On-site Wastewater Management Training Course

Other Primary Treatment Systems and Greywater Options

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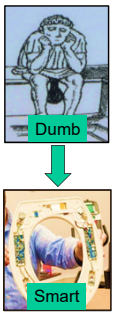
Primary Waste Toilet Treatment Systems

- Flush away (gravity, single, dual, micro etc)
- Chemical (addition of solution and may involve maceration)
- Composting (waterless or dry)
- Biological filter systems (vermiculture)
- Hybrid toilet
- Urine diversion (UD) systems
- "Smart" toilets (uses sensors to analyse waste and even health of user e.g. heart scan)



Some of these systems have the potential to reduce water use and capture nutrients, but there is a need to also consider greywater separation and treatment options

Aerobic/Anaerobic Decomposition

Organic solids are readily broken down into more stable inorganic compounds by bacteria and other micro-organisms

Aerobic oxidation

Organic matter + bacteria + O_2 → New cells
Organic matter + bacteria + O_2 → CO_2, NH_3, H_2O

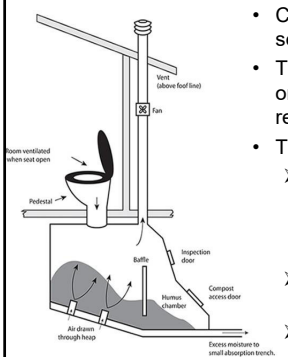
Anaerobic oxidation

Organic matter + bacteria → New cells
Organic matter + bacteria → Intermediate products + bacteria → New cells
Intermediate products + bacteria → CH_4, H_2S, CO_2, NH_3, H_2O

Composting Toilets

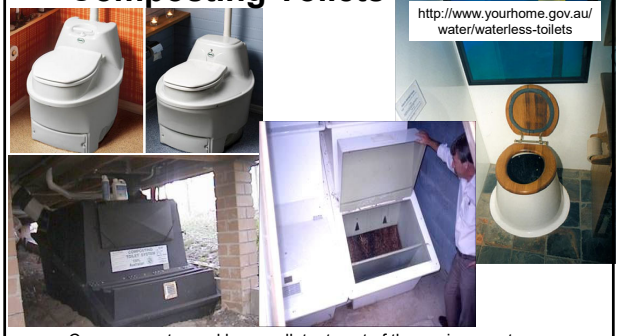
- Rely on actions of microorganisms in an aerobic environment to decompose organic material into humus like material which must be periodically removed
- Systems usually dry (waterless), although wet system available incorporating vermiculture
- Success is dependent to a large degree upon the commitment of the homeowner
- Liquid waste still requires disposal and necessary to install a greywater treatment and LA system
- Refer to requirements of AS 1546.2 Part 2: Waterless Composting Toilets

Composting Toilets



- Can take either all toilet waste or separate the solids and urine
- Typically faecal solids collected in one or several containers and replaced when full
- Types of container systems:
  - Continuous - single container where toilet waste decomposes and moves through chamber or large vault
  - Batch - two or more containers, one active and one fallow
  - Self-contained with heating element and fan

Composting Toilets



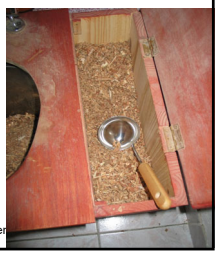
- Conserve water and keep pollutants out of the environment
- Humus needs to be periodically removed and buried
- Liquid directed to urine trenches or evaporated

Control Variables

- Optimum composting achieved with C:N ratio approaching 30:1 - excreta requires added carbon source to balance C:N ratio; 12-month composting period before subsurface disposal
- Moisture content needs to be reduced to 12-40% - adequate ventilation required to enhance moisture:air ratio

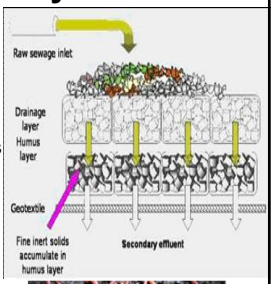
http://www.yourhome.gov.au/water/waterless-toilets

Odours	None, inoffensive
Consistency	Friable, humus
C:N ratio	> 14:1
Microbiological Criteria	< 200cfu/g Thermotolerant coliforms



