DEPARTMENT OF NATURAL RESOURCES & WATER

Planning Guidelines for Water Supply and Sewerage

Chapter 6

NETWORK MODELLING

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Network Modelling

1.0 Purpose

Water supply and sewerage planners use a range of models to support decision-making. Network modelling is a key activity:

- To gain an understanding of how the water supply or sewerage system operates under various demand/flow scenarios, now and into the future
- To assess the performance of the water supply or sewerage system in the event of various failure events (eg critical asset failure or overflows)
- To assess the impacts of proposed operational modifications, augmentations or renewals
- To review the impacts of proposed developments
- To provide the supporting information for a planning study

This chapter provides an overview of the networking modelling process and highlights issues that should be considered to ensure that models efficiently deliver reliable outputs.

2.0 Key Principles

- The desired outcomes of the modelling work and the extent/detail are to be established before commencing the process.

- Operational staff should be involved in the construction and analysis of the network model.

- Successful network modelling requires the investment of time by experienced staff to interpret the results of the modelling.

- Model outputs should be verified against actual system performance.

3.0 Why is Network Modelling Important?

Network modelling is a key component of water supply and sewerage planning because:

- It allows existing infrastructure to be utilised to its maximum capacity.
- It will support the development of an optimised capital works program.
- It provides service providers with the information necessary to make optimal decisions in relation to system operation and planning to achieve the desired service standards.
- It will lead to value for money to customers

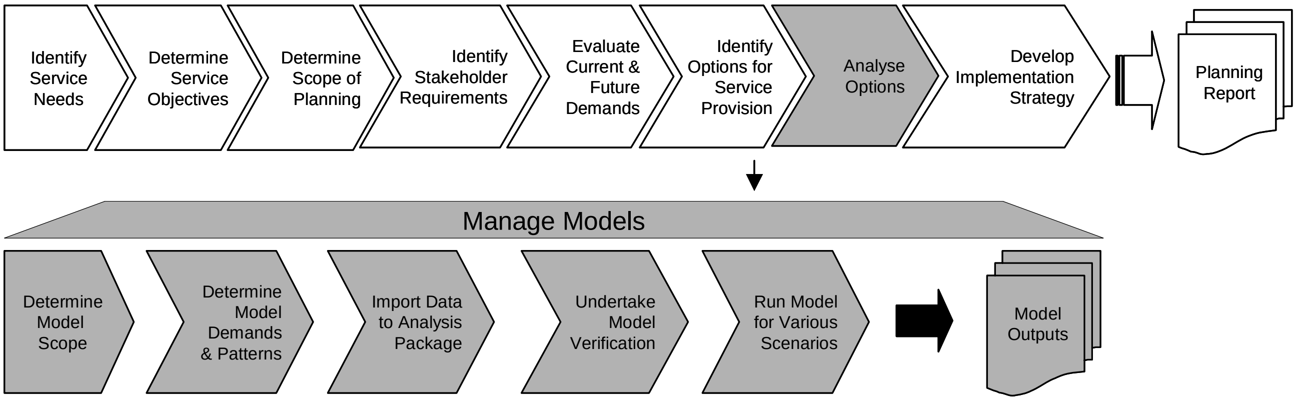
4.0 When Should Network Modelling be Undertaken?

- For larger service providers with high growth rates, network modelling will be an ongoing process undertaken by skilled in-house staff and/or external consultants.
- For smaller service providers with static populations, network modelling will be undertaken intermittently to support specific planning studies or to identify the cause of operational problems. The modelling is likely to be undertaken by external consultants. “Shareware” and “Freeware” analysis packages, such as EPANET, are available to those who do not wish to invest in software

5.0 Key Elements

The network modelling process is illustrated in Figure 5.1 and discussed in the following sections.

FIGURE 5.1 - Network Modelling – Key Elements



5.1 Model Management

Effective model management is essential to the success of modelling for planning, decision support and operations.

A key process will be the selection of the appropriate software.

A wide range of dynamic network modelling software packages exist on the market. These are becoming increasingly more powerful. For water supply, dynamic modelling should be used in most cases. Water supply static models are only suitable to analyse peak hour demand or fireflow impacts downstream of a reservoir. Static sewerage models are common. However, dynamic sewer modelling is becoming more prevalent for the larger systems. Selection of an appropriate modelling software package would depend on such factors as:

- The applications required
- The outputs now and in future years
- Number of pipe lengths in the networks to be modelled
- Compatibility with the service provider's SCADA, GIS and other systems
- Lifecycle cost of software
- The service provider's modelling capability
- Frequency of use
- Level of support by software supplier
- Availability of user groups
- Track record in other sites

The following issues need to be considered in managing the model:

- The service provider should determine who is responsible for managing the model, whether an external consultant or internally. An agreement should be made in relation to access to data files, outputs, data updates, cost of service and intellectual property
- Only one master model should exist. This should be a read only file that is available to users.
- Formal systems should be set up to ensure that the master model is up to date so that it reflects reality (eg new infrastructure, revised zonal boundaries)
- Formal systems should be developed to ensure efficient and reliable data transfer to and from other service provider information systems

- Records of the source and quality of each model component should be kept. Notes on the context of the model should be maintained
- Each model should have an audit trail on how the model was built to provide some assurance on the quality of the model
- Processes should be set in place to ensure that tedious, repetitive tasks can be automated, or at least minimised. This will allow modellers to allocate more time to the analysis of network performance
- Operational as well as planning staff should have ownership of the model

5.2 Determine Model Scope

Prior to commencing the model the service provider will need to clarify exactly what the objectives of the model are so that the appropriate level of data is collected.

A decision will need to be made on the extent of the model, for instance, will it include the source and treatment plant or all pipes or a skeletal network.

5.3 Determine Model Demand/Flow & Patterns

Model demands or flows can either be set up using GIS software or manually. Projections of these demands will need to consider the issues highlighted in Chapter 5 – Demand/Flow and Projections.

Diurnal demand/flow patterns will be based on a range of factors including the type of development and location. Diurnal demand patterns are available from:

- Various dynamic network modelling packages
- Internal service provider studies
- Consulting engineers, who generally have a library of diurnal demand patterns

For water supply the diurnal pattern should include a separate component for water losses which would have a peaking factor of 1.0 (unless the service provider has more reliable information on water loss variation throughout the day) and remain unchanged over the analysed period. However, water losses may change over time depending on the service provider's supply management strategy.

Diurnal patterns should be developed for:

- Average day demand (AD)
- Mean day maximum month (MDMM)
- Peak day (PD)

The modeller will need to confirm that the selected pattern is realistic for the scheme being modelled. The pattern may change over time in response to demand management initiatives.

For sewerage, static models will be based on fixed dry weather flows plus infiltration and inflow (refer to Chapters 5 and 7).

Dynamic sewer models will incorporate:

- Dry weather diurnal flow patterns
- Groundwater infiltration
- Rainfall dependent infiltration/inflow for various rainfall return periods (e.g. 2 year ARI)
- Dynamic models should be run for a nominated design flow

5.4 Import Data to Analysis Package

A network model requires a wide range of inputs. These are listed in Table 5.1.

TABLE 5.1 - Inputs for Network Modelling

	Water Supply	Sewerage
Mains	▪ Pipe diameter (nominal) ▪ Pipe diameter (internal) ▪ Length ▪ No. of connections ▪ Material/class ▪ Age ▪ Location ▪ Friction factors	▪ Pipe diameter (nominal) ▪ Pipe diameter (internal) ▪ Length ▪ No. of connections ▪ Material/class ▪ Age ▪ Location ▪ Friction factors ▪ Invert levels ▪ Grade (pipe & manhole)
Maintenance Holes		▪ Location, invert levels, ground levels
Overflow Structures		▪ Location, invert levels, ground levels, operating levels, diameter, volume outfall location
Valves	▪ Type ▪ Diameter ▪ Location ▪ Operational settings ▪ Design performance	▪ Type ▪ Diameter ▪ Location
Pumps	▪ Location ▪ Type ▪ System head curves including power & efficiency ▪ Performance testing/monitoring data (eg flows, suction and discharge pressure, operating periods) ▪ Operational control settings	▪ Location ▪ Type ▪ System head curves including power & efficiency ▪ Performance testing/monitoring data (eg flows, suction and discharge pressure, drawdown tests, operating periods) ▪ Operational control settings (eg. for pump control valves and variable frequency drives)
Wet/Dry Wells		▪ Location ▪ Volume, area ▪ Ground level, invert levels
Reservoirs	▪ Location ▪ Volume, area ▪ Operating levels (BWL, TWL, Overflow) ▪ Any restrictions to the operating levels	
Treatment Plants	▪ Location ▪ Operating levels ▪ Capacity ▪ Clear water storage	▪ Location ▪ Operating levels ▪ Capacity
Spatial Data	▪ Land Use Plans ▪ Priority Infrastructure Plan ▪ Contour Plans ▪ Infrastructure data for model input	▪ Land Use Plans ▪ Priority Infrastructure Plan ▪ Contour Plans ▪ Infrastructure data for model input

	Water Supply	Sewerage
Demands/Flows	▪ Current demands by customer type ▪ Unaccounted-for-water use ▪ Peaking factors by customer type ▪ Diurnal demand patterns by customer type ▪ Demand projections by customer type ▪ Fireflow policy	▪ Current dry weather flows ▪ Flows by customer type ▪ Peaking factors ▪ Diurnal flow patterns by customer type ▪ Infiltration/Inflow
Customer Data	▪ Location of major customers ▪ Standards of service (particularly flow and pressure) ▪ Fireflow policy ▪ Customer complaint data (eg flow/pressure complaints, main break locations and possibly water quality complaints)	▪ Location of major customers ▪ Standards of service (particularly overflow events) ▪ Customer complaint data (eg odours)
Operational Knowledge	▪ Knowledge of operational staff ▪ Operating philosophy including seasonal variations, operational constraints, zone boundaries, restrictions and local service issues	▪ Knowledge of operational staff
Water Quality (where modelled)	▪ Chlorine residual levels ▪ Microbiological results ▪ Location of failure events	▪ Environmental sensitivity of natural body that receives controlled overflows.

