DEPARTMENT OF NATURAL RESOURCES & MINES

Planning Guidelines for Water Supply and Sewerage

Chapter 7

OPTIONS FOR SERVICE PROVISION

TABLE OF CONTENTS

Options for Service Provision

1.0 Purpose

A range of options exist for the provision of water supply and sewerage services. These include non-asset, source substitution and infrastructure options. This chapter outlines a number of these options and highlights the need to explore a wide range of solutions that go beyond the traditional infrastructure approach.

2.0 Key Principles

The objectives of a proposal to deliver an identified water supply or sewerage service should be clearly defined before evaluating options.

A range of options (non-asset, source substitution, new and replacement asset) should be examined in a holistic manner that considers water supply, sewerage and stormwater management as component parts of an integrated urban water management program.

Non-asset solutions should generally be considered preferentially. Traditional solutions involving new infrastructure construction may not always be the optimal solution for providing a service.

3.0 Why Is This Important?

Planners should consider a wider range of options for the provision of water or sewerage services for the following reasons:

- There is a growing world-wide trend towards seeking alternative service provision options that are more environmentally friendly.
- The community is keen to ensure an ecological sustainability approach and value for money for services.
- There are limited traditional water resources to meet demands.
- It will ensure defined outcomes at the lowest social, environmental and financial costs.
- It will deliver an appropriate solution to a particular situation rather than a “one size fits all” approach.
- It is likely to satisfy the aims of a wider range of stakeholders.
- Failure to consider a wider range of options may expose the service provider to criticism from stakeholders.

4.0 When Should Options for Service Provision be Considered?

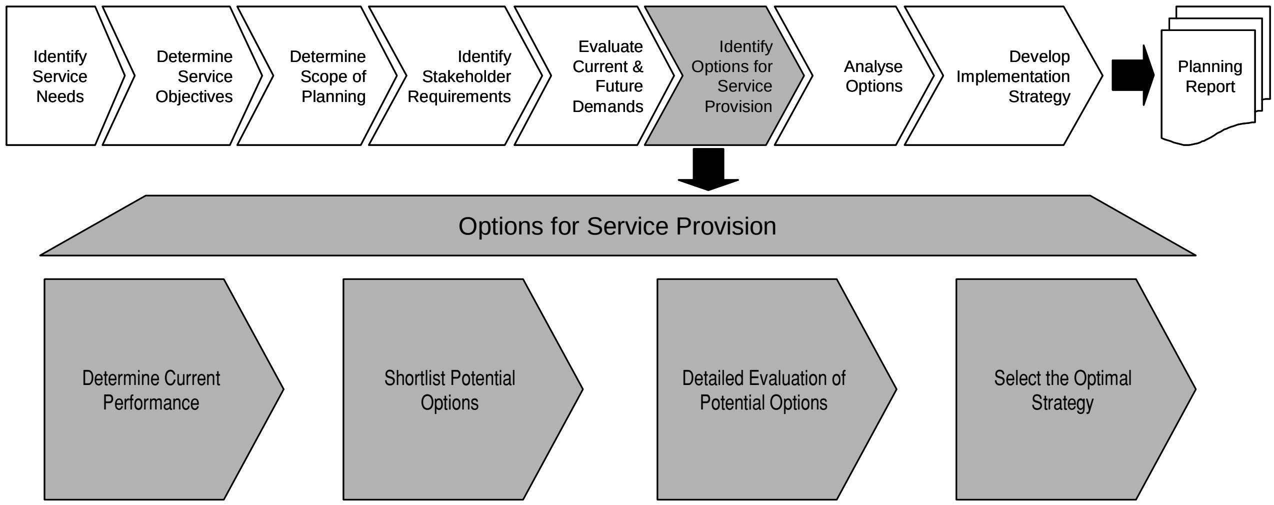
Options for Service provision should be considered once the service needs and service objectives have been clearly defined. These objectives would relate to:

- service requirements and standards
- regulatory compliance
- operational performance objectives
- social objectives
- environmental objectives
- financial objectives.

5.0 Key Elements

The process for selecting the optimal strategy is illustrated in Figure 5.1.

FIGURE 5.1 – Selecting the Optimal Strategy for Providing a Service



5.1 Determine Current Performance

It is essential that the planner clearly understands the performance of the existing infrastructure. This will require access to reliable information which should be readily available. If this information is not available a plan should be actioned to obtain reliable information. This issue is discussed in Chapter 2 – Knowledge Management.

The planner will need to review such matters as:

- actual service levels against service standards
- compliance with current and future regulatory requirements
- current and future service demands (refer to the section on demands and projections)
- achievement of stakeholder requirements
- operational performance
- costs of providing the existing service and the components of these costs
- performance in comparison to similar service providers (metric benchmarking)
- identifying in detail where the gaps exist between current performance and desired service needs and objectives (short, medium and long term).

5.2 Shortlist Potential Options

An iterative process for determining options may be necessary. All possible options should be identified for further evaluation.

The following tables indicate that a wide range of asset, non-asset solutions and a combination of asset and non-asset solutions, exist to deliver water supply and sewerage services. Planners should have an open mind in relation to potential solutions.

5.3 Detailed Evaluation of Potential Options

Chapter 9 – *Analysis of Options* outlines methodologies for selecting the most appropriate strategies to achieve the desired outcomes. In evaluating options, consideration should be given to:

- an integrated urban water management approach
- the need for more detailed studies, pilot studies etc.
- the technical feasibility of the options to deliver the defined service
- the skills and capabilities of the service provider to manage the proposed infrastructure
- potential social and environmental (including heritage) impacts
- potential for staging
- risks associated with the option, some of these risks are listed in Table 5.1
- regulatory approvals
- lifecycle revenues and costs.

Options are likely to be a combination of non-asset, source substitution and infrastructure solutions.

There may be a number of constraints which impact on the technical, financial and environmental feasibility of an option. These constraints which may include the following should be identified and evaluated in relation to each option:

- regulatory
- compliance with guidelines (eg *Australian Drinking Water Guidelines*)
- climatic
- geotechnical conditions
- heritage/native title issues
- topographical
- environmental.

Options should be evaluated and ranked according to a previously defined set of objectives and include a detailed assessment of constraints and implementation limitations.

The sizing of system components is summarised in Table 5.8 (Water Supply) and Table 5.15 (Sewerage).

TABLE 5.1 – Some Potential Risks to be Considered in Evaluating Options for the Provision of Services

Risk Category	Risk
Commercial/Financial	Erroneous capital and operational costs.
Demand	Demand estimates and projections are over or under estimated. Out of sequence development
Climate	Climate change Climate variability
Environmental	Adverse environmental impacts ▪ short and long term Approval processes
Implementation	Contractual risks Delays Latent conditions
Infrastructure	Sub-optimal sizing of infrastructure Sub-optimal timing of infrastructure Infrastructure failure Power supply failure Lightning strikes
Natural Disasters	Impacts on infrastructure Impacts on construction
Organisational	Service provider doesn't have the skills/capabilities/resources to effectively operate and maintain the proposed infrastructure
Political	Community perceptions and complaints in relation to: ▪ increased charges ▪ the service being delivered ▪ standards of service ▪ perceived public health risks ▪ location of infrastructure. Policy changes
Public Health	Risks include: ▪ drinking water quality doesn't meet *Australian Drinking Water Guidelines* ▪ cross-connections between the drinking water system and non-drinking water or wastewater systems ▪ exposure to aerosols ▪ contamination from wastewater or other sources.
Regulatory	Non compliance Time to obtain approvals
Security	Potential for sabotage or vandalism
Social	Adverse community perception Community disruption Pressure groups Vandalism Lack of householder maintenance of on-site facilities Inadequate community education Inadequate community consultation Infrastructure failure impacts
Technical	Topographic constraints Unforseen geotechnical problems
Technological	Limited track record for system, process, equipment or materials Long term performance of infrastructure

5.3.1 Selection of the Optimal Strategy

Refer to Chapter 9 – Analysis of Options.

5.4 Water Supply Options

5.4.1 Non Asset Solutions – Water Supply

In many instances improved service delivery can be achieved through enhanced utilisation of existing infrastructure, demand management, source substitution, etc. Potential non-asset solutions are summarised in Table 5.2.

