B3
Wastewater

Guiding principles

Access and equity: Access to appropriate, affordable and effective sanitation affects a community's overall health and standard of living. Improving sanitation is an important part of improving the health of Indigenous people, particularly those living in remote and rural Australia.

Health and safety: Wastewater around houses and backyards is a major health risk, and governments and communities can find it challenging to adequately inform residents about these risks.

Environmental health: Inadequate water supply and poor sanitation increase the prevalence of diseases including hepatitis B, gastroenteritis and trachoma.

Appropriateness: Developing an appropriate sanitation system for a community is an important step towards reducing health risks associated with waterborne pathogens. Designers, manufacturers and installers of wastewater treatment systems must ensure that systems are correctly sized, installed and maintained, to make it easier for the community to use them. Designers should consider the community's location (including climate) to reduce the risk of system failures.

Affordability: Purchasing and installing sanitation infrastructure can be a significant cost for a community, and operating and maintaining a wastewater treatment system has ongoing costs. These costs should be weighed up against how much the system will be used and how easy it will be to use, and the environmental health benefits for the community.

Sustainable livelihoods: Each individual, household and community can take action to make water supplies more sustainable, especially in remote areas where water is scarce. One important action is to reuse wastewater from greywater and blackwater.

Systems overview

Treatment methods

Wastewater is treated in several stages — each stage provides higher quality water, with higher levels of protection against biological health risks. However, more treatment requires more advanced technology, with higher costs for construction, operation and maintenance.

Pretreatment involves screening to remove large objects (such as sticks, plant matter or bones) that may reduce the longevity and effectiveness of the treatment system.

Primary treatment involves the removal of solid matter, often using sedimentation, filtration and anaerobic microorganisms. An example of primary treatment is a septic tank, alone or with an absorption trench.

Secondary treatment then removes smaller particles by filtering the water through fine membranes; aeration tanks with aerobic microorganisms are also often used.

Tertiary treatment reduces risks to human health. For example, disinfectant or reed beds and sand filtration may be used to reduce the amount of pathogens in the wastewater.

Advanced treatment systems often use ultraviolet (UV) radiation to remove remaining pathogens and bacteria. This is the only treatment method that may be used on certain food crops: check current state or territory legislation.

Technology

Two levels of technology are available for sewage treatment:

Low-technology systems are often older, simpler systems that can be used in almost every situation, without using methods like flushing, or in situations with limited or no access to electricity. Low technology alternatives include pit latrines, pan collection, vaulted toilets, pour flush toilets and chemical toilets.

High-technology systems use modern equipment and provide greater protection against direct contact with pathogens, reducing health risks. However, the capital and maintenance costs associated with these systems are higher.

Both low-technology and high-technology systems allow residents to manage on-site wastewater, and are suitable for small Indigenous communities and outstations.

Wastewater from Indigenous communities can be managed in on-site localised (household) systems or off-site centralised (community) systems. Both systems use anaerobic and aerobic microorganisms to break down waste matter. However, chemicals such as solvents, paints, oils, pesticides, disinfectants and household cleaner products can kill these microorganisms, reducing the system’s effectiveness.

On-site treatment and disposal systems

On-site treatment and disposal systems usually store and treat wastewater on a property. On-site treatment includes low-technology options (an underground septic tank or pit or composting toilets) and high-technology options (an aerated water treatment system that filters primary and secondary treated wastewater to an absorption trench or reed bed).

Off-site treatment and disposal systems

Off-site treatment systems collect and dispose wastewater from many households in a single location. Treatment systems include conventional wastewater treatment plants, lagoons and constructed wetlands, fully centralised sewerage systems and common effluent disposal systems.

Involving the community

Knowledge of healthy living practices is essential for healthy, sustainable Indigenous communities. Individuals and community leaders must be involved in developing suitable wastewater management strategies to ensure the health of their community, particularly in the maintenance of the systems.

Ensure that:

- all community members understand that disease-causing agents are carried in wastewater
- all community members understand the importance of washing hands after using the toilet
- community members have a basic understanding of the community's sanitation system, particularly in relation to repairs (for example, whether a maintenance job requires a qualified plumber or an essential services officer)
- community members who maintain systems follow appropriate risk minimisation strategies, such as using approved cleaning agents and wearing protective clothing
- community members know which materials can be disposed of in the sanitation system (biological materials that can be broken down by anaerobic or aerobic decomposition)
- material to promote occupational health and safety (such as diagrams, posters, stickers) is clearly displayed.

Consider:

- providing the community with diagrams
  - to demonstrate how the sanitation system operates
  - to illustrate what can and can't be disposed in the sanitation system, and the damage that may occur from misuse
  - to explain appropriate hand washing techniques (similar to those used in hospitals and clinics).

Current service delivery arrangements

Each state and territory government is responsible for creating laws and regulations to minimise or eliminate health risks from waterborne pathogens. Health authorities and environmental protection agencies should be able to provide specific information about guidelines, and regulations about wastewater reuse; environmental protection agencies provide information and licensing for infrastructure that may affect the natural environment.

States and territories also produce guidelines to help local authorities and community members make decisions about wastewater reuse (Tables B3.1 and B3.2). Generally, local government agencies support good wastewater management practices, including regulation requirements and by-laws.

Table B3.1: State and territory guidelines relating to wastewater reuse

State/ territory	Guideline
NSW	Draft Guidelines for Recyclable Water NSW Guidelines for Greywater Reuse in Sewered, Single Household Residential Premises www.water.nsw.gov.au/Urban-Water/Recycling-water/Greywater/default.aspx NSW Water Conservation Strategy www.naturalresources.nsw.gov.au/water/pdf/nsw_water_conservation_strategy.pdf
NT	National Water Quality Management Strategy (NWQMS) Northern Territory legislation www.nt.gov.au/dcm/legislation/current.html
Qld	Queensland Water Recycling Guidelines 2005 www.nrw.qld.gov.au/water/regulation/recycling/pdf/recycle_guidelines.pdf Recycled Water Management Plan and Validation Guidelines 2008 www.nrw.qld.gov.au/water/regulation/recycling/pdf/rwmp_validation_guidelines.pdf Recycled Water Management Plan Exemption Guidelines 2008 www.nrw.qld.gov.au/water/regulation/recycling/pdf/rwmp_exemption_guidelines.pdf Water Quality Guidelines for Recycled Water Schemes 2008 www.nrw.qld.gov.au/water/regulation/recycling/pdf/water_quality_guidelines.pdf Environmental Protection (Water) Policy 2009 www.legislation.qld.gov.au/LEGISLTN/SLS/2009/09SL178.pdf
SA	South Australian Reclaimed Water Guidelines (Treated Effluent) 1999 www.health.sa.gov.au/pehs/branches/wastewater/reclaimed-water.pdf Environment Protection (Water Quality) Policy 2003 www.legislation.sa.gov.au/LZ/C/POL/ENVIRONMENT%20PROTECTION%20 (WATER%20QUALITY)%20POLICY%202003/2004.11.24_(2003.10.01)/2003.-.UN.pdf
Tas	Environmental Guidelines for the Use of Recycled Water in Tasmania 2002 www.environment.tas.gov.au/file.aspx?id=1886
Vic	Guidelines for Environmental Management: Use of Reclaimed Water 2003 http://epanote2.epa.vic.gov.au/EPA/publications.nsf/ PubDocsLU/464.2?OpenDocument
WA	State Water Quality Management Strategy 2003 Western Australia legislation www.slp.wa.gov.au/legislation/statutes.nsf/default.html Western Australia Department of Health wastewater management www.mandurah.wa.gov.au/council/health/code_of_practice_reuse_of_greywater.pdf

