UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

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UCC File: 23163

# FUNCTIONAL SERVICING REPORT

# 524 & 528 QUAKER ROAD

# CITY OF WELLAND
# September 2025

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## INTRODUCTION

The purpose of this Functional Servicing Report (FSR) is to address the municipal servicing requirements for the proposed mixed use residential/commercial condominium development located at 524 & 528 Quaker Road in the City of Welland. The subject lands are situated in the western portion of the Northwest Welland Secondary Plan (NWWSP) Area in the City of Welland, on the north side of Quaker Road, west of Regional Road 54 (Rice Road), and east of Line Avenue.

The development area is approximately 0.51 hectares and will consist of a single 7 storey mixed use commercial/residential building. The subject lands will be developed to include associated asphalt driveway/parking lot area, concrete curb, catch basins, storm sewers, sanitary service, and water service.

The objectives of this report are as follows:

1. Identify domestic and fire protection water servicing needs for the site;
2. Identify sanitary servicing needs for the site; and,
3. Identify stormwater management needs for the site.

As part of the Northwest Welland Secondary Plan (NWWSP), a Conceptual Municipal Servicing Design Report was prepared by Associated Engineering on behalf of the City of Welland. This design report assessed the existing municipal infrastructure (water, sanitary, and storm) to service the Secondary Plan Area, and provided a conceptual framework to identify the locations where new or upgraded infrastructure will be required to support future development. The updated report (June 2024) has been included in Appendix F.

**WATER SERVICING**

There is an existing 300mm diameter Municipal watermain located on Quaker Road. It is proposed to connect a single water service from the existing 300mm diameter watermain on Quaker Road, and extend the service to the proposed building to provide both domestic water supply and fire protection.

The exact size and location of the proposed water service will be determined as part of the Detailed Engineering Design.

The Conceptual Municipal Servicing Design Report assessed the City of Welland watermain model to determine the required watermain sizes to provide adequate domestic water supply and fire protection to a minimum fire flow of 133L/s within the Secondary Plan area.

The estimated peak domestic and commercial water demands have been summarized in Table 1 for the proposed 68 condominium units (136 persons), using an average residential flow rate of 270 L/capita/day. Domestic peaking factors for the maximum daily and maximum hourly demands were taken from Table 3-1 of the Ministry of the Environment Design Guidelines for Drinking Water Systems. It is assumed that the commercial flow is at a rate of 28,000 L/ha/day per Section 3.4.3 of the MECP Guidelines. Commercial peaking factors for the maximum daily and maximum hourly demands were assumed to be 1.5 and 2.0 respectively. All peak demands will be confirmed as part of the Detailed Engineering Design.

| Table 1. Estimated Peak Water Demand | |
|---|---|
| **Estimated Peak Domestic Water Demand** | |
| **Average Domestic Demand**<br>*270 L/cap/day; 136 persons* | **0.43 L/s** |
| Maximum Day Domestic Peaking Factor | 2.75 |
| **Maximum Day Domestic Demand** | **1.18 L/s** |
| Peak Hour Domestic Peaking Factor | 4.13 |
| **Peak Hour Domestic Demand** | **1.78 L/s** |
| **Estimated Peak Commercial Water Demand** | |
| **Average Commercial Demand**<br>*28,000 L/ha/day; 0.51ha* | **0.17 L/s** |
| Maximum Day Commercial Peaking Factor | 1.5 |
| **Maximum Day Commercial Demand** | **0.26 L/s** |
| Peak Hour Commercial Peaking Factor | 2.0 |
| **Peak Hour Commercial Demand** | **0.34 L/s** |
| **Estimated Peak Total Water Demand** | |
| **Total Maximum Day Demand** | **1.44 L/s** |
| **Total Peak Hour Demand** | **2.12 L/s** |

There are municipal fire hydrants located in front of 518 Quaker Road and 544 Quaker Road, on the South Side of Quaker Road. I required, a private fire hydrant can be installed within the subject lands to provide fire protection for the proposed mixed use building in accordance with Ontario Building Code Requirements.

