9 Full Development System

9.1 Preliminary Sizing

Table 9.1 provides an estimate of the expected infrastructure requirements based on the projected demands included in **Table 4.14**. It has been assumed that the bores will continue to operate at a combined capacity of 26L/s with the remaining water sourced from Callide Dam.

- **Table 9.1 – Full Development Preliminary Sizing**

	Design Criteria		Requirement	Existing Infrastructure
Average Day	6.4 ML/d	74 L/s	-	-
Mean Day Max Month	9.6 ML	111 L/s	-	-
Max Day	14.4 ML	167 L/s	-	-
Raw water pumps	MDMM in 20hrs		135 L/s[3]	180 L/s
Borefield	retain existing		26 L/s	26 L/s
Water Treatment Plant	MDMM in 20 hrs		135 L/s[3]	120 L/s
Ground Level Reservoirs (Biloela) [1]	3(MD-MDMM)		14.3 ML	10.5 ML
Elevated Storage (HLZ) – 39L/s AD	6(MH-MDMM/12)+FF		1.6 ML	1.95 ML
Elevated Storage (LLZ)- 29L/s AD[2]	6(MH-MDMM/12)+FF		1.2 ML	1.35 ML
Pumping to elevated storage (HLZ) Operating capacity = 200kL	(6MH-operating capacity)/6x3600		174 L/s	208 L/s
Pumping to elevated storage (LLZ) Operating capacity = 110kL	(6MH-operating capacity)/6x3600		131L/s	90 L/s

Note: (1) Includes Thangool

(2) Includes Thangool and extended LLZ

(3) Less 26L/s for the bores plus 33L/s for Callied PS

The table shows that the existing system components generally have sufficient capacity to cater for the future development. The table indicates that the WTP will require upgrading, that there is insufficient GL storage capacity and that the booster pumps for the LLZ will need to be upgraded. The above table should be used as a guide only and actual infrastructure requirements will be based on providing 3MDMM plus 3MD capacity as outlined in the DNRM Guidelines (DNRM, 2005).

9.2 Future Development Area – Pressure/Level Implications

The proposed future development areas are shown on **Figure 9.1**.

The figure shows that the TWL of Earlsfield St reservoir is 234.1m and some areas of the proposed development have elevations up to 210, this leaves little scope for friction losses, particularly when the operating level of the reservoir is lower than 232m.

The proposed Washpool Gully development is in an area with a lower elevation. It is therefore proposed to supply this area directly from the 300mm diameter treated water main entering the town.

The Hills Avenue and Jo Kooyman Drive areas have a lower elevation and do not need to be included on the HLZ. It is considered appropriate to convert these areas to the LLZ to increase the capacity of the HLZ (this will be referred to as the LLZ extension). The timing of the change in zones will depend on the performance of the system as the town develops.

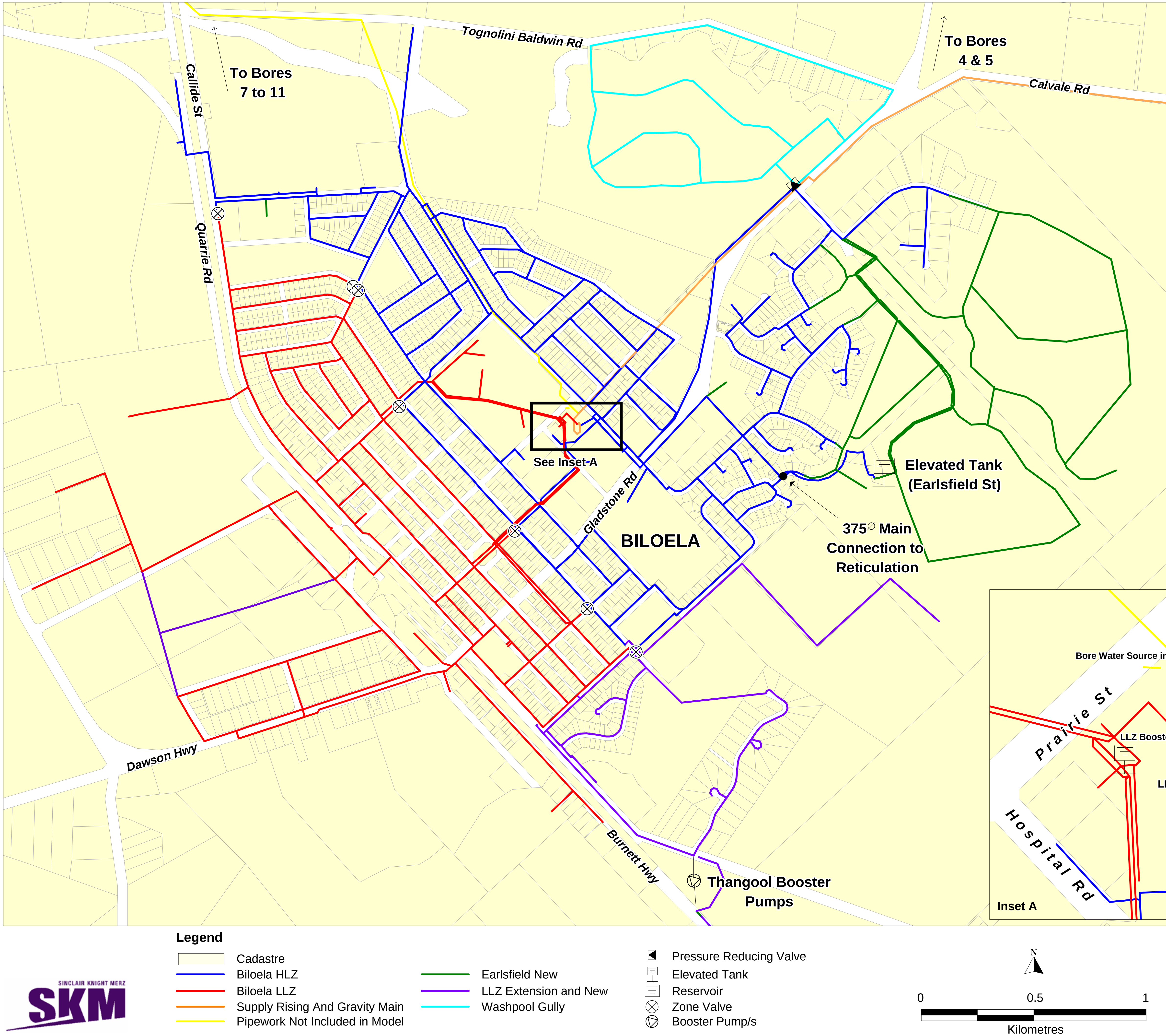

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Figure 9.1

Future Development Zones and Layout

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10 Full Development System Model Results

10.1 Full Development System Model

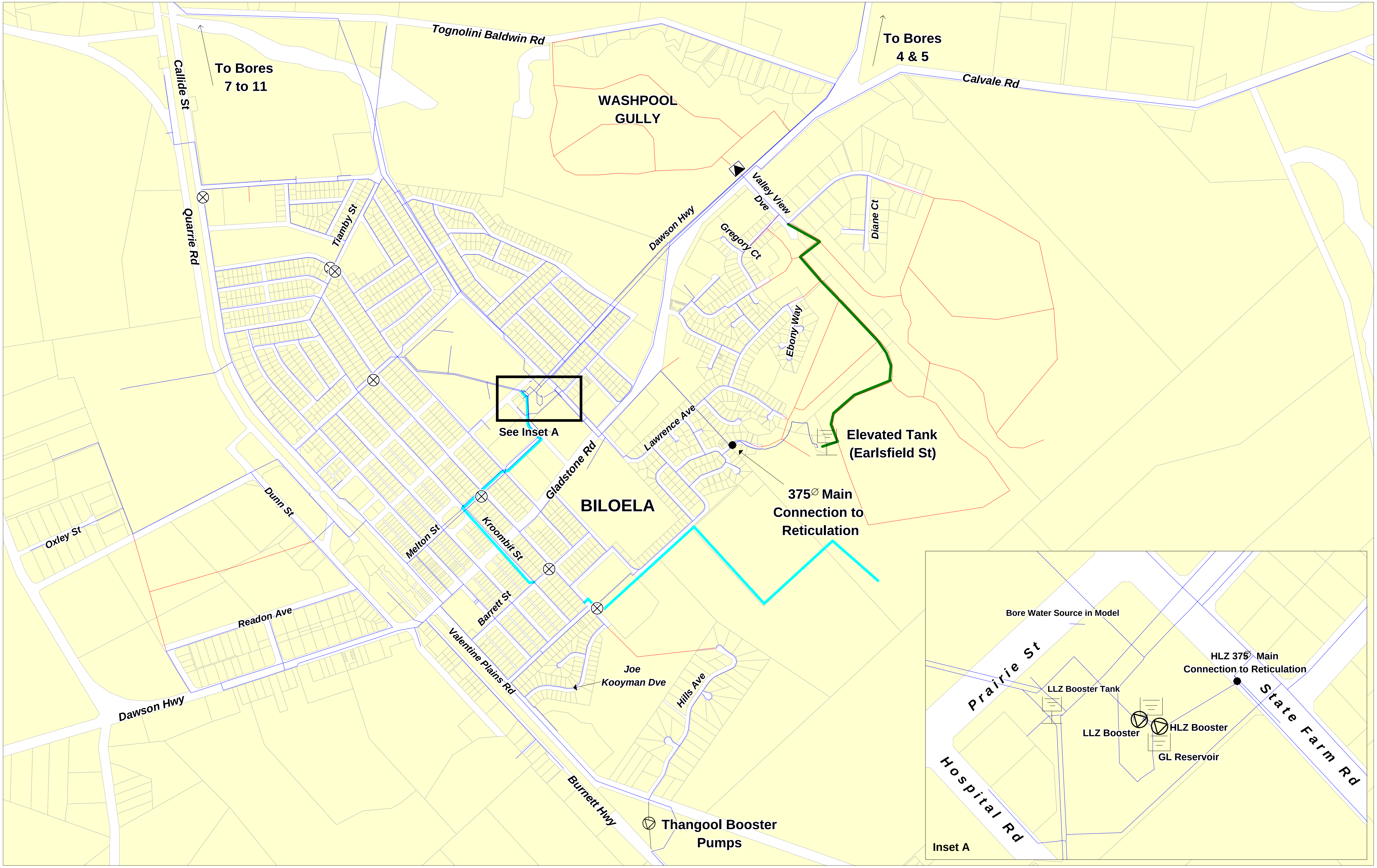
The adopted full development model diameters and augmentations are shown in **Figure 10.1**. The layout is based on existing development applications for the various areas. Only major mains have been included in the model and where sub-division plans are not available for an area the mains have been arbitrarily included.

A break up of the modelled demands in each of the areas is included in **Table 10.1**.

