environmental flows, freeing up TasWater network capacity and reducing ratepayer costs.

ECOLOGICAL POTENTIAL

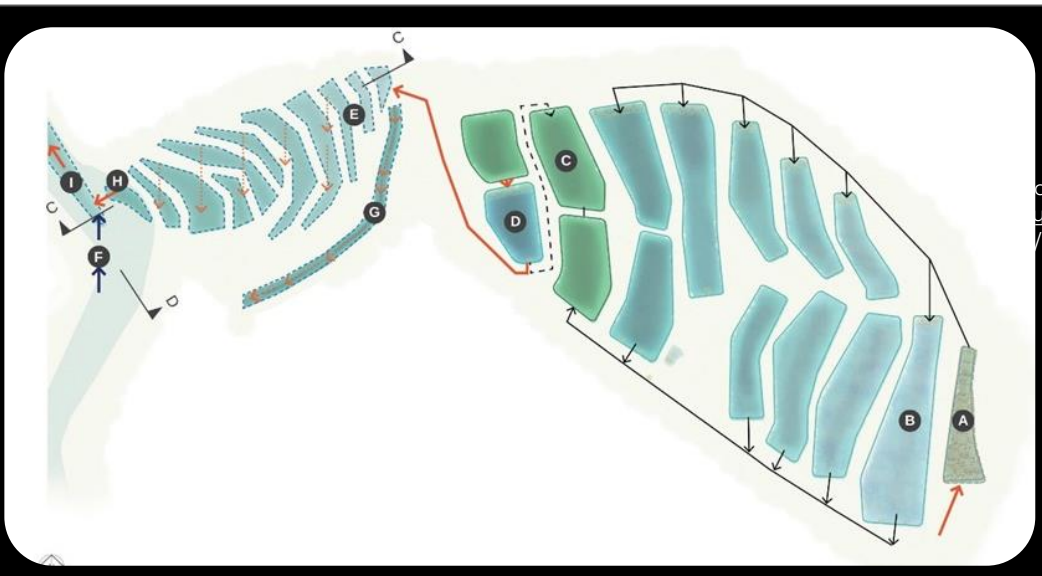
The facility effectively cleans precipitation in the form of surface runoff. In addition, it accumulates heavy metal compounds and biogenic compounds that are harmful to soils and inland waters. The surroundings around the facility allows to spend quality free time and relax. In addition, it can be a learning experience on many plants that grow in Tasmania.

ADVANTAGES

1. Use of TW technology for treatment of leachate provided an effective and relatively low-cost solution that goes beyond simply addressing an issue.

DISADVANTAGES

1. Very stringent discharge standards set to protect the sensitive receiving creek system.



ource:
rnix.net.au/portfoli
/burnie

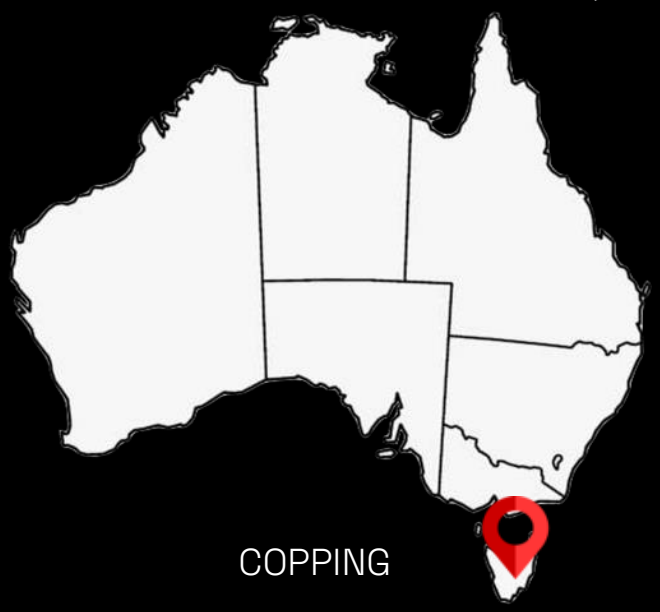
Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

LANDFILL LEACHATE TREATMENT WETLAND SYSTEM

OBJECT INFORMATION

Name: TW pilot trial for copping landfill
Type of facility: TW
Treated medium: landfill leachate
Description of the solution: The Copping Pilot Trial Wetland is a TW and biofilter system designed to treat leachate from the Category B-Cells within the Copping Regional Landfill Facility. This system treats the leachate to a standard that enables sustainable, beneficial reuse for TW irrigation, using a modular, novel series of phytoremediation / adsorption biofilters and wetlands. The combined technologies use the processes of oxidation, precipitation, aeration, adsorption, biotransformation and phytoremediation to remediate the leachate.



GEOGRAPHICAL COORDINATES

Latitude: 31° 56' 29" S
Longitude: 115° 57' 02" E

BASIC INFORMATION

Construction year: 2015-2020
Constructor: SYRINX company
Source of financing: project funding
Total cost: 12 000 000$
Facility operator: Southern Waste Solutions, a joint authoroty made up of Clarance City, Sorell and Tasman Councils
Maintenance cost: 35 000 – 60 000 $ /year
Contact person: Syrinx – Dr Kathy Meney (kmeney@syrinx.net.au)

LOCATION

Country: Australia
City: Copping
Type of climate: Csa
Average temperature: 18.6 °C
Sum of precipitation: 766mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_6- energy efficiency and recovery





Source: SYRINX

ECOSYSTEM SERVICES ACCORDING TO CICES

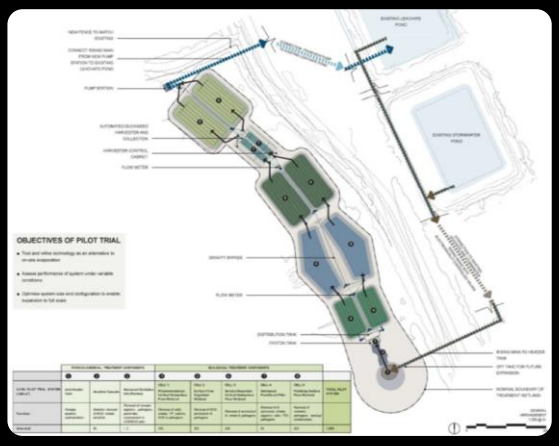
Section	Provisioning	Regulation & Maintenance	Cultural
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TECHNICAL DATA

Area of the facility: 30 000 m^2
Capacity: 4 000 m^3 per year (evaporation is the reason of describing capacity by perspective of time)
Dominant plant species: *Lemna spp, Duckweed ,Schoenoplectus pungens, Eleocharis spp, Suaeda australis, Atriplex spp, Phragmites australis.*
Others important: Flows have been successfully disconnected from the sewer network, reinstating environmental flows, freeing up TasWater network capacity and reducing ratepayer costs.

ECOLOGICAL POTENTIAL

The facility performs many regulating services: it purifies wastewater, reduces the salinity of wastewater from the landfill, protects against flooding. In addition, it is a place to relax. It is a symbol of a given region in the country and scientific research is carried out here.



ADVANTAGES

1. The system is closed with no discharge to the environment.
2. Low levels of odor from leachate, low levels of volatile compounds.

DISADVANTAGES

1. The facility generates noise due to the excavation process and ongoing operation of pumps.
2. Sludge in the header tank and settlement tank to be disposed of in the landfill cells

Source: SYRINX

Funded by the Horizon 2020 Framework Programme of the European Union

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LANDFILL LEACHATE TREATMENT WETLAND SYSTEM

OBJECT INFORMATION

Name: Tianjin Qiaoyuan Park: The Adaptation Palettes
Type of facility: TW
Treated medium: reject water from garbage dump and shooting range
Description of the solution: The site had previously been a military shooting range and then a garbage dump, surrounded by slums and highways. Polluted urban runoff drained to and ponded on the site, with drainage further complicated by several connections between surface and groundwater. The soil was heavily contaminated and quite saline and alkaline, making it a challenging environment for plants. The facility manages urban runoff from offsite and reject water from garbage dump, improve the saline-alkali soil through natural processes, and allow rich patches of native vegetation to establish seasonally creating a unique, "messy" aesthetic experience.



