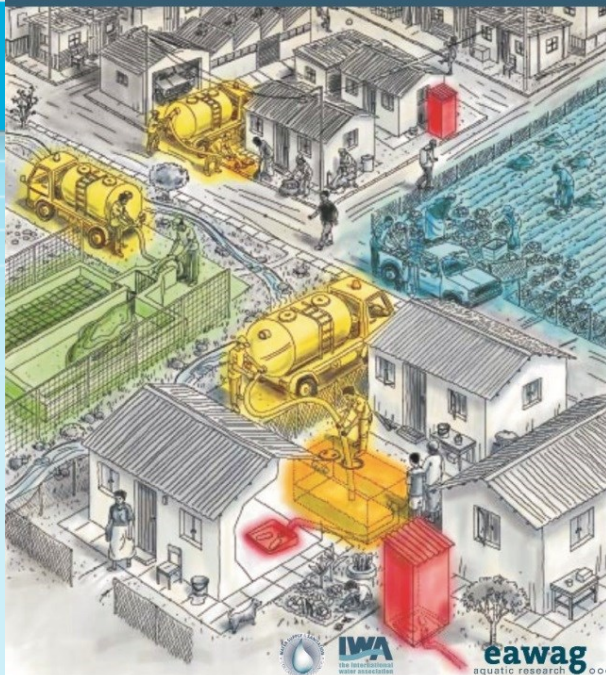
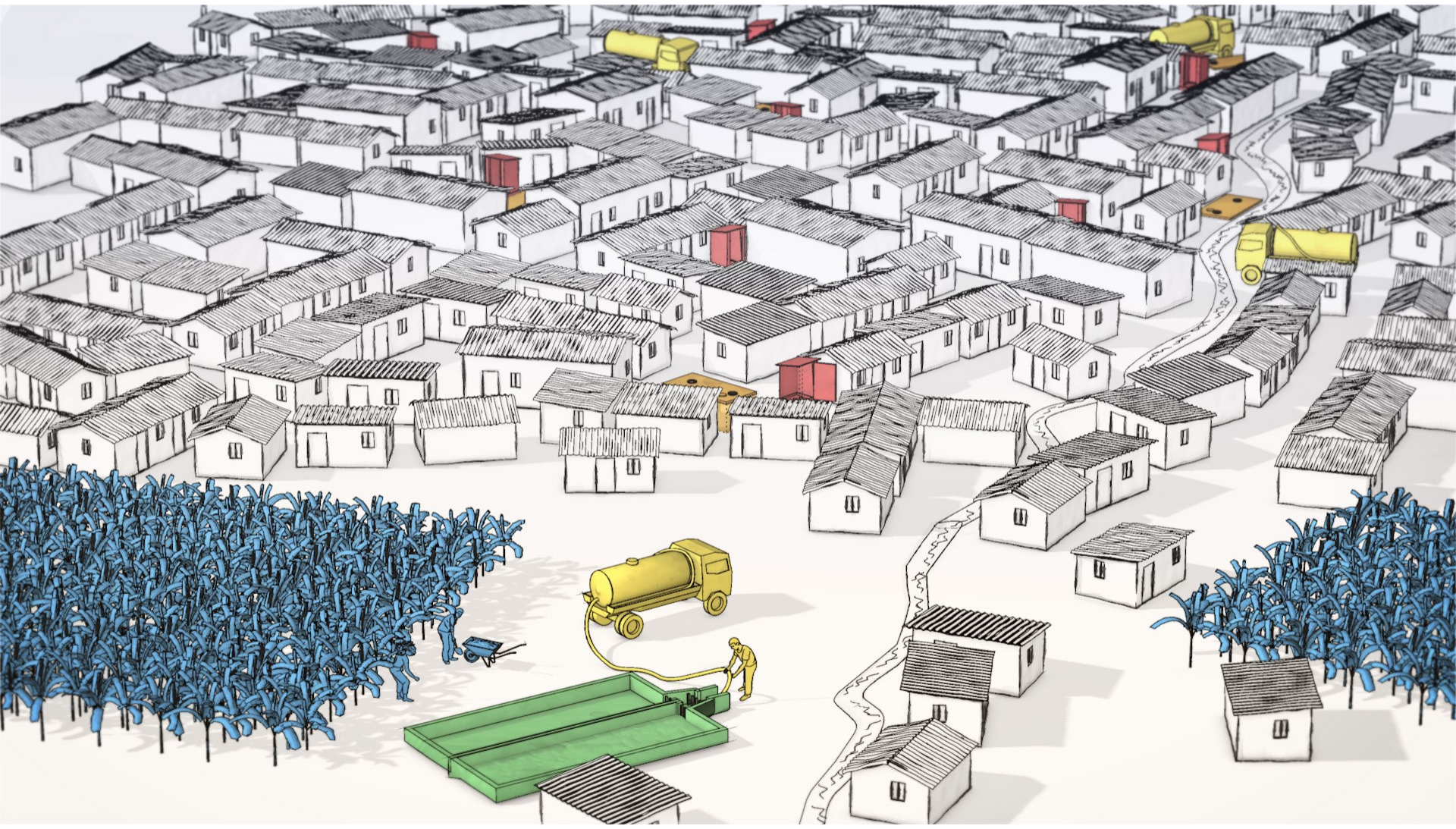


Introduction to the Compendium of Sanitation Systems and Technologies

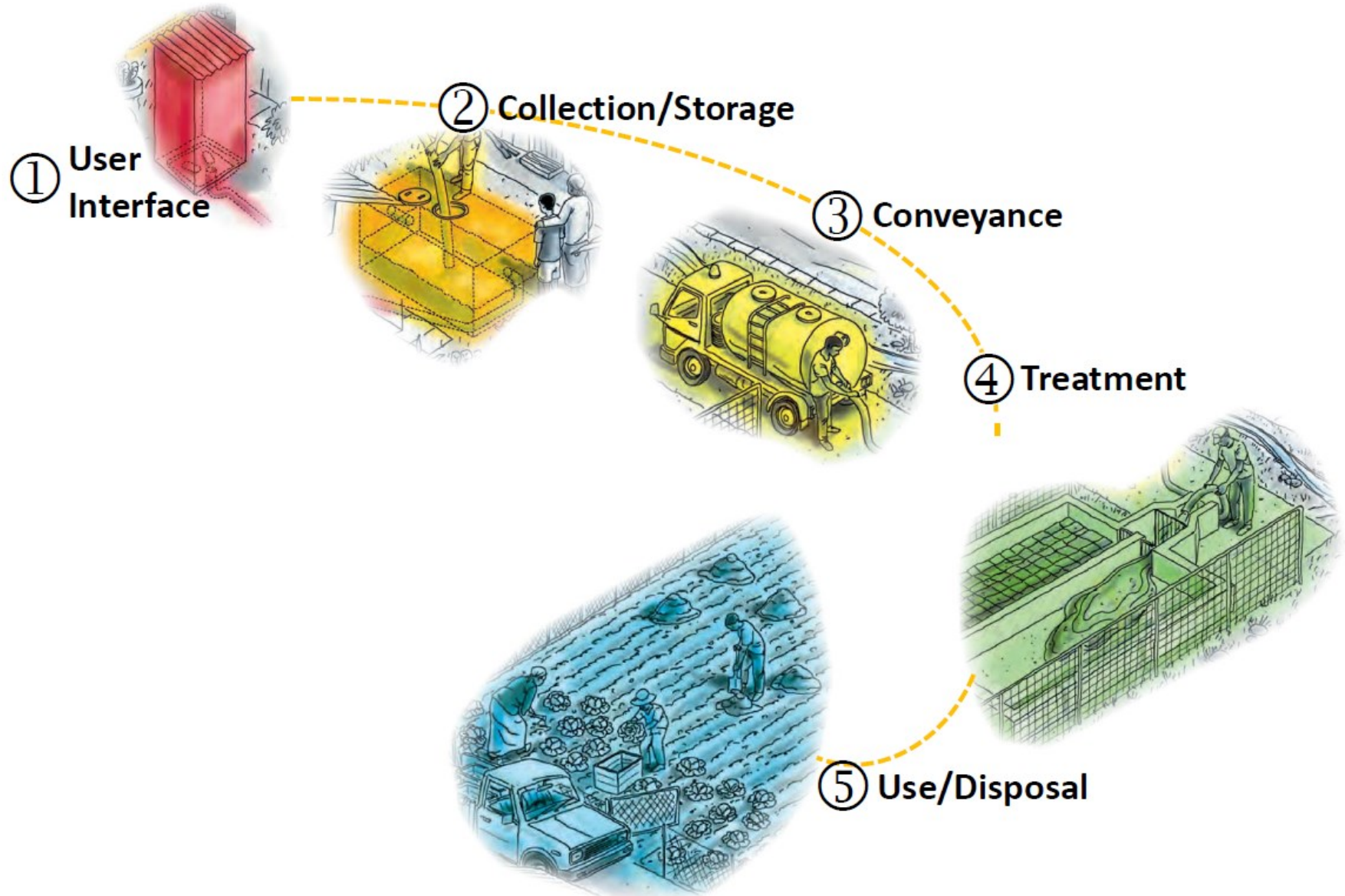
Справочник
санитарных систем
и технологий