TABLE 5.2 – Non-Asset Options – Water Supply

Category	Option	Service Delivery Impacts			
		Continuity of Supply	**Quantity of Supply**	**Quality of Supply**	**Deferring Capital Investment**
Demand Management	User pays pricing		✓		✓
	Volumetric charging for wastewater		✓		✓
	Retrofitting water use devices		✓		✓
	Water use audits – internal & external		✓		✓
	Public education		✓		✓
	Business water use efficiency programs		✓		✓
	House "tune up" water conservation programs		✓		✓
	Sub-metering of building units		✓		✓
	Water restrictions		✓		✓
	Real time public tracking of progress		✓		✓
Reduction of water losses	Identification and reduction of NRW components		✓		✓
	Leakage management		✓		✓
	Meter audits/calibration		✓		✓
Pressure Management	Pressure management/pressure reduction	✓	✓		✓
System Improvements	Enhance monitoring (eg. telemetry or other alternatives)	✓	✓	✓	✓
	Treatment plant automation	✓	✓	✓	
	Mains cleaning		✓	✓	✓
	Alternative service delivery (water tankering)	✓	✓		✓
	Rezoning		✓		
	Improved responsiveness	✓			
	Training/skills development	✓	✓	✓	✓
	Investment in predictive/planned maintenance	✓			✓
Source Substitution	Rainwater harvesting, effluent reuse		✓	✓	✓
	Diversion from sewer eg. greywater, sewer mining				✓
Land Use Planning	Increased residential density		✓		✓
	Catchment management and source water protection			✓	✓
Service Standards	Modify standards of service in consultation with customers. (Note *Water Act 2000* compliance in relation to SAMP/CSS)	✓	✓	✓	✓

5.4.2 Infrastructure Options – Water Supply

A range of infrastructure options exist for the provision of water supply services which can be implemented in conjunction with a range of non-asset solutions. These options are summarised in the following tables:

- Table 5.3 Indicative Water Source and End Use Options
- Table 5.4 Applicability of Water Supply Infrastructure for Different Urban Areas
- Table 5.5 Typical Options Available to Provide a Water Supply Service
- Table 5.7 Overview of Applicability of Water Treatment Processes

These tables imply that:

- Different types of infrastructure could be provided in various parts of an urban environment.
- Not all the infrastructure would necessarily need to be supplied by the service provider.
- Some infrastructure may only be required seasonally (eg when a saline secondary supply has to be utilised during the dry season).
- Different standards of water services and treatment levels could be provided for different end uses.

Other valid options may also be appropriate.

For any water source end use option (Table 5.3), the water must be fit for the intended end use. The characteristics of specific sources will determine the level of treatment, monitoring and maintenance regime required for the proposed use. Consult Section 7 – Bibliography for specific guidance on water quality criteria for drinking and recycling purposes.

TABLE 5.3 – Indicative Water Source and End Use Options

Water Source / End Use	Surface Water		Ground Water		Rainwater		Sea water		Recycled Water		Aquifer Re-Charge (Stormwater)		Aquifer Re-Charge (Recycled water)		Greywater	
Treatment (U=untreated/T=treated)	U	T#	U	T#	U	T#	U	T#	U##	T#	U	T#	U	T#	U	T#
Drinking*	X	✓	1	✓	1	✓	X	✓	X	X	X	✓	X	X	X	X
Hot water###	X	✓	1	✓	1	✓	X	✓	X	X	X	✓	X	X	X	X
Bath/Showers*	X	✓	1	✓	1	✓	X	✓	X	X	X	✓	X	X	X	X
Toilet flushing	1	✓	1	✓	✓	✓	X	✓	X	✓	1	✓	X	✓	X	X
Dishwashing*	X	✓	1	✓	1	✓	X	✓	X	X	X	✓	X	X	X	X
Laundry	X	✓	1	✓	1	✓	X	✓	X	X	X	✓	X	X	X	X
Garden Watering / irrigation	1	✓	1	✓	✓	✓	X	✓	X	✓	1	✓	X	✓	2	2
Pools*	X	✓	1	✓	1	✓	1	✓	X	X	X	✓	X	X	X	X
Car Washing	1	✓	1	✓	✓	✓	X	✓	X	✓	1	✓	X	✓	X	X
Industrial processes	1	✓	1	✓	✓	✓	X	✓	X	✓	1	✓	X	✓	X	X
Fire fighting	1	✓	1	✓	✓	✓	✓	✓	X	?	?	✓	X	?	X	X

<u>Notes for Table 5.3</u>

#T (treated) assumes that water is treated to a quality suitable for the proposed end use

"Untreated recycled water" refers to secondary treated sewage effluent

###. Hot water: water temperature must comply with the requirements of AS/NZS 3500.4 (Applied Provisions under the *Standard Plumbing and Drainage Regulation 2003*), that is, must be stored at a minimum of 60°C and be delivered at the outlet of all sanitary fixtures at a temperature not exceeding 45°C for specified facilities for young, aged, sick or disabled persons or 50°C in all other buildings)

* Where a reticulated drinking water supply is provided, water used for drinking, food preparation, utensil washing, oral hygiene and bathing purposes should be of drinking water quality (see section 5.4.3)

✓ Appropriate (note that while option may be appropriate it may not be cost effective)

X Unsuitable

? Under consideration

1.Need to verify that untreated water is of a quality suitable for the intended end use See Section 7 – Bibliography for specific guidance on water quality for drinking and recycling uses and for guidance on rainwater.

2. Greywater use must comply with regulatory requirements under the *Plumbing and Drainage Act 2002* and *Environmental Protection Act 1997*.

TABLE 5.4 – Applicability of Water Supply Infrastructure for Different Urban Areas

Infrastructure \ Settlement	Major Urban >25,000 connections	Medium Urban 1,000-25,000 connections	Small Urban 100-1,000 connections	V. Small Urban <100 connections	Rural Residential	Dispersed Housing (Locality)	Comments
Water Source							
▪ off-site	✓	✓	✓	✓	✓	✓	
▪ on-site	✓	✓	✓	✓	✓	✓	On-site sources could include rainwater tanks or bores.
Treatment							
▪ off-site	✓	✓	✓	✓	✓	X	
▪ on-site	✓	✓	✓	✓	✓	✓	On-site rainwater treatment could be provided in all settlements.
▪ mobile	X	X	✓	✓	✓	X	Provides supplementary treatment when secondary sources are utilised (eg sea water desalination) during drought periods.
Pumping							
▪ off-site	✓	✓	✓	✓	✓	X	
▪ on-site	✓	✓	✓	✓	✓	✓	On-site pumping required if rainwater supply
▪ Storage							
▪ off-site	✓	✓	✓	✓	X	X	
▪ on-site	✓	✓	✓	✓	✓	✓	Rainwater tanks
Mobile Supply							
▪ tankered	X	X	✓	✓	✓	✓	Tankered water would be an emergency supply or supplementary source to rainwater.
▪ bottled	X	X	✓	✓	✓	✓	Includes delivery

TABLE 5.5 – Typical Options Available to Provide a Water Supply Service

Service	Type	Description	Advantages	Disadvantages
Water Distribution	Fully reticulated drinking water supply	System designed to meet peak demands & fire flows Note – smaller systems may not always meet fire flow demands Most common system in Queensland	1. Ensures public health protection 2. On demand system 24 hours per day 3. Provides irrigation water for gardens 4. Proven track record	1. May not be cost-effective for dispersed housing (eg rural residential development) 2. This type of system by itself may not be environmentally sustainable in the long term
	Fully reticulated non-drinking water supply (with specific separate provisions for drinking water)	Occasionally applied where provision of treatment plant is uneconomic System designed to meet peak demands and possibly fire flows Should be supplemented by an on-site drinking water supply (eg rainwater tanks with treatment)	1. On demand system 24 hours per day 2. Can be upgraded to drinking water standard 3. Provides irrigation water for gardens	1. Public health risks from non-drinking water system and rainwater supply 2. May not be cost-effective for dispersed housing (eg rural residential development)
	Constant flow reticulated drinking water scheme	Provides a reticulated drinking water supply to meet average demands. Peak demands are met by a storage tank at each house. This must be separated by suitable backflow prevention from any rainwater storage tanks. The rate of supply to each tank is controlled by a suitable restriction device. Drinking water can be provided directly to the kitchen tap. The reticulation is designed for lower constant flows.	1. Appropriate for scattered communities where the supply of reticulated peak demands would be uneconomic	1. Cannot provide fire flows (could be provided from on-site tanks) 2. Cannot be easily upgraded to a fully reticulated drinking water supply 3. Customer service standard issues may arise at a later date as city/town residents relocate into the area
	Tankered system	Distribution of water via tankers. Tankers obtain water from metered standpipes operated by the service provider or an adjacent service provider. This would supplement existing on-site non-drinking water systems (rainwater tanks, bores, surface sources)	1. May be appropriate and cost-effective for dispersed housing located away from water supply service areas 2. Householders take a more responsible attitude to water consumption 3. No cost to the service provider.	1. Possible high costs to householders 2. Potential risk of contamination of source via water tankering or poor maintenance of tankers or storage tanks
	Dual reticulation	Two parallel reticulated systems are provided. One system provides drinking water. The second system provides non-drinking water (eg untreated raw water or recycled water) for garden	1. Increased use of recycled water 2. Reduced direct release of effluent to waterways 3. Reduced overall drinking water demand	1. Higher level of treatment required to provide reclaimed water of required standard 2. Health risks (possible cross connection, public contact,

