
Technical Appendix 7 - Alternatives Evaluation

1 Appendix Introduction

This Technical Appendix is intended to summarize the Alternative Review and Evaluation Results. The identification and evaluation of each Cluster Area alternative falls under Phase 2 of the Class EA Master Plan process. The intent is to evaluate technically viable options to address the observed system deficiencies through a defined process to determine a preferred solution. When implemented, the preferred solutions will be combined to provide a robust water distribution system to service to the City of Waterloo to 2031.

2 Evaluation of Alternatives Process

System deficiencies were classified in two (2) distinct groups:

- “Clustered” areas of system deficiencies which may or may not be impacted by growth
- Existing localized and independent system deficiencies not impacted by growth

The “clustered” system deficiencies were consolidated into a number of cluster areas. These grouped deficiencies can be resolved through system improvements which impact integrated infrastructure components in each cluster area. **Technical Appendix #6** describes each cluster area, including a description of the identified deficiencies and potential solutions. In this Technical Memorandum, the potential solutions to address the deficiencies in each Cluster Area were evaluated.

The recommended solutions to address the Group 1 and Group 2 deficiencies were determined using the following approach:

- **Step 1:** Evaluation of improvement options for each Group 1 (cluster area deficiencies) based on technical, environmental, social/cultural, financial, and legal/jurisdictional criteria
- **Step 2:** Selection of preferred alternative for each Group 1 cluster area using the Reasoned Argument Approach (RAA)
- **Step 3:** Optimization of each cluster area through identification of related infrastructure improvements in the City’s existing infrastructure renewal program
- **Step 4:** Identification of localized upgrades required to address Group 2 deficiencies remaining not already addressed by recommendations to address the Group 1 cluster area deficiencies

2.1 Reasoned Argument Approach

Each alternative was evaluated through the reasoned argument approach which provided a clear and thorough rationale of the trade-offs among the various options based on the anticipated impacts caused by various evaluation criteria and factors. The basis of this approach is to qualitatively evaluate the relative advantages, disadvantages, and impacts of each alternative against the established criteria. This process highlights why the preferred alternative was chosen through evaluation of technical, environmental, social/cultural, financial, and legal/jurisdictional criteria which is detailed in **Technical Appendix #3**.

2.2 Development of Feasible Alternatives

The development of feasible alternatives to address the Group 1 cluster area deficiencies relied on both technical viability and the costs versus benefits of the alternatives.

Technical feasibility utilized the concept of the two types of deficiencies, Action and Flag. Action deficiencies, which do not meet MOECC levels of service, must be addressed through a system upgrade. Flag deficiencies, which are within the MOECC requirements but do not meet City desired levels of service, were evaluated on a case-by-case basis using cost-benefit analysis of addressing the deficiency.

The cost-benefit analysis for each alternative was evaluated in terms of a total cost, cost per improvement, and cost per weighted improvement:

- The total cost is the costs associated with the supply and installation of infrastructure, as well as operational changes
- The cost per improvement is total cost divided by the number of properties that experience an improvement to an action deficiency
- The cost per weighted improvement is the total cost divided by the number of properties that experience an improvement to an Action and/or Flag deficiency. The Action and Flag deficiencies are weighted appropriately as an improved Action deficiency is more important than a Flag deficiency.

The costing methodology is outlined in **Technical Appendix #9**.

2.3 Alternatives Screened for More Detailed Evaluation

Several alternatives in each cluster area were developed to address their deficiencies; however, only the alternatives which provided a technically viable solution were moved forward to the more robust evaluation process. Alternatives were screened out if any of following conditions were met:

- Alternative did not address the Action deficiency in the cluster area
- Alternative generated new system deficiencies when implemented
- Alternative required excessive costs to resolve the deficiencies

Figure 1 depicts the process described above.

Figure 1 – Determination of Viable Alternatives Methodology



3 Evaluation of Alternatives

The alternatives for each Cluster Area were fully evaluated using the RAA in order to determine the preferred solution. Full evaluation tables are located in **Appendix A**. It should be noted that only viable alternatives were subjected to the evaluation process.

3.1 Cluster Area A

Cluster Area A, located in Wat 6 along the border of Wat 5 and Wat 6, experiences high pressures between 90-100 psi and greater than 100 psi. **Figure 2** highlights the high pressures in Cluster Area A. Alternatives to address Area A are as follows:

3.1.1 Cluster Area A: Option 1 – Do Nothing

The “Do Nothing” option consists of maintaining the existing water system (no upgrades to the water system). This option does not address the pressure above 100 psi, which is an Action deficiency.

3.1.2 Cluster Area A: Option 2 – Pressure Zone Boundary Adjustment through Valving Only

Figure 3 presents the servicing solution Option 2. Pressure boundary adjustments will be made to service high pressure properties by means of Wat 5. This option recommends that the boundary adjustment be made through the opening and closing of valves only. This solution would result in the creation of new system dead ends; however, the resulting water quality impacts can be minimized through the installation of boundary valves at the new system dead ends.

Note: This option will require existing private pressure reducing valves to be removed from any services being transferred from Wat 6 to Wat 5.

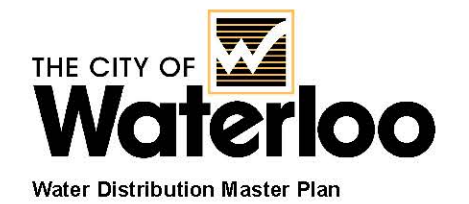
3.1.3 Cluster Area A: Option 3 – Pressure Zone Boundary Adjustment through Valving and Looping

Figure 4 presents the servicing solution Option 3. Pressure boundary adjustments will be made to service high pressure properties by means of Wat 5. This option recommends that the boundary adjustment be made through the opening and closing of valves and an additional 600 m of 200 mm watermain to minimize the creation of new system dead ends. Further, the new watermain reduces the criticality of the existing Fischer-Hallman 400 mm Wat 5 watermain through looping and the additional of a secondary supply to the area.

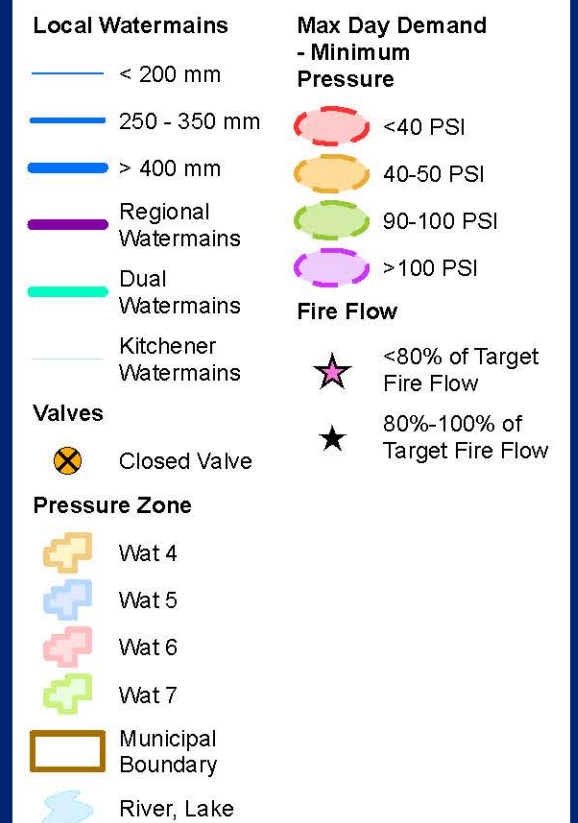
New 200 mm PVC watermain would be installed to twin the existing watermain along the following roads:

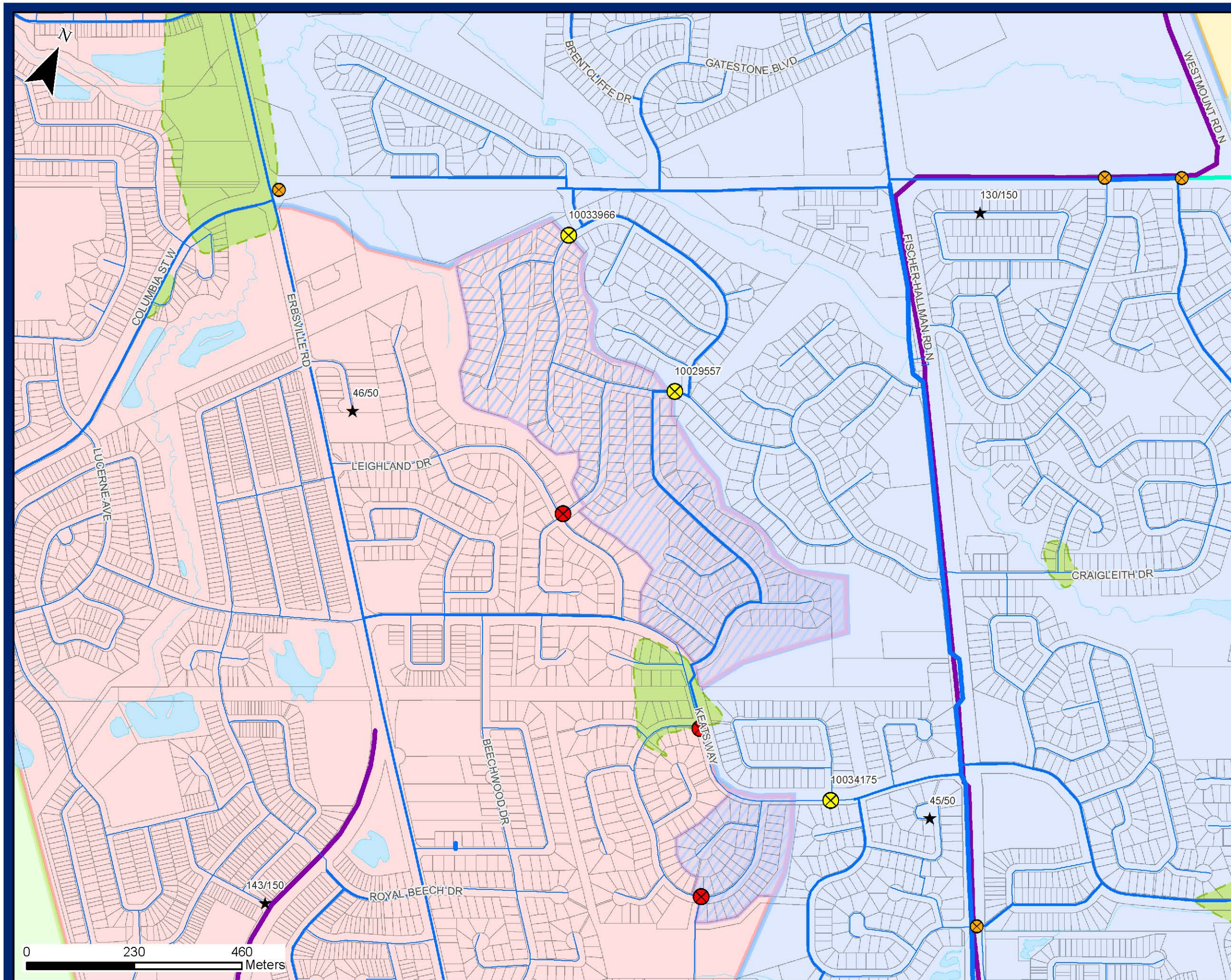
- Keats Way
- Leighland Drive
- Easement from Sandford Fleming Drive to Beechwood Drive

Note: This option will require existing private pressure reducing valves to be removed from any services being transferred from Wat 6 to Wat 5.

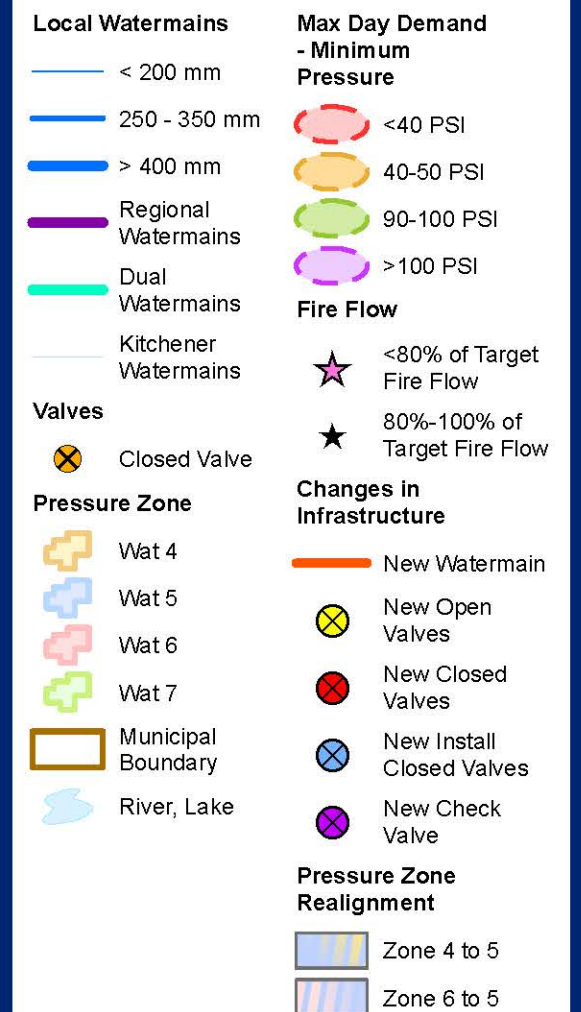


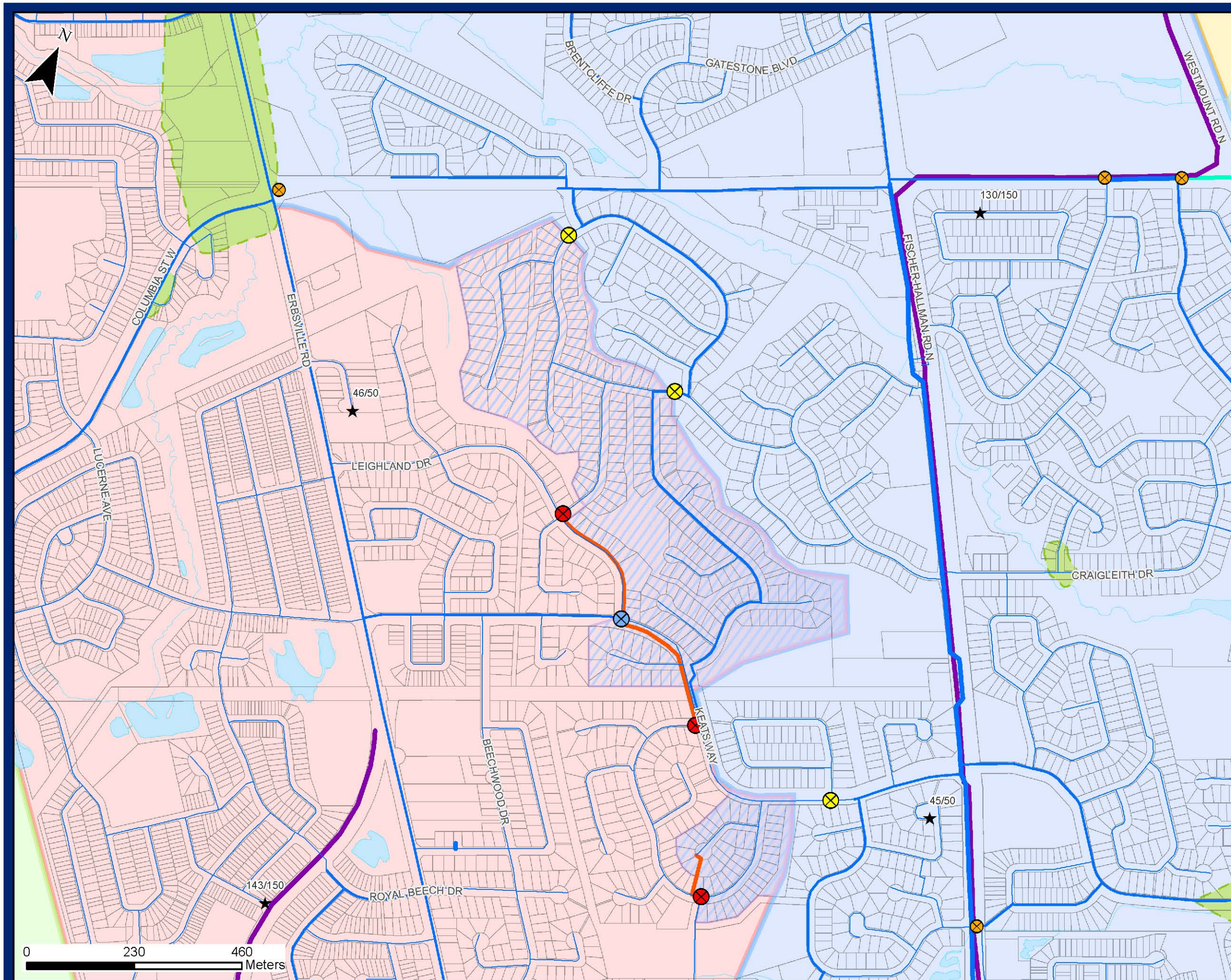
**Figure 2 - Water System Upgrade
Alternative Cluster Area A -
Baseline**



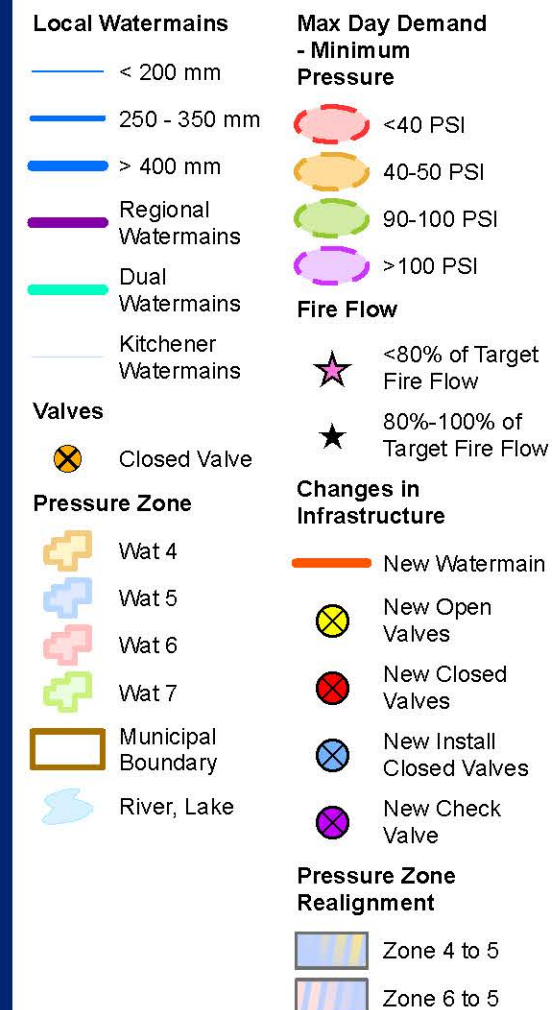


**Figure 3 - Water System Upgrade
Alternative Cluster Area A -
Option 2**





**Figure 4 - Water System Upgrade
Alternative Cluster Area A -
Option 3**



3.1.4 Cluster Area A: Evaluation

The evaluation process is summarized in **Table 1** and further detailed in **Appendix A**.

Table 1 - Cluster Area A - Evaluation

Criteria	Option 1 Do Nothing	Option 2 Valving Only	Option 3 Valving and Looping
Technical Viability	No work required	Generally easy	Generally easy
Meets Pressure Objectives	No	Yes	Yes
Meets Fire Flow Objectives	Yes	Yes	Yes
Operation and Maintenance	Dead end flushing required	Boundary valves eliminate need for dead end flushing	Addition of 1 km of watermain to O&M
Impact to Criticality	No change	No change	Reduced existing system criticality
Property Impacts	None	Impact to privately serviced pressure reducing valves	Impact to privately serviced pressure reducing valves
Traffic Impacts	None	Minimal	Moderate
Capital Costs	\$0	\$0.08 million	\$0.9 million
Cost per Improvement	\$0	\$800/weighted improvement	\$9,000/weighted improvement
Evaluation	Does not meet Flag or Action pressure requirements	Deficiencies addressed at a relatively low cost	High costs associated with the installation and maintenance of looped watermain

3.1.5 Cluster Area A: Recommended Solution

The recommended solution for the deficiencies in Cluster Area A was **Option 2: Pressure Zone Boundary Adjustment through Valving Only**, which presented the lowest cost alternative to address the identified Action items. While this solution creates new system dead-ends; the associated water quality issues generated by the new dead ends can be mitigated through the installation of boundary valves. **Figure 5** and **Figure 6** show the location of valving required to move the zone boundary.

A summary of the recommended works are as follows:

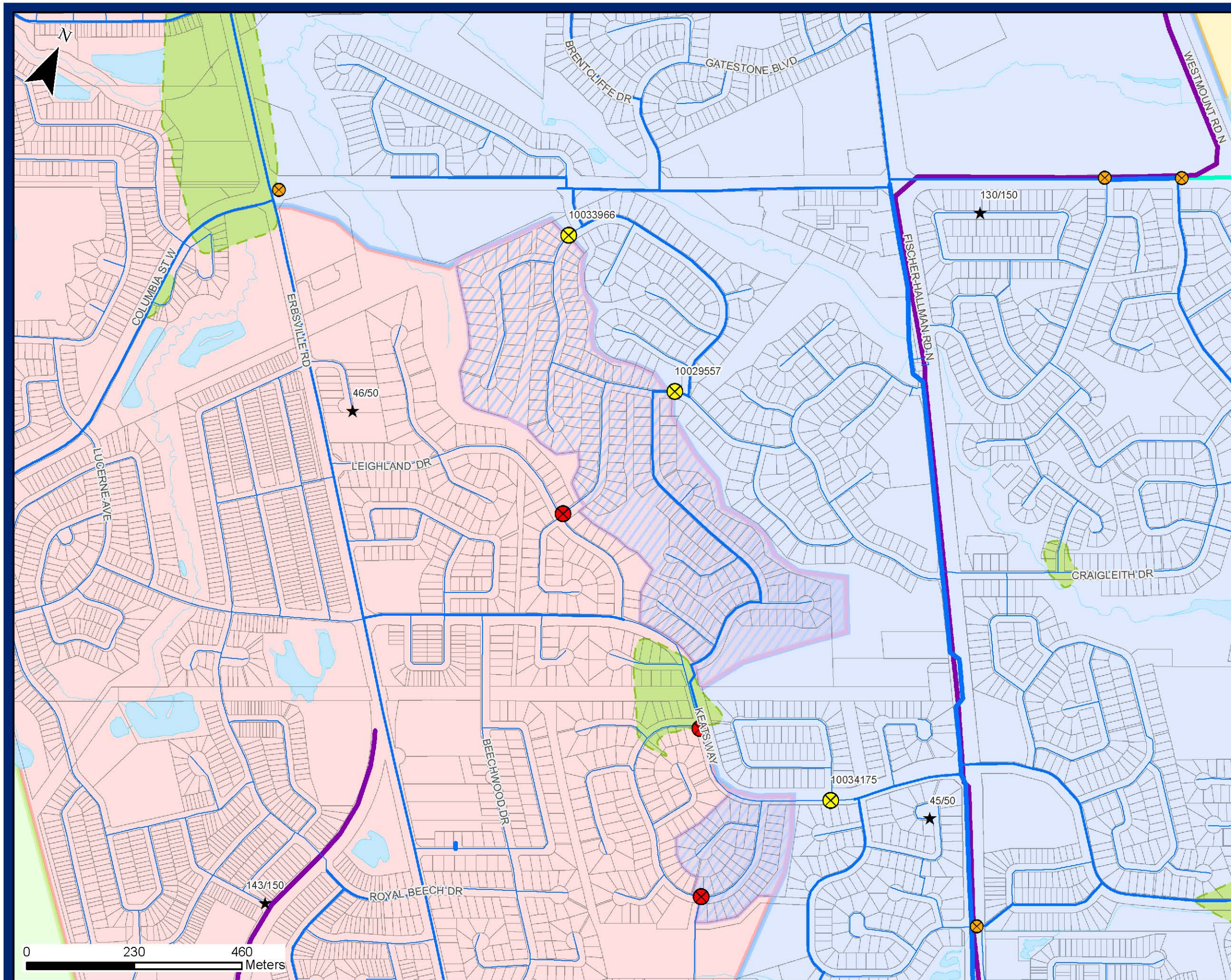
- Open valves
 - 10033966
 - 10029557
 - 10034175
- Close valves
 - 10030626 (optional as a boundary valve)
 - 10035396
 - 10032238 (optional as a boundary valve)

3.1.6 Cluster Area A: Costing

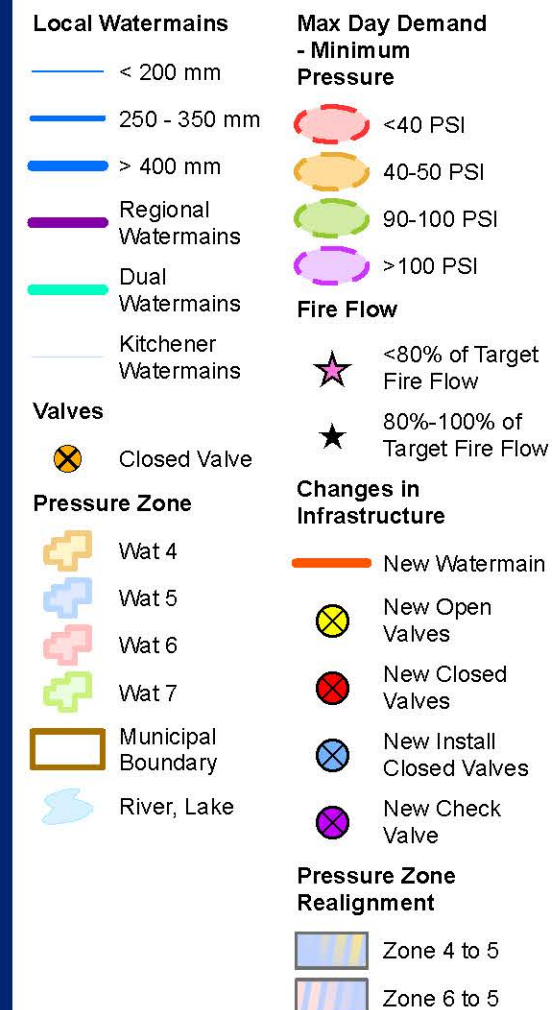
The costs associated with the Cluster A recommended solution are summarized in **Table 2** totalling \$73,000.