GEOGRAPHICAL COORDINATES

Latitude: 39° 07' 26" N
Longitude: 117° 15' 24" E

LOCATION

Country: China
City: Tianjin
Type of climate: DWa
Average temperature: 13.3 °C
Sum of precipitation: 605mm

BASIC INFORMATION

Construction year: 2008
Constructor: Tianjin TEDA Eco-Landscape Development Co, Ltd
Source of financing: governmental
Total cost: 14 100 000$
Facility operator: Environment Construction and Investment Co, Ltd ; Tianjin city
Maintenance cost: 50 000 – 70 000$
Contact person: Kongjian Yu, (phone: +86-10-62745788)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_6- energy efficiency and recovery

BEFORE



AFTER



Source: landscapeperformance.org/case-study-briefs/tianjin-qiaoyuan-park-the-adaptation-palettes

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
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TECHNICAL DATA

Area of the facility: 220 000 m^2
Volume: around 6000 m^3
Efficiency and effectiveness: Soil pH dropped from 7.7 and now fluctuates around 7.2, and water pH levels dropped from 7.4. to 7 or less.
Operating experience: When compared to the typical cost of weeding, pruning, irrigating, and fertilizing a traditional park, the low-maintenance "bubbles" (wet and dry ponds) save nearly 19,000$ in maintenance costs each year.

ECOLOGICAL POTENTIAL

The natural resources contained in the facility are the source of ornaments and decorations. TW cleans the surface runoff water from the city, and the vegetation planted during the works purifies the air and increases the biodiversity of the area. It serves as a recreation destination for inhabitants.

ADVANTAGES

1. Sequesters an estimated 539 tons of carbon in the trees and plants on the site, a service valued at approximately 7200$.

DISADVANTAGES

1. Deep basins, some of them even up to 5 m deep, pose a risk of drowning for children.



Source: landscapeperformance.org/case-study-briefs/tianjin-qiaoyuan-park-the-adaptation-palettes

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

POST-INDUSTRIAL LEACHATE TREATMENT WETLAND SYSTEM

OBJECT INFORMATION

Name: Sydney Olympic Millennium Parklands
Type of facility: TW
Treated medium: post-industrial leachate
Description of the solution: The facility covers an area slightly larger than 4km^2 that was once home to various industrial uses and was contaminated with commercial and industrial waste. The site has set world standards for the innovative techniques devised to deal with massive quantities of both contaminated material and clean fill on site, integrate highly technical water recycling systems, and create an environment in which native plants can thrive. The resulting parklands, which were designed to be self-sustaining, reconnect residents of Sydney's western suburbs to its major waterway and provide recreational and educational opportunities for 2.5 million visitors annually.



GEOGRAPHICAL COORDINATES

Latitude: 33° 50' 22" S
Longitude: 151° 03' 57" E

LOCATION

Country: Australia
City: Sydney
Type of climate: Cfa
Average temperature: 18.0 °C
Sum of precipitation: 912mm

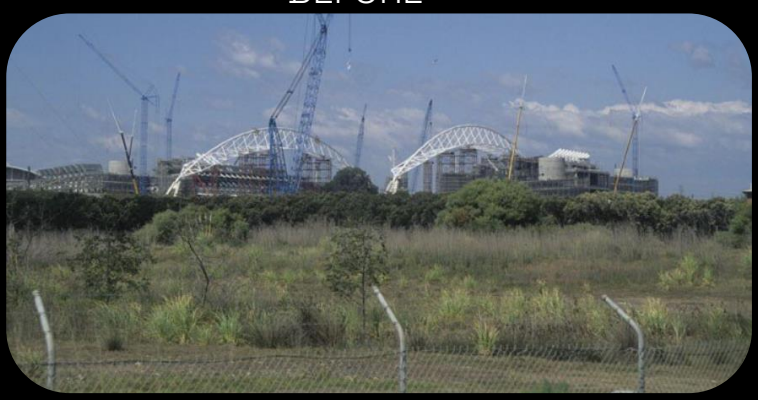
BASIC INFORMATION

Construction year: 2000
Constructor: OCA Olympic Coordination Authority
Source of financing: governmental funding
Total cost: 50 000 000 €
Maintenance cost: 75 000-100 000 €
Facility operator: OCA
Contact person: GIPA (ethics@dpie.nsw.gov.au)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_6- energy efficiency and recovery

BEFORE



AFTER



Source: landscapeperformance.org/case-study-briefs/sydney-olympic-millennium-parklands

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
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TECHNICAL DATA

Area of the facility: 4 km^2
Efficiency and effectiveness: Treats contaminated soils. Roughly 35 000m^3 of leachate have been collected and transferred to a waste treatment facility. Groundwater contaminated with 750 kg of hydrocarbons, including 430 kg of benzene, has been successfully degraded .
Recycled over 4 600m^3 of water over 7 years, for irrigation. Of total water consumption during this period, only 2% was sourced from Sydney's water supply despite one of the worst droughts in Australia's history.

ECOLOGICAL POTENTIAL

The site allows for the capture and treatment of surface runoff water that comes from the city, as well as the purification and use of surface water for plants irrigation in the park.
The park is home to many native species of animals and birds, whose numbers are constantly monitored. In addition, this facility is a meeting place for residents and a destination for tourists.

ADVANTAGES

1. Effective solution to the problem of the globe and groundwater containing hydrocarbons.

DISADVANTAGES

1. The constant need to monitor the hydrological situation, including the occurrence of flooding, as well as chemical and biological monitoring.



Source: landscapeperformance.org/case-study-briefs/sydney-olympic-millennium-parklands

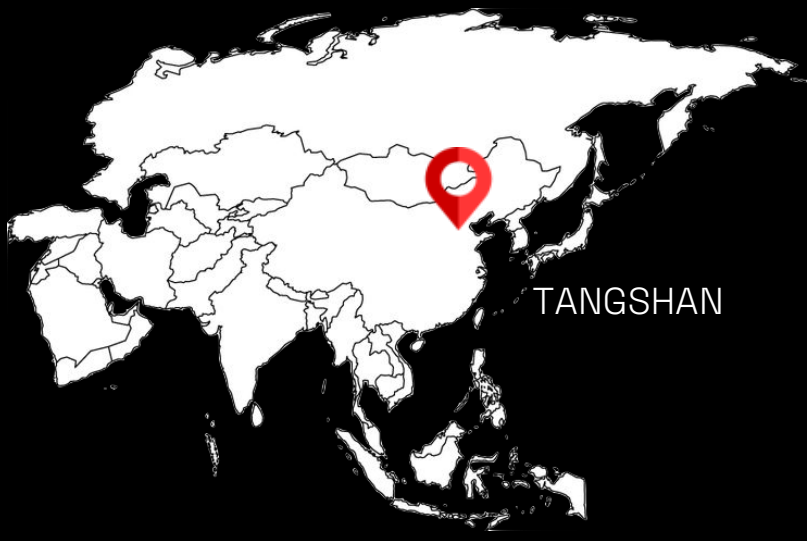
Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

POST-INDUSTRIAL LEACHATE TREATMENT WETLAND SYSTEM

OBJECT INFORMATION

Name: Tangshan Nanhu Eco-city Central Park
Type of facility: TW
Treated medium: post-industrial leachate
Description of the solution: The facility is a mine reclamation project, the former 6.3km^2 post-industrial area is now a dynamic public space, featuring recreational facilities, conservation areas. The former coal mining site was heavily polluted and damaged after a massive 1976 earthquake. The site became a safety hazard and was used largely as a city landfill and a sewage lagoon. In 2008, the reclamation project began. Using sustainable practices such as material reuse, surface runoff management, and wildlife habitat restoration, the project has fundamentally improved the environmental quality of Tangshan City and created a major new public recreational space, accessible to more than 10,000 residents within a 15 minute walk.



GEOGRAPHICAL COORDINATES

Latitude: 39° 35' 04" N
Longitude: 118° 07' 54" E

LOCATION

Country: China
City: Lunan Tangshan
Type of climate: DWa
Average temperature: 12.7 °C
Sum of precipitation: 566mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_4- material recovery and reuse
UCC_6- energy efficiency and recovery

BASIC INFORMATION

Construction year: 2009
Constructor: Tangshan Nanhu Eco-city Management Committee
Source of financing: governmental
Total cost: 68 000 000$
Facility operator: Tangshan Urban and Rural Planning Bureau
Annual maintenance: 15 000 - 20 000$
Contact person: Ming-Han Li (minghan@msu.edu)





Source: landscapeperformance.org/case-study-briefs/tangshan-nanhu-eco-city-central-park

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 6,3 km^2
Catchment: 30 km^3
Efficiency and effectiveness: Sequesters an estimated 2 828 tons of CO_2 annually in the trees of the park. Reduces potable water consumption by 29 200 000 m^3 annually by importing reclaimed water from a nearby sewage treatment plant. The reclaimed water is further treated in a series of TWs and used for water body recharge and irrigation in the park, saving about $15.4 million per year.