As assessed in the Conceptual Municipal Servicing Design Report, the existing 300mm diameter watermain on Quaker Road will ultimately support a minimum fire flow of 133 L/s. Therefore, as fire flow requirements are dependent on the detailed building design, and the building design is determined in accordance with the available flows for fire fighting in the existing system, there is expected to be adequate capacity for domestic water supply and fire protection.

## SANITARY SERVICING

There is presently a 300mm diameter Municipal sanitary sewer flowing easterly on Quaker Road, which connects to the Regional 750mm diameter sanitary trunk sewer which flows easterly on Quaker Road, and ultimately outlets to the Towpath Sanitary Pumping Station (SPS). Future sanitary flows from the subject lands will be conveyed to the existing municipal sewer on Quaker Road via a single private sanitary service. The location of the proposed sanitary service will be determined as part of the Detailed Engineering Design

A total sanitary drainage area of 0.51 hectares and an approximate population of 136 persons has been allocated for the subject lands. A commercial sanitary flow of 28,000 L/ha/day has been assumed in accordance with the domestic water demand. The future peak sanitary flow from the subject lands is calculated to be 1.89L/s as shown in the detailed sanitary flow calculations provided in Appendix A.

As part of the City of Welland's Conceptual Municipal Servicing Design Report, the existing sanitary flows within the 300mm diameter Municipal sanitary sewer were evaluated in addition to the future development within the properties on the south side of Quaker Road, west of Rice Road. The external flow within the existing 300mm diameter sanitary sewer is 44.70 L/s, per the calculations provided in Appendix B of the Design Report. Therefore, the total proposed flow in the 300mm diameter sewer is 46.74 L/s including the subject lands, which is 60.8% of the 76.80 L/s full flow capacity as shown in the detailed sanitary flow calculations provided in Appendix B of this report.

Additionally, the external upstream flows within the 750mm diameter Regional trunk sewer is 176.80 L/s (97.70 L/s from the Regional 600mm diameter trunk on Rice Road, and 79.10 L/s from the recently constructed 600mm diameter Regional sanitary sewer on Quaker Road, west of Rice Road). Therefore, the total combined flow at the Regional trunk sewer is 223.54 L/s including the subject lands, which occupies 41.0% of the 544.75 L/s full flow capacity as shown in the detailed sanitary flow calculations provided in Appendix A of this report.

Therefore, the receiving Municipal and Regional sanitary sewer system is expected to have adequate capacity to receive the future sanitary flows from the subject lands.

## STORMWATER MANAGEMENT

As part of the development of the NWWSP, both Quaker Road and Regional Road 54 (Rice Road) are to be reconstructed to a full urban cross section, including curb and gutter, catch basins, and municipal storm sewers which convey future stormwater flows to the Towpath Drain, approximately 260m north of the intersection of Quaker Road and Rice Road. Upper Canada Consultants has been retained by the City of Welland to prepare the 30% design of Quaker Road and the future storm sewers to the outlet into the Towpath Drain.

The future storm sewers will be designed to receive 5 year stormwater flows from the properties on the north side of Quaker Road at an existing runoff coefficient of 0.40, which will include the subject lands. Therefore, future 5 year stormwater flows from the subject lands are limited to the allocated runoff coefficient of 0.40.

### Quantity Controls

It is proposed to develop the 0.51 hectare site as a mixed-use condominium development, which will include a new proposed mixed-use building and associated parking lot/driveway area.

In accordance with the City of Welland Design Standards, a runoff coefficient of 0.80 is applicable to this site, which indicates a significant increase in impervious area compares to the allocated runoff coefficient of 0.40. Therefore, stormwater quantity controls are required for the site.