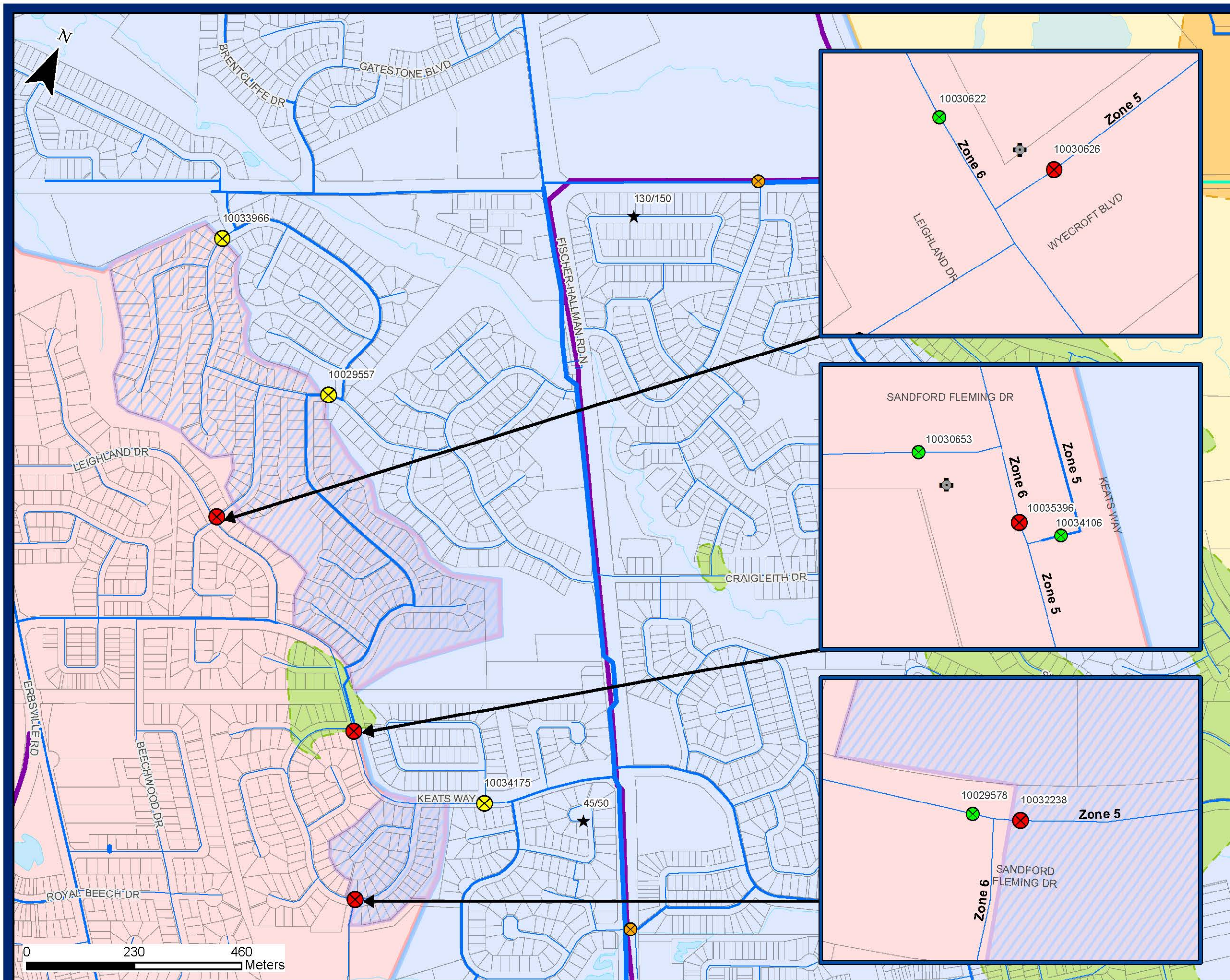
Table 2 - Cluster Area A – Recommended Solution Costing

		Install New Boundary Valve	Close Existing Isolation Valve	Open Existing Isolation Valve
	Number of Units	2	1	3
Base Construction Costs	Base Cost	\$40,000	\$500	\$1,500
	Uplift Cost	\$8,000	\$100	\$300
	Total Base Cost	\$48,000	\$600	\$1,800
Total Construction Costs	Engineering and Design Cost	\$9,600	\$120	\$360
	Contingency Cost	\$11,520	\$144	\$432
	Total Cost	\$69,120	\$864	\$2,592

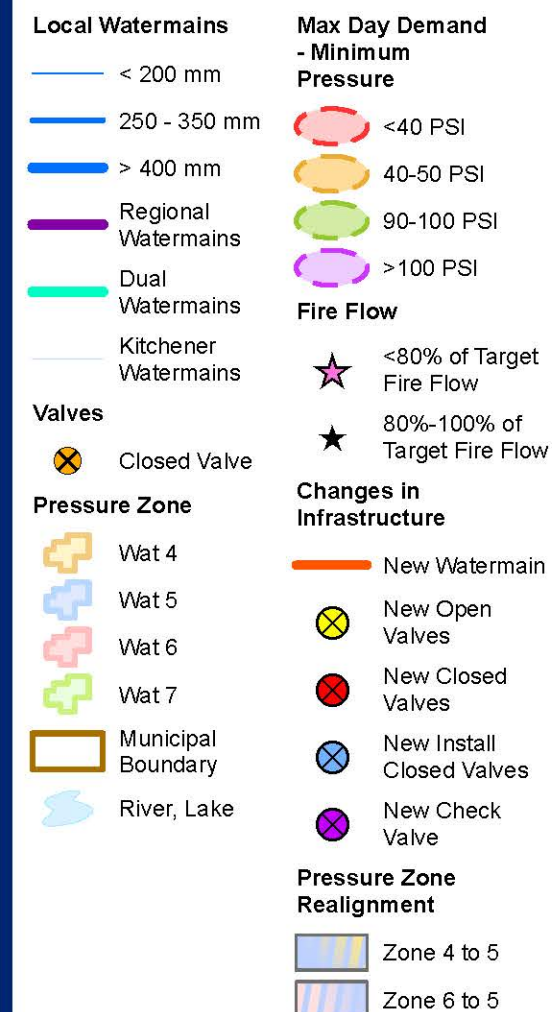


**Figure 5 - Water System Upgrade
Alternative Cluster Area A -
Preferred Alternative**





**Figure 6 - Water System Upgrade
Alternative Cluster Area A -
Preferred Alternative (valving)**



3.2 Cluster Area B

Cluster Area B, located in Wat 5 along the border of Wat 5 and Wat 6, experiences low pressures between 40-50 psi. **Figure 7** highlights the high pressures in Cluster Area B. Alternatives to address Area B are as follows:

3.2.1 Cluster Area B: Option 1 – Do Nothing

The “Do Nothing” option consists of maintain the existing water system (no upgrades to the water system). This option does not address pressure below 40-50 psi, which is a Flag deficiency.

3.2.2 Cluster Area B: Option 2 – Pressure Zone Boundary Adjustment through Valving Only

Figure 8 presents the servicing solution Option 2. Pressure boundary adjustments will be made to service low pressure properties through Wat 5. This option recommends that the boundary adjustment be made through the opening and closing of valves only. This solution would result in the creation of new system dead ends; however, the resulting water quality impacts can be minimize through the installation of boundary valves at the new system dead ends.

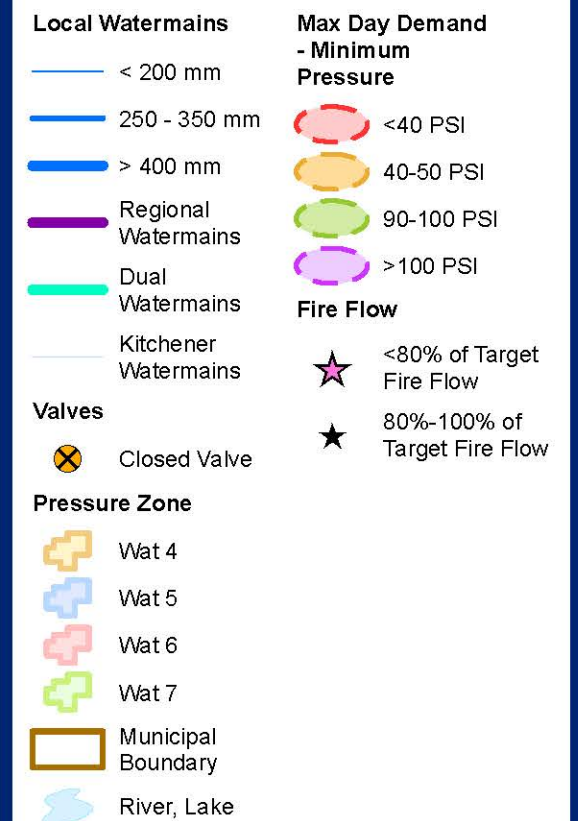
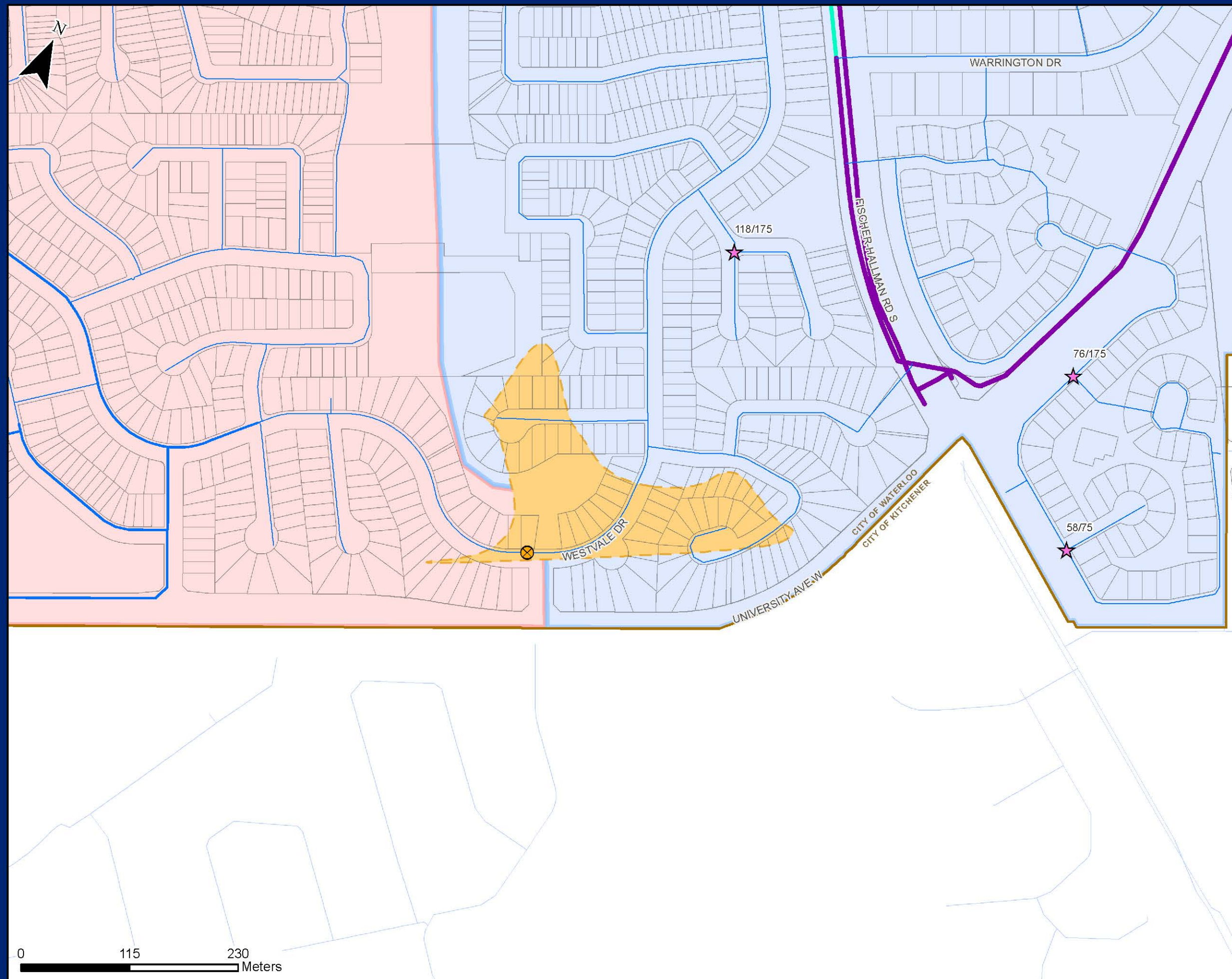
3.2.3 Cluster Area B: Option 3 – Pressure Zone Boundary Adjustment through Valving and Looping

Figure 9 presents the servicing solution Option 3. Pressure boundary adjustments will be made to service low pressure properties through Wat 5. This option recommends that the boundary adjustment be made through the opening and closing of valves and an additional 170 m of watermain to minimize the creation of new system dead ends.

New 150 mm PVC watermains would be installed to twin the watermain along the following road:

- Herron Place

**Figure 7 - Water System Upgrade
 Alternative Cluster Area B -
 Baseline**



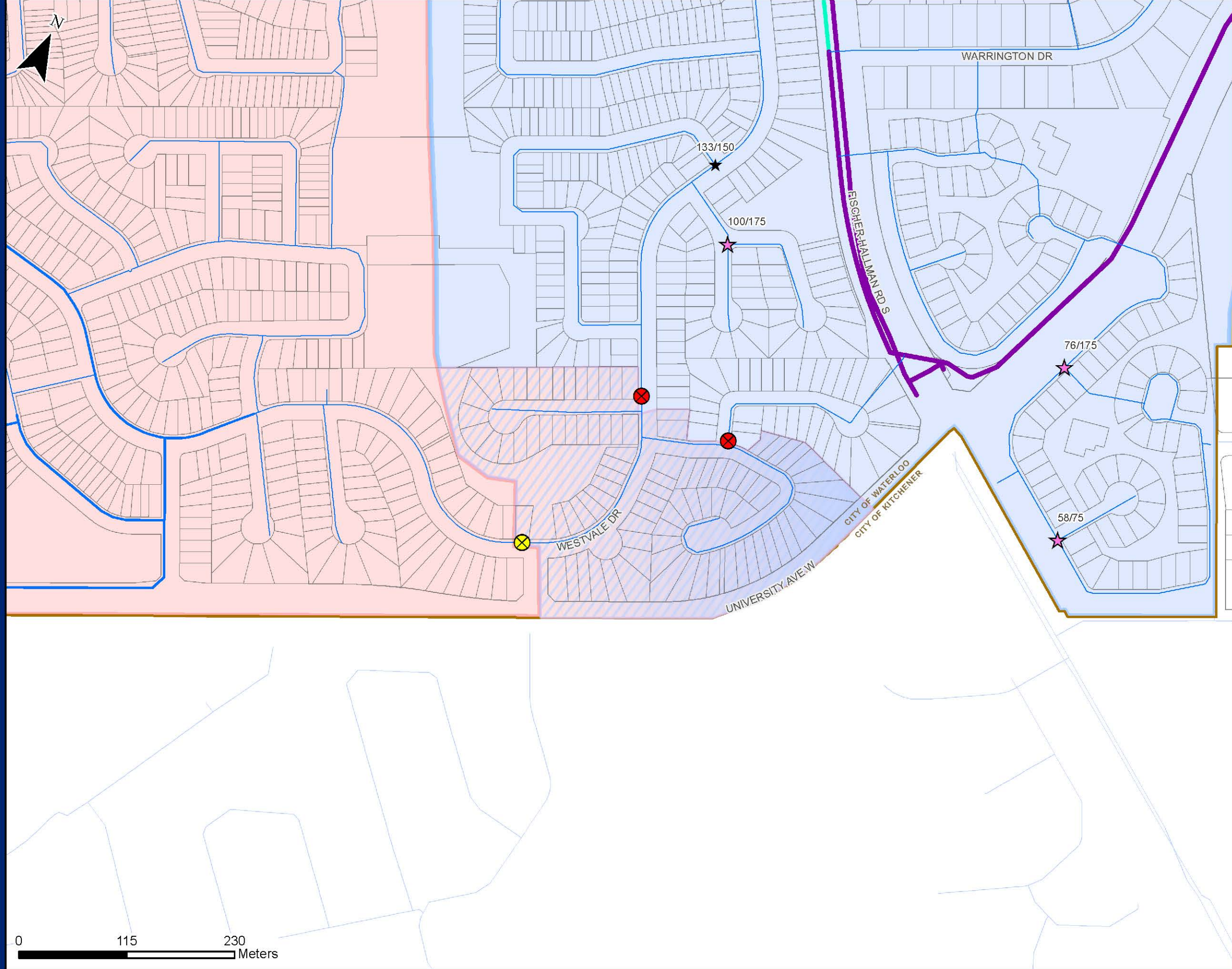


Figure 8 - Water System Upgrade
Alternative Cluster Area B -
Option 2

Local Watermains

- < 200 mm
- 250 - 350 mm
- > 400 mm
- Regional Watermains
- Dual Watermains
- Kitchener Watermains

Max Day Demand - Minimum Pressure

- < 40 PSI
- 40-50 PSI
- 90-100 PSI
- > 100 PSI

Fire Flow

- < 80% of Target Fire Flow
- 80%-100% of Target Fire Flow

Valves

- Closed Valve

Pressure Zone

- Wat 4
- Wat 5
- Wat 6
- Wat 7
- Municipal Boundary
- River, Lake

Changes in Infrastructure

- New Watermain
- New Open Valves
- New Closed Valves
- New Install Closed Valves
- New Check Valve

Pressure Zone Realignment

- Zone 4 to 5
- Zone 6 to 5

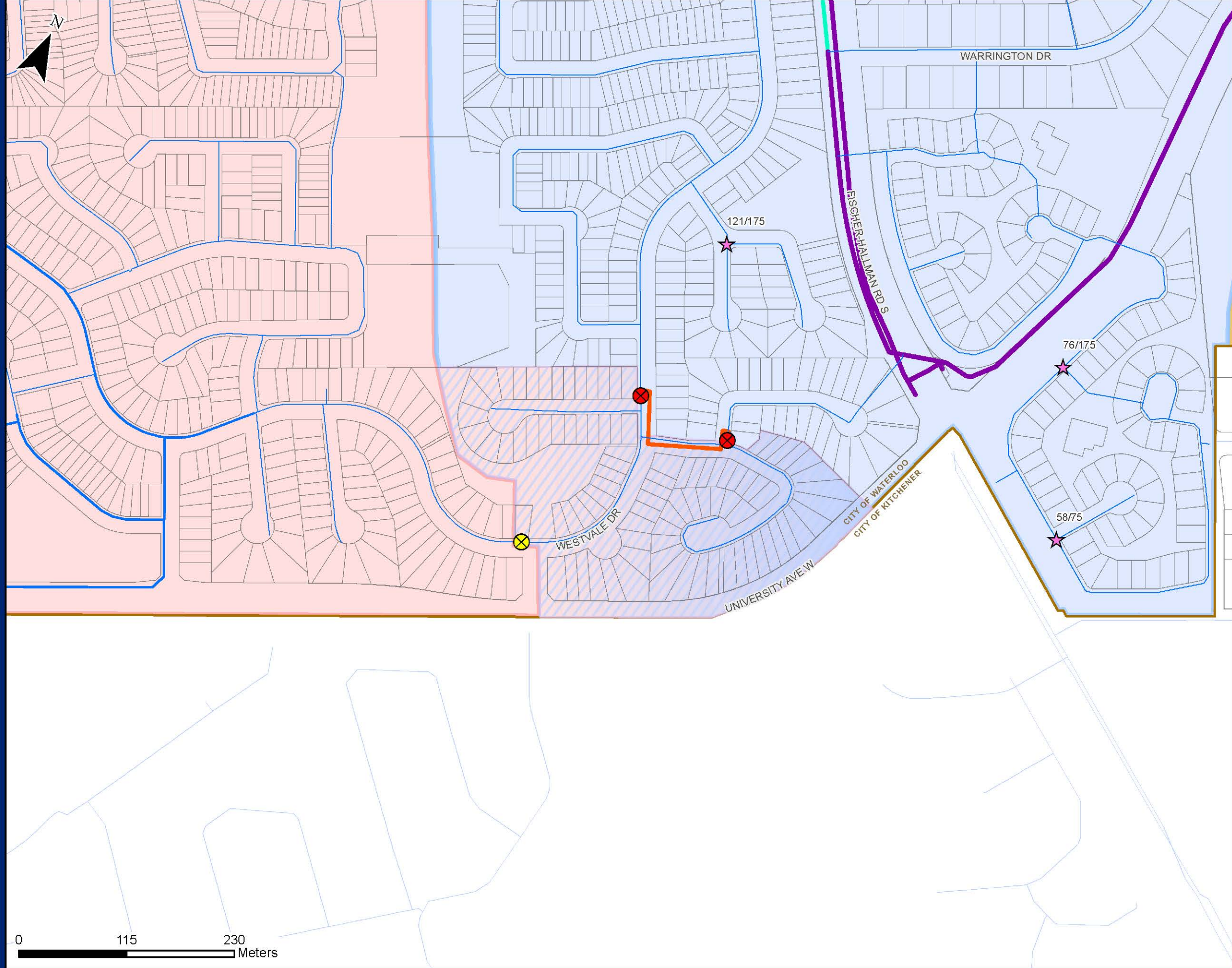


Figure 9 - Water System Upgrade
Alternative Cluster Area B -
Option 3

Local Watermains

- < 200 mm
- 250 - 350 mm
- > 400 mm
- Regional Watermains
- Dual Watermains
- Kitchener Watermains

Max Day Demand - Minimum Pressure

- <40 PSI
- 40-50 PSI
- 90-100 PSI
- >100 PSI

Valves

- Closed Valve

Pressure Zone

- Wat 4
- Wat 5
- Wat 6
- Wat 7
- Municipal Boundary
- River, Lake

Changes in Infrastructure

- New Watermain
- New Open Valves
- New Closed Valves
- New Install Closed Valves
- New Check Valve

Pressure Zone Realignment

- Zone 4 to 5
- Zone 6 to 5

3.2.4 Cluster Area B: Evaluation

The evaluation process is summarized in **Table 3** and further detailed in **Appendix A**.

Table 3 - Cluster Area B Evaluation

Criteria	Option 1 Do Nothing	Option 2 Valving Only	Option 3 Valving and Looping
Technical Viability	No work required	Generally easy	Generally easy
Meets Pressure Objectives	Regulatory only	Yes	Yes
Meets Fire Flow Objectives	Yes	Regulatory only	Yes
Operation and Maintenance	Dead end flushing required	Boundary valves eliminate need for dead end flushing	Addition of 150 m of WM to O&M
Impact to Criticality	No change	No change	No change
Property Impacts	None	None	None
Traffic Impacts	None	Minimal	Moderate
Capital Costs	\$0	\$0.06 million	\$0.15 million
Cost per Improvement	\$0	\$8000/weighted improvement	\$12,000/weighted improvement
Evaluation	Flag deficiencies do not justify excessive costs	High costs associated with system modifications	High costs associated with system modifications

3.2.5 Cluster Area B: Recommended Solution

The recommended solution for the deficiencies in Cluster Area B was ***Option 1 – Do Nothing***, which will not require any works as shown in **Figure 10**. The identified deficiencies are Flag deficiencies, which would only be resolved if financially feasible. Based on the alternatives evaluation the monetary costs of addressing the “Flag” deficiencies exceeds the benefit provided.

3.2.6 Cluster Area B: Costing

No works are recommended.

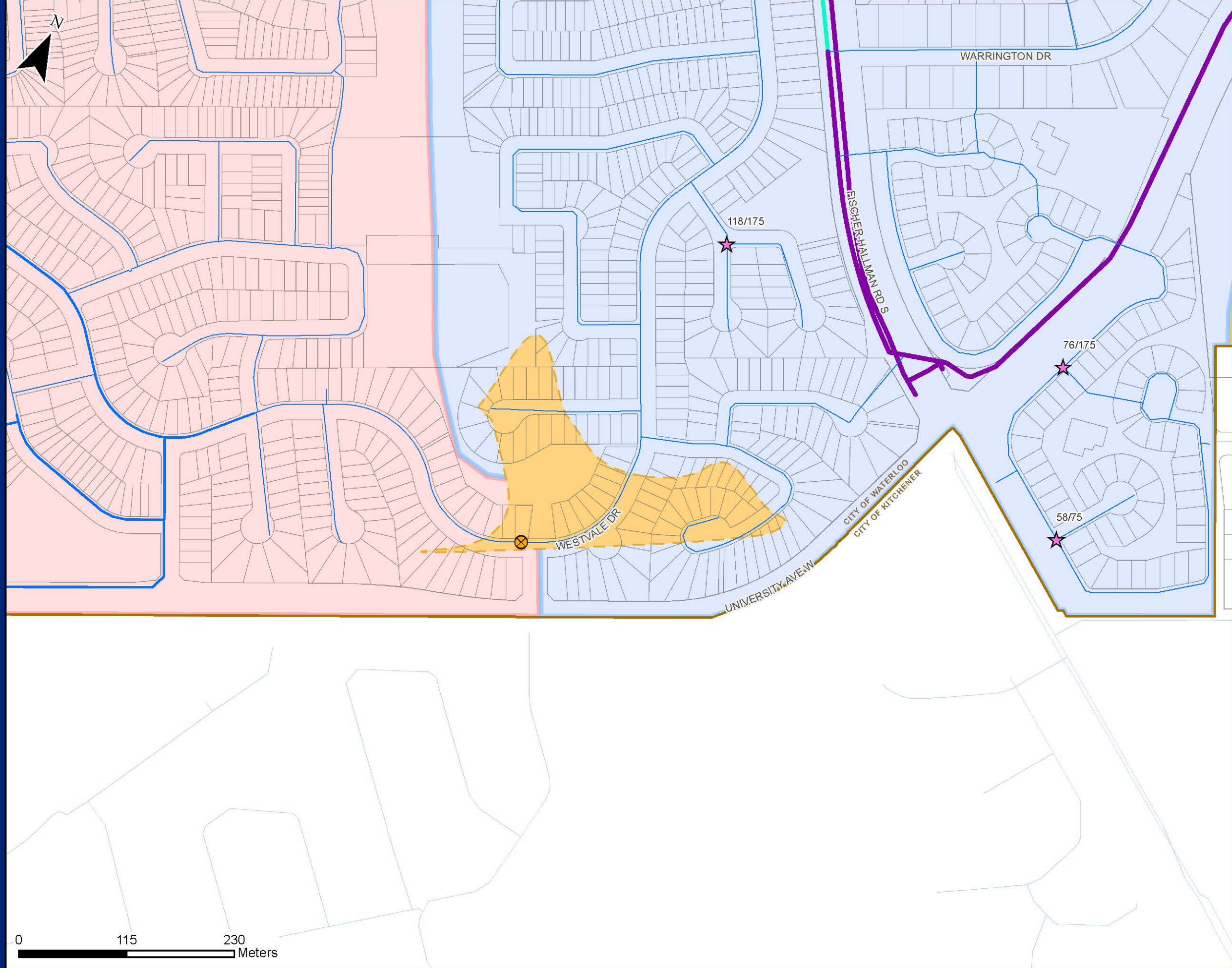


Figure 10 - Water System Upgrade
Alternative Cluster Area B -
Preferred Alternative

Local Watermains

- < 200 mm
- 250 - 350 mm
- > 400 mm
- Regional Watermains
- Dual Watermains
- Kitchener Watermains

Max Day Demand - Minimum Pressure

- < 40 PSI
- 40-50 PSI
- 90-100 PSI
- > 100 PSI

Valves

- Closed Valve

Pressure Zone

- Wat 4
- Wat 5
- Wat 6
- Wat 7
- Municipal Boundary
- River, Lake

Fire Flow

- < 80% of Target Fire Flow
- 80%-100% of Target Fire Flow

Changes in Infrastructure

- New Watermain
- New Open Valves
- New Closed Valves
- New Install Closed Valves
- New Check Valve

Pressure Zone Realignment

- Zone 4 to 5
- Zone 6 to 5

3.3 Cluster Area C

Cluster Area C, located in Wat 4 along the border of Wat 4 and Wat5, experiences low pressures between 40-50 psi and less than 40 psi. **Figure 11** highlights the high pressures in Cluster Area C. Alternatives to address Area C are as follows:

3.3.1 Cluster Area C: Option 1 – Do Nothing

The “Do Nothing” option consists of maintaining the existing water system (no upgrades to the water system). This option does not address pressure below 40 psi, which is an Action deficiency.