Table B3.2: Relevant Australian guidelines and standards relating to wastewater reuse

Guidelines and standards	Topic
Agriculture and Resource Management Council of Australia and New Zealand/ Australian and New Zealand Environment and Conservation Council (1995) National Water Quality Management Strategy: *Guidelines for Groundwater Protection in Australia*	Groundwater protection
All building standards	Building Code of Australia
AS 14001	Environment management systems
AS 1477–1999	PVC pipes and fittings for pressure applications
AS 4765–2000	Modified PVC (PVC-M) pipes for pressure applications
AS/NZ 3500.0	Plumbing and drainage
AS/NZS 1547:2000	Site evaluation

General guidelines and practices for water use, water reuse and public health across Australia are being constantly generated, although there was no Australian Government legislation covering specific uses of treated wastewater as at June 2009. Up-to-date information can be found at:

- National Water Commission
  www.nwc.gov.au
- National Water Quality Management Strategy
  www.environment.gov.au/water/policy-programs/nwqms/index.html
- Environment Protection and Heritage Council of Australia and New Zealand
  www.ephc.gov.au
- Food Standards Australia New Zealand (wastewater that is used to irrigate food crops, particularly salad-type vegetables such as lettuce, must comply with health standards)
  www.foodstandards.gov.au
- Australian Government Department of the Environment, Water, Heritage and the Arts (including guidance on the *Environment Protection and Biodiversity Conservation Act 1999* and associated rules and regulations)
  www.environment.gov.au

Appraising community requirements

The type of sewerage system used in Indigenous communities depends on the size of the system, the community and the available land.

When planning to upgrade or enlarge an existing sanitation system, or when planning to install a new system, consider each option's service and reliability, capital and operating costs, and robustness. To minimise maintenance problems, factors such as population, climate, landscape and soil, groundwater level, flooding potential, available sustainable water supply and power source should also be considered, along with funding available.

Community information

Consider how the following features of the community will affect the choice of sanitation system:

- population profile and demographics (including how much of the population is permanent and how much is seasonal, whether community members have mobility problems or disabilities and whether the population is likely to grow or decline in the next five years)
- number of houses, and their size, location, design construction and use (such as number of residents per house)
- size, location and accessibility of the community (including proximity to water and power supplies, transportation networks and other communities or regional centres)
- employment, enterprise and education levels (including whether community members will be able to help operate and maintain the system)
- community plans and aspirations for the future, including tourism ventures
- impact of sanitation needs on other infrastructure and activities in the community (for example, schools, clinic, store, workshop, service station, water and power supplies)
- proximity and access to other sewerage infrastructure (such as treatment facility, effluent ponds)
- funding availability (including funding for installation, operation and maintenance).

Current status of the community's sanitation system

Thoroughly evaluate the existing system before planning a new or upgraded system.

Consider:

- the number and capacity of existing systems or units
- current patterns of use
- community satisfaction with the current system
- service and maintenance needs of the system, including ongoing costs and current funding arrangements
- whether the current system is reliable, robust and appropriate (including climatic and geographical appropriateness)
- how involved the community is in operating and maintaining the current system, including safety measures
- whether the existing system can be upgraded or maintained.

Climatic and geographical factors

Climate and geography will play a large part in determining appropriate infrastructure for a community. For example, floodwaters can increase inflow into the primary treatment system; septic tanks may overflow or become less efficient. Floodwaters can enter and fill pit toilets, spreading waste matter to the surrounding environment.

Consider:

- the likelihood of high rainfall events, flooding and high winds
- the balance between rainfall and evapotranspiration (this will determine whether leachate ponds and effluent ponds will be effective)
- the slope of the land (for example, effluent ponds should be located downslope from the community)
- the direction of prevailing winds (for example, will odours be blown away?)
- features of the natural environment that could be incorporated into wastewater management (for example, aquatic reeds absorb nutrients naturally; constructed wetlands can reduce nutrient loads, providing a natural process for reducing environmental degradation).

Landscape and soil factors

Knowing the type of soil around a community will help to determine appropriate technology. When the spaces between soil particles fill with water, water cannot soak into the ground, and more water flows along the surface. Clay soils become saturated quickly; sandy soils drain well.

If the soil becomes saturated quickly (that is, high clay content) it may be inappropriate for septic systems because trenches can become clogged. If the soil drains very quickly (that is, sandy soils), wastewater may leach into underground watercourses, creating a health hazard. Soil conditions can also be affected by community activity. For example, kitchen greywater may contain fats, oils and greasy food particles that remain in the soil for a long time, clogging the soil and preventing it from absorbing water. If this is a problem, chemicals may be required to allow the water to penetrate the soil.

Consider:

- investigating local soil conditions and drainage patterns
- whether soil conditions will assist with filtration
- how floodwaters will interact with the soil.

Site considerations

Consult Australian Standards for suitable site selection. For example, AS/NZS 1547:2000 — *On-site domestic-wastewater management* provides a guide to slope angle, slope shape, aspect, exposure, rock outcrops, run-on and upslope seepage, site drainage, surface condition, landfill and erosion or mass movement.

Consider:

- whether there is an appropriate buffer between the site and a watercourse
- whether a site is likely to flood
- whether vegetation in the area indicates likely waterlogging or soil quality.

Reliability

Appropriate technology should be reliable and robust. However, this is more important in some areas than in others. For example, communities in remote locations may require a more robust system to reduce ongoing maintenance.

Consider how to avoid the following problems:

- Septic systems that are too small may lead to effluent accumulating and flooding houses or yards. This problem is exacerbated when houses are overcrowded.
- Poor installation leads to blockages and ongoing maintenance problems.
- Inadequate routine maintenance increases the risk of leaks and hardware failure.
- Inappropriate use (such as flushing hygiene products, nappies and cloths) can lead to blockages and hardware damage.