Planning & programming for the entire sanitation chain

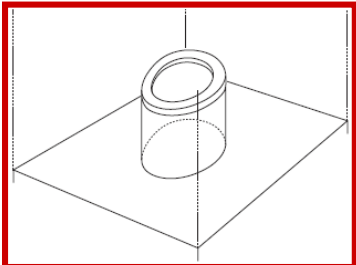


The functional groups

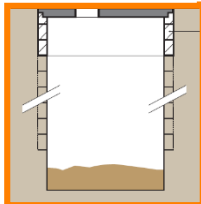


What is a Sanitation System?

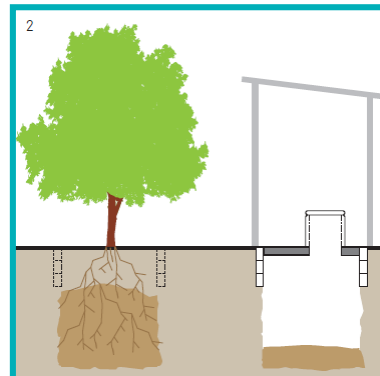
The typical rural context



User Interface
eg. Dry Toilet



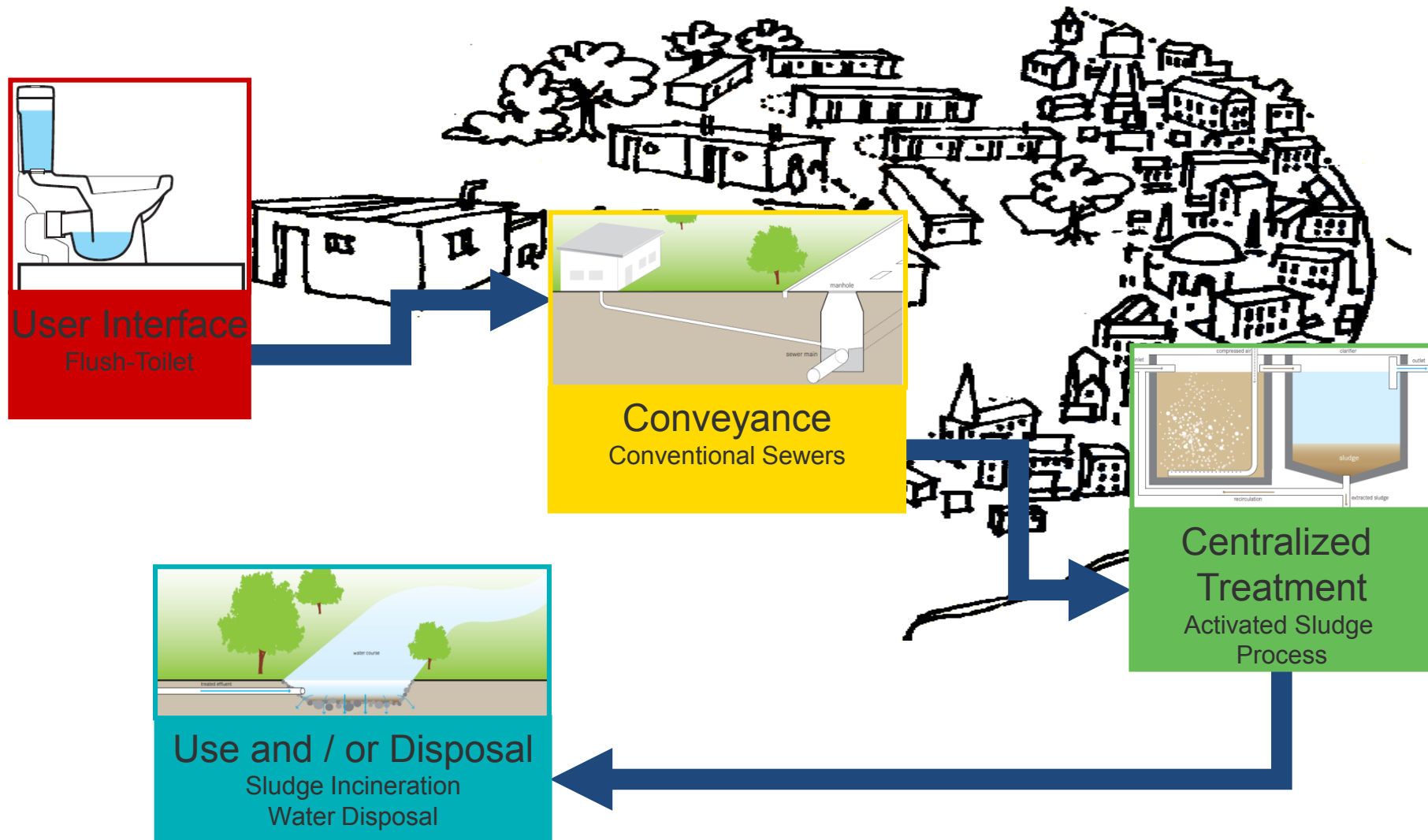
Collection
and Storage
eg. Simple Pit



Use and / or
Disposal
eg. Surface Disposal

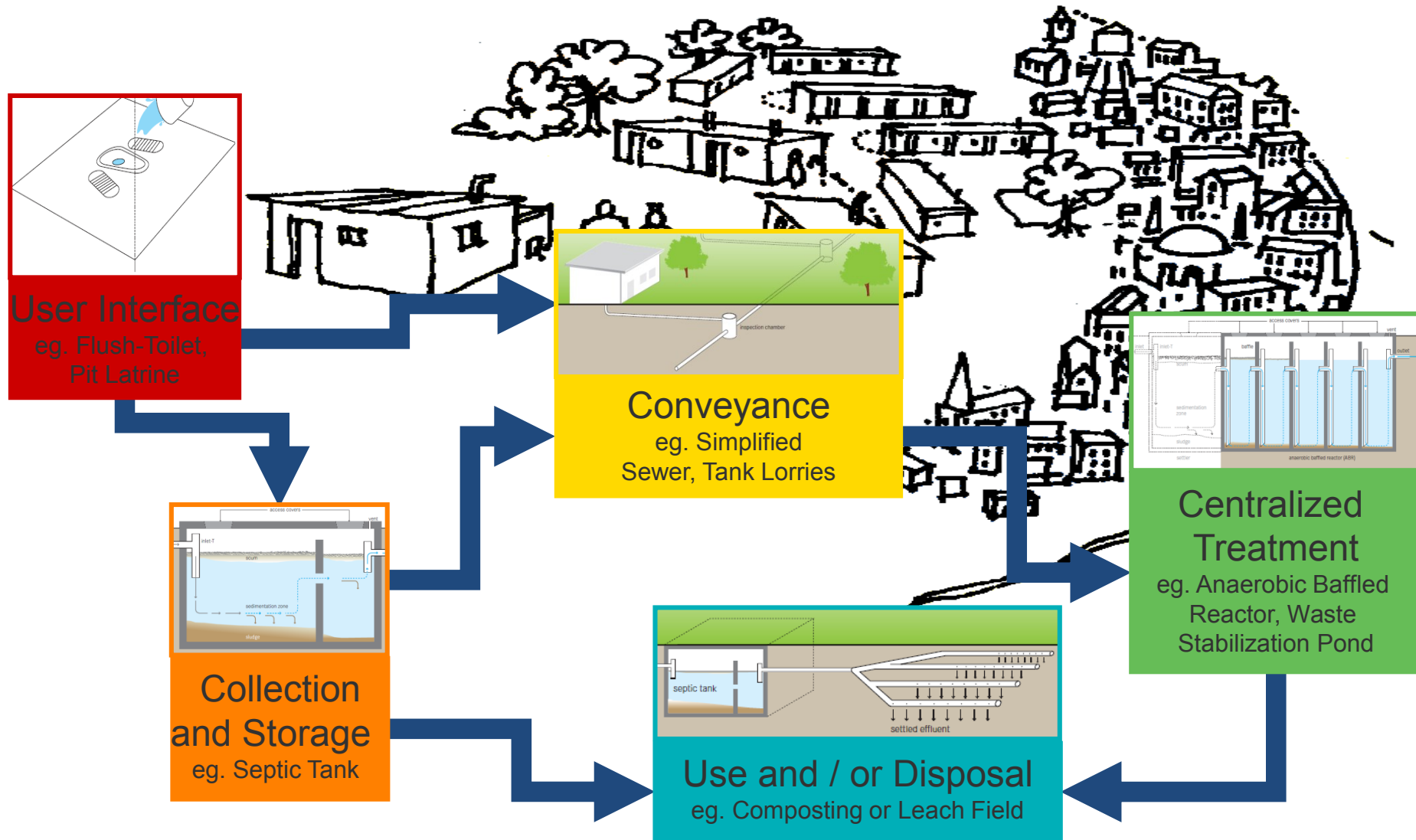
What is a Sanitation System?

The typical urban European context

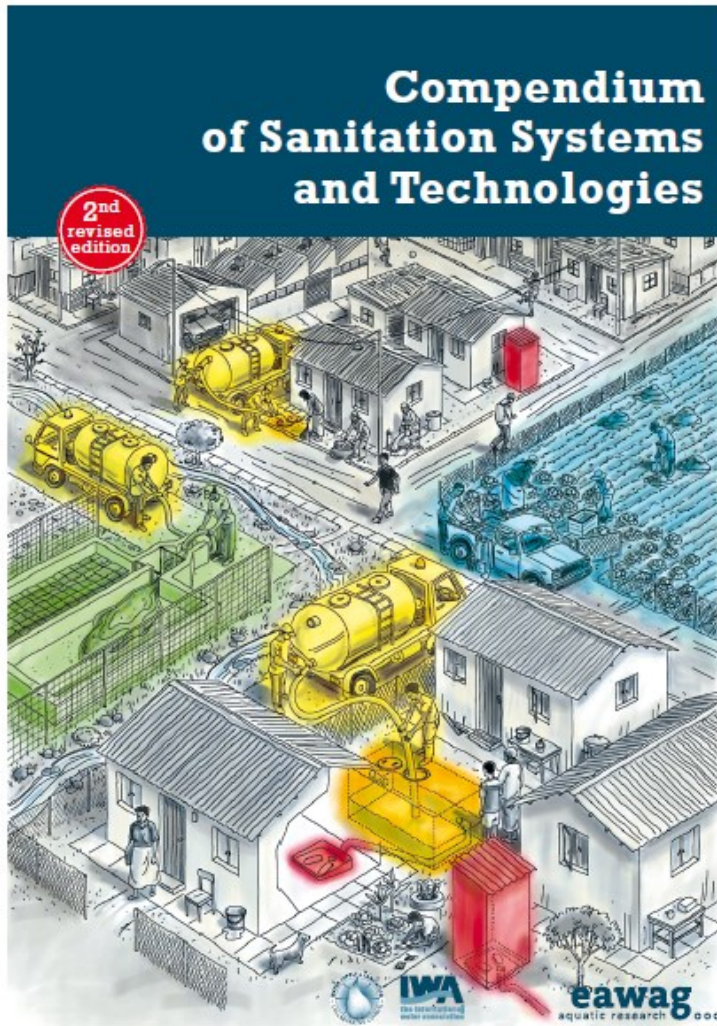


What is a Sanitation System?

A logical combination of technologies from 5 different functional groups



The Compendium of Sanitation Systems and Technologies



Tilley E. *et al.* (2014): Compendium of Sanitation Systems and Technologies. 2nd Revised Edition

 www.sandec.ch/compendium

