Infrastructure Services Department

LIVINGSTONE SHIRE
WATER SUPPLY INFRASTRUCTURE NETWORK

Water Supply Network
COMPUTER MODELLING GUIDELINES

Rev No.	Date	Revision Details	Author	Verifier	Approver
0	19/04/2018	Initial Issue	CW	AM	PM
1	23/03/2022	V.1	CW	AM	TL

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Abbreviations

LSC	Livingstone Shire Council
CMDG	Capricorn Municipal Development Guidelines
LGIP	Local Government Infrastructure Plan
Infowater	Innovyze Modelling Software
EPANET	US (EPA) Modelling Software
MD	Max Day
MH	Max Hour
ET	Equivalent Tenement – A typical low density residential lot

PURPOSE & SCOPE

The purpose of this water network modelling guideline is to identify Livingstone Shire Council (LSC) requirements for water supply network modelling of water supply projects where LSC is the registered service provider.

The following principles set out guidelines and standards to create consistency upon the development of a water supply network model in the computer based program Infowater or EPANET for Livingstone Shire Council.

This guideline takes priority over the CDMG 12 – Design and Construction sewerage reticulation network and is intended to achieve the Desired Standards of Service as stated in the LGIP.

MODEL REQUIREMENTS

2.1 Format

Where Infowater or EPANET has been chosen to model new water network infrastructure, the model shall be contained in one file. If EPANET has been chosen to model the new water network infrastructure it may be required to submit a number of files depending on the complexity of the model. It is recommended to consult council to prior to commencement of modelling to seek further advice.

2.2 Spatial Reference

The preferred spatial reference for a model shall be GDA 1994 MGA Zone 56.

2.3 Scenarios

The base scenario shall be the proposed ultimate design layout for the water network work model. Each scenario that is being identified from the ultimate network (E.g. Stage one, Stage two etc.) shall inherit information from the previous data set. For each scenario created, with the exception to the ultimate design layout, they shall be created as an individual query set for editing purposes. The following model structure presents an example of a model scenario structure.

Model Existing Conditions (without the proposed development)

-BASE, Base Network Scenario (Ultimate Design Layout)

---STAGE1, Proposed development construction 2018

------STAGE2, Proposed development construction 2020

----------STAGE3, Proposed development construction 2025

2.4 Labelling

The modeller must ensure the *Description* input box and the *Information* tab should contain information regarding the particular object in the *Attribute Browser*. The *Description* input box shall be utilised for location purposes such as street names for pipes, junctions, pumps and valves. The information tab shall be utilised to label zones, stages material type etc. The following labelling format provides an example for modelling scenario/staging structure.

Attribute Browser:

Description Input Box – New Street

Information tab:

Installation Year – 2020

Phase – Stage 1

2.4.1 File Identification

On submission of the file submitted the following format shall be applied to the naming of the file.

LOCATION (project) - COMPANY NAME - APLLICATION NUMBER (if applicable) - DATE SUBMISSION (dd/mm/yy)

2.5 Legend

The Map legend for nodes and links shall follow the standardised colour arrangement below and have specific pre-set limits for pressure and velocity (Table 1 and Table 2).

Table 1: Node Legend with pressure intervals

Colour	Size	Break	Label
(red)	4.00	12.00	Less than 12
(yellow)	4.00	22.00	12.00~22.00
(green)	4.00	50.00	22.00~50.00
(cyan)	4.00	80.00	50.00~80.00
(blue)	4.00	-	Greater than 80

Table 2: Link Legend with velocity intervals

Colour	Size	Break	Label
(blue)	2.00	0.50	Less than 0.5
(cyan)	2.00	1.00	0.5~1.00
(green)	2.00	1.50	1.00~1.50
(yellow)	2.00	2.00	1.50~2.00
(red)	2.00	-	Greater than 2.00

2.6 Layers

If layers are used within the water network model, clearly indicate what the layer represents with concise titles.

TECHNICAL SPECIFICATIONS

3.1 Units

The International System of units (SI) shall be used in all water network models. The table in Appendix D indicates which SI unit to use for each data category.

3.2 Hydraulic Method

The Hazen-Williams hydraulic head loss formula is to be used when modelling. Pipe friction coefficients from Appendix C are to be applied to all models.

3.3 Controls

Simple controls to be used where possible within the model, rule based controls to be used if necessary. The modeller must use existing Council controls and obtain prior approval with Council if any new controls of any form are to be used in the model.