- **Table 10.1 – Model Demand Break Up**

Development Area	AD Demand (ML/d)	AD Demand (L/s)
Existing LLZ area, plus LLZ extension and new industrial/commercial development	2.23	25.8
Exising HLZ, less LLZ extension	2.00	23.2
Washpool Gully New Development (including Togolini Baldwin Rd development)	0.47	5.4
Earlsfield Reservoir New Development	1.3	15.5
Thangool	0.26	3.0
Callide	0.04	0.5
Total demand in Model	**6.4**	**73.5**
Total from Table 4.14	**6.4**	**73.7**

Note: (1) Includes Thangool and extended LLZ



Legend

- Cadastre
- Existing Biloela
- 150mm dia extension/augmentation
- 200mm dia augmentation
- 300mm dia extension
- Elevated Tank
- Reservoir
- Zone Valve
- Booster Pump/s
- Pressure Reducing Valve

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0 0.5 1
Kilometres

Figure 10.1

Full Development Augmentations and Extensions

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10.2 Hydraulic Analysis

The same Hazen Williams coefficients have been used for the full development model as were used for the existing system model. Operating levels for existing reservoirs have been left unchanged.

10.2.1 Upgrade Requirements

In order to provide sufficient water to the town to meet the increase in demand and to meet Council's desired standards of service in terms of pressure, it is proposed to augment the system as follows:

- Upgrade the WTP to Stage 1A which has a capacity of 160L/s.
- Construct a booster pump on the existing 300mm diameter town water main on Calvale Road down stream of the Callide off-take (with a 300mm diameter bypass with a non-return valve).
- Upgrade the LLZ booster pumps from 20kw to 30kw.
- Construct 1.2 km of 200mm diameter main from the LLZ elevated tank, down Melton St and along Kroombit St to Barrett Street.
- Construct 500 m of 150mm diameter water main to connect the Hills Avenue water main to Jo Kooyman Drive.

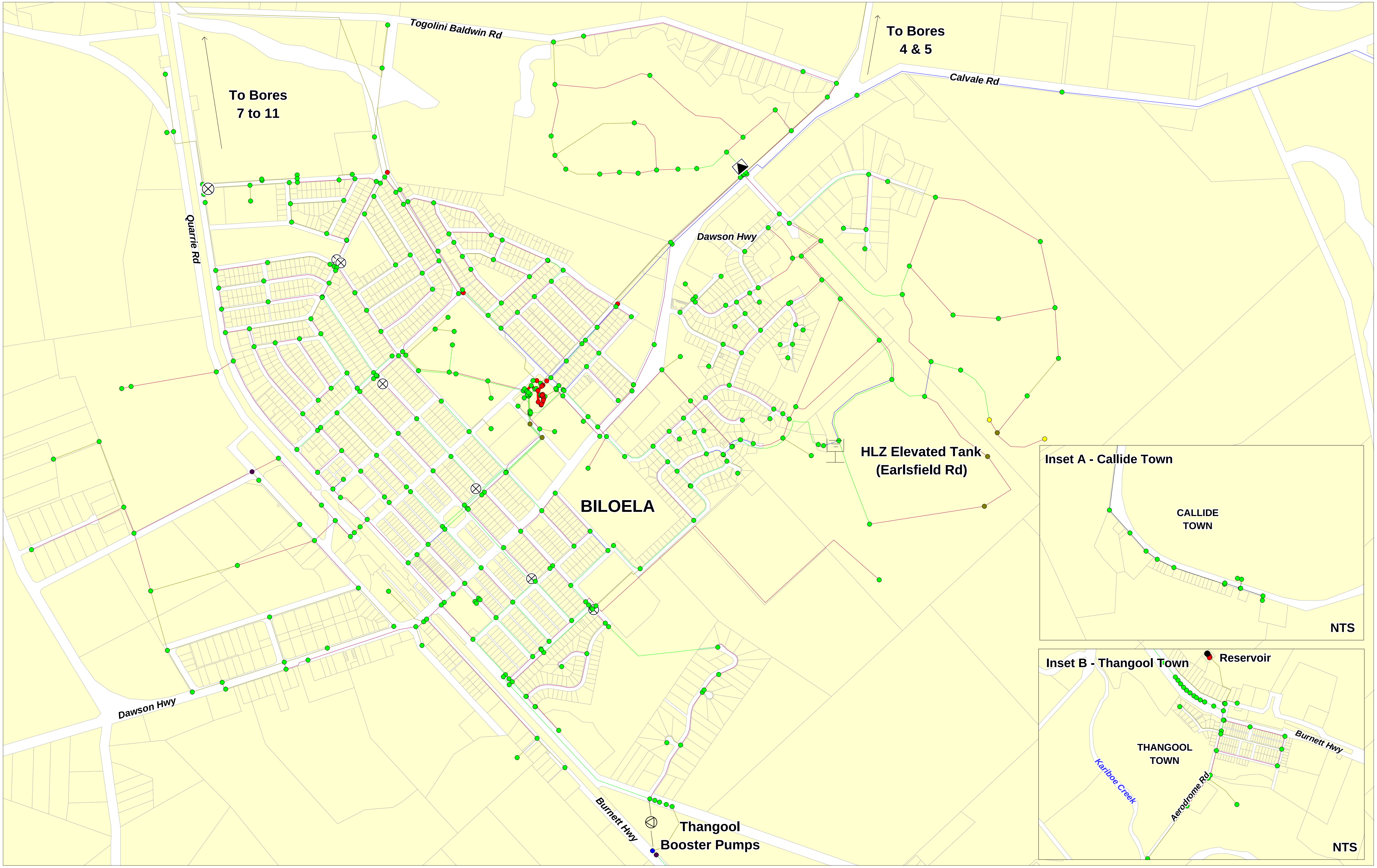
10.2.2 Residual Pressures

Max Day Max Hour

The range of MH pressures in the future development model are shown graphically in **Figure 10.2**.

The figure shows that all areas except for the high level areas near the Earlsfield Street Reservoir meet the 22m standard of service during MH on MD. Pressures in this area range from 18.8m to 21.6m on MD. Pressures are above 22m at MH when the AD scenario is run in the model. Given that they are in an isolated elevated area the slightly lower pressures obtained on peak days are considered acceptable.

In order to provide sufficient pressures to the new development near Earlsfield Street Tank a 300 mm diameter trunk main is needed from the reservoir to the connection at the end of Valley View Drive (see **Figure 10.1**). As this main is required for all new development in the area Council is responsible for its construction through "headworks charges".



Legend

- Pressure Reducing Valve
- Cadastre
- Zone Valve
- Elevated Tank

Existing Water Network Pipe Velocity (m/s)

- 0 - 0.1
- 0.1 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 5
- > 5

Existing Water Network Pipe Pressure (m)

- 0 - 16
- 16 - 20
- 20 - 22
- 22 - 80
- 80 - 120
- > 120

N

0 0.5 1

Kilometres

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Figure 10.2

Full Development System MH Pressures

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The pressures shown are for the worst case scenario when the Earlsfield Tank booster pump is off and the Thangool Booster pump is on. The proposed extension of the LLZ has contributed to the reduced sensitivity of the system to booster operation.

Average Day

The Washpool Gully area has an off-take directly from the 300mm dia treated water main. As a result there are excessive pressures in the system when the reservoir is not being filled and the booster pump is off. To prevent excessive pressures during low demand periods a PRV has been included in the model set at a pressure of 30m. This PRV should be provided by the Washpool Gully area developer.

Minimum Hour

Pressures in the system are all below 80m during low flow periods.

10.2.3 Fire Fighting Requirements

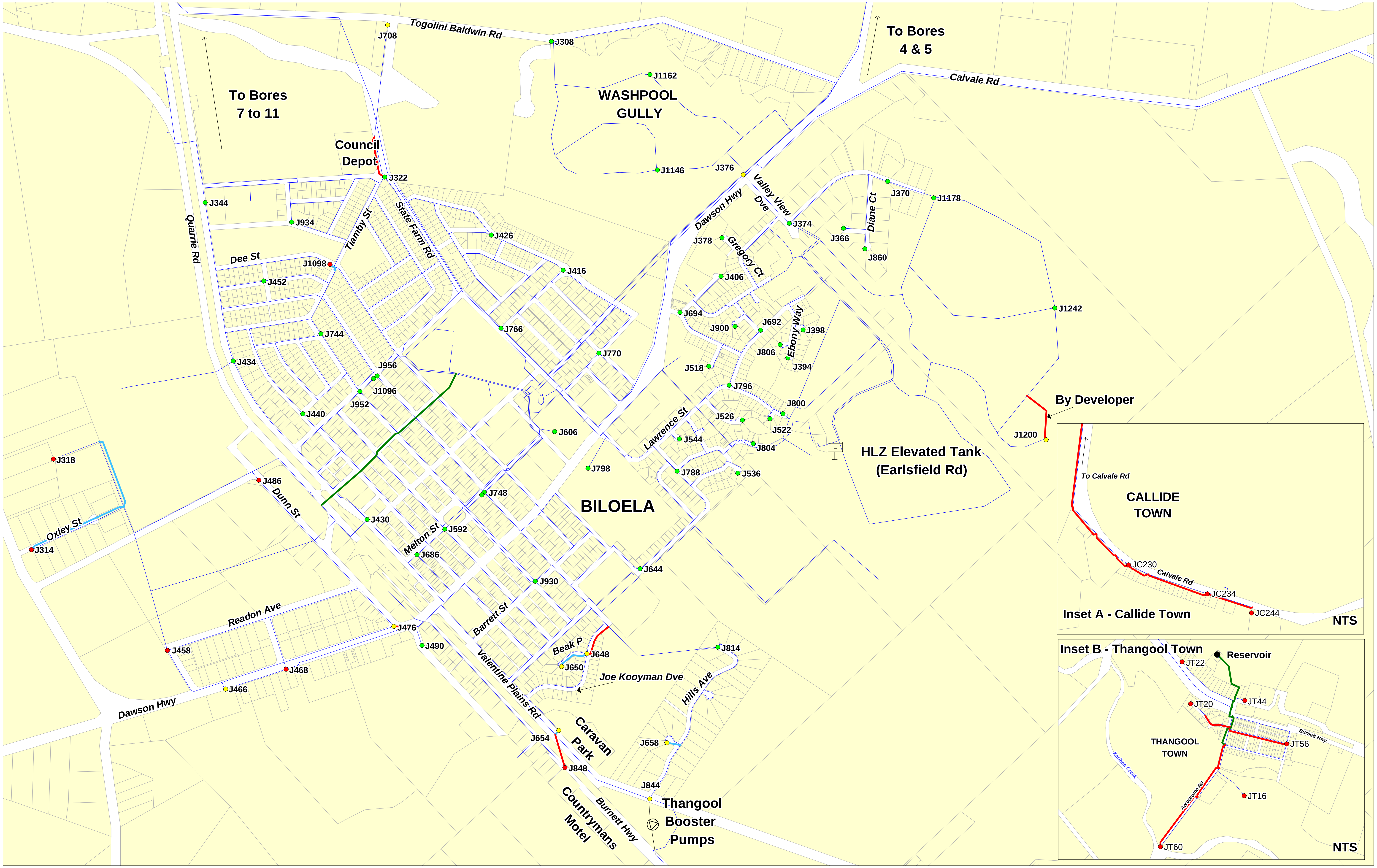
A summary of the fire fighting results at full development is included in **Table 10.2**. The nodes where Fire Flows have been included are shown on **Figure 10.3**.