3.3.2 Cluster Area C: Option 2 – Pressure Zone Boundary Adjustment to Westmount Road

Figure 12 presents the servicing solution Option 2. Pressure boundary adjustments will be made to service low pressure properties through Wat 5. The new Wat 5 will generally extend to Westmount Road South. This option recommends that the boundary adjustment be made through the opening and closing of valves and an additional 660 m of 300 mm watermain be installed along Westmount Road South to maintain adequate fire flow levels and water quality along the new zone boundary.

Further, new 300 mm PVC watermains, needed to minimize the creation of new dead ends, would be installed to twin the watermain along the following roads:

- Westmount Road South

3.3.3 Cluster Area C: Option 3 – Pressure Zone Boundary Adjustment to Roslin Avenue South

Figure 13 presents the servicing solution Option 3. Pressure boundary adjustments will be made to service low pressure properties through Wat 5. The New Wat 5 will generally extend to Dawson St and Roslin Avenue South. This option recommends that the boundary adjustment be made through the opening and closing of valves and an additional 350 m of 150 mm watermain be installed to maintain adequate fire flow levels and water quality.

New 150 mm PVC watermains would be installed to twin the watermain along the following roads:

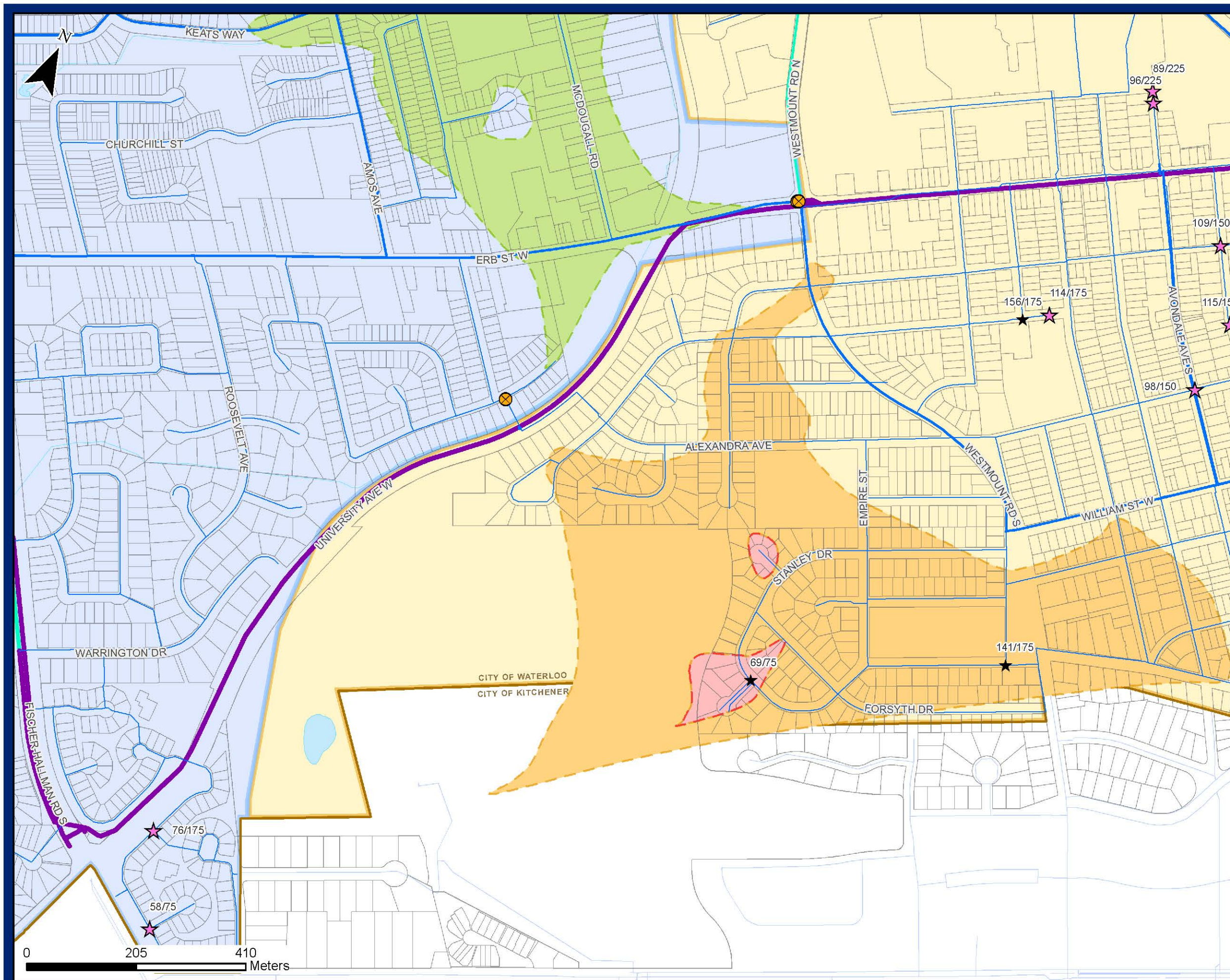
- Westmount Road South
- Dietz Avenue North
- Lourdes Street

3.3.4 Cluster Area C: Option 4 – Pressure Zone Boundary Adjustment to Avondale Avenue South

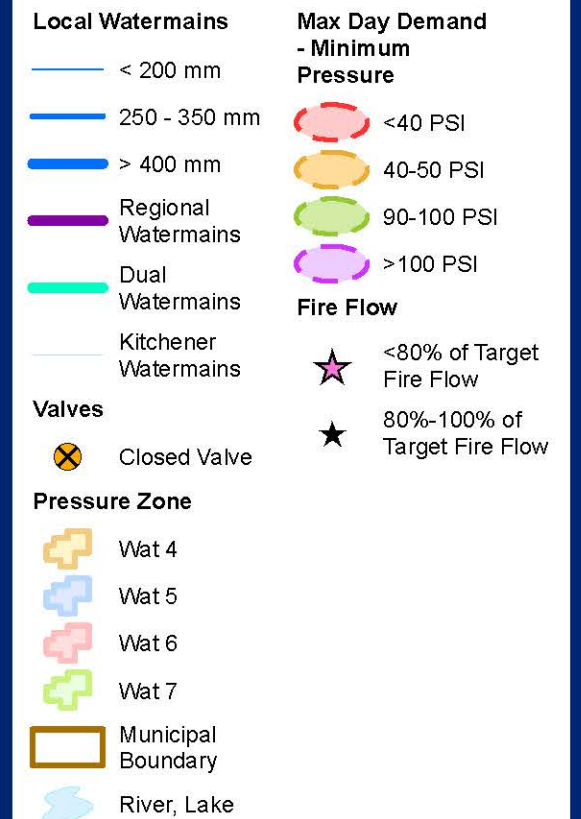
Figure 14 presents the servicing solution Option 4. Pressure boundary adjustments will be made to service low pressure properties through Wat 5. The new Wat 5 will generally extend to Dawson St and Avondale Avenue South. This option recommends that the boundary adjustment be made through the opening and closing of valves and an additional 350 m of 150 mm watermain maintain adequate fire flow levels and water quality.

New 150 mm PVC watermains would be installed to twin the watermain along the following roads:

- Westmount Road South
- Dietz Avenue North
- Lourdes Street



**Figure 11 - Water System Upgrade
 Alternative Cluster Area C -
 Baseline**



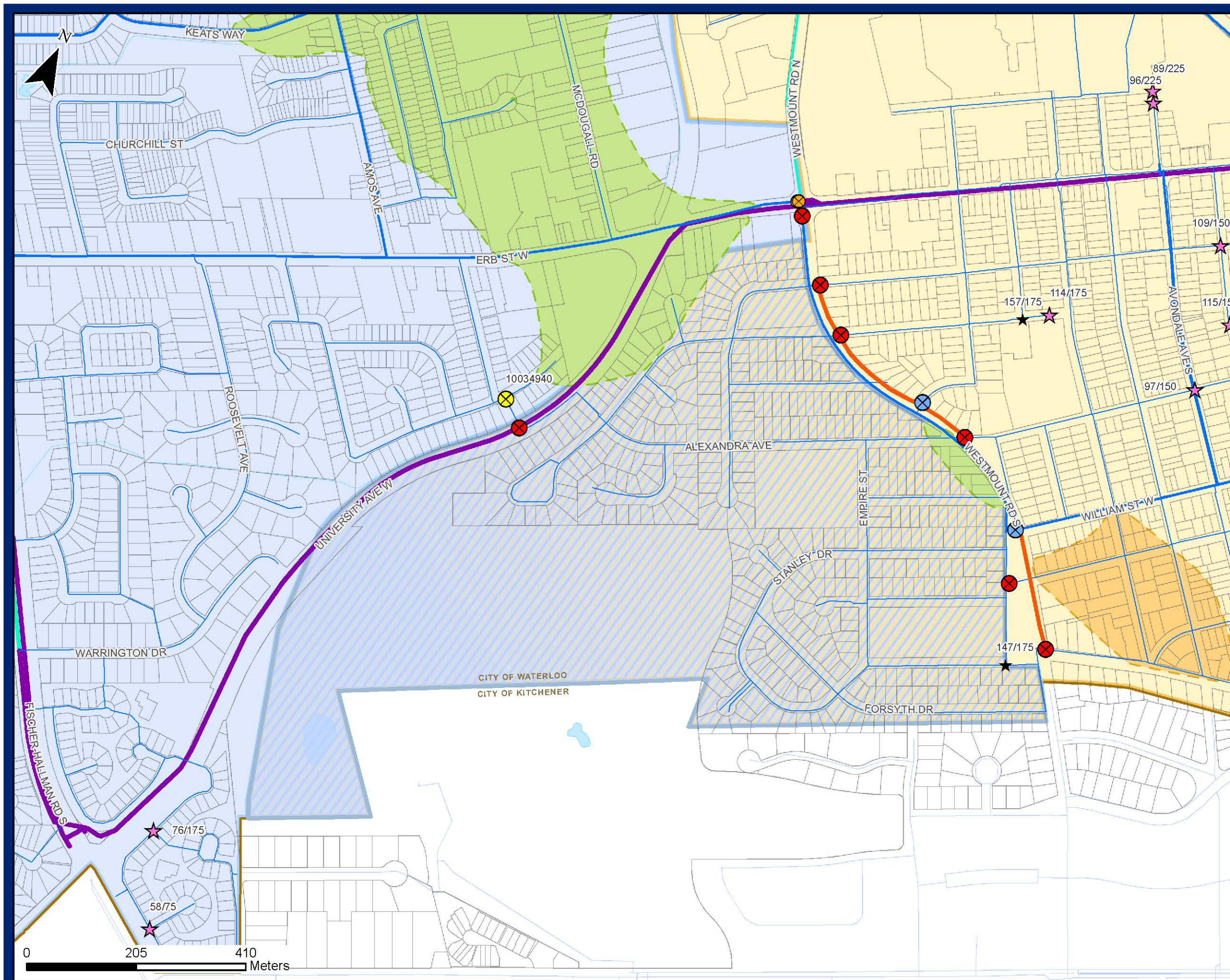
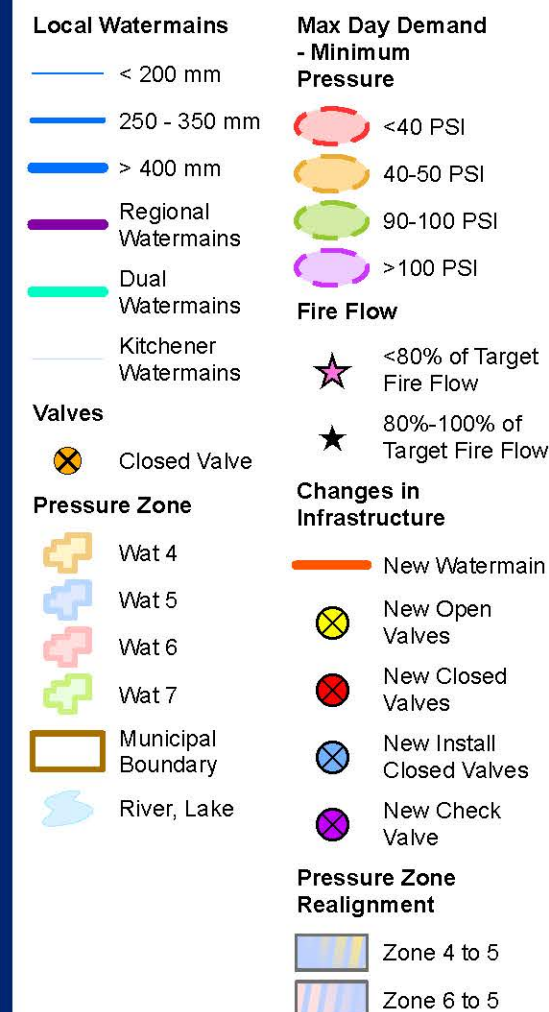


Figure 12 - Water System Upgrade
Alternative Cluster Area C -
Option 2



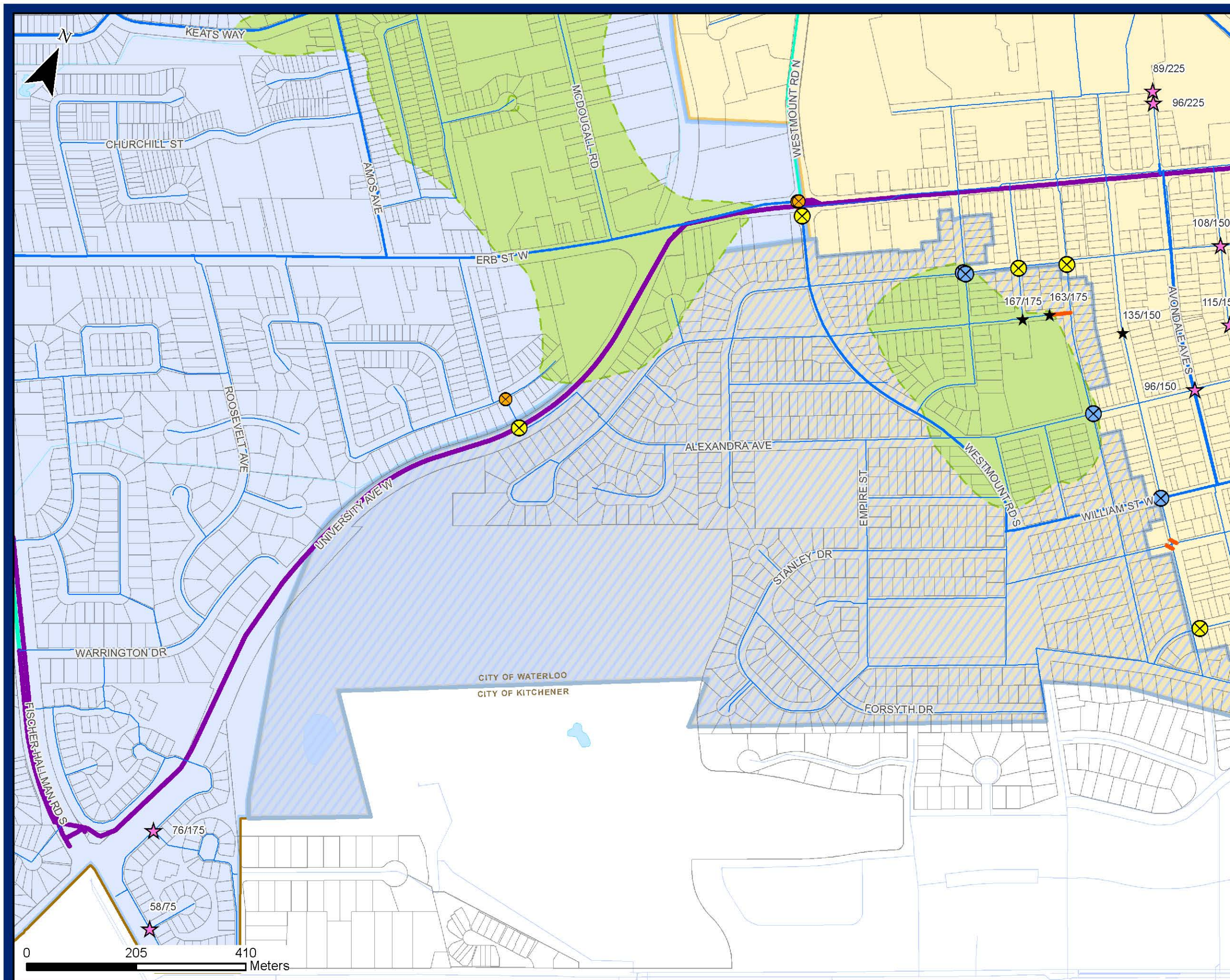
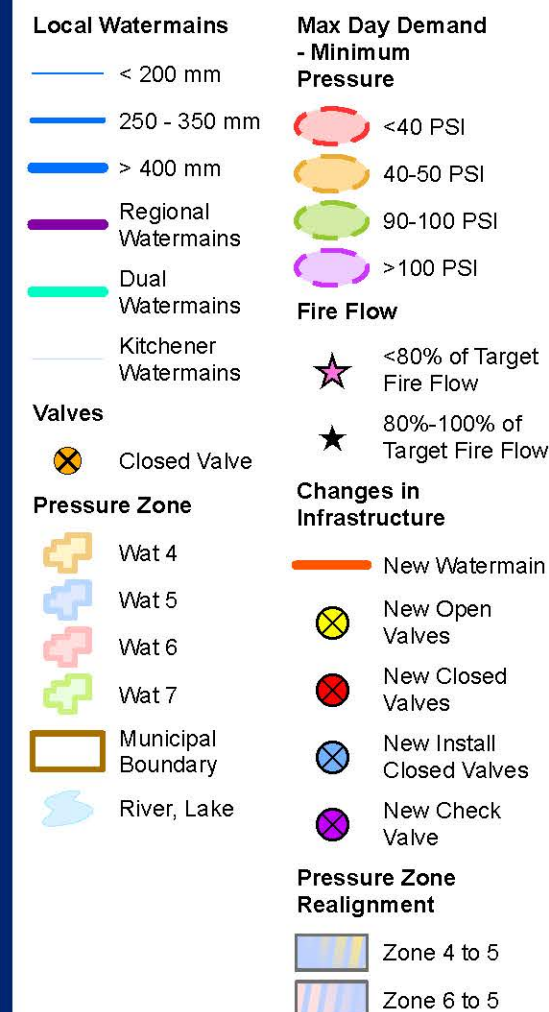
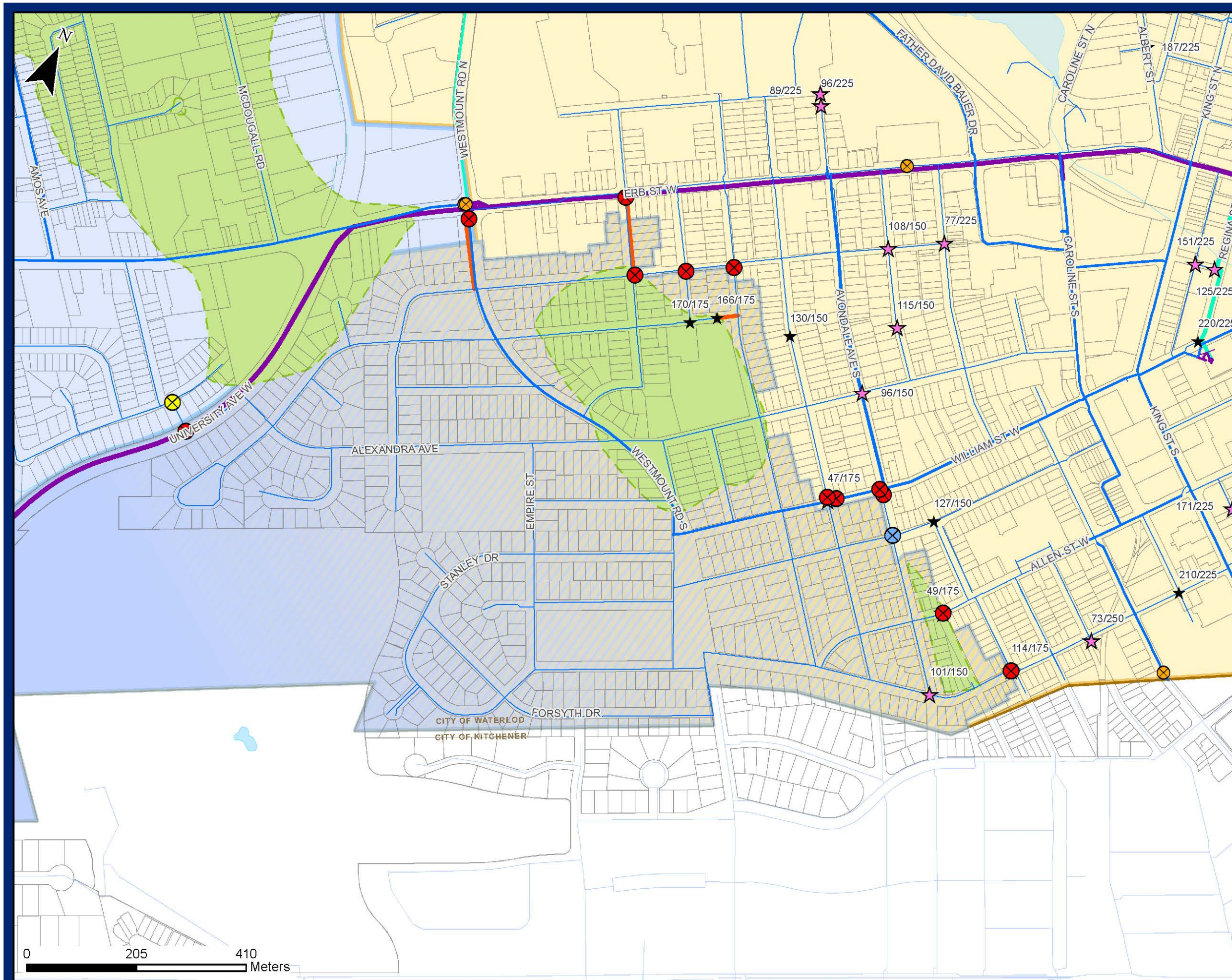
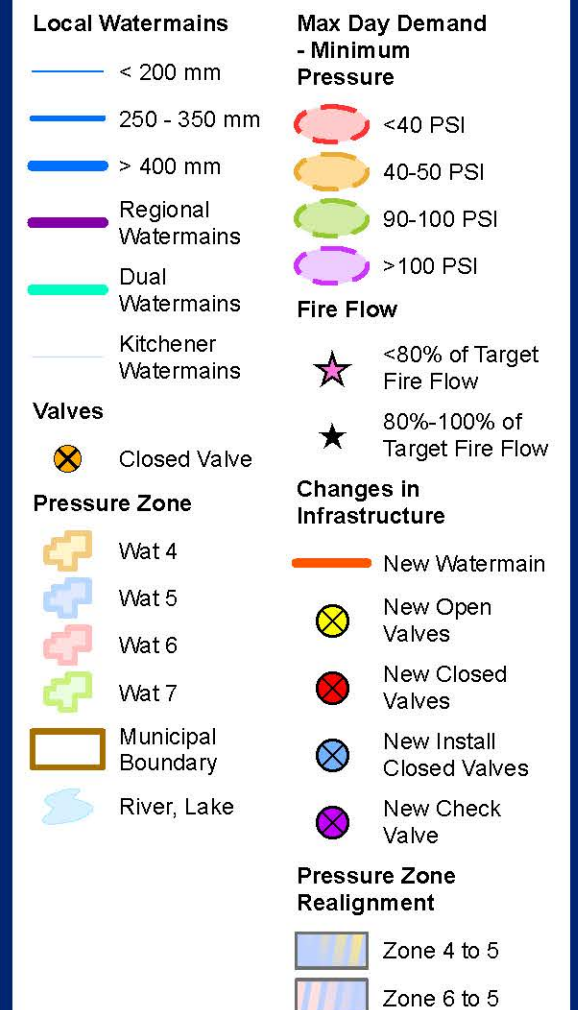


Figure 13 - Water System Upgrade
Alternative Cluster Area C -
Option 3





**Figure 14 - Water System Upgrade
Alternative Cluster Area C -
Option 4**



3.3.5 Cluster Area C: Evaluation

The evaluation process is summarized in **Table 4** and further detailed in **Appendix A**.

