On-site Wastewater Management Training Course

Primary Treatment

Septic Systems

Septic Tank

- Is the most common type of domestic primary treatment system
- Use can be traced back to about 1860 in France and about 1900 in Australia
- Current designs have changed little
- Septic systems and trenches provide the only form of wastewater treatment in many rural communities

Septic Tank

- Provides a quiescent environment in which wastewater can settle and clarify between a settled sludge layer (below) and a surface scum layer (above)
- Accumulated sludge is periodically removed
- Clarified effluent passes downstream to land application or further treatment

AS/NZS1546:1

Details of septic tanks are provided in AS/NZS1546:1 *On-site domestic wastewater treatment units Part 1: Septic tanks*, which covers:

- Performance requirements and criteria
- Design and fittings
- Materials and testing

Septic Tanks

- Watertight, durable concrete, glass fibre reinforced resin or plastic tank

Source: Midwest Concrete

Source: Access Septic

Source: Everhard Industries

Septic Tanks

- Cylindrical, with vertical or horizontal axis, or rectangular in shape

Source: Grahams Concrete Pty Ltd

Source: Tumby Bay Concrete Pty Ltd

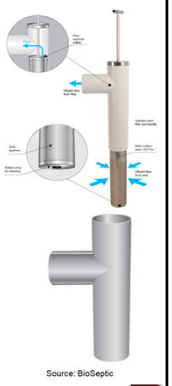
Source: Hynds NZ

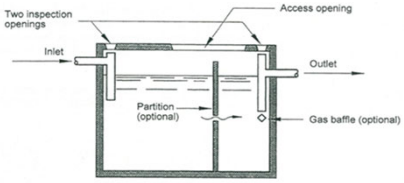
Baffles

- May include a partition or baffle divider to assist with hydraulic buffering and reduce carry-over of solids

Septic Tank Access

- Inverted inlet and outlet fittings, with inspection openings above for access and pump-out





Source: Standards Australia

Source: BioSeptic

Septic Tank Installation

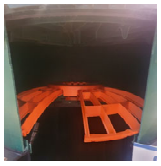
- In ground, with top of tank at or just above ground surface to avoid stormwater ingress

Risers

- If installed below ground a watertight riser is fitted to support access and inspection covers

Safety

- Protection from unintended and accidental access “Kid Catchers”
- Nihal’s Legacy Program - following child death in septic tank, Wallan VIC, March 2023



Ground Anchors

- May require ground anchors to prevent hydrostatic uplift

Primary Treatment

A number of simple processes operate in a septic tank:

- Sedimentation
- Flocculation
- Flotation
- Anaerobic digestion
- Clarification

Sedimentation

- Achieved by density settling in quiescent conditions
- Aided by the flocculation of suspended particles into larger aggregates
- Removes >60% of the suspended solids load
- Sludge or biosolids accumulates at base of tank

Flotation

- Fats, oils, grease, surfactants and other low density materials rise to the surface and form a scum layer
- Scum retained in the tank by an inverted outlet pipe (tee) or baffle
- Scum layer precludes oxygen and creates anaerobic conditions which assists in the breakdown of organic solids

Scum Layer or Crust

Scum Layer or Crust

Anaerobic Digestion

- Organic material retained at the base of the tank undergoes microbiologically facilitated facultative and anaerobic decomposition
- Organic material is converted to stable compounds and gases such as carbon dioxide (CO_2), methane (CH_4) and hydrogen sulphide (H_2S)
- Retained sludge comprised mainly of lignous material that is difficult to decompose and will continue to accumulate

Clarification

- Settled and skimmed wastewater retained within the central portion of the septic tank
- Re-suspension of settled solids is minimised under quiescent conditions
- Tanks are appropriately sized to allow for maximum solids settling
- Effluent is drawn from the clarified liquid between the sludge and scum layers and discharged for further treatment

Septic Tank

- Provides capacity for a minimum of 24 hours hydraulic residence time for daily flow
- Provides storage capacity for accumulated sludge
- Prevents scum from moving downstream
- Starts microbiological degradation to reduce BOD_5, pathogens and settled solids

Septic Tank Capacity

All-waste septic tank capacities (AS/NZS1547:2012)

Persons	Bedrooms	Average daily flow (L)	Tank capacity
1 - 5	1-3	Up to 1,000L	3,000L
6 - 7	4	1,000 - 1,400L	3,500L
8	5	1,400 - 1,600L	4,000L
9 - 10	6	1,600 - 2,000L	4,500L

Source: Standards Australia Standards New Zealand

Sludge Accumulation

- Sludge in a residential all-waste septic tank accumulates at approximately 80L/person/year
- Pumpout interval is determined by tank capacity required for 24-hour residence time for daily load (varies from system to system)
- For example, a 3,000L septic tank provides 24-hour residence time for 1,000L daily load, plus up to 2,000L sludge and scum capacity
  i.e. 5 persons x 80L/person/year x 5 years

Sludge Accumulation

Assess sludge and scum accumulation in a septic tank using either:

- Sludge Judge
- Sludge Depth Indicator
- Pressure sensor operated septic tank monitoring system

Sludge Judge

Sludge Depth Indicator

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Septic Tank Monitoring System

Comprises:

- Control Panel and Modem
- Tank Sensor
- Apparatus Controller
- Distribution Pit Sensors
- Flow Improvement Control System
- Central Data Repository and Management System

