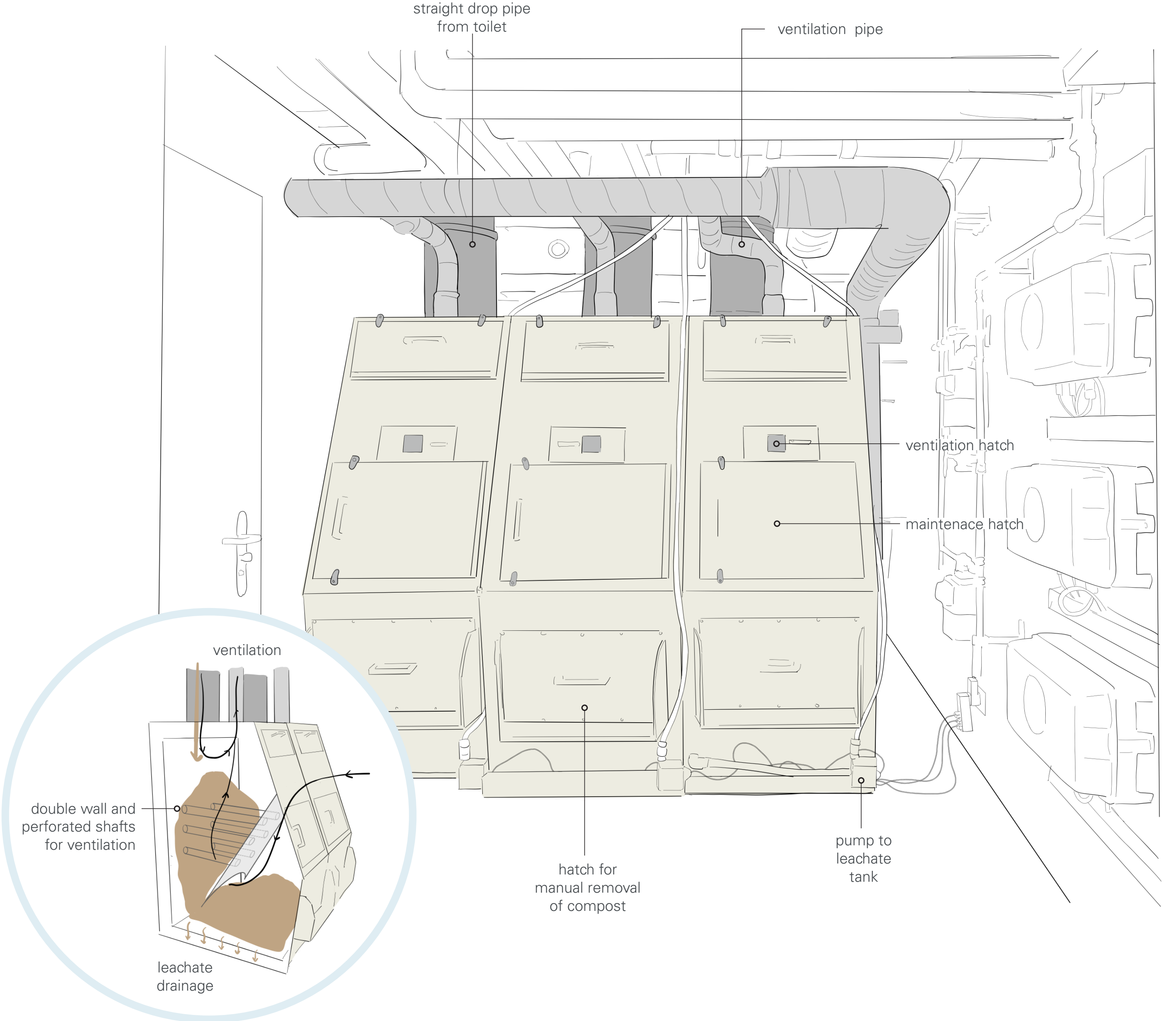
ON-SITE COMPOSTING

TECHNOLOGY



Composting is the microbial degradation of organic matter under aerobic conditions to a humus-like product: compost. Composting requires a specific carbon to nitrogen (C:N) ratio, moisture content, and oxygen flow to reach temperatures for optimal degradation and sanitization. On-site composting, often in chambers or containers, achieves mesophilic conditions (20-45 °C), but not thermophilic conditions (45-70 °C). Composting in chambers can be designed to facilitate passive and active aeration and to separate excess leachate from the pile. Often manual turning/watering is required for operation. Vermicomposting, relies on both earthworms and microorganisms for the degradation of organic matter. The worms provide aeration of the compost pile, via borrowing, and reduce the volume of the compost significantly. Volume reduction achieved during composting and vermicomposting allows for long residence times (months to years).

Compost and vermicompost are rich in organic matter and nutrients and can be used as soil amendments in agriculture. Sufficient stabilisation and sanitization need to be considered to prevent human and environmental health risks.

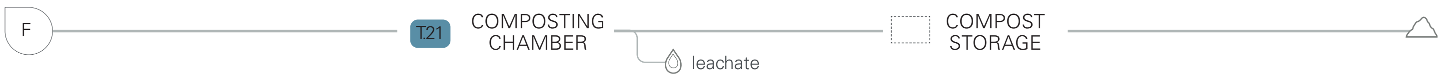
INPUT STREAMS	TARGET OUTPUT(S)
F Feces	Soil amendment, compost
Ex Excreta	
BW Blackwater, vacuum-collected	

CRESSY

Geneva, Switzerland | 2011

One composting chamber per apartment

Each of the 13 apartments in this cooperative building (~ 45 residents) is connected to a composting chamber in the basement via a 32 cm diameter straight drop pipe directly below the toilet. A ventilation pipe connects each of the chambers to the building's central ventilation system. Residents manage the chambers themselves. Compost is used in the garden after further maturation, while excess leachate is sent to the sewer.



SPECIFICATIONS

INFRASTRUCTURE