Table 4 - Cluster Area C - Evaluation

Criteria	Option 1 Do Nothing	Option 2 Boundary Adjustment to Westmount	Option 3 Boundary Adjustment to Roslin	Option 4 Boundary Adjustment to Avondale
Technical Viability	No work required	Generally easy	Generally easy	Generally easy
Meets Pressure Objectives	No	Yes	Regulatory only	Regulatory only
Meets Fire Flow Objectives	No	Improved (Addressed through SOGR program)	Improved (Addressed through SOGR program)	Improved (Addressed through SOGR program)
Operation and Maintenance	Dead end flushing required	Addition of 660 m of WM to O&M	Addition of 500 m of WM to O&M	Addition of 500 m of WM to O&M
Impact to Criticality	No change	No change	No change	No change
Property Impacts	None	None	None	None
Traffic Impacts	None	Major	Moderate	Moderate
Capital Costs	\$0	\$0.8 million	\$0.7 million	\$0.7 million
Cost per Improvement	\$0	\$8000/weighted improvement	\$8000/weighted improvement	13,000/weighted improvement
Evaluation	Does not meet Action pressure or fire flow requirements	Planned road reconstruction and stormwater works on Westmount Road minimizes traffic impacts and costs	Creates additional pockets of high pressure	Creates additional pockets of high pressure and has high costs associated with system modifications

3.3.6 Cluster Area C: Preferred Solution

The recommended solution for the deficiencies in Cluster Area C was **Option 2 – Pressure Zone Boundary Adjustment to Westmount Drive**. Option 2 provided the best cost per improvement of all options. Further, both Options 3 and 4 substantially increased the total area transferred to Wat 5, and would result in a number of new areas within the New Wat 5 to have “Flag” deficiencies with pressure greater than 90 psi, where previously they were meeting the City’s pressure objectives.

Option 2 will experience more significant property and traffic impacts during construction as the watermain works are located within an arterial road - Westmount Drive; however, these impacts can be mitigated through the coordination of the watermain works with previously planned road and stormwater projects along the same alignment. The City should coordinate with the Region for these timings.

Figure 16, Figure 17, and Figure 18 show the location of valving and watermains required to move the Zone boundary. A summary of the recommended works are as follows:

Open valves

- 10034940
- Close valves
 - 10028998
 - 10033828
 - 10032664
 - 10036652
 - 10030362
 - 10036598
- Install new valves
 - On Dietz Avenue South at Westmount Road South
 - On William Street West at Westmount Road South
- New Watermains
 - Twin 30 m at Erb Street West and Westmount Road South for valve isolation
 - Twin 400 m on Westmount Road South from Dawson Street to Alexandra Avenue
 - Twin 230 m on Westmount Road South from William Street West to John Street West

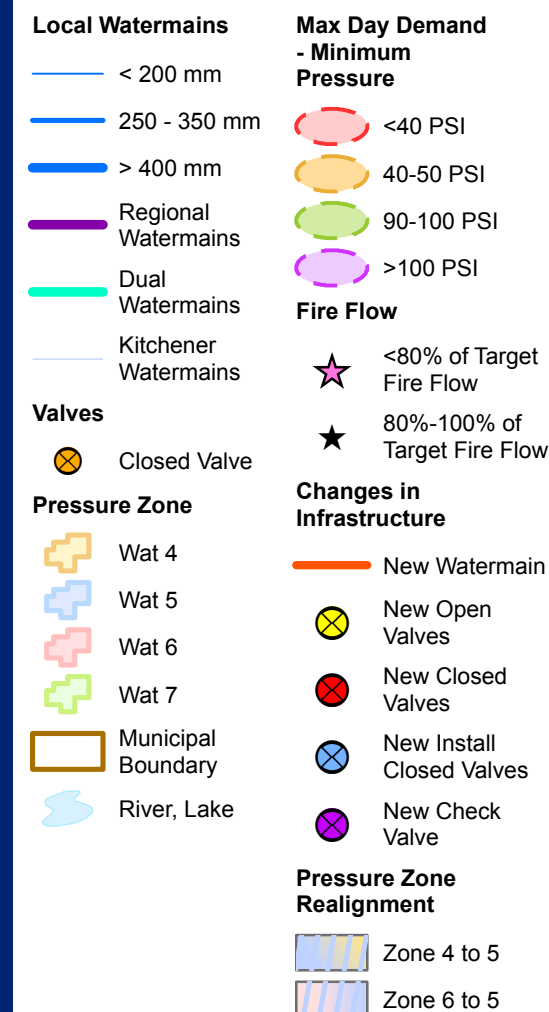
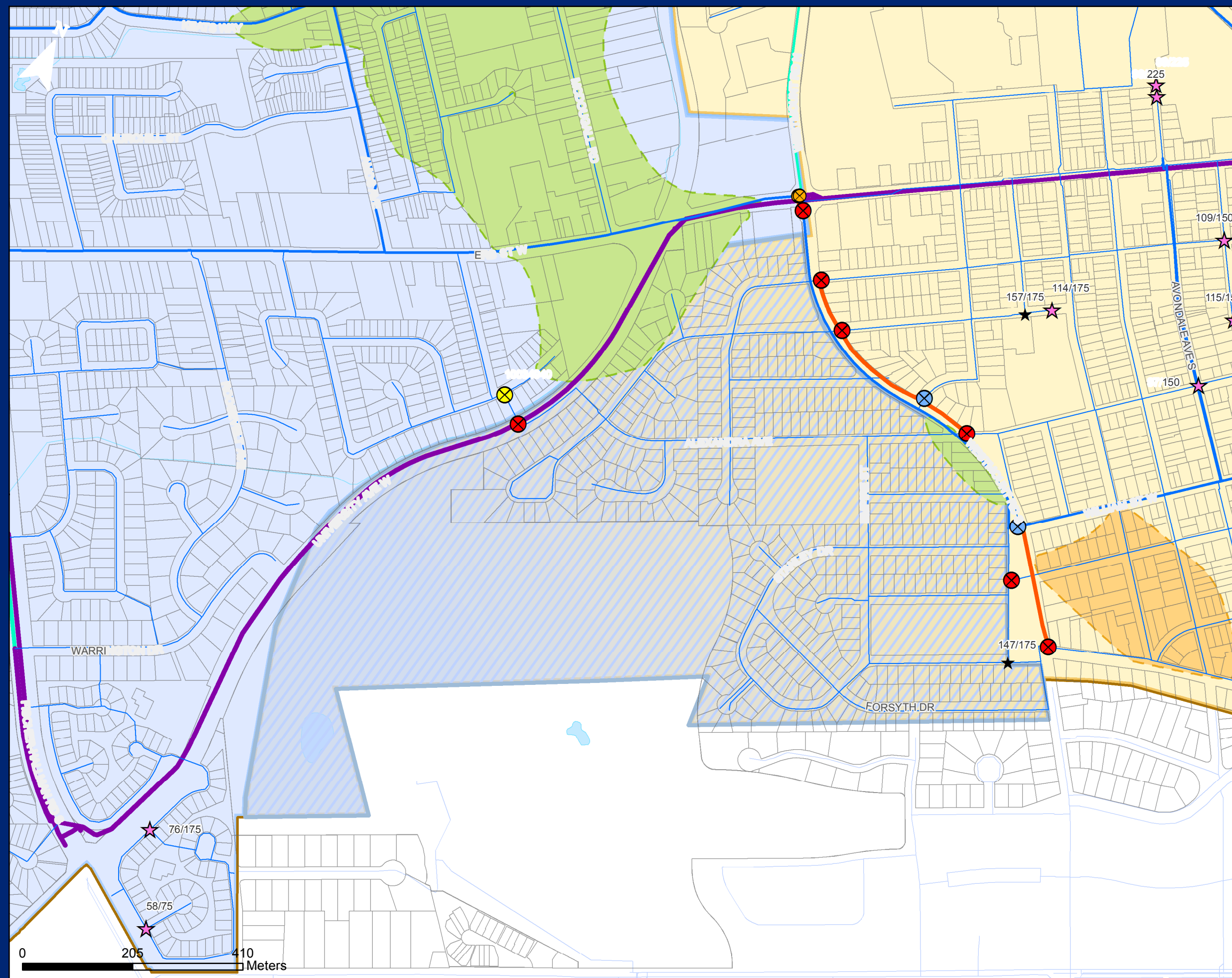
3.3.7 Cluster Area C: Costing

The costs associated the recommended solution for Area C are summarized in **Table 5** totalling \$783,000.

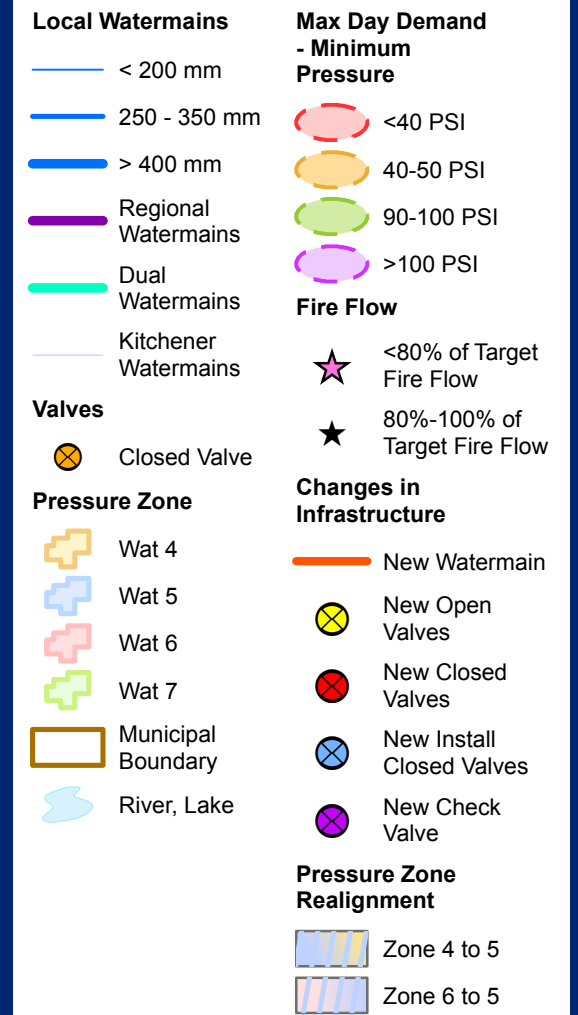
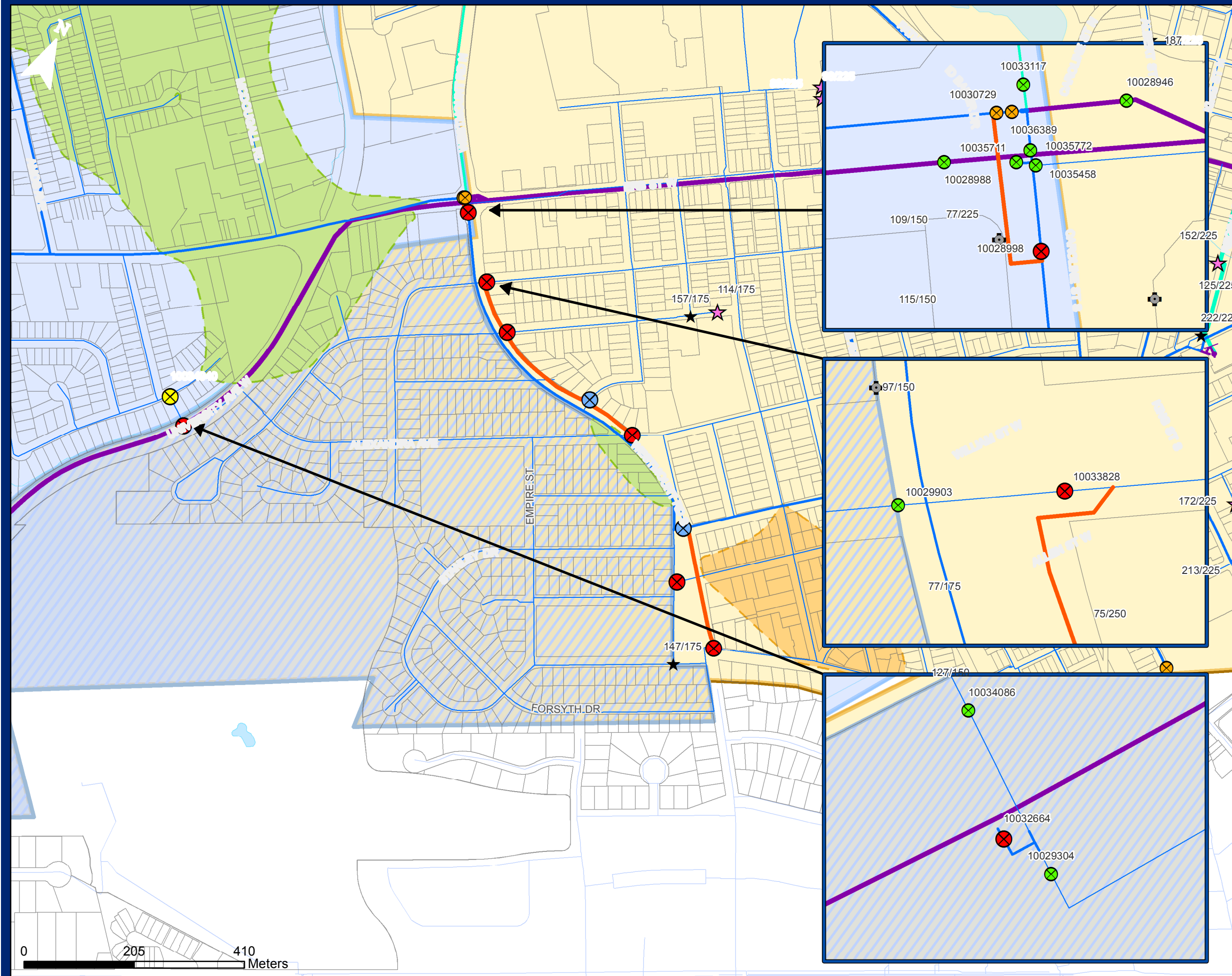
Table 5 - Cluster Area C – Recommended Solution Costing

		Install New Valve	Close Existing Isolation Valve	Open Existing Isolation Valve	Install New Watermain
	Number of Units	2	7	1	660 m
Base Construction Costs	Base Cost	\$20,000	\$3,500	\$500	\$429,000
	Uplift Cost	\$4,000	\$700	\$100	\$85,800
	Total Base Cost	\$24,000	\$4,200	\$600	\$514,800
Total Construction Costs	Engineering and Design Cost	\$4,800	\$840	\$120	\$102,960
	Contingency Cost	\$5,760	\$1,008	\$144	\$123,552
	Total Cost	\$34,560	\$6,048	\$864	\$741,312

**Figure 15 - Water System Upgrade
 Alternative Cluster Area C -
 Preferred Alternative**



**Figure 16 - Water System Upgrade
Alternative Cluster Area C -
Preferred Alternative (valving)**



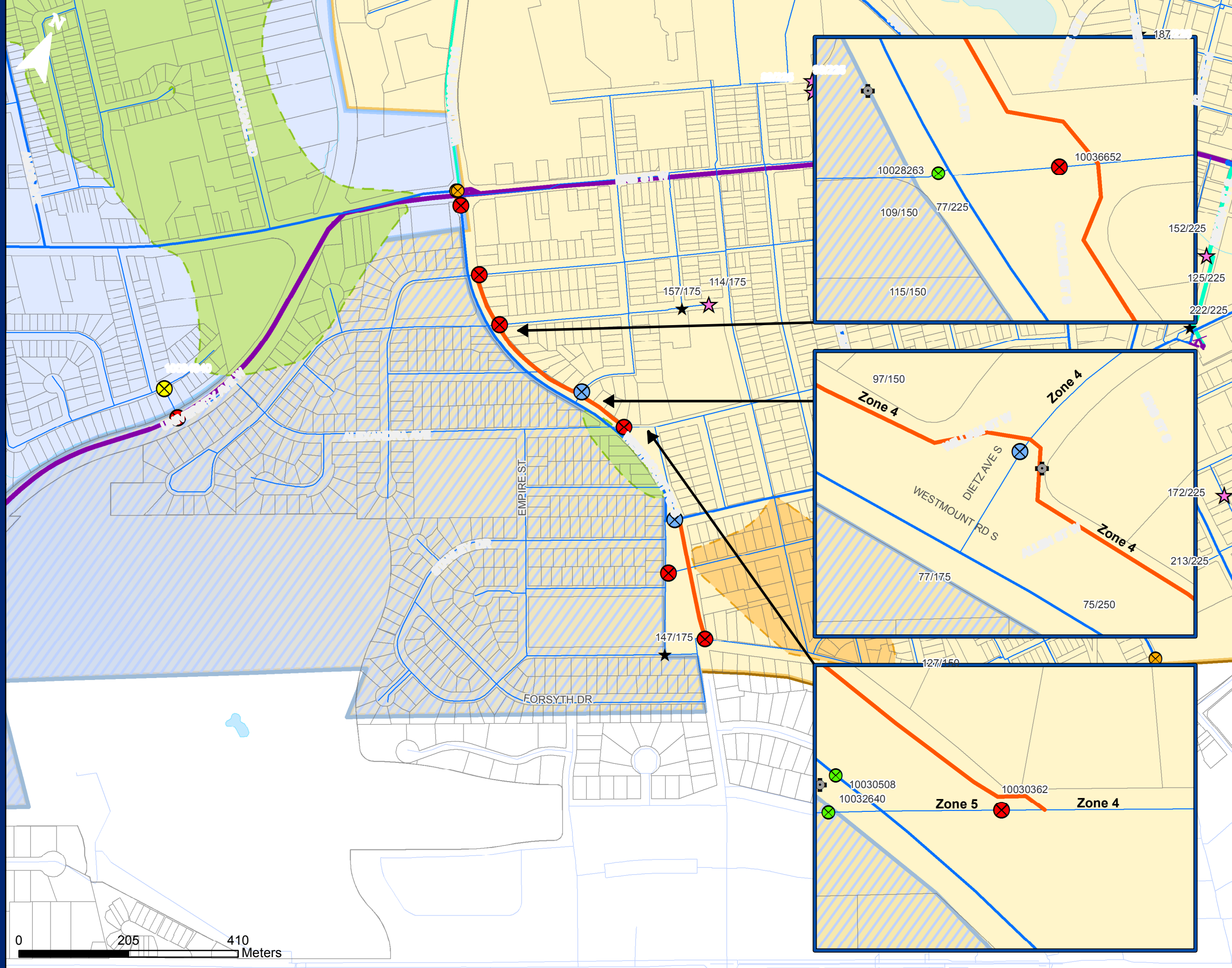


Figure 17 - Water System Upgrade
Alternative Cluster Area C -
Preferred Alternative (valving)

- Local Watermains**

 - < 200 mm
 - 250 - 350 mm
 - > 400 mm
 - Regional Watermains
 - Dual Watermains
 - Kitchener Watermains
- Max Day Demand - Minimum Pressure**

 - <40 PSI
 - 40-50 PSI
 - 90-100 PSI
 - >100 PSI
- Valves**

 - Closed Valve
- Pressure Zone**

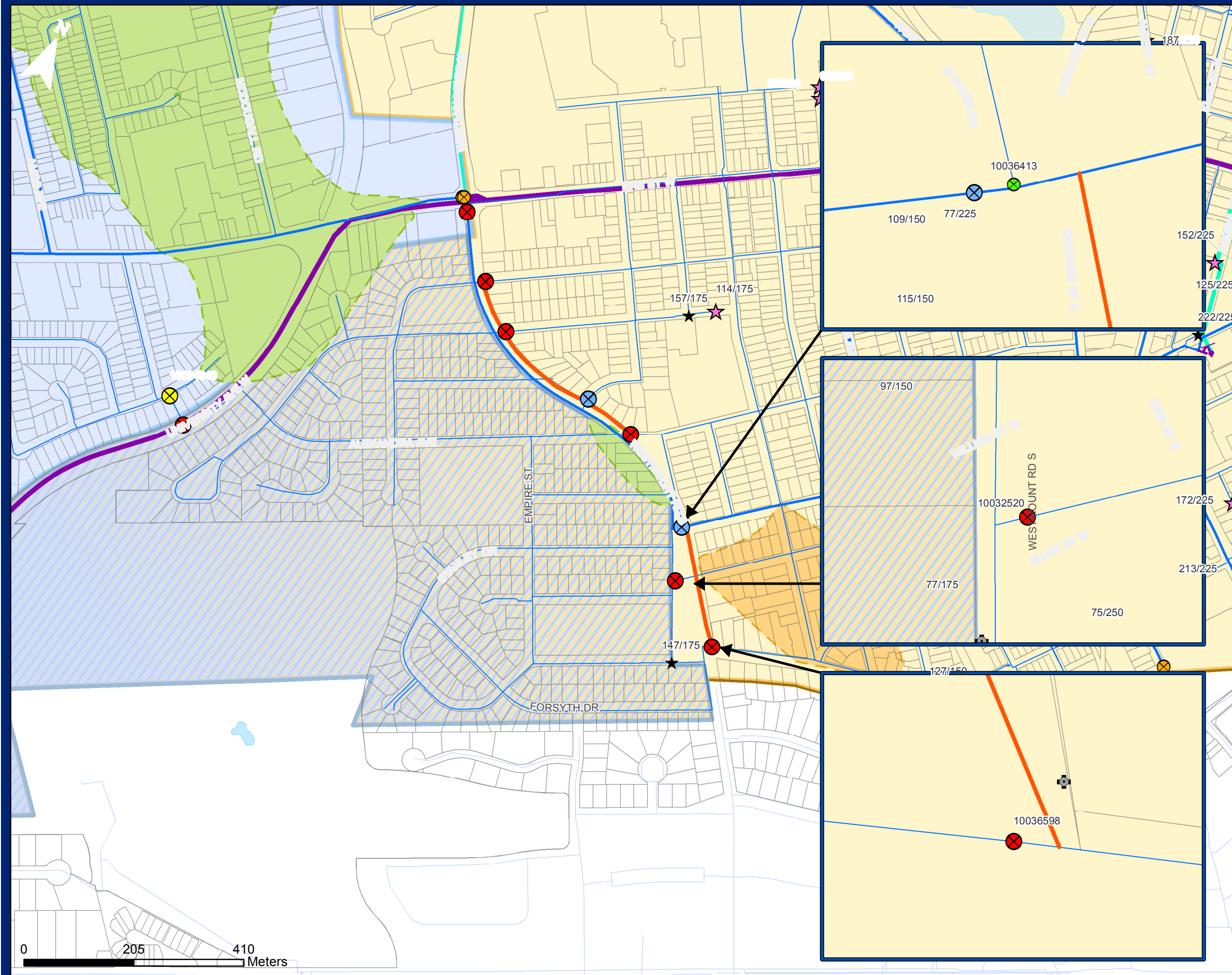
 - Wat 4
 - Wat 5
 - Wat 6
 - Wat 7
 - Municipal Boundary
 - River, Lake
- Fire Flow**

 - <80% of Target Fire Flow
 - 80%-100% of Target Fire Flow
- Changes in Infrastructure**

 - New Watermain
 - New Open Valves
 - New Closed Valves
 - New Install Closed Valves
 - New Check Valve
- Pressure Zone Realignment**

 - Zone 4 to 5
 - Zone 6 to 5

**Figure 18 - Water System Upgrade
 Alternative Cluster Area C -
 Preferred Alternative (valving)**



- | | |
|-------------------------|--|
| Local Watermains | Max Day Demand - Minimum Pressure |
| < 200 mm | <40 PSI |
| 250 - 350 mm | 40-50 PSI |
| > 400 mm | 90-100 PSI |
| Regional Watermains | >100 PSI |
| Dual Watermains | Fire Flow |
| Kitchener Watermains | <80% of Target Fire Flow |
| Valves | 80%-100% of Target Fire Flow |
| Closed Valve | Changes in Infrastructure |
| Pressure Zone | New Watermain |
| Wat 4 | New Open Valves |
| Wat 5 | New Closed Valves |
| Wat 6 | New Install Closed Valves |
| Wat 7 | New Check Valve |
| Municipal Boundary | Pressure Zone Realignment |
| River, Lake | Zone 4 to 5 |
| | Zone 6 to 5 |

3.4 Cluster Area D

Cluster Area D, located in Wat 4 along the border of Wat 4 and Wat 5, experiences low pressures between 40-50 psi and less than 40 psi and a number of deficient fire flow areas. **Figure 19** highlights the high pressures in Cluster Area D. Alternatives to address Area D are as follows:

Note: That solutions to address Cluster Area D require the following Regional Upgrade Projects to be completed before they can be fully implemented:

- Zone 5 Consolidation
- Waterloo North WTP

3.4.1 Cluster Area D – Woolwich Stockyards Considerations

Wat 4 pressure zone directly supply the Woolwich Stockyards, which primarily consists of commercial and industrial properties system, via a feed along Kumpf Drive. The Woolwich Stockyards, under the existing system configuration, experiences deficient pressures and fire flows as per the City's criteria outlined in the WDMP.

3.4.2 Cluster Area D: Option 1 – Do Nothing

The “Do Nothing” option consist of maintain the existing water system (no upgrades to the water system). This option does not address pressure below 40 psi which is an Action deficiency.

3.4.3 Cluster Area D: Option 2 – Minor Adjustment to Zone Boundary

Figure 20 presents the servicing solution Option 2. Pressure boundary adjustments will be made to service low pressure properties through Wat 5. The new Wat 5 will generally extended to Parkside Drive and Kumpf Drive.

This option recommends that the boundary adjustment be made through the opening and closing of valves, installation of a check valve, and an additional 600 m of 300 mm watermain.

The check valve, located at Northfield Drive West and Kumpf Drive, will serve primarily to supplement fire flows in the industrial area west of Conestoga Parkway.

The new watermain will be installed to supplement supply from Laurel Tank to Wat 4 and to minimize the creation of new system dead ends. The watermain will be located along the following roads:

- Weber Street North

The Regional trunk main along Columbia Street West from Westmount Road North to King Street North must be installed, to service Wat 4, before work can begin. The existing 300 mm watermain along Columbia Street West from Westmount Road North to King Street North will be maintained and transferred to Wat 5.

3.4.4 Cluster Area D: Option 3 – Marginal Adjustment to Zone Boundary

Figure 21 presents the servicing solution Option 3. Pressure boundary adjustments will be made to service low pressure properties through Wat 5. The new Wat 5 will generally extend to Albert Street and Kumpf Drive.

This option recommends that the boundary adjustment be made through the opening and closing of valves, installation of a check valve, and an additional 600 m of 300 mm watermain.

The check valve, located at Northfield Drive West and Kumpf Drive, will serve primarily to supplement fire flows in the industrial area west of Conestoga Parkway.

The new watermains will be installed to supplement supply from Laurel Tank to Wat 4 and to minimize the creation of new system dead ends. The watermains will be located along the following roads:

- Weber Street North

The Regional trunk main along Columbia Street West from Westmount Road North to King Street North must be installed, to service Wat 4, before work can begin. Additionally, the existing 300 mm watermain along Columbia Street West from Westmount Road North to King Street North will be maintained and transferred to Wat 5.

3.4.5 Cluster Area D: Option 4 – Medium Adjustment to Zone Boundary

Figure 22 presents the servicing solution Option 4. Pressure boundary adjustments will be made to service low pressure properties through Wat 5. The new Wat 5 will generally extended to Weber Street North and Kumpf Drive.

This option recommends that the boundary adjustment be made through the opening and closing of valves, installation of a check valve, and an additional 600 m of 300 mm watermain.