ECOLOGICAL POTENTIAL

The area where the NBS is located, is home to many animal species. Nearby wetlands treat post-mining leachate, which after treatment is used to irrigate the entire park. Altitude, wetlands and trees capture a huge amount of CO_2. It is a popular place for residents who spend their free time and relax.

ADVANTAGES

1. Saved $47.2 million in material costs by reusing 6 000 000 m3 of coal ash to produce foundations and bricks used in park construction.

DISADVANTAGES

1. The facility does not have biochemical monitoring. No analysis of the properties of the physicochemical medium. Danger to visitors.



Source: landscapeperformance.org/case-study-briefs/tangshan-nanhu-eco-city-central-park

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

www.nice-nbs.eu

NBS FOR COMBINED SEWER OVERFLOW

Type of object	Location	Name
French Reed Bed (FRB) ∑=1	Challex (France)	FRENCH REED BED FOR COMBINED SEWER OVERFLOW
Hybrid Treatment Wetland (HTW) ∑=2	Gorla Maggiore (Italy)	MULTISTAGE TREATMENT FOR COMBINED SEWER OVERFLOW
	Carimate (Italy)	MULTISTAGE TREATMENT FOR COMBINED SEWER OVERFLOW
Treatment Wetland (TW) ∑=1	Bergheim (Germany)	TREATMENT WETLAND FOR COMBINED SEWER OVERFLOW

FRENCH REED BED FOR COMBINED SEWER OVERFLOW

OBJECT INFORMATION

Name: French vertical-flow treatment wetland in France
Type of facility: FRB
Treated medium: surface runoff and WW in CSO
Description of the solution: The Challex WWTP, which is situated in the Rhône Alpes region of France, alongside the Rhône river, was commissioned in April 2010. The WWTP is composed of two VFTW. The first stage is composed of three parallel cells (861m^2 each) and receives raw wastewater (sludge and wastewater treatment) while the second stage is composed of two parallel cells (712.5m^2 each). All filters are 0.8 m deep.



BASIC INFORMATION

Construction year: 2010
Constructor: SCRIPE
Source of financing: no data available
Total cost: 1 847 000 €
Facility operator: no data available
Maintenance cost: 12 000 € / year
Contact person: Pascal Molle (pascal.molle@inrae.fr)

GEOGRAPHICAL COORDINATES

Latitude: 46° 10' 31" N
Longitude: 5° 59' 02" E

LOCATION

Country: France
City: Challex
Type of climate: Cfb
Average temperature: 9.7°C
Sum of precipitation: 1584mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_4- material recovery and reuse

ECOLOGICAL POTENTIAL

The content of water and plants has a positive effect impact on the microclimate. The TW system is also visually appealing. The plant also became part of the walkway of Challex residents.



Source: J. Bertrand-Krajewski et al. "Vertical-flow constructed wetlands for the treatment of wastewater and stormwater from combined sewer systems"

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae, plants, and animals -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

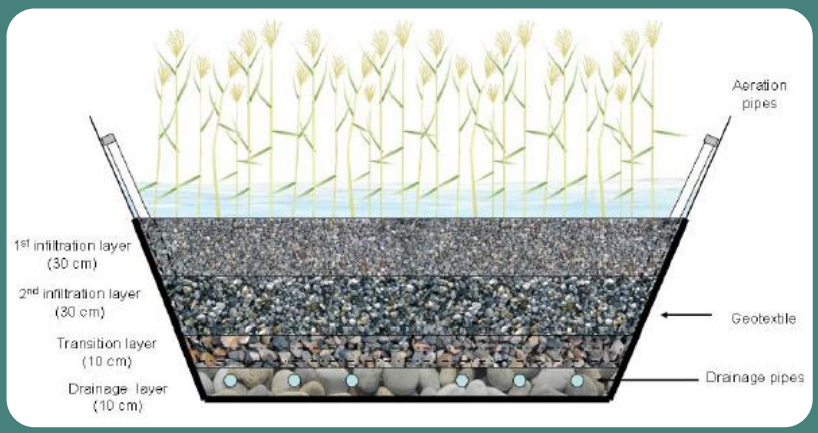
Area of the facility: 4000m^2
1st stage - 2580m^2 **2nd stage -** 1420m^2
Volume: 3 200 m^3
Primary design factors: 2000 PE
Catchment: 60 hectare
Efficiency and effectiveness: maximal 24h mean concentration for dry weather period: BOD_5= 25 mg/L; COD=90 mg/L; SS=35 mg/L; TKN=20 mg/L.
Operating experience: Batches are delivered at a flow rate of about 0.38 m³/h and 0.29 m³/h per m² to the first and second stage, respectively. Flow rate and batch volume are lower than the French guidelines (Molle et al. 2005a) which do not ensure good water distribution onto the filter surface (the system requires 20 to 50 mm of water at a minimal flow rate of 0.5 m³/h per m²).

ADVANTAGES

1. The facility is designed to avoid untreated overflow during rain events.

DISADVANTAGES

1. Requires regular maintenance such as plant harvest.





Source: J. Bertrand-Krajewski et al. "Vertical-flow constructed wetlands for the treatment of wastewater and stormwater from combined sewer systems"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

MULTISTAGE TREATMENT FOR COMBINED SEWER OVERFLOW

OBJECT INFORMATION

Name: CSO-TWs in Gorla Maggiore
Type of facility: HTW
Treated medium: surface runoff and WW in CSO
Description of the solution: The treatment system consists of a VSSF followed by a FWS-TW for polishing. Additionally, the use of green infrastructure allowed the abandoned poplar site to be converted into a park near the Olona River. Finally, the FWS-TW was designed also to work as a detention basin for flood mitigation and to increase biodiversity in the area.



BASIC INFORMATION

Construction year: 2014
Constructor: IRIDRA company
Source of financing: local funds- Lombardy Region
Total cost: 820 510 €
Facility operator: Gorla Maggiore Munipacility
Maintenance cost: 3500 € / year
Contact person: Anacleto Rizzo (rizzo@iridra.com)

GEOGRAPHICAL COORDINATES

Latitude: 45° 39' 53.9" N
Longitude: 8° 53' 09.7" E

LOCATION

Country: Italy
City: Gorla Maggiore, Lombardy
Type of climate: Cfa
Average temperature: 12.5 °C
Sum of precipitation: 1467 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_4- material recovery and reuse





Source: A. Rizzo „ Treatment wetland combined sewer overflow at Gorla Maggiore water park, Italy"

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
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TECHNICAL DATA

Area of the facility:
First stage VF - 3840m^2
Second stage FWS-TW - up to 7200m^2
Total - around 11 000m^2
Volume: 7 700m^3
Efficiency and effectiveness: Showed overall measured mean removal efficiencies of 87% and 93% for COD and NH_4^+, respectively.

ECOLOGICAL POTENTIAL

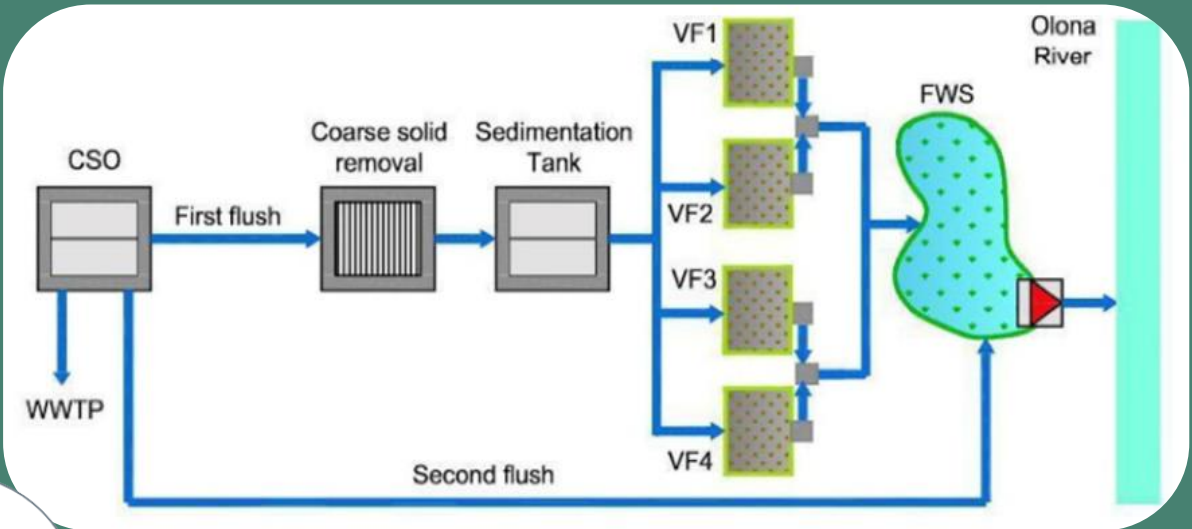
The FWS-TW stage was designed to support biodiversity. The presence of a surface water body resulted in a clear advantage in terms of biodiversity for the NBS, which received a score for support of wildlife of approximately 85%. It is a place of recreation for nearby citizens.