2nd edition also in French, Arabic and Spanish.

1st edition also available in Vietnamese, Nepali and Korean

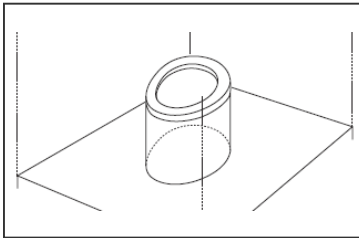

Compendium

Also as an interactive online version based on the content of the 2nd edition!

 www.ecompendium.sswm.info

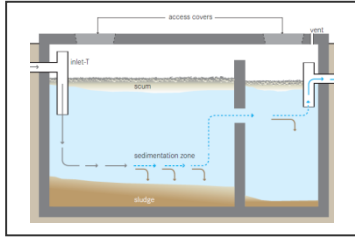
Overview of Functional Groups and Sanitation Technologies

User Interface



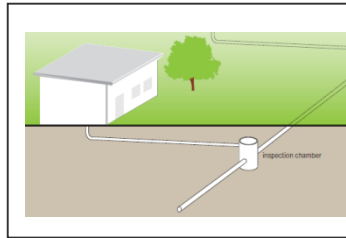
- Dry Toilet
- Urine Diverting Dry Toilet (UDDT)
- Urinal
- Pour Flush Toilet
- Cistern Flush Toilet
- Urine Diverting Flush Toilet

Collection and Storage / Treatment



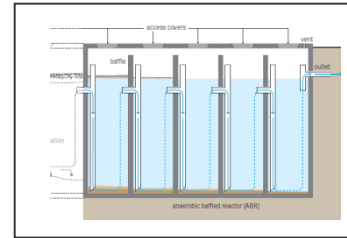
- Urine Storage Tank / Container
- Single Pit
- Single Ventilated Improved Pit (VIP)
- Double Ventilated Improved Pit (VIP)
- Fossa Alterna
- Twin Pits for Pour Flush
- Dehydr. Vaults
- Composting Chamber
- Septic Tank
- Etc.