The check valve, located at Northfield Drive West and Kumpf Drive, will serve primarily to supplement fire flows in the industrial area west of Conestoga Parkway.

The new watermains will be installed to supplement supply from Laurel Tank to Wat 4 and to minimize the creation of new system dead ends. The watermains will be located along the following roads:

- Weber Street North

The Regional trunk main along Columbia Street West from Westmount Road North to King Street North must be installed, to service Wat 4, before work can begin. Additionally, the existing 300 mm watermain along Columbia Street West from Westmount Road North to King Street North will be maintained and transferred to Wat 5.

3.4.6 Cluster Area D: Option 5 – Major Adjustment to Zone Boundary

Figure 23 presents the servicing solution Option 5. Pressure boundary adjustments will be made to service low pressure properties through Wat 5. The new Wat 5 will generally extended from University Avenue West to Weber Street North.

This option recommends that the boundary adjustment be made through the opening and closing of valves, installation of a check valve, and an additional 850 m of 150 mm watermain and 600 m of 300 mm watermain.

The check valve, located at Northfield Drive West and Kumpf Drive, will serve primarily to supplement fire flows in the industrial area west of Conestoga Parkway.

The new watermains will be installed to restore supply from Laurel Tank to Wat 4 and to minimize the creation of new system dead ends. The watermains will be located along the following road:

- Weber Street North

New 150 mm PVC watermains would be installed to twin the watermain along the following road:

- University Avenue West

The Regional trunk main along Columbia Street West from Westmount Road North to King Street North must be installed to service Wat 4 for work can begin. Additionally, the existing watermain along Columbia Street West from Westmount Road North to King Street North will be maintained and transferred to Wat 5.

3.4 Cluster Area D

Cluster Area D, located in Wat 4 along the border of Wat 4 and Wat 5, experiences low pressures between 40-50 psi and less than 40 psi and a number of deficient fire flow areas. **Figure 19** highlights the high pressures in Cluster Area D. Alternatives to address Area D are as follows:

Note: That solutions to address Cluster Area D require the following Regional Upgrade Projects to be completed before they can be fully implemented:

- Zone 5 Consolidation
- Waterloo North WTP

3.4.1 Cluster Area D – Woolwich Stockyards Considerations

Wat 4 pressure zone directly supply the Woolwich Stockyards, which primarily consists of commercial and industrial properties system, via a feed along Kumpf Drive. The Woolwich Stockyards, under the existing system configuration, experiences deficient pressures and fire flows as per the City's criteria outlined in the WDMP.

3.4.2 Cluster Area D: Option 1 – Do Nothing

The “Do Nothing” option consist of maintain the existing water system (no upgrades to the water system). This option does not address pressure below 40 psi which is an Action deficiency.

3.4.3 Cluster Area D: Option 2 – Minor Adjustment to Zone Boundary

Figure 20 presents the servicing solution Option 2. Pressure boundary adjustments will be made to service low pressure properties through Wat 5. The new Wat 5 will generally extended to Parkside Drive and Kumpf Drive.

This option recommends that the boundary adjustment be made through the opening and closing of valves, installation of a check valve, and an additional 600 m of 300 mm watermain.

The check valve, located at Northfield Drive West and Kumpf Drive, will serve primarily to supplement fire flows in the industrial area west of Conestoga Parkway.

The new watermain will be installed to supplement supply from Laurel Tank to Wat 4 and to minimize the creation of new system dead ends. The watermain will be located along the following roads:

- Weber Street North

The Regional trunk main along Columbia Street West from Westmount Road North to King Street North must be installed, to service Wat 4, before work can begin. The existing 300 mm watermain along Columbia Street West from Westmount Road North to King Street North will be maintained and transferred to Wat 5.

3.4.4 Cluster Area D: Option 3 – Marginal Adjustment to Zone Boundary

Figure 21 presents the servicing solution Option 3. Pressure boundary adjustments will be made to service low pressure properties through Wat 5. The new Wat 5 will generally extend to Albert Street and Kumpf Drive.

This option recommends that the boundary adjustment be made through the opening and closing of valves, installation of a check valve, and an additional 600 m of 300 mm watermain.

The check valve, located at Northfield Drive West and Kumpf Drive, will serve primarily to supplement fire flows in the industrial area west of Conestoga Parkway.

The new watermains will be installed to supplement supply from Laurel Tank to Wat 4 and to minimize the creation of new system dead ends. The watermains will be located along the following roads:

- Weber Street North

The Regional trunk main along Columbia Street West from Westmount Road North to King Street North must be installed, to service Wat 4, before work can begin. Additionally, the existing 300 mm watermain along Columbia Street West from Westmount Road North to King Street North will be maintained and transferred to Wat 5.

3.4.5 Cluster Area D: Option 4 – Medium Adjustment to Zone Boundary

Figure 22 presents the servicing solution Option 4. Pressure boundary adjustments will be made to service low pressure properties through Wat 5. The new Wat 5 will generally extended to Weber Street North and Kumpf Drive.

This option recommends that the boundary adjustment be made through the opening and closing of valves, installation of a check valve, and an additional 600 m of 300 mm watermain.

The check valve, located at Northfield Drive West and Kumpf Drive, will serve primarily to supplement fire flows in the industrial area west of Conestoga Parkway.

The new watermains will be installed to supplement supply from Laurel Tank to Wat 4 and to minimize the creation of new system dead ends. The watermains will be located along the following roads:

- Weber Street North

The Regional trunk main along Columbia Street West from Westmount Road North to King Street North must be installed, to service Wat 4, before work can begin. Additionally, the existing 300 mm watermain along Columbia Street West from Westmount Road North to King Street North will be maintained and transferred to Wat 5.

3.4.6 Cluster Area D: Option 5 – Major Adjustment to Zone Boundary

Figure 23 presents the servicing solution Option 5. Pressure boundary adjustments will be made to service low pressure properties through Wat 5. The new Wat 5 will generally extended from University Avenue West to Weber Street North.

This option recommends that the boundary adjustment be made through the opening and closing of valves, installation of a check valve, and an additional 850 m of 150 mm watermain and 600 m of 300 mm watermain.

The check valve, located at Northfield Drive West and Kumpf Drive, will serve primarily to supplement fire flows in the industrial area west of Conestoga Parkway.

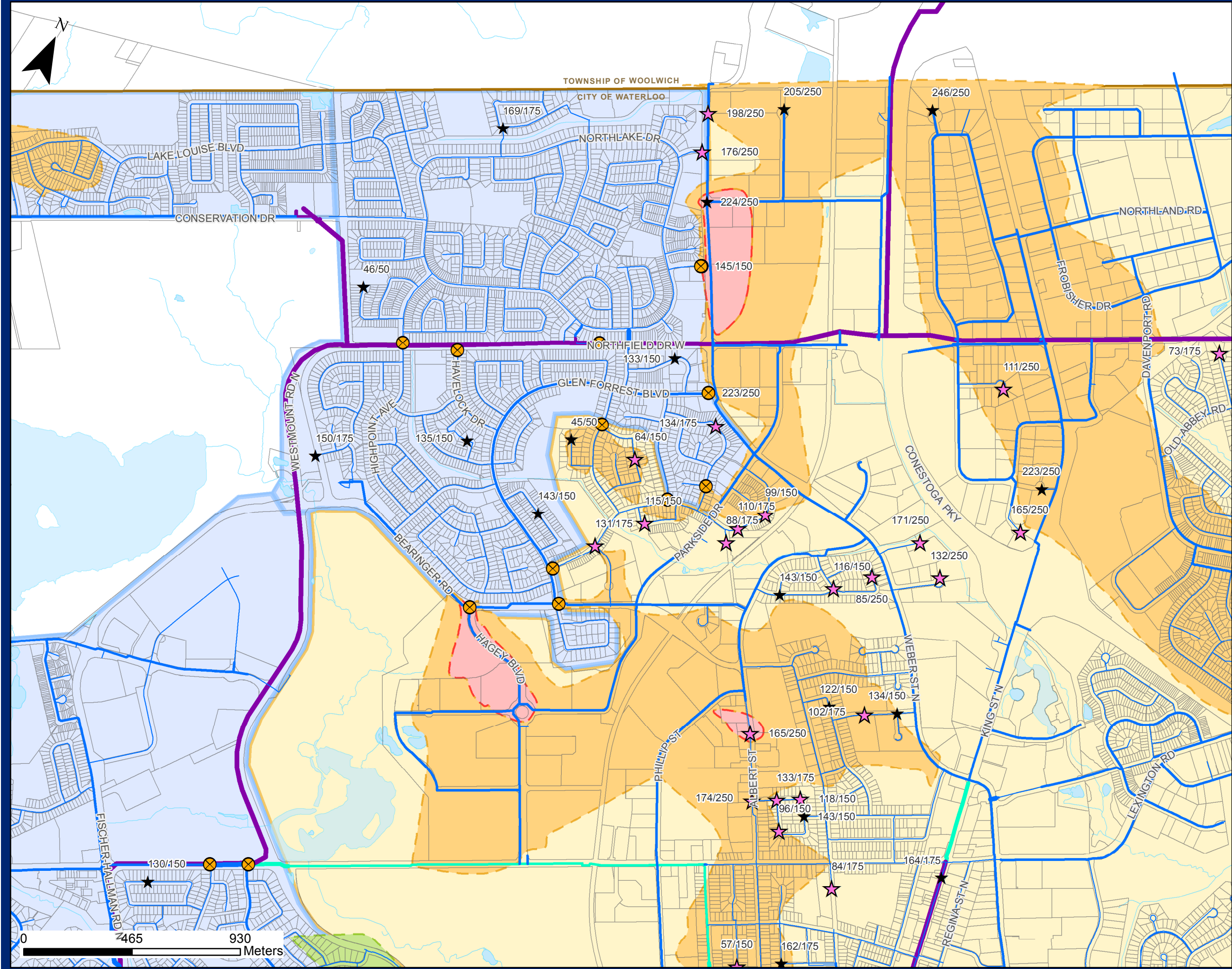
The new watermains will be installed to restore supply from Laurel Tank to Wat 4 and to minimize the creation of new system dead ends. The watermains will be located along the following road:

- Weber Street North

New 150 mm PVC watermains would be installed to twin the watermain along the following road:

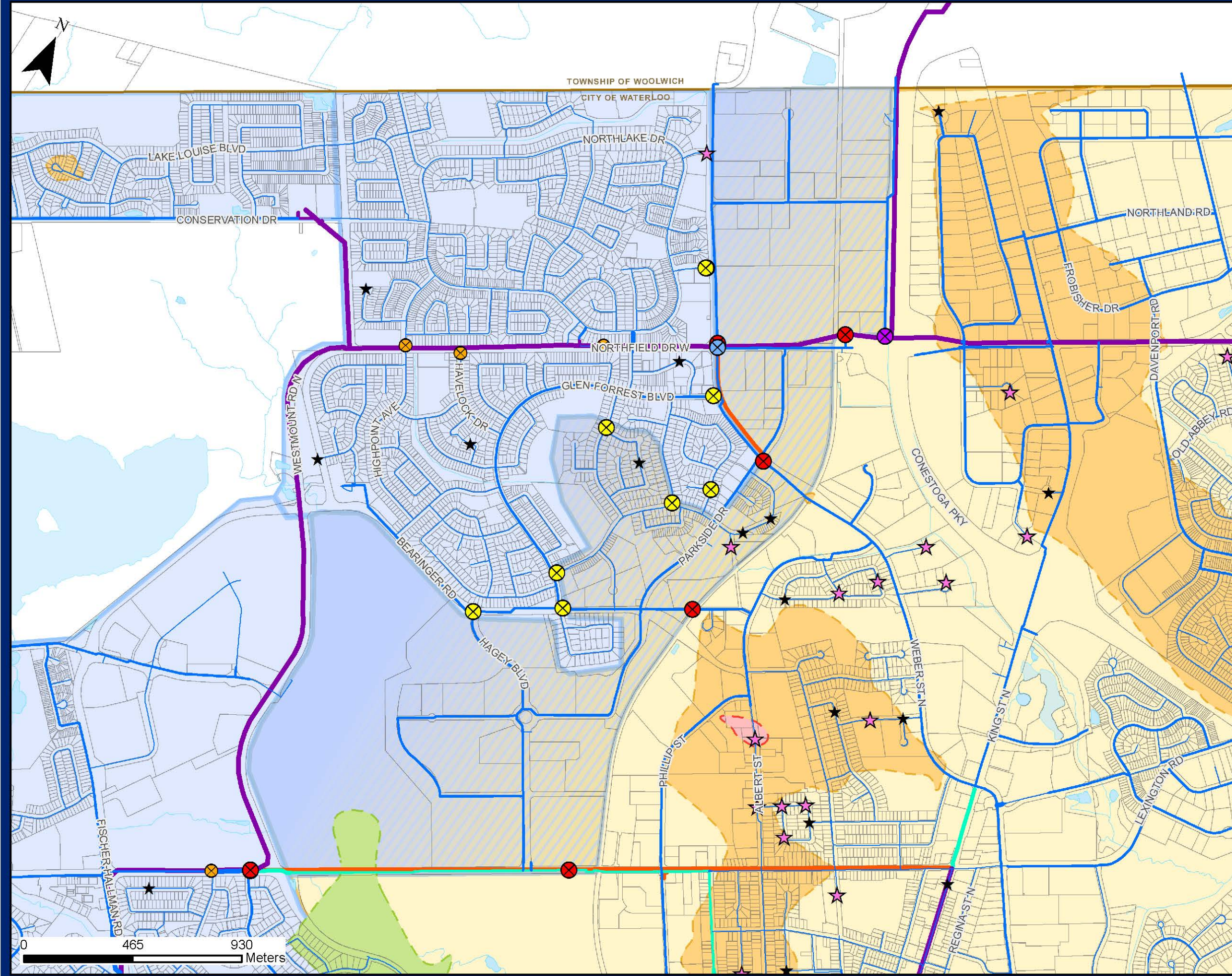
- University Avenue West

The Regional trunk main along Columbia Street West from Westmount Road North to King Street North must be installed to service Wat 4 for work can begin. Additionally, the existing watermain along Columbia Street West from Westmount Road North to King Street North will be maintained and transferred to Wat 5.



**Figure 19 - Water System Upgrade
 Alternative Cluster Area D -
 Baseline**

- | | |
|--|--|
| Local Watermains | Max Day Demand - Minimum Pressure |
|  < 200 mm |  < 40 PSI |
|  250 - 350 mm |  40-50 PSI |
|  > 400 mm |  90-100 PSI |
|  Regional Watermains |  > 100 PSI |
|  Dual Watermains | Fire Flow |
|  Kitchen Watermains |  < 80% of Target Fire Flow |
| Valves |  80%-100% of Target Fire Flow |
|  Closed Valve | |
| Pressure Zone | |
|  Wat 4 | |
|  Wat 5 | |
|  Wat 6 | |
|  Wat 7 | |
|  Municipal Boundary | |
|  River, Lake | |



**Figure 20 - Water System Upgrade
 Alternative Cluster Area D -
 Option 2**

- | | |
|---|---|
| Local Watermains
< 200 mm
250 - 350 mm
> 400 mm
Regional Watermains
Dual Watermains
Kitchener Watermains
Valves
Closed Valve
Pressure Zone
Wat 4
Wat 5
Wat 6
Wat 7
Municipal Boundary
River, Lake | Max Day Demand - Minimum Pressure
<40 PSI
40-50 PSI
90-100 PSI
>100 PSI
Fire Flow
<80% of Target Fire Flow
80%-100% of Target Fire Flow
Changes in Infrastructure
New Watermain
New Open Valves
New Closed Valves
New Install Closed Valves
New Check Valve
Pressure Zone Realignment
Zone 4 to 5
Zone 6 to 5 |
|---|---|

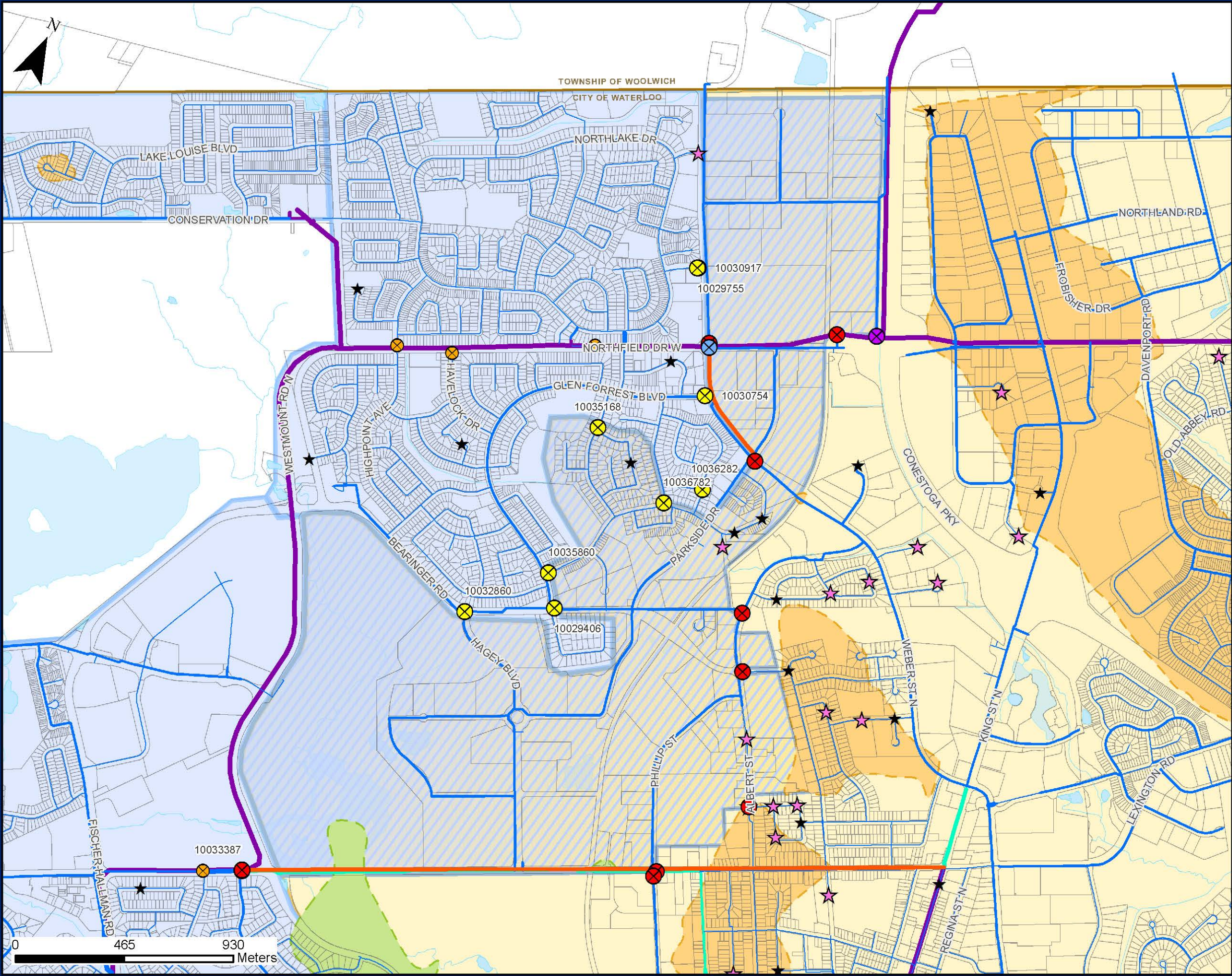
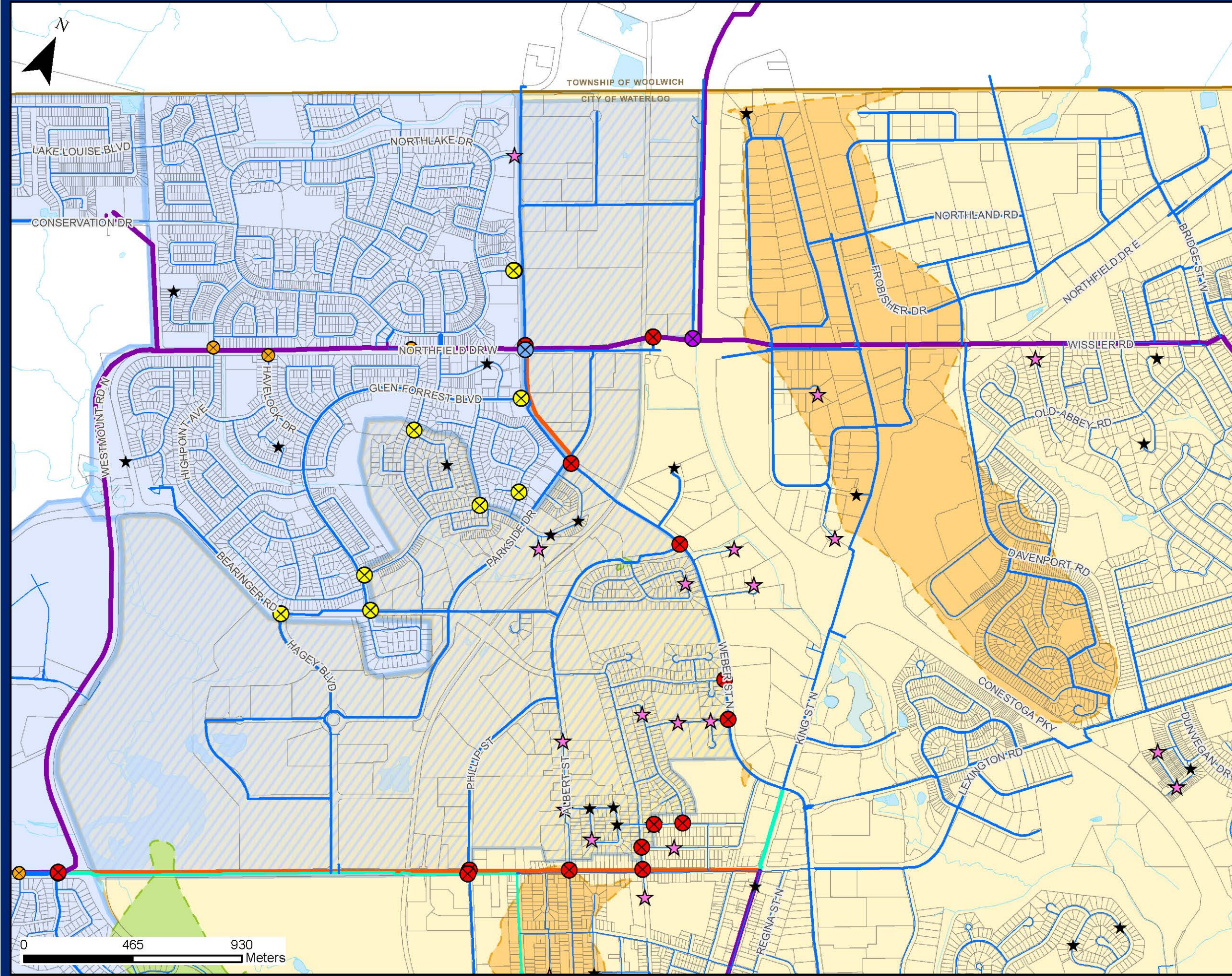


Figure 21 - Water System Upgrade
Alternative Cluster Area D -
Option 3

- | | |
|-------------------------|--|
| Local Watermains | Max Day Demand - Minimum Pressure |
| < 200 mm | <40 PSI |
| 250 - 350 mm | 40-50 PSI |
| > 400 mm | 90-100 PSI |
| Regional Watermains | >100 PSI |
| Dual Watermains | Fire Flow |
| Kitchen Watermains | <80% of Target Fire Flow |
| Valves | 80%-100% of Target Fire Flow |
| Closed Valve | Changes in Infrastructure |
| Pressure Zone | New Watermain |
| Wat 4 | New Open Valves |
| Wat 5 | New Closed Valves |
| Wat 6 | New Install Closed Valves |
| Wat 7 | New Check Valve |
| Municipal Boundary | Pressure Zone Realignment |
| River, Lake | Zone 4 to 5 |
| | Zone 6 to 5 |



**Figure 22 - Water System Upgrade
Alternative Cluster Area D -
Option 4**

- | | |
|---|--|
| Local Watermains
< 200 mm
250 - 350 mm
> 400 mm
Regional Watermains
Dual Watermains
Kitchener Watermains
Valves
Closed Valve
Pressure Zone
Wat 4
Wat 5
Wat 6
Wat 7
Municipal Boundary
River, Lake | Max Day Demand - Minimum Pressure
< 40 PSI
40-50 PSI
90-100 PSI
> 100 PSI
Fire Flow
< 80% of Target Fire Flow
80%-100% of Target Fire Flow
Changes in Infrastructure
New Watermain
New Open Valves
New Closed Valves
New Install Closed Valves
New Check Valve
Pressure Zone Realignment
Zone 4 to 5
Zone 6 to 5 |
|---|--|