#### *5 Year Storm Event*

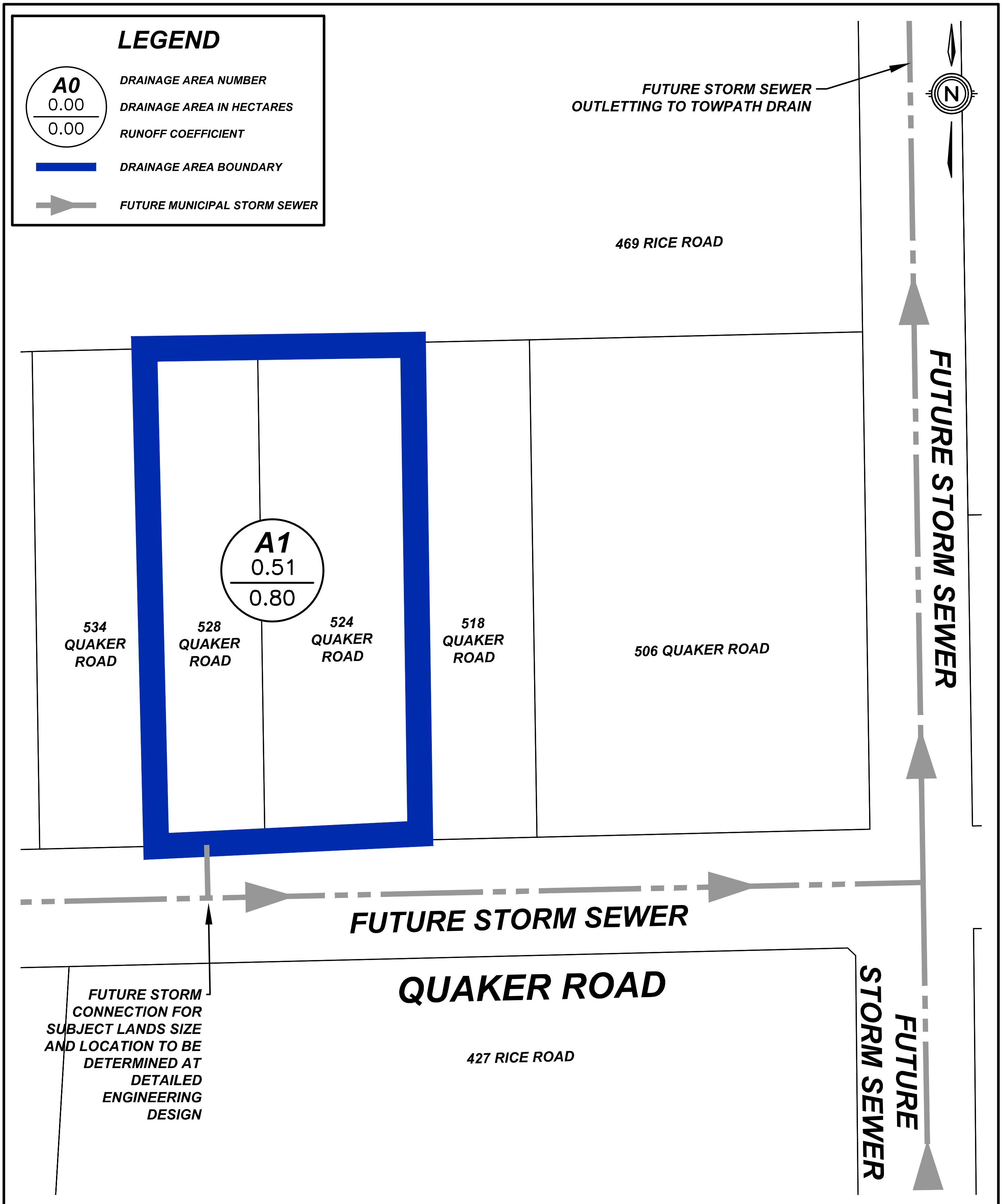
Modified Rational Method calculations have been prepared to estimate the allocated and future peak 5 year design storm flows from the subject lands and are included in Appendix B. During the 5 year event, the subject lands generate a peak flow of 51.3 L/s at the allocated runoff coefficient of 0.40. The peak flow rate is increased to 102.7 L/s for the runoff coefficient of 0.80 at post-development conditions.