Choosing appropriate solutions

More than one-third (38%) of major remote Indigenous communities are served by on-site systems. About 1% of major communities (comprising more than 200 people) have no organised sewerage system; 2.5% of minor communities have no organised sewerage system (Table B3.3). Although these figures appear low, this equates to more than 2000 Indigenous people at risk of illness.

Major communities: more than half (59%) of the total remote population use centralised sewerage systems. Approximately 61% of major communities have a sewerage system that removes effluent into a common sewerage lagoon (ABS 2007). Such communities can support community waterborne systems that have additional capital and maintenance requirements.

Minor communities: either septic tanks (situated under houses or close by with absorption trenches) or pit toilets coupled with ad hoc septic systems (situated within the property boundaries) are used. Composting toilets are also used in some communities.

Table B3.3: Wastewater systems for discrete Indigenous communities

Wastewater system	Population <200 (%)	Population >200 (%)
Community waterborne system	5.8	60.9
Septic tanks with common effluent disposal	8.8	19.5
Septic tanks with leach drain	60.7	17.2
Pit toilets	21.1	1.1
Pan toilets	0.1	0.0
Other organised sewerage system	0.9	0.0
Communities with no organised sewerage system	2.5	1.1

Source: ABS (2007)

Table B3.4 gives a breakdown of the most common wastewater problems in remote communities and Table B3.5 lists advantages and disadvantages of the most common types of sanitation systems.

Table B3.4: Wastewater problems for remote Indigenous communities

Problem with wastewater system	Occurrence (%)
System leak or overflow	39.3
Blocked drains	30.7
Equipment failure	20.1
Design or installation failure	13.9
Inappropriate use	10.4

Source: ABS (2007)

Table B3.5: Advantages and disadvantages of the most common types of sanitation systems

Sewerage system	Capacity	Advantages	Disadvantages
Pit toilet/ composting toilet	1 house	■ low maintenance ■ no water required, thus may be ideal in locations where water is scarce ■ remains functional under most use conditions (not susceptible to blocking if non-biological items are placed in them, such as disposable nappies) ■ requires small area of land for wastewater disposal ■ easily constructed ■ less expensive than septic systems ■ a reliable back-up if the septic system should fail ■ advantageous in some remote communities that experience high population fluctuations, including long periods of non-permanent residency	■ odours can be problematic ■ not suitable for disposal of greywater ■ wastewater not removed from property ■ disposal of non-biological materials (eg disposable nappies) may create decomposition problems ■ inconvenient location — often situated away from house ■ regarded as ‘bush toilets’ by many residents, affecting use

(continued)

Septic and leachate drain	1 house	■ disposal for wastewaters from flush toilets ■ accepts greywater ■ easier to manage waterborne wastes	■ requires a regular water supply ■ wastewater not removed from property ■ misuse results in blockages ■ leaking taps cause overload of waterborne disposal systems ■ not suitable on all sites, (eg slope, soil) ■ high ongoing maintenance ■ high failure rate
Common effluent drains	Whole community	■ accepts greywater ■ no problems associated with transporting solids (eg clogged pipes and pumps) ■ cheaper to install than centralised system ■ no sludge accumulation in primary ponds ■ can use existing septic tanks ■ no power requirements	■ regular septic pump-outs required ■ all problems associated with septic tanks ■ only removes effluent from property (solids remain in septic tank) ■ requires large amounts of land for disposal of effluent
Full sewerage system	Whole community	■ accepts greywater ■ no septic tanks required ■ removes all wastewater from property	■ problems associated with clogging of pipes and pumps by solids ■ bigger pipes and greater pipe grades required to transport solids ■ more expensive to install than common effluent drains ■ requires large amounts of land for disposal of effluent

Source: Marshall (1996)

On-site systems

The most common on-site sewerage system options in remote Indigenous communities are:

- pit toilets
- composting toilets
- septic systems
- aerobic wastewater treatment systems.

Pit toilets

Pit toilets have long been a feature of residential housing, and are suitable for variable populations and intermittent use. They consist of a hole in the ground over which a pedestal and shelter are placed. The effluent decomposes mainly through the action of anaerobic bacteria. Manual removal of human waste is required after a period of decomposition — usually about three years, depending on how big the compartment is and the patterns of use.

It is preferable to have two pits side by side so that as one is being used, the contents of the second pit decompose. This configuration also makes the removal of relatively dry decomposed waste from the non-active pit convenient, without disrupting use of the toilet. Some anaerobic decomposition of the waste occurs in the pit. This process continues when the first pit is closed and the second pit is in use.

Pit toilets are best suited to locations where sewage disposal is on-site. Regional legislation and regulations should be considered for sewered and unsewered areas. For example, pit toilets are not permitted in sewered areas in the Northern Territory. In the Northern Territory, pit toilets must:

- comply with the *Code of practice for small on-site sewage and sullage treatment systems and the disposal or reuse of sewage effluent*
- have sufficient artificial lighting to allow safe access to and from the pit toilet at night (however, artificial lighting is not required internally).

In unsewered areas, internal toilets may be substituted for a pit toilet. If a household is using two toilets, then it may be good practice to use a pit toilet to reduce the amount of water used.

Human urine has a high concentration of nitrogen, which increases the nitrogen:carbon ratio in the pit, causing odour. Carbon-based materials (such as wood ash or soil) can be added to the pit as required to overcome this problem.

Appropriate choice, design and installation

Ensure that:

- greywater from the kitchen, bathroom and laundry drains to a separate disposal system.

Consider:

- installing a ventilated pit latrine to draw away odours and trap flies
- installing a urine separation cistern to minimise the build-up of odours in the pit.

See the *National Indigenous Housing Guide* Part B3 for further information.

Composting toilets

Composting toilets are designed to convert waste through the action of aerobic bacteria, in contrast to pit toilets where the action is anaerobic. Composting toilet design, construction and maintenance is generally more complicated than for pit toilets, but composting toilets may be preferable in some situations where pit toilets are not appropriate, such as locations:

- that are prone to flooding or high watertable levels
- where pit waste could leach into underground water sources
- where there is impermeable rock at shallow depth
- where hard rock makes pit excavation impractical.

A composting toilet should remain dry to increase its aerobic composting capacity. This process uses aerobic bacteria to convert waste to a final product that looks like soil. It takes up to a year for waste to decompose fully into compost, which is then safe to handle and can be used as fertiliser in the garden (though not for fertilising food plants directly).