ADVANTAGES

1. NBSs allow the on-site treatment of CSO since traditional solutions are not suitable for this aim.
2. Approval of the people in the community, who use the new Water Park without any complaints.

DISADVANTAGES

1. FWS-TW only fed by CSO can face prolonged dry periods due to stochastic rainfall patterns. Therefore mosquito and odor issues may arise in the summer months.



Source: A. Rizzo „ Treatment wetland combined sewer overflow at Gorla Maggiore water park, Italy"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

MULTISTAGE TREATMENT FOR COMBINED SEWER OVERFLOW

OBJECT INFORMATION

Name: TW system of Carimate WWTP in Italy
Type of facility: HTW
Treated medium: surface runoff and WW in CSO
Description of the solution: The centralized WWTP of Carimate treats the wastewater from the CSO serving 11 towns in Como province (70,040 inhabitants). The CSO-TW is a 2 stage system.
The 1st stage comprises two VF TW beds, each one further divided into 2 separated hydraulic sectors for a total area of 8500m^2.
The 2nd stage is a free water surface (FWS) TW of 4500 m^2. The system is fed by a pumping system and automatically regulated by a PLC to properly treat the first more polluted fraction of the CSO events.



GEOGRAPHICAL COORDINATES

Latitude: 45° 41' 27.51" N
Longitude: 9° 7' 10.2" E

LOCATION

Country: Italy
City: Carimate
Type of climate: Cfa
Average temperature: 12.7°C
Sum of precipitation: 1467mm

BASIC INFORMATION

Construction year: 2018
Constructor: Sud Seveso Servizi spa
Source of financing: no data available
Total cost: 1 300 000 €
Facility operator: Sud Seveso Servizi spa
Maintenance cost: waste disposal for VF 8500m^2 = 500 € / year
Contact person: Anacleto Rizzo (rizzo@iridra.com)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_4- material recovery and reuse

Source: F. Massi et al. „Treatment of combined sewer overflow upstream centralized treatment plants with nature-based solutions: the constructed wetland system of Carimate WWTP"



ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: VF - 8500m^2 ; FWS 4500m^2
Volume: VF - 7650m^3; FWS - variable water depth around 3500m^3
Hydraulic and hydrological data:
Hydraulic load 1300 m^3/h.
Load of pollutants- 700 m^3/h
(104t COD/year; contained in about 890.000m^3/year)

ECOLOGICAL POTENTIAL

The maximum exploitation of TW ecosystem services is planned thanks to the FWS stage, which also aims to increase biodiversity and to recreate an area suitable for environmental educational activities. The riparian area along the left side of the Seveso river is planned to be involved in river restoration activities, with plantation of vegetation more suitable for riparian environments.

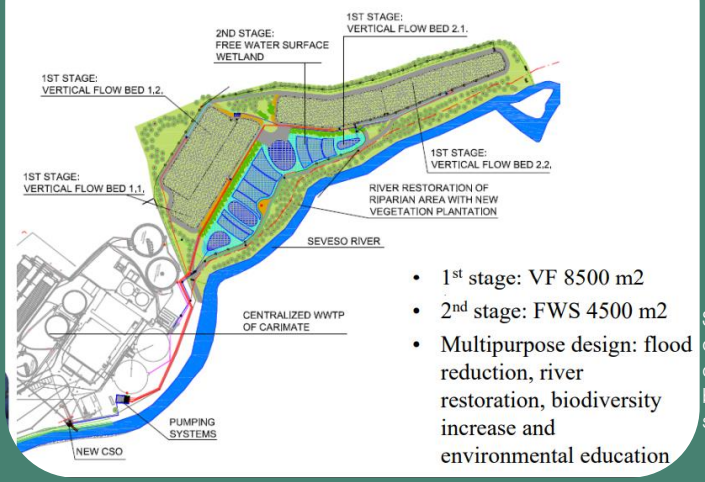
ADVANTAGES

1. In situ treatment of CSO, intercepting high pollutant loads.
2. The facility reduces diluted wastewater conveyed to centralized WWTPs.

DISADVANTAGES

1. The design of TW for CSO upstream WWTP requires profound care.

Design: CW configuration



Source: F. Massi et al. „Treatment of combined sewer overflow upstream centralized treatment plants with nature-based solutions: the constructed wetland system of Carimate WWTP"

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

TREATMENT WETLAND FOR COMBINED SEWER OVERFLOW

OBJECT INFORMATION

Name: Retentionsbodenfilter Kenten CSO Treatment Wetland in Germany
Type of facility: TW
Treated medium: surface runoff and WW in CSO
Description of the solution: The TW is situated after two retention tanks and is only charged when the overflow from the sewer network exceeds their capacity. The filter has a surface of 2,200 m^2 and is designed to treat up to 4,200 m^3 with a filtration velocity of 0.025 $L/s/m^2$. The minimum interval between two events is 36 hours. Located on the suburbs of the city, the facility treats the volume of water runoff from the fields of the Erft river basin. The presented wetland is one of the 36 objects that purify the surface runoff entering the Erft watercourse and is an important part of the hydrotechnical infrastructure in the area.



GEOGRAPHICAL COORDINATES

Latitude: 50° 51' 37" N
Longitude: 6° 44' 11" E

LOCATION

Country: Germany
City: Bergheim
Type of climate: Cfb
Average temperature: 10.7 °C
Sum of precipitation: 989 mm

BASIC INFORMATION

Construction year: 2006
Constructor: Erft Verband
Source of financing: governmental
Total cost: 820 510 €
Facility operator: IMT Atlantique
Maintenance cost: 8 000-10 000 €/year
Contact person: Katharina Tondera (info@katharina-tondera.de)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_4- material recovery and reuse



Source: Pinnekamp, J. „Betriebsoptimierung von Retentionbodenfiltern im Mischsystem.



Source: A.I „The role of constructed wetlands as green infrastructure for sustainable urban water managemnt"

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
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TECHNICAL DATA

Area of the facility: 2200 m^2
Volume: 4200 m^3
Dominant plant species: *Phragmites Australis*
Primary design factor:
- approximately inflow 1000 m^3/hour of CSO;
- minimum interval between two events is 36 hours
- filtration velocity of 0.027 L/s/m^2

ECOLOGICAL POTENTIAL

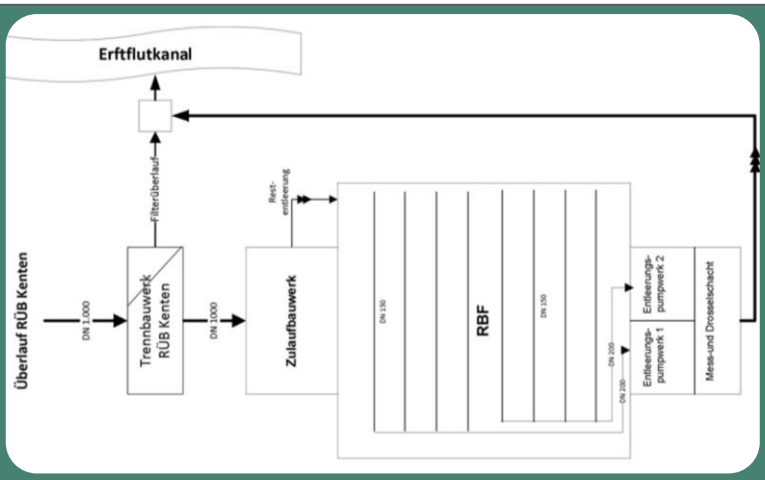
Wastes from the facility are used to grow plants. Moreover, the planted species of reeds develop the biodiversity. The facility improves the microclimate of the environment and captures biogenic and carbon compounds.

ADVANTAGES

1. This technology is currently the only one available to provide biological, biochemical and mechanical treatment of combined sewer overflows.
2. Retention of TSS (90%), COD (60–85%), nitrification of ammonium (60%) and indicator bacteria (1–3 log10) have been very well documented.