3.4 Pumps Curves

Models containing pumps should utilise the actual pump curve provided by the manufacturer. Single point pump curves may be used when the actual pump curve is not known. For proposed single point pump curves the modeller must be certain the curve can be achieved from commercially available pumps.

3.5 Default Inputs

There are five generally individual default input options available in water modelling software: *General, Quality, Reactions, Times* and *Energy*. In each of these options Council uses specific parameters and values for each data category. It is up to the modeller to know where to apply these changes in the different water modelling software packages so they are enabled (EPANET and Infowater).

The following defaults apply to these physical components within the model:

Zone Valves – 1m in length of pipe (usually closed).

Tanks - Start of analysis half full.

- 0.2m between overflow and top operating level

Pressure Reduction Valves – are not supported.

3.5.1 General Options

See Table 4 in Appendix B for details.

3.5.2 Demand Options

See Table 5 in Appendix B for details.

3.5.3 Quality Options

See Table 6 in Appendix B for details.

3.5.4 Advanced Options

See Table 7 in Appendix B for details.

3.5.5 Energy Options

See Table 8 in Appendix B for details.

3.5.6 Simulation Time Options

See Table 9 in Appendix B for details

DEMANDS

4.1 General

Design demands are be calculated in accordance with the CDMG design and construction guidelines and the LGIP.

The default demands must be applied and are currently calculated to simulate a Max Day model. The model must utilise the compliant demand patterns type as stipulated in section 4.2. Non-compliant demand patterns that are not listed in Appendix A must be approved by council prior to usage within water network models.

Council typically applies demands to water network models in terms of Equivalent Tenements (ET) rather than L/s. An exception is fire loading where the demand input is based on flow requirements (L/s). Examples of applying residential demands and fire demands are below:

	Demand Type	**Demand**
Example 1	Residential demand of three ET placed on one junction	3 (Min 10 ET/ha)
Example 2	Commercial fire demand	30 (L/s)
Example 3	Residential fire demand	15 (L/s)
Example 4	Commercial demand	20 (ET/Ha)

4.2 Demand Pattern Types

Council typically utilises four compliant demand patterns in water supply network models. Each pattern has an associated pattern curve identification name which is related to the demand usage type. The four compliant demands patterns that are utilised by council are Residential, Commercial and Industrial, Residential Fire, Commercial and Industrial Fire. The pattern curve identification names associated to these are *Curve4*, *Curve6*, *Fire15* and *Fire30* respectively. The use of these names is desirable. If non-compliant curve identification names are used they must be easily distinguishable between each demand pattern. The diurnal water demand patterns can be viewed in Appendix A.

Contact Council for further information if other various patterns are required.

ANALYSIS

5.1 Peak Hour Analysis (Max Hour)

Council typically analyse water network models based off Max Day design demands. Models are simulated over a 24 hour period and utilising 1900 hours as the peak reporting time step. If the peak demand is not represented within the time step of 1900 hours, the peak demand will then be taken as the highest reported value during a specific time step.

The peak hour analysis determines if the water network model has met the design criteria of the CMDG guidelines. Typically the objective for a residential sub-division design is to achieve a minimum 22m residential pressure at the centroid of all new lots and all parts of the network.

5.2 Fire-loading Analysis

To completely assess the water supply network capacity, fire loading must applied during the model simulation. The design criteria for fire-fighting conditions must meet the CMDG guidelines. The objective is to achieve a minimum 12m residual pressure at any node. The following fire-loading terms must be adhered to:

- Fire loading shall be applied to the most disadvantaged node within the water supply network model.
- Fire loading must be applied in addition to the base demand loading for the specific node that is being analysed.
- The water supply network model only needs to satisfy one fire loading demand during one simulation period.

In Infowater there are several methods of applying a fire loading to the water supply network. Council requires fire loadings to be placed via the *Attribute Browser* box. The modeller shall place the fire loading as a second demand in addition to any domestic/commercial loading at the node.

5.3 Model Verification & Calibration

Verification of a network models is review of the inputs of a model to ensure that the outputs reflect reality of the network. Verification activities may include:

- Check inputs data such as demands, demand types, boundary valve conditions or locations; and
- Discussions with Council in regards to operational settings, system layout and use of field data sourced from SCADA may be appropriate.

Calibration of a network model is the process of adjusting a model’s parameters to ensure that the model’s output achieve agreement with field measured data. Typically, calibration of models lodged to Council are not expected, though verification of the performance of water supply models must be undertaken as a minimum to confirm the performance of the system.

Note: For models developed by Council for internal use, refer to User Guidelines for details around verification and calibration.