Service	Type	Description	Advantages	Disadvantages
		watering, toilet flushing and other external uses including parks, gardens and playing fields. Possibly the recycled water could be used for fire fighting	4. Reduced peak drinking water demand 5. Possible decrease in drinking water pipe sizes 6. Recycled water may be a potential source of water for fire fighting 7. More reliable local source of water for non-drinking uses 8. Potential to delay provision/expansion of major drinking water supply infrastructure (eg future dam, water treatment upgrades) 9. Potential lower tariff for recycled water use compared to drinking water 10. Potential relaxation of water restrictions	pathogen transfer via aerosols) 3. Additional cost to householder due to additional plumbing requirements and on-going monitoring to ensure that no cross connection exists 4. Additional network for service provider to operate and maintain 5. Potential regulatory/legislative constraints 6. Public perception particularly in the early stages of the proposal 7. Need to develop a recycled water headworks charge 8. Potential for recycled water run-off 9. Need to gain acceptance of fire authorities and fire fighters 10. The need to develop a policy on recycled water use 11. Potential impact of recycled water salinity on gardens
	Rainwater tank (sole supply)	Collects rainfall run-off from roofs for water supply. Generally used for drinking and non-drinking purposes. May be supplemented by a bore or surface supply for non-drinking purposes supplemented by tankered water during low rainfall periods.	1. No cost to service provider 2. Householders take a more responsible attitude to water consumption 3. Low water consumption	1. Failure of supply during low rainfall periods. Supplementary tankered water required 2. Area requirements for location of a tank, particularly on small lots 3. Associated costs to householders of supply installation, operation and maintenance of tanks and associated pumps and pipe work 4. Potential contamination of stored water (eg airborne contaminants, animal wastes etc) 5. Potential public health issues (mosquito breeding) 6. Limited guidelines for rainwater tanks currently exist 7. Cost of ongoing Council

Service	Type	Description	Advantages	Disadvantages
				monitoring of system 8. Noise from pumps
	Rainwater tanks (supplementary supply)	Collects rainfall run-off for water supply and possibly stormwater attenuation. Rainwater could be used for all non-drinking water uses including toilet flushing, laundry and garden watering. Could be used as a back up for drinking.	1. Reduced demand for drinking water supply 2. Reduced stormwater run-off therefore reducing size of downstream stormwater infrastructure	1. Failure of supply during low rainfall periods. This would have to be supplemented by drinking supply (which could be also under stress) or tankered water 2. Area requirements for location of a tank, particularly on small lots 3. Associated costs to householders of supply installation, operation and maintenance of tanks and associated pumps and pipe work 4. Potential contamination of stored water (eg airborne contaminants, animal wastes etc) 5. Potential public health issues (mosquito breeding) 6. Comprehensive guidelines for rainwater tanks don't currently exist 7. Ongoing Council monitoring of system 8. Issues in relation to responsibility (owner or service provider) for ongoing maintenance, particularly if tanks are mandatory 9. Noise from pumps
Drinking Water	Centralised water treatment	A range of water treatment processes exist. These are summarised in Table 5.7. The appropriate water treatment process will depend on: ▪ raw water characteristics and variability; ▪ service standards (drinking water quality); ▪ cost effectiveness of the process; ▪ operational capability of service	1. This facility is critical to the maintenance of public health 2. Water quality to customers can be controlled by the service provider 3. Economies of scale 4. Plant managed by qualified operation and maintenance staff 5. If particular customers require further treatment this can be provided by a "point of use"	1. Water quality can decay due to characteristics of the reticulation system (eg condition, detention) 2. Some service providers may have difficulty attracting qualified staff to run facilities

Service	Type	Description	Advantages	Disadvantages
		provider	system paid for by the customer	
	Point of use water treatment	A range of small systems are available to enhance the water quality provided by the service provider. These systems include: ▪ Activated carbon & mechanical filters ▪ Water softeners ▪ Iron removal equipment ▪ Neutralisers ▪ Reverse osmosis	1. May be an appropriate solution where the cost of centralised water treatment is prohibitive 2. The consumer has more control of water quality 3. No cost to the service provider	1. Each of the alternative systems has specific applications and some limitations 2. Consumers may not properly maintain the systems and would result in water quality deterioration and potential public health concerns 3. Not all consumers will select the most appropriate system 4. Total cost of service will be increased to consumers 5. The homeowner may have to be trained in system selection, operation and maintenance
	Bottled Water	Bottled water is increasingly being used as an alternative to tap water. Bottled water quality is covered by the Australia New Zealand Food Standard Code Standard 1.6.1 Microbiological Standards for Food and Standard 2.6.2: Non-Alcoholic Beverages and Brewed Soft Drinks	1. May be an appropriate solution where the cost of centralised water treatment is prohibitive 2. Possible opportunities for bulk purchase cost reduction	1. The cost/litre of bottled water is over a 1000 times that of tap water 2. The service provider may need to organise contracts for the supply of bottled water 3. The service provider may have to organise/manage the distribution of bottled water 4. Environmental impacts if containers not recycled

Note: Some of the information in this table has been adapted from:

- Pimpama Coomera Water Futures – Master Plan Options Report, Gold Coast Water, July 2003
- Affordable Water Supply & Sewerage for Small Communities, WSAA, 1999

5.4.3 Drinking Water Quality

The *Australian Drinking Water Guidelines* (NHMRC/NRMMC 2004) are adopted as the basis of drinking water quality in Queensland. These guidelines define drinking water as “water intended primarily for human consumption either directly, as supplied from the tap, or indirectly in beverages, ice or foods prepared with water. Drinking water is also used for other domestic purposes such as bathing and showering”. These criteria apply to water as delivered to the consumer and the water utility should be operated accordingly.

Where there is a reticulated drinking water supply, water of drinking water quality should be used for human consumption, food preparation, utensil washing, oral hygiene and bathing (AS/NZS 3500, AS/NZS 4020, WSAA, 2002, *Water Supply Code of Australia*).

The Framework for Management of Drinking Water Quality outlined in the Guidelines provides a preventive risk management approach which is comprehensive from catchment to consumer.

As a minimum standard, the quality of the water must not impair human health. It is also important to consider other characteristics, including the water’s palatability and its aesthetic quality. Drinking water should be clear, colourless, adequately aerated, have no discernible taste or odour and be pleasant to drink. It should be free from suspended matter or turbidity, pathogenic organisms and harmful chemical substances.

Where necessary water should be treated to minimise corrosion of pipes, fittings and structures or scaling and staining of pipes and fixtures.

Where the water does not meet the requirements of the *Australian Drinking Water Guidelines* and the service provider determines that the cost of further treatment exceeds the benefit, the community should be involved in setting the levels of service for characteristics not directly related to health. An informed community could agree to accept levels in excess of the *Australian Drinking Water Guidelines*. However the *Australian Drinking Water Guidelines* values for characteristics of direct health significance should not be exceeded and the process of community consultation should not be seen as a licence to simply degrade the quality of a water supply.

TABLE 5.7 – Overview of Applicability of Water Treatment Processes

Characteristic / Process	Catchment Management	Raw Water Storage	Destratification	Screening	Micro strainers	Pre-chlorination	Aeration & Stripping	Coagulation, Sedimentation or DAF	Precoat Filtration	Direct Filtration	Lime Softening	Ozone/BAC	Chemical Oxidation	Disinfection	Microfiltration	Ultrafiltration	Nanofiltration	Reverse Osmosis	Electrodialysis/Electrodialysis Reversal	Ion Exchange	Activated Carbon	Activated Alumina
Debris	●	●		●	●																	
Algae	●		●		●	●		●		●		●			●	●	●				●	
Blue-green algae	●		●		●			●		●		●			●	●	●				●	
Turbidity	●	●						●		●		●			●	●	●					
Colour								●		●		●	●				●	●			●	
Taste & Odour						●	●					●	●								●	
Hardness											●						●	●	●	●		
TDS																		●	●	●		
Chloride																		●	●			
Sulphate																	●	●	●			
Iron			●			●	●	●	●	●	●		●							●		
Manganese			●			●		●	●	●	●		●							●		
Heavy metals								●			●							●	●			●
Nitrate																		●	●	●		
Fluoride											●							●	●			●
Organic contaminants																						
▪ volatile												●									●	
▪ synthetic							●					●						●			●	
Pesticides/Herbicides	●											●					●	●				
Dissolved organic carbon												●					●	●			●	
Radionuclides											●							●	●	●		
Viruses								●		●	●	●		●			●	●				
Bacteria						●		●		●	●	●		●	●	●	●	●				
Protozoa								●		●	●	●		●	●	●	●	●				

Adapted from: Water Quality & Treatment – A Handbook of Community Water Supply, American Water Works Association 1999

5.4.4 Infrastructure Sizing – Water Supply

This section should in read in conjunction with the following chapters:

- Chapter 5 – Demand/Flow and Projections; and
- Chapter 6 - Network Modelling.