The inputs will be obtained from various sources including drawings, asset registers, GIS, O&M manuals etc.

Importing of data from GIS or other databases is becoming more prevalent. It also provides a means of verifying or amending existing GIS data.

The importation of data from GIS typically requires major time and resource inputs. Extensive time is usually required to identify and address errors in the database and to verify the base network data. Modellers should determine GIS requirements and accuracy before commencing modelling input.

For water supplies the modeller will need to determine appropriate friction factors for the mains. These will be based on a range of inputs such as pipe age, material, internal condition, extent of fittings and connections and level of treatment. It is preferable that flow/pressure testing is undertaken at critical locations in the distribution system to determine actual friction factors for various pipe materials and age within a given network. This can prove difficult in some networks but the benefit would also include the location of restrictions such as unlined fittings etc. This approach would be used in model verification/calibration (refer to Section 5.5).

For dynamic modelling of sewers the challenge will be to determine the level of infiltration/inflow into the system for defined events. This will depend on the loading, condition, location and level of maintenance of system components (including house drains).

Other inputs required by the modeller to make optimal decisions include:

- Unit cost rates for various pipe diameters in various locations (greenfield, residential, CBD) and conditions (eg. topography, geology)
- Cost estimates for pump stations and reservoirs of various capacities.

For compatibility of GIS and modelling packages, modellers will need to ensure connectivity between nodes.

5.5 Model Verification

Most water supply and sewerage schemes have some form of data logging or SCADA systems which allow real-time measurement of system performance. Records available include:

- For water supply:
  - Flow rates
  - Reservoir levels
  - Pump station flow rates, suction and discharge pressure
  - On/off times

- For sewerage:
  - Flows
  - Pump station wastewater levels including overflow events
  - Pump station on/off times
  - Rainfall event recorders

For water supply the modeller can select a series of recorded demand periods (eg a peak week) and run the dynamic model over a series of days to assess actual system performance against model outputs. Where there is a significant variation in factors such as reservoir levels, pump run times etc then adjustments will need to be made on variables such as demands, friction factors or diurnal patterns.

Calibration of a water supply network model requires more work and the need for real time pressure monitoring in critical sections of the distribution system. As service providers develop their SCADA systems to incorporate distribution system pressure monitoring then model calibration should become more prevalent.

Verification of a static sewerage model will be relatively straightforward. Verification of a dynamic sewerage model will include checking pump hours for dry weather and wet weather and overflow events, based on a defined ARI. Flow gauging to determine dry weather flows in trunk mains is also used for calibration of sewerage network models.

Attention will be required to the performance of pump stations and rising mains. An undulating profile for the rising main can cause instability in modelling software.

Care should be taken in the use of sewerage pump flow/hours data during PWWF events as overflows in the system may lead to an underestimation of modelled flows.

5.6 Run Model for Various Scenarios

The modeller should run the water and sewerage models for the scenarios listed in Tables 5.2 & 5.3 respectively in lieu of any other scenarios which may be more applicable to the systems. The model should typically be run for:

- Current demand flows
- 5 year
- 10 year
- 15 year
- 20 year demand
- Ultimate development
- Failure analysis of critical infrastructure

TABLE 5.2 -Modelling Scenarios – Water Supply

Scenario	Required Performance Criteria	Comment
1. 3 days at Mean Day Maximum Month	All reservoirs to have a positive net inflow at the end of each day	Commence reservoir level at 90% full at midnight (ie start of day 1)
2. Scenario 1 to be followed by 3 peak days	No reservoir should have failed during period of analysis	Scenarios 1&2 could be run using Peak Week if historical data available, rather than 3 peak days
3. Fireflow	12m residual pressure minimum at hydrant	Refer to Section 5.7

The modeller may need to run the water network model for low demand periods to assess whether reservoir detention periods are excessive, which may lead to a detrimental impact on water quality.

The minimum pressures at the property boundary should be:

- Residential – 20 to 25m
- Industrial/commercial – 25m

The maximum pressures should not exceed 80m to limit leakage and stresses on the reticulation system and to minimise problems with household plumbing fixtures.

