WATER REUSE

STRATEGY

Collecting and treating greywater or mixed wastewater for reuse in irrigation, non-potable building uses, or even potable reuse, results in significant drinking water savings. Reuse can also alleviate pressure on existing sewage infrastructures by reducing the volume of wastewater produced. Implementing water reuse can contribute credits, via water savings and supporting blue-green infrastructure, to attain green building certificates. For holistic water management solutions, water reuse is best integrated with water efficient fixtures, rainwater harvesting, and heat recovery. Cities like Melbourne, San Francisco, and Barcelona are pioneering legislative frameworks enabling widespread on-site water reuse at different scales.

INPUT STREAMS

- Greywater
- Mixed wastewater

TARGET OUTPUTS

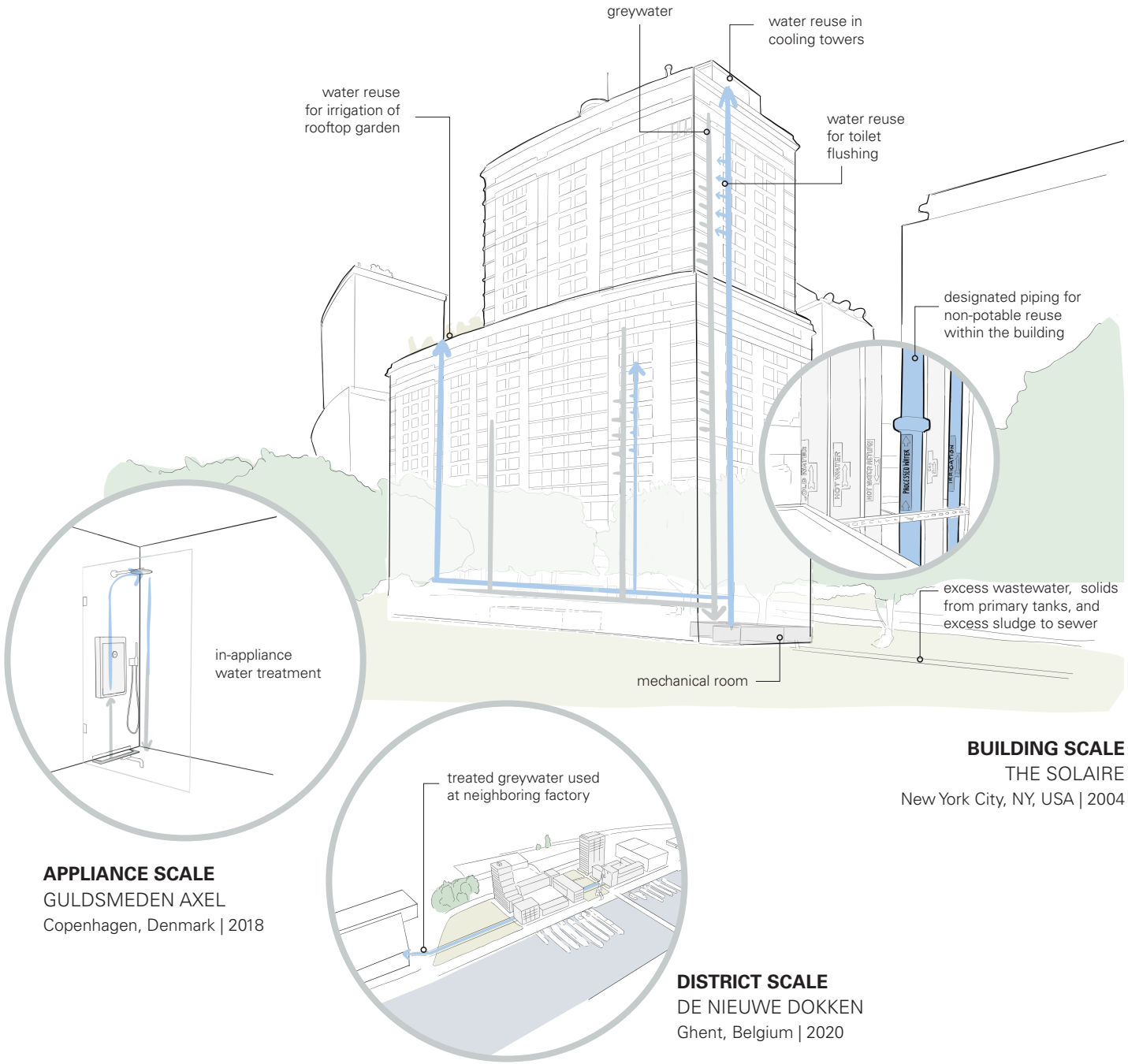
- Treated water for non-potable reuse (toilet flushing, irrigation, infiltration, laundry)
- Treated water for potable reuse

PIPING

Building scale water reuse must consider needs for additional piping for collecting greywater (if implemented) and/or for distributing treated water to the point of use. For non-potable, in-building reuse, adequate measures should be taken to prevent cross connections and backflow between treated water pipes and drinking water pipes and to minimize microbial regrowth in storage tanks and pipes.