As shown in the Modified Rational Method Calculations (Appendix B), a minimum of 23.0 $m^3$ of on-site stormwater storage is required to control future stormwater flows to 51.3 L/s. The proposed internal storm sewers will serve as underground stormwater storage in addition to a control orifice to limit future peak stormwater flows from the site.

Approximately 80 m of 600 mm diameter storm sewer can be constructed internally to provide 23.0 $m^3$ of stormwater storage. Preliminary calculations indicate that a 175mm diameter orifice located at the site outlet can limit future peak flows to 49.0 L/s with an overall storage depth of 0.66 m in the system as shown in Appendix B.

Therefore, adequate stormwater storage can be provided on-site to control future 5 year design storm flows to allowable levels.

Detailed stage-storage calculations will be provided as part of the Detailed Engineering Design in addition to the size and location of the storm sewer connection to the future Rice Road storm sewers.





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**506 QUAKER ROAD**

CITY OF WELLAND

**FUTURE STORMWATER DRAINAGE AREAS**

| | |
|---|---|
| DATE | 2025–08–14 |
| SCALE | 1:1000 m |
| REF No. | 2180 |
| DWG No. | FIGURE 1 |

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***100 Year Storm Event***
Site major overload flows (in excess of the 5 year event) will be conveyed overland to the road allowances of Quaker Road and Rice Road, then outlet to the Towpath Drain, which remains unchanged from present conditions.

As part of the Stormwater Management Implementation Plan that UCC prepared for the NWWSP, the overall existing stormwater drainage areas were assessed for the Towpath Drain as shown in the Existing Stormwater Drainage Area Plan provided in Appendix C. The existing stormwater drainage areas upstream of the subject lands, west of Rice Road, which outlet to the Towpath Drain (Areas A1 to A4) was calculated to be 89.41 hectares, with an overall runoff coefficient of 0.38 (26% Impervious), for a total existing A*R value of 33.98.

Assuming the subject lands conveyed future 100 year flows entirely uncontrolled, the overall A*R would increase from 33.98 to 34.20, or 0.6%. The resulting change in A*R would not change the overall runoff coefficient of 0.38 for the areas west of Rice Road and will have an even lesser impact on the areas further downstream of Rice Road as the overall drainage area increases (Areas A6 to A8).

Therefore, there will be negligible impact to the future peak 100 year flows as a result of the proposed development and additional quantity controls for the 100 year design storm event are not considered necessary.

**Quality Controls**

To improve stormwater quality levels for this site, a stormwater oil/grit separator (OGS) is proposed. The OGS will be located within a maintenance hole located upstream of the site outlet to the future Rice Road storm sewers.

As per the City of Welland requirements, oil/grit separators are required to provide a minimum average of 80% Total Suspended Solids (TSS) Removal (Enhanced protection). The contributing drainage area from the proposed development and adjacent lands to the proposed oil/grit separator is 0.51 hectares. The Hydroworks modelling software has indicated that an HD5 will provide 80.1% TSS overall removal and capture 99.0% of the stormwater flows. Therefore, A Hydroworks HD5 is proposed for the site development. The modelling output file has been provided in Appendix D.

## MAINTENANCE OF STORMWATER MANAGEMENT FACILITY

**HD5 Oil/Grit Separator**
The function of the proposed stormwater quality protection facility, a stormwater oil/grit separator, will require maintenance on an annual basis. The following is a summary of the maintenance activities required.

Regular inspections of the stormwater Maintenance Hole (MH) oil/grit interceptor will indicate whether maintenance is required or not. They should be made after every significant storm during the first two years of operation to ensure that it is functioning properly. This will translate into an average of six inspections per year.