Conveyance



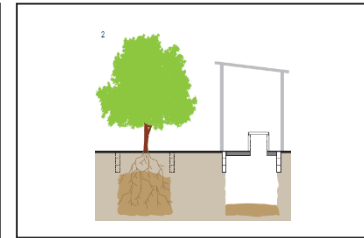
- Jerry can / Tank
- Human-Powered Emptying and Transport
- Motorized Emptying and Transport
- Simplified Sewer
- Solids-Free Sewer
- Conventional Gravity Sewer
- Transfer Station (Holding Tank)

(Semi-) Centralised Treatment



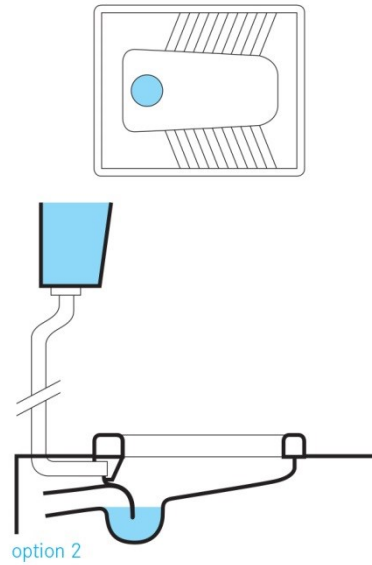
- Anaerobic Baffled Reactor (ABR)
- Anaerobic Filter
- Waste Stabilization Ponds
- Aerated Pond
- Constructed Wetland
- Trickling Filter
- Activated Sludge
- Drying Beds
- Co-composting
- Biogas Reactor
- Etc.

Use and / or Disposal

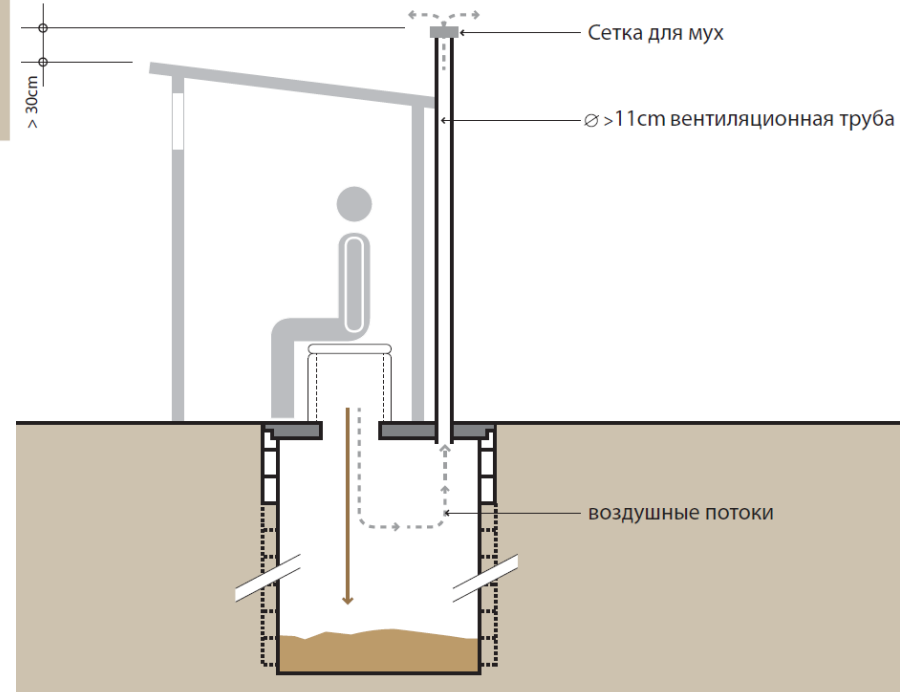
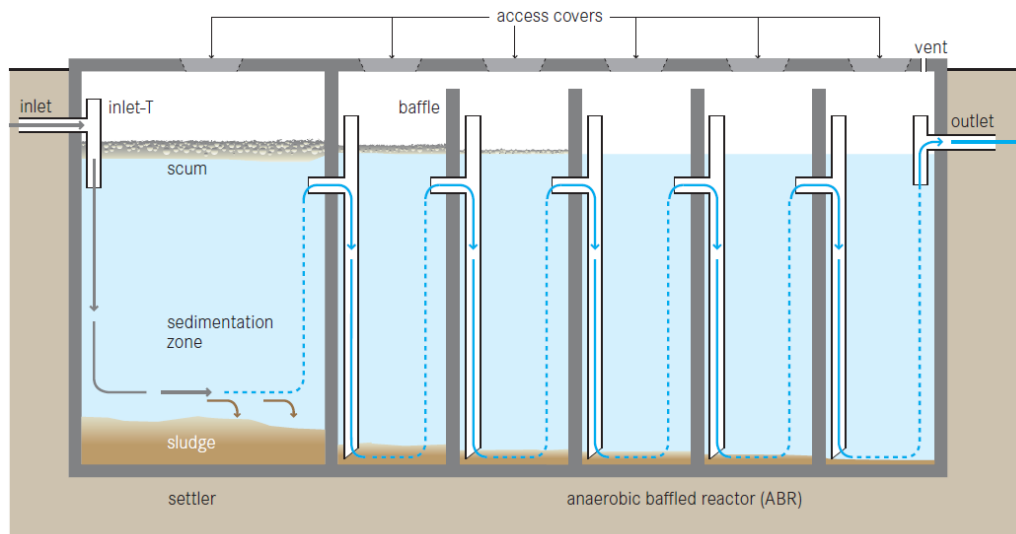


- Fill and Cover / Arborloo
- Applic. of Urine
- Application of Dehydr. Faeces / Compost/Sludge
- Irrigation
- Soak Pit
- Leach Field
- Fish Pond
- Floating Plant Pond
- Water Disposal / Groundwater Recharge
- Surface Disposal
- Biogas Combust.

User Interface



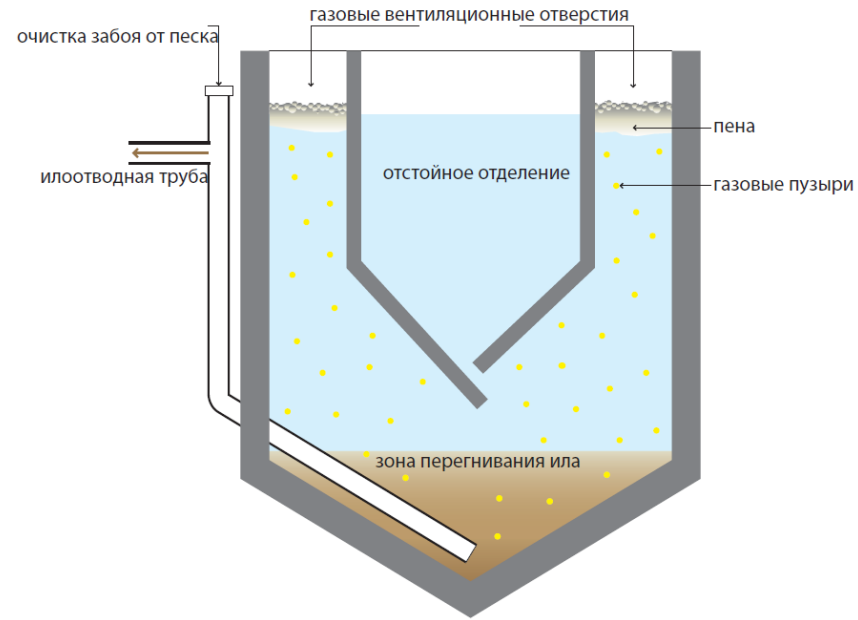
Collection and Storage / Treatment



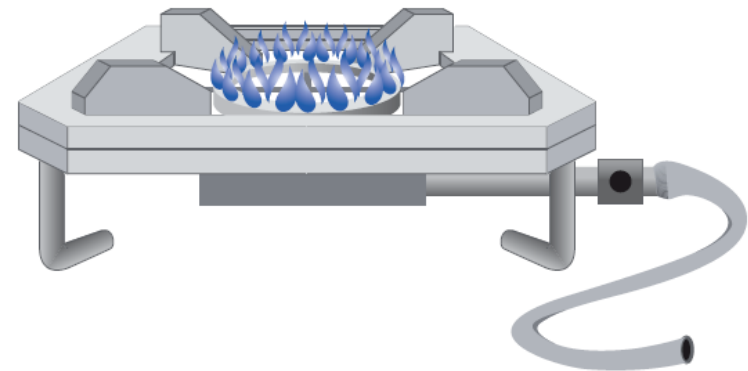
Conveyance



(Semi-) Centralised Treatment



Use and / or Disposal



Designing a Sanitation System

Considerations



To design a robust system you need to consider:

- What goes in
- What comes out
- What needs to be collected, stored, transported, processed, disposed of
- What technologies can perform the required tasks
- How the required technologies can be linked together (compatibility)

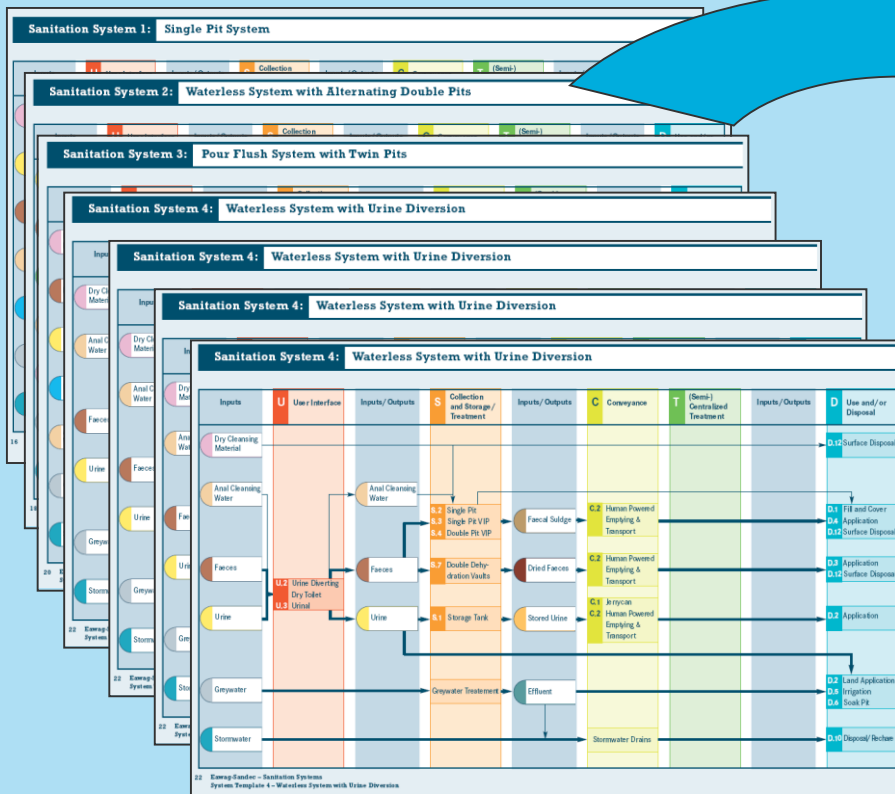
Further considerations:

- Existing infrastructure & services
- Operation & maintenance (O&M) requirements
- Lifecycle cost

The Compendium of Sanitation Systems and Technologies

Part 1: Sanitation System Templates

Part 2: Technology Information Sheets



U.5 Cistern Flush Toilet Applicable to: System 5, 6, 7 U.5

S.4 Double Ventilated Improved Pit (VIP) Applicable to: System 2, 4 S.4

C.6 Conventional Gravity Sewer Applicable to: System 7, 8 C.6

T.2 Anaerobic Filter Applicable to: System 6, 7 T.2

D.12 Surface Disposal Applicable to: Systems 1-8 D.12

Application Level	Management Level	Inputs:
<input type="checkbox"/> Household	<input type="checkbox"/> Household	<input type="checkbox"/> Faecal Sludge <input type="checkbox"/> Feces
<input type="checkbox"/> Neighbourhood	<input type="checkbox"/> Shared	<input type="checkbox"/> Urine
<input type="checkbox"/> City	<input type="checkbox"/> Public	

Surface Disposal refers to the stockpiling of sludge, faeces, biosolids, or other materials that cannot be used elsewhere. Once the material has been taken to a Surface Disposal site, it is not used later. This technology is primarily used for biosolids, although it is applicable for any type of dry, useable material.

One application of Surface Disposal that is shown on the System Templates is the disposal of dry cleansing materials, such as toilet paper, corn cobs, stone, newspaper and/or leaves. These materials can not always be included along with other water-based products in some technologies and must be separated. A rubbish bin should be provided beside the User Interface to collect the cleansing materials. Dry materials can be buried (e.g. corn cobs) or disposed of along with the household waste. For simplicity, the remainder of this Technology Information Sheet will be dedicated to faecal sludge, since standard solid-waste practices are beyond the scope of this Compendium.

When there is no demand or acceptance for the beneficial use of biosolids, they can be placed in monofills (biosolids-only landfills) or heaped into permanent piles. The main difference between surface disposal and land application is the application rate. There is no limit to the quantity of biosolids that can be applied to the surface, since there are no concerns about nutrient loads or agronomic rates. There is however, concern related to groundwater contamination and leaching. More advanced surface disposal systems may incorporate a liner and leachate collection system in order to prevent nutrients and contaminants from infiltrating the groundwater.

Landfilling biosolids along with Municipal Solid Waste (MSW) is not advisable since it reduces the life of a landfill which has been designed for the containment of more noxious materials. As opposed to more centralized MSW landfills, Surface Disposal sites can be situated close to where the faecal sludge is treated, limiting the need for long transport distances.

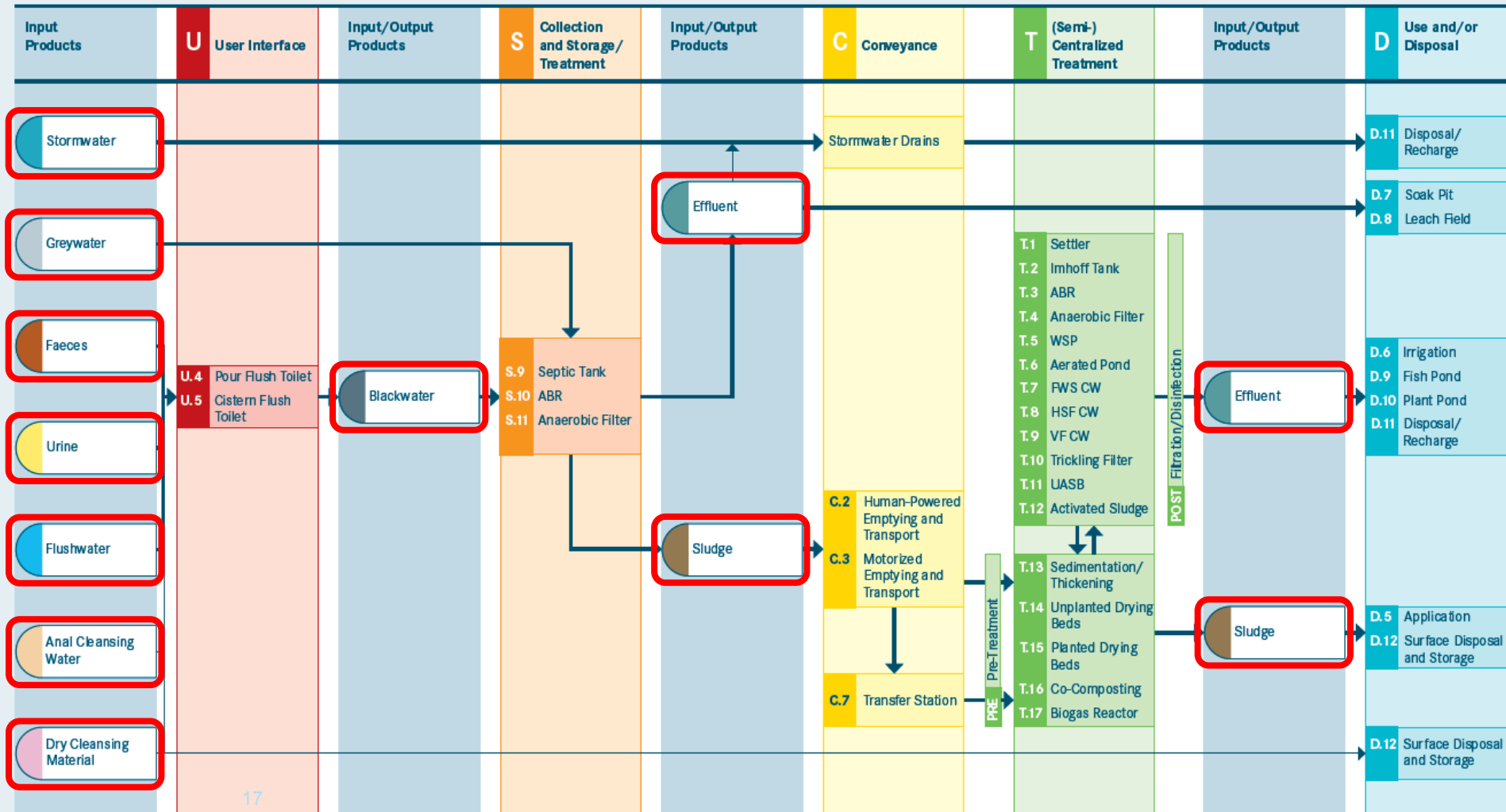
Advisory Since there are no benefits gained from this type of disposal technology, it should not be considered as a primary option. However, where acceptance towards biosolid use does not exist, the contained and controlled stockpiling of biosolids is far preferable to uncontrolled dumping.

