On-site Wastewater Management Training Course

Secondary Treatment

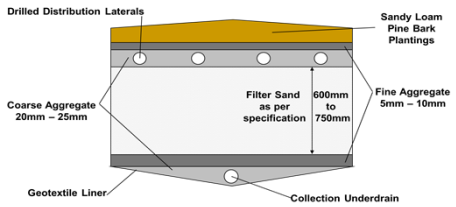
Sand Filters, Media Filters and Mound Systems

Sand Filter

- Aerobic treatment provided by trickling primary treated effluent though 600mm - 900mm sand bed (packed bed)
- Biofilm develops on media surface
- In contact with air in pore spaces in media
- Media contained within an impermeable liner
- May be above, partially above, or below ground
- Filter surface may be open or covered

Single-pass Layout

- Simple design and installation
- Gravity distribution via low-pressure manifold

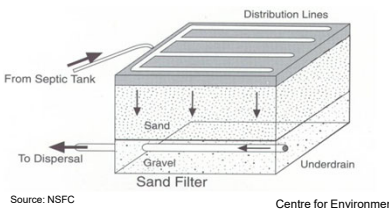


Treatment

- Acquired in a single pass through media
- Effectiveness dependent on hydraulic and organic load
- Hydraulic conductivity determined by media characteristics (particle size distribution)
  - Hydraulic design rule = 50L/m^2/d
  - Organic (BOD_5) design rule = 25g/m^2/d
- Typically achieves BOD_5/TSS: 20/30mg/L or better (secondary)

Design Philosophy

- Historically gravity fed with demand dosing
- Results in uneven distribution and may lead to creeping failure and clogging of media

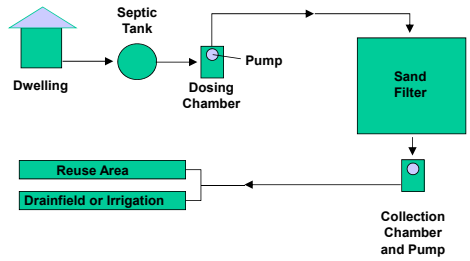


Source: NSFC

Improved Efficiency

- Pressure dosing for more even distribution
- Small and frequent ‘timed’ doses

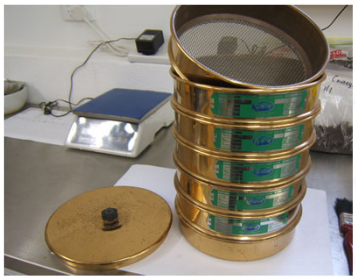
Typical System Configuration

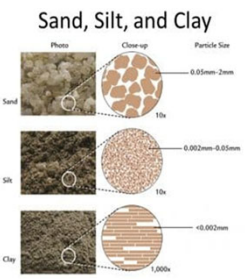


Filter Sand Considerations

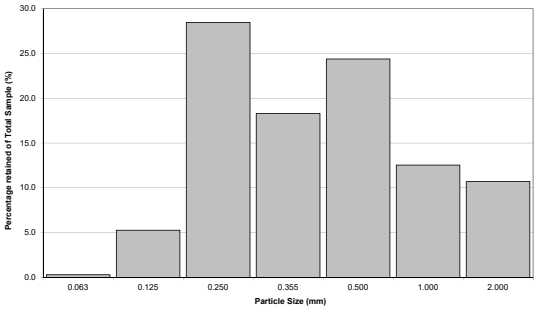
- Sand sieved for particle size analysis (PSA)
- Plot histogram or cumulative frequency curve
- Required Filter Sand spec:
  - <3% clay and fine silt (<0.006mm)
  - Effective size (ES) (d_{10} - smallest 10% diameter) between 0.25mm and 1.00mm
  - Uniformity coefficient (UC) (d_{60}/d_{10}) = <4

Sieve Analysis

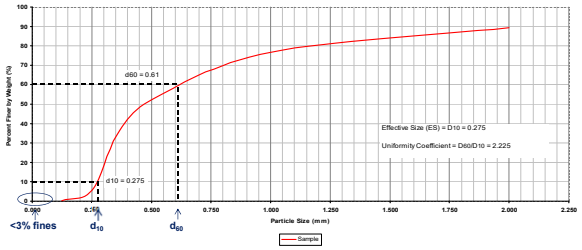




Histogram



Cumulative Frequency Curve



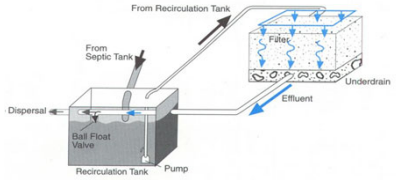
Bottomless Sand Filter

- Treatment and land application in single footprint

Source: W Cromer

Recirculating Filter

- Acquires treatment in several passes
- Higher hydraulic conductivity media – gravel
- Permits higher aerial loading rate