Table 5.8 provides a summary of water supply system component sizing. These are generally based on parameters adopted in the previous State guidelines. Service providers can develop modified sizing guidance based on the performance and characteristics of their existing systems.

Where a dual reticulation system or other alternative means of service delivery is proposed then the applicability of the component sizing should be re-evaluated. In particular, for reticulation systems the source of water for firefighting should be determined and the sizing of components for the other system re-evaluated. In dual reticulation systems care should be taken not to apply traditional sizing criteria without considering the water quality issues that may arise from installation of oversized components.

The planner should undertake a risk assessment in determining:

- the level of pump stand-by capacity
- reservoir emergency storage/fire fighting reserve.

Factors to be considered in the risk assessment are listed in Table 5.9.

TABLE 5.8 – Sizing of Water Supply System Components

Component	Sizing	Comments
Surface water source	Historical no failure yield	Refer to Principles for Surface Source Yield Determination (page 17)
Groundwater source	Long term safe yield of bore/bores	Based on drawdown tests
Raw water pumps	MDMM over 20 hours or long term safe yield of bores	The period of operation can be confirmed/amended through modelling and risk assessment
Raw water mains	MDMM (gravity supply) MDMM over 20 hours (pumped supply)	Max velocity 2.5m/s The period of operation can be confirmed/amended through modelling and risk assessment
Treatment Plant	Delivery flow rate from source (over 20 hours)	The period of operation can be confirmed/amended through modelling and risk assessment
Treated water pumps feeding a ground level reservoir	MDMM over 20 hours	The period of operation can be confirmed/amended through modelling and risk assessment
Treated water pumps feeding an elevated reservoir	Capacity (L/s) = $\frac{\text{6PH – reservoir operating volume}}{6 \times 3600}$ Volume in litres	
Trunk mains feeding ground level reservoir	MDMM (gravity) MDMM over 20 hours (pumped supply)	
Trunk mains feeding elevated reservoir	Capacity of treated water pumps	

Component	Sizing	Comments
Reservoirs (ground level)	3 (PD-MDMM) + (greater of Emergency Storage/Firefighting Storage)	This sizing relates to operating level. Emergency storage subject to risk assessment by service provider. Firefighting storage would need to be incorporated for smaller reservoirs.
Elevated reservoir	$6 \frac{(PH - MDMM)}{12}$ + firefighting reserve	A firefighting reserve should be determined through network modelling and subject to risk assessment by the service provider Based on the proven capability of variable speed pumps and pressure cells, elevated reservoirs may not be economically viable. The planner should determine the optimal combination of inflow/storage and capacity/demand based on lifecycle cost analysis. The frequency/duration of power failures should also be considered.
Trunk reticulation mains	PH	Max velocity 2.5m/s For smaller schemes the trunk mains may have to be sized to accommodate fireflow.
Reticulation mains	PH + fireflow	Max velocity 2.5m/s @ PH
Reticulation booster pump station	PH + fireflow	
Pumped System	Peak instantaneous flow + fireflow	This situation may exist in smaller systems if variable speed pumps would replace any elevated storage. In these instances it would be necessary to calculate instantaneous flow based on concurrent demand. This would exceed PH by a significant margin.
Standby pumps	Standby pump capacity to match the largest single unit pump capacity	
Constant flow system	AD for all system components Typical on-site storage = 22.5kL	Fire fighting requirements to be determined in consultation with Local Fire Service
Dual reticulation system	System components generally sized as for conventional system	There may be a need to re-evaluate sizing of some components where alternative systems are proposed.

TABLE – 5.9 Risk Assessment Consideration – Water Supply

Factor	Pump or Equipment Standby Capacity	Reservoir Emergency/Firefighting Reserve
Asset criticality (likelihood & consequence of failure)	✓	✓
Availability of alternative supply (eg standby generation equipment)	✓	✓
Level of maintenance	✓	
Water quality impacts (eg detention time)		✓
Reservoir storage capacity versus pump station or supply capacity	✓	✓
Site aspects (space limitations)		✓
Operational requirements	✓	✓

Principles for Surface Source Yield Determination

The historical simulation modelling methodology should be adopted for calculation of yields.

Theoretical yield calculations should utilise a simulation from 1900 or earlier to the present, where sufficient rainfall data is available.

The minimum storage level should be determined and revised at appropriate intervals. The volume below the minimum storage level should not be included in the storage volume for theoretical yield calculation.

The environmental flow requirements determined under the State Government's Water Resource Planning process are to be incorporated into the theoretical yield calculations for storages/systems.

The theoretical yield of all storages/systems should target the Historic No Failure Yield (HNFY) for both monthly and annual measures.

A contingency storage volume should be determined based on a detailed assessment of the risks associated with inaccuracies in the modelling and the risk of experiencing a worse drought than that which is historically recorded.

Management strategies such as demand management, drought management, imposition of restrictions, multi-source management may serve to increase the managed yield of a source/system.

It would be desirable for service providers to re-evaluate yields of existing storages and the sensitivity of these yields to any land use or climatic changes.

Adapted from:
Queensland Government & SEQROC, Determination of Source Water Availability in South East Queensland – Discussion Paper (draft), May 2004.

Independent Pricing and Regulatory Tribunal of New South Wales (IPART), Review of the Performance Criteria in Sydney Catchment Authority's Operating Licence, July 2003.

5.5 Sewerage Options

5.5.1 Non-Asset Solutions – Sewerage

Table 5.10 summarises potential non-asset solutions that can contribute to the provision of sewerage services.

TABLE 5.10 – Non Asset Solutions

Category	Option	Impacts					
		Wastewater Quantity	Wastewater Release (wet & dry weather)	Breaks/Chokes	Odours	Treatment Plant Loading	Effluent Quality
Water Demand Management	Refer to Table 5.2	✓	✓			✓	✓
Trade Waste Management	Policy Implementation	✓	✓	✓	✓	✓	✓
	Pre-treatment	✓	✓	✓	✓	✓	✓
	Cleaner production	✓	✓	✓	✓	✓	✓
	Education	✓	✓	✓	✓	✓	✓
Infiltration/Inflow Management	Infiltration/inflow reduction	✓	✓			✓	✓
System Improvements	Enhance monitoring (eg. telemetry)		✓			✓	✓
	Treatment plant automation						✓
	Improved responsiveness		✓	✓			
	Training/skills development				✓		✓
	Investment in predictive/planned maintenance		✓	✓			✓
	Flow balancing					✓	✓
	Pump station scheduling		✓				
	Improve the performance of existing on-site systems				✓	✓	✓
	Standby generators		✓				
	Septicity control				✓		
	Storage		✓			✓	✓

5.5.2 Infrastructure Options – Sewerage

Table 5.13 provides an overview of the various sewage collection options available. These could be combined with centralized or localised treatment facilities or with sewer mining facilities. Various on-site sewerage management systems are also available.

Figure 5.2 provides a generalised overview of potential wastewater treatment options. Table 5.11 provides a Treatment Process Summary.

Preliminary treatment involves the removal of large objects (eg plastics) through screening. Smaller particles (eg sand) are removed in grit removal units.

Primary treatment involves solids settlement and the removal of grease and scum.

Secondary treatment uses micro-organisms to break down and remove remaining dissolved wastes and fine particles. Micro-organisms and wastes are incorporated in the sludge.

Nutrient reduction removes nitrogen and phosphorus nutrients that could cause algal blooms in waterways and threaten aquatic life. Nutrient reduction is not available at all sewage treatment plants because it requires expensive specialised equipment. It is becoming more common in Queensland. Operational enhancements can provide some nutrient reduction.

Disinfection reduces disease-causing micro-organisms.

TABLE 5.11 - Treatment Process Summary – Wastewater Treatment and Recycling
(adapted from Table 4.2 Metcalf and Eddy, 3rd edition)

Contaminant	Unit operation / unit process
Suspended solids	▪ Screening and comminution ▪ Grit removal ▪ Sedimentation ▪ Filtration (granular medium, membrane) ▪ Flotation ▪ Chemical polymer addition ▪ Coagulation/sedimentation ▪ Natural systems (land treatment, wetlands)
Biodegradable organics	▪ Attached growth systems o Trickling filters o Rotating contact filters ▪ Suspended growth systems o Activated sludge variations ▪ Lagoon variations ▪ Physical/chemical systems (coagulation; chemical precipitation) ▪ Membrane bioreactors ▪ Natural systems
Volatile organics	▪ Air stripping ▪ Off gas treatment ▪ Carbon adsorption
Pathogens	▪ Disinfection o Chlorination o Chlorine dioxide o UV radiation o Ozonation ▪ Lagoons ▪ Natural systems ▪ Membrane systems ▪ Primary and secondary processes
Nitrogen	▪ Suspended growth nitrification and denitrification variations ▪ Fixed growth nitrification and denitrification variations ▪ Ammonia stripping ▪ Ion exchange ▪ Breakpoint chlorination ▪ Lagoons ▪ Natural systems
Phosphorus	▪ Chemical precipitation (alum, iron salts, lime) ▪ Biological phosphorus reduction ▪ Biological-chemical phosphorus reduction ▪ Natural systems
Nitrogen and Phosphorus	▪ Biological nutrient reduction
Heavy Metals	▪ Chemical precipitation ▪ Ion exchange ▪ Naturals systems

Contaminant	Unit operation / unit process
Dissolved salts	▪ Reverse Osmosis ▪ Ultra filtration ▪ Ion Exchange ▪ Electrodialysis
Toxic compounds and refractory organics	▪ Carbon adsorption ▪ Chemical oxidation ▪ Natural systems

The treatment system will comprise a combination of unit processes selected to produce a quality of effluent suitable for the intended end use eg discharge or recycling, and which meets EPA requirements.

