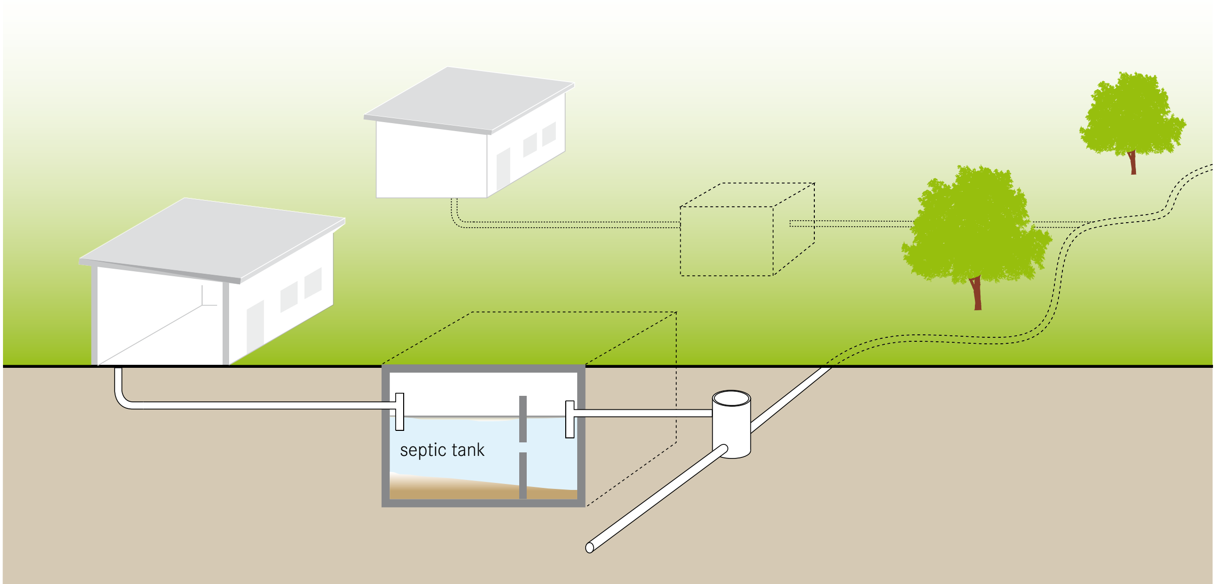
C.5

Solids-Free Sewer

Applicable to:
System 7

Application Level:	**Management Level:**	**Inputs/Outputs:**
Household	★ Household	Effluent
★★ Neighbourhood	★★ Shared	
★ City	★★ Public	



A solids-free sewer is a network of small-diameter pipes that transports pre-treated and solids-free wastewater (such as Septic Tank effluent). It can be installed at a shallow depth and does not require a minimum wastewater flow or slope to function.

Solids-free sewers are also referred to as settled, small-bore, variable-grade gravity, or septic tank effluent gravity sewers. A precondition for solids-free sewers is efficient primary treatment at the household level. An interceptor, typically a single-chamber Septic Tank (S.9), captures settleable particles that could clog small pipes. The solids interceptor also functions to attenuate peak discharges. Because there is little risk of depositions and clogging, solids-free sewers do not have to be self-cleansing, i.e., no minimum flow velocity or tractive tension is needed. They require few inspection points, can have inflective gradients (i.e., negative slopes) and follow the topography. When the sewer roughly follows the ground contours, the flow is allowed to vary between open channel and pressure (full-bore) flow.