TABLE 5.3 - Modelling Scenarios - Sewerage

Scenario	Required Performance Criteria
1. Dry weather flow	System meets explicit operational criteria e.g. minimising detention periods (odour management), or overflow events (equipment or power supply failure)
2. Wet weather flows (refer to Chapters 5 and 7)	Number and location of overflows do not exceed service provider customer service & design standards and EPA requirements

In certain circumstances the model should be run for an ultimate demand/flow case. Typically the circumstances when the model should be run for the ultimate demand/flow case include:

- Where pipeline corridors exist that can only accommodate one main
- To determine land requirements for future reservoir, water or sewage pump station sites
- To determine optimal staging strategies

The scenarios should include assessing the impacts of various strategies (eg new works, renewals, operational modifications, leakage or pressure management) to meet service standards and operational objectives (eg energy management or I/I reduction). Optimising pipe network, reservoir and pump station capacity and lifecycle costs will be a key element of this process.

Many dynamic network modelling packages are sufficiently powerful to accommodate all pipes in a network. This allows a more accurate allocation of nodal demands. Alternatively the approach listed in Table 5.4 should be used.

TABLE 5.4 - Mains to be Included for Various Planning Levels

Planning Level	Model Type	Pipe Sizes
Strategic/master planning	Trunk Distribution Model	All mains greater than 225mm Critical 150mm mains
Detailed planning/operations management and fireflow analysis	Zonal, reticulation or fireflow	All mains

Transient Analysis

Some planning studies may require the need for surge analysis to be undertaken.

Water Quality Modelling

A number of water supply network models have the capacity to model chlorine residual decay in the system. Greater utilisation of this capability is likely in the future.

Hydrogen Sulphide Modelling

In situations were long detention periods are anticipated or where the system may experience low loadings in the early stages of its life, then hydrogen sulphide generation should be modelled.

The modelling would be based on empirical predictive equations for rising and gravity mains.

5.7 Fire Provision

5.7.1 Intent of Fire Provision

Provision of network capacity to fight fires in the community is an important part of the water supply network. Most water supply reticulation systems are designed to meet some level of fire protection, however the level provided is variable and depends on the available system capacity.

To comply with this guideline, a service provider must develop a policy detailing the fire fighting provisions required for water supply reticulation systems in its area. Cooperation with the fire authority is essential for the continuing provision of reliable fire service.

5.7.2 Definitions

For the purpose of this section the following terms are defined:

- **Excessive Pressure Area** – An area of the network where residual pressure is greater then 65 m head
- **Pressure Disadvantaged Area** – An area that contains critical hydrants
- **Critical Hydrant** – A hydrant where residual pressures range between 12 m to 15 m head based on the fire provision criteria (if the hydrant is not in good condition the required level of service may not be achieved and the hydrant's condition and operation should be checked under regular maintenance)
- **Failure Hydrant** – A hydrant where residual pressure falls below 12 m under the fire provision criteria
- **Risk Hazard** – A risk hazard is defined as an area with high risk of fire or a property that has a fire requirement that is higher than the minimum required by this guideline (refer to Section 5.7.4)
- **Critical Customer** – A critical customer can be defined as a customer that the service provider has agreed to provide specific flow and or pressure conditions from the water supply network, e.g. private fire fighting systems in accordance with the Building Code of Australia

5.7.3 Fire Provision Policy

To comply with this guideline a service provider must develop a specific fire provision policy detailing the relevant provisions adopted within the water supply network. A service provider must consult with the local fire authority during development of the fire provision policy.

A Fire Provision Policy should be inclusive of the following:

- Cooperation – A commitment to cooperate and communicate with the local fire authority (and other relevant stakeholders) to provide an appropriate standard of fire protection to the community
- Communication – Commitment to a communication protocol, and details of relevant information to be provided to the fire authority on a periodic basis (refer to Section 5.7.12)
- Risk Assessment – A plan to identify and address existing and future fire risks (refer to Section 5.7.4)
- Service Level Agreements – A way of formally documenting agreed service levels between the water service provider and the local fire authority (refer to Section 5.7.5)
- Flow Provisions – Details of the flow provisions to be provided in the water supply network (refer to Section 5.7.6)

- Residual Pressure – Details of the minimum residual pressure requirements adopted within the water supply network (refer to Section 5.7.7)
- Background Demand – Outline of the background demand criteria applied during a fire provision analysis (refer to Section 5.7.8)
- Demand and Pressure Management – Details of the procedures to design, implement and manage these areas (refer to Section 5.7.10)
- Fire Provision Register – Reference to the maintenance of a property register detailing cases where additional fire provision is to be delivered above and beyond the levels specified in this guideline (refer to Section 5.7.9)
- Recycled Water – Linkage of any recycled water network nominated for fire provision to a Recycled Water Management Plan (refer to Section 5.7.12).

It should be noted that the relevant Australian Standards and the Building Code of Australia refer to fire protection services, including hydrants and sprinkler systems, within the property and therefore do not apply to hydrants in the reticulation system provided by the service provider.