Process selection depends on:

- effluent quality requirements
- influent characteristics
- compatibility with existing facilities
- capital cost considerations
- operation and maintenance costs
- environmental considerations
- energy and resource requirements
- equipment availability
- equipment or process reliability
- process complexity – skills required to operate, level of automation
- appropriateness.

Consideration will need to be given to management of solids (screenings and sludge) from the treatment process to minimise environmental harm.

Increasing use is being made of kinetic models of the activated sludge process. These are powerful models which are invaluable to experienced process engineers. Care must be taken in the use of these models particularly the use of default settings. Monitoring of influent characteristics on an extended timeframe is essential to enable maximum benefits from the modelling to be realised.

Product recycling is becoming more prevalent. Issues relating to recycling are summarised in Table 5.14 with more detailed guidance listed in Section 7.0 – Bibliography.

5.5.3 Sewage Quality

Monitoring of sewage characteristics should be undertaken on an extended timeframe. This is essential where kinetic modelling of the sewage treatment process is to be undertaken. Typical composition of domestic sewage is listed in Table 5.12. The variations would be due to internal water usage, infiltration/inflow and trade waste loadings.

TABLE 5.12 – Typical Composition of Domestic Sewage

Constituent	Unit	Municipal[1]	Resort[2,3]
pH value		6.5-8	6-8
Electrical Conductivity[1]	μS/cm	700-900	700
Total Dissolved Salts[1]	mg/L	500-650	500
Suspended Solids	mg/L	140-410	400
BOD_5	mg/L	140-480	450
Total Organic Carbon	mg/L	160-250	-
Ammonia Nitrogen (as N)	mg/L	20-60	60
Orthophosphate (as P)	mg/L	6-10	10
Total Phosphorus (as P)	mg/L	6-30	
Total Sulphide	mg/L	5-15	5
Hydrogen Sulphide	mg/L	1-5	1
Alkalinity[1]	mg/L	50-300	
Total Oil and Grease	mg/L	10-100	

[1] Concentration will depend on water supply characteristics, level of infiltration of saline groundwater and trade waste characteristics.
[2] Data provided by Simmonds & Bristow.
[3] Self contained resorts (eg island resorts) with laundry facilities etc would also have a higher flow rate per EP.

TABLE 5.13 – Typical Options Available to Provide a Sewerage Service

Service	Type	Description	Advantages	Disadvantages
Collection System	Conventional Gravity System	Wastewater is collected through gravity sewers, which grade downhill. Manholes (or maintenance shafts) are provided at intervals and change of direction to provide maintenance access points. Pump stations may be provided to pump wastewater into another sub-catchment, catchment or treatment plant. This is the most common form of wastewater collection system in Queensland.	1. Extensive experience of this type of system in Queensland. 2. Provides a reliable and cost-effective means of collecting wastewater. 3. Designed to meet a designed wet weather flow.	1. Can be susceptible to infiltration/inflow from both service provider infrastructure and customer sewerage pipework. 2. Is susceptible to tree root intrusion causing blockages. 3. May require deep and expensive excavation in flat areas (or alternatively a number of pump stations). 4. May need to be constructed below the water table or in rock which will add significantly to costs. 5. Potential for odours where long detention times exist. 6. Potential operational problems if greywater re-use is implemented.
	Smart Sewers	Smart Sewers are systems designed to modified design criteria compared with existing 'traditional' reticulated gravity wastewater systems. The main features of the modified criteria include: ▪ reduced peak wet weather flow allowance ▪ the use of modern pipe materials ▪ provision of smaller and less frequent access structures ▪ replacement of access chambers with non-accessible inspection openings The concept of 'smart' sewers takes advantage of modern materials and design and construction approaches to produce a lower cost collection system	1. Reduced capital cost for system construction. 2. Reduced O&M costs. 3. Less infiltration/inflow. 4. Less corrosion. 5. Longer useful life. 6. Less obtrusive system. 7. Less capacity for illegal connections.	1. No comprehensive design guidelines exist. 2. Requires paradigm shift in industry. 3. Increased supervision and quality control costs. 4. House drains may continue to be a source of infiltration/inflow. 5. Detailed documentation and/or above ground markers required to provide on-going access to inspection points.

Service	Type	Description	Advantages	Disadvantages
		without any loss in the quality of service to customers.		
	Modified Conventional Sewerage with Lift Pumping (MCS)	Similar to conventional gravity system except that extensive use is made of access chamber lift pumping to reduce trench excavation. Access chambers are replaced with small diameter flushing and rodding points. Able to use smaller diameter sewer reticulation mains and adopt flatter grades.	1. More cost-effective for smaller communities. 2. May be appropriate for areas with high excavation costs (eg rock or high groundwater levels).	1. May have slightly reduced service levels (eg sewer blockages, possibly more frequent wet weather overflows). 2. May generate more greenhouse gases. 3. May generate odours through longer detention times.
	Vacuum Sewerage (VS)	Small diameter shallow collection system that is maintained under negative pressure using a number of centralised vacuum pumping stations. Groups of 6-8 houses drain to a single pit incorporating a vacuum valve to control wastewater flow into the pipeline. At a predetermined level the valve in the pit opens and wastewater is “sucked” into the pipeline system to a central vacuum/pumping station. The collection radius for the pump station is in the order of 2km.	1. Appropriate for areas with high excavation costs (eg rock or high groundwater levels). 2. Appropriate where terrain is flat and low-lying. 3. Lower infiltration/inflow (but still potential in upstream gravity pipework). 4. Central vacuum/pumping station rather than a number of stations as for a conventional system. 5. Less odour potential.	1. Each house must be drained to a communal pit. 2. Relatively high energy user. 3. May generate more greenhouse gases. 4. Possible need for an access easement to facilitate maintenance of collection pits.
	Common Effluent Drainage scheme (CED)	This involves treatment of wastewater on-site by means of septic tanks with effluent transported off-site for further treatment. On-site treatment reduces solids and the pipework can be laid at a shallower grade. The effluent tends to be more septic. Appropriate where: ▪ existing septic tanks are in good condition ▪ low housing density with little growth anticipated; ▪ relatively flat terrain; ▪ rock is at shallow depths; and ▪ where cluster development in rural	1. Reduced costs for sewer reticulation in flat terrain or where rock exists at shallow depths. 2. Sewer gradients can be reduced, most manholes eliminated and inspection openings provided. 3. Lower maintenance costs due to fewer sewer and pump blockages. 4. Suitable for schemes not provided with a reticulated water supply.	1. Septic tanks on premises may require desludging every 2 years. 2. Alterations to house drainage may make connection costs more expensive. 3. May prevent economic upgrading to conventional sewerage at a later date. 4. When individual householder costs (eg septic tank capital and operation costs) are included with service provider costs, this option may not be significantly cheaper than a conventional sewerage scheme. 5. Requires maintenance to be

Service	Type	Description	Advantages	Disadvantages
		areas exist, particularly where soils are not suitable for on-site sewerage systems.		undertaken by householder.
	Variable Grade Sewerage (VGS)	Similar to CED but it permits the collecting sewers to be laid at inflective grades (ie with a series of low points) with a net fall from inlet to outlet.	As for CED	As for CED
	Septic Tank Effluent Pumping (STEP)	This is similar to a CED system except that the septic effluent flows to a storage tank with a pump. It is then pumped to the treatment plant. The storage tank can serve individual houses or a group of 2-4 houses. Septic tanks should be desludged every 2 years. May be appropriate for small communities <500 persons.	1. Reduced capital costs where rock exists at shallow depths. 2. Reduced infiltration/inflow.	1. As for CED. 2. Householder energy costs will increase. 3. Possible problems of solids carryover into the pressure main 4. Householders may install facilities (eg pumps) for which system is not designed – problem if common pumping main 5. May generate more greenhouse gases. 6. Requires ongoing service provider monitoring of householder system.
	Pressure Sewerage Collection System	Each property is provided with an in-ground tank. A grinder pump in the tank discharges wastewater from the property by a small diameter polyethylene pipeline to a common pressure sewer in the street. The pressure sewer discharges to either a gravity sewer, pumping station or directly to a treatment plant. System introduced to Australia in late 1990's after 30 years experience in the US and Europe.	1. Appropriate in situations where groundwater level is high, land is flood prone or is rocky and steep. 2. Appropriate to waterfront areas where overflows from conventional systems may cause environmental harm. 3. An alternative where it is impractical to install a conventional system. 4. Can be a cost-effective alternative through the elimination of pump stations, deep excavation. 5. Potential lower householder connection costs. 6. Reduced infiltration/inflow. 7. Less construction disruption due to shallow trenching.	1. Limited experience of technology by Service providers. 2. Householder energy costs will increase. 3. Potential for odours if long detention times in tank. 4. Requires a greater level of customer cooperation to protect pumps from blockage and premature wear. 5. Requires ongoing service provider monitoring of system 6. May generate more greenhouse gases.