Points of regular inspections are as follows:

a) Is there sediment in the separator sump? The level of sediment can be measured from the surface without entry into the oil/grit separator via a dipstick tube equipped with a ball valve (Sludge Judge) or with a graduated pole with a flat plate attached to the bottom.

b) Is there oil in the separator sump? This can be checked from the surface by inserting a dipstick in the 150mm vent tube. The presence of oil is usually indicated by an oily sheen, frothing or unusual colouring. The separator should be cleaned in the event of a major spill contamination.

c) Is there debris or trash at the inlet weir and drop pipe? This can be observed from the surface without entry into the separator. Clogging at the inlet drop pipe will cause stormwater to bypass the sedimentation section and continue downstream without treatment.

d) Completion of the Inspection Report (a sample report is included in Appendix E for reference purposes). These reports will provide details about the operation and maintenance requirements for this type of stormwater quality device. After an evaluation period (usually 2 years) this information will be used to maximize efficiency and minimize the costs of operation and maintenance for the maintenance hole oil/grit separator.

Typically, stormwater MH oil/grit separators are cleaned out using vacuum pumping. No entry into the unit is required for maintenance. Cleaning should occur annually or whenever the accumulation reaches sediment storage specified by the manufacturer and after any major spills have occurred. Oil levels greater than 2.5 centimeters should be removed immediately by a licensed waste management firm.

Generally, the sediment removed from the separator will not be contaminated to the point that it would be classified as hazardous waste. However, the sediment should be tested to determine the disposal options. The Ministry of Environment, Conservation and Parks publishes sediment disposal guidelines which should be consulted for up-to-date information pertaining to the exact parameters and acceptable levels for the various disposal options. The preferred option is an off-site disposal, arranged by a licensed waste management firm.

The future owners of a Hydroworks facility are provided with an Owner's Manual upon installation, which explains the function, maintenance requirements and procedures for the facility with extensive use It is recommended to follow the manufacturers instructions to allow the oil/grit separator to perform as intended.

## CONCLUSIONS AND RECOMMENDATIONS

Therefore, based on the above comments and design calculations provided for this site, the following summarizes the servicing for this site:

1. The existing municipal watermain system is expected to have adequate capacity to provide both domestic and fire protection water supply for the subject lands.

2. The receiving 300mm diameter municipal sanitary sewer and 750mm diameter Regional trunk sewer are expected to have adequate capacity to service the subject lands.

3. Stormwater quantity controls up to and including the 5 year design storm event can be provided with on-site storm sewer storage and a 175mm diameter orifice.

4. 100 year quantity controls are not considered necessary.

5. A Hydroworks HD5 Oil/Grit Separator can provide MECP Enhanced stormwater quality improvements (80% TSS Removal) for the subject lands.

Based on the above and the accompanying calculations, there exists adequate municipal infrastructure for this development. We trust the above comments and enclosed calculations are satisfactory for approval. If you have any questions or require additional information, please do not hesitate to contact our office.

Respectfully Submitted,
Prepared By:

Taia Mussari, B.Eng.

LICENSED PROFESSIONAL ENGINEER
B. J. KAPTEYN
100509155
PROVINCE OF ONTARIO

Reviewed By:

Brendan Kapteyn, P.Eng.
September 25, 2025

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# APPENDICES

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# APPENDIX A

## Sanitary Sewer Calculations

**UPPER CANADA CONSULTANTS**
**30 HANNOVER DRIVE, UNIT 3**
**ST.CATHARINES, ON, L2W 1A3**

| **DESIGN FLOWS** | | | **SEWER DESIGN** | | |
|---|---|---|---|---|---|
| RESIDENTIAL: | 255 | LITRES/PERSON/DAY (AVERAGE DAILY FLOW) | PIPE ROUGHNESS: | 0.013 | FOR MANNING'S EQUATION |
| INFILTRATION RATE: | 0.286 | LITRES/HECTARE (MECP EXTRANEOUS FLOW ALLOWANCE) | PIPE SIZES: | 1.016 | IMPERIAL EQUIVALENT FACTOR |
| POPULATION / DENSITY: | 2.0 | PERSONS / UNIT (APARTEMENT BUILDINGS) | PERCENT FULL: | | TOTAL PEAK FLOW / CAPACITY |
| COMMERCIAL: | 28000 | LITRES/HECTARE/DAY (AVERAGE COMMERCIAL DAILY FLOW) | | | |