Design Considerations If the interceptors are correctly designed and operated, this type of sewer does not require self-cleansing velocities or minimum slopes. Even inflective gradients are possible, as long as the downstream end of the sewer is lower than the upstream end. In sections where there is pressure flow, the water level in any interceptor tank must be higher than the hydraulic head within the sewer, otherwise the liquid will flow back into the tank. At high points in sections with pressure flow, the pipes must be ventilated. Solids-free sewers do not have to be installed on a uniform gradient with a straight alignment between inspection points. The alignment may curve to avoid obstacles, allowing for greater construction tolerance. A minimum diameter of 75 mm is required to facilitate cleaning. Expensive manholes are not needed because access for mechanical cleaning equipment is not necessary. Cleanouts or flushing points are sufficient and are installed at upstream ends, high points, intersections, or major changes in direction or pipe size. Compared to manholes, cleanouts can be more tightly sealed to prevent stormwater from entering. Stormwater must be excluded as it could exceed pipe capacity and lead to blockages due to grit depositions. Ideally, there should not be any storm- and groundwater in the sewers, but, in practice, some imperfectly sealed pipe joints must be expected. Estimates of groundwater infiltration and stormwater inflow must, therefore, be made when designing the system. The use of PVC pipes can minimize the risk of leakages.

Appropriateness This type of sewer is best suited to medium-density (peri-)urban areas and less appropriate in low-density or rural settings. It is most appropriate where there is no space for a Leach Field (D.8), or where effluents cannot otherwise be disposed of onsite (e.g., due to low infiltration capacity or high groundwater). It is also suitable where there is undulating terrain or rocky soil. A solids-free sewer can be connected to existing Septic Tanks where infiltration is no longer appropriate (e.g., due to increased housing density and/or water use).
As opposed to a Simplified Sewer (C.4) a solids-free sewer can also be used where domestic water consumption is limited.
This technology is a flexible option that can be easily extended as the population grows. Because of shallow excavations and the use of fewer materials, it can be built at considerably lower cost than a Conventional Sewer (C.6).

Health Aspects/Acceptance If well constructed and maintained, sewers are a safe and hygienic means of transporting wastewater. Users must be well trained regarding the health risks associated with removing blockages and maintaining interceptor tanks.

Operation & Maintenance Trained and responsible users are essential to avoid clogging by trash and other solids. Regular desludging of the Septic Tanks is critical to ensure optimal performance of the sewer. Periodic flushing of the pipes is recommended to insure against blockages.
Special precautions should be taken to prevent illegal connections, since it is likely that interceptors would not be installed and solids would enter the system.
The sewerage authority, a private contractor or users committee should be responsible for the management of the system, particularly, to ensure that the interceptors are regularly desludged and to prevent illegal connections.

Pros & Cons

\+ Does not require a minimum gradient or flow velocity
\+ Can be used where water supply is limited
\+ Lower capital costs than conventional gravity sewers; low operating costs
\+ Can be extended as a community grows
\+ Greywater can be managed concurrently
\- Space for interceptors is required
\- Interceptors require regular desludging to prevent clogging
\- Requires training and acceptance to be used correctly
\- Requires repairs and removals of blockages more frequently than a conventional gravity sewer
\- Requires expert design and construction
\- Leakages pose a risk of wastewater exfiltration and groundwater infiltration and are difficult to identify

References & Further Reading

_ Azevedo Netto, J. and Reid, R. (1992). *Innovative and Low-Cost Technologies Utilized in Sewerage.* Technical Series No. 29, Environmental Health Program, Pan American Health Organization, Washington, D.C., US.
(A short summary and component diagrams – Chapter 5)

_ Crites, R. and Tchobanoglous, G. (1998). *Small and Decentralized Wastewater Management Systems.* WCB/McGraw-Hill, New York, US. pp. 355-364.
(A short summary of design and construction considerations)

_ Mara, D. D. (1996a). *Low-Cost Sewerage.* Wiley, Chichester, UK.
(Assessment of different low-cost systems and case studies)

_ Mara, D. D. (1996b). *Low-Cost Urban Sanitation.* Wiley, Chichester, UK. pp. 93-108.
(Comprehensive summary including design examples)

_ Otis, R. J. and Mara, D. D. (1985). *The Design of Small Bore Sewer Systems.* UNDP Interregional Project INT/81/047, The World Bank and UNDP, Washington, D.C., US.
Available at: documents.worldbank.org/curated/en/home
(Comprehensive summary of design, installation and maintenance)