

On-site Wastewater Management Training Course

Secondary Treatment

Sand Filters, Media Filters and Mound Systems

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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 = $50\text{L}/\text{m}^2/\text{d}$
 - Organic (BOD_5) design rule = $25\text{g}/\text{m}^2/\text{d}$
- Typically achieves BOD_5/TSS : 20/30mg/L or better (secondary)

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Sand Filter

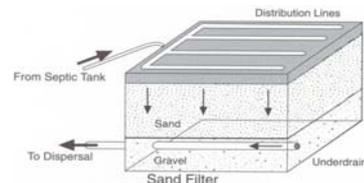
- Aerobic treatment provided by trickling primary treated effluent through 600mm - 900mm sand bed (packed bed)
- Biofilm develops on media surface
- In contact with air in pore spaces in media
- Media contained within an impermeable liner
- May be above, partially above, or below ground
- Filter surface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

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Design Philosophy

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



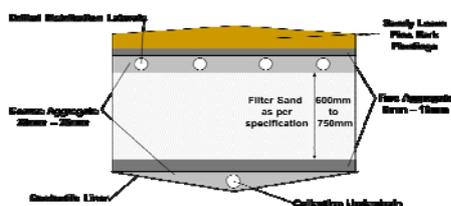
Source: NSFC

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Single-pass Layout

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



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Improved Efficiency

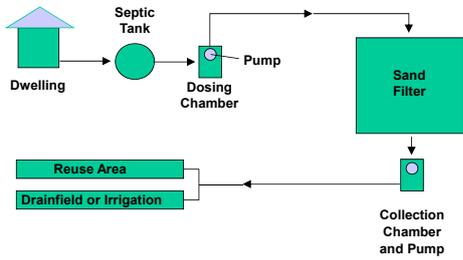
- Pressure dosing for more even distribution
- Small and frequent 'timed' doses



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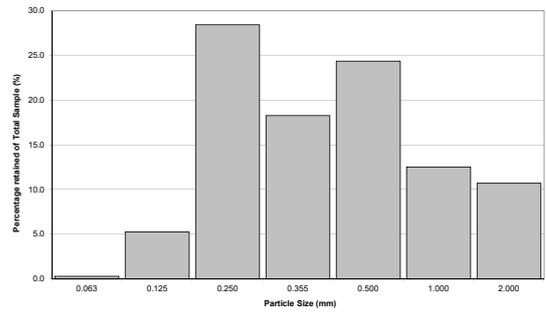
Typical System Configuration



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Histogram



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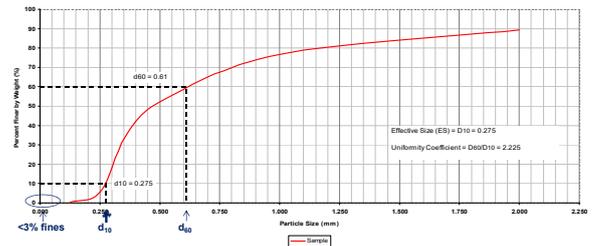
Filter Sand Considerations

- 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

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Cumulative Frequency Curve



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Sieve Analysis



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Bottomless Sand Filter

- Treatment and land application in single footprint



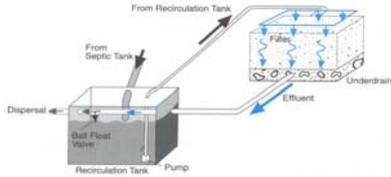
Source: W Cromer

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Recirculating Media Filter

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



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Sand Filter Construction



Filter sand and distribution bed

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Liner

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Drilling manifold 'orifices'

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Underdrain and gravel bed

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Distribution manifold

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Testing Distribution System



Uniform squirt height

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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

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Completed Sand Filter



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Peat Filter



Bioflow modules, Bord na Mona, USA

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Completed Sand Filter



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Peat Filter



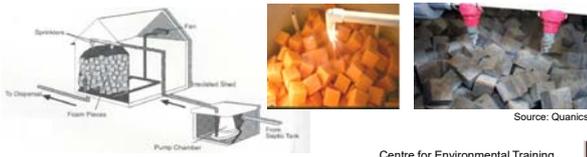
Peat Biofilter installation, VIC

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Foam Filter

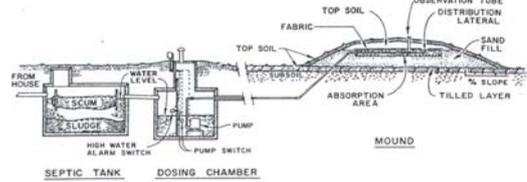
- Foam filters
- Provide some physical filtration
- Combine porosity and high surface area
- Main function as surface for biofilm growth



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Mound Systems

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



Source: Converse 2000

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Foam Filter

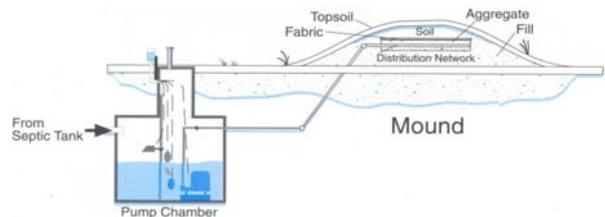


Waterloo Biofilter, Canada

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Wisconsin Mound Systems

- Mound Systems are in effect bottomless intermittent sand filters



Source: NSFIC

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Fabric Filter

- Hydraulic loading rate = up to 1,000L/m²
- 96 'doses' per day (15 min intervals)
- Recirculation rate ~3-5 times



Orenco Advantex fabric filter

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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

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Wisconsin Mound Systems



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Completed Wisconsin Mound



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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

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Completed Wisconsin Mound



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Completed Wisconsin Mound



Source: B. Banens

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Alternative Vegetation Cover



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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)

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Ecomax System, WA



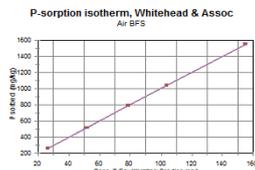
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Amended Soil Systems

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



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Ecomax System, NSW



Source: Ecomax NSW

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Ecomax System, WA



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Ecomax System, NSW



Source: Ecomax NSW

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Ecomax Mound at School, NSW



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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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Amended Ecomax Design



Source: Ecomax NSW

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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).

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Ecomax Hydraulic Overload



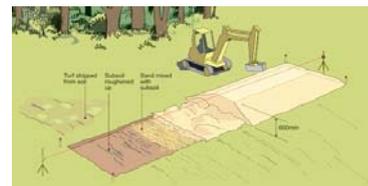
Flat bed limits rainfall runoff and evapotranspiration

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References

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



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