URINE DIVERSION

STRATEGY

Urine contains most nutrients and pharmaceuticals excreted, though accounts for less than 1% of the mixed wastewater flow. Diverting urine from other wastewater streams sent to sewer reduces nutrient and micropollutant loads to centralized treatment plants extending their operating capacity and increasing their treatment performance. Recovering nutrients from urine to produce fertilizer can help close nitrogen, phosphorus and other nutrient cycles, and reduce reliance on synthetic fertilizers in agriculture. Urine diversion via urine-diverting flush toilets or dry toilets also enables the separate collection and treatment of blackwater via flush toilets or feces via dry toilets. Urine diverting dry toilets, as well as waterless urinals are water efficient fixtures that reduce water use.

INPUT STREAMS

- Urine
- Yellow water

TARGET OUTPUTS

- Liquid fertilizer
- Solid fertilizer

TOILETS

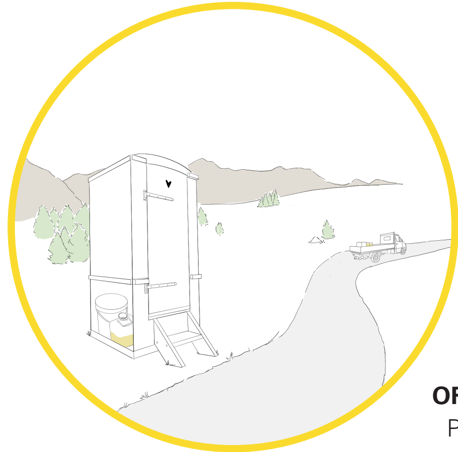
Commercially available urine-diverting toilets, separate urine from feces and most flush water while waterless urinals and urine-diverting dry toilets allow for the undiluted collection of urine. Portable fixtures (e.g., funnel attachment on a jerrycan) are a low-cost urine collection option.