DISADVANTAGES

1. Risk of clogging in the hydraulic system of the running pump.
2. Difficulties to measure the physicochemical properties of the water infiltrate in the surface of the object due to the effect of the periodic drought.



Source: Pinnekamp, J. „Betriebsoptimierung von Retentionbodenfiltern im Mischsystem.

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

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URL PORTFOLIOS FROM NICE PROJECT

Medium category	Type of object	Location	Name
Domestic wastewater ∑=2	Hybrid Treatment Wetland (HTW) ∑=1	Aarhus (Denmark)	HYBRID TREATMEMT WETLAND
	Vertical Subsurface Flow Treatment Wetland (VSSF or VF) ∑=1	Talavera de ls Reina (Spain)	VERTICAL SUBSURFACE FLOW TREATMENT WETLAND
Greywater / Greywater + Direct of rainfall ∑=4	Vertical Subsurface Flow Treatment Wetland (VSSF or VF) ∑=1	Algeciras (Spain)	VERTICAL SUBSURFACE FLOW TREATMENT WETLAND
	Hybrid Treatment Wetland (HTW) ∑=1	Madrid (Spain)	HYBRID TREATMENT WETLAND
	Living walls (LW) ∑=2	Turin (Italy)	LIVING WALL FOR GREYWATER REUSE
		Benalmádena (Spain)	LIVING WALL FOR GREYWATER REUSE
Surface runoff ∑=1	Rain Garden (RG) ∑=1	Gdańsk (Poland)	RAIN GARDEN 2.0 FOR STREET RUNOFF
Surface water ∑=1	Hybrid Treatment Wetland (HTW) ∑=1	Cairo (Egypt)	HYBRID TREATMENT WETLAND
Combined sewer overflow (CSO) ∑=1	Treatment Wetland (TW) ∑=1	Lyon (France)	TREATMENT WETLAND FOR COMBINED SEWER OVERFLOW

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003765.

HYBRID TREATMENT WETLAND

OBJECT INFORMATION

Name: Hybrid treatment wetland for domestic wastewater
Type of facility: VSSF + HSSF
Treated medium: domestic wastewater
Description of the solution:
This hybrid TW use the sophisticated aeration system that is based on injecting nano-bubbles. It analyses how different plant exudates interfere in the contaminant removal performance. The five different media were tested in order to analyse its removal efficiency. These different medias include those using natural materials such as biochar.
Each have similar setups:
-hybrid VSSF and HSSF TW
-different materials are tested (graded coarse sand, non-woven geotextile), and different plant species *(Phragmites, Australis*, and *Iris pseudacorus*).



GEOGRAPHICAL COORDINATES

Latitude: 56°07'31.4"N
Longitude: 10°08'35.1"E

LOCATION

Country: Denmark
City: Aarhus
Type of climate: Cfb
Average temperature: 9°C
Sum of precipitation: 700 mm

URBAN CIRCULARITY CHALLENGES

UCC_2- water and waste treatment, recovery, and reuse



BASIC INFORMATION

Construction year/put to use year: 2023
Constructor: NA (Its an experimental unit constructed by Aarhus University)
Source of financing: NICE, EU project
Total cost: NA (The cost of construction does not represent real costs associated with a real wetland. This is due to the installation of equipment and pipes used to take water samples, but also due to flow and pollutant monitoring.
Facility operator: Aarhus University
Maintenance cost: NA
Contact person: Emil Jespersen (emil@bio.au.dk) , Carlos A. Arias (carlos.arias@bio.au.dk)

Source: NICE project

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae and plants -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of facility: ~20 m^2
Volume: ~10 m^3
HLR: 8-32 cm per day
Efficiency and effectiveness of facility:
Removal of: COD, BOD_5 and TOC- 0-90%, TN- 30-50% (depending in the operational mode and the conditions for NOx removal), TP- 10-30% , TSS higher than 90% (ranges of removal are provided as its experimental unit, where we tested different HLR resulting in different removal rates). Higher removal rates are associated with lower HLR. Additionally, the selection of the filling media will have an effect in the removal of TSS as well as the removal of pathogen indicators but increasing the risk of clogging. The performance of the unit has been satisfactory and able to comply with the discharge demands (except for P), but additional strategy for P removal must be established. Either by chemical precipitation or specific media for P retention.

ECOLOGICAL POTENTIAL

The hybrid TW tested can remove a broad range of pollutants from water, resulting in the production of cleaner water favoring the protection of environment, increasing biodiversity and achieving additional services of the production of water of better quality.

ADVANTAGES

1. An experimental unit provides detailed spatial info on removal processes (depth variation, media and plant selection but also different types of flow, pollutant loadings and water volume saturation in the reactors).

DISADVANTAGES

1. As the system is experimental and since the experiment has demanded operational changes, it requires continuous maintenance and changes in loadings and sample collection. In a real, upscaled system, the maintenance requirement is minimum and therefore resulting in more affordable technology in terms of O and M.

Source: NICE project

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

VERTICAL FLOW SUBSURFACE TREATMENT WETLAND

OBJECT INFORMATION

Name: Vertical Flow Treatment Wetland
Type of facility: VSSF
Treated medium: municipal wastewater
Description of the solution: The project consists in the construction of intensified vertical flow artificial wetland, testing different designs to treat wastewater.
- Unsaturated-saturated: configuration that used superimposed layers, a water-unsaturated (aerobic) top layer built with sand, and a water-saturated (anoxic) bottom layer built with gravel. Aerobic conditions were maintained in the water-unsaturated layer using a series of pipe networks as a transition layer. Recirculation in the top later.
- Forced bed aeration unsaturated-saturated: configuration that presented a similar design, but aerobic conditions in the water-unsaturated layer were further improved by injecting air using a blower. Internal recirculation.
- Bioelectroconductive forced bed unsaturated-saturated: presented a similar design, but the water-unsaturated layer was built with a bioelectroconductive material (coke) to enhance ammonium removal. Also incorporates fan blowers and internal recirculation.



TALAVERA DE LA REINA

GEOGRAPHICAL COORDINATES

Latitude: 39°55'3"N
Longitude: 4°52'44"W

LOCATION

Country: Spain
City: Talavera de la Reina
Type of climate: Csa
Average temperature: 15°C
Sum of precipitation: 550mm

BASIC INFORMATION

Construction year/put to use year: 2024/2025
Constructor: FABRICADOS EN POLIESTER ROBLEPOL,SL/GLOBAL EI, S.L./ROJOGA CONSTRUCCIONES, S.L.
Source of financing: This project has received funding from the European Union's Horizon 2020 Research and Innovation Program under grant agreement 101003765.
Total cost: 50.000,00 €
Facility operator: Aqualia service
Maintenance cost: approximately 3.000,00 € per year
Contact person: Zouhayr Arbib
zouhayr.arbib@fcc.es

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery



Source: NICE project

ECOSYSTEM SERVICES ACCORDING TO CICES

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TECHNICAL DATA

Area of the facility: 20m^2
Catchment area: collection of urban wastewaters coming from a Talavera de la Reina city (pop. 80.000) and nearby peripheral rural areas (pop. 2000). The deposit can uphold up to 2 m^3 of pretreated wastewater.
Volume: The TW can treat a total volume of up to 1.1 m^3 per day.
Efficiency and effectiveness of facility:
The 90-99% removal of organic matter, solids and ammonia nitrogen. Nitrate removal is still poor, but enough to meet discharge requirements.
Operating experience:
-Low-to-mid energy consumption: 0,15-0,20 kWh/m^3
-Mid surface requirements: 1.0-1.2 m^2 per PE

ECOLOGICAL POTENTIAL

The vegetation (*Phragmites australis*) offers aesthetic value to the treatment plant facility. The pilot also enhances the landscape and contributes to urban beautification. The wetland treats wastewater using natural filtration and plant-based processes.

ADVANTAGES

1. Fed with pretreated wastewater (grid).
2. Resilience against variations in hydraulic loading rates, organic loading rates and temperatures.
3. Integrated sludge management and treatment.
4. No pumping required, feeding can be performed by gravity (if conditions are met).
5. Aerobic treatment of wastewater (thus, no odor problems).
6. Simple operation, non-skilled workers required.

DISADVANTAGES

1. Feeding strategy is only through pulses, thus a high flowrate must be maintained.
2. Arids costs and transports can be high as only a few suppliers are available worldwide.
3. Recirculation is needed to further improve nitrogen removal (thus, energy consumption through pumps).