- **Table 10.2 –Full Development System Fire Fighting Model Results**

Critical Area	Nodes[1]	MH + Fire Fighting Demands			2/3 MH + Fire Fighting demands		
		Total Demand (L/s)	Head with Fire Flow (m)	Available Flow (L/s) @ 12m head	Total Demand (L/s)	Head with Fire Flow (m)	Available Flow (L/s) @ 12m head
Hills Avenue	J658	15.0	6.6	11.4	-	-	OK
	J844	15.0	11.41	14.3	-	-	OK
Valentine Plains Rd	J654	16.7	3.7	12.9	16.1	10.8	15.6
The Bruce Highway (near Countryman's Motel)	J848	30.5	-ve	8.0	30.4	-ve	8.8
Commercial and industrial area near Readon Avenue and Dawson Highway	J466	31.0	9.3	28.4	-	-	OK
	J476	30.2	-ve	18.9	30.2	-ve	20.9
End of Oxley St	J314	16.2	3.3	14.0	15.8	7.3	14.5
	J318	15.2	2.5	12.7	15.1	5.5	13.5
Eastern end of Dee St (near the zone valve)	J1098	15.0	-ve	10.7	15.0	-ve	11.3
End of State Farm Rd past the Council Depot	J708	15.0	5.7	13.7	-	-	OK
Earlsfield Res New Development	J1200	17.72	10.3	15.4	-	-	OK

Critical Area	Nodes[1]	MH + Fire Fighting Demands			2/3 MH + Fire Fighting demands		
		Total Demand (L/s)	Head with Fire Flow (m)	Available Flow (L/s) @ 12m head	Total Demand (L/s)	Head with Fire Flow (m)	Available Flow (L/s) @ 12m head
Thangool	JT16	15.7	-ve	7.4	15.5	-ve	7.0
	JT20	15.7	-ve	9.1	15.5	-ve	8.0
	JT56	15.6	5.2	12.2	15.4	0.4	10.2
	JT60	30.6	-ve	7.9	30.4	-ve	7.5
Callide Town	JC230	15.2	7.9	12.6	15.2	11.45	17.9
	JC234	15.2	-ve	7.2	15.2	-ve	9.6
	JC244	15.2	-ve	6.2	15.2	-ve	7.3

Note: (1) Only nodes with fire fighting demands that don't meet the requirements at MH are included here



Legend

Cadastre	
Zone Valve	
Elevated Tank	

Fire Fighting demand locations

- Able to provide Fire Flow
- Unable to provide Fire Flows at 2/3 MH
- Unable to provide Fire Flows at MH

Existing Water Network Pipe Diameters (mm)

- Full Development Network
- 100mm Augmentation
- 150mm Augmentation
- 200mm Augmentation

N

0 0.5 1

Kilometres

Figure 10.3

Full Development Fire Fighting Augmentations

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To meet the required standard of service at MH for all areas in the existing system the augmentations shown on **Figure 10.3** are required.

Table 10.3 –Full Development Augmentations for MH Fire Fighting

Critical Area	Nodes[1]	Augmentation Description	Diameter (mm)	Length (m)
Hills Avenue	J658	Connect cul-de-sac to Hills Avenue main	100	60
Valentine Plains Rd and the Bruce Highway (near Countryman's Motel)	J654 J844 J848	Connect the two 150mm dia pipes (previously in the HLZ) to J848.	100	170
Commercial and industrial area near Readon Avenue and Dawson Highway	J466 J476	Connect 200mm dia main from the 225mm delivery main in the sports fields to the 200mm dia main in Dunn St	200	800
End of Oxley St	J314	Augment Oxley St with 100 dia main	100	440
Near Oxley St	J318	Augment with 100mm dia main.	100	320
Eastern end of Dee St (near the zone valve)	J1098	Cross connect the two LLZ dead ends at the zone boundary	100	50
End of State Farm Rd past the Council Depot	J708	Augment the 100 mm dia main with a 150mm dia pipe from the corner of Auburn St and State Farm Road	150	200
Earlsifield Rd New Development	J1200	Connect main from cul-de-sac to other main in area	150	220
Thangool	JT16 JT20 JT56 JT60	Augment the 150mm main from the reservoir past the Burnett Highway. Augment the 100mm dia main with a 150mm main to the air port. Augment the 100mm main with a 150mm dia pipe to node JT56	200 150	1350 1150
Callide Town	JC230 JC234 JC244	Augment the existing 150mm main from Calvale Rd to the end of Callide Town	150	2000

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11 Infrastructure Cost Recovery

11.1 Cost Estimates and Augmentation Summary

A summary of the augmentation requirements and cost estimates are shown in **Table 11.1**. Rates include a 30% allowance for contingencies, survey, planning, design, construction supervision and contract administration.

- **Table 11.1 –Augmentation and Cost Summary**

Item	Description	Qty	Unit	Rate*	Amount
1.	**Delivery and Water Treatment Plant Infrastructure All New Development**				
	Upgrade WTP to Stage 1A				
	Replace Filter Media	1	item	60000	$60 000
	Inlet inline mixer modification	1	item	7000	$7 000
	Inlet control valve settings	1	item	3000	$3 000
	Flash Mixer weirs	1	item	5000	$5 000
	Clarifier downpipes	1	item	20000	$20 000
	Sub-Total				$95 000
	Construct a 20kw booster pump on Calvale Road with bypass and NRV (duty & standby)	1	item	209000	$209 000
	Total say				**$300 000**
2.	**Delivery Infrastructure - LLZ development**				
	Upgrade LLZ Booster Pumps from 20kw to 30kW	1	item	198000	$198 000
	Construct 200mm dia main from LLZ elevated tank	1200	m	198	$237 600
	Total say				**$440 000**
3.	**Delivery Insfrastructure - HLZ development**				
	Construct 300 mm dia main through the new high level zone development	1500	m	304	$456 000
	Total say				**$460 000**
4.	**Council Reticulation Upgrade**				
	Construct 150mm dia main between Hills Avenue and Joe Kooyman Drive	500	m	176	$88 000
	Total say				**$90 000**
5.	**Council Fire Fighting Upgrades**				
	Hills Avenue - 100 mm dia	60	m	133	$7 980
	Valentine Plains Road - 150 mm dia	170	m	176	$29 920
	Commercial and Industrial Area - 200 mm dia	800	m	198	$158 400
	End of Oxley St - 100mm dia	440	m	133	$58 520
	Near Oxley St - 100 mm dia	320	m	133	$42 560
	Dee St - 100mm dia	50	m	133	$6 650

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Item	Description	Qty	Unit	Rate*	Amount
	End State Farm Road - 150mm dia	200	m	176	$35 200
	Earlsifield Rd New Development (Needs to be included in development plan)	-	-	-	-
	Thangool - 200mm dia	1350	m	198	$267 300
	Thangool - 150mm dia	1150	m	176	$202 400
	Callide Town - 150mm dia	2000	m	176	$352 000
	Total say				**$1 160 000**

*June 2004 dollars plus 10%

11.2 Water Supply

The water supply infrastructure costs calculated on a per lot basis can be summarised as follows.

- **Table 11.2 – Delivery and Treatment Cost Distribution**

Description	All Development	HLZ Development	LLZ Development
Delivery & WTP infrastructure	$300 000	$460 000	$440 000
Less 40% state govt subsidy	$120 000	n/a	n/a
Net cost	$180 000	$460 000	$440 000
Lots	990	622	424(1)
Cost per lot	$182	$740	$1 037
Total Cost Per Lot	**-**	**$922**	**$1 219**

Note: (1) Councils LLZ extension (127 lots), new LLZ development (140lots) and Thangool (157lots)

The developer contribution for the low level zone (140lots) will be about $145 000 based on the cost per lot cost for rezoning the area. The remaining $295 000 is for upgrading the service to existing lots and the cost will need to be met by Council.

Fire fighting augmentations total $1 160 000. This includes $340 000 for Biloela, $470 000 for Thangool and $350 000 for Callide Town.

11.3 Cost Recovery from Developers

It is assumed that developers will provide all water supply mains less than 300mm dia as part of their developments.

Trunk water mains (ie 300mm diameter and larger) plus water treatment plant augmentation service more than one development and their cost can be apportioned between developments.

In this respect it has been assumed that these costs could be apportioned on a per lot basis.

Council will need to develop the formal mechanisms for infrastructure cost recovery under IPA legislation - these include a priority infrastructure plan (PIP) and an infrastructure charges schedule (ICS).

12 References

Australian Bureau of Statistics, *Australian Social Trends 2002, Housing – National Summary Tables* (www.abs.gov.au/ausstats).

Banana Shire Council (BSC), *Planning Scheme*, December 2004.

Department of Natural Resources and Mines (DNRM), *Planning Guidelines for Water Supply and Sewerage,* March 2005.

Draft Banana Shire, IPA Planning Scheme, December 2004

Valley View Infrastructure Agreement

Ullman & Nolan Pty Ltd Consulting Engineers, *Banana Shire Council - Revised Report on Augmentation of Biloela Water Supply Storage and Reticulation,* January 1981.

Water Resource Commission (WRC), *Guidelines for Planning and Design of Urban Water Supply Schemes*, October 1989.