Intermittent use of composting toilets may be adequate for communities or outstations with low populations or infrequent use. However, because aerobic bacteria require air, insufficient ventilation (for example, in a power failure if an electric fan for ventilation is used) can slow down the composting process, leading to odours. If odour does occur, it can be reduced by adding carbon-based materials such as wood ash or paper.

Appropriate choice, design and installation

Ensure that:

- waste is kept dry and well ventilated — if necessary, install a drain to remove excess liquid and a ventilation system to keep air moving around the compost pile
- a separate disposal system is available for wastewater from the kitchen, bathroom and laundry
- composted waste is not placed directly on plants, particularly salad crops, that are to be eaten
- a reliable energy supply is available if an electric fan is used for ventilation
- community members understand the maintenance requirements, and a maintenance program is in place including weekly checks to ensure proper operation
- dry, carbon-based material (such as leaves or shredded paper) is available, to add to the chamber when necessary to improve the composting process
- frequent emptying of materials (that is, handling of human waste) is avoided
- non-compostable materials and toxic chemicals are not disposed of in the composting chamber — this may kill the microorganisms that are responsible for the composting process.

Consider:

- designing systems to cater for population peaks and troughs, taking into account the number of houses to be serviced by the one system
- installing dual toilets with alternating maintenance regimes (that is, use one while the second is composting).

Design toilet floor areas to facilitate cleaning, with easy access and appropriate drainage. Inadequate floor drainage is common, which increases the risk of infection and illness. Other considerations include the design or placement of accessories such as toilet roll holders, which are important in maintaining a functional toilet.

To allow for overcrowding, at least one toilet should be provided in buildings that have one or two bedrooms; two toilets should be provided in buildings with three or more bedrooms. Each toilet should be provided with an adequate wash basin.

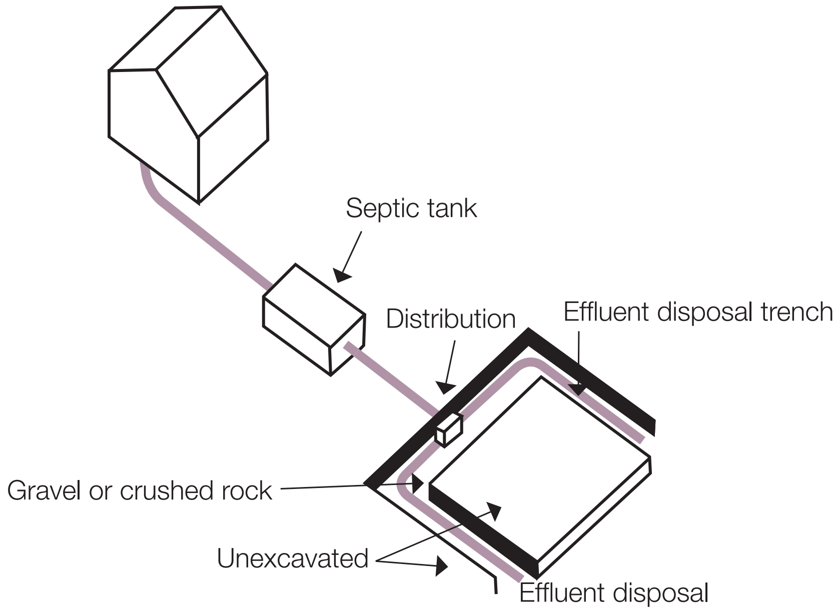
Septic systems

Septic systems allow for limited reuse of wastewater; they most often comprise a septic tank and absorption trench. Although there is widespread failure of septic systems across Australia, their simplicity ensures they remain the standard for primary on-site wastewater treatment for both blackwater and greywater. The process involves the flotation of lighter materials such as oils, fats and grease, and sedimentation of heavier solids. These solids are then stored at the bottom as stabilised sludge prior to removal.

A septic tank is a large, watertight container that is buried in the ground. Effluent from the house (toilet cistern) flows through drainage pipes into the septic tank. The larger solids settle to the bottom of the tank, allowing the remaining wastewater to be discharged to a soil absorption trench, or transferred to a secondary or tertiary treatment system (Figure B3.1). Absorption trenches, or leachate drains, treat wastewater by filtration.

Septic tanks, with either leachate drains or common effluent disposal, are used in nearly 70% of communities with fewer than 200 people, and in 37% of communities with more than 200 people (ABS 2007). Septic tanks are relatively simple to maintain; however, they will only last if they are properly operated and maintained.

Figure B3.1 Relative components in a typical septic tank system



Source: L Davison, Lecturer in Ecotechnology, Southern Cross University, Lismore NSW (pers comm, 2008)

Appropriate choice, design and installation

Although septic systems are a proven technology and widely used, major problems can be experienced with design (such as selecting tanks that are too small), installation (for example, inappropriate soil types in the disposal trench) and maintenance (such as irregular sludge removal).

The following formula can be used to estimate the minimum capacity of a septic system for domestic purposes:

$C = (S \times P \times Y) + (P \times DF)$

where C = capacity (in litres)

S = sludge/scum rate (80 litres per person per year)

P = number of people using the system

Y = worst case de-sludging interval (in years)

DF = daily inflow (litres per person)

Questions that will assist service providers to assess the needs of communities with sanitation systems include:

- How many systems are required in each community?
- How many systems are failing?
- What is the result of the failure? (For example, raw sewage in houses and backyards.)
- What is causing the system failure? (Such as poor drainage from house to septic tank, undersized septic tanks, undersized trenches.)
- Can problems be solved through upgrades?
- Is the trench an appropriate size for peak capacity?
- Is the watertable more than two metres below the lowest drainage point at the wettest time of year?
- Are the bores located at least 100 metres from absorption trenches?
- Is the water of good enough quality to prevent damage? (For example, are there problems with the water being hard or corrosive?)
- Is the soil suitable for absorption trenches?
- Is the area large enough to accommodate an absorption trench?

If problems occur, consider either upgrading to centralised sewerage systems or upgrading existing septic systems. The health department in each state or territory should provide up-to-date information on how to manage problems with septic systems. The need for upgrades is often assessed on:

- population size
- extenuating circumstances such as regular visitors or peak fluctuations
- funding availability (centralised sewerage systems cost approximately $1–1.5 million)
- landscape features (such as rock or hills, suitability of soil type for constructing effluent lagoons)
- location (for example, risk of flooding and consequences of overflow, whether wind would blow odours away, whether effluent lagoons would be downslope from the community).