**MUNICIPALITY:** CITY OF WELLAND
**PROJECT :** 506 QUAKER ROAD
**PROJECT NO:** 2180

## S A N I T A R Y S E W E R D E S I G N S H E E T

| **LOCATION** | | | **AREA** | | | | **ACCUMULATED PEAK FLOW** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Description** | **From M.H** | **To M.H.** | **Increment (hectares)** | **Accumulated (hectares)** | **Population Increment** | **Total Population Served (P)** | **Peaking Factor (PF)** | **Flow (L/s)** | **Infiltration Flow L/s** | **Total Peak Flow (L/s)** | **Pipe Diameter (mm)** | **Pipe Slope (%)** | **Full Flow Velocity (m/s)** | **Full Flow Capacity (L/s)** | **Percent Full** |
| A1 - Commercial Flows | SITE | EX MH | 0.51 | 0.51 | 136 | 136 | 1.50 | 0.21 | 0.15 | 0.36 | | | | | |
| A1 - Residential Flows | SITE | EX MH | | 0.51 | | 136 | 4.20 | 1.69 | 0.15 | 2.04 | 200 | 0.40 | 0.7 | 21.64 | 9.4% |
| | | | | | | | | | | | | | | | |
| **EX Flows from Hurricane SPS/Rice Road (North of Quaker) per Appendix B of City of Welland Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report** | | | | | | | | | | | | | | | |
| External Quaker Road Flows (West of Rice) | | | | | | 136 | 4.20 | 1.69 | 0.00 | 44.70 | | | | | |
| Total Flow in Municipal 300mm dia. Sewer on Quaker Road | | | | | | | | | | 46.74 | 300 | 0.58 | 1.1 | 76.83 | 60.8% |
| External Flows from Hurricane SPS/Rice Road (North of Quaker) | | | | | | | | | | 97.70 | | | | | |
| External Flows feom West of Quaker and Rice (From Line Ave) | | | | | | | | | | 79.10 | | | | | |
| Combined flow at Regional 750mm dia. | | | | | | | | | | 223.54 | 750 | 0.22 | 1.2 | 544.75 | 41.0% |

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# APPENDIX B

**Modified Rational Method (MRM) Calculations**
**Preliminary Stage Storage Calculations**

# STORM SEWER DESIGN SHEET

## PROJECT: 524/528 QUAKER ROAD, CITY OF WELLAND

| LOCATION | | | | | | TIME OF FLOW | | STORMWATER ANALYSIS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESCRIPTION | FROM M.H. | TO M.H. | PIPE LENGTH (m) | INCREMENT AREA (hectares) | TOTAL AREA (hectares) | TO UPPER END (min) | IN SECTION (min) | RUNOFF COEFF | SECTION A X R | ACCUMLD A x R | RAINFALL INTENSITY (mm/hr) | PEAK FLOW (L/s) |
| **EXISTING CONDITIONS** | | | | | | | | | | | | |
| EX | SITE | OUTLET | | 0.51 | 0.51 | 10.00 | 0.00 | 0.400 | 0.204 | 0.204 | 90.598 | 51.3 |
| **FUTURE CONDITIONS** | | | | | | | | | | | | |
| A10 - Controlled | SITE | OUTLET | | 0.51 | 0.51 | 10.00 | 0.00 | 0.800 | 0.408 | 0.408 | 90.598 | 102.7 |
| ALLOWABLE PEAK OUTFLOW | | | | | | | | | | | | 51.3 |
| PROVIDED OUTFLOW (250mm PIPE) | | | | | | | | | | | | **51.3** |

**DESIGN BY:** **UPPER CANADA CONSULTANTS**
**30 HANNOVER DRIVE, UNIT 3**
**ST. CATHARINES, ON L2W 1A3**

**DESIGN BY:** **T. MUSSARI, B.ENG.**

**DATE:** **JUNE 2025**

**RAINFALL PARAMETERS:**

Time to Upper End = 10 min.