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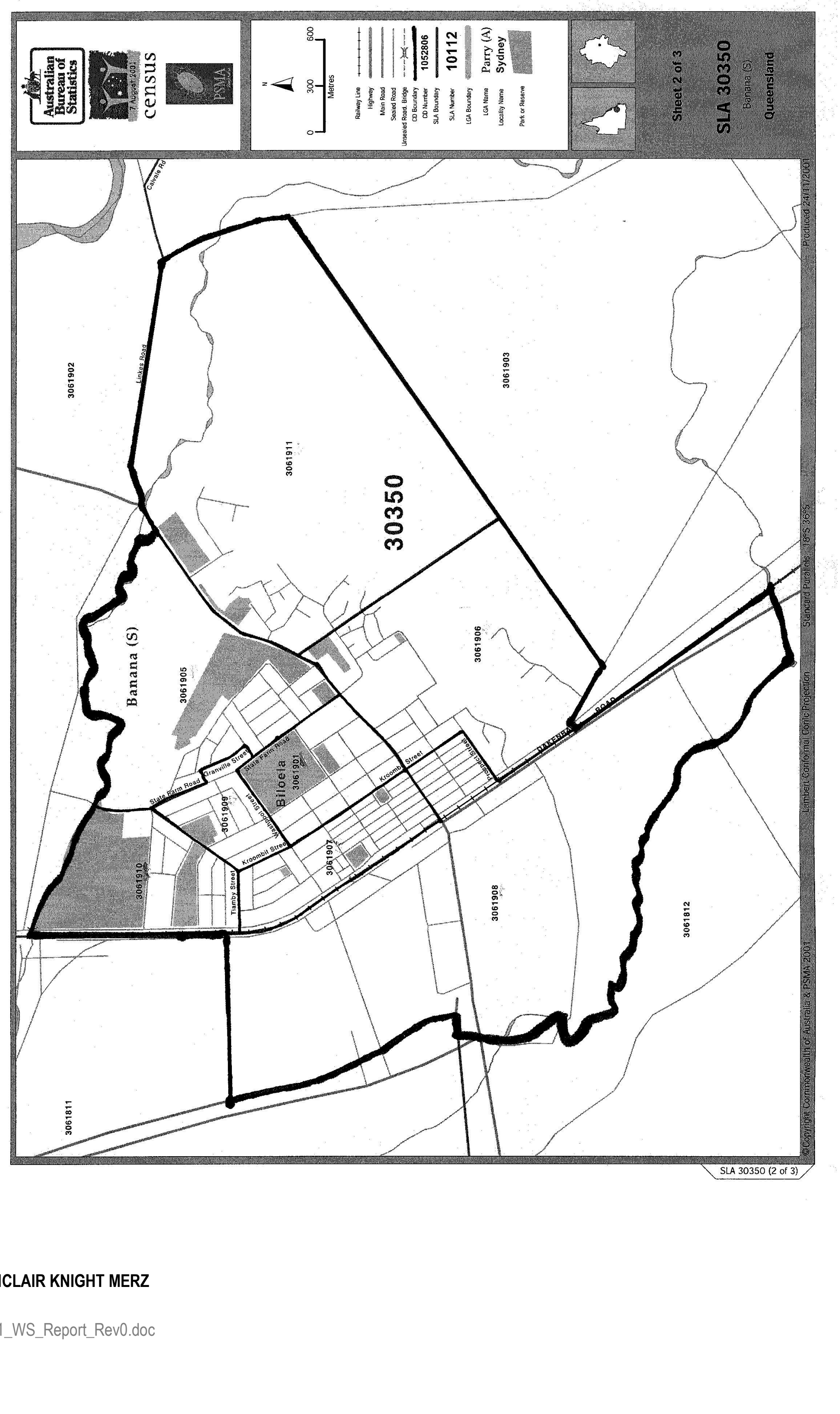
Appendix A – 2001 Census Collector Districts



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Appendix B – Water Supply Unit Entitlement

WATER SUPPLY - UNIT ENTITLEMENT PER ANNUM SCHEDULE 2004/2005

Class	Use	Units (1 Unit = 1 kL)	
		Biloela	Thangool
1	Private dwelling	600	600
2	Flats (per flat)	360	300
3	Boarding House, Lodging House	1200	900
4	Hospital	18000	---
5	Schools (per 100 students - nearest 100)	2400	2400
6	Convent	1200	---
7	Halls Association, Lodge Acc, Rooms	300	240
8	Church	240	120
9	Picture Theatre	600	600
10	Sawmill	1200	---
11	Bowling Club	6000	---
12	Hotel	4800	3120
13	Post Office	240	240
14	Garage, Service Station	900	720
15	C.W.A Rest Room	300	240
16	Butchery, Bakery	720	720
17	Cafe, Restaurant	1200	960
18	Railway Station	900	600
19	Caravan Park	1800	1200
20	Cordial Factory	1800	---
21	Retail Shop, Office, Bank, Warehouse or bulk store	600	600
	(if building is used for more than one of such purposes - for each purpose)	360	300
22	Motel (per unit)	240	240
23	Any other land, building or other structure whatsoever	600	600
24	Swimming Pool	---	---
25	Dry Cleaners & Laundry Service	8000	---
26	Blue Nurses Depot	240	---
29	As determined by Council resolution specific to the site		

Note: In any case where a building is used for a dual or multiple purpose, other than the purpose enumerated in classification No. 21 of this schedule, the combined charges for the various classifications herein mentioned shall be payable.

Appendix C – Land Use Zones and Water Supply Categories

Water Supply Category	Rating Data Land Use Name	Rating Data Land Use Number
Residential	Vacant Urban Land	1
	Single Unit Dwelling	2
	Multi Unit Dwelling (Flats)	3
	Outbuildings	6
	Building Units - Private use o	8
	Group Title - Primary use only	9
Rural Residential	Large Home Site - Vacant	4
	Large Home Site - Dwelling	5
Commercial	Shop single	11
	Shops - group (more than 6 sho	12
	Shopping Group (2 to 6 shops)	13
	Shops - main retail (Central B	14
	Drive in Shopping Centre	16
	Special Tourist attraction	18
	Car Parks	22
	Retail Warehouse	23
	Sales area outdoors (Dealers b	24
	Professional Offices	25
	Funeral parlours	26
	Transport Terminal	29
	Service Station	30
	Hotel/tavern	42
	Motel	43
	Licensed Club	47
	Sports clubs/facilities (Minor water users)	48
	Other clubs (Non - business)	50
	Religious	51
	Library	55
	Educational include Kindergarten (Minor Water Users)	58
	Community Protection Centre	99
Industrial	Warehouse & Bulk Stores	28
	Oil Depot & refinery	31
	Builders yard, contractors	33
	General Industry	35
	Light Industry	36
	Noxious/Offensive Industry	37

Water Supply Category	Rating Data Land Use Name	Rating Data Land Use Number
Agricultural	Cattle Breeding & Fattening	65
	Agricultural – Grains	73
	Agricultural -Small Crop/Fodder	83
	Other Rural -Animal Special	89
	Other Rural -Transformers	91
Individual	Shop single (Major Water User Only)	11
	Residential Institution	21
	Retail Warehouse (Major Water User Only)	23
	Hospitals, Convalescent homes	27
	Service Station (Major Water User Only)	30
	Child care ex Kindergarten	41
	Hotel/tavern (Major Water Users Only)	42
	Motel (Major Water User Only)	43
	Licensed Club (Major Water User Only)	47
	Sports clubs/facilities (Major Water Users)	48
	Caravan Parks	49
	Show Ground, Racecourse	56
	Parks, gardens	57
	Educational include Kindergarten	58
	Public Hospital	96
	Welfare home/institution	97
Not In Biloela Rates Data	Guest House/Private Hotel	7
	Comb. Multi Dwelling & Shops	10
	Restaurant	17
	Extractive	40
	Cemeteries (Include Crematorium)	52
	Vacant Rural Land	94
	Reservoir, dams, bores	95

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Appendix D – Biloela WTP Equipment List

1	Raw Water Pumps		
		-	Axially split single stage centrifugal, Thompsons Byron Jackson
		-	Super Titan 200 x 250-6300
		-	120L/s x 95m
		-	200kW TECO motor, 415V, 3Ø, 50Hz, 1460rpm
		-	Fitted with variable speed drives with a range up to 180L/s
		-	Pump capacity is also limited on the suction size when the Callide Dam water levels are low.
2	Flash Mixer (1 No)		
	Tank	-	29m^3, 3.5m deep, 8.29m^2 area
3	Sludge Blanket Clarifiers with Tube Settlers (2 No)		
	Tank	-	2/7.5m wide, 7.5m breadth, 56.25m^2 area
		-	Side wall 2.4m, hopper height 2.4m
		-	4 hoppers/clarifier
		-	Upflow rate 3.84m/hr
4	Filters (4No)		
	Tank	-	4/3.6m wide x 3.6m breadth, 12.5m^2 area
		-	0.9m sand (No.4) depth, 0.25m gravel depth
		-	Filtration rate 8.64 m/hr
		-	Backwash rate 54m/hr
		-	Air scour rate 32m/hr
5	Treated Water Reservoir (1No)		
	Tank	-	2.15ML volume, 24m diameter, 4.80m depth
		-	260.0m TWL
6	Backwash Collection Surge Tank (1 No)		
	Tank	-	120m^3 volume, 6m diameter
		-	Straight height 2.5m, straight volume 92m^3
		-	Hopper height 3m, hopper volume 28m^3
7	Backwash Pumps (2No)		
		-	Centrifugal back pull-out, Ajax 250 x 200 - 250
		-	194.4 L/s x 18m, 268mm impellor (maximum 288mm)
		-	45 kW Toshiba motor, 415V, 3Ø, 50Hz, 1465 rpm

8	Superintendent Recycle Pumas (2No)		
		-	Centrifugal back pull-out, Ajax 65 x 40 – 250
		-	8.6L/s x 56m, 238mm impeller (maximum 262mm)
		-	15kW Toshiba motor, 415V, 3Ø, 50Hz, 2900 rpm
9	Service Water Pumas (2No)		
		-	Centrifugal back pull out, Ajax 80 x 50-200
		-	8.5L/s x 48m, 197mm impeller (maximum 208mm)
		-	11kW Toshiba motor, 415V, 3Ø, 50Hz, 2900 rpm
10	Filter Air Scour Blower (1No)		
		-	Roots, Powermax – Robusihi
		-	318m^3/hr, 50kPa delivery
		-	7.9kW blower shaft, 3240 rpm
11	Alum Feeder (1 No) Alum/Lime Standby Feeder (1No)		
		-	Volumetric 43.2m^3/hr feed rate
		-	115L solution tank
		-	2.55m^3 storage hopper
12	Lime Feeder (1No)		
		-	Volumetric 21.6m^3/hr feed rte
		-	115L solution tank
		-	2.55m^3 storage hopper
13	Chlorinators (3No) pre, post, standby		
		-	V notch, 2.2kg/hr feed rate, automatic changeover.
14	Sodium Fluoride Batch Tank (1No)		
		-	2,300L polyethylene, 1.46m diameter, 1.425m high
		-	2.5% sodium fluoride solution.