Ensure that:

- water supply is reliable
- sufficient land is available for disposal of treated waste (to meet current and future needs)
- soil type is appropriate (heavy clay soils may clog rapidly; sandy soils may increase potential leaching into groundwater)
- the peak watertable level is well below the bottom of the septic tank in case of leakage (at least two metres but may need to be more depending on soil type — specific watertable information will be available from hydrogeologists and engineers responsible for locating and drilling the community bore)

- a skilled tradesperson (such as a plumber) is employed to install the septic tank system
- tanks are emptied by a specialised disposal truck.

Consider:

- designing systems to accommodate the current and future population size
- checking whether the toilet will be used by members of one house or many houses
- installing separate septic tanks for greywater and blackwater
- installing a grease trap on the kitchen drain to prevent grease or food solids getting into the system.

Maintenance

Ensure that:

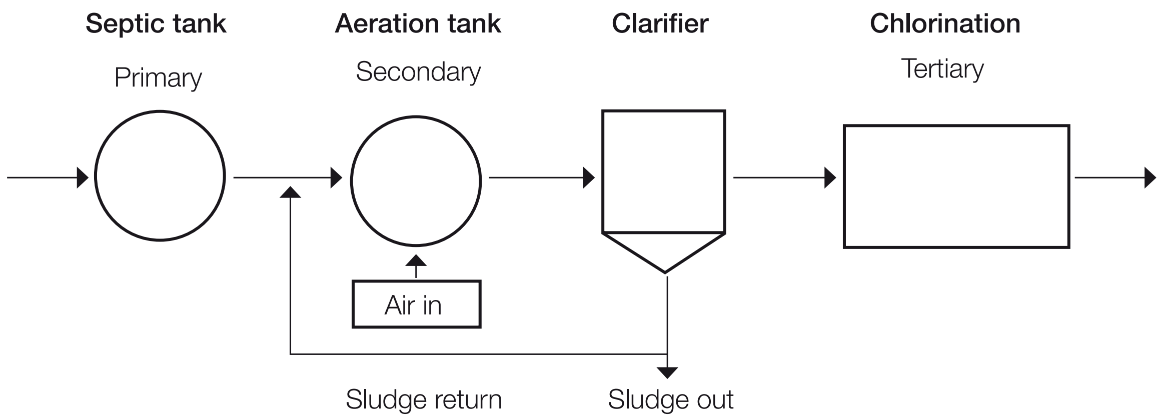
- operating procedures are followed correctly
- the amount of detergents, disinfectants and cleaners in the wastewater is minimised
- a routine maintenance plan including pump-out is developed and implemented
- routine preventive maintenance schedules are appropriate for the system and the situation (for example, tropical areas compared to desert)
- tanks are inspected every year
- community members have up-to-date knowledge of, and access to, external technical support
- sludge is regularly removed from the tanks, with no more than 3 years between pump-outs.

See the *National Indigenous Housing Guide* Part B3 for further information.

Aerated wastewater treatment systems

Aerated wastewater treatment (AWT) systems are common in on-site treatment, combining primary and secondary treatment processes in one large facility. The system consists of two large tanks: the primary (septic) tank and the aeration tank. Solids settle in the septic tank, where scum also forms. The anaerobic digestion of carbohydrates occurs here. The wastewater then moves into the secondary aeration tank where oxygen is bubbled through the effluent to assist aerobic decomposition (Figure B3.2).

Figure B3.2 A typical aerated wastewater treatment system flow structure



Source: Hagare and Dharmappa (1999)

Tertiary (disinfection) treatment adds to the effectiveness of an AWT system. Ultraviolet radiation, ozone and chlorination are effective disinfection agents. Chlorination is the cheapest. Tertiary-treated effluent can generally be used for gardens and lawns, depending on relevant state and territory legislation and guidelines.

These systems need to be in constant use to be effective. Two main reasons for failure of AWT systems are:

- rapid changes in hydraulic loads (for example, sudden increase in household population or residents are absent for an extended period)
- loss of microorganisms, which reduces the treatment rate.

Appropriate choice and design

When choosing AWT systems, consider whether the number of people in the household will fluctuate rapidly at any point. This is often the case in Indigenous households and therefore AWT systems are likely to be less functional, particularly in remote communities.

Additionally, maintenance is a high priority with AWT systems, and contracts with manufacturers or suppliers are often required unless local expertise is available. These systems also require a reliable power source.

AWT systems are also poor at removing nitrogen and phosphorus (Table B3.6). Therefore, a tertiary treatment method, such as wastewater distribution to a reed bed, may be required.

Table B3.6 Strengths and weaknesses of aerated wastewater treatment systems

Strengths	Weaknesses
■ good solids and biological oxygen demand removal ■ good nitrification ■ effluent clear enough for disinfection ■ effluent suitable for irrigation ■ relatively compact units	■ minimal total nitrogen removal ■ minimal total phosphorus removal ■ poor response to rapid changes in hydraulic loads (eg rapid increase or decrease in household) ■ requires power — failures can result from blackouts ■ requires a maintenance contract

Ensure that:

- connections are sized for high anticipated loads
- the system chosen doesn’t require complex maintenance
- systems are properly installed
- hardware is appropriate for the water quality (such as corrosive or hard water)
- regular maintenance programs are developed and implemented.

Consider:

- installing an additional tertiary treatment system to improve the removal of nitrogen and phosphorus.

Installation

Ensure that:

- an experienced site supervisor is engaged to provide quality control
- communities receive a copy of the installation documents for filing
- all pipes are clearly marked and documented to prevent accidental damage by other contractors
- any repairs to accidental damage are quality checked before backfill.

Consider:

- checking installation before the system is covered.

Maintenance

There are many important maintenance considerations with AWT systems.

Ensure that:

- correct operating procedures are followed, so that the system is reliable.

Important maintenance steps include:

- leaving the power switched on even if going away for extended periods
- minimising the amounts of fats and oils that are washed down the drain
- keeping food waste out of the system
- preventing foreign materials (such as nappies or personal hygiene products) from entering the system
- avoiding the use of large quantities of bleaches, disinfectants, whiteners, spot removers or detergents, which will kill essential bacteria in the AWT system
- using biodegradable products with low sodium and phosphorus if possible
- inspecting and testing the disinfection chamber quarterly to ensure correct disinfectant levels
- developing routine preventative maintenance schedules that are appropriate for the system and the situation (for example, tropical areas compared to desert)
- ensuring community members have up-to-date knowledge of, and access to, external technical support.

Regular monitoring and maintenance includes:

- checking the pump stations, preferably on a daily basis, and keeping records of pumping, inspections and other maintenance
- checking and clearing screens daily (including grease traps)
- performing maintenance tasks for lagoons at least every two months
- servicing the pumps and pump station (between monthly and quarterly)
- arranging for the AWT systems to be checked regularly (around four times per year)
- cleaning and inspecting pressure mains periodically
- checking the performance of irrigation areas
- removing sludge from lagoons
- assessing sludge and scum levels in all tanks; de-sludging all tanks at least every three years.