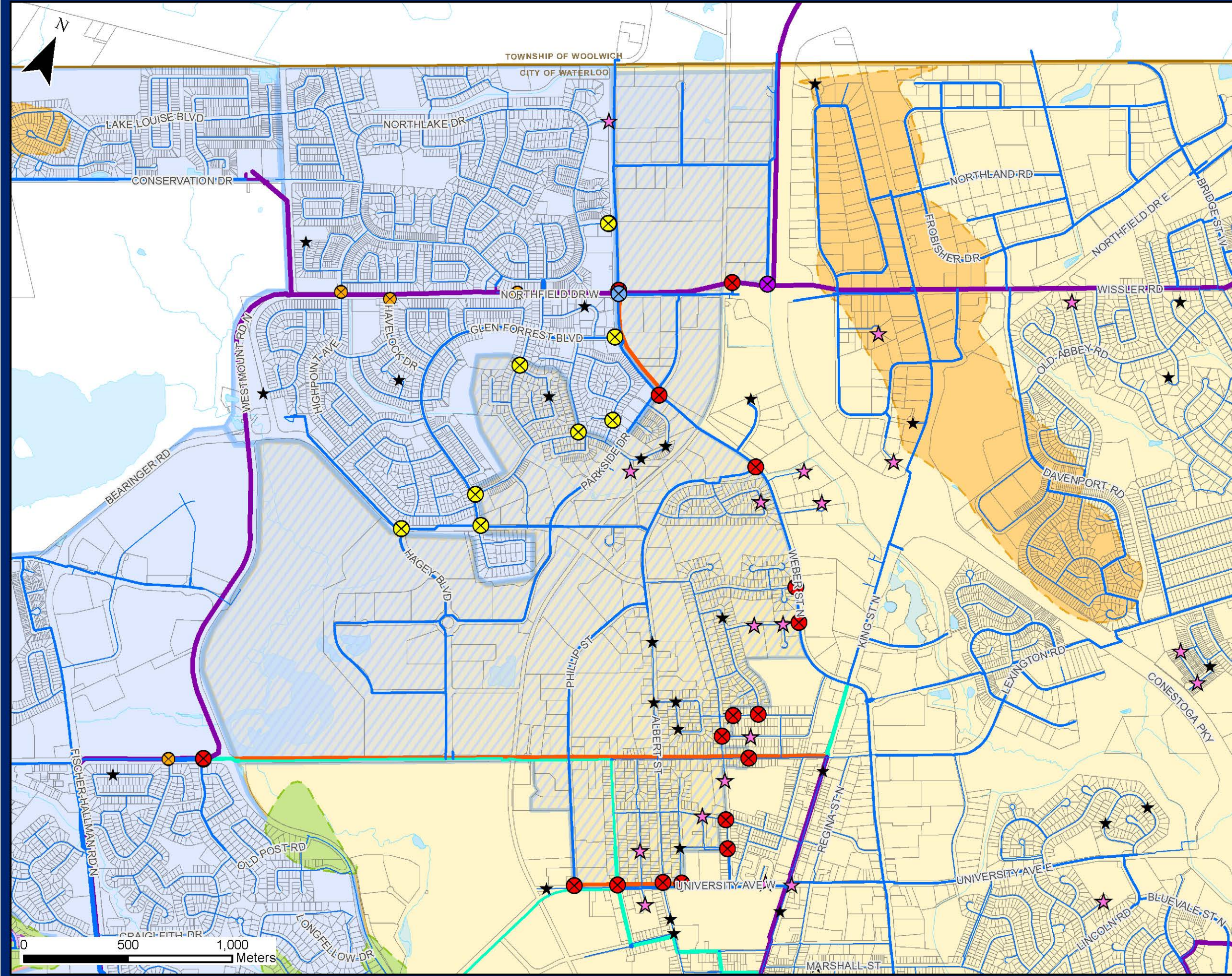


Figure 23 - Water System Upgrade
Alternative Cluster Area D -
Option 5

Local Watermains

- < 200 mm
- 250 - 350 mm
- > 400 mm
- Regional Watermains
- Dual Watermains
- Kitchener Watermains

Max Day Demand - Minimum Pressure

- <40 PSI
- 40-50 PSI
- 90-100 PSI
- >100 PSI

Valves

- Closed Valve

Pressure Zone

- Wat 4
- Wat 5
- Wat 6
- Wat 7
- Municipal Boundary
- River, Lake

Fire Flow

- <80% of Target Fire Flow
- 80%-100% of Target Fire Flow

Changes in Infrastructure

- New Watermain
- New Open Valves
- New Closed Valves
- New Install Closed Valves
- New Check Valve

Pressure Zone Realignment

- Zone 4 to 5
- Zone 6 to 5

3.4.7 Cluster Area D: Evaluation

The evaluation process is summarized in **Table 6** and further detailed in **Appendix A**

Table 6 - Cluster Area D - Evaluation

Criteria	Option 1 Do Nothing	Option 2 Minor Boundary Adjustment	Option 3 Marginal Boundary Adjustment	Option 4 Medium Boundary Adjustment	Option 5 Major Boundary Adjustment
Technical Viability	No work required	Generally easy	Generally easy	Generally easy	Generally easy
Meets Pressure Objectives	No	No (Albert properties with privately serviced boosters)	Yes	Yes	Yes
Meets Fire Flow Objectives	No	Improved (Addressed through SOGR program)	Improved (Addressed through SOGR program)	Improved (Addressed through SOGR program)	Improved (Addressed through SOGR program)
Operation and Maintenance	Dead end flushing required	Addition of 600 m of WM to O&M	Addition of 600 m of WM to O&M	Addition of 600 m of WM to O&M	Addition of 850 m of WM to O&M
Impact to Criticality	No change	No change	No change	No change	No change
Property Impacts	None	None	Impact to privately serviced booster pumps	Impact to privately serviced booster pumps	Impact to privately serviced booster pumps
Traffic Impacts	None	Moderate	Moderate	Moderate	Moderate
Capital Costs	\$0	\$0.8 million	\$0.9 million	\$1.0 million	\$1.2 million
Cost per Improvement	\$0	\$4,000/ weighted improvement	\$4,500/ weighted improvement	\$4,000/ weighted improvement	\$9,000/ weighted improvement
Evaluation	Does not meet Action pressure or fire flow requirements	Does not meet Action pressure requirements	Pressure deficiencies are addressed through low costs and minimal valve changes	Requires more valve modification than Option 3	High costs associated with system modifications

3.4.8 Cluster Area D: Recommended Solution

The recommended solution for the deficiencies in Cluster Area D was **Option 3 – Marginal Adjustment to Zone Boundary**. Both Option 3 and Option 4 provided similar benefits and demonstrated similar costs per benefit. However, Option 3 was selected as the most feasible option as it provided the lowest total capital cost to address all of the “Action” deficiencies. Further, the new pressure zone boundary created by Option 3 is easier to construct than Option 4, and presents fewer system dead-ends, which may lead to future operational issues. **Figure 26, Figure 27, Figure 28, and Figure 29** show the location of valving and watermains required to move the zone boundary.

The Zone boundary realignment modifies the Woolwich Stockyards supply feed from a Wat 4 watermain to a Wat 5 watermain. The modified Wat 5 supply results in improved Stockyard pressures and fire flows. Under the proposed configuration the available fire flows within the Stockyards are maintained above the “Flag” level of service objective for Industrial properties.

A summary of the recommended works are as follows:

- Open valves
 - 10030917
 - 10029755
 - 10030754
 - 10036282
 - 10036782
 - 10035168
 - 10035860
 - 10032860
 - 10029406

- Close valves
 - 10034988
 - 10033369
 - 10033526
 - 10029518 (optional as a boundary valve)
 - 10033825 (optional as a boundary valve)
 - 10029998 (optional as a boundary valve)
 - 10028476
 - 10028966
 - 10029674
- Install new valves
 - On Weber Street North at Northfield Drive West
- Install check valve
 - On Kumpf Drive at Northfield Drive West
- New Watermains
 - Twin 25 m at Phillip Street and Columbia Street West for valve isolation
 - Twin 25 m at Weber Street North and Northfield Drive West for valve isolation
 - Twin 550 m on Weber Street North from Northfield Drive West to Parkside Drive
- Regional Project
 - New trunk watermain on Columbia Street West from Westmount Road North to King Street North requiring old Columbia Street West watermain to be retained and used to service Zone 5

3.4.9 Cluster Area D: Costing

The costs associated the Area D Recommended Solution are summarized in **Table 7** totalling \$900,000.

Table 7 - Cluster Area D – Recommended Solution Costing

		Install New Valve	Install New Boundary Valve	Install New Check Valve	Close Existing Isolation Valve	Open Existing Isolation Valve	Install New Watermain
	Number of Units	1	3	1	6	10	600 m
Base Construction Costs	Base Cost	\$10,000	\$60,000	\$50,000	\$3,000	\$5,000	\$390,000
	Uplift Cost	\$2,000	\$12,000	\$10,000	\$600	\$1,000	\$78,000
	Total Base Cost	\$12,000	\$72,000	\$60,000	\$3,600	\$6,000	\$468,000
Total Construction Costs	Engineering and Design Cost	\$2,400	\$14,400	\$12,000	\$720	\$1,200	\$93,600
	Contingency Cost	\$2,880	\$17,280	\$14,400	\$864	\$1,440	\$112,320
	Total Cost	\$17,280	\$103,680	\$86,400	\$5,184	\$8,640	\$673,920

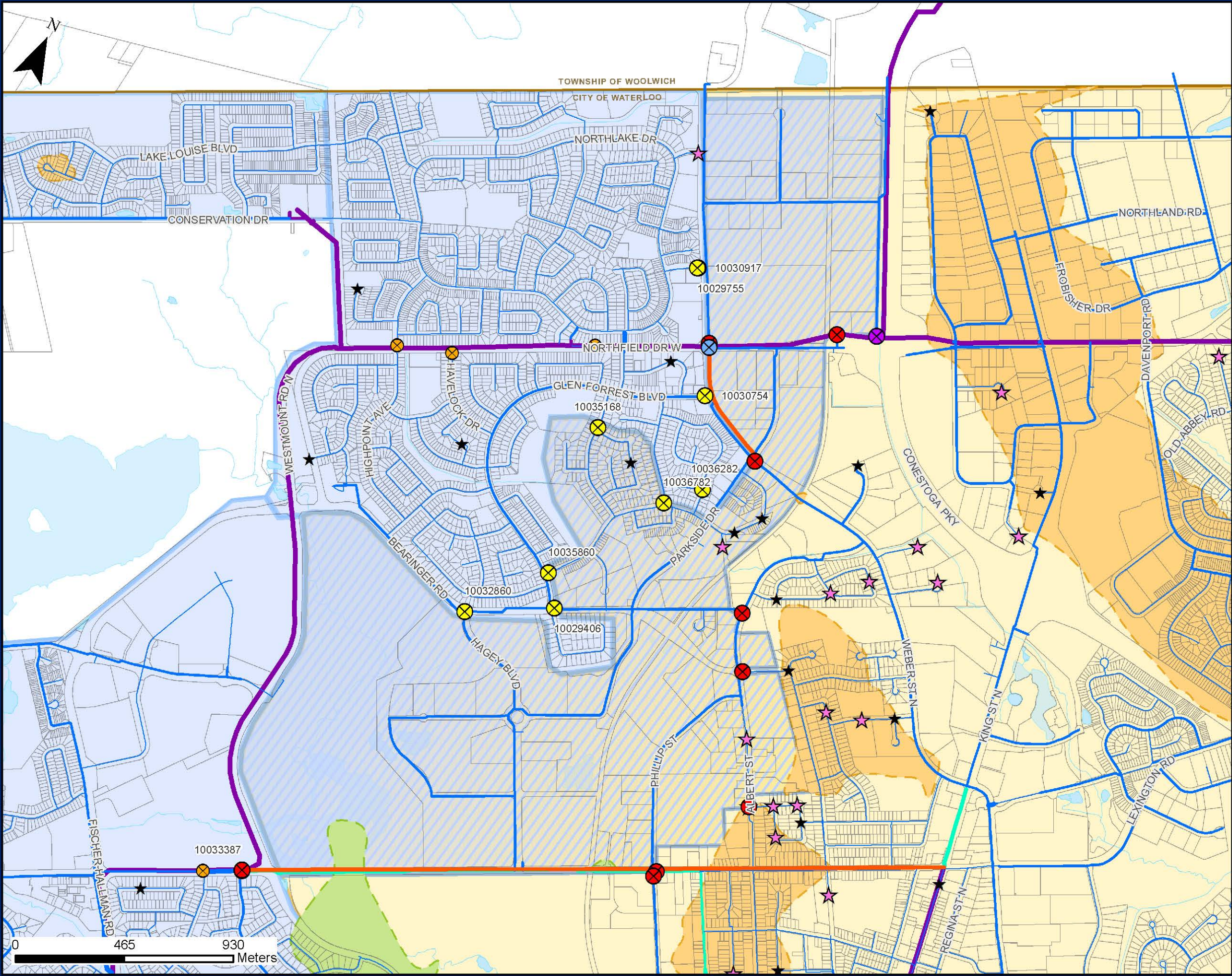
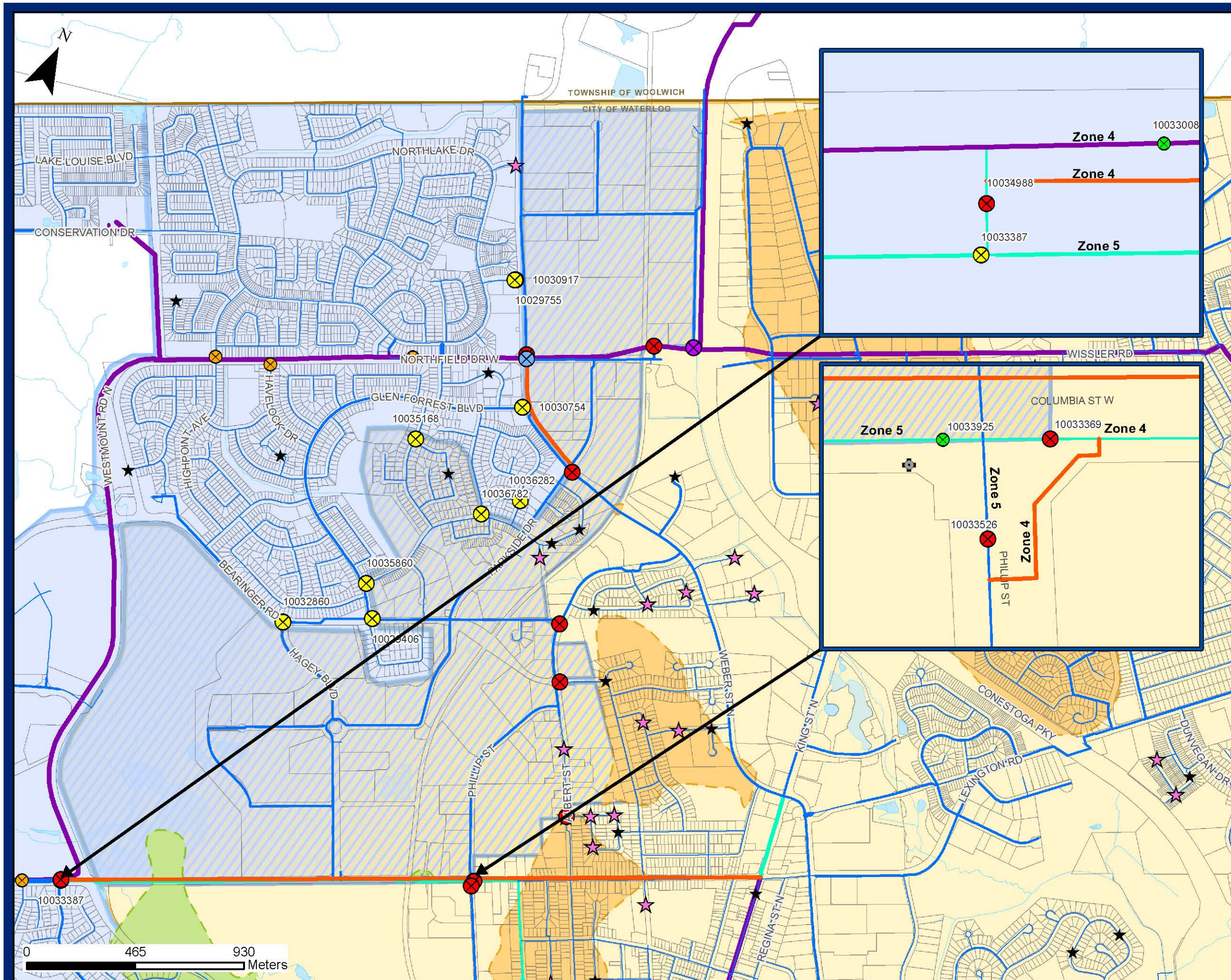
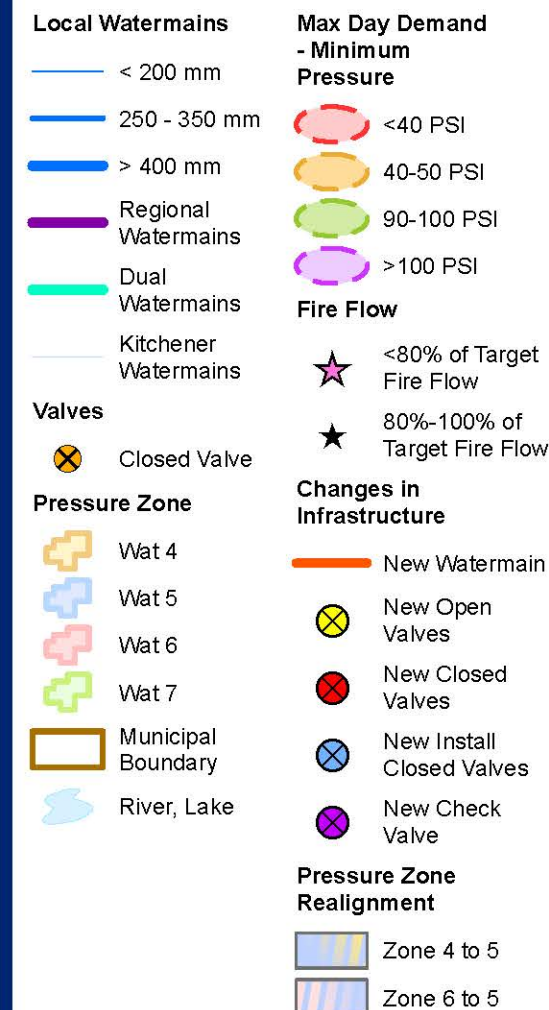


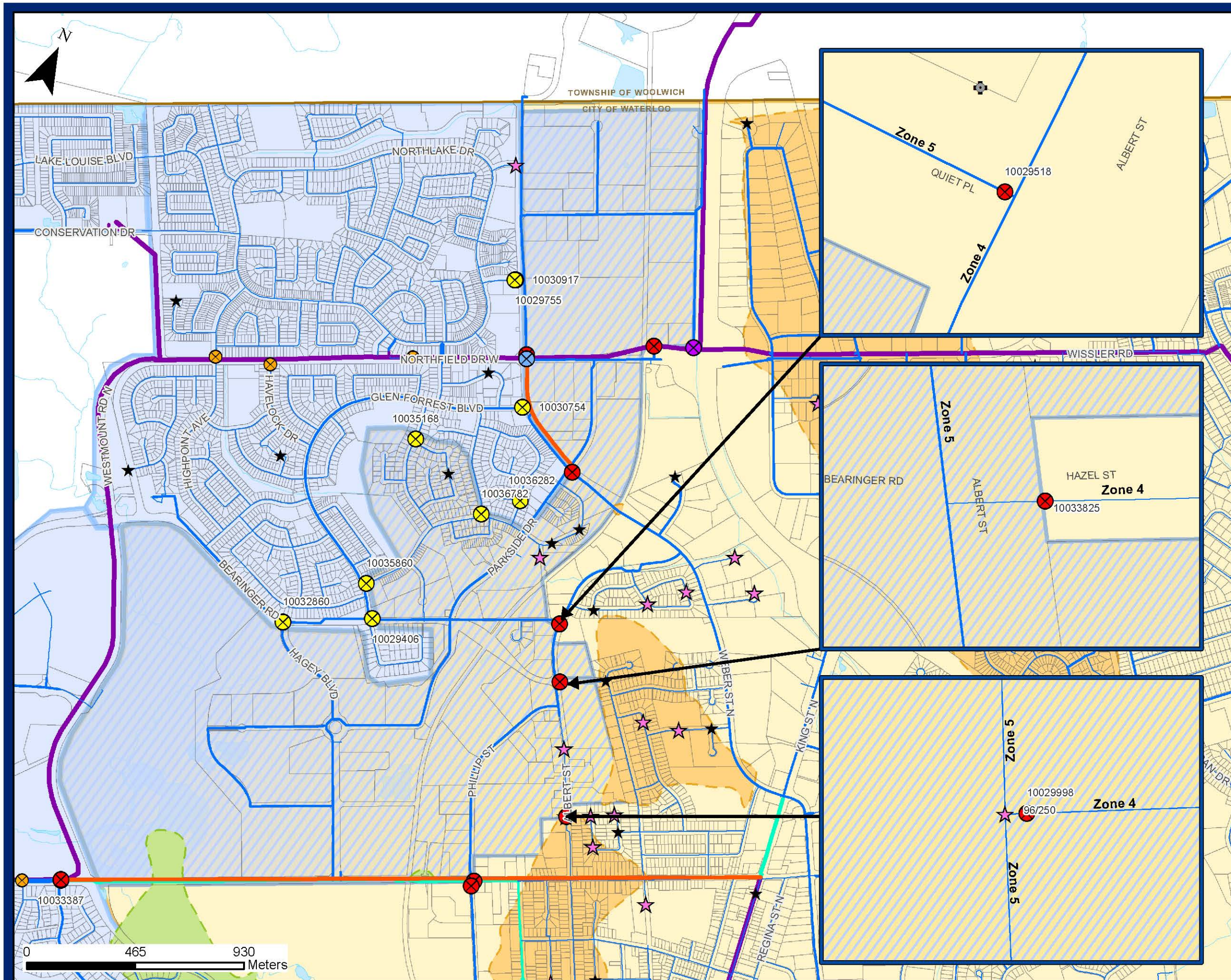
Figure 24 - Water System Upgrade
Alternative Cluster Area D -
Preferred Alternative

- | | |
|---------------------------|--|
| Local Watermains | Max Day Demand - Minimum Pressure |
| < 200 mm | < 40 PSI |
| 250 - 350 mm | 40-50 PSI |
| > 400 mm | 90-100 PSI |
| Regional Watermains | > 100 PSI |
| Dual Watermains | Fire Flow |
| Kitchener Watermains | < 80% of Target Fire Flow |
| Kitchener Watermains | 80%-100% of Target Fire Flow |
| Valves | Changes in Infrastructure |
| Closed Valve | New Watermain |
| New Open Valves | New Open Valves |
| New Closed Valves | New Closed Valves |
| New Install Closed Valves | New Install Closed Valves |
| New Check Valve | New Check Valve |
| Pressure Zone | Pressure Zone Realignment |
| Wat 4 | Zone 4 to 5 |
| Wat 5 | Zone 6 to 5 |
| Wat 6 | |
| Wat 7 | |
| Municipal Boundary | |
| River, Lake | |

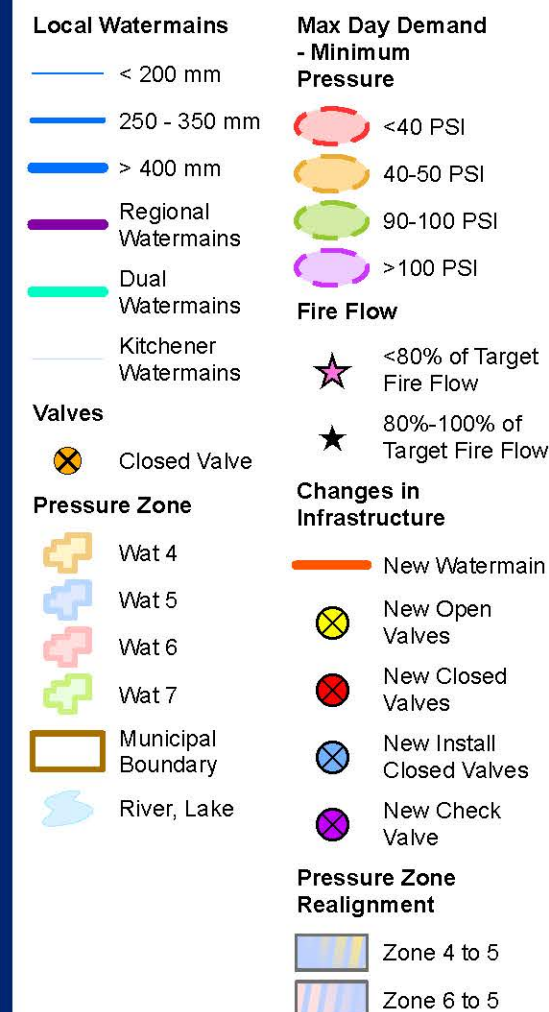


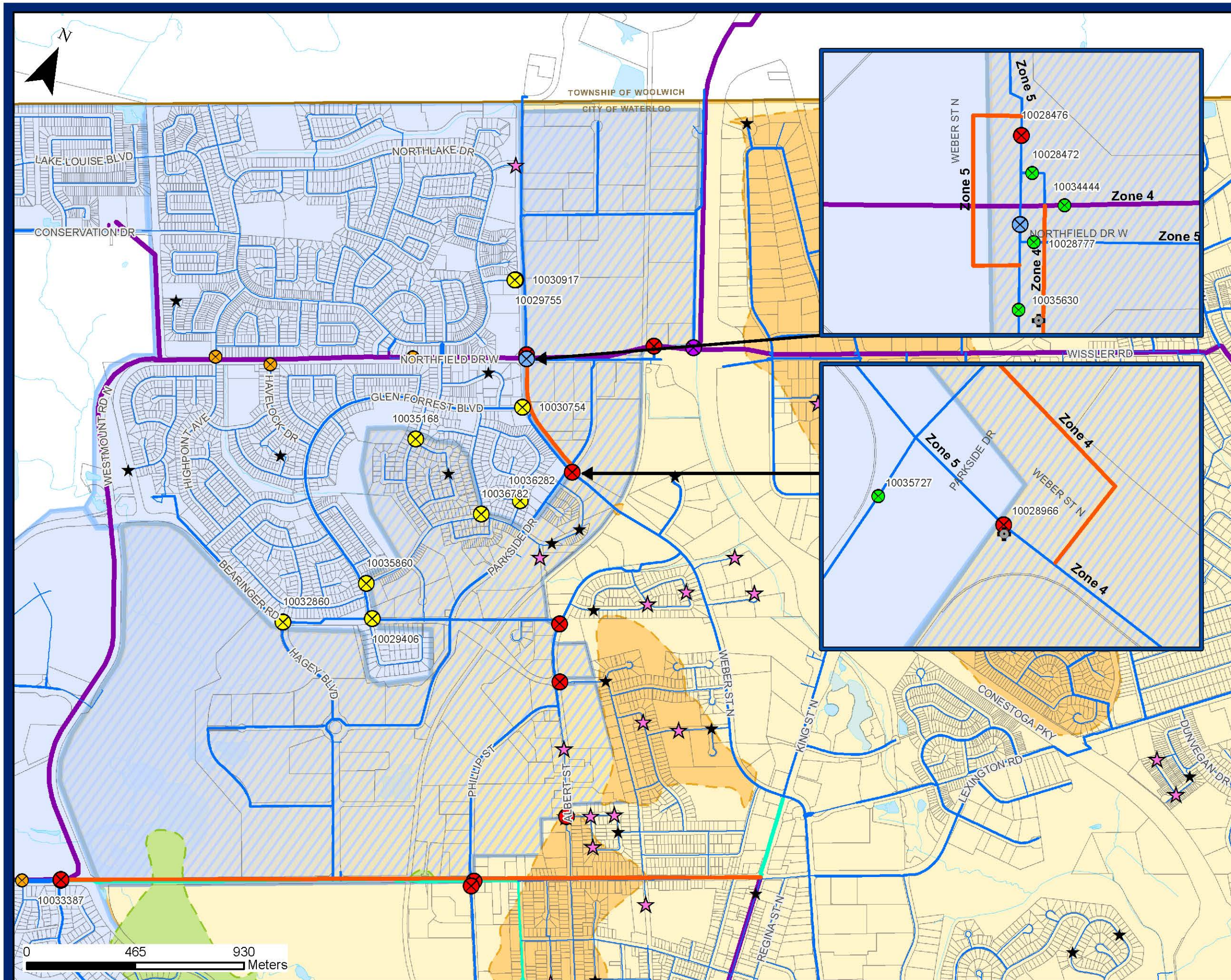
**Figure 25 - Water System Upgrade
Alternative Cluster Area D -
Preferred Alternative (valving)**