Part I: Sanitation System Templates

System 1:	Single Pit System
System 2:	Waterless Pit System without Sludge Production
System 3:	Pour Flush Pit System without Sludge Production
System 4:	Waterless System with Urine Diversion
System 5:	Biogas System
System 6:	Blackwater Treatment System with Infiltration
System 7:	Blackwater Treatment System with Effluent Transport
System 8:	Blackwater Transport to (Semi-) Centralized Treatment System
System 9:	Sewerage System with Urine Diversion

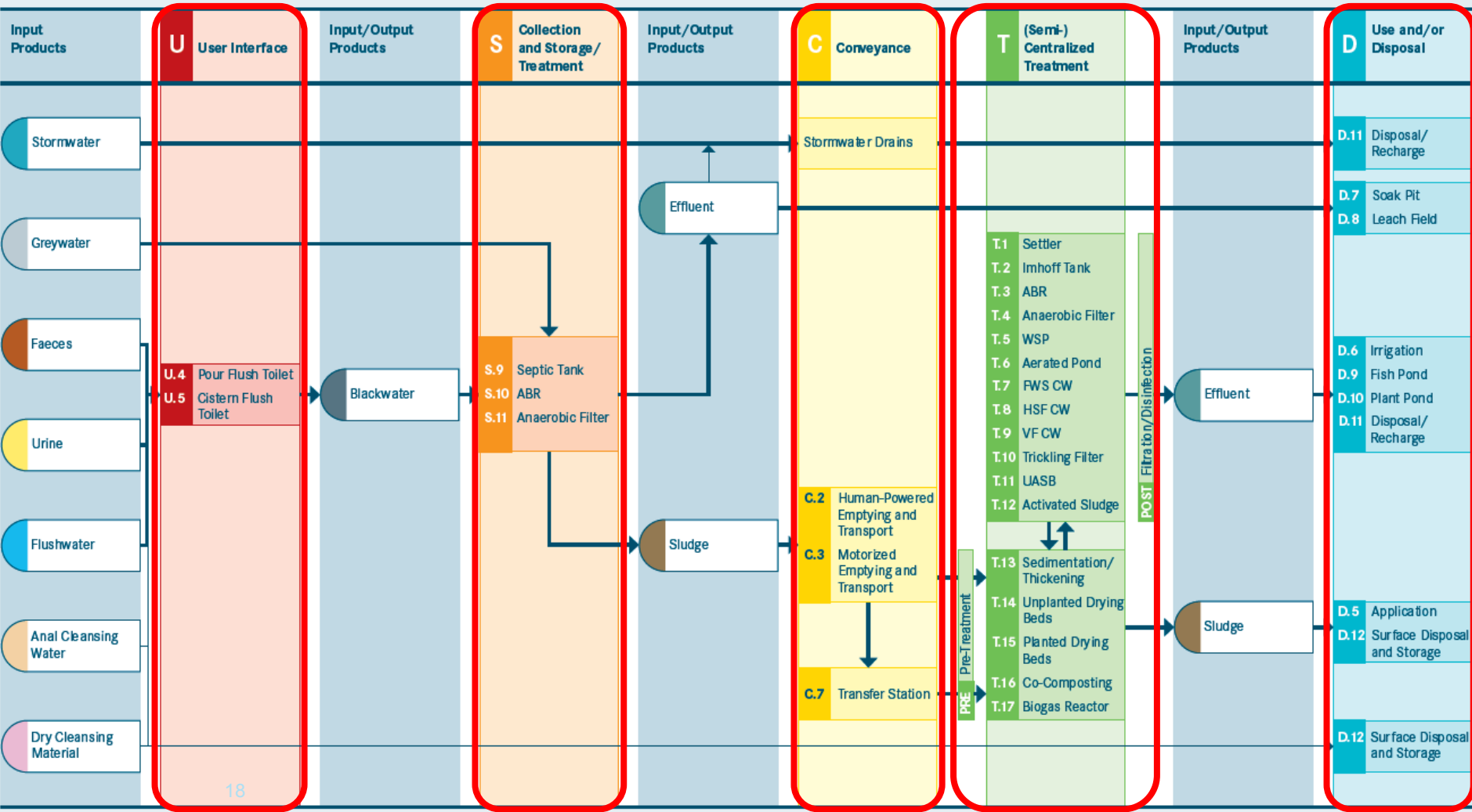
Products

Sanitation System 6: Blackwater Treatment System with Infiltration

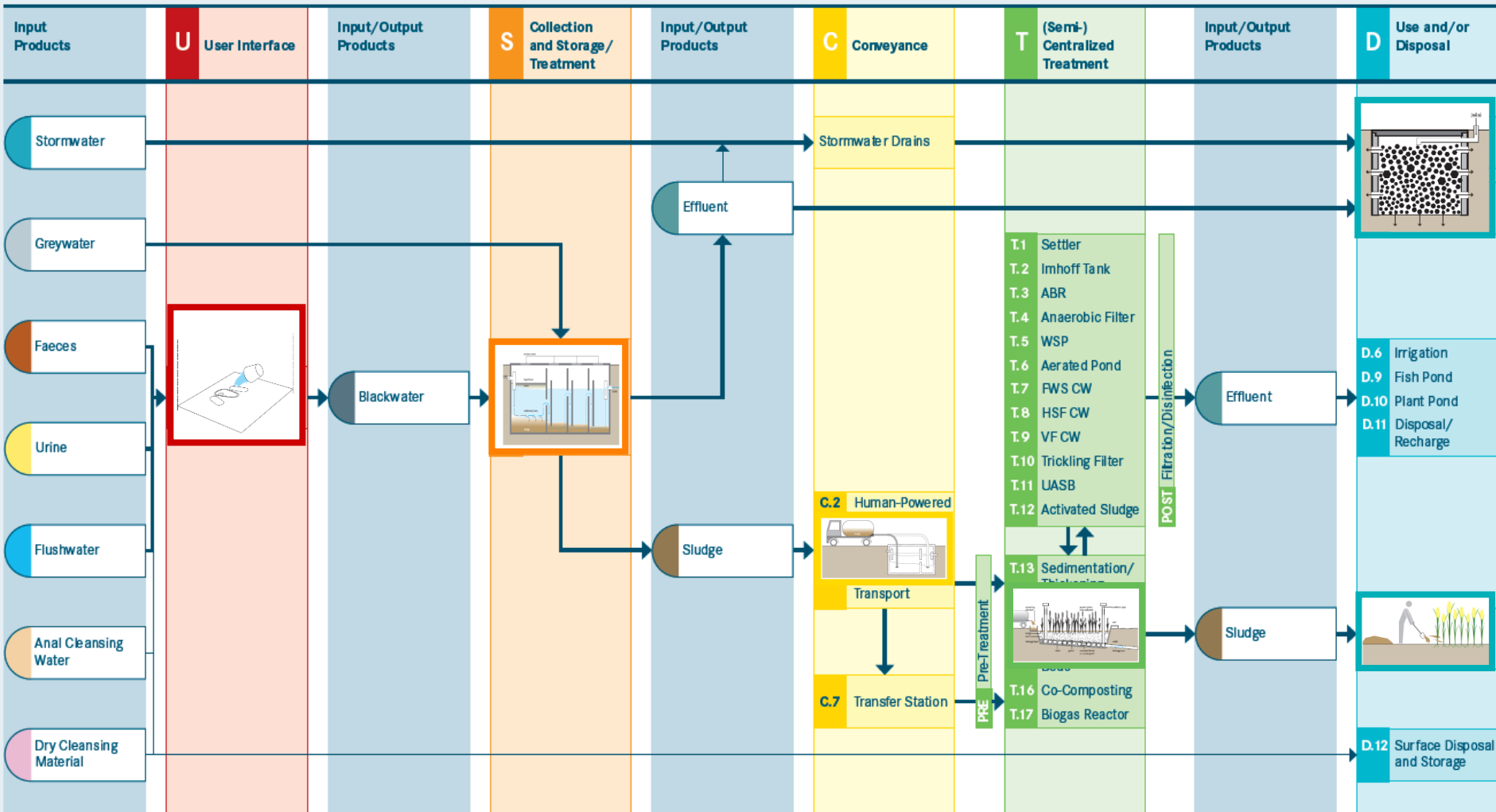


Functional Groups

Sanitation System 6: Blackwater Treatment System with Infiltration



Sanitation System 6: Blackwater Treatment System with Infiltration



Part II: Technology Information Sheets

U.4 Pour Flush Toilet Applicable to:
Systems 1, 3, 5, 8

Inputs: Faeces Urine Flushwater
 (Anal Cleansing Water) (Dry Cleansing Material)

Outputs: Blackwater

U.4 **Pour Flush Toilet**

Technology Code

Input / Output Products

Link to System Templates

U.4

Operation & Maintenance Because there are no mechanical parts, pour flush toilets are quiet, robust and rarely require repair. Despite the fact that it is a water-based toilet, it should be cleaned regularly to maintain hygiene and prevent the buildup of sludge. To reduce water requirements for flushing and to prevent clogging, it is recommended that dry cleansing materials and products used for repeated hygiene be collected separately and not flushed down the toilet.

Pre & Care

- The water seal effectively prevents odours
- The excess of one user are flushed away before the next user arrives
- Suitable for all types of users (infants, squatters, wheelchair users)
- Low capital costs; operating costs depend on the price of water
- Requires a constant source of water (can be recycled water and/or collected rainwater)
- Requires materials and skills for production that are not available everywhere
- Certain dry cleansing materials may clog the water seal

References & Further Reading

Wiers, D. D. (1985). The Design of Pour Flush Toilets. UNCP International Project Report UNCP/IDC The World Bank and UNCP Washington, D.C., USA. Available at: documents.worldbank.org/external/ur/house

Wiers, D. D. (1986). Low-Cost Toilet Installation. Wiley, Chichester, UK.

Phillis, Christodoulos and Stefanos, George (2004). Design and construction of a low-cost pour flush toilet for open field use in rural areas.

Phillis, C., Christodoulos, S., Stefanos, G., N. N., N. N., N. N., N. N., N. N. and Singh, R. S. (1998). Manual on the Design, Construction and Rehabilitation of Low-Cost Pour Flush Toilets. UNCP International Project Report UNCP/IDC The World Bank and UNCP Washington, D.C., USA. Available at: documents.worldbank.org/external/ur/house (Please refer to the manual for the full text and construction details)

U.4 Pour Flush Toilet Applicable to:
Systems 1, 3, 5-8

Inputs: Faeces Urine Flushwater
 (Anal Cleansing Water) (Dry Cleansing Material)

Outputs: Blackwater