Off-site systems

Common components of off-site sewerage systems in remote Indigenous communities are:

- centralised sewerage systems
  - common effluent disposal systems
  - full effluent disposal systems
- effluent transportation (pumps) and distribution (pipes)
- constructed wetlands.

Centralised sewerage systems

A full sewerage system takes wastewater (solids and water) directly from the house through a pipe network to a treatment facility. Treatment commonly occurs in a series of effluent lagoons or ponds where it is broken down by microorganisms (aerobic and anaerobic bacteria) or environmental factors such as sunlight and wind. Trained staff and appropriate resources are necessary to maintain these systems.

The major advantage of this type of system is a lower health risk due to reduced exposure to sewage. Examples of centralised sewerage systems include common effluent disposal systems and full effluent disposal systems. The main difference between the two systems is that common effluent disposal systems include a septic tank near individual households so solid matter can be removed immediately. This system may therefore be classified as a hybrid on-site, off-site system. By contrast, full effluent disposal systems transport all effluent directly to the off-site treatment facility.

Appropriate choice and design

A common effluent disposal system allows only wastewater (and no larger solids) to flow from the septic tank at individual households to a central treatment facility. Smaller pipes at flatter grades can be used, reducing installation costs.

Where the topography of the land allows, gravity alone may be used to facilitate flow from the house (or septic tank) to the centralised treatment facility. If this is not possible, pump stations may be required to transport the wastewater or effluent through the pipe network.

Problems associated with overloading of effluent ponds during rainfall events or due to increased water flows from leaking household systems can reduce detention times of effluent in the ponds, thus reducing the treatment effectiveness. The average rainfall, including whether the area is flood prone, is another important consideration.

Another consideration during the design phase is the average and peak flow rates under different climatic conditions. The average dry weather flow is the normal sewage flow expected per person per day, and excludes any variation for infiltration and rainfall. The highest flow rate under dry weather conditions is termed the peak dry weather flow, and can vary depending on the extent of dry weather infiltration and catchment size.

The size of the community will influence the variation; for example, population increase means a decrease in the effect of peaking (dilution). Other factors that influence the design include extent and age of the collection system, capacity to maintain the system, development density and groundwater tables.

Extensive piping and pumps are required if communities wish to use common effluent disposal systems. Larger centres often have a central treatment plant that uses pipes and pumps to transport effluent to a location, such as a sewage treatment plant, away from the main residential area. A sewage treatment plant is a much larger facility that uses aerobic and anaerobic activity.

Sewage treatment plants receive effluent from households through a series of pipes. Depending on size, sewage treatment plants contain several ponds that treat the wastewater in different ways. However, the basic treatment methods are similar, such as primary treatment through sedimentation tanks, secondary treatment with the use of aerobic bacteria, and usually followed by tertiary treatment.

Centralised systems are expensive and require large amounts of space, so they are not appropriate for minor communities and outstations. Costs for centralised systems can range from $600 000 for a population of around one hundred people to more than $1 million for larger populations. In general, septic systems with a simple design are the most common, but they are often poorly constructed or poorly designed. These issues may exacerbate the already high maintenance requirements of these systems.

Ensure that:

- connections are sized for the higher anticipated loads
- the system doesn't require complex maintenance
- the system is properly constructed (such as adequate pipe grades, appropriate joint construction)
- lagoons are fenced to prevent access by children
- hardware is appropriate for the water quality (for example, corrosive or hard water)
- regular maintenance programs are developed and implemented.

Consider:

- installing dual-pump systems in pump stations, as backup.

Installation

Ensure that:

- an experienced site supervisor is engaged to provide quality control
- communities receive a copy of the design and quality control documents for filing
- all pipes are clearly marked and documented to prevent accidental damage by other contractors
- contractors working nearby (such as road crews) are thoroughly briefed about the location of sewerage pipes
- any repairs to accidental damage are quality checked before backfill.

Consider:

- installing dual-pump systems in pump stations, as backup (in certain circumstances)
- installing metering to measure inflow and outflow of community water; this can be very useful in detecting leaks and remediating problems
- checking the installation before the system is covered.

Site supervisors cost around 3–6% of the project's budget; their presence ensures the other 94% is well spent. Poor installation leads to poor performance, which has been known to result in drainage running uphill and ongoing high-cost maintenance, so correct installation is important. All plumbing work requires a Certificate of Compliance to be lodged with the plumbers licensing board of the relevant state or territory.

Maintenance

The same maintenance procedures as for septic tanks should be followed for centralised sewerage systems; other important steps are:

- ensuring correct operating procedures are followed so that the system is reliable
- developing routine preventive maintenance schedules that are appropriate for the system and the situation (for example, tropical areas compared to desert)
- ensuring community members have up-to-date knowledge of, and access to, external technical support.

Regular monitoring and maintenance includes:

- checking pump stations regularly, preferably daily
- checking and clearing screens daily
- maintaining lagoons, including removing sludge
- maintaining the entire system
- servicing pumps and pump stations periodically (monthly to quarterly)
- cleaning and inspecting pressure mains periodically.

Effluent transportation and distribution (pipes and pumps)

This section provides a guide to important considerations for transporting wastewater to its destination. These considerations will involve pumping and piping, including examples of their performance measures. A full list of pump manufacturers and suppliers is too long to include in this document; local suppliers can provide guidance in this area.

Transportation system

An important consideration with the transportation of effluent is the pressure head at each point along the distribution pipe. The head is dependent on:

- pump characteristics
- the pipe diameter[1]
- total flow from all the orifices
- diameter of the distribution pipe, size of the holes and the distance between holes
- frictional loss in the delivery pipe, which will vary depending on the pipe material used.

If these factors are not considered during planning and design, the distribution pipe will be less effective and require more maintenance.

Pump selection

Many types of pumps are available; local manufacturers and suppliers will have the best understanding of what products are available and suitable. Each pump has its own specifications chart and performance curve that will provide evidence of the pump's capability under varying flow rates. Local suppliers will also be able to provide immediate service and after-sale servicing.

The nature of the wastewater to be pumped will help to determine appropriate pump materials and configurations.

Design codes will also help to determine the number of pumps required for each system. For example, in New South Wales, two pumps may be required for systems with one day's storage, or one pump may be acceptable where storage capacity is approximately three times the daily flow.

Consider:

- including a backup pump in case the duty pump fails.

Pump control

Automatic control of pumps will ensure that pumps turn on and off at specified levels of wastewater in the pump well.