APPENDICES

6.1 Appendix A

Table 3: LSC diurnal water demand patterns

Time	Demand Curve 4	Demand Curve 6	Demand Fire 15	Demand Fire30
	Residential	Commercial & Industrial	Residential Fire	Commercial & Industrial Fire
0:00	0.4	0.18	0	0
0:30	0.31	0.14	0	0
1:00	0.24	0.11	0	0
1:30	0.2	0.1	0	0
2:00	0.17	0.11	0	0
2:30	0.17	0.14	0	0
3:00	0.18	0.22	0	0
3:30	0.18	0.35	0	0
4:00	0.22	0.64	0	0
4:30	0.38	0.82	0	0
5:00	0.57	0.98	0	0
5:30	0.72	1.15	0	0
6:00	0.85	1.25	0	0
6:30	0.97	1.32	0	0
7:00	1.07	1.37	0	0
7:30	1.2	1.42	0	0
8:00	1.25	1.45	0	0
8:30	1.28	1.47	0	0
9:00	1.3	1.5	0	0
9:30	1.25	1.5	0	0
10:00	1.15	1.5	0	0
10:30	1.07	1.5	0	0
11:00	1	1.5	0	0
11:30	0.96	1.5	0	0
12:00	0.95	1.5	0	0
12:30	1.03	1.5	0	0
13:00	1.18	1.5	0	0
13:30	1.19	1.5	0	0
14:00	1.21	1.5	0	0
14:30	1.23	1.5	0	0
15:00	1.27	1.48	0	0
15:30	1.35	1.47	0	0
16:00	1.45	1.44	0	0

16:30	1.57	1.41	0	33.68
17:00	1.7	1.35	0	33.68
17:30	1.83	1.3	33.68	33.68
18:00	1.97	1.22	33.68	33.68
18:30	2.08	1.13	33.68	33.68
19:00	2.1	1.04	33.68	33.68
19:30	1.9	0.95	0	33.68
20:00	1.55	0.86	0	33.68
20:30	1.2	0.75	0	0
21:00	0.97	0.64	0	0
21:30	0.82	0.53	0	0
22:00	0.72	0.43	0	0
22:30	0.63	0.34	0	0
23:00	0.54	0.23	0	0
23:30	0.47	0.19	0	0

6.2 Appendix B

Default Simulation Options

Table 4: Default General

Property	Value
Flow Units	LPS
Head loss Equation	H-W
Trials	1000
Accuracy	0.1
Specific Gravity	1
Unbalanced	Continue
Hydraulic Usage	None
Hydraulic File	-
Working Folder	-
Pressure Unit	Meter
Viscosity	1
Vapour Pressure	0.84
Extended Run	10

Table 5: Default Demand Options

Property	Value
Global Demand Multiplier	0.0296875
Emitter Exponent	0.5
Demand Pattern Type	Stepwise
Default Demand Pattern	Curve4

Table 6: Default Quality Options

Property	Value
None	-

Table 7: Default Advanced Options

Property	Value
Status Check Frequency	2
Max. Status Check Iteration	10
Relaxation Factor	0.6
Damping Limit	0
Maximum Allocated Thread for WQ Simulation	Default

Table 8: Default Energy Options

Property	Value
Global Pump Efficiency	75
Global Energy Price	0.3
Global Energy Price pattern	-
Global Demand Charge	0

Table 9: Default Simulation Time

Category	Unit	Decimal Time	Clock Time
Duration	Hours	24.00	-
Hydraulic Time Step	Hours	0.50	-
Pattern Time Step	Hours	0.50	-
Quality Time Step	Hours	0.0833	-
Report Time Step	Hours	0.50	-
Rule Time Step	Hours	0.10	-
Pattern Start	Hours	0.00	-
Start Clock Time	AM	-	12:00:00
Statistic	NONE		

6.3 Appendix C

Table 10: Co-efficient for Pipe Material

Pipe Material	C-Value
Plastic (uPVC, MPVC, PE, OPVC.)	130
Asbestos Cement (AC)	110
Ductile Iron Cement Lined (DICL)	110
Ductile Iron (DI) Unlined	100

6.4 Appendix D

Table 11: Defaults SI units

Data	Unit
Node Elevation	m
Node Demand	L/s
Node Head	m
Node Pressure	m
Tank Volume	ML
Flow Volume	Litre
Link Diameter	mm
Pipe Length	m
Link Flow	L/s
Link Velocity	m/s
Link Head-loss	m
Pump Power	kw
Sustainable Data	kg-CO2
Output Time	hour