City of Welland - 5 Year IDF Curve

a = 830.00 mm/hr

b = 7.30 minutes

c = 0.78

# Modified Rational Method (MRM) Required Storage Volume

| | |
|---|---|
| Project: | 524/528 QUAKER ROAD, CITY OF WELLAND |
| Project No: | 23163 |
| Date: | AUGUST 2025 |
| Design By: | T. MUSSARI, B.ENG. |
| Description: | STORMWATER MANAGEMENT PLAN |

Storm Event: **City of Welland - 5 Year IDF Curve**

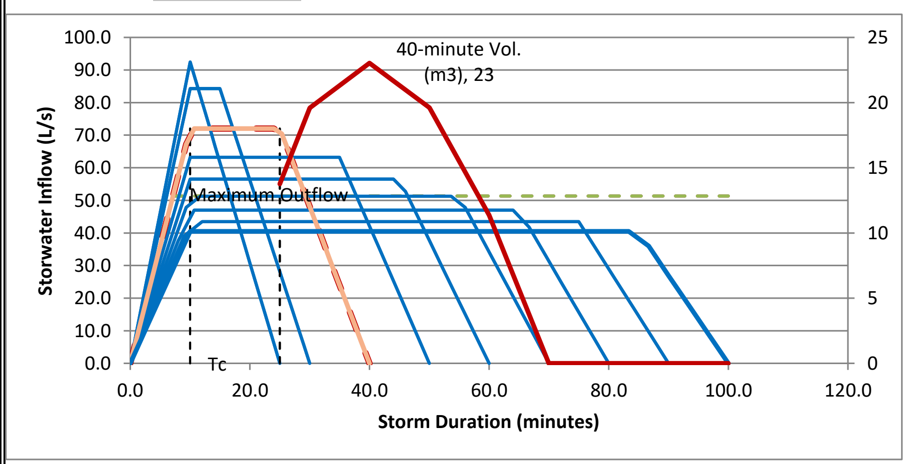
| | | |
|---|---|---|
| a = | 830.00 | mm/hr |
| b = | 7.30 | minutes |
| c = | 0.78 | |

| | | |
|---|---|---|
| Critical Storm Duration: | 40.00 | minutes Tail Multiplier (x1-1 1.5 |
| Tc From Design: | 10.00 | minutes |
| Storm Tail Time: | 25.00 | minutes |
| Accumulated Area x R (Ha): | 0.408 | <-- Area x Runoff Coefficient (Sewer Design Sheet) |
| Peak Rainfall Intensity: | 63.56 | mm/hr |
| Peak Inflow at Tc: | 72.03 | L/s |
| Maximum Release Rate: | 51.34 | <-- Outlet Full Flow Capacity (Design Sheet) |
| Time When Outlet Exceeded: | 7.13 | |