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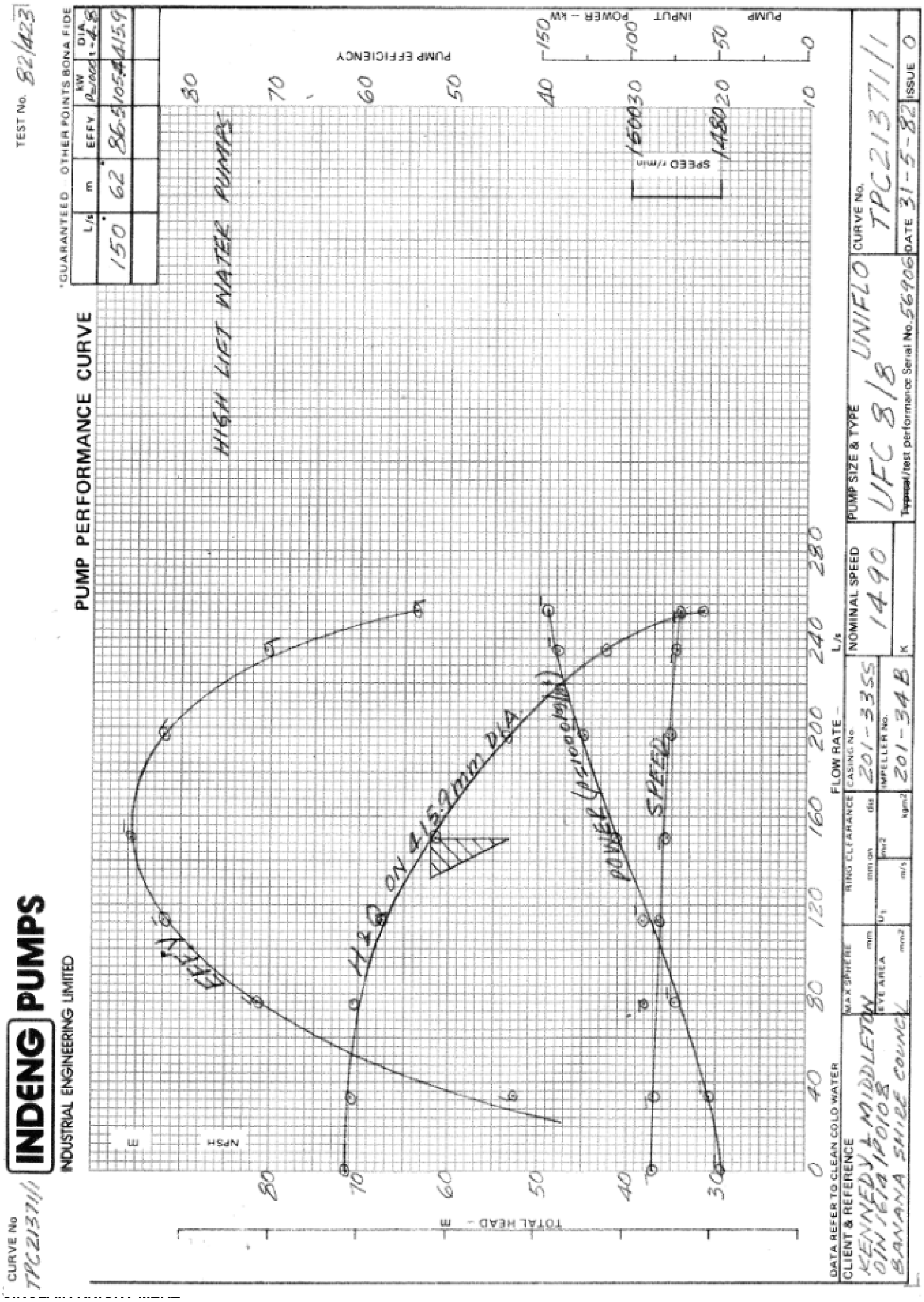
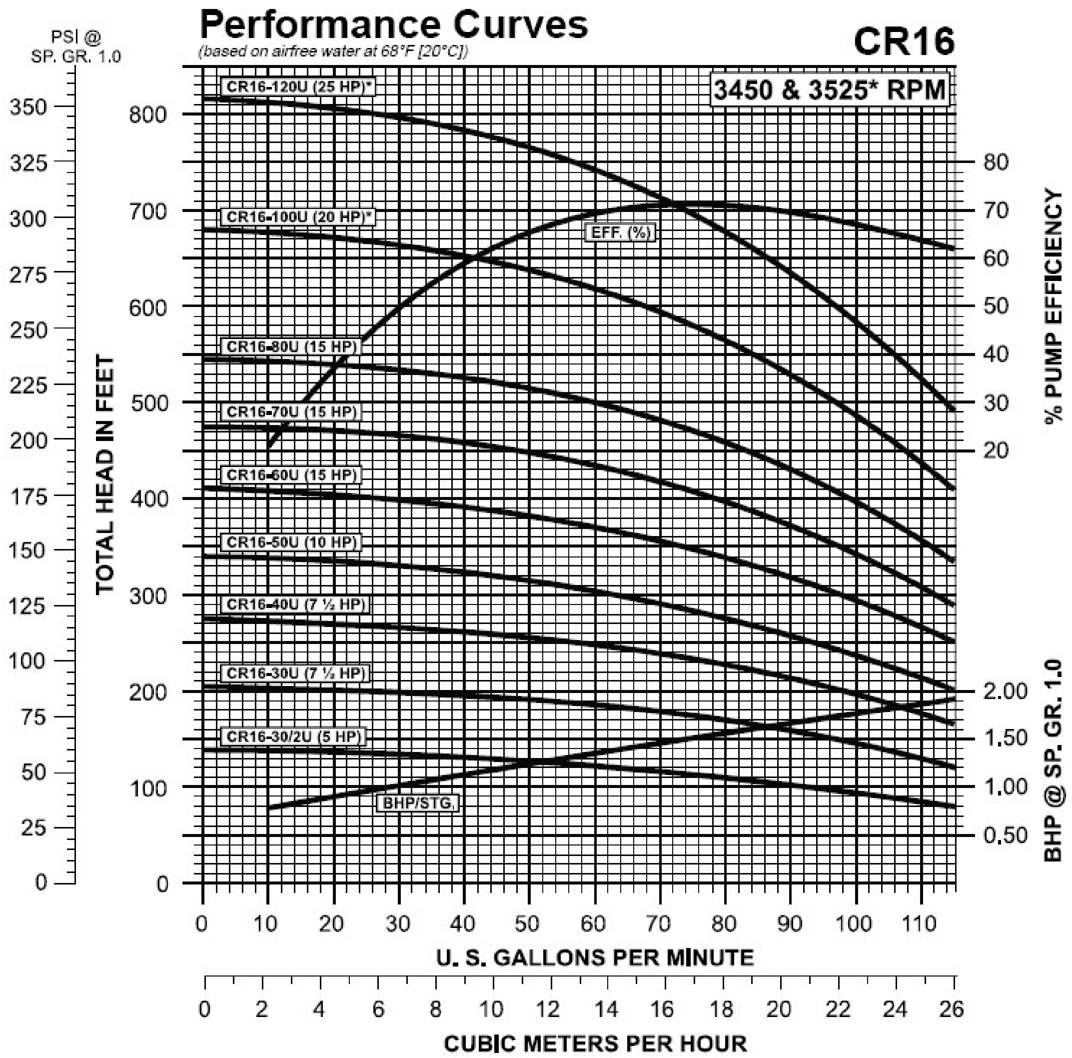
Appendix E – Booster Pump Curves

Biloela LLZ Pumps Performance Curves



Thangool Booster Pump Performance Curves (CR16-40U)



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Appendix F – Existing System Reservoir Results

The results of running 3 MDMM (initial water levels at 90%) directly followed by 3MD for each of the storages is included below.

Figure E.12.1 – WTP Clear Water Storage

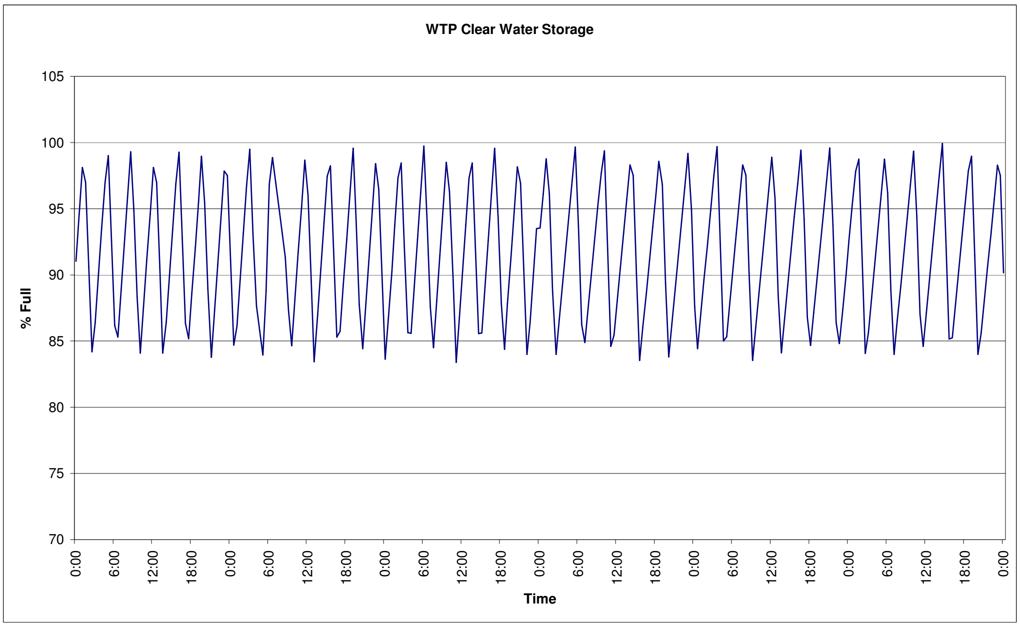
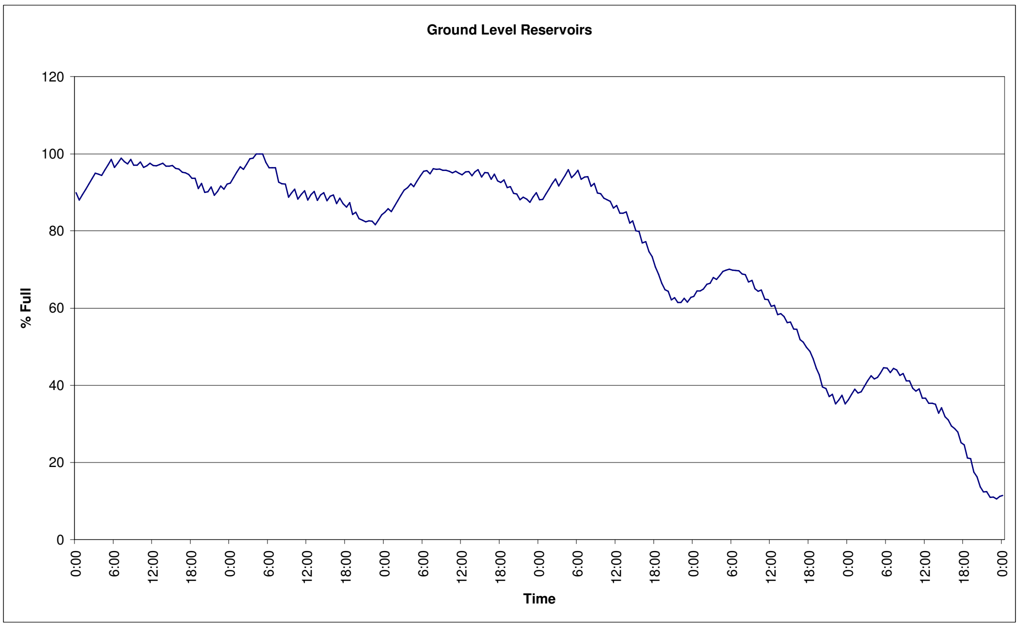
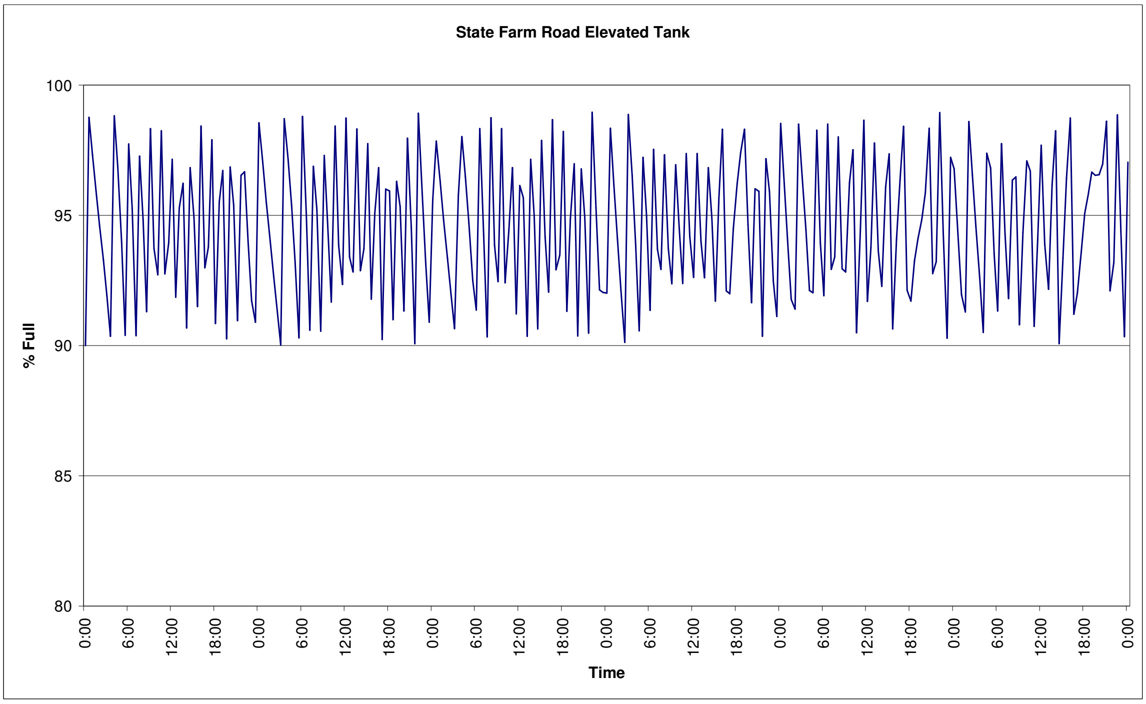