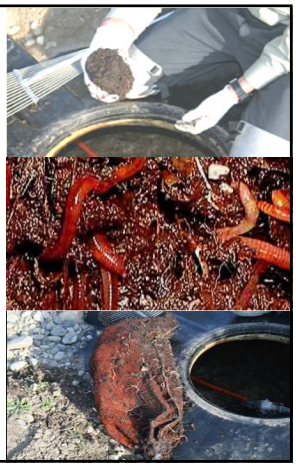
Biological Filter Systems

- "Wet" composting systems that are comprised of different filtering mediums
- Earthworms and bacteria breakdown and consume the solid residuals and liquid organics
- Consist of several layers - worms and finely structured humus and coco-peat layer and geofabric layer
- Worms aerate the entire system, which allows the aerobic bacteria to survive and convert waste into humus and maintain drainage and air porosity

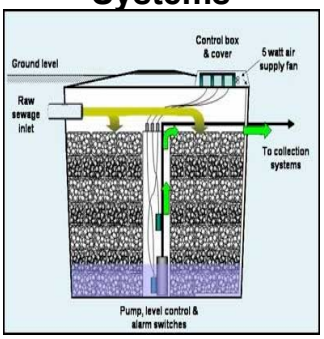


Vermiculture (worm-based)

- Aerobic process, low or no odour
- Mechanical components - single-phase industrial strength pump + small air pump
- Secondary effluent land applied
- Requires some maintenance



Biological Filter Systems



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Hybrid Toilet System

- Two-tank system involving primary and secondary tanks – separation chamber in primary tank allows liquids to pass
- Aeration provided by standard rotary ventilation.
- Second tank contains maze of plastic pipe media which allows biofilm to develop and results in long retention time before discharge
- Treated effluent of higher quality discharged to ground in land application area or to holding tank
- Used successfully in remote and low use areas

Source: https://www.gough.com.au/hts/commercial/photo.php#

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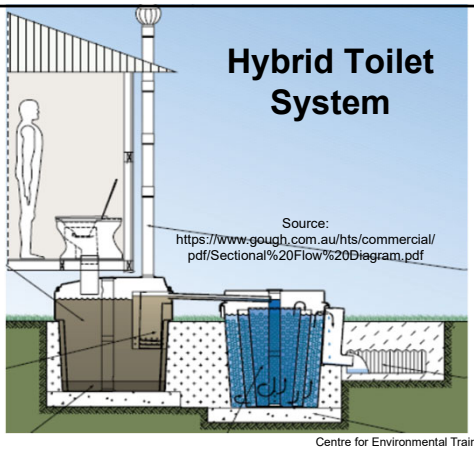
Hybrid Toilet System



Source: https://www.gough.com.au/hts/commercial/pdf/Sectional%20Flow%20Diagram.pdf

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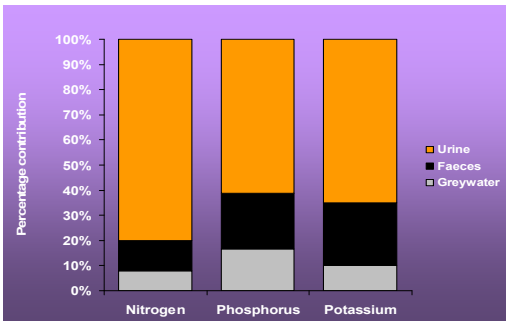
Percent Nutrients in Wastewater

80% N, 60% P, 70% K of all nutrients in domestic wastewater are in urine



Yellow is the New "Grey"

- UST used in Europe for many years to separate urine from faeces and N, P, K at source to avoid mixing with faecal matter
- Reduces water use and nutrient discharge
- Stored dehydrated urine can be used as alternative fertiliser in agriculture
- Closes the "nutrient loop"
- Global P scarcity!