Source: NICE project

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

VERTICAL FLOW SUBSURFACE TREATMENT WETLAND

OBJECT INFORMATION

Name: Mixed Multi-Stage TW
Type of facility: VSSF
Treated medium: greywater and surface runoff
Description of the solution: The system is located in the Bay of Algeciras, next to the IES Torre Almirante educational institute.
The system consists of a one shallow basin (85 m2) divided into two interconnected filtering areas.
Greywater filtration zone (15 m2) functions as a VF artificial wetland, where influent water intermittently flows across stratified substrates of sand and gravel. The area is covered with *Equisetum hyemale* and *Iris sibirica*, well adapted to constant moisture. At the bottom of the basin, water flows horizontally towards the second area.
Rainwater filtration zone (70 m2) also operates as a VF artificial wetland, where surface runoff collected in a storage tank intermittently floods the surface and percolates across stratified substrates of sand and gravel towards the bottom. The area is covered with *Cyperus papyrus, Carex spp.*, and *Miscanthus sinensis*, well adapted to water flow changes.
Treated water is then moved towards collection.



GEOGRAPHICAL COORDINATES

Latitude: 36°08'50"N
Longitude: 5°26'45"W

LOCATION

Country: Spain
City: Algeciras
Type of climate: CSa
Average temperature: Summers are hot and dry with highest temperature near 28°C, while winters are mild, with temperatures averaging around 11°C.
Sum of precipitation: 850 mm

BASIC INFORMATION

Construction year/put to use year: 2023/2025
Constructor: Orión agua y depuración, S.L.
Source of financing: Funding from the European Union's Horizon 2020 Research and Innovation Program under grant agreement 101003765.
Total cost: 114.742,00 €
Facility operator: Aqualia service
Maintenance cost: Approximately 3.500,00 € per year
Contact person: Zouhayr Arbib
zouhayr.arbib@fcc.es

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery and reuse
UCC_5- food and biomass production
UCC_6 – Energy efficiency and recovery
UCC_7- building system recovery



Source: NICE project

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae and plants -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 85 m^2
Catchment area:
-rainwater: drainage systems, which collect surface runoff from the surrounding urban area of TW
-greywater: the IES Torre Almirante, mostly from sinks and showers
Volume: 35 m3/d (rainwater) & 2 m3/d (greywater)
Instant flow rate: of 0.5 m3/h (rainwater tank),
Hydraulic loading rate: was calculated based on a maximum of 100m/year,
Evapotranspiration: round 2 cm/day and is balanced by a constant inflow of greywater
Efficiency and Effectiveness: 84% of solids are removed and 44% of COD is consumed. Nutrient removal is poor (influent is very diluted), but enough to achieve less than 1,0 mg/L in the effluent. Some pathogens (1-log) and acetaminophen (94%) are also eliminated.
Operating experience: Pilot has been under full operation since February 2025. Loading variations of water quality, caused by school breaks during summer and winter months, limits knowledge on full nutrient removal capacity.

ECOLOGICAL POTENTIAL

The TW contributes to restoration of the urban water balance by enabling infiltration, evapotranspiration and delayed drainage of rainwater, compensating for the sealed surfaces typical of urban areas.
By treating rainwater and greywater, pressure on drainage networks and natural water bodies are reduced. Although the treated water is not reused directly, the process supports safe reintegration into the environment.



ADVANTAGES

1. Vegetation resilience against variations in hydraulic and organic loading rates, temperatures
2. Integrated sludge management and treatment
3.Low energy consumption: 0 - 0,15 kWh/m3
4. No pumping required, feeding can be performed by gravity
5. Aerobic treatment of wastewater (no odor problems)
6. Simple operation and excellent landscape integration

DISADVANTAGES

1. Great surface area requires (more than 1-2 m2 per PE)
2. Feeding strategy is only through pulses, thus a high flowrate must be maintained
3. Arids costs and transports can be high as only a few suppliers are available worldwide

Source: NICE project

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HYBRID TREATMENT WETLAND

OBJECT INFORMATION

Name: Multi-Stage Treatment Wetlands for greywater treatment
Type of facility: HTW
Treated medium: greywater
Description of the solution:
The TW is located at the back of FCC Aqualia Headquarters in Las Tablas, Madrid. The system consists of two shallow basins.
The first basin (15 m2) consists of a single-stage, hybrid flow artificial wetland divided into two filtering areas.
Filtration zone 1 acts as a VF artificial wetland, where influent greywater intermittently flows across stratified substrates of sand and gravel. The area is covered with *Cyperus papyrus* and *Equisetum hyemale*, well adapted to constant moisture. At the bottom of the basin, water flows horizontally towards the second area.
Filtre zone 2 acts as a HF artificial wetland, where greywater continues its path until the disinfection unit. The area is covered with *Rosmarinus officinalis* and *Stipa tenuissima,* to give a natural and pleasant appearance.
The second basin (15 m2) functions as as a garden area, where treated greywater is used for irrigation of endemic ornamental plant species.



GEOGRAPHICAL COORDINATES

Latitude: 40°30'23"N
Longitude: 3°40'15"W

LOCATION

Country: Spain
City: Madrid
Type of climate: Csa
Average temperature: Winters are relatively cool, with temperatures averaging around 6°C, while summers are hot, with highs often reaching 32-34°C.
Sum of precipitation: 450 mm

BASIC INFORMATION

Construction year/put to use year: 2024/2025
Constructor: Energiza Instaladores S.L., Electricidad EUFON, S.A.,
Source of financing: This project has received funding from the European Union's Horizon 2020 Research and Innovation Program under grant agreement 101003765.
Total cost: 185.000,00 € (including segregation of greywater)
Facility operator: FCC Aqualia HQ
Maintenance cost: approx. 3.000,00 € per year
Contact person: Zouhayr Arbib
zouhayr.arbib@fcc.es

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery



Source: NICE project

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae and plants -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 30 m²
Volume: 2 m^3 per day
Hydraulic and hydrological data:
-subsurface permanent water column of 0.2 m, Pumps are dimensioned to deliver an instant flowrate of 3.9 m^3/h, based on a design hydraulic loading rate of 0.375 $m^3/m^2/d$.
Efficiency and effectiveness of facility:
97% of solids are removed and 68% of COD is consumed. Nutrient removal is poor as influent is very diluted. Pathogens are completely eliminated (ClO2 disinfection unit). 94% of acetaminophen is greatly eliminated.
Operating experience: Pilot has been under full operation since June 2025. Loading variations of water quality, especially during summer and winter months, limits knowledge on full nutrient removal capacity.

ECOLOGICAL POTENTIAL

Beyond water treatment, the facility contributes to the urban landscape, encourages community awareness of sustainable practices, and provides educational opportunities for visitors. Its effectiveness lies not only in water management, but in promoting urban resilience and environmental education.



ADVANTAGES

1. Resilience against variations in hydraulic loading rates, organic loading rates and temperatures.
2. Integrated sludge management and treatment.
3. Low energy consumption: 0 - 0,15 kWh/m^3.
4. Aerobic treatment of wastewater.
5. Simple operation, non-skilled workers required.
6. Excellent landscape integration.

DISADVANTAGES

1. Great surface area requires (more than 1-2 m2 per PE).
2. Feeding strategy is only through pulses, thus a high flowrate must be maintained.
3.Arids costs and transports can be high as only a few suppliers are available worldwide.

Source: NICE project

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

LIVING WALL FOR GREYWATER REUSE

OBJECT INFORMATION

Name: LW at Cecchi Point
Type of facility: LW
Treated medium: greywater
Description of the solution: The system uses a modular structure with 8 modules, each containing 3 rows of 4 pots. Greywater is treated through a vertical filtration system using a mixed substrate of coconut fiber, LECA, and sand.