PIPING | TRANSPORT

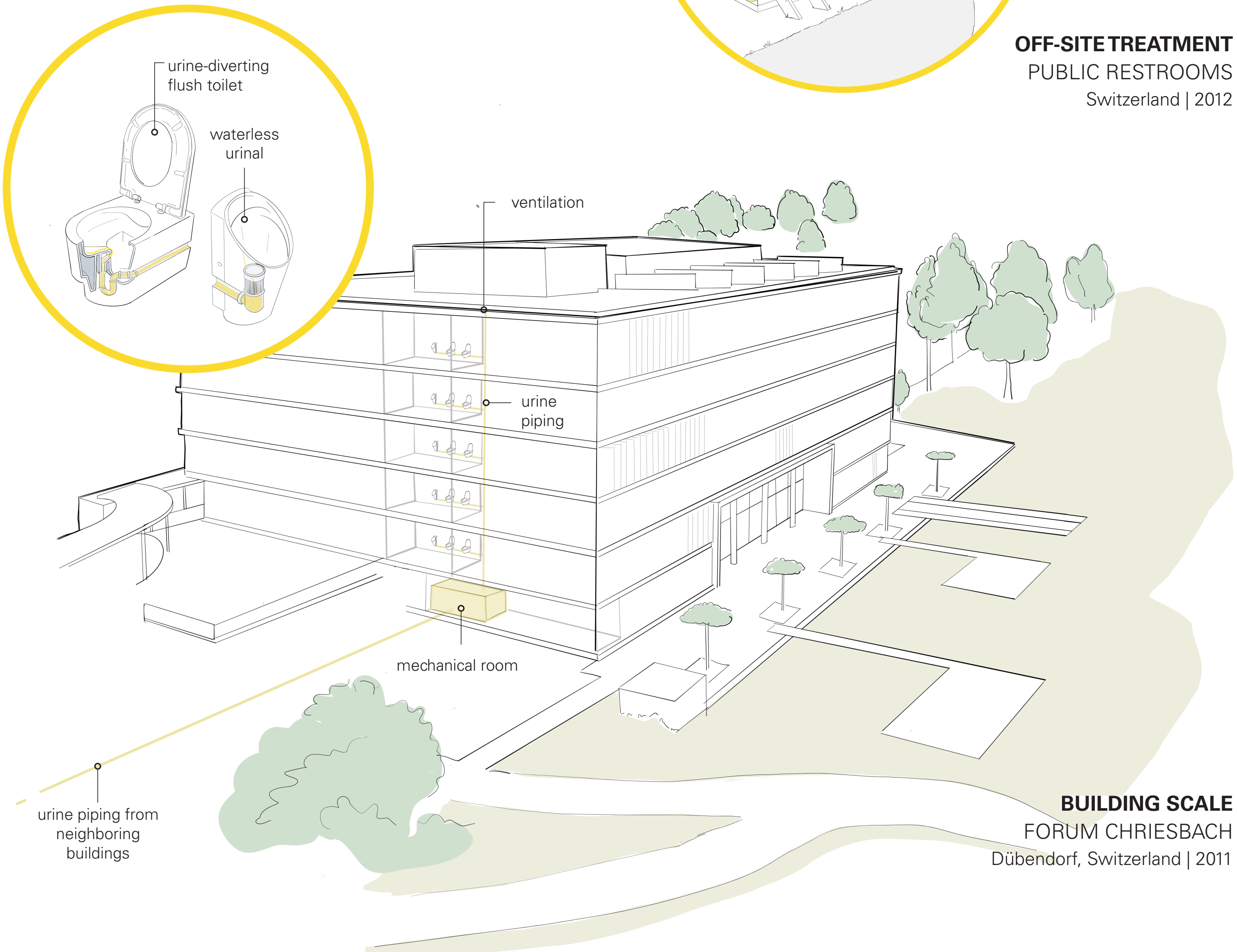
At building and neighborhood scales, designated urine piping leads urine to a storage tank for collection. Pipes and pumps can lead the urine further through on-site urine treatment, if available. Alternatively, urine can be transported in containers to a centralized treatment point (e.g., by truck). Adequate access points for collection should be considered.

TREATMENT

Treatment of the urine can take place on site or off site. On-site treatment usually takes place close to the urine collection tanks in a mechanical room in the basement. Off-site treatment can require the pumping of urine from smaller containers to larger tanks. Urine treatment integrated into the toilet/bathroom is also possible.



OFF-SITE TREATMENT
PUBLIC RESTROOMS
Switzerland | 2012



BUILDING SCALE
FORUM CHRIESBACH
Dübendorf, Switzerland | 2011

TO CONSIDER

COLLECTED STREAM

Approximately 0.5 m³ of urine can be collected per person per year. A urine stream collected with flushwater has a significantly larger volume. Spontaneous mineral precipitation in toilets and pipes can lead to deposit build-up and clogging. Flushing with rainwater reduces mineral precipitation compared to flushing with (calcium- and magnesium-rich) tapwater.

SPACE & PLACEMENT

Unless urine collection occurs at bathroom scale, or in portable fixtures (e.g., jerry cans), urine diversion requires designated piping. Space requirements for a mechanical room for storage and treatment depend on the volume of the collected urine and the treatment process of choice. A mechanical room is often placed in the basement.

RESOURCE INTENSITY

There are initial material, planning and installation costs for toilets, pipes, storage and treatment, which vary with the configuration and technology selected. To prevent deposit build-up and clogging of pipes, regular cleaning and maintenance is needed. In the case of urine collection in containers, transport of urine to a treatment hub should be considered. Some treatment processes (e.g., struvite precipitation) require additional chemical dosing.

NEW BUILD VS. RETROFIT

The installation of urine-diversion toilets and designated urine piping is easiest in new build planning and construction where designated piping can be incorporated into the building skeleton. However, urine diversion is possible when retrofitting buildings. The planning process is critical for a coordinated and well-executed implementation.

