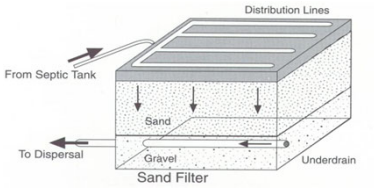
On-site Wastewater Management Training Course

Secondary Treatment

Sand Filters, Media Filters and Mound Systems

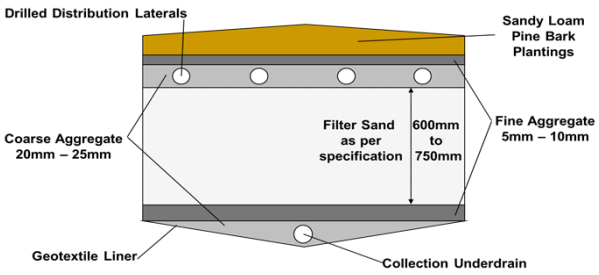
Aerobic Sand Filters

- Historically gravity fed with demand dosing
- Can result in uneven distribution and may lead to creeping failure and clogging of media
- Primary (septic tank) pre-treatment required



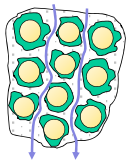
Source: NSFC

Typical Form



Treatment Process

- 'Passive' aerobic treatment provided by trickling (primary) effluent though 600mm - 900mm of select sand (packed bed)
- Biofilm develops on media surfaces
- Biofilm in contact with air in pore spaces in media
- Treatment acquired in a single pass through media
- Effectiveness dependent on hydraulic and organic load



Treatment Performance

- Hydraulic Loading Rate (HLR) - rate at which effluent is added to the surface of the filter (L/m^2)
- Significant effect on treatment effectiveness
- If HLR too high, saturated conditions dominate and effluent may by-pass treatment, moving rapidly through the bed
- Excess organic loading (high BOD) can also significantly impact treatment performance (clogging, anaerobic conditions)

ASF Sizing

- In sizing ASF, we apply 2 general rules for design:
- Hydraulic loading rate = $50L/m^2/d$
- Organic (BOD) loading rate = $25g/m^2/d$
- ASF sized using these criteria will typically achieve minimum secondary effluent standard
- BOD_5/TSS: 20/30mg/L (or better)

ASF Sizing - Example

- Effluent Spec = 900L/day and 150mg/L BOD
- Hydraulic Load rule
  - 900L/day ÷ 50L/m^2/day = 18m^2
- Organic Load rule
  - 900L/day x 150mg/L = 135,000mg/day
  - 135,000mg/day / (1,000mg/g) = 135g/day
  - 135g/day (BOD) ÷ 25g/m^2/day = 5.4m^2

Typical ASF Installation

- Constructed within durable impermeable liner or container
- Installed above, partially above, or below ground
- Partial or full pressure distribution
- Gravel (20-40mm washed aggregate) – used for underdrain and distribution bed
- Pea gravel (5-10mm) used for separation
- Filter surface may be open or covered – contact with atmosphere must be maintained

Filter Sand Considerations

To achieve 20/30 standard:

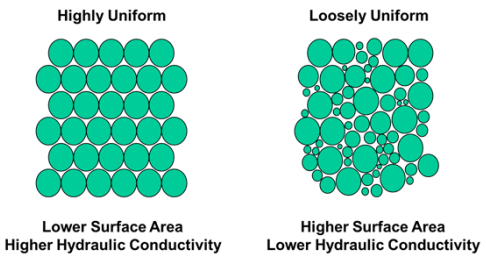
- Sand sieved for particle size analysis (PSA)
- Plot histogram and cumulative frequency curve

- Filter sand <3% clay and fine silt (<0.074mm)
- Effective size (ES) (d_{10} - smallest 10% diameter) between 0.25mm and 1.00mm
- Uniformity coefficient (UC) (d_{60}/d_{10}) <4

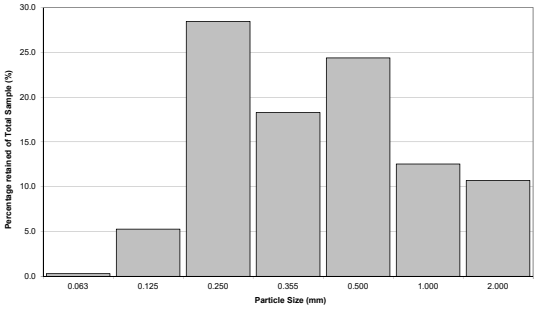
Media Size and Grading

- Sands, and most other gradational filter media, contain a variety of grain sizes
- Media with a diverse range of grain sizes will pack much more tightly, providing a large surface area for biofilm growth, but hydraulic conductivity and air-flux may be low
- Media with a narrow range of grain sizes will pack in a loose uniform manner, providing less surface area, but increased hydraulic conductivity and air-flux

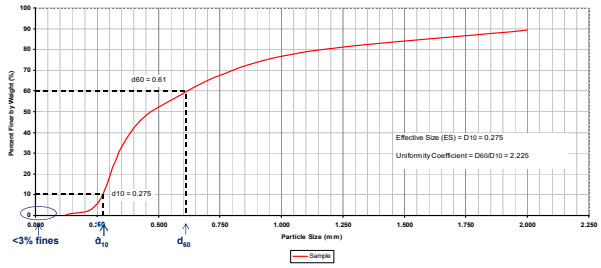
Media Size and Grading



Histogram



Cumulative Frequency Curve

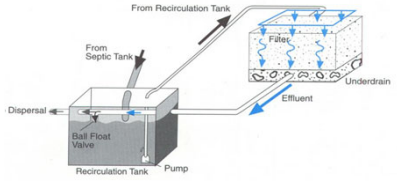


Improving Performance

- Septic outlet filter
- Pressure distribution – pump / drilled manifold
- Timed dosing
  - Smaller dosing volumes
  - Regular application throughout day (12-24 times)
- Recirculation