Service	Type	Description	Advantages	Disadvantages
Wastewater Treatment	Centralised Wastewater Treatment	A range of wastewater processes exist. These are summarised in Figure 5.2. The appropriate wastewater treatment process will depend on: ▪ current and anticipated EPA licence conditions and development approvals ▪ the appropriateness of the process to the service provider's resources, skills and operational capability; and ▪ cost-effectiveness of the process	1. Effluent quality can be controlled by the service provider. 2. Economies of scale. 3. The plant is managed by qualified operation and maintenance staff.	1. Provides a point source of pollution. 2. Location may not be optimal to facilitate effluent re-use. 3. Long wastewater detention time in collection system may cause odour and corrosion problems. 4. Buffer distance may limit surrounding development.
	Localised Wastewater Treatment	Provides localised communal wastewater treatment facilities with local reuse. Treatment of wastewater from a small group of lots with local discharge or reuse of effluent would reduce transportation infrastructure and costs.	1. Flexibility to handle dispersed development. 2. Potentially easier environmental approvals because of small scale. 3. Close to reuse application. 4. Lower conveyance costs. 5. Less odour and corrosion in wastewater system. 6. Less greenhouse emissions.	1. Community objection. 2. Difficult to find suitable plant locations. 3. Potentially more difficult to obtain environmental approvals because of large number of affected sites. 4. Diseconomies of scale in relation to capital and operational costs. 5. More operational risk. 6. More skilled resources required. 7. Higher administration costs. 8. Ownership/operational issues.
	Sewer Mining (also termed Water Mining)	Provision of small-scale treatment facilities close to centres of reuse demand to supply recycled water as required. The idea of sewer (or water) mining is that wastewater is drawn from the wastewater system as required and treated, and the residuals from the treatment processes returned to the sewer. The benefit of sewer mining is that it produces recycled water at the point of use, reducing the transportation requirements for treated water.	1. Produces recycled water close to point of use. 2. Reduces infrastructure required to transport treated water. 3. Reduces system costs. 4. By returning residuals to sewer it simplifies the processes and costs at the plant.	1. Requires multiple treatment facilities 2. Potential community objection to number of plants and proximity to development. 3. Difficult to find suitable sewer mining plant locations. 4. Potentially more difficult to obtain environmental approvals because of number of affected sites. 5. Diseconomies of scale in relation to capital and operational costs. 6. More operational risk. 7. More skilled resources required.

Service	Type	Description	Advantages	Disadvantages
				8. Downstream sewers require a steeper minimum gradient to be self-cleaning (higher viscosity of sewage due to high solids concentration).
On-site Sewerage Management Systems (OSMS)	On-site Systems (household)	This includes the settlement and/or flotation in a septic tank, prior to effluent discharge to either a secondary treatment process or land application system. Secondary systems include aerated wastewater treatment systems, sand filters, constructed wetlands. Wet composting toilets are another treatment option. Land application includes modified trench systems, evapo-transpiration beds, mounds, surface and sub surface drip irrigation systems and surface spray systems. Appropriate where sufficient land area is provided.	1. Appropriate for rural properties with sufficient land area. 2. Low cost. 3. Allows beneficial reuse on-site. 4. All waste is contained within the allotment.	1. Likelihood of failure due to poor design including siting and sizing and inadequate operation and maintenance. 2. Potential public health and environmental risks from poorly performing systems. 3. Environmental impacts from the cumulative impacts of on-site plants. 4. Monitoring required by Council. 5. Reliance on householder for running and maintaining the system.
	On-site systems (trade waste pre-treatment facilities)	Treatment ranges from simple grease arrestors to packaged treatment plants to treat various trade wastes. These are provided by the trade waste generator to comply with a service provider's trade waste policy or to reduce trade waste charges. May be accompanied by recycling of effluent.	1. Reduces load on the sewerage system. 2. Reduced probability of treatment plant (service provider's) shock loading. 3. Provides opportunities for local re-use. 4. Reduced capital and operational cost for sewerage system.	1. Diseconomies of scale (for generator). 2. Some trade waste may be beneficial to treatment processes (eg BNR). 3. May require trade waste generator to have in house treatment skills (unless contracted out).
	Waterless Composting Toilets	Composting toilets are an alternative to conventional flush toilets. Composting toilets receive toilet waste only (faeces, urine and paper) and generally have no flushing mechanism. Waste is allowed to compost naturally over time and is periodically removed for disposal as a fertiliser/soil improver. A separate system is required for collection and treatment of greywater, ie	1. Provide human waste disposal systems that do not use water, chemicals or heat and have no polluting discharge. 2. Reduced water demand. 3. Reduced wastewater flows. 4. Reduced infrastructure costs for water supply and wastewater disposal. 5. System managed on-site.	1. Social acceptance. 2. Limited track record in urban development. 3. Paradigm shift required. 4. Not permitted in sewered areas. 5. Potential odour problems in operation. 6. Potential health and safety concerns, especially associated with disposal of compost. 7. Potential environmental concerns

Service	Type	Description	Advantages	Disadvantages
		wastewater from kitchen, bathroom and laundry. This would reduce the amount of water used as wastewater discharged to a centralised system, potentially reducing the size of the systems.	6. Decreased Operation and Maintenance costs for centralised services. 7. All waste contained within allotment.	associated with disposal of compost. 8. Reliance on householder for operation and maintenance of system.
Partial On-site System	Greywater Re-use	Use of greywater from on-site systems for some household reuse applications (eg watering lawns and gardens) Greywater is wastewater, excluding toilet and possibly kitchen wastes, ie mainly bathroom and laundry wastewater. This has the potential to reduce demand on the drinking water supply and reduce flows to the wastewater system.	1. Reduced demand on water supply systems. 2. Reduced load on wastewater system (septic or collection system). 3. Potential wastewater system size reductions. 4. Allows beneficial reuse on-site.	1. Requires separate wastewater and blackwater collection and handling systems. 2. Requires additional storage capacity. 3. Additional cost to householder to install household greywater collection and reuse system. 4. Operation and maintenance cost to householder to run the system. 5. Current regulations may not allow greywater reuse. 6. Potential odour problems in operation. 7. Potential health and safety concerns, especially associated with irrigation of untreated greywater. 8. Potential environmental concerns associated with greywater irrigation. 9. Reliance on householder for operation and maintenance of system. 10. Higher strength wastewater collection system may cause odour and corrosion problems.

Note

The information in this table has been adapted from:

- *Pimpama Coomera Water Futures – Master Plan Options Report, Gold Coast Water, July 2003.*
- *Affordable Water Supply and Sewerage for Small Communities, WSAA, 1999.*
- *Comparison of Alternative Sewerage Systems, Shoalhaven Water (http://www.shoalwater.nsw.gov.au/6hotnews/SewerageSystems.html)*