HYBRID VS. DECENTRALIZED

Urine diversion can be implemented in a hybrid scenario, where other streams are sent to the centralized sewer, or as part of a decentralized solution, in combination with treatment of fecal and greywater streams.

USER EXPERIENCE

Urine-diverting toilets typically require all users to sit while urinating for optimal collection and separation, though urinals are also an option. Awareness among users about appropriate cleaning products is critical for biological treatment processes and fertilizer end use of recovered products.

Circular Sanitation TOOLBOX | 2025 | © Eawag
References and further information available at www.eawag.ch/en/wh/toolbox

TREATMENT OPTIONS

Urine treatment aims to degrade organic substances (to prevent malodor and unwanted biological processes), minimize volatilization of ammonia (causing nitrogen losses, air pollution, and bad smell), remove or kill pathogens and micropollutants, and concentrate or extract nutrients. Different treatments yield urine-based fertilizers with different physico-chemical characteristics (e.g., solid/liquid; basic/acidic) and composition, suitable for different agricultural uses (e.g., hydroponics, soil injection, fertigation, broadcasting).

TREATMENT OF THE URINE STREAM

Treatment of the full urine stream yields multinutrient fertilizers. Concentration is not strictly necessary, but reduces the need for storage space and facilitates transport and fertilizer application.

NUTRIENT EXTRACTION

Processes for the targeted extraction of phosphorus and/or nitrogen from urine yield single-nutrient fertilizers which can be used directly or in fertilizer manufacturing.

SAFE END USE

PATHOGENS & PHARMACEUTICALS

Pathogens in urine mainly come from fecal cross-contamination during excretion, while pharmaceuticals, and their metabolites, come from consumed, and subsequently excreted, medication. Treatment of urine inactivates pathogens and removes pharmaceutical compounds to varying degrees depending on the treatment technology applied. It is recommended to follow safety measures during fertilizer application (lag time between last application and harvest and soil application or injection as opposed to foliar application) to further reduce risks arising from the presence of pathogens in urine based fertilizers.

Risks arising from pharmaceuticals include plant take-up of these substances, or dissipation into the environment. Targeted micropollutant removal steps, like the activated carbon filtration, ensure high removal.

PROCESS OBJECTIVES | TECHNOLOGY | PRODUCT(S)

Hygienization involves the reduction of pathogens, via ammonia sanitization or heat. Micropollutant removal is achieved to varying degrees by filtration and sorption.

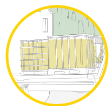
Stabilization processes (e.g., biological treatment or acid/base addition) limit nitrogen losses during treatment and other steps of the value chain (e.g., field application).

Processes of distillation and evaporation separate out water to concentrate target nutrients and reduce volume.

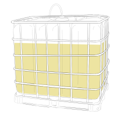
VOLUME REDUCTION | STABILIZATION | HYGIENIZATION

The extraction of one or more nutrients via chemical and physical mechanisms. Additives are often required (e.g., magnesium for precipitation).

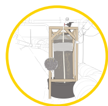
NUTRIENT EXTRACTION



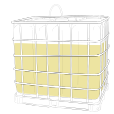
T1 URINE STORAGE | PASTEURIZATION



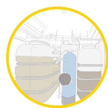
STORED URINE



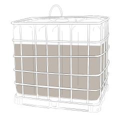
T2 NITRIFICATION ON BIOCHAR



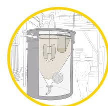
NITRIFIED URINE



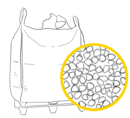
T3 NITRIFICATION - DISTILLATION



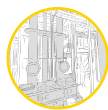
NITRIFIED-CONCENTRATED URINE



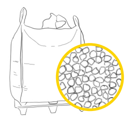
T4 STRUVITE PRECIPITATION



STRUVITE



T5 AMMONIA STRIPPING



AMMONIA SALTS