The minimum requirement in respect to residual pressure in these guidelines is 12 m. The owner of a development should provide any additional facilities to achieve the requirements of Australian Standards and the Building Code of Australia within the property, above that provided by the service provider. The universal compliance with the standard's requirements for pressure in the reticulation system would incur substantial infrastructure and operating costs to the service provider due to the required higher service pressures, which would also result in increased leakage.

Where the service provider agrees to provide levels of service as provided in the standards, the service provider must accept the responsibility to maintain the levels of service in the future and should consider the implications of legal action in the event of future reduced levels of service or unreasonable failure of the system.

5.7.4 Risk Assessment

A service provider should conduct a risk assessment to identify fire related risks or risk hazards. Efforts should be made to mitigate risks, however in cases where mitigation is not feasible consideration may be given to increased fire flow and or higher residual pressure.

It is recommended that the risk assessment be undertaken in conjunction with the fire authority.

As part of the risk study the service provider needs to undertake initial fire capacity investigation through network modelling to identify hydrants that fall into the following categories:

- Critical Hydrants
- Failure Hydrants
- Excessive Pressure Areas
- Pressure Disadvantaged Areas
- Critical Customers
- Risk Hazards

Should any potential failure hydrants be identified as part of a risk assessment, checks should be done to ensure that the minimum fire provision is achievable and any required works should be placed on a prioritised program, based on risk.

As part of the assessment, the service provider should, in conjunction with the fire authority, identify and categorise risk hazards including:

- Buildings that are constructed of high risk material e.g. full timber construction
- Buildings that are constructed in close proximity
- Buildings close to dense vegetation with a high risk of bushfires
- Areas with aged infrastructure including mains, hydrants and fittings
- Areas where access to buildings is difficult due to terrain
- Risk / hazard buildings with fire demand greater than the default values provided in Table 5.5
- Pressure management exists or is to be implemented in future
- Areas served by pump systems to ensure adequate residual pressures
- Area is pressurised and no fire fighting reserve exists.
- Area is pressure disadvantaged or has critical hydrants

Assessment of the above factors should be undertaken to ascertain the level of risk related to these factors. Where critical hydrants exist in areas that have no risk factors, then further action will not be necessary. However, if any of the risk factors exist in the system, risk mitigation strategies need to be developed. This may require further hydraulic performance assessment of the network.

Strategies that should be considered may include the following:

- Further assessment of the hydraulic performance of the network
- Replacement of aged hydrants with new epoxy coated units
- Regular hydrant inspection, testing and maintenance
- Pipe lining or replacement (including hydrant riser)
- Additional hydrant installation (smaller spacings e.g. 40 m spacing) to reduce high headloss through hydrants and improve available fire flow. This may be of particular importance in commercial / industrial areas.
- Installation / upgrade of water supply network pumps to improve fire flow performance. Consideration should be given to standby power in these situations e.g. pressurised systems / high level zones without sufficient fire storage.
- Adoption of localised peaking factors for high level systems where system pressure is solely provided by pumps.
- Flow modulation of pressure reducing valves or secondary feeds in pressure managed areas.
- Additional flow and or residual pressure provision above that specified in the Planning Guidelines
- Treatment of risk hazard buildings with fire demand under the Building Code of Australia which are greater than the default values in this guideline.

The methodology, assessment and outcomes of the risk assessment should be fully documented and revised regularly when system characteristics are changed, or new risk hazards identified.

5.7.5 Service Level Agreements

Service Level Agreements, between the water service provider and the local fire authority, are recommended as a way of documenting the risk management process and ensuring it is revised regularly.

The purpose of these agreements is to define the expected standard of procedures and communication activities that will occur between the water service provider and the local fire authority to ensure that community expectations for fire flows are maintained.

Service Level Agreements are achieved by:

- Establishing and defining the communication requirements and expectations between the water service provider and the local fire authority
- Understanding that any requirements or expectations should be compatible with the service provider's system
- Building strong co-operation around critical technical decision-making in distribution network performance, augmentation and alteration
- Ensuring the water service provider nominate an on-call officer to advise fire authority officers in the event that changes to the distribution network may have a adverse impact on fire fighting capability, including significant supply interruptions
- Sharing of information regarding distribution network performance including pressures and water flows
- Providing a framework for escalation of unresolved issues around water loss management activities between the water service provider and the local fire authority

Template documents for creating a Service Level Agreement are available from the Queensland Water Directorate website.