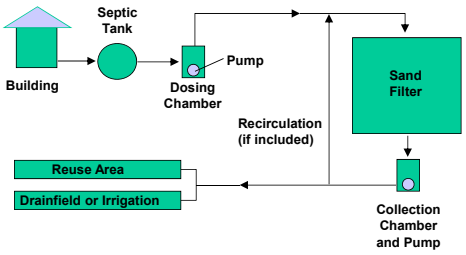
Recirculating Sand/Media Filter

- Allows treatment across several filter passes
- Higher hydraulic conductivity media – gravel
- Permits higher aerial loading rate
- Treated effluent proportionally released to LAA



Source: NSFC

Typical System Configuration



Sand Filter Construction

Liner

Sand Filter Construction

Underdrain and gravel bed

Sand Filter Construction

Filter sand and distribution bed

Sand Filter Construction

Drilled Manifold (orifices)

Sand Filter Construction

Distribution manifold

Pressure Testing

Uniform squirt height

Completed Sand Filter

Bottomless Sand Filter

- Single-pass ASF, with soil absorption
- Treatment and land application in single footprint
- Critical to consider hydraulic contrast at interface

Source: W Cromer

Alternative Filter Media

- Some modify or enhance performance of traditional sands and gravels:
  - Amended systems (i.e. adsorption materials)
- Others are economically viable alternatives:
  - Peat
  - Foam
  - Fabric

Peat Filter

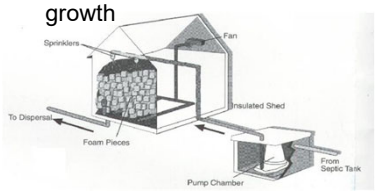
Bioflow modules, Bord na Mona, USA

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

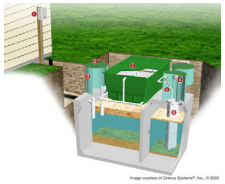


Source: Quanics

Recirculating Fabric Filter

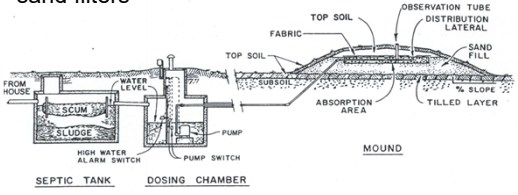
- Offer significant improvement in surface loading efficiency (up to 1,000L/m^2/day)
- High recirculation rate (96x per day)
- Large primary (septic) and recirculation tank requirements

Source: Innoflow NZ



Wisconsin Mound Systems

- Developed in 1970s
- Over 30,000 Wisconsin mounds in Wisconsin
- In effect, bottomless intermittent (single-pass) sand filters



Source: Converse 2000

Sand Mound Systems

- Soil absorption systems
- Elevated above natural soil surface
- Uses suitable fill such as quality sand media
- Pretreated (septic) 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

Sand Mound Systems

Sand Mound Design

Design considerations:

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

Sand Loading Rate

- Sand loading rate (SLR) – mm/day
  - at distribution gravel / sand interface
  - affected by effluent quality
  - AS/NZS 1547:2012 suggests <40mm/day
  - Acceptable range - 40 (primary) to 50 (secondary)
- Rate at which effluent contacts the sand bed surface
- Critical to ensure sufficient depth (~400mm) if topsoil selected

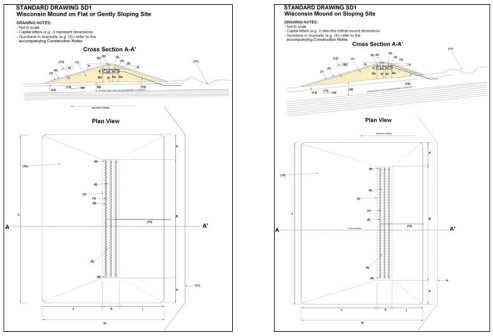
Basal Loading Rate

- Basal loading rate (BLR) – mm/day
  - at sand / natural soil interface
  - from Table N1 in AS/NZS 1547:2012
  - select for the limiting soil layer
  - 8 (light clay) to 32 (sand) mm/day
- Rate at which effluent contacts the natural (underlying) soil
- Critical to ensure sufficient depth (~400mm) if topsoil selected

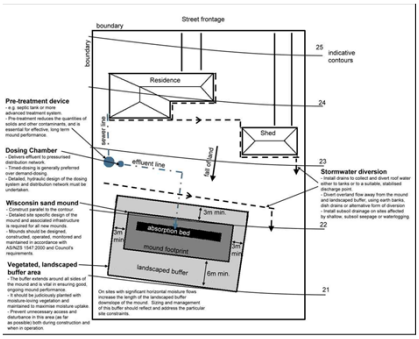
Linear Loading Rate

- Linear loading rate (LLR) – L/m/day
  - effluent application rate parallel to slope
  - based on water movement away from the mound, i.e. mainly vertical, horizontal, or both
  - affected by slope (%) and soil (type / thickness)
  - AS/NZS 1547:2012 suggests 50 (minimum)
  - Acceptable range - 30 to 125 L/m/day
- Rate at which effluent is loaded 'across' the contour

Standard Mound Drawings



Generic Site Layout



Completed Sand Mound

Source: B Barens

Completed Sand Mound

Completed Sand Mound

Alternative Vegetation Cover

Ecomax Amended Mound System

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)

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.

References

- 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