Technology Code

Input / Output Products

Link to System Templates

U.4 **Pour Flush Toilet**

Technology Code

Input / Output Products

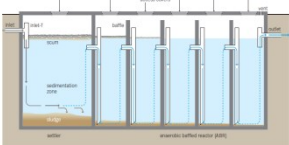
Link to System Templates

Part II: Technology Information Sheets

S.10 Anaerobic Baffled Reactor (ABR)

Applicable to Systems 6, 7

Application Level:	Management Level:	Inputs:
<input type="checkbox"/> Household <input checked="" type="checkbox"/> Neighbourhood <input type="checkbox"/> City	<input type="checkbox"/> Household <input checked="" type="checkbox"/> Shared <input type="checkbox"/> Public	<input checked="" type="checkbox"/> Blackwater <input checked="" type="checkbox"/> Brownwater <input type="checkbox"/> Greywater
Outputs:		
<input checked="" type="checkbox"/> Effluent <input checked="" type="checkbox"/> Sludge		



An anaerobic baffled reactor (ABR) is an improved Septic Tank (ST) with several baffles under which the wastewater is forced to flow. The increased contact time with the active biomass (sludge) results in improved treatment.

The upflow chambers provide enhanced removal and digestion of organic matter (OD) that can be reduced by up to 90%, which is far superior to its removal in a conventional Septic Tank.

Design Considerations: The majority of settleable solids are removed in a sedimentation chamber in front of the actual ABR. Small-scale, stand-alone units typically have an integrated settling compartment, but primary sedimentation can also take place in a separate tank (T) or another preceding technology (e.g. existing Septic Tanks). Designs without a settling compartment (as shown in 1.2) use of particulate retention (Semi-) Continuous Treatment plants that combine the ABR with another technology for primary settling, or where prefabricated, modular units are used. Typical inflow range from 1 to 200 m³ per day. Critical design parameters include a hydraulic retention time (HRT) between 48 to 72 hours, upflow velocity of the wastewater below 0.5 m/h and the number of upflow chambers (3 to 6). The connection between the chambers can be designed either with vertical pipes or baffles. Accessibility to all chambers (through access points) is necessary for maintenance. Ideally, the biogas produced in an ABR through anaerobic digestion is not collected because of its inefficient amount. The tank should be vented to allow for controlled release of odor and potentially harmful gases.

Appropriateness: This technology is easily adaptable and can be applied at the household level in small-scale households or even in larger collection areas. It is most appropriate where a relatively constant amount of blackwater and greywater is generated. A fairly controlled ABR is appropriate when there is a pre-existing Conventional Technology, such as a Septic Tank (ST). This technology is suitable for areas where land use is limited since the tank is most commonly installed underground and requires a small area. However, a vacuum truck should be able to access the location because the sludge must be regularly removed (particulate from the settler).