5.7.6 Minimum Fire Flow

The minimum fire flow provision will vary dependent on the type of development, and the capability of the community to resource fire protection. The following categories of development should be considered for the design fire flow:

- **General Urban Category** – comprises areas served by an urban fire service. Minimum fire flows for this category are:
  - Residential buildings (3 storeys and below) – 15 L/s for 2 hour duration
  - High Density Residential buildings (greater than 3 storeys) – 30 L/s for 4 hour duration
  - Commercial / Industrial buildings – 30 L/s for 4 hour duration
  - Risk Hazard buildings – refer to Section 5.7.4

- **Small Community Category** – comprises communities with a permanent population of less than 500 people, served by a rural fire service or equivalent. In these communities discussions with the local rural fire service are required to determine minimum fire flows. It is recommended that the following is considered:
  - Residential buildings (up to 2 storeys) – The agreed fire flow should not be below 7.5 L/s for a 2 hour duration.
  - Non-Residential buildings (up to 2 storeys) - The agreed flow rate should not be below 15 L/s for a 2 hour duration.

- Other buildings – In the case where identified risks are associated with a building or group of buildings, the 'General Urban Category' provision should be adopted. A building may be deemed to be subject to an identified risk due to one or more of the following factors:
  - Public access buildings that are constructed of high risk material e.g. full timber construction
  - Buildings that are constructed in close proximity e.g. multiple sole occupancy, building spacing less than 1.5 m etc
  - Buildings with more than 2 storeys
  - Buildings close to dense vegetation with a high risk of bushfires
  - Areas with aged water supply infrastructure including mains, hydrants and fittings
  - Areas where access to buildings is difficult due to terrain
  - Risk / hazard buildings with fire demand greater than the default residential and non-residential values.

Where identified risks cannot be mitigated, more appropriate fire flow provisions should be adopted.

- **Tourist Affected Small Community Category –** This category comprises small communities with a permanent population of less than 500 people and served by a rural fire service or equivalent. A risk assessment should be undertaken, in conjunction with the local fire service to determine whether an elevated level of risk exists during peak holiday periods. Based on the assessed level of risk the fire flow adopted for this category should be as follows:
  - Limited Risk – Refer to 'Small Communities' category above
  - Elevated Risk – Refer to 'General Urban' category above.

- **Rural Residential Category** – This category includes large lot rural or park residential development (e.g. >5000 m^2). Due to the difficulties that exist in providing effective and practical fire protection to areas of sparse residential development, a clear standard should be developed with the fire service. Service providers should consider the following when determining a minimum fire flow:
  - Urban Fire Service – 'General Urban' category flows should be provided.
  - Rural Fire Service – The greater of the 'Small Communities' flow provision or the standard provided in surrounding areas should be provided.
  - Include development provisions such as on site storages (swimming pools or tanks) or tanker filling points on the main for schemes where small mains or a constant flow water supply scheme is provided which will not provide adequate fire flows.

5.7.7 Residual Pressure

The minimum residual pressure to be provided is that which will maintain a positive pressure on the suction side of the fire authority appliance when operating at the minimum fire flow. The adopted residual pressure should be as follows:

- 12 metres head measured in the main at the hydrant / dedicated fire service location, assuming that the elevation of the supply point is equal to the ground elevation at the hydrant / dedicated fire service
- 6 metres head in the main for all other areas of the water supply zone to ensure a minimum level of service to other customers during a fire event.

Analysis of a typical water supply reticulation arrangement indicates that:

- Dependent on the background pressure and local pipe diameters, 2 hydrants in good condition can be required to obtain a minimum flow rate of 15 L/s at 12 m head
- To enable the extraction of a commercial / industrial flow provision (minimum of 30L/s) up to 3 hydrants in good condition are required at the specified residual pressure of 12 m head. Spacing of hydrants in such areas requires careful consideration (refer Section 5.7.4).

A service provider should also ensure that positive residual pressure exists within the main at peak hour during a fire event.

It is essential that mains and hydrants are kept in good condition through regular inspection and maintenance programs. This particularly applies to infrastructure in pressure disadvantaged areas to ensure that the minimum residual pressure is achieved and that, ultimately, sufficient operating pressure is provided to the suction side of the fire authority appliance

5.7.8 Background Demand

The level of background demand needs to be established to provide a balance between risk and cost. Assessment of fire events for the past 9 years was undertaken to assess the probability of fire occurrence. Based on this assessment the following minimum criteria should be adopted for background demand during a fire event:

- Predominantly Residential Areas
  - The minimum residual pressure specified in Section 5.7.7 should be exceeded with a background demand of 2/3 Peak Hour demand (calculated using adopted Desired Standard of Service criteria)
  - A check should be undertaken at Peak Hour demand (calculated using adopted Desired Standard of Service criteria) to ensure that pressures in the network remain positive.
  - The calculated background demand should not be less than AD.
- Predominantly Commercial / Industrial Areas – In this case, the following scenarios should be investigated with the worst case being adopted:
  - At Peak Hour demand of the Commercial / Industrial area (e.g. between 10am to 4pm). The intent of this model is to assess the local reticulation performance.
  - At the 2/3 Peak Hour demand of the water supply zone (e.g. around 6pm). The intent of this model is to assess the zone trunk performance.
- Mixed Residential / Commercial / Industrial Areas – In such cases a combination of background demand conditions similar to the Predominantly Commercial / Industrial Areas above should be examined.