Figure E.12.2 – GL Reservoirs, State Farm Road



- **Figure E.12.3 – State Farm Road Elevated Tank (LLZ)**



- **Figure E.12.4 – Earlsfield Street Elevated Tank (HLZ)**

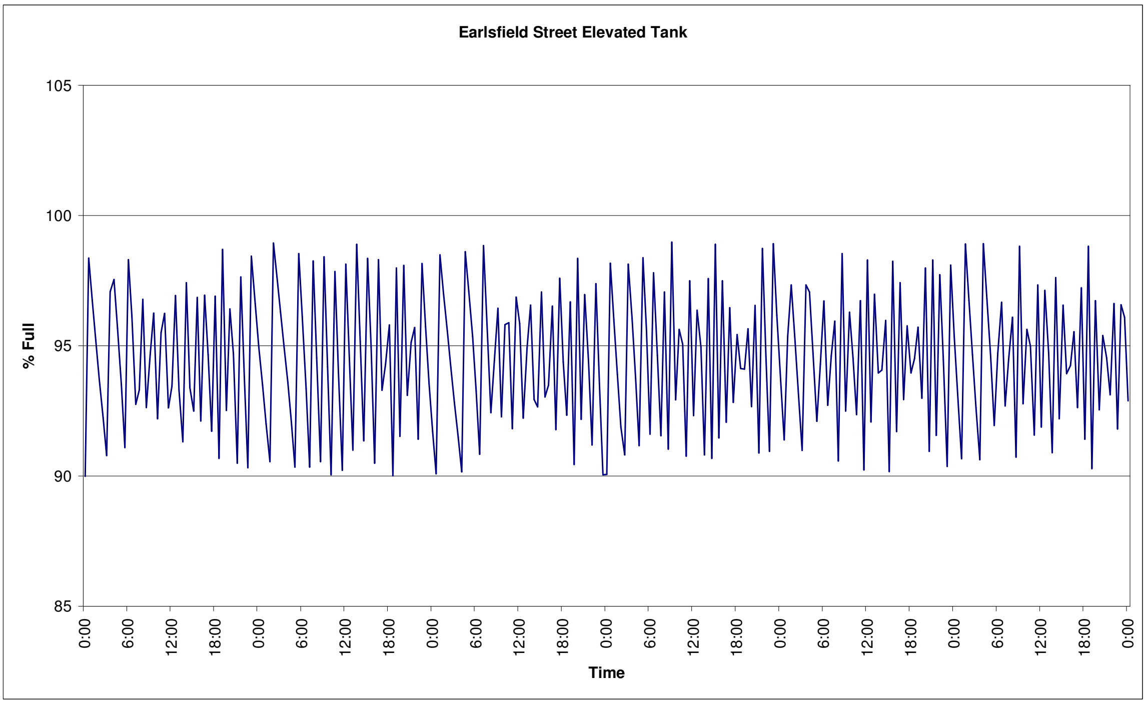
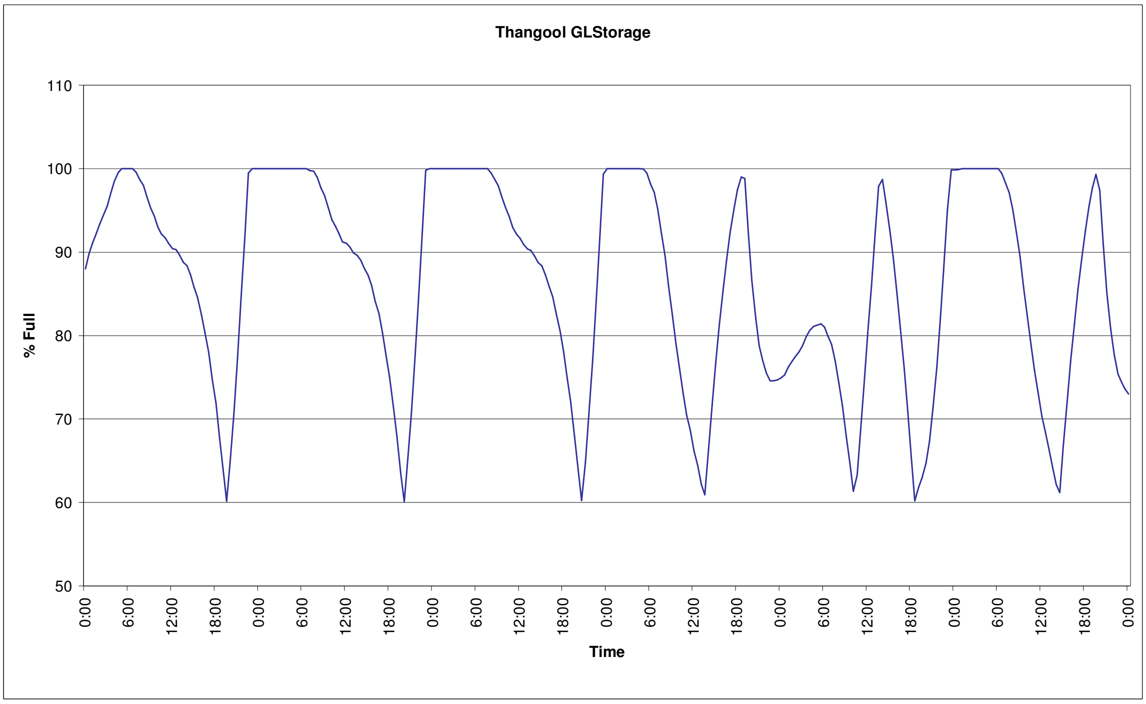


Figure E.12.5 – Thangool GL Reservoir



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Appendix G – Existing System Fire Fighting Results

MH Demands

ID	Total Demand (L/s)	Critical Node 1 ID	Critical Node 1 Pressure (m)	Critical Node 1 Head (m)	Available Flow @Hydrant (L/s)	Critical Node 2 ID	Critical Node 2 Pressure (m)	Critcal Node 2 Head (m)	Adjusted Available Flow (L/s)	Design Flow (L/s)
J1094	15	J800	17.6	203.08	36.75	J1094	12	197.49	36.75	36.75
J1096	15	J800	17.6	202.62	38.9	J1096	12	197.03	38.9	38.9
J1098	15	J1098	-2.62	171.59	10.99	J1098	12	186.21	10.99	10.99
J308	16.37	J308	-51.29	119.21	8.57	J308	12	182.5	8.57	8.57
J314	16.23	J314	3.29	170.29	13.95	J314	12	179	13.95	13.95
J322	15.41	J322	11.62	200.62	14.89	J322	12	201	14.89	14.89
J344	15.15	J800	17.6	188.1	28.54	J344	12	182.5	28.54	28.54
J366	15.61	J366	-40.49	140.67	6.36	J860	8.29	189.44	5.34	5.34
J370	15.9	J860	-23.89	155.61	8.21	J860	6.85	186.35	6.53	6.53
J374	16.09	J860	8.33	184.33	21.6	J860	0.15	176.15	13.33	13.33
J376	15.56	J382	9.36	181.36	25.39	J860	-3.67	168.33	13.81	12.6
J378	15.41	J382	8.47	189.15	14.02	J382	9.84	190.53	11.75	11.75
J394	15	J394	-11.12	184.37	4.95	J394	12	207.49	4.95	4.95
J398	15.41	J398	-3.7	190.67	6.82	J394	11.6	205.97	6.49	6.49
J406	15.41	J406	0.82	191.32	9.56	J394	11.86	202.36	9.37	9.37
J416	15.41	J322	13.31	199.31	21.86	J322	9.29	195.29	17.54	17.54
J426	16.63	J322	12.72	198.08	22.38	J322	8.96	194.32	17.76	17.76
J430	30.15	J800	17.6	193.6	50.12	J510	11.05	187.05	47.88	47.88
J434	30.32	J738	13.73	186.73	44.8	J736	7.27	180.27	34.62	34.58
J440	15.65	J800	17.6	192.6	34.76	J440	12	187	34.76	34.76
J452	16.63	J800	17.6	192.6	25.16	J452	12	187	25.16	25.16
J458	30.32	J458	-4.75	168.25	21.23	J458	12	185	21.23	21.23
J466	30.54	J466	-3.71	170.29	21.49	J466	12	186	21.49	21.49