TREATMENT

Mechanical rooms for water treatment and recovery are typically placed in the basement for building scale reuse or at a neighboring treatment facility in larger district-scale projects. Some treatment technologies can be placed outdoors, either underground or integrated in the (urban) landscape (e.g., constructed wetlands).



BUILDING SCALE
THE SOLAIRE
New York City, NY, USA | 2004

APPLIANCE SCALE
GULDSMEDEN AXEL
Copenhagen, Denmark | 2018

DISTRICT SCALE
DE NIEUWE DOKKEN
Ghent, Belgium | 2020

TO CONSIDER

COLLECTED STREAM

Both greywater or mixed wastewater can be reused. Greywater collection requires designated piping, though keeps the greywater from mixing with streams containing urine and feces, often requiring less intensive treatment than for mixed wastewater. Treating greywater yields smaller volumes than mixed wastewater, especially in non-residential buildings.

SPACE & PLACEMENT

The space required for treatment varies greatly depending on the technologies selected: higher tech solutions (e.g membrane bioreactors) can be very compact, while lower tech or nature-based solutions (e.g., constructed wetlands) require more space. Collection and storage tanks also require space.

RESOURCE INTENSITY

Operational costs for mixed wastewater treatment are generally higher than for greywater treatment. Separate greywater piping adds capital costs. When considering treatment options, the costs of advanced systems (e.g., membrane bioreactors) should be compared to real estate costs of space-intensive systems (e.g., constructed wetlands). Energy use varies by technology.

NEW BUILD VS. RETROFIT

Reusing treated mixed wastewater is easier to integrate into existing buildings, where greywater separation is not implemented. It is easier to plan for and implement separate greywater collection in new construction, although retrofitting existing buildings is possible.

HYBRID VS. DECENTRALIZED

If connected to the sewer, excess wastewater, solids from separation, or excess sludge can be discharged, ideally during low-flow periods to reduce strain on sewer and treatment infrastructure. A connection to the drinking water network provides backup if treated water volumes are insufficient.

USER EXPERIENCE

Nature-based treatment technologies may bring added value to the user by improving biodiversity, air quality, and aesthetics. For all water reuse scenarios, willingness of users to use lower than drinking water quality for applications where high quality is not necessary is important.

TREATMENT OPTIONS

A typical water reuse treatment train combines technologies from four process groups. Treatment trains do not need to include technologies from all process groups and can include more than one technology from the same process group.

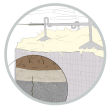
S-L SEPARATION

Solid-liquid separation removes grit, debris, and grease, and/or separates suspended solids (from toilet paper, feces) from the liquid fraction.

T.42 SETTLING TANKS | SCREENS

BIOLOGICAL TREATMENT

Biological processes, driven by microorganisms, remove organic compounds and can be designed to remove nitrogen as well as phosphorus. Limited pathogen and micropollutant removal is achieved.



T.43 VERMIFILTERS

T.44 CONSTRUCTED WETLANDS

T.45 TRICKLING FILTERS

T.46 AERATED BIOREACTORS

T.47 MEMBRANE BIOREACTORS

FILTRATION

Filtration is the removal of particles and colloids using membranes or granular media. Pathogen and micropollutant removal is achieved to varying degrees.

T.48 MEMBRANE FILTERS

T.49 GRANULAR MEDIA FILTERS

DISINFECT. & ADV. OX.

Disinfection is the inactivation or removal of pathogens to ensure microbial safety for reuse. Advanced oxidation processes also provide targeted removal of micropollutants.

T.50 UV & CHLORINE DISINFECTION

T.51 OZONATION & ADVANCED OXIDATION

SAFE REUSE

PATHOGEN REMOVAL & INACTIVATION

Enteric viruses, protozoa, and bacteria pose health risks, and their removal or inactivation, measured by log reduction, is essential for safe reuse. The required treatment level depends on 1) the source water (e.g., mixed wastewater will require higher log reductions than greywater), 2) the reuse application (e.g., irrigation has lower pathogen risk than indoor use), and 3) acceptable risk or regulatory standards. Water reuse treatment trains should be designed using a multi-barrier approach, which includes redundancies against pathogenic risks.

PREVENTING MICROBIAL REGROWTH

Trace levels of biodegradable organic matter and nutrients can cause microbial regrowth in storage tanks and pipes, affecting water color, odor, and system maintenance. Growth of opportunistic pathogenic microorganisms, like *Legionella pneumophila* or *Legionella spp.*, is a major concern for water reuse.

To minimize microbial regrowth, measures include: 1) filtration to remove organics and nutrients, 2) disinfection (e.g., with residual disinfection) 3) reducing treated water temperature, and 4) regular cleaning of tanks and pipes.

T.41 WATER TANKS | CISTERNS

DEALING WITH MICROPOLLUTANTS

Treated water may contain organic micropollutants from cleaning products, pesticides, pharmaceuticals, and personal care products. While exposure is low for most non-potable uses, it poses a concern for potable and agricultural applications, as well as irrigation or infiltration where water enters the environment without further treatment.

Micropollutant removal depends on the sequence of technologies in the treatment train. Targeted removal (e.g., with activated carbon or advanced oxidation) can achieve desired removal for specific pollutants.