Urine Diversion Systems

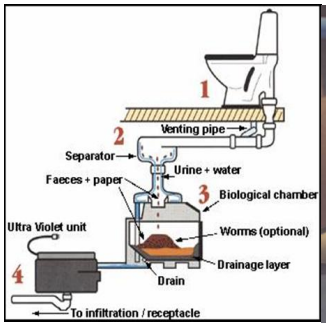
- Urine separating or diverting toilets - liquid fraction separated by manual use or centrifugal force and gravity
- Urine pipe diverts liquid to collection vessel e.g. bladder

Urine Collection Storage and Reuse

300L Storage Bladder

Nutrients in urine: pollute waterways but useful fertilsers for crop growth

Aquatron Separator



Uses centrifugal force and gravity to separate liquids and solids – schematic shows Collecting Chamber and Ultraviolet Unit (Source: www.aquatron.se)

Research Trials

- Continuing trials in Brisbane and Sydney through UTS and Griffith Universities (Nutrients in a Circular Economy Project)
- Currumbin Ecovillage, QLD - 20 households used Gustavsberg toilets over 2 years – sustainable living philosophy part of design to maximise conservation and/or recycling of resources
- Kinglake West, VIC – Yarra Valley Water project to examine sustainable sewerage solutions; 23 households participated to investigate yellow water harvesting, greywater systems and STEP tanks
- *Results at Kinglake indicated no significant reduction in nutrient load going to STP, although harvested nutrients delivered agronomic benefits (irrigation to turf farm). As a fertilizer though, significantly more expensive than commercially available fertilisers; high costs due to dilution of urine with toilet flush water and management of increased volumes*

Domestic Greywater

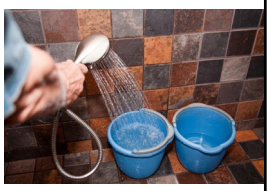
- Greywater contains some pathogenic micro-organisms (see table)
- Kitchen greywater typically not reused (due to quality) while bathroom and laundry may be
- Typically contains particles of dirt, food, lint, sand, some of which can be removed by basic filtering
- Also contains inorganic salts (sodium) and organics such as oils, fats, milk, soap and detergents (plus N, P and K)
- Has potential to cause unpleasant odours and contribute to environmental problems off-site

Source	Rose *et al.* (1991)
Bathing/ Shower water	6 x 10^3 cfu
Laundry wash water	126 cfu
Laundry rinse water	25 cfu
Combined wastewater	6 to 80 cfu 1.5 x 10^3 cfu

FCs – cfu/100mL

Reuse Options – Manual Bucketing

- Considered low risk but contaminants still present as no treatment
- Reuse of relatively small volumes
- Bath, shower or laundry water collected manually
- Can also bucket water for direct toilet flushing but not to be added to cistern
- With water shortages option more commonly used



Diversion Using Gravity or Pumping

- Greywater is untreated so must be used when generated
- Gravity Diversion appropriate where slope away from house
- Pump Diversion requires surge tank and backflow protection; electrically operated pump
- Both devices should have tap, valve or switch to provide for diversion to garden or to sewer (but some do not)
- Distributed through subsurface irrigation (min. 10 cm) and requires careful management
- Considered low to medium risk activity with reduced risk of pathogen exposure

Gravity Device

Pump Device

Treatment Systems

- Collects, stores, treats using mechanical and biological processes and may disinfect greywater
- Appropriately treated greywater can be reused for subsurface and surface irrigation and for in-house use such as toilet flushing and laundry
- Most States accredit treatment systems and installation must be Council approved; installed by a licensed plumber and maintained
- Refer also to AS 1546.4 2016 Part 4: Domestic Greywater Treatment Systems

Examples

Subsurface Irrigation

- Leaky pipe, soaker hoses, ag pipe, sullage drain, poly drain etc

Further Reading

- AS/NZS 1546 On-site Domestic Wastewater Treatment Units: Part 2: Waterless Composting Toilets (2008); Part 4: Domestic Greywater Treatment Systems (2016)
- Beal, C. *et al* (2008) Urine-Separation and Reuse Trial, *Water*, 35(1), February, 66-69
- Beal C.D, Fam D. & Clegg S (2020), Over-promising and under-delivering: institutional and social networks influencing the emergence of urine diversion systems in Queensland, Australia. See: file:///C:/Users/philg/Downloads/Bealetal2020_UDSlessonslearnt_preprint.pdf
- Fernando, R. *et al* (2014) Decentralised Sewerage Servicing – Evaluation of a Yellow Water, Greywater and Blackwater Trial, *Water*, 41(7), November, 41-53
- NSW Department of Water and Energy (2007) Greywater Fact Sheets - No. 2 Choosing the Right Greywater System For Your Needs
- Wald, C. (2022) How Recycling Urine Could Help Save The World, *Nature*, 602, 10 February, 202-206