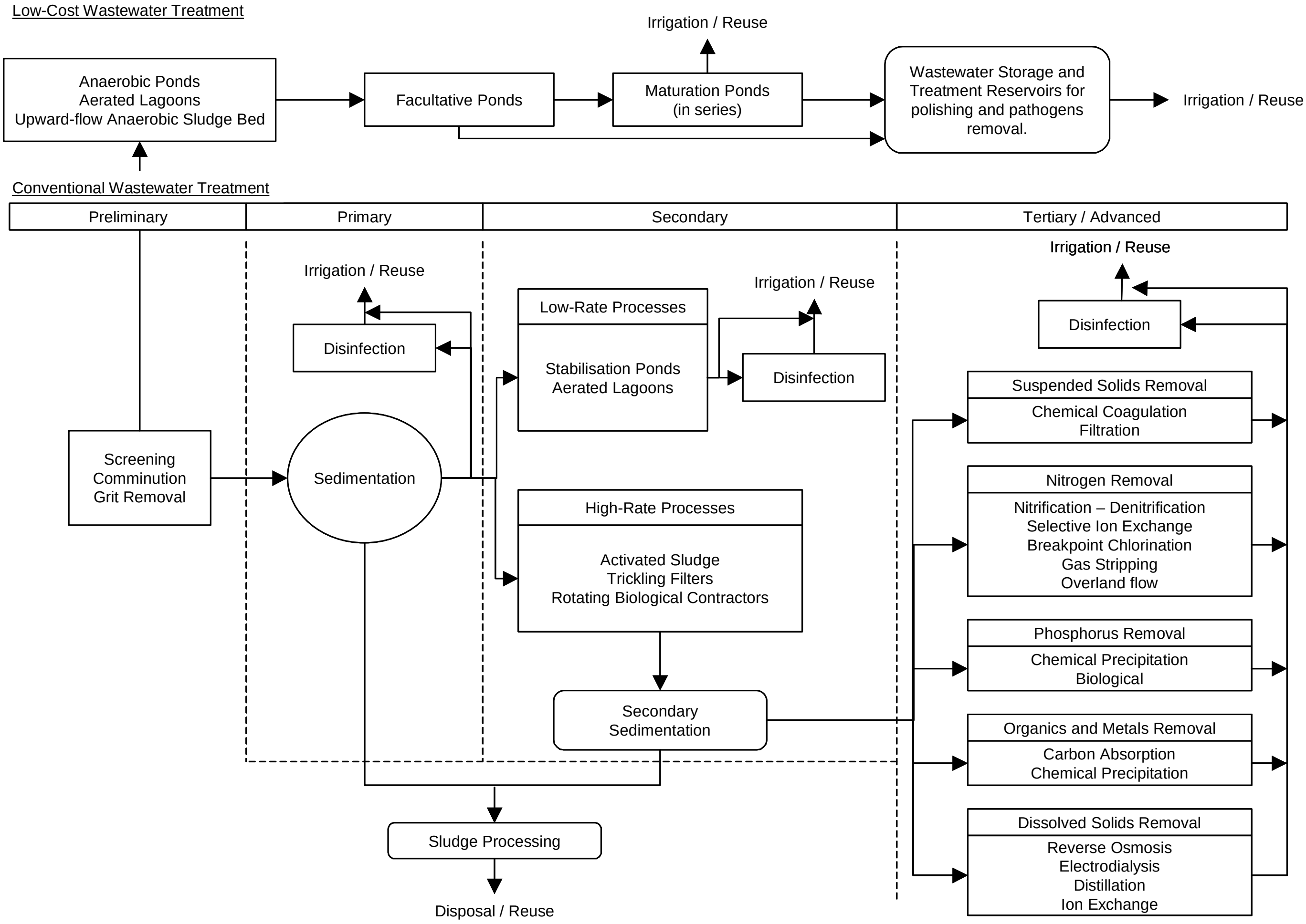
TABLE 5.14 - Product Recycling

Product	Description	Advantages	Disadvantages
Effluent	This involves recycling effluent for either: ▪ Urban/residential recycling ▪ Agricultural use ▪ Industrial applications The level of treatment will vary for different purposes. Effluent is classified (A+ to D) for different uses. Refer to relevant references in Section 7.0 – Bibliography.	1. Provides positive benefits in the areas of water conservation and environmental improvements. 2. Improved management of a scarce source.	1. Potential public health, environmental and legal risks 2. Without effective planning and management, some recycling schemes may not be environmentally, socially or financially sustainable. 3. Public is yet to fully accept effluent recycling.
Biosolids	This involves beneficially reusing biosolids for: ▪ Agriculture; and ▪ Horticulture Biosolids are graded for different uses.	1. Potential resource which provides organic matter, nutrients, trace elements and moisture to land with subsequent improvements in soil structure and fertility. 2. Reduced volume of waste transferred to landfill.	1. Potential public health, environmental and legal risks. 2. Without effective planning some recycling schemes may not be environmentally, socially or financially sustainable. 3. Potential land contamination.

FIGURE 5.2 Typical Levels of Wastewater Treatment

Generalised Wastewater Treatment Processes and Operations, and Effluent Reuse Schemes

(Asano 1999, adapted from Asano, Smith and Tchobanoglous 1985)



5.5.4 Infrastructure Sizing – Sewerage

This section should be read in conjunction with the following chapters:

- Chapter 5 – Demand/Flow & Projections
- Chapter 6 – Network Modelling

Table 5.15 provides a summary of sewerage system component sizes. Service providers can develop modified sizing guidance based on the performance and characteristics of their existing systems and a comprehensive risk assessment.

TABLE 5.15 – Sizing of Sewerage System Components

Component	Sizing	Comments
Conventional System		
Gravity sewers	150mm minimum size Depth of flow at PWWF <= 0.75d Min velocity = 0.7m/s @ PDWF + GWI Minimum Sewer Grades Diameter (mm) — % 150 — 0.55 225 — 0.33 300 — 0.25 375 — 0.17 450 — 0.14 525 — 0.12 600 — 0.10 750 — 0.08 For EPs < 20 the min grade for 150 main should be 1% For EPs 20-50 the min grade for 150 main should be 0.67%	Gravity sewers sized for PWWF (ie. 5 x ADWF min or C_1 x ADWF, whichever is the larger). There will be a need to consider water conservation impacts on minimum sewer grades. For smart sewers a reduced peaking factor for PWWF may be applied (ie. 4 x ADWF).
Rising mains	Min velocity > 0.75m/s Max velocity 1.5m/s (single) and 2.5m/s (all pumps)	May need to reduce velocity prior to discharge to receiving sewer
Pump station wet well storage	$\left(\frac{0.9 \text{ x Single pump capacity L/s}}{N}\right)$ kL	Storage is between pump start and stop. N = 12 starts for motors less than 50kW. N = 5 starts for motors greater than 50kW. Other options can be considered based on starting regime (soft starters etc) and manufacturers' recommendations.
Emergency storage	4 hours x ADWF above duty pump start level in wet well. Can include system storage below wet well overflow level	EPA may impose a higher level of emergency storage depending on the environmental sensitivity of receiving water. The availability of a standby generator may reduce the required detention period.
Single Pump Capacity (duty & standby)	C_1 x ADWF Where $C_1 = 15 \times (EP)^{-0.1587}$ Minimum value of C_1 to be 3.5	Other derived values for C_1 may be used based on system performance. . Alternatively the approach in the WSAA Code can be adopted.
Total pump capacity (both pumps operational)	PWWF (ie. 5 x ADWF min or C_1 x ADWF; whichever is the greater)	Overflows should not occur at flow < 5 x ADWF or C_1 x ADWF (whichever is the larger). Alternatively the approach in the WSAA Code can be adopted. EPA should be consulted.
Vacuum Sewerage		
Mains	PWWF = (4 x ADWF)	A peaking factor of 4 is reasonable to take into account • reduced I/I into a vacuum system; and

Component	Sizing	Comments
		• the potential for I/I from upstream gravity pipework WSAA code released 2004
Valves	80mm diameter to prevent blockage	
Smart Sewers		
Mains	PWWF = (4 x ADWF)	
Common Effluent Drainage System		
Connection	100mm main	May require a second septic tank (1.37kL min) to treat household sullage if existing septic tank only treats toilet wastes.
Mains	Depth of flow at 3 x ADWF <= 0.75d Min velocity in sewers > 100mm = 0.3m/s Min grades 100mm – 1 in 100 for first 30m 1 in 250 thereafter 150mm – 1 in 400 225mm – 1 in 670	
Rising mains	Min 50mm diameter (ID) Min velocity = 0.3m/s	A larger diameter main may be needed to prevent system blockage Peak flow 3 x ADWF
Septic Tank Effluent Pumping		
Connection	50mm (ID) minimum	
Pumping mains	32mm (ID) minimum	Peak flow 3 x ADWF
Pressure Sewerage Collection System		
Property tank Pumping main	630L 40mm (ID) minimum	Peak flow 3 x ADWF WSAA code under preparation
Wastewater Treatment		
Treatment Plant	Full treatment provided for 3x ADWF Minimum of screening and settling provided for 3-5xADF Minimum of coarse screening for >5x ADWF	EPA may impose more stringent conditions depending on the environmental sensitivity of receiving water.
On-Site Sewerage Management System		
	Refer to: *On-site Sewerage Code*, Queensland Department of Local Government & Planning, Nov 2003 AS/NZS 1546:1998 On-site Domestic Wastewater Treatment Units – Septic tanks AS/NZS 1546:2:2001 On-site Domestic Wastewater Treatment Units – Waterless composting toilets AS/NZS 1546:2001 On-site Domestic Wastewater Treatment Units – Aerated wastewater treatment systems AS/NZS 1547:2000 On-site domestic wastewater management	
Grey Water Reuse		
	Refer to: *Guidelines for the Use and Disposal of Greywater in Unsewered Areas*, Queensland Department of Local Government and Planning, June 2003	*Queensland Plumbing and Wastewater Code,* Queensland Department of Local Government, Planning, Sport and Recreation, 2005 (available late 2005; will cover greywater in sewered areas).
Effluent Re-Use		
Storage/Irrigation	Size determined from modelling of water balance, soil dryness and nutrients.	