BASIC INFORMATION

Construction year /put to use year: 2024
Constructor: IRIDRA Srl (design and technical supervision), local contractors for construction
Source of financing: H2020 NICE Project, European Commission funds
Total cost: Approximately €30,000
Facility operator: Municipality of Turin, managed by the NGO Il Campanile Onlus
Maintenance cost: €1000 - €1500
Contact person: IRIDRA (rizzo@iridra.com; masi@iridra.com), POLITO (fulvio.boano@polito.it; elisa.costamagna@polito.it)

GEOGRAPHICAL COORDINATES

Latitude: 45°05'08.4"N
Longitude: 7°40'55.2"E

LOCATION

Country: Italy
City: Turin
Type of climate: Cfa
Average temperature: 13°C
Sum of precipitation: 950 mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_7- building system recovery



Source: NICE project

ECOSYSTEM SERVICES ACCORDING TO CICES			
Section	Provisioning	Regulation & Maintenance	Cultural
Class	ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific -Characteristics of living systems that enable education and training investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 6.5 m² (1.8 m width, 3.6 m height)
Catchment area: GW from 2 restrooms (washbasins only)
Volume: Design max treatment capacity of 0.5 m³/d (average 0.25 m³/d)
Flow rate: 0.01 – 0.09 m³/d
Hydraulic loading rate: 6-49 L/m²d;
Retention time: Intermittent, based on 1-8 daily flushes (15 minutes per flush)
Efficiency and Effectiveness:
Average *E. coli* removal exceeded 99%, with Legionella and Salmonella never detected. Stable nitrogen removal was observed, while early monitoring showed temporary increases in TSS, COD, BOD_5, and TP at the outlet due to substrate start-up effects. System performance improved progressively as stabilization was achieved.
Operating experience:
The system proved effective for decentralized greywater treatment in an urban setting, while also supporting biodiversity and educational activities. Initial challenges related to coconut fiber substrate leaching were managed through adaptive operation, including washing and polishing measures, leading to improved effluent quality and providing valuable guidance for future implementations.

ECOLOGICAL POTENTIAL

The LW effectively contributes to local water recycling, supports urban farming, and enhances building resilience by integrating vegetation into the facade.



ADVANTAGES

1. Provides decentralized greywater treatment, supports urban biodiversity, offers educational and demonstration opportunities.

DISADVANTAGES

1. Initial substrate leaching (coconut fibers), requiring system stabilization.

Source: NICE project

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

LIVING WALL FOR GREYWATER REUSE

OBJECT INFORMATION

Name: Living wall
Type of facility: LW
Treated medium: greywater
Description of the solution:
The installation area of the project is approximately 31 m^2, located in the office of Aqualia water utility service in the city of Benalmadena. The project consists of the construction of a LW designed to treat greywater coming from the office building.
The system is built on the façade of the building, supported by a galvanized steel structure for durability. As part of the landscape integration, low maintenance plants with a green-blue-white palette has been planted to mimic Aqualia corporate identity and give a natural and pleasant appearance. These plants include *Vinca minor*, *Cerastium tomentosum*, *Hedera algeriensis*, *Carex comans*, *Carex flacca*, *Festuca glauca*, *Rosmarinus officinalis*, *Senecio cineraria*, *Hebe pinguifolia*, *Hebe*, *Gentiana acaulis*, and *Pulmonaria officinalis*.



GEOGRAPHICAL COORDINATES

Latitude: 36°36'3"N
Longitude: 4°32'16"W

LOCATION

Country: Spain
City: Benalmadena
Type of climate: Csa
Average temperature: Winters are mild (≈13°C), while summers are warm to hot, with July and August highs of 28-30°C
Sum of precipitation: 400-475 mm

BASIC INFORMATION

Construction year/put to use year: 2025/2025
Constructor: AGROJARDIN OBRAS Y PROYECTOS S.L. / TERAPIA URBANA S.L.
Source of financing: This project has received funding from the European Union's Horizon 2020 Research and Innovation Program under grant agreement 101003765.
Total cost: 20.000,00 €
Facility operator: Aqualia service
Maintenance cost: aprox. 1.500,00 € per year
Contact person: Zouhayr Arbib
zouhayr.arbib@fcc.es

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_5- food and biomass production
UCC_6- energy efficiency and recovery
UCC_7- building system recovery



Source: NICE project

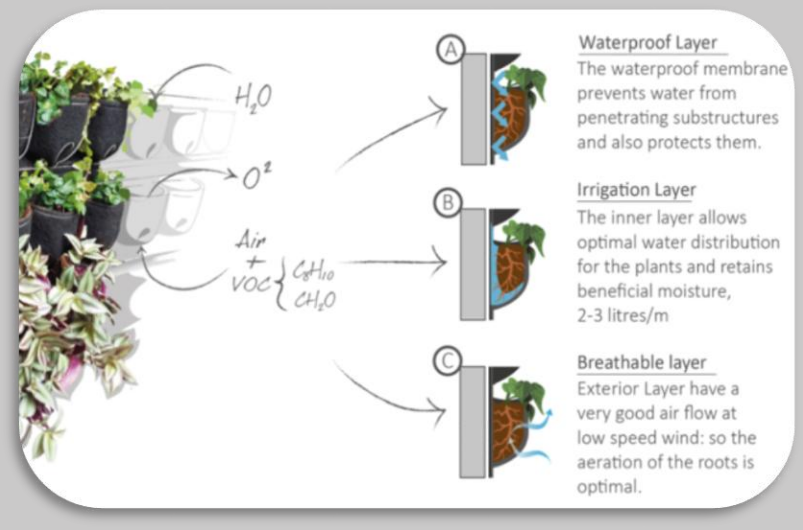
ECOSYSTEM SERVICES ACCORDING TO CICES			
Section	Provisioning	Regulation & Maintenance	Cultural
Class	ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific -Characteristics of living systems that enable education and training investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 31 m^2
The catchment area: includes the drainage system of greywater, mostly from sinks, connected directly to the LW through a line.
Volume: 1-3 m^3 per day, (1-2 m^3 in winter, 2-3 m^3 in summer)
Efficiency and effectiveness of facility: The facility functions effectively through a combination of engineered infrastructure and ecological processes. The integration of textile modular pockets, which increases root oxygenation and improves irrigation distribution by combining different layers of soil with plants, allows for consistent operation, even during dry periods or fluctuating flow conditions. Once water is fed to the plant, treatment relies on passive biological and physical processes, helping reduce energy consumption after pumping.
Operating experience: Due to the pilot-scale nature of the system, operational experience remains limited.

ECOLOGICAL POTENTIAL

The LW treats greywater and rainwater using natural filtration and plan-based processes. The vegetation *(Cyperus papyrus, Lantana sellowiana, Iris sibirica)* offers aesthetic value and may be used ornamentally. The facility enhances the landscape and contributes to urban beautification.



ADVANTAGES

1. Space Optimization.
2. Thermal and Acoustic Benefits.
3. Air Quality Improvement.
4. Aesthetic Enhancement.
5. Modular and Lightweight Design.
6. Efficient Irrigation.
7. Biodiversity Support.

DISADVANTAGES

1. Initial Cost.
2. Maintenance Requirements.
3. Structural Considerations.
4. Water and Energy Use.
5. Plant Selection Limitations.
6. Potential for Pests and Diseases.

Source: NICE project

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

RAIN GARDEN 2.0 FOR STREET RUNOFF

OBJECT INFORMATION

Name: Rain garden at the Gdańsk University of Technology
Type of facility: RG
Treated medium: surface runoff
Description of the solution: The RG has a capacity of over 11 m³ and collects surface runoff from an internal road at Gdańsk University of Technology. It consists of several functional zones – beginning with the inlet zone, where the energy of incoming water is dissipated, followed by sedimentation and sorption sections, and finishing in a retention basin planted with over 1100 hydrophytic plants. This structural configuration enables effective retention of pollutants including organic, mineral, and traffic-related contaminants. Three distinct sorptive materials were applied, selected based on their capacity to remove a broad spectrum of pollutants.



GEOGRAPHICAL COORDINATES

Latitude: 54°22'10.19" N
Longitude: 18°37'4.79" E

LOCATION

Country: Poland
City: Gdańsk
Type of climate: Cfb
Average temperature: 9 °C
Sum of precipitation: 511 mm

BASIC INFORMATION

Construction year /put to use year: 2023
Constructor: Gdańskie Wody
Source of financing: NICE
Total cost: 30 000 € (included design and construction)
Facility operator: Gdańsk University of Technology
Maintenance cost: 600 € per year
Contact person: Magdalena Gajewska (mgaj@pg.edu.pl) or Agnieszka Kowalkiewicz (a.kowalkiewicz@gdanskieowdy.pl)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_7- building system recovery





Source: NICE project

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific -Characteristics of living systems that enable education and training investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of the facility: 90 m^2
Volume: 11 m^3
Catchment: 540 m^2
Efficiency and effectiveness: The facility fulfills the assumed functions of flood protection, drainage and purification
Dominant plant species: *Hedera helix, Hemerocaliss hybrida , Bergenia cordifolia*

ECOLOGICAL POTENTIAL

RG 2.0 enhances biodiversity by providing habitat for pollinators and various microorganisms. It also supports local microclimate regulation via vegetation-driven processes such as evaporation and transpiration, mitigating urban heat island effects. The system treats surface runoff and delivers multiple ecosystem services, including water retention, air purification, and noise reduction.