Sand Filter Construction

Liner

Sand Filter Construction

Underdrain and gravel bed

Sand Filter Construction

Filter sand and distribution bed

Sand Filter Construction

Drilling manifold 'orifices'

Sand Filter Construction

Distribution manifold

Testing Distribution System

Uniform squirt height

Completed Sand Filter

Completed Sand Filter

Media Filters

- Variety of alternative filter media used
- Some modify or enhance performance of traditional sands and gravels
- Others are economically viable alternatives
  - Peat
  - Foam
  - Fabric
  - Amended soils

Peat Filter

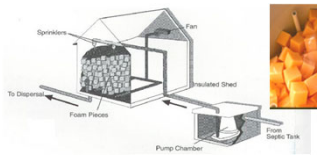
Bioflow modules, Bord na Mona, USA

Peat Filter

Peat Biofilter installation, VIC

Foam Filter

- Foam filters
- Provide some physical filtration
- Combine porosity and high surface area
- Main function as surface for biofilm growth



Source: Quanics

Foam Filter

Waterloo Biofilter, Canada

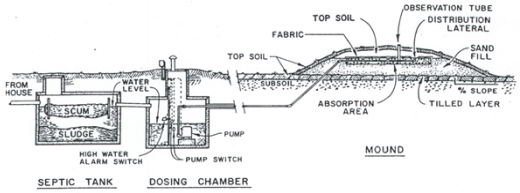
Fabric Filter

- Hydraulic loading rate = up to 1,000L/m^2
- 96 'doses' per day (15 min intervals)
- Recirculation rate ~3-5 times

Orenco Advantex fabric filter

Mound Systems

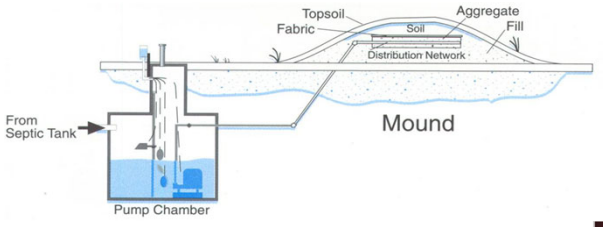
- Developed in 1970s
- Incorporated in Wisconsin Code in 1980s
- Over 30,000 Wisconsin mounds in Wisconsin



Source: Converse 2000

Wisconsin Mound Systems

- Mound Systems are in effect bottomless intermittent sand filters



Source: NSFC

Wisconsin Mound Systems

- Soil absorption systems
- Elevated above natural soil surface
- Uses suitable fill such as quality sand media
- Pretreated effluent is dosed to the mound
- Overcome site restrictions such as:
  - slowly permeable soils
  - shallow permeable soils over porous bedrock
  - permeable soils with high water table

Wisconsin Mound Systems

Wisconsin Mound Systems

Design considerations:

- Aligned on contour
- Ground suitably prepared
- Appropriate materials and construction
- Sand loading rate – at distribution manifold
- Linear loading rate – across slope
- Basal loading rate – on soil at base of mound

Completed Wisconsin Mound

Completed Wisconsin Mound

Completed Wisconsin Mound

Alternative Vegetation Cover

Treatment Performance of Sand Filters and Mound Systems

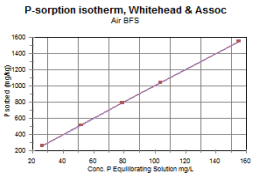
	BOD_5 (% removal)	TSS (% removal)	TN (% removal)	FC (% removal)
Intermittent sand filter / Mound	90-98	90-95	14-50	97-99
Recirculating sand filter	95-99	81-95	45-82	97-99

Source: Crites and Tchobanoglous (1998)

Amended Soil Systems

Use soil or alternative media for nutrient reduction

- P-sorption
  - Gypsum amended red mud (by-product of bauxite refining for aluminium)
  - Air-dried Blast Furnace Slag
- N reduction
  - Zeolite



Ecomax System, WA

Ecomax System, WA

Ecomax System, NSW

Ecomax System, NSW

Ecomax Mound at School, NSW

Amended Ecomax Design

Source: Ecomax NSW

Ecomax Hydraulic Overload

Flat bed limits rainfall runoff and evapotranspiration

References

- Converse, JC & Tyler EJ (2000). Wisconsin Mound Soil Absorption System: Siting, Design and Construction Manual, #15.24, University of Wisconsin-Madison, Small Scale Waste Management Project.

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- Cromer, WC (2013). Bottomless sand filters: Notes for designers, installers and regulators July 2013. Land application systems for domestic wastewater management. Unpublished report by William C Cromer Pty Ltd, 1 December 2013.
- Whitehead, J & Geary P (2009). Sand Mounds for Effective Domestic Effluent Management, Water 36, 1 (pp 27-32).

References

- A guide to installing a sand mound to manage onsite wastewater, WaterNSW, https://vimeo.com/72859822