ID	Total Demand (L/s)	Critical Node 1 ID	Critical Node 1 Pressure (m)	Critical Node 1 Head (m)	Available Flow @Hydrant (L/s)	Critical Node 2 ID	Critical Node 2 Pressure (m)	Critcal Node 2 Head (m)	Adjusted Available Flow (L/s)	Design Flow (L/s)
J468	30.49	J468	2.96	176.96	24.2	J468	12	186	24.2	24.2
J476	30.22	J476	-15.56	160.26	17.51	J476	12	187.82	17.51	17.51
J486	30	J486	-56.41	114.59	13.97	J486	12	183	13.97	13.97
J490	15	J800	17.6	193.6	22.59	J490	12	188	22.59	22.59
J518	15.41	J518	4.56	194.51	10.94	J394	10.7	200.65	9.25	9.25
J522	15.41	J522	2.58	199.51	7.32	J522	12	208.93	7.32	7.32
J526	15.82	J526	0.79	194.16	9.75	J526	12	205.37	9.75	9.75
J536	15.41	J800	16.57	217.57	73.16	J800	11.08	212.08	65.11	65.11
J544	15.25	J800	11.42	201.81	19.44	J800	9.43	199.82	13.96	13.96
J592	31.25	J800	17.6	198.1	63.66	J1094	9.53	190.03	55.36	55.36
J606	31.42	J606	6.82	198.66	23.51	J800	11.56	203.4	22.04	22.04
J644	15.82	J800	15.53	193.41	63.9	J918	0.95	178.83	44.41	35.9
J648	16.72	J800	15.53	192.03	24	J814	10.53	187.04	23.01	23.01
J650	15.9	J650	12.17	189.55	15.96	J650	12	189.39	15.96	15.96
J654	16.72	J654	-0.47	175.2	13.12	J654	12	187.66	13.12	13.12
J658	15	J658	-10.42	165.58	9.23	J658	12	188	9.23	9.23
J686	30.44	J930	17.29	194.86	55.06	J930	8.6	186.18	46.21	46.21
J692	15	J394	6.24	199.14	11.6	J394	9.31	202.21	8.32	8.32
J694	15.82	J394	7.09	184.59	25.4	J394	-2.06	175.44	9.74	9.74
J708	15	J708	-4.43	164.57	11.52	J708	12	181	11.52	11.52
J744	16.23	J800	17.6	200.87	27.26	J744	12	195.27	27.26	27.26
J748	17.45	J800	13.68	199.39	29.35	J800	10.22	195.93	23.38	23.38
J766	15.82	J800	13.96	200.71	25.05	J322	8.81	195.57	19.57	19.57
J770	16.23	J800	13.9	202.9	19.93	J770	12	201	19.93	19.93
J788	15.82	J800	14.92	210.64	41.12	J800	8.57	204.29	28.82	28.82
J796	16.63	J800	7.5	199.48	17.28	J800	7.01	198.99	10.41	10.41
J798	18.58	J800	12.52	202.8	27.78	J800	8.86	199.15	19.94	19.94

ID	Total Demand (L/s)	Critical Node 1 ID	Critical Node 1 Pressure (m)	Critical Node 1 Head (m)	Available Flow @Hydrant (L/s)	Critical Node 2 ID	Critical Node 2 Pressure (m)	Critcal Node 2 Head (m)	Adjusted Available Flow (L/s)	Design Flow (L/s)
J800	15.25	J800	5.26	202.22	7.96	J800	12	208.96	7.96	7.96
J804	15.41	J800	17.14	216.84	24.77	J804	12	211.7	24.74	24.74
J806	15.41	J806	-8.66	185.34	6.32	J394	11.21	205.21	5.78	5.78
J814	19.21	J814	-11.71	164.29	13.06	J814	12	188	13.05	13.05
J844	15	J814	-1.56	174.65	10.81	J814	11.32	187.52	10.57	10.57
J848	30.54	J848	-162.06	12.94	8.45	J848	12	187	8.45	8.45
J860	15.47	J860	-44.36	141.57	5.03	J860	12	197.93	5.03	5.03
J900	15.41	J900	4.72	195.01	10.77	J394	10.92	201.22	9.36	9.36
J930	16.94	J800	17.6	200.19	31.18	J930	12	194.6	31.18	31.18
J934	15.41	J322	11.86	185.87	29.02	J354	0.89	174.9	16.43	15.21
J952	16.23	J800	17.6	199.18	61.88	J1096	8.56	190.14	51.98	51.98
J956	16.23	J322	12.75	199.25	19.48	J322	10.62	197.12	17.38	17.38
JC230	15.24	JC244	9.3	235.86	16.71	JC244	6.79	233.35	13.54	13.54
JC234	15.24	JC244	-14.14	214.33	8.88	JC244	8.94	237.41	7.78	7.78
JC244	15.24	JC244	-26.37	205.12	6.68	JC244	12	243.49	6.68	6.68
JT20	15.57	JT20	-19.51	174.49	7.4	JT20	12	206	7.4	7.4
JT22	15.57	JT24	15.72	216.25	15.55	JT24	15.73	216.26	21.44	21.44
JT44	15.57	JT44	15.06	215.65	19.49	JT44	12	212.59	19.49	19.49
JT56	15.57	JT56	-1.6	193.9	9.16	JT42	10.86	206.36	8.5	8.5
JT60	15.57	JT60	-32.92	156.26	7	JT30	9.45	198.63	6.3	6.3

SKM

2/3 MH Demands

ID	Total Demand (L/s)	Critical Node 1 ID	Critical Node 1 Pressure (m)	Critical Node 1 Head (m)	Available Flow @Hydrant (L/s)	Critical Node 2 ID	Critical Node 2 Pressure (m)	Critcal Node 2 Head (m)	Adjusted Available Flow (L/s)	Design Flow (L/s)
J1094	15	J1094	22.4	207.89	43.71	J1094	12	197.49	43.71	43.71
J1096	15	J1096	22.96	207.99	45.97	J1096	12	197.03	45.97	45.97
J1098	15	J1098	1.67	175.88	12.18	J1098	12	186.21	12.18	12.18
J308	15.91	J308	-37.86	132.64	9.79	J308	12	182.5	9.79	9.79
J314	15.82	J314	8.45	175.45	14.88	J314	12	179	14.88	14.88
J322	15.27	J606	19.24	208.24	26.85	J322	12	201	26.85	26.85
J344	15.1	J744	23.42	193.92	32.28	J344	12	182.5	32.28	32.28
J366	15.41	J366	-25.9	155.26	8.71	J860	9.14	190.3	7.99	7.99
J370	15.6	J860	-10.36	169.14	10.9	J860	8.06	187.56	9.72	9.72
J374	15.72	J800	17.62	193.62	28.05	J860	1.16	177.16	20.93	20.93
J376	15.38	J800	17.76	189.76	32.3	J860	-2.11	169.89	22.31	22.31
J378	15.27	J800	17.51	198.19	18.28	J378	12	192.68	18.28	18.28
J394	15	J394	-2.19	193.3	9.2	J394	12	207.49	9.2	9.2
J398	15.27	J398	5.15	199.52	11.71	J398	12	206.37	11.71	11.71
J406	15.27	J406	9.54	200.04	14.04	J406	12	202.5	14.04	14.04
J416	15.27	J606	19.4	205.4	33.62	J322	11	197	31.98	31.98
J426	16.09	J606	19.32	204.68	33.66	J322	10.32	195.67	31.11	31.11
J430	30.1	J1094	21.51	197.51	59.81	J430	12	188	59.81	59.81
J434	30.21	J744	19.56	192.56	52.58	J744	11.55	184.55	51.44	51.44
J440	15.44	J800	23.61	198.61	38.93	J440	12	187	38.93	38.93
J452	16.09	J744	23.35	198.35	28.5	J452	12	187	28.5	28.5
J458	30.21	J458	1.31	174.31	24.32	J458	12	185	24.32	24.32
J466	30.36	J466	2.33	176.33	24.7	J466	12	186	24.7	24.7

ID	Total Demand (L/s)	Critical Node 1 ID	Critical Node 1 Pressure (m)	Critical Node 1 Head (m)	Available Flow @Hydrant (L/s)	Critical Node 2 ID	Critical Node 2 Pressure (m)	Critcal Node 2 Head (m)	Adjusted Available Flow (L/s)	Design Flow (L/s)
J468	30.33	J468	8.81	182.81	28.07	J468	12	186	28.07	28.07
J476	30.15	J476	-9.7	166.12	20.05	J476	12	187.82	20.05	20.05
J486	30	J486	-51.5	119.5	15.16	J486	12	183	15.16	15.16
J490	15	J1094	23.46	199.46	25.7	J490	12	188	25.7	25.7
J518	15.27	J518	13.08	203.03	15.9	J518	12	201.95	15.9	15.9
J522	15.27	J522	10.5	207.43	14.02	J522	12	208.93	14.02	14.02
J526	15.54	J526	8.25	201.63	13.59	J526	12	205.37	13.59	13.59
J536	15.27	J800	22.74	223.74	87.49	J536	12	213	87.49	87.49
J544	15.16	J800	18.25	208.64	25.08	J544	12	202.39	25.08	25.08
J592	30.83	J1094	20.87	201.38	77.29	J1094	9.69	190.19	68.96	68.96
J606	53.45	J606	3.74	195.59	43.14	J606	12	203.84	43.14	43.14
J644	15.54	J800	21.87	199.75	77.29	J814	9.78	187.65	73.99	72.35
J648	16.14	J800	21.87	198.37	30.32	J650	11.09	187.59	29.81	29.81
J650	15.6	J800	21.87	199.26	19.75	J650	12	189.39	19.75	19.75
J654	16.14	J654	13.19	188.85	16.49	J654	12	187.66	16.49	16.49
J658	15	J658	5.98	181.98	13.41	J658	12	188	13.41	13.41
J686	30.29	J1094	21.25	198.82	66.61	J930	9.67	187.24	60.22	60.22
J692	15	J394	14.71	207.61	20.98	J394	9.36	202.26	18.14	18.14
J694	15.54	J394	15.46	192.96	32.72	J406	-0.53	176.97	22.45	19.94
J708	15	J708	3.99	172.99	13.35	J708	12	181	13.35	13.35
J744	15.82	J744	21.97	205.25	33.67	J744	12	195.27	33.67	33.67
J748	16.63	J606	15.99	201.7	27.67	J606	8.35	194.05	22.6	22.6
J766	15.54	J606	19.52	206.28	37.73	J322	9.65	196.4	33.93	33.93
J770	15.82	J606	19.55	208.55	29.86	J770	12	201	29.86	29.86
J788	15.54	J800	21.28	217	53.47	J788	12	207.72	53.47	53.47
J796	16.09	J800	15.29	207.27	27.29	J800	7.02	199	20.85	20.85
J798	17.39	J800	19.42	209.71	34.69	J798	12	202.29	34.69	34.69