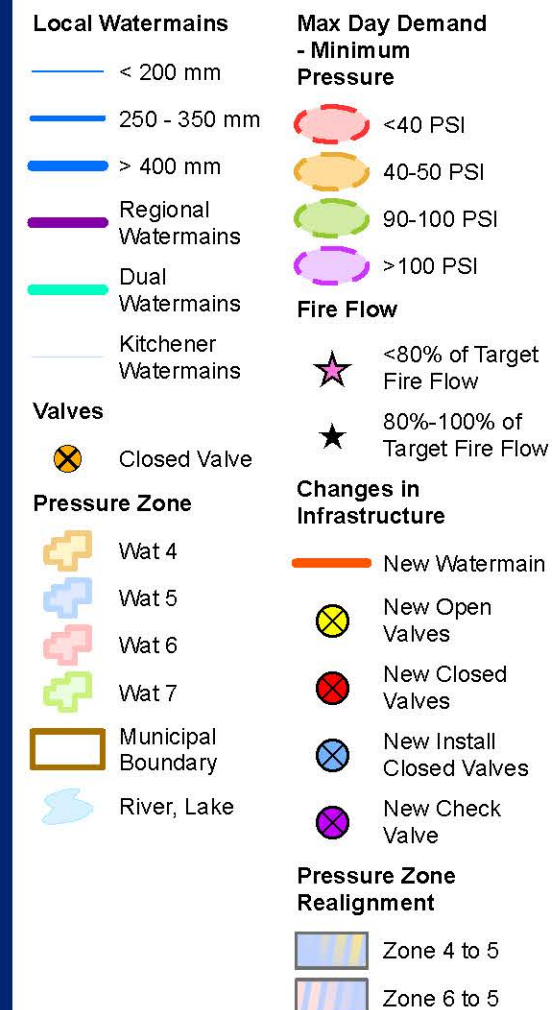


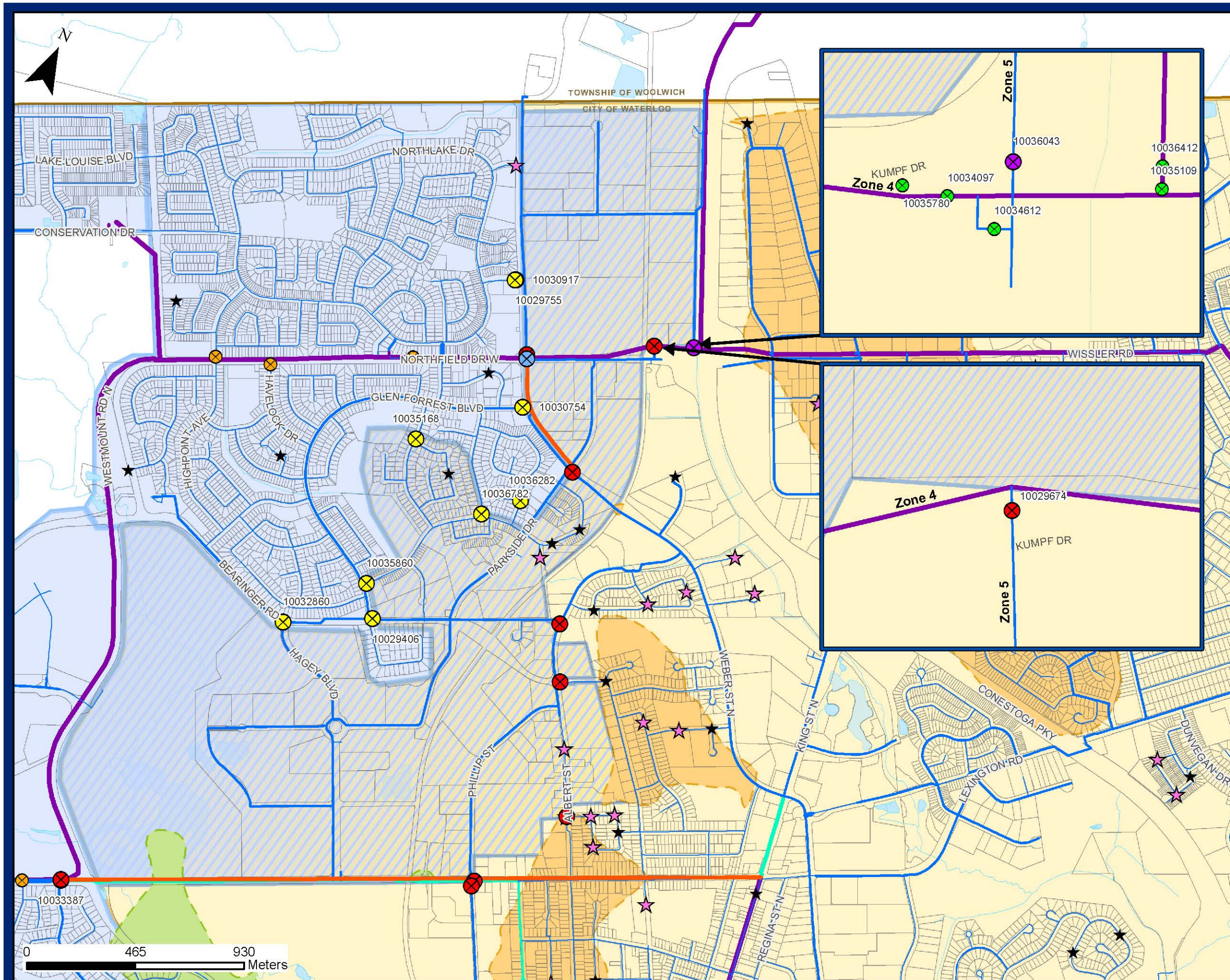
**Figure 26 - Water System Upgrade
Alternative Cluster Area D -
Preferred Alternative (valving)**



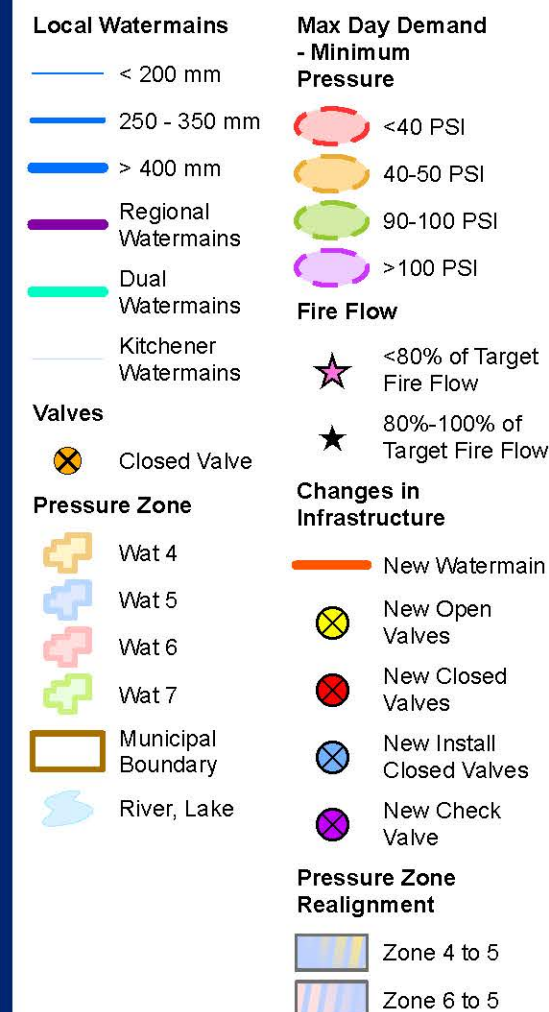


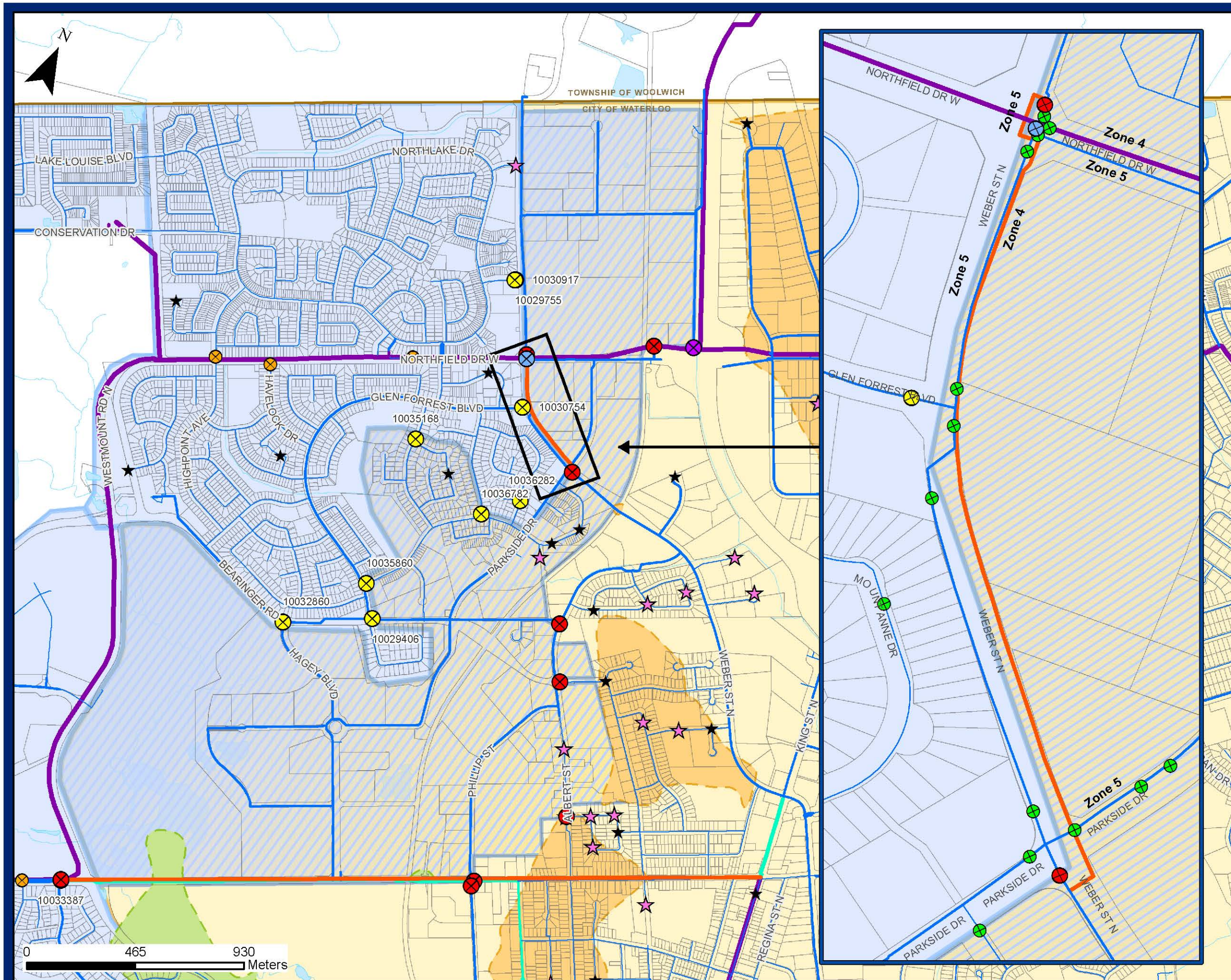
**Figure 27 - Water System Upgrade
Alternative Cluster Area D -
Preferred Alternative (valving)**





**Figure 28 - Water System Upgrade
Alternative Cluster Area D -
Preferred Alternative (valving)**





**Figure 29 - Water System Upgrade
Alternative Cluster Area D -
Preferred Alternative (valving)**

3.5 Cluster Area E

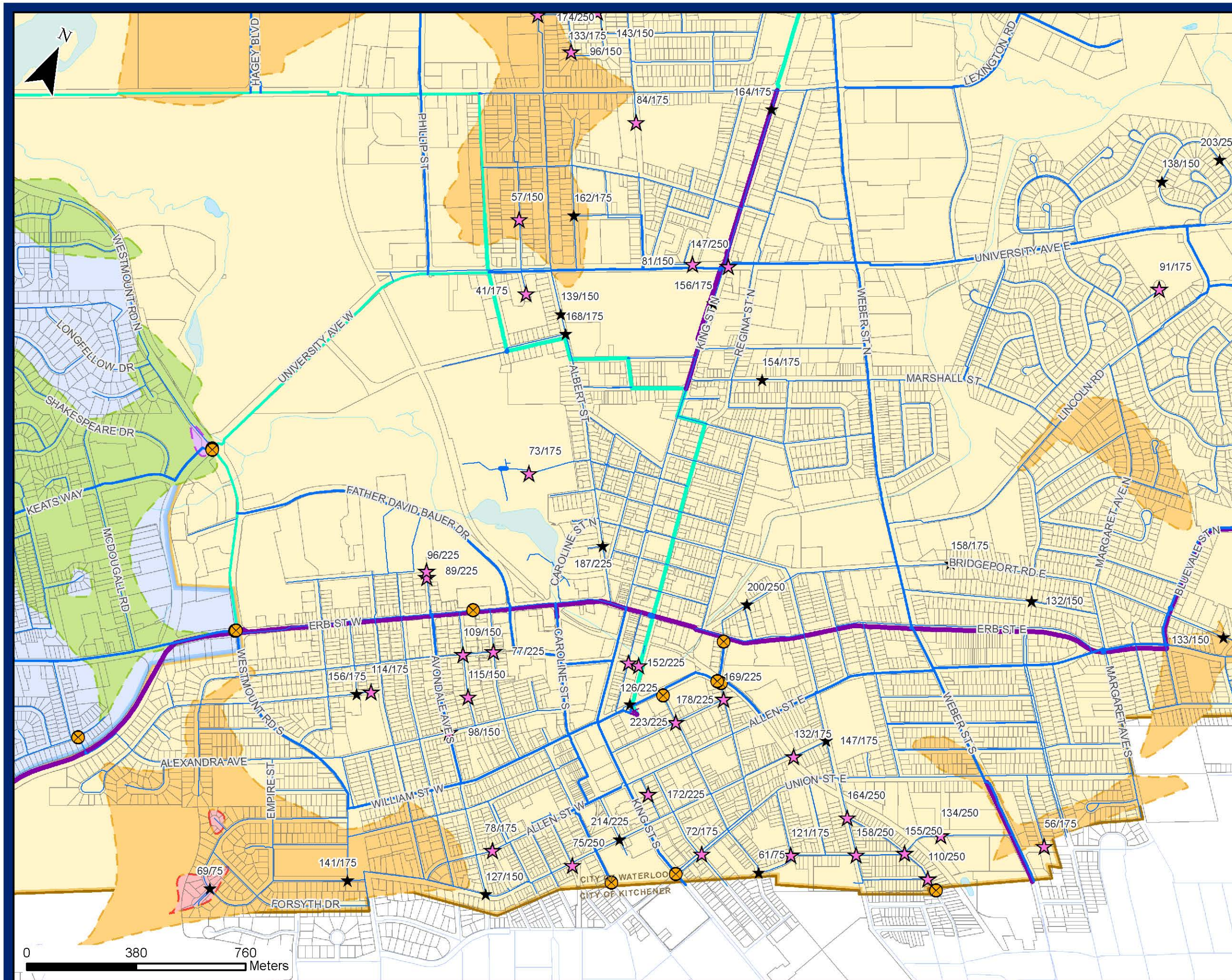
Cluster Area E is located in the intensification core of the City which consists of Uptown Waterloo, Northdale area and surrounding intensification areas. Higher fire flows are required in this area as intensification occurs. Therefore, the Cluster Area experiences fire flows below the level of service objectives. **Figure 30** highlights the low fire flows in Cluster Area E. Alternatives to address Cluster Area E are as follows:

3.5.1 Cluster Area E: Option 1 – Do Nothing

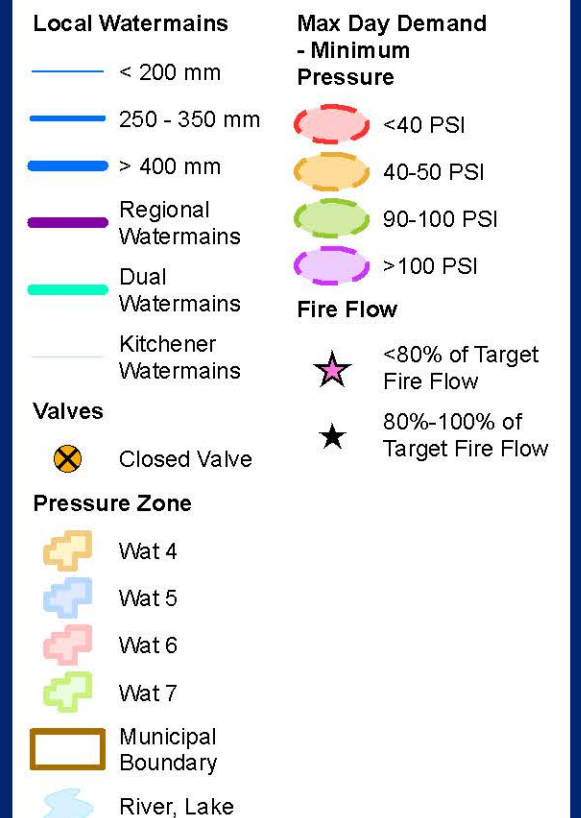
The “Do Nothing” option consists of maintaining the existing water system (no upgrades to the water system). This option does not address fire flow Action deficiencies.

3.5.2 Cluster Area E: Option 2 – Local Upsizing

The rehabilitation, replacement, or upsizing of watermain within the intensification core to a minimum diameter of 200 mm will result in higher fire flows. This process will be done in conjunction with the City’s infrastructure renewal program to rehabilitate or replace other right-of-way infrastructure.



**Figure 30 - Water System Upgrade
Alternative Cluster Area E -
Baseline**



3.5.3 Cluster Area E: Evaluation

The evaluation process is summarized in **Table 8** and further detailed in **Appendix A**.

Table 8 - Cluster Area E - Evaluation

Criteria	Option 1 Do Nothing	Option 2 Local Upsizing
Technical Viability	Generally Easy	Yes
Meets Pressure Objectives	Not required	Yes
Meets Fire Flow Objectives	No	Yes
Operation and Maintenance	-	No change
Impact to Criticality	No change	No change
Property Impacts	None	None
Traffic Impacts	None	Major
Capital Costs	\$0	\$40 million
Cost per Improvement	\$0	-
Evaluation	Does not meet fire flow requirements needed for growth in the intensification core	Requires upsizing to meet fire flow objectives relative to growth

3.5.4 Cluster Area E: Recommended Solution

The recommended solution for the deficiencies in Cluster Area E was **Option 2 – Local Upsizing** as the existing water infrastructure within the core intensification areas is not sufficient to meet the desired fire flow targets. Option 2, with the targeted upsizing of local watermain, will allow for supplementation of fire flows within these core intensification areas.

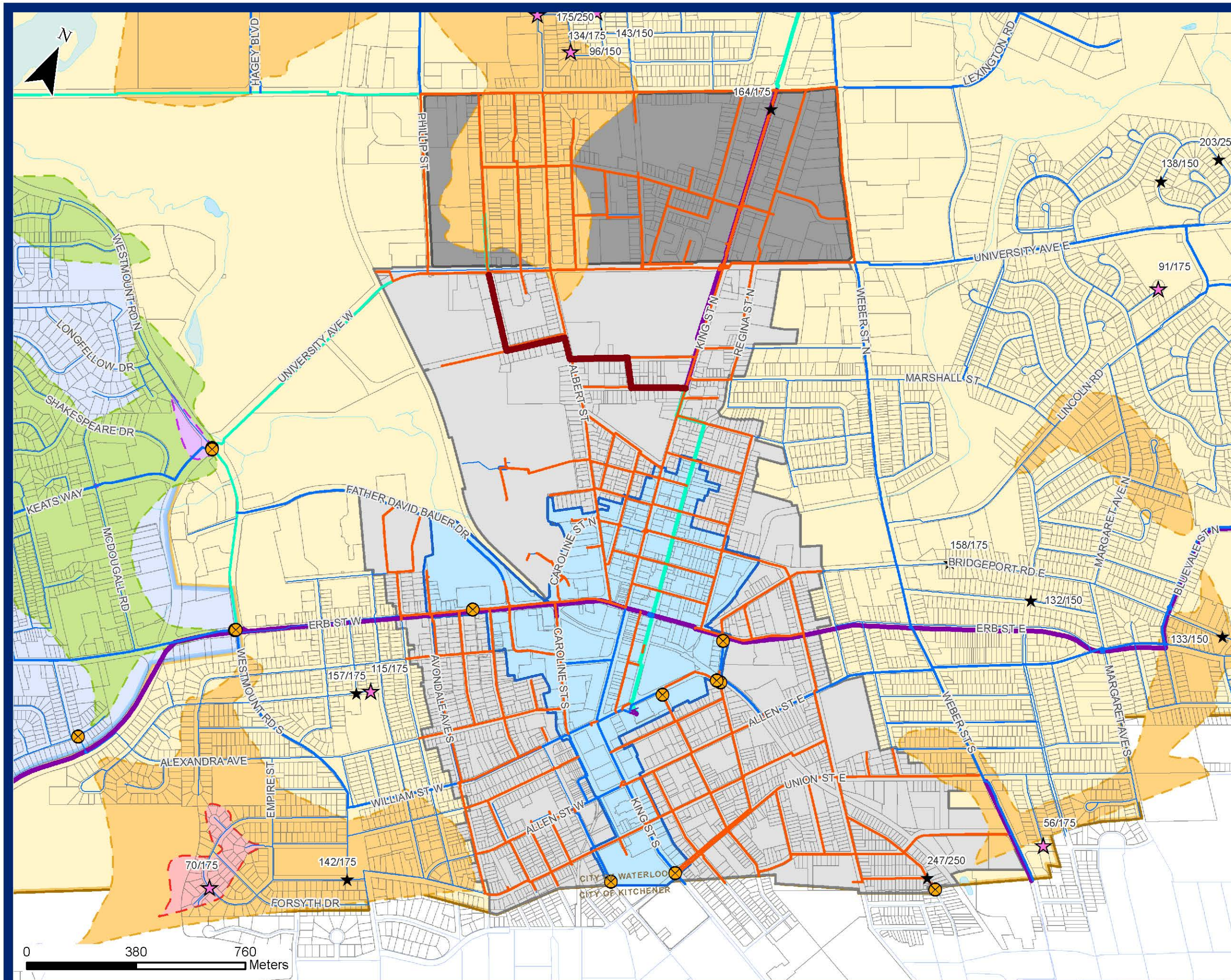
Additional information regarding which watermain require upsizing are provided in the electronic deliverables submitted to the City as part of the WDMP. **Figure 31** shows the location the watermain to be upsized.

3.5.5 Cluster Area E: Costing

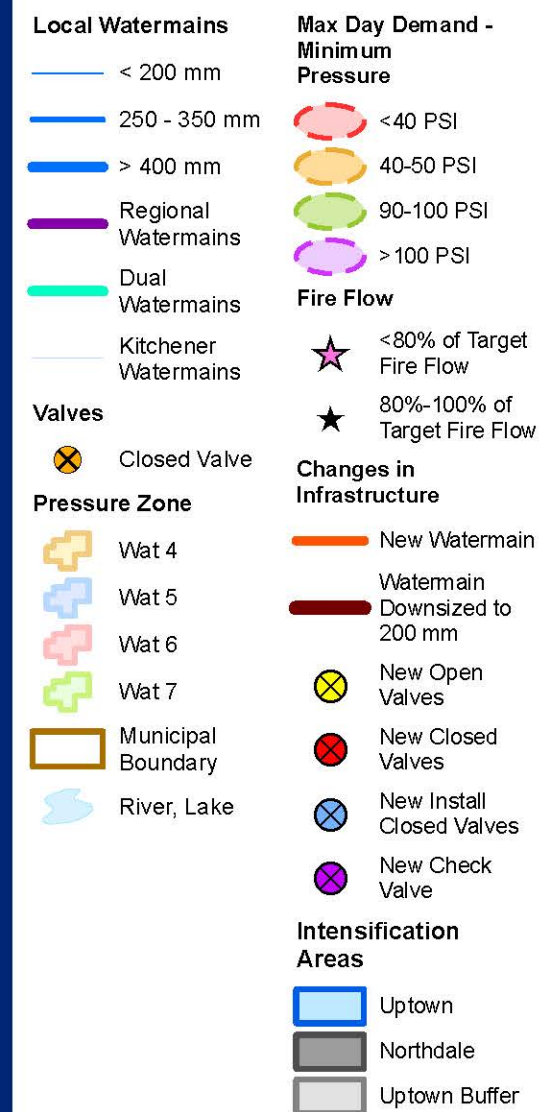
The costs associated the Area E Recommended Solution are summarized in **Table 9** totalling \$40,000,000.

Table 9 - Cluster Area E – Recommended Solution Costing

		Install New Watermain
	Number of Units	36,000 m
Base Construction Costs	Base Cost	\$23,400,000
	Uplift Cost	\$4,680,000
	Total Base Cost	\$28,080,000
Total Construction Costs	Engineering and Design Cost	\$5,616,000
	Contingency Cost	\$6,739,200
	Total Cost	\$40,435,200



**Figure 31 - Water System Upgrade
Alternative Cluster Area E -
Option 2**



3.6 Group 1 Localized System Deficiencies

When the recommendations to address the Group 2 Cluster Area deficiencies are implemented, there are still some additional areas throughout the system that experience fire flows below level of service flags and requirements. These areas are not within a Cluster Area and are not centralized. Alternatives to address these are as follows:

3.6.1 Group 1 Localized System Deficiencies: Option 1 – Do Nothing

The “Do Nothing” option consists of maintaining the existing water system (no upgrades to the water system). This option does not address fire flow Action deficiencies.

3.6.2 Group 1 Localized System Deficiencies: Option 2 – Infrastructure Improvements excluding dead End Upsizing

The rehabilitation, replacement, or upsizing of deficient watermain (excluding systems dead ends) as part of the City’s ongoing infrastructure renewal program informed through their asset management planning processes. This option does not include the rehabilitation, replacement or upsizing of system dead ends.

3.6.3 Localized System Deficiencies: Option 3 – Infrastructure Improvements Including dead End Upsizing

The rehabilitation, replacement, or upsizing of deficient watermain (including systems dead ends) as part of the City’s ongoing infrastructure renewal program informed through their asset management planning processes. This option does include the rehabilitation, replacement or upsizing of system dead ends.