ADVANTAGES

1. Effective retention and infiltration of surface runoff, reducing the risk of flash flooding.
2. Treatment of runoff through the removal of pollutants.
3..Enhancement of biodiversity.
4. Local microclimate regulation.
5. Aesthetic improvement of urban space through green infrastructure integration.

DISADVANTAGES

1. Requirement for regular maintenance and performance monitoring.
2. Limited hydraulic capacity – insufficient as a standalone solution under extreme precipitation events.
3. Treatment efficiency dependent on the proper selection and condition of sorptive / filter.



Source: NICE project

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

HYBRID TREATMENT WETLAND

OBJECT INFORMATION

Name: Treatment Wetland for Nile River Environmental Improvement
Type of facility: HTW
Treated medium: Surface water
Description of the solution:
This system is composed by a hybrid treatment wetland. In addition to the TW itself, the system included the selection of a specific kind of vegetation (*Cyperus papyrus*) which is endogenous and has been scientifically proven over the last years to be highly efficient in removing a number of common contaminants that are present in waste water, especially heavy metals. The entire system helps to remove heavy metals, cations and anions. Pottery drippers reduce the concentration of heavy metals and water salinity. An important point for the system is that the materials' local substrate were utilised, mitigating the CO2 footprint of material transport.

BASIC INFORMATION

Construction year/put to use year: 2022/2023
Constructor: Prof Mohamed Elhagarey, Desert Research Center, DRC, Cairo, Egypt
Source of financing: Project, INNOVATIVE AND ENHANCED NATURE-BASED SOLUTIONS FOR SUSTAINABLE URBAN WATER CYCLE, NICE, H2020, EU
Total cost: 21000 €
Facility operator: Prof Mohamed Elhagarey, Desert Research Center, Cairo, Egypt.
Maintenance cost: 340 € per year
Contact person: Prof. Mohamed Elhagarey (elhagarey@gmail.com)





GEOGRAPHICAL COORDINATES

Latitude: 30° 14' 26.7"N
Longitude: 31°30'44.6"E

LOCATION

Country: Egypt
City: Cairo
Type of climate: BWh
Average temperature: 23° C
Sum of precipitation: 10mm

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_7- building system recovery



Source: NICE project

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae and plants -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of facility: two basins (10 X 10 Meters)
Catchment area: 200 M^2
Volume: more 100 m^3 for one basin
Flow: 15 m^3/day,
Water retention: 48 hours
Efficiency and effectiveness of facility:
TW effectively removes organic pollutants, suspended solids, nutrients (NO_2^-, NO_3^-, NH_4^+), and heavy metals such as Fe and Mn.
The system significantly reduces microbial contaminants such as *E. coli* and *Salmonella*, enhancing sanitary safety.

ECOLOGICAL POTENTIAL

TW enhances nutrient cycling, especially nitrogen and phosphorus dynamics.
Provides habitat and ecological refuge for microorganisms, insects, and small fauna. Maintains ecological processes necessary for ongoing water purification and biomass production.

ADVANTAGES

1. Bioremediation the polluted water with mini applied Energy.
2. Ecosystem where provides green landscape and fresh water.
3. The a fordable costs of operating, maintaining and construction systems.
4. The long lifespan of wetland constructions.
5. Removing the pathogen such as C*oli* and *Salmonella.*
6. Reduce the GHG comparing with the other artificial approaches of water treating.
7. Introduce a sheep fresh healthy water for poultry and animal production.

DISADVANTAGES

1. The used land for wetland constrictions.
2. The Lack of standard diameters for natural filtration media in some countries (sand – gravel).
3. The lack of wetland knowledge of most farmers.

Source: NICE project

Funded by the Horizon 2020 Framework Programme of the European Union

This document was prepared as a part of NICE Project by the technical team from Gdansk University of Technology

TREATMENT WETLAND FOR COMBINED SEWER OVERFLOW

OBJECT INFORMATION

Name: Treatment wetland at research platform facility
Type of facility: TW
Treated medium: CSO
Description of the solution:
The pilot is based on the hidr'epur solution. This entails incorporating Forced Aeration and also, to implement reactive materials. It is obviously functioning for both storm water run-off and CSO. Filtration happens through 3 main layers:
-filtering layer (composed by unsaturated gravel)
-transiton layer (saturated and composed by medium sized gravel)
-drainage layer,
enhancing the removal of pollutants and sediments.



LOCATION

Country: France
City: Lyon
Type of climate: Cfb
Average temperature: The average temperature in winter is about 5 °C with minimum temperature until – 5°C, while the average temperature in summer is about 23 °C) with peaks above 35 °C.
Sum of precipitation: 830 mm

GEOGRAPHICAL COORDINATES

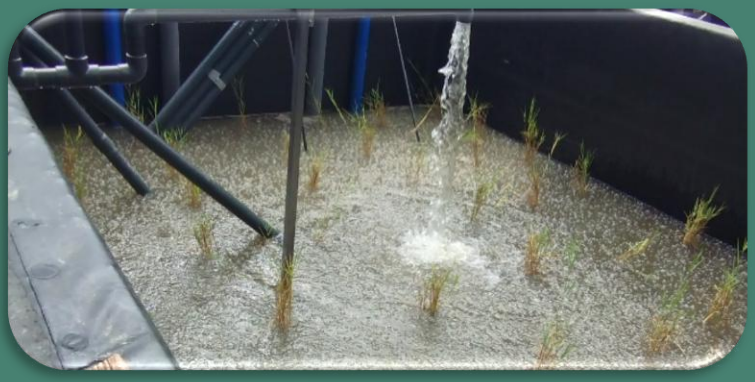
Latitude: 45° 44′ 11.78″ N
Longitude: 4° 43′ 3.37″ E

BASIC INFORMATION

Construction year/put to use year: 2022/2023
Constructor: INRAE
Source of financing: Project, NICE, H2020, EU
Total cost: 20 000 €
Facility operator: INRAE.
Maintenance cost: 400 € per year
Contact person: Pascal Molle, (pascal.molle@inrae.fr)

URBAN CIRCULARITY CHALLENGES

UCC_1- restoring and maintaining the water cycle
UCC_2- water and waste treatment, recovery, and reuse
UCC_3- nutrient recovery and reuse
UCC_5- food and biomass production





Source: NICE project

ECOSYSTEM SERVICES ACCORDING TO CICES

Section	Provisioning	Regulation & Maintenance	Cultural
Class	BIOTIC: -Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials) ABIOTIC: -Surface water used as a material (non-drinking purposes)	BIOTIC: -Bio-remediation by micro-organisms, algae and plants -Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals -Smell reduction -Hydrological cycle and water flow regulation (Including flood control, and coastal protection) -Disease control -Regulation of the chemical condition of freshwaters by living processes -Regulation of temperature and humidity, including ventilation and transpiration ABIOTIC: -Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	BIOTIC: -Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions -Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge -Characteristics of living systems that enable education and training -Characteristics of living systems that enable aesthetic experiences

TECHNICAL DATA

Area of facility: 20 m²
Catchment area: not relevant (research facility)
Volume: 24 m^3
Flow: until 30 m^3/ event
Hydraulic water retention time: 8 hours
Efficiency and effectiveness of facility:
Average removal efficiency:
-Suspended Solids (SS)- 96%
-Chemical oxygen demand (COD)- 88%
-Ammonia N-NH_4- 74%
-TN- <20
-Phosphorus (P)- <20

ECOLOGICAL POTENTIAL

Overflow treated in TW positively influence on the freshwaters. The strong hydraulic buffer capacity of the TW system allows decreasing flooding and the impact on river banks. The CSO TW use less resources than concrete storage/release retention basin and has a lower environmental impact. TW provides habitat and ecological refuge for microorganisms, insects, and small fauna.

ADVANTAGES

1. High aerobic treatment and filtration capacity, Robust to load variations.
2. Lower (5 times) investment and operational costs than grey infrastructure (storage/release concrete basins) .
3. Reduce environmental impact by minimizing untreated overflows on the waterbodies.
4. Provides green landscape and fresh water.
5. The long lifespan of wetland constructions.
6. Allows reuse opportunity if a final disinfection step is added.

DISADVANTAGES

1. Need of land for implementation (maximum 2 m of water ponding on the top).
2. The need of electricity (aeration) compared to passive CSO TW.
3. The need of dissemination to decision makers to favor CSO wetland implementation.

Source: NICE project

Funded by the Horizon 2020 Framework Programme of the European Union

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