5.7.9 Fire Provision Register

A water service provider may in certain situations provide fire provision higher than those specified in this guideline, either to individual developments where capacity is available, or to specific areas such as CBDs and industrial estates. To ensure the higher flow provisions are accounted for into the future a service provider should maintain a Fire Provision Register.

The register should record the conditions under which the approval of the higher fire provision was made, including:

- Development based approval:
  - Date of approval
  - Property identification
  - Description of the applicable structures on the property (e.g. BCA building class, number of levels, floor area etc) and approved use
  - Location and size of supply from the network (asset ID and details)
  - Level of service provided (flow and pressure)
  - Additional devices installed on the property for fire protection, e.g. separate fire main, fire pump, tank or other equipment

- Risk hazard decision:
  - Date of commencement
  - Level of service to be provided (flow and pressure)
  - Outline a nominated off take point or applicable asset from the network (infrastructure asset ID etc)
  - Use of the building or facility

5.7.10 Demand and Pressure Management Areas

The introduction of Demand Management Areas (DMAs) and Pressure Managed Areas (PMAs) increases the system operation complexity resulting in a higher risk of failure relative to the adopted standards of service. It is important to consult with the local fire service on all aspects of the planning, design, implementation and operation of such systems.

The following measures should be considered as part of any DMA / PMA project:

- Contingency Planning and Records
  - A risk assessment and mitigation strategy should be developed using a reliable methodology such as that outlined in AS4360, including either HAZOP assessment or failure analysis to identify possible modes of failure
  - Risks should be addressed as part of system design, where possible. If this is not possible then monitoring should be provided, together with consideration of critical spares and external maintenance providers for specialist equipment
  - System monitoring should identify any abnormal operation with immediate alarming to operations staff. This may be achieved using either SCADA or mobile technology
  - Contingency plans should be documented and provided to operations staff through suitable training. Information needs to be kept up to date through quality management procedures
  - Documentation of boundary valve location is essential together with methods to manage the on-going operation of valves during emergency and routine maintenance
- DMA / PMA Design
  - Design should be undertaken using network models calibrated to a reasonable density of data loggers and appropriate tolerances. The aim of this exercise is to ensure that the model replicates the actual configuration and operation of the network under a range of conditions

  - System controllers should be designed to operate pressure reducing valves (PRVs) across the full range of flow and pressure including fire flows for all serviced customers. Monitoring should be connected to either SCADA or dial up systems configured to alarm on any abnormal condition
  - Risk hazard customers (critical customers) should be identified and consulted regarding the proposals for pressure reduction at the earliest practical time. Where agreed fire protection levels are to be maintained critical customers may need to be designed out of PMAs. Where a large flow range is required PRV installations may need to incorporate high and low flow valves or multiple feeds. Large increases in local flow rates and pressures during fire events can cause damage to assets including PRVs and private connections
  - PRV design must consider the reaction time for supplying fire flows. This may be achieved by ensuring that the controller and valve operator are fully compatible and that the system has sufficient capacity for the full range of flows
  - Failure mode of PRVs needs to be considered. From a fire protection perspective the preferred solution is to fail fully open or at a pressure designed to deliver the required background demand and fire flow.
  - Alternative feeds to DMAs / PMAs taking account of fire flows should be included for use during maintenance
- System Commissioning and Maintenance
  - Procedures for testing of all equipment should be developed to ensure that specifications are met. This should include a combination of factory and field tests and should test under a range of conditions. For example the accuracy of PRV operation under all conditions may include a final live test of the PMA using critical fire hydrants and possibly fire appliances. The local fire authority should be given the opportunity to attend such a test
  - A plan for gradual implementation of the pressure reduction
  - A communication plan to advise critical customers and the fire authority of the commissioning program
  - Routine maintenance programs need to recognise the criticality of assets such as PRVs and monitoring equipment. Pressure disadvantaged hydrants should also be regularly inspected, tested and replaced where necessary

5.7.11 Recycled Water

Service providers operating a recycled water network (third pipe, dual reticulation) designated as providing fire protection should consider the following:

- Fire provision should be consistent with that of a potable system
- Water quality requirements of the fire authority need to be considered in design and operation as part of the Recycled Water Management Plan

5.7.12 Communication

Regular communication is a key element of the Fire Provision Policy. As part of this process service providers should provide the following to the fire authority:

- Maps showing the water network and all fire hydrants in an agreed GIS format and identifying:
  - Critical pressure hydrants (those with residual pressure less than 12 m head during a fire event) and expected timing for rectification
  - Pressure disadvantaged hydrants (those with a residual pressure between 12 to 15m head during a fire event)
  - Excessive pressure hydrants (those with residual pressure areas > 65 m head under night demand conditions)
- Maps showing details of DMAs and PMAs, including:
  - Location of normally open supply points
  - Location and type of PRVs e.g. flow modulated, fixed outlet pressure
  - Area boundary and any secondary supply points
  - Critical pressure points i.e. location of lowest operating pressure
- Maps showing recycled water areas designated for fire flow application
- Adopted fire flow provision for each hydrant
- Identification of high risk properties (as agreed with the fire authority)
- Fire Provision Register data for relevant properties

Information provided to the fire authority should be updated on a periodic basis or when substantial changes to network operation warrant.