5.6 Other Issues to be Considered in Infrastructure Planning

Planners should give consideration to such issues as:

- drought management, including contingency plans
- the need for specific materials (eg corrosion protection) or specialist support services, which could impact on capital and operational costs
- siting of facilities to ensure access in all weathers; and to minimise impacts, including noise, air pollution, radio interference and visual impacts
- management of by-products (eg biosolids)
- surge pressures
- how the scheme is to be monitored and controlled, level of automation, out of hours operation
- resourcing the operation and maintenance of the infrastructure
- lifecycle cost impacts of additional assets (eg financial models should incorporate additional O&M costs)
- actions to minimise the probability and consequence of various risks (refer to Table 5.1).

6.0 Checklist

What evidence exists to support the need for improvements? How confident are you of this evidence?

Have the objectives for providing the service been clearly documented?

Do these objectives cover service standards, social, financial and environmental objectives?

Have stakeholder requirements been adequately identified?

How well has the current performance been assessed? How confident are you of the information?

How have the future service demands been assessed?

How has the gap between existing performance and desired service needs and objectives (short, medium and long term) been determined? Has this been clearly documented?

Have non-asset options been rigorously considered before considering investing in infrastructure?

Has a sufficiently wide range of infrastructure options or a combination of options been considered?

Has the basis for selecting a preferred option been clearly documented? Is this supported by rigorous analysis commensurate with the level of infrastructure investment.

7.0 Bibliography

ANZECC/ARMCANZ, 2000, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy, agriculture and Resource Management Council of Australia and New Zealand, Australian and New Zealand Environment and Conservation Council, Canberra. (http://www.deh.gov.au/water/quality/nwqms/index.html)

ARMCANZ/ANZECC/NHMRC, 2000, Guidelines for Sewerage Systems – Use of Reclaimed Water, National Water Quality Management Strategy, Agriculture and Resource Management Council of Australia and New Zealand, Australian and New Zealand Environment and Conservation Council, and National Health and Medical Research Council, Canberra.

AS/NZS 3500: 2003 Plumbing and Drainage

AS/NZS 1546:1998 On-Site Domestic Wastewater Units – Septic Tanks.

AS/NZS 1546:2:2001 On-Site Domestic Wastewater Treatment Units – Waterless Composting Toilets.

AS/NZS 1546:2001 On-Site Domestic Wastewater Treatment Units – Aerated Wastewater Treatment Systems.

AS/NZS 1547:2000 On-Site Domestic Wastewater Management.

AS/NZS 4020:2002 Testing of Products for Use in Contact With Drinking Water.

AS/NZS 4348:1995 Water Supply – Domestic Type Water Treatment Appliances – Performance Requirements.

Australia New Zealand Food Standard Code Standard 1.6.1 Microbiological Standards for Food.

Australia New Zealand Food Standard Code Standard 2.6.2 Non-Alcoholic Beverages and Brewed Soft Drinks.

Australian Academy of Technological Sciences and Engineering, 2004, Water Recycling Australia (http://www.atse.org.au/index.php?sectionid=597)

Australian Research Centre for Water in Society. (http://www.clw.csiro.au/research/water/arcwis/)

Beaudesert Shire Council, Mixed Constant Flow and Rainwater Tanks (http://www.bsc.qld.gov.au/council_information/Waterwise/TankBrochure.pdf)

Cooperative Research Centre for Water Quality and Treatment, Research Report 11, A Guide to Hazard Identification and Risk Assessment for Drinking Water Supplies.

Cooperative Research Centre for Water Quality and Treatment. (http://www.waterquality.crc.org.au/). Note also includes a wastewater program.

DPIWE, 2002, Environmental Guidelines for the Use of Recycled Water in Tasmania, Department of Primary Industries Water and Environment. (http://www.dpiwe.tas.gov.au/inter.nsf/Attachments/LBUN-5FL7QL/$FILE/Recycle%20Water%20Guideline.pdf)

EnHealth 2004, Guidance on the Use of Rainwater Tanks (http://enhealth.nphp.gov.au/council/pubs/documents/rainwater_tanks.pdf)

EPA NSW, 1997, Environmental Guidelines: Use and Disposal of Biosolids Products.

EPA Queensland, 2001, Queensland Water Recycling Strategy (http://www.epa.qld.gov.au/environmental_management/water/water_recycling_strategy/)

EPA, Queensland, 2004, Consultation Draft Queensland Guidelines for the Safe Use of Recycled water

to be replaced mid 2005 by

EPA Queensland, 2005, Queensland Water Recycling Guidelines (http://www.epa.qld.gov.au/environmental_management)

EPA Queensland, Operational Policies (http://www.epa.qld.gov.au/environmental_management/planning_and_guidelines/environmentally_relevant_activities/operational_policies)

EPA South Australia, 1997, South Australian Biosolids Guidelines. (http://www.environment.sa.gov.au/epa/pdfs/biosolids.pdf)

EPA Victoria, 2002, Victorian Guidelines for Environmental Management: Use of Reclaimed Water EPA Victoria. (http://tinyurl.com./smt9)

EPA Victoria, 2004, Guidelines for Environmental Management – Biosolids Land Application (http://epanote2.epa.vic.gov.au/EPA/publications.nsf/716543f3e369a021ca256aa7001e5635/822b33fca69d0a58ca256dc6000e7835/$FILE/943.pdf)

EPA/DHS, 1999, South Australian Reclaimed Water Guidelines (Treated Effluent), Department of Human Services and Environmental Protection Agency, Adelaide. (http://www.dh.sa.gov.au/pehs/branches/wastewater/reclaimed-water.htm)

Gold Coast Water, 2003, Master Plan Options Report (condensed version) (http://www.goldcoastcity.com.au/attachment/goldcoastwater/GCWFuturesMasterPlan.pdf)

Gold Coast Water, 2003, Pimpama Coomera Water Futures – Master Plan Options Report.

Heise, Natalie, Common Effluent System Design Criteria, Australian Water Association Convention, 1999.

NHMRC/NRMMC (2004) Australian Drinking Water Guidelines). (http://www.nhmrc.gov.au/publications/synopses/eh19syn.htm)

NHMRC, 2005, Draft Electronic Decision Support Tool for the Management of Drinking Water Quality in Rural and Remote Communities.

Queensland Department of Local Government & Planning, 2003, On-Site Sewerage Code.

to be replaced in late 2005 by

Queensland Department of Local Government, Planning, Sport and Recreation, 2005, Queensland Plumbing and Wastewater Code

Queensland Department of Local Government and Planning, 2003, Guidelines for the Use and Disposal of Greywater in Unsewered Areas. http://www.lgp.qld.gov.au/Docs/local_govt/on-site_sewerage/greywater_unsewered.pdf

to be replaced in late 2005 by

Queensland Department of Local Government, Planning, Sport and Recreation, 2005, Queensland Plumbing and Wastewater Code.

Queensland Department of Natural Resources & Mines, Sept 2000, Guidelines for Using Free Water Surface Constructed Wetlands to treat Municipal Sewerage (http://www.nrm.qld.gov.au/compliance/wic/wetlands.html)

Queensland Health, 2000, Code of Practice for the Fluoridation of Public Water Supplies (http://www.health.qld.gov.au/phs/Documents/ohu/4438.pdf)

Queensland Health, 2001, Environmental Health Assessment Guidelines - Cyanobacteria in Recreational and Drinking Waters (http://www.health.qld.gov.au/phs/Documents/ehu/11870.pdf)

Shoalhaven Water, 2003, Comparison of Alternative Sewerage Systems. (http://www.shoalwater.nsw.gov.au/6hotnews/SewerageSystems.html)

World Health Organisation, 1999, Toxic Cyanobacteria in Water. A guide to their public health consequences, monitoring and management. Edited by Ingrid Chorus and Jamie Bartram

World Health Organisation, 2004, Guidelines for Drinking-water Quality, third edition, Volume 1 Recommendations (http://www.who.int/water_sanitation_health/dwg/guidelines/en/

WSAA Pressure Sewerage Code – in preparation.

WSAA, 1999, Affordable Water Supply & Sewerage for Small Communities.

WSAA, 2001, WSA 04-2001, Sewage Pumping Station Code of Australia (currently being revised).

WSAA, 2002, WSA 02-2002, Sewerage Code of Australia Version 2.3 (published April 2004).

WSAA, 2002, WSA 03-2002, Water Supply Code of Australia Version 2.3 (published April 2004).

WSAA, 2004, Dual Water Supply Systems First edition version 1.1. A supplement to the Water Supply Code of Australia WSA03 - 2002

WSAA, 2004, WSA 06–2004, Vacuum Sewerage Code 2004 Version 1.1 (published June 2004)