3.6.4 Localized System Deficiencies: Recommended Solution

The recommended solution to address cluster-wide fire flows was ***Option 3 – Infrastructure Improvements Including Dead End Upsizing*** as it best addressed the Group 1 deficiencies. While the infrastructure improvements (replacement or upsizing of watermain) on system dead ends will result in improved fire flows, it will also increase water age, which is the primary proxy indicator for water quality. However, a dead end analysis (**Technical Appendix #6**) determined that the majority of system dead ends could be upsized to improve fire flow performance without significantly impacting water quality.

Additional information regarding which the recommended renewal intervention for each watermain are provided as part of the electronic deliverables of the WDMP.

3.6.5 Localized System Deficiencies: Costing

The Group 1 deficiencies represent existing issues which are not expected to deteriorate over time and consist primarily of “Flag” deficiencies. Therefore it was determined that proactive upgrade projects would not be triggered to address these Group 1 deficiencies. Instead, these deficiencies would be addressed on a case by case basis within the existing process to establish the City’s infrastructure renewal program. To this end, the final electronic deliverables provided to the City does identify the specific watermain upgrade recommendations needed to address these deficiencies (i.e. reline or replace with same diameter, replace with 200 mm watermain, etc.). However, no project cost or timing were recommended for these infrastructure renewal recommendations. It is expected that the funding will be derived from the City’s existing infrastructure renewal program and the timing will be coordinated through the City’s Asset Management planning processes.

4 Easement Watermains

Watermains which pass through easements are difficult to maintain due to limited space available for work activities. The City would like to eliminate as many of these watermains as possible without negatively impacting the system causing additional deficiencies. The City currently has 84 watermains which pass through an easement, of which, 22 can be decommissioned with minimal impacts on system performance and levels of service. **Figure 32** and **Table 10** summarize the findings of the easement decommissioning review.

Note: Watermain 10004358 should remain in operation until the Regional Wat 5 transmission watermain on Beaver Creek Drive Road to Conservation Drive is completed.

Note: Prior to decommissioning watermains 10009235 and 10009424, Waterloo Fire Rescue should be consulted as the decommissioning will decrease available fire flow at the vulnerable property located at 444 Malabar Drive.

4.1 Easement Watermains: Costing

It is assumed that decommissioning as part of the City's ongoing infrastructure renewal program.

Table 10 - Easement Watermains to be Decommissioned

Watermain ID	Watermain Length (m)	Watermain Material	Watermain Diameter (mm)	Easement Width (m)	Location
10006241	108	CI	150	3.6	159-172 Tennyson Place
10006787	1	PVC	150	3.0 - 4.0	176 Tennyson Place
10006088	3	CI	150	3.0 - 4.0	176 Tennyson Place
10003923	110	PVC	200	4.5	269-271 Old Post Road
10009743	58	CI	150	3.6	307-314 Shakespeare Place
10009314	128	DI	150	2.3	33-37 Roosevelt Avenue
10008009	93	CI	150	4.5	335-337 Craicleith Drive
10004195	1	DI	150	3.0	365-367 Lee Circle
10007869	62	DI	150	3.0	365-367 Lee Circle
10005567	3	DI	150	3.0	365-367 Lee Circle
10004823	87	DI	100	3.0	391-393 Craigleth Drive
10005742	6	DI	200	9.0	393-395 Stillmeadow Crescent
10007568	84	DI	200	1.8	408 Clairbrook Crescent
10007700	88	PVC	150	3.0	427-429 Barrington Lane

Watermain ID	Watermain Length (m)	Watermain Material	Watermain Diameter (mm)	Easement Width (m)	Location
10006776	50	DI	300	3.0	427-429 Winchester Drive
10009235*	39	PVC	150	6.0	435 Malabar Drive
10009424*	57	PVC	150	6.0	435 Malabar Drive
10003918	39	PVC	150	6.0	481-484 Citadel Court
10007822	43	PVC	200	4.0	522 524 Heather Hill Place
10004358	98	PVC	300	8.5	804-806 Cedar Bend Place
10007148	45	CI	300	4.4	82-84 Lillian Drive
10008833	116	PVC	300	3.0	North Of Beechwood Place Condos
10008264	2	PVC	300	3.0	North Of Beechwood Place Condos

* - Consult and confirm with Waterloo Fire Rescue prior to decommissioning as a decrease in available fire flow at the vulnerable property located at 444 Malabar Drive will be experienced.

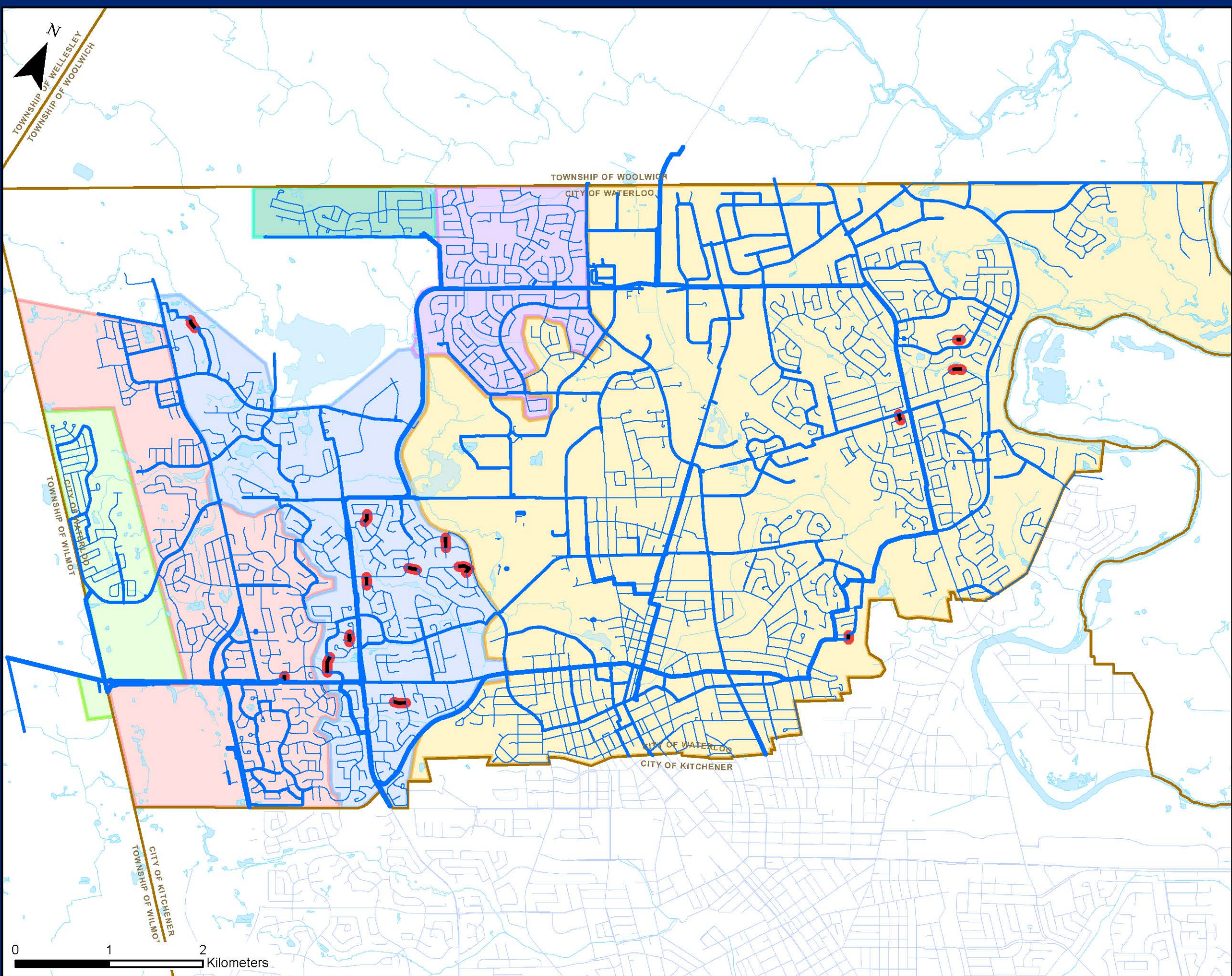


Figure 32 - Easement Watermains to be Decommissioned

- Local Watermains**
- < 200 mm
 - 250 - 350 mm
 - > 400 mm
 - Kitchener Watermains
- Changes in Infrastructure**
- Easement Watermains to be Decommissioned
- Pressure Zone**
- Wat 4
 - Wat 4B
 - Wat 4C
 - Wat 5
 - Wat 6
 - Wat 7
 - Municipal Boundary
 - River, Lake

5 Recommended Servicing Strategy

The recommended short and long-term servicing strategy for the City's water distribution system encompasses the cluster area recommendations and local improvements. **Figure 33** presents the final alternative encompassing the recommended local improvements.

This system relies on the implementation of Regional infrastructure outline in **Technical Appendix #1**. Further implementation triggers for each individual project are outline in **Technical Appendix #8**.

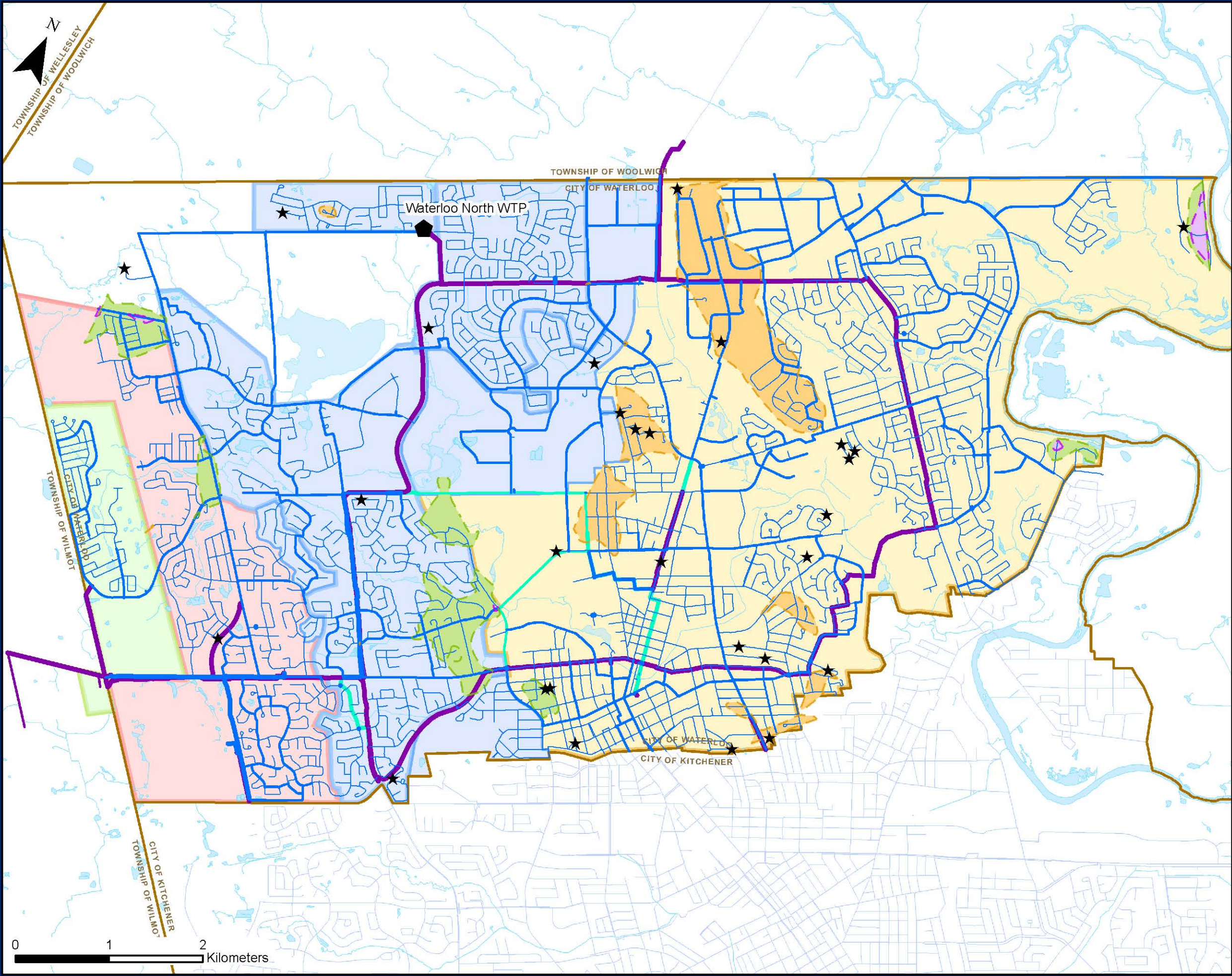


Figure 33 - 2031 Water System Performance With All Preferred Alternatives

Local Watermains		Max Day Demand - Minimum Pressure	
< 200 mm	< 40 PSI		
250 - 350 mm	40-50 PSI		
> 400 mm	90-100 PSI		
Regional Watermains	> 100 PSI		
Dual Watermains	Available Fire Flow		
Kitchener Watermains	< 80% of Target Fire Flow	80%-100% of Target Fire Flow	
Pressure Zone			
Wat 4			
Wat 5			
Wat 6			
Wat 7			
Municipal Boundary			
River, Lake			

APPENDIX A:

Waterloo Water Distribution Master Plan

Evaluation of Alternative Solutions by Cluster Area

- Few or no impacts / significant benefits 
- Moderate impacts / some benefits 
- Significant impacts / minimal or no benefits 

Table 1 - Cluster Area A

Evaluation Criteria		Option 1	Do Nothing	Option 2	Boundary Adjustment: Valving Only	Option 3	Boundary Adjustments: Valving and Looping
Technical							
Meets capacity for future growth	Yes			Yes		Yes	
Technical viability	No implementation required			Generally easy to implement		Generally easy to implement	
Meets water quality objectives	Yes			Yes		Yes	
Meets pressure objectives	No			Yes		Yes	
Meets fire flow objectives	Yes			Yes		Yes	
Operations and maintenance	Dead end flushing required			Use of a more efficient boundary valves would eliminate need for flushing		No dead end flushing required	
Impact to system criticality	No change			No change		Creates a secondary feed to zone 5 (north of Keats Way), resulting in a decrease in the criticality of alternative supply mains	
Environmental							
Environmentally sensitive features impacts	No environmental impacts			No environmental impacts		No environmental impacts	
Water features and resources impacts							
Species at Risk impacts							
Soil (contamination)							
Geology and hydrogeology considerations							
Social / Cultural							
Property impacts	None			Potential impact to private home service pressure reducing valves		Potential impact to private home service pressure reducing valves	
Traffic and transportation impacts	None			Minimal short-term disruption to traffic		Moderate short term disruption to traffic	
Construction impacts (noise, vibration, dust)	None			Minimal, short term		Moderate, short term	
Financial							
Capital / construction costs	\$0			\$0.08 million		\$0.9 million	
Operations and maintenance costs	No change			Small reduction in need to conduct flushing program		Small reduction in need to conduct flushing program; however, would result in an additional ~1 km of watermain that the City would have to operate and maintain in perpetuity	
Lifecycle cost	No change			Negligible change		Marginally higher	
Cost per Improvement	\$0			\$800/weighted improvement		\$9,000/weighted improvement	
Legal / Jurisdictional							
Land use requirements	None			None		None	
Integration with other local / regional plans	Not relevant to this area			Not relevant to this area		Not relevant to this area	
Coordination with other jurisdictions	Not relevant to this area			Not relevant to this area		Not relevant to this area	
Recommendation	Not recommended, recognizing that Area A deficiencies would not be fully addressed			Recommended for implementation as Area A deficiencies would be addressed at a relatively low cost		Not recommended, as the high costs to implement valving and looping don't justify the need address the deficiencies that exist in Area A	

Table 2 -Cluster Area B

Evaluation Criteria	Option 1 Do Nothing	Option 2 Boundary Adjustment: Valving Only	Option 3 Boundary Adjustments: Valving and Looping
Technical			
Meets capacity for future growth	Yes	Yes	Yes
Technical viability	No implementation required	Generally easy to implement	Generally easy to implement
Meets water quality objectives	Yes	Yes	Yes
Meets pressure objectives	Partially, meets Action pressure deficiencies but does not meet Flag pressure deficiencies	Yes	Yes
Meets fire flow objectives	Yes	Partially, creates additional fire flow deficiencies between 80-100% of required flow	Yes
Operations and maintenance	Dead end flushing required	Use of boundary valves would eliminate need for flushing	No dead end flushing required
Impacts to System Criticality	No change	No change	No change
Environmental			
Environmentally sensitive features impacts	No environmental impacts	No environmental impacts	No environmental impacts
Water features and resources impacts			
Species at Risk impacts			
Soil (contamination)			
Geology and hydrogeology considerations			
Social / Cultural			
Property impacts	None	None	None
Traffic and transportation impacts	None	Minimal short-term disruption to traffic	Moderate short term disruption to traffic
Construction impacts (noise, vibration, dust)	None	Minimal short term	Moderate, short term
Financial			
Capital / construction costs	\$0	\$0.06 million	\$0.15 million
Operations and maintenance costs	No change	Small reduction in need to conduct flushing program	Small reduction in need to conduct flushing program; however, would result in an additional ~150 m of watermain that the City would have to operate and maintain in perpetuity
Life cycle costs	No change	Negligible change	Marginally higher
Cost per Improvement	\$0	\$8,000/weighted improvement	\$12,000/weighted improvement
Legal / Jurisdictional			
Land use requirements	None	None	None
Integration with other local / regional plans	Not relevant to this area	Not relevant to this area	Not relevant to this area
Coordination with other jurisdictions	Not relevant to this area	Not relevant to this area	Not relevant to this area
Recommendation	Recommended , as the modest deficiencies that exist in Area B don't justify the excessive costs associated with Options 2 and 3. While the "Do Nothing" does not meet the Flag pressure flow objective, it does fully comply with regulatory, or Action, pressure requirements	<u>Not</u> recommended, as the excessive costs of valving don't justify the need to address the deficiencies that exist in Area B	<u>Not</u> recommended, as the excessive costs of valving and looping don't justify the need address the deficiencies that exist in Area B

Table 3 -Cluster Area C

Evaluation Criteria		Option 1 Do Nothing	Option 2 Boundary Adjustment to Westmount	Option 3 Boundary Adjustment to Roslin	Option 4 Boundary Adjustments to Avondale
Technical					
Meets capacity for future growth	Yes	Yes	Yes	Yes	Yes
Technical viability	No implementation required	Generally easy to implement	Generally easy to implement	Generally easy to implement	Generally easy to implement
Meets water quality objectives	Yes	Yes	Yes	Yes	Yes
Meets pressure objectives	No	Yes	Partially, creates an area of minor pressure deficiency between 90-100 PSI	Partially, creates an area of minor pressure deficiency between 90-100 PSI	
Meets fire flow objectives	No	Eliminates all but one minor fire flow deficiency between 80-100% of required flow within boundary change	Eliminates all but two minor fire flow deficiencies and creates one minor fire flow deficiencies between 80-100% of required flow within boundary change	Eliminates all but three minor fire flow deficiencies and creates one minor fire flow deficiencies between 80-100% of required flow within boundary change	
Operations and maintenance	Dead end flushing required	No dead end flushing required	No dead end flushing required	No dead end flushing required	No dead end flushing required
Impact to system criticality	No change	No change	No change	No change	No change
Environmental					
Environmentally sensitive features impacts	No environmental impacts	No environmental impacts	No environmental impacts	No environmental impacts	No environmental impacts
Water features and resources impacts					
Species at Risk impacts					
Soil (contamination)					
Geology and hydrogeology considerations					
Social / Cultural					
Property impacts	None	None	None	None	None
Traffic and transportation impacts	None	Construction - Major disruption to traffic along an arterial road; however, Westmount has is planned for reconstruction before 2031 and 660m of watermain can be installed as well during this time	Construction - Moderate short term disruption to traffic	Construction - Moderate short term disruption to traffic	
Construction impacts (noise, vibration, dust)	None	Major, short term	Moderate, short term	Moderate, short term	
Financial					
Capital / construction costs	\$0 million	\$0.8 million	\$0.7 million	\$0.7 million	
Operations and maintenance costs	No change	Small reduction in need to conduct flushing program; however, would result in an additional ~660 m of watermain that the City would have to operate and maintain in perpetuity	Small reduction in need to conduct flushing program; however, would result in an additional ~500 m of watermain that the City would have to operate and maintain in perpetuity	Small reduction in need to conduct flushing program; however, would result in an additional ~500 m of watermain that the City would have to operate and maintain in perpetuity	
Life cycle costs	No change	Marginal change	Marginal change	Marginal change	
Cost per improvement	\$0	\$8,000/weighted improvement	\$8,000/weighted improvement	\$13,000/weight improvement	
Legal / Jurisdictional					
Land use requirements	None	None	None	None	None
Compliance with local and regional planning policies	Not relevant to this area	Not relevant to this area	Not relevant to this area	Not relevant to this area	Not relevant to this area
Coordination with other jurisdictions					
Recommendation	<u>Not</u> recommended because the “Do Nothing” option does not meet pressure or fire flow objectives	<u>Recommended</u> for implementation given the modest costs associated with addressing Area C deficiencies and planned construction on Westmount	<u>Not</u> recommended, as pockets of minor pressure deficiencies are created even with similar capital costs, operations and maintenance costs, and relative cost per improvements	<u>Not</u> recommended, as the high capital costs and relative cost per improvement exceed those of Option 3 - without additional benefits	

Table 4 -Cluster Area D

Evaluation Criteria	Option 1 Do Nothing	Option 2 Minimal Boundary Adjustment	Option 3 Marginal Boundary Adjustment	Option 4 Medium Boundary Adjustment	Option 5 Major Boundary Adjustment
Technical					
Meets capacity for future growth	No	Yes	Yes	Yes	Yes
Technical viability	No implementation required	Generally easy to implement	Generally easy to implement	Generally easy to implement	Generally easy to implement
Meets water quality objectives	No	Yes	Yes	Yes	Yes
Meets pressure objectives	No	No	Yes	Yes	Yes
Meets fire flow objectives	No	Eliminates all but three Flag and two Action fire flow deficiency within boundary change	Eliminates all but three Flag and two Action fire flow deficiency within boundary change	Eliminates all but nine Flag and eight Action fire flow deficiency within boundary change	Eliminates all but twelve Flag and nine Action fire flow deficiency within boundary change
Operations and maintenance	Dead end flushing required	No dead end flushing required	No dead end flushing required	No dead end flushing required	No dead end flushing required
Impact to system criticality	No change	No change	No change	No change	No change
Environmental					
Environmentally sensitive features impacts	No environmental impacts	No environmental impacts	No environmental impacts	No environmental impacts	No environmental impacts
Water features and resources impacts					
Species at Risk impacts					
Soil (contamination)					
Geology and hydrogeology considerations					
Social / Cultural					
Property impacts	None	None	Potential impact to private properties with existing booster pumps	Potential impact to private properties with existing booster pumps	Potential impact to private properties with existing booster pumps
Traffic and transportation impacts	None	Moderate short term disruption to traffic	Moderate short term disruption to traffic	Moderate short term disruption to traffic	Moderate short term disruption to traffic
Construction impacts (noise, vibration, dust)	None	Moderate, short term	Moderate, short term	Moderate, short term	Moderate, short term
Financial					
Capital / construction costs	\$0	\$0.8 million (City) \$4.2 million (Region)	\$0.9 million (City) \$4.2 million (Region)	\$1.0 million (City) \$4.2 million (Region)	\$1.2 million (City) \$4.2 million (Region)
Operations and maintenance costs	No change	Reduction in need to conduct flushing program; however, would result in an additional ~600 m of watermain that the City would have to operate and maintain in perpetuity	Reduction in need to conduct flushing program; however, would result in an additional ~600 m of watermain that the City would have to operate and maintain in perpetuity	Reduction in need to conduct flushing program; however, would result in an additional ~600 m of watermain that the City would have to operate and maintain in perpetuity	Reduction in need to conduct flushing program; however, would result in an additional ~850 m of watermain that the City would have to operate and maintain in perpetuity
Life cycle costs	No change	Marginal change	Marginal change	Marginal change	Marginal change
Cost per improvement	\$0	\$4,000/weighted improvement	\$4,500/weighted improvement	\$4,000/weighted improvement	\$9,000/weighted improvement
Legal / Jurisdictional					
Land use requirements	None	None	None	None	None
Integration with other local / regional plans	Not relevant to this area	Not relevant to this area	Not relevant to this area	Not relevant to this area	Not relevant to this area
Coordination with other jurisdictions	Not relevant to this area	Not relevant to this area	Not relevant to this area	Not relevant to this area	Not relevant to this area
Recommendation	Not recommended because the “Do Nothing” option does not meet future servicing capacity	Not recommended, as Option 2 does not address all of Area D deficiencies while also relatively high operations and maintenance costs and cost per improvement	Recommended, as Option 3 addresses Area D deficiencies through lower costs and general ease of implementation through minimized valve adjustments	Not recommended, as Option 4 will require more valve modifications than Option 3, resulting in more implementation challenges.	Not recommended, as Option 5 exhibits higher operations and maintenance costs and relative cost per improvement versus other options without generating additional benefits

Table 5 -Cluster Area E

Evaluation Criteria		Option 1 Do Nothing	Option 2 Local Upsizing (Intensification Area)
Technical			
Meets capacity for future growth	No		Yes
Technical viability	No implementation required		Generally easy to implement
Meets water quality objectives	No		Yes
Meets pressure objectives	Yes		Yes
Meets fire flow objectives	No		Yes
Operations and maintenance	-		No additional
Impact to system criticality	No change		No change
Environmental			
Environmentally sensitive features impacts	No environmental impacts		No environmental impacts
Water features and resources impacts			
Species at Risk impacts			
Soil (contamination)			
Geology and hydrogeology considerations			
Social / Cultural			
Property impacts	None		None
Traffic and transportation impacts	None		Major disruption to traffic in Uptown core
Construction impacts (noise, vibration, dust)	None		Moderate
Financial			
Capital / construction costs	\$0		\$40 million
Operations and maintenance costs	No change		No change
Life cycle costs	No change		Moderate change
Cost per improvement	\$0		\$112,000/weighted improvement
Legal / Jurisdictional			
Land use requirements	None		None
Integration with other local / regional plans	Not relevant to this area		Not relevant to this area
Coordination with other jurisdictions	Not relevant to this area		Not relevant to this area
Recommendation	Not recommended because the “Do Nothing” option does not meet future servicing capacity		Recommended, as Uptown, Northdale, and intensification area require upsizing to meet fire flow objective relative to growth