Alarm systems may be needed to alert operators to any maintenance requirements. In the case of pump failure there may be a requirement to have an overflow trench. In New South Wales, the minimum size of this trench is 1.5 metres long, 0.5 metres wide and 0.4 metres deep. Again, consult the building code of practice in the relevant state or territory.

1 Because the speed of flow increases when water flows from a larger pipe into a smaller one, the total head (or pressure) decreases — the reason is that the water's energy of motion (kinetic energy) increases while the potential energy provided by the pump or gravity decreases.

Pump well

The design considerations should include the pump well — an area that encloses the pump or pumps and assorted equipment such as alarm systems. The pump well should be sized according to the building code of practice; for example, *New South Wales Code of Practice: Plumbing and Drainage*. Take into account local flood areas to ensure that the electrical cabinet does not get inundated during wet seasons.

When designing a pump well, ensure pumps can be removed for easy access and cleaning.

Case study 7 — Constructing wastewater gardens

A small community in the Kimberley, Western Australia, was established near a creek providing a fresh source of drinking water. The community had six houses, so was not considered large enough to require a common effluent wastewater system. The existing houses were each supplied with a septic tank and leach drains (absorption trenches).

During every wet season, the watertable rose significantly, backfilling the leach drains and septic tanks, then flooding back through the toilets into the houses. The flooded septic tanks also discharged into the nearby creek.

Consultants suggested that wastewater gardens should be designed and constructed to use some of the wastewater. The design included a pumping system to transport surplus water from the septic tanks into the wastewater gardens, then to pump any surplus uphill to a large new set of leach drains (common to all houses) on high ground and away from the creek.

Within months of construction, the wastewater gardens were lush with heavy tropical plants. When functioning properly, they absorbed all or most wastewater passing into the gardens. There was little or no need to pump surplus wastewater into the leach drains during the dry season.

The following issues arose during the defect liability period:

- *Each septic tank needed to be installed at a depth with sufficient fall (1:4) from the toilet bowl to the septic tank inlet. The septic tank overflow outlet to the leach drain had to be exactly level due to the physics of the system. It was critical that the levels and falls were exact; however, the levels were not initially correct, which led to much more excavation work.*
- *Both pumping systems (septic tank to wastewater gardens, and wastewater gardens to leech drains) were manually operated and required local maintenance staff to be trained, or residents to monitor the water levels and switch the pumps on as required. Both maintenance staff and residents were highly mobile, so this measure often failed. As a result, the gardens filled above the gravel bed level, exposing children and animals to contaminated water, and creating an ideal breeding ground for mosquitoes.*
- *The pump switches were within easy reach of children, who would often play with the switches and upset the pumping systems.*

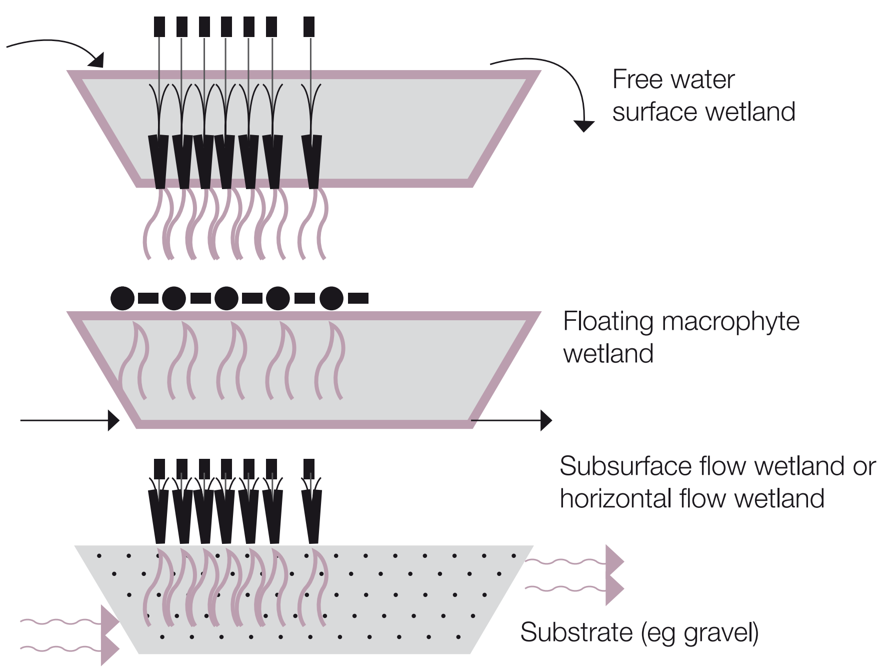
(continued)

- *Children playing around the outlets to the drains and septic tank would fill the vents and overflow pipes in the gardens with rocks, causing blockages.*
- *An elderly resident assumed that the gardens required heavy pruning and stripped back the heavy foliage in one of the gardens. This reduced the garden's uptake of nutrients.*
- *The pumps installed initially were not of an appropriate quality, and failed regularly. This may have resulted from a poor choice of pump. A pump made from more robust materials and components and provided with regular maintenance may have been sufficient.*

Constructed wetlands

Use of natural systems like wetlands to treat wastewater is becoming more common. Wetlands are open water habitats and seasonally or permanently waterlogged land areas. Natural wetlands can be described as 'kidneys of the landscape' due to their capacity to filter pollutants from wastewater. Constructed wetlands may thus be thought of as 'kidney transplants'. Constructed wetlands are similar to natural wetlands in that they use physical, chemical and biological processes that nature has already developed. The physical processes include settling and filtration (Figure B3.3). Chemical reactions mediated by waterborne microorganisms remove carbon and nitrogen from the wastewater. The biological action of microorganisms also helps reduce the amount of nutrients in the wastewater by filtering suspended solids and decomposing organic matter.

Figure B3.3: Types of constructed wetland



Source: Centre for Appropriate Technology, 2009

Constructed wetlands can be classified according to their structure and function — surface flow wetlands or subsurface flow. Surface flow systems are often used as tertiary and stormwater wetlands. Subsurface flow wetlands such as reed beds utilise a substrate such as gravel into which wastewater flows without exposing any water surface. Subsurface constructed wetlands are less likely to provide habitat for mosquitoes. Also, in areas where the water is of good quality, mosquito predators such as frogs and other wetland fauna can help to reduce mosquito populations. However, wetlands should be located some distance from the community.

Appropriate choice, design and installation

The choice of suitable vegetation is the most important aspect of constructed wetlands in terms of nutrient removal. The most appropriate species should preferably be local to the area as examples have shown that inappropriate species selection can lead to weed infestations and increased environmental problems. Examples of common wetland species include *Typha domingensis* and *Phragmites australis*. Species such as *Triglochin procerum* and *Bolboschoenus medianus* are not as common, but are being been trialled in a constructed wetland at Willunga, South Australia.