Composting chambers are typically placed indoors (sheltered from low temperatures) in treatment rooms directly below toilets and drop pipes. This limits the amount of stories the building can have, and takes up a considerable amount of space in the building. Composting chambers are made of durable, moisture-resistant materials (e.g., reinforced plastic, stainless steel, concrete). Ventilation is key: pipes, chambers and mechanical rooms can be connected to the building's central ventilation system. To reach and maintain higher temperatures, chambers can be insulated. Backyard composting in dedicated bins requires a safe conveyance plan for the transport of feces from the dry toilet to the outdoor container, a base platform to prevent groundwater contamination, a roof to prevent rainwater infitration, and coverings or screens to prevent pest entry. For both indoor and outdoor composting, adequate drainage for and management of leachate should be considered.

Simple vermicomposting is often implemented in alpine huts as a robust and low-maintenance solution.

OPERATION & MAINTENANCE

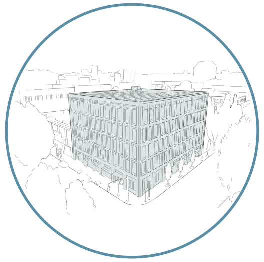
Operation and maintenance of decentralized composting or vermicomposting is relatively simple and can be carried out by the users/residents themselves. Depending on the chamber or container design and stream treated, varying operational measures may be required, for example, the addition of a bulking material (e.g., wood chips, saw dust) to adjust the carbon to nitrogen (C:N) ratio, the manual turning of the fresh compost to increase oxygen supply, or the watering of the compost (with water or leachate) to increase moisture. Energy use is small depending on the configuration and design selected (i.e., energy may be used for active ventilation, mixing, temperature control or pumps. Mature compost must be removed manually (usually no more than twice per year, in some cases after many years).