ID	Total Demand (L/s)	Critical Node 1 ID	Critical Node 1 Pressure (m)	Critical Node 1 Head (m)	Available Flow @Hydrant (L/s)	Critical Node 2 ID	Critical Node 2 Pressure (m)	Critcal Node 2 Head (m)	Adjusted Available Flow (L/s)	Design Flow (L/s)
J800	15.16	J800	13.14	210.09	16.39	J800	12	208.96	16.39	16.39
J804	15.27	J800	23.22	222.92	26.29	J804	12	211.7	26.29	26.29
J806	15.27	J806	0.33	194.33	10.41	J806	12	206	10.4	10.4
J814	17.8	J814	5.59	181.59	16.08	J814	12	188	16.08	16.08
J844	15	J814	14.56	190.77	15.94	J814	11.79	188	15.87	15.87
J848	30.36	J848	-153.75	21.25	9.29	J848	12	187	9.29	9.29
J860	15.31	J860	-29.82	156.12	7.57	J860	12	197.93	7.57	7.57
J900	15.27	J900	13.43	203.73	16.16	J900	12	202.29	16.16	16.16
J930	16.29	J930	23.04	205.64	38.12	J930	12	194.6	38.12	38.12
J934	15.27	J606	19.22	193.23	38.51	J322	3.28	177.29	27.48	27.48
J952	15.82	J1096	23.57	205.15	73.1	J1096	8.56	190.14	62.89	62.89
J956	15.82	J606	18.96	205.46	29.53	J956	12	198.5	29.52	29.52
JC230	15.16	JC244	12.01	238.57	18.17	JC244	6.94	233.49	15.16	15.16
JC234	15.16	JC244	-10.34	218.13	9.78	JC244	8.96	237.43	8.71	8.71
JC244	15.16	JC244	-22.31	209.18	7.44	JC244	12	243.49	7.44	7.44
JT20	15.38	JT20	-11.29	182.71	9.04	JT20	12	206	9.04	9.04
JT22	15.38	JT22	14.81	215.34	18.26	JT22	12	212.53	18.26	18.26
JT44	15.38	JT44	17.82	218.42	24.46	JT44	12	212.59	24.46	24.46
JT56	15.38	JT56	6.29	201.79	12.42	JT56	12	207.5	12.42	12.42
JT60	15.38	JT60	-22.33	166.85	8.5	JT60	12	201.18	8.5	8.5

Appendix H – Full Development Fire Fighting Results

MH – Full Development Fire Fighting Results

ID	Total Demand (L/s)	Critical Node 1 ID	Critical Node 1 Pressure (m)	Critical Node 1 Head (m)	Available Flow @Hydrant (L/s)	Critical Node 2 ID	Critical Node 2 Pressure (m)	Critcal Node 2 Head (m)	Adjusted Available Flow (L/s)	Design Flow (L/s)
J1094	15	J1200	18.79	204.28	40.33	J1094	12	197.49	40.33	40.33
J1096	15	J1200	18.79	203.82	38.5	J1096	12	197.03	38.5	38.5
J1098	15	J1098	-3.5	170.71	10.68	J1098	12	186.21	10.68	10.68
J1146	16.13	J1200	18.79	189.79	36.32	J1146	12	183	36.32	36.32
J1162	18.4	J1200	18.79	191.51	35.05	J1162	12	184.72	35.05	35.05
J1178	15	J1200	14.92	193.92	65.49	J1200	-4.31	174.69	24.16	24.16
J1200	17.72	J1200	10.33	218.28	15.42	J1200	12	219.95	15.41	15.41
J1202	19.72	J1200	18.46	221.04	359.75	J1200	3.27	205.85	202.45	202.45
J1224	31.05	J1224	13.85	186.85	33.1	J1224	12	185	33.09	33.09
J1242	17.83	J1200	13.94	197.13	58.18	J1200	-5.29	177.9	22.92	22.91
J1264	17.13	J1200	17.58	224.98	35.71	J1264	12	219.4	35.71	35.71
J1276	19.25	J1200	18.7	198.7	27.07	J1276	12	192	27.07	27.07
J308	16.37	J1200	18.79	189.29	27.98	J308	12	182.5	27.98	27.98
J314	16.23	J314	3.28	170.28	13.8	J314	12	179	13.8	13.8
J318	15.19	J318	2.51	169.42	12.74	J318	12	178.91	12.74	12.73
J322	15.41	J1200	18.69	207.69	29.36	J322	12	201	29.36	29.36
J344	15.15	J738	18.11	188.61	28.14	J344	12	182.5	28.14	28.14
J366	15.61	J1200	15.4	196.56	17.53	J366	12	193.15	17.53	17.53
J370	15.9	J1200	15.06	194.56	55.88	J1200	1.57	181.07	26.05	26.05
J374	16.09	J1200	18.4	194.4	438.63	J1200	-9.44	166.56	171.43	171.43
J376	15.56	J1200	18.48	190.48	109.51	J376	12	184	109.51	109.51
J378	15.41	J1200	18.43	199.11	34.8	J378	12	192.68	34.8	34.8
J394	15	J394	17.79	213.28	17.73	J394	12	207.49	17.73	17.73

ID	Total Demand (L/s)	Critical Node 1 ID	Critical Node 1 Pressure (m)	Critical Node 1 Head (m)	Available Flow @Hydrant (L/s)	Critical Node 2 ID	Critical Node 2 Pressure (m)	Critcal Node 2 Head (m)	Adjusted Available Flow (L/s)	Design Flow (L/s)
J398	15.41	J1200	18.48	212.85	24.27	J398	12	206.37	24.27	24.27
J406	15.41	J1200	18.52	209.02	24.07	J406	12	202.5	24.07	24.07
J416	15.41	J1200	18.69	204.69	38.29	J322	10.97	196.97	36.57	36.57
J426	16.63	J1200	18.69	204.05	37.62	J322	10.47	195.83	35.27	35.27
J430	30.15	J1128	17.79	193.79	52.69	J510	11.37	187.37	50.89	50.89
J434	30.32	J738	13.31	186.31	44.81	J736	7.26	180.26	33.85	33.79
J440	15.65	J1200	18.79	193.79	34.44	J440	12	187	34.44	34.44
J452	16.63	J736	17.73	192.73	24.65	J452	12	187	24.65	24.65
J458	30.32	J476	14.07	187.07	33.3	J476	11.95	184.95	33.24	33.24
J466	30.98	J466	9.27	183.27	28.42	J466	12	186	28.41	28.41
J468	30.49	J468	13.58	187.58	32.34	J468	12	186	32.34	32.34
J476	30.22	J476	-7.89	167.93	18.91	J476	12	187.82	18.91	18.91
J486	30	J486	15.08	186.08	33.12	J486	12	183	33.12	33.12
J490	15	J1200	18.79	194.79	22.67	J490	12	188	22.67	22.67
J518	15.41	J1200	18.53	208.48	28.35	J518	12	201.95	28.35	28.35
J522	15.41	J1200	18.54	215.47	38.09	J522	12	208.93	38.09	38.09
J526	15.82	J1200	18.59	211.96	21.18	J526	12	205.37	21.18	21.18
J536	15.41	J1200	18.74	219.74	104.18	J536	12	213	104.18	104.18
J544	15.25	J1200	18.63	209.02	38	J544	12	202.39	38	38
J592	31.25	J1200	18.79	199.3	75.55	J1128	10.31	190.81	68.24	68.24
J606	31.42	J1200	18.59	210.44	51.64	J606	12	203.84	51.64	51.64
J644	15.82	J1200	18.71	196.59	111.58	J918	7.47	185.35	93.21	93.21
J648	16.72	J650	12.82	189.32	18.32	J650	11.07	187.57	17.48	17.47
J650	15.9	J650	2.82	180.21	11.37	J650	12	189.39	11.36	11.36
J654	16.72	J654	3.7	179.37	12.9	J654	12	187.66	12.9	12.9
J658	15	J658	6.57	182.57	11.4	J658	12	188	11.4	11.4
J686	30.44	J1128	17.57	195.15	61.61	J1128	10.12	187.7	54.44	54.44

ID	Total Demand (L/s)	Critical Node 1 ID	Critical Node 1 Pressure (m)	Critical Node 1 Head (m)	Available Flow @Hydrant (L/s)	Critical Node 2 ID	Critical Node 2 Pressure (m)	Critcal Node 2 Head (m)	Adjusted Available Flow (L/s)	Design Flow (L/s)
J692	15	J1200	18.51	211.41	105.27	J692	12	204.9	105.26	105.26
J694	15.82	J1200	18.52	196.02	76.49	J406	1.68	179.18	63.55	63.55
J708	15	J708	5.7	174.7	13.72	J708	12	181	13.72	13.72
J744	16.23	J744	17.62	200.89	26.32	J744	12	195.27	26.32	26.32
J748	17.45	J1200	18.69	204.4	56.61	J750	11.84	197.55	56.36	56.36
J766	15.82	J1200	18.69	205.45	44.94	J322	9.3	196.05	40.36	40.36
J770	16.23	J1200	18.69	207.69	36.02	J770	12	201	36.02	36.02
J788	15.82	J1200	18.68	214.4	73.31	J788	12	207.72	73.31	73.31
J796	16.63	J1200	18.55	210.53	122.96	J796	12	203.98	122.96	122.96
J798	18.58	J1200	18.65	208.93	55.71	J798	12	202.29	55.71	55.71
J800	15.25	J1200	18.54	215.5	103.04	J1214	9.66	206.62	93.31	93.31
J804	15.41	J1200	18.56	218.26	66.68	J804	12	211.7	66.68	66.68
J806	15.41	J1200	18.48	212.48	19.45	J806	12	206	19.45	19.45
J814	19.21	J1128	13.22	189.22	21.24	J1128	11.68	187.68	20.81	20.81
J844	15	J1128	11.41	187.62	14.93	J1128	11.47	187.68	14.34	14.34
J848	30.54	J848	-161.2	13.8	8.05	J848	12	187	8.04	8.04
J860	15.47	J860	14.29	200.22	16.23	J860	12	197.93	16.23	16.23
J900	15.41	J1200	18.5	208.79	31.01	J900	12	202.29	31	31
J930	16.94	J1200	18.79	201.39	55.11	J930	12	194.6	55.11	55.11
J934	15.41	J1200	18.69	192.7	39.92	J354	2.39	176.4	29.44	29.44
J952	16.23	J1200	18.79	200.38	63.75	J1096	8.56	190.14	52.93	52.93
J956	16.23	J1200	18.69	205.19	33.12	J956	12	198.5	33.12	33.12
JC230	15.24	JC244	7.89	234.45	15.89	JC244	6.79	233.35	12.58	12.58
JC234	15.24	JC244	-15.55	212.92	8.39	JC244	8.94	237.41	7.23	7.23
JC244	15.24	JC244	-27.78	203.71	6.22	JC244	12	243.49	6.22	6.22
JT16	15.74	JT16	-28.27	164.14	7.41	JT16	12	204.42	7.41	7.41
JT20	15.74	JT20	-13.01	180.99	9.1	JT20	12	206	9.1	9.1

ID	Total Demand (L/s)	Critical Node 1 ID	Critical Node 1 Pressure (m)	Critical Node 1 Head (m)	Available Flow @Hydrant (L/s)	Critical Node 2 ID	Critical Node 2 Pressure (m)	Critcal Node 2 Head (m)	Adjusted Available Flow (L/s)	Design Flow (L/s)
JT22	15.74	JT22	17.47	218	21.31	JT22	12	212.53	21.31	21.31
JT44	15.74	J1200	18.79	219.38	29.15	JT44	12	212.59	29.13	29.13
JT56	15.62	JT56	5.24	200.74	12.24	JT42	11.62	207.12	12.01	12.01
JT60	30.62	JT60	-156	33.18	7.85	JT30	9.66	198.83	7.2	7.2