Ensure that:

- suitable local species are chosen for nutrient removal
- the soil is adequately tested
- there is enough land area.

Consider:

- environmental and climatic factors when designing the wetland.

Maintenance

Maintenance for wetlands is mainly concerned with primary and secondary treatment processes, including any pumps that may be used. Water quality monitoring should be conducted regularly to determine if there are any adverse changes to the influent. Observations can also detect if vegetation is deteriorating to an extent that warrants concern.

Ensure that:

- routine preventive operating and maintenance procedures for primary and secondary treatment technologies are maintained
- water tests for nutrient content in wastewater, especially heavy metal concentrations, are regularly conducted.

Case study 8 — Recycled water irrigation options

As part of a move to improve environmental health and recreational areas in a community of approximately 600 people, the local government body proposed an investigation into the options for grassing the women's softball field. The field was used for women's softball on a daily basis throughout the year, and more intensely in winter. It was also used for after-school children's day care groups throughout the year.

The feasibility study explored the options of grassing, by either seed or turfing, or using synthetic surfaces such as artificial lawn. The key issues around these options were capital cost, water supply and its distribution, and ongoing maintenance requirements. Limited by cost, the local government's preferred option was grassing of the oval. Options for providing irrigation water included using groundwater, requiring a new, dedicated bore in an already fragile aquifer, or treating and recycling water from the existing sewage ponds.

Based on costs and water resource implications, recycling of effluent including biological and/or chemical treatment was preferred. Design and implementation of the system involved an extensive risk assessment to satisfy regulatory requirements under public health and environmental legislation. Rigorous procedures were required to ensure appropriate monitoring, operation and maintenance of the system to eliminate health and environmental risks.

Critical to the success and ongoing use of such a system was consultation with the managers of the sewage ponds, community residents and users, community maintenance managers, and other stakeholders around community aspirations, skills, resources and acceptability. Initial consultation with the local government staff and maintenance staff was undertaken during the preparation of the feasibility study, which identified the availability of a small labour force for non-skilled operation and maintenance roles. Consultation with other existing users of the effluent ponds, such as the adjacent solar power station, identified their use and requirements of the sewage ponds, which had to be provided for before effluent for the softball field could be extracted.

Ongoing consultation was required throughout the concept and detailed design phases, focusing particularly on the acceptability of recycled water for a community recreation facility. Without first exploring the actual risks and, equally as important, the cultural and community beliefs associated with reuse of effluent with the existing users of the softball field, it was a real possibility that users would reject the irrigation system and the grassed oval, thus losing an important community asset.

Managing and maintaining services

The many different sanitation systems all have advantages in reducing health risks. Each system also has specific use and maintenance requirements. Suitable training and employment opportunities should be investigated, for unskilled maintenance crews through to qualified trades and construction people to managers. Once established, ongoing employment will contribute to the local economy and livelihoods development.

Ensure that:

- suitably qualified professionals install the system, or at least provide advice and assistance to non-qualified people
- any non-qualified community members involved are provided with adequate training on the system's installation and maintenance requirements
- a regular maintenance program is developed and strictly monitored for sustainability.

Consider:

- training more than one person to do any particular job thus improving skills base, increasing productivity and efficiency, and reducing maintenance waiting times for residents
- providing ongoing training opportunities through technical colleges (such as Technical and Further Education, or TAFE)
- encouraging inter-community assistance programs whereby skilled people from one community can assist in maintenance works or training of personnel in a nearby community.

Useful terms

Aerobic	Meaning ‘with air’, is used in reference to organisms that use oxygen to convert waste material to soil.
Aerobic treatment unit	A self-contained electrical wastewater (sewage) treatment system for treating sewage either wholly or partially by aerobic means.
Anaerobic	Meaning ‘without air’, is used in reference to organisms that convert waste material to soil without the use of oxygen.
AS/NZS	Australian/New Zealand Standard
AWT	aerated wastewater treatment
Biological oxygen demand (BOD)	A measure of the dissolved oxygen required for the breakdown of organic material in effluent (BOD5 is a 5-day test to determine the amount of BOD in a sample).
Blackwater	Wastewater from the toilet. It can be separated into two streams: ‘yellow’ (ie urine) and ‘brown’ (ie faeces). Blackwater contains pathogens capable of causing serious human health risks such as faecal coliforms.
Compost	The result of controlled aerobic decomposition of organic matter into material suitable for use as a fertiliser or soil conditioner.
Denitrification	The natural conversion of nitrates through anaerobic bacterial action (usually in wetlands or other oxygen-depleted environments) into gaseous nitrogen.
Disinfection	A process that reduces the number of microorganisms but does not sterilise or remove all microorganisms.
Faecal coliforms	A subset of coliforms (eg *Escherichia coli*) found in the intestinal tract of humans and other warm-blooded animals, and used as indicators of faecal pollution and effectiveness of disinfection processes.
Greywater	A type of wastewater having three different sources: bathrooms (bath, basin and shower), laundries and kitchens. In combination, they can account for up to 90% of wastewater from a house. Bathroom greywater contributes about 55% of the total greywater volume, laundry greywater 34% and kitchen greywater 11%.
Leach drain	Typically associated with a septic tank system. A drain excavated and refilled with gravel or other material that allows treated greywater to slowly filter into the soil.
Microorganisms	Microscopic organisms including bacteria, worms and fungi, which convert waste to material that can be more readily used by plants.

Nitrification	The natural conversion of organic wastes through slow aerobic bacterial action into nitrates.
NWQMS	National Water Quality Management Strategy
Pathogens	Disease-causing microorganisms (eg viruses, bacteria, helminths and protozoa).
PVC	polyvinylchloride
Sewage	Sewage or effluent is the traditional term for human waste (excreta). It typically consists of solid matter and liquid that exits a household through bathroom, toilet and kitchen drainage systems.
Sewerage	The system designed to transport human waste (sewage) from the household to the disposal site (eg wastewater treatment plant). The sewerage system comprises the sewer pipe leaving the building and the treatment method.
Suspended solids	Solids that are retained after wastewater has passed through a filter.
Wastewater	Nutrient-rich water that takes effluent to its treatment destination. This chapter refers mainly to wastewater except for discussion on dry sewage such as pit toilets. Wastewater is often separated into greywater and blackwater, to indicate what types of nutrients, detergents and solid matter (eg faeces) may be present. Although there are general distinctions between greywater and blackwater, both contain particular contaminants normally associated with each of the other streams.

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