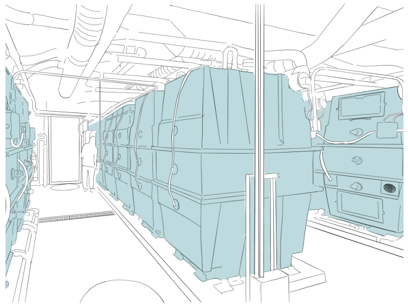
TARGET OUTPUTS

Feces-derived compost is a product rich in organics and nutrients that can be used as a soil amendment with a low nitrogen to phosphorus (N:P) ratio. In practice, optimal conditions for the composting process (e.g., C:N ratio, moisture, temperature, oxygen) are difficult to maintain in decentralized configurations. Moreover, in vermicomposting, the high temperatures considered necessary to obtain a safe compost product (50 °C over a period of a week) are not reached to not harm the worms. As a result, the output products are often not sufficiently stabilized and sanitized, and require safe handling and further treatment/maturation (e.g., via prolonged storage or secondary composting – see T.22).

SELECTED CASE STUDIES

PAE BUILDING
Portland, OR, USA | 2020



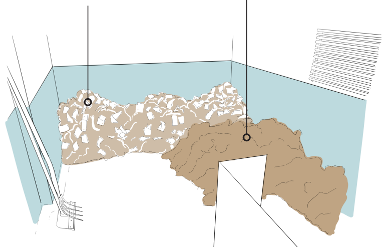


On-site composting from vacuum-collected blackwater

Vacuum-collected blackwater from the toilets of the five-story office building is first collected in an underground tank. It is then equally distributed by means of a manifold, pump, and control system over the 20 composting chambers in a mechanical room on the ground floor. The whole system (including the mixing of the chambers) is run automatically but requires consistent maintenance and monitoring. The compost is used on-site. Leachate from the chambers, as well as urine from male urinals, is collected in tanks for further nitrogen and phosphorus recovery.

BW — T.21 COMPOSTING CHAMBERS — leachate

GRIALETSCH HUT
Zernez, Switzerland| 2021

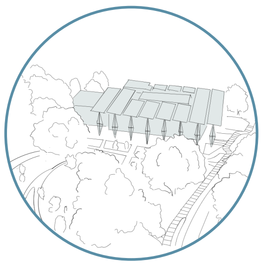


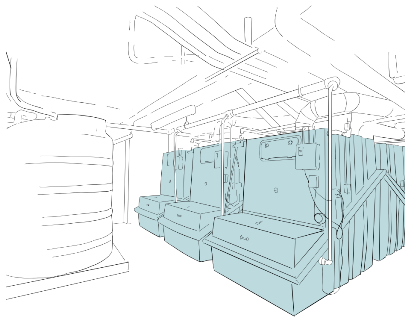
Vermicomposting of feces in alpine hut

Located at 2542 m above sea level in the Swiss alps, this mountain hut hosts circa 6000 overnight-guests per year. The renovations in 2021 included urine-diverting dry toilets and onsite greywater treatment. Feces are collected via urine-diverting, conveyor-belt toilets and fall directly into a dedicated composting room below forming vermicomposting heaps on the floor. Maintenance includes sporadic watering, and turning once or twice a year. The compost is retained for several years and used onsite for landscaping. The urine is led to a trickling filter together with greywater for treatment before infiltration.

F — T.21 VERMICOMPOSTING HEAPS

KENDEDA BUILDING
Atlanta, GA, USA | 2017





University building with foam flushing toilets

In this two-story building, excreta from 12 foam-flush toilets is treated in six mesophilic composting chambers in the basement. The toilets use biodegradable foam and < 90 mL of water per flush. Bulking materials (such as pine shavings) are added and manually mixed via the access hatch at the top. In the composting chamber, microrganisms, fungi, insects, and earthworms stabilize the excreta. Leachate from the composters is pumped to two adjacent 3 m^3 tanks, and transported offsite for use as fertilizer in drip irrigation. The compost is removed every few years for use as a soil amendment.

Ex — T.21 COMPOSTING CHAMBERS — leachate