As discussed in Section 5.7.5, Service Level Agreements should be in place between the water service provider and local fire authority to formally document communication requirements and expectations.

5.7.13 Summary

A summary of minimum fire provisions is contained in Table 5.5.

TABLE 5.5 – Summary of Fire Provisions

Item	Description
Flow Provision – General Urban Category (Section 5.7.6)	
Residential building (3 storeys and below)	15 L/s for 2 hour duration
High Density Residential building (greater than 3 storeys)	30 L/s for 4 hour duration
Commercial / Industrial building	30 L/s for 4 hour duration
Risk Hazard building	Refer to 'Risk Assessment' provision below
Flow Provision – Small Community Category (Section 5.7.6)	
Residential buildings (up to 2 storeys)	7.5 L/s for 2 hour duration*
Non-Residential buildings (up to 2 storeys)	15 L/s for 4 hour duration*
Other buildings	Refer 'General Urban' category above
Residual Pressure (Section 5.7.7)	
Minimum Residual Pressure – In the main at the hydrant / dedicated fire service	12 metres head
Maximum Residual Pressure – In the main at the hydrant	65 metres head (> 65m requires QFRS consultation)
Minimum Pressure – Elsewhere in the supply zone during a fire event	6 metres head
Risk Hazard	Refer to 'Risk Assessment' provision below
Positive residual pressure must be provided in the main at PH demand during a fire event.	
Background Demand (Section 5.7.8)	
Predominantly Residential Areas	▪ 2/3 PH ▪ Not to be less than AD ▪ Check for positive pressure at PH
Predominantly Commercial / Industrial	The assessment is to be conducted for the following scenarios: ▪ PH for localised Commercial / Industrial area ▪ 2/3 PH for total zone The worst case scenario is to be used, which may vary from site-to-site.
Risk Assessment (Section 5.7.4)	
Risk Hazard	▪ Risk areas to be identified ▪ QFRS to be consulted ▪ Mitigation measures to be utilised to reduce risk

Note: * Consultation must occur between the service provider and the Rural Fire Service to determine the adopted flow provision. These specified flow rates represent the minimum allowable provision.

5.8 Model Outputs

Model outputs will include:

- Pump station operating periods over time (water supply & sewerage)
- Reservoir levels over time (water supply)
- Mains pressure & velocity over time (water supply & sewer rising mains)
- Overflow events.

This information can be presented in a range of graphical and textural outputs. The results should be presented in a report that describes:

- The methodology for the model
- The customer service, design and operational criteria adopted for the model
- Assumptions used in the model
- Limitations of the model
- Verification of model accuracy
- Results of the modelling and implications on the service provider.

The model should be presented in a workshop to planning and operational staff.

Adequate training should be provided to relevant service provider staff.

6.0 Checklist

- ☐ How confident are you that the following model inputs are accurate?
    - Infrastructure attributes (plans and GIS)
    - Demands
    - Friction factors
- ☐ What have you done to confirm the reliability of inputs?
- ☐ Have you fully considered how inputs (eg demands, diurnal patterns etc) will change over time?
- ☐ Has there been sufficient time spent on model analysis or has the time been spent on mechanical data input?
- ☐ Does the model reflect reality of operation?
- ☐ What is the level of model verification/calibration undertaken?
- ☐ Have operational staff been involved in the development of the model?
- ☐ Do operational staff have ownership of the model?
- ☐ Has sufficient strategic thinking been applied to this modelling? How?
- ☐ Has a realistic policy on fireflows been developed? Are the modelling outputs consistent with this policy?
- ☐ Are you confident that the proposed strategies are optimal for the system? What have you done to confirm that this is the optimal solution?
- ☐ Have adequate arrangements been made for managing this model? (eg responsibilities, maintenance, audit trail, data transfer)
- ☐ Has adequate hand-over and training been provided on the model?

7.0 Bibliography

Australian Building Codes Board, Building Code of Australia.

AS2118 – Automatic Fire Sprinkler Systems

AS2419 – Fire Hydrant Installations

Carthew M, Jegatheesan V, Fracchia H, Network Modelling for Townsville Distribution System, AWA Federal Convention 2003.

Walski T, Barnard TE, Merritt LB, Harold E, Walker N, Whitman BE, Wastewater Collection Systems Modeling and Design, Haestad Press.

Walski T, Chase DV, Savic D, Grayman WM, Beckwith S, Koelle E, Advanced Water Distribution Modeling and Management, Haestad Press