Source: Samaran International

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Sludge Accumulation and Removal

- Sludge accumulates at base of tank
- Progressively reduces the effective capacity of system and will require periodic removal

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Septic Tank Effluent Quality

Parameter	Untreated domestic wastewater	Primary treated effluent
BOD_5	200 - 300 mg/L	~ 150 mg/L
Suspended Solids	200 - 300 mg/L	~ 50 mg/L
Total Nitrogen	20 - 100 mg/L	50 - 60 mg/L
Total Phosphorus	10 - 25 mg/L	10 - 15 mg/L
Faecal Coliforms	10^3 - 10^{10} cfu/100mL	10^5 - 10^7 cfu/100mL

Source: NSW DLG

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Primary Treatment

- Capable of removing approximately 25-35% of the BOD_5 load and greater than 60% of the suspended solids load in raw domestic wastewater
- Solids accumulate in the base of the septic tank and liquids are discharged for further treatment
- Floating material (scum) accumulates on the liquid surface and provides an air tight seal, creating anaerobic conditions

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Outcomes

- Moderate reduction in the TN load
- Slight reduction in the TP load
- Limited pathogen removal
- High bacterial counts remain in effluent
- Septic tank effluent not suitable for direct environmental discharge
- Further or Secondary treatment is necessary using soil based systems or aerobic processes (AWTS or sand filter etc.)

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Improving Septic Tank Performance

- Simplest way to improve the performance of a standard septic tank is to fit or retrofit the outlet with an outlet filter
- Filters of various designs are commercially available and can reduce the impacts of solids carry over to the land application area or secondary treatment system
- Should prevent discharge of solids >3mm particle size and achieve TSS <100mg/L
- Filters have a large surface area to limit clogging and reduce maintenance requirements
- However, they do require periodic inspection and cleaning
- Now required in all systems in Victoria

Septic Tank Outlet Filters

Fitting a Septic Tank Outlet Filter

Cleaning a Septic Tank Outlet Filter

Outlet Filter Performance

	Concentration (mg/L)			
Parameter	Typical ST effluent	Without effluent filter	With effluent filter	% Improvement
BOD_5	450	180	130	28%
TSS	503	80	50	38%
NH_3-N	41	40	40	0%
Org. N-N	29	28	28	0%
TKN-N	70	68	68	0%
Org. P-P	6.5	6	6	0%
Inorg. P-P	11	10	10	0%
TP	17	16	16	0%
Oil and grease	164	25	15	40%

Source: Crites & Tchobanoglous 1998

References

- Care and maintenance of residential septic systems (2002) B3583, University of Wisconsin-Extension
- Bounds, T.R., " Design and Performance of Septic Tanks," Site Characterization and Design of Onsite Septic Systems ASTM STP 901, M.S. Bedinger, A.I. Johnson, and J.S. Fleming, Eds., American Society for Testing Materials, Philadelphia, 1997.
- Stafford, D. and Whitehead J.H. 2005. *Septic Tank Outlet Filters.* In Patterson, R.A. and Jones, M.J. eds. On-site '05 Performance Assessment of On-site Systems. Lanfax Laboratories, Armidale, September 2005.
- Stafford, D. and Whitehead J.H. 2007. *Performance of Septic Tank Outlet Filters.* In Patterson, R.A. and Jones, M.J. eds. On-site '07 Innovation and Technology for On-site Systems. Lanfax Laboratories. Armidale, September 2007.

Septic Tank Calculations

Question 1.

A new three bedroom house is supplied with reticulated water and has a 3,000L septic tank installed on construction. Assume that five people occupy the house.

(i) Calculate the daily hydraulic load based on a design hydraulic load of 150L/person/day.

(ii) Calculate the detention time of effluent in the septic tank at the outset.

(iii) If sludge accumulates at the rate of 80L/person/year, calculate the amount of sludge that will accumulate in one year.

Question 2.

An older three bedroom house is supplied with reticulated water and is occupied by three people. On inspection, it is determined that the septic tank is of 2,300L capacity, but the tank is half full of sludge.

(i) Calculate the daily hydraulic load based on a design hydraulic load of 150L/person/day.

(ii) Calculate the annual sludge accumulation based on a sludge accumulation rate of 80L/person/year.

(iii) A minimum of 24 hours detention must be maintained in the tank at all times. Calculate the length of time remaining before a pumpout will be required.

Septic Tank Calculations

ANSWERS

Question 1.

(i) Daily hydraulic load = 5 x 150L/person/day = 750L/day

(ii) Septic tank volume = 3,000L

Daily hydraulic load = 750L/day

Detention time = 3,000L / 750L/day = 4 days

(iii) Occupancy = 5 persons

Sludge accumulation rate = 80L/person/year

Annual sludge accumulation = 5 persons x 80L/person/year = 400L/year

Question 2.

(i) Daily hydraulic load = 3 x 150L/person/day = 450L/day

(ii) Occupancy = 3 persons

Sludge accumulation rate = 80L/person/year

Annual sludge accumulation rate = 3 persons x 80L/person/year = 240L/year

(iii) Tank capacity = 2,300L

Daily hydraulic load = 450L

Volume of sludge in tank = 2,300L / 2 = 1,150L

Volume available for further sludge accumulation = 1,150L – 450L = 700L

Sludge accumulation rate = 240L / year

Maximum time remaining prior to pumpout 700L / 240L/year = 2.9 years