S.10

Anaerobic Baffled Reactor (ABR)

Applicable to: Systems 6, 7

Application Level:

- Household
- Neighbourhood
- City

Management Level:

- Household
- Shared
- Public

Inputs:

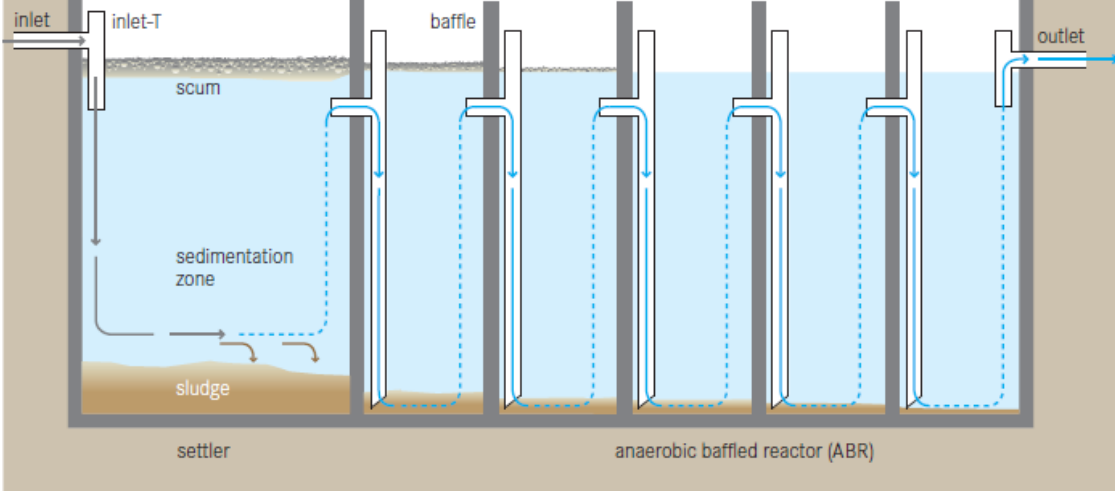
- Blackwater
- Brownwater
- Greywater

Outputs:

- Effluent
- Sludge

Application Level

Management Level



S.10

ABRs can be installed in every type of climate, although the efficiency is lower in colder climates. They are efficient at removing nutrients and pathogens. The effluent usually requires further treatment.

Health Aspects/Acceptance: Under normal operating conditions, users do not come in contact with the influent or effluent. Effluent, scum and sludge must be handled with care as they contain high levels of pathogens or organisms. The effluent contains coliforms, compounds that may have to be removed at a further polishing step. Care should be taken to design and locate the facility such that odours do not bother surrounding residents.

Operation & Maintenance: An ABR requires a start-up period of several months to reach full treatment capacity since the slow growing anaerobic biomass first needs to be established in the reactor. To reduce start-up time, the ABR can be inoculated with anaerobic bacteria, e.g., by adding fresh cow slurry or Septic Tank sludge. The added stock of active bacteria can then multiply and adapt to the incoming wastewater. Because of the delicate ecology, care should be taken not to discharge harsh chemicals into the ABR. Scum and sludge levels need to be monitored to ensure that the tank is functioning well. Process operation in general is not required, and maintenance is limited to the removal of accumulated sludge and scum every 1 to 3 years. This is best done using a Mechanical Emptying and Transport technology (C-T). The emptying frequency depends on the chosen pre-treatment step, as well as on the design of the ABR. ABR tanks should be checked from time to time to ensure that they are watertight.

- Pros & Cons**
- + Reduced to organic and hydraulic shock loads
 - + No electrical energy is required
 - + Low operating costs
 - + Long service life
 - + High reduction of BOD
 - + Low sludge production; the sludge is stabilised
 - + Moderate area requirement (can be built underground)

Requires expert design and construction

- Low reduction of pathogens and nutrients
- Effluent and sludge require further treatment and/or appropriate discharge

References & Further Reading

Beckmann, A., Baur, V. L. and McCarthy, P. L. (1981). Performance Characteristics of the Anaerobic Baffled Reactor. *Water Research* 15 (3): 361-366.

Berlin, W. D. and Stuckey, D. C. (1989). The Use of the Anaerobic Baffled Reactor (ABR) for Wastewater Treatment. *Water Research* 23 (7): 1059-1074.

Frans, C. M., Buiting, C. A., Broekmans, C. J., Dronk, P., Wiersma, J., Buiting, M., van der Meer, A. J. M., van der Wal, T. and Bak, J. (2005). Evaluation of the Anaerobic Baffled Reactor for Sanitation in Small Peri-urban Settlements. WRC Report No. 1247/1/05. Water Research Commission, Pretoria, ZA. Available at: www.wrc.org.za

Frans, C. M., Pley, S., Lubbeke, T., Buiting, M., Wiersma, J. and Bak, J. A. (2006). Evaluation of the Anaerobic Baffled Reactor (ABR) as Appropriate Technology for on-site Sanitation. *Water* 8 (6): 923 (Special Edition). Available at: www.wrc.org.za

Stuckey, D. C. (2010). Anaerobic Baffled Reactor (ABR) for Wastewater Treatment. In: *Environmental Sanitation Technology Applications and New Developments*, H. H. P. Fung (Ed.). Springer, College Park, London, UK.

Ullrich, A. (Ed.), Bauer, S. (Ed.), Cretney, B. (Ed.), Stone, L., Thompson, J., and Woodcock, L. (2005). *Environmental Sanitation Technology (EMSAT) and Sanitation in Developing Countries*. A Practical Guide. WEDC, Loughborough University, Loughborough, UK.

How to use the Compendium



Decision-making

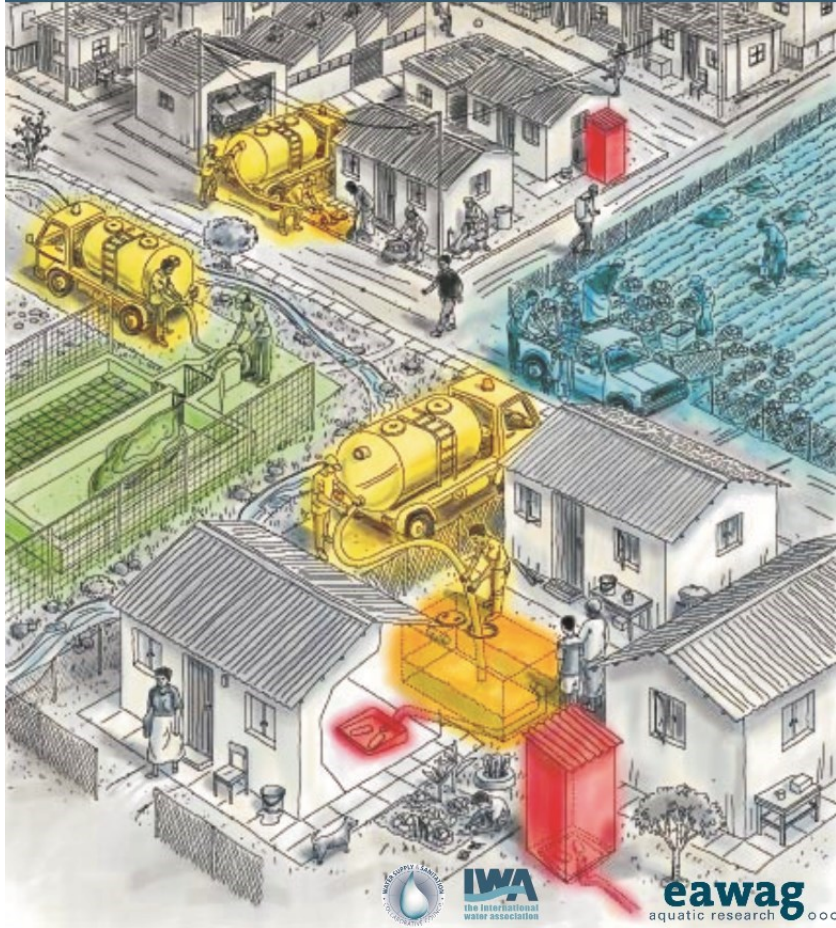


Sharing



Capacity-building

Справочник санитарных систем и технологий



Questions ?

Reactions ?