| Time (min) | Intensity (mm/hr) | Inflow (L/s) | Outflow (L/s) | Interval Volume (m3) | Total Required Volume (m3) |
|---|---|---|---|---|---|
| 0.0 | 0.00 | 0.00 | 51.34 | -3.1 | 0.0 |
| 1.3 | 8.47 | 9.60 | 51.34 | -3.3 | 0.0 |
| 2.7 | 16.95 | 19.21 | 51.34 | -2.6 | 0.0 |
| 4.0 | 25.42 | 28.81 | 51.34 | -1.8 | 0.0 |
| 5.3 | 33.90 | 38.42 | 51.34 | -1.0 | 0.0 |
| 6.7 | 42.37 | 48.02 | 51.34 | -0.3 | 0.0 |
| 8.0 | 50.85 | 57.63 | 51.34 | 0.5 | 0.5 |
| 9.3 | 59.32 | 67.23 | 51.34 | 1.3 | 1.8 |
| 10.7 | 63.56 | 72.03 | 51.34 | 1.7 | 3.4 |
| 12.0 | 63.56 | 72.03 | 51.34 | 1.7 | 5.1 |
| 13.3 | 63.56 | 72.03 | 51.34 | 1.7 | 6.7 |
| 14.7 | 63.56 | 72.03 | 51.34 | 1.7 | 8.4 |
| 16.0 | 63.56 | 72.03 | 51.34 | 1.7 | 10.1 |
| 17.3 | 63.56 | 72.03 | 51.34 | 1.7 | 11.7 |
| 18.7 | 63.56 | 72.03 | 51.34 | 1.7 | 13.4 |
| 20.0 | 63.56 | 72.03 | 51.34 | 1.7 | 15.0 |
| 21.3 | 63.56 | 72.03 | 51.34 | 1.7 | 16.7 |
| 22.7 | 63.56 | 72.03 | 51.34 | 1.7 | 18.3 |
| 24.0 | 63.56 | 72.03 | 51.34 | 1.7 | 20.0 |
| 25.3 | 62.15 | 70.43 | 51.34 | 1.5 | 21.5 |
| 26.7 | 56.50 | 64.03 | 51.34 | 1.0 | 22.5 |
| 28.0 | 50.85 | 57.63 | 51.34 | 0.5 | ***23.0*** |
| 29.3 | 45.20 | 51.22 | 51.34 | 0.0 | 23.0 |
| 30.7 | 39.55 | 44.82 | 51.34 | -0.5 | 22.5 |
| 32.0 | 33.90 | 38.42 | 51.34 | -1.0 | 21.5 |
| 33.3 | 28.25 | 32.02 | 51.34 | -1.5 | 19.9 |
| 34.7 | 22.60 | 25.61 | 51.34 | -2.1 | 17.9 |
| 36.0 | 16.95 | 19.21 | 51.34 | -2.6 | 15.3 |
| 37.3 | 11.30 | 12.81 | 51.34 | -3.1 | 12.2 |
| 38.7 | 5.65 | 6.40 | 51.34 | -3.6 | 8.6 |
| 40.0 | 0.00 | 0.00 | 51.34 | -4.1 | 4.5 |

**Variable Storm Duration Storage Requirements**

| *Duration* | *Max Storage* | *Duration* | *Max Storage* | *Duration* | *Max Storage* |
|---|---|---|---|---|---|
| 25 Min | 13.8 m3 | 50 Min | 19.6 m3 | 80 Min | 0.0 m3 |
| 30 Min | 19.6 m3 | 60 Min | 11.4 m3 | 90 Min | 0.0 m3 |
| 40 Min | **23.0 m3** | 70 Min | 0.0 m3 | 100 Min | 0.0 m3 |



# Underground Superpipe Stage Storage/Discharge Curve

| | |
|---|---|
| **Project** | **524/528 QUAKER ROAD, WELLAND** |
| **Project No.** | **23163** |
| **Date:** | **AUGUST 2025** |

| **Storage** | | | **Orifice** | |
|---|---|---|---|---|
| | | | Dia (m) = | 0.175 |
| PIPE DIAMETER (m) | | 0.600 | Cd = | 0.63 |
| PIPE LENGTH (m): | | 80.0 | Invert (m) = | 0.00 |

| Elevation (m) | | 600mm Pipe ($m^3$) | Orifice ($m^3/s$) |
|---|---|---|---|
| 2.00 | | 23.3 | 0.092 |
| 1.86 | | 23.3 | 0.089 |
| 1.71 | | 23.3 | 0.085 |
| 1.57 | | 23.3 | 0.081 |
| 1.43 | | 23.3 | 0.077 |
| 1.29 | | 23.3 | 0.073 |
| 1.14 | | 23.3 | 0.068 |
| 1.00 | | 23.3 | 0.063 |
| 0.86 | | 23.3 | 0.058 |
| **0.66** | **5 YR** | **23.3** | **0.049** |
| 0.57 | | 22.7 | 0.045 |
| 0.43 | | 17.5 | 0.037 |
| 0.29 | | 10.7 | 0.028 |
| 0.14 | | 4.2 | 0.011 |
| 0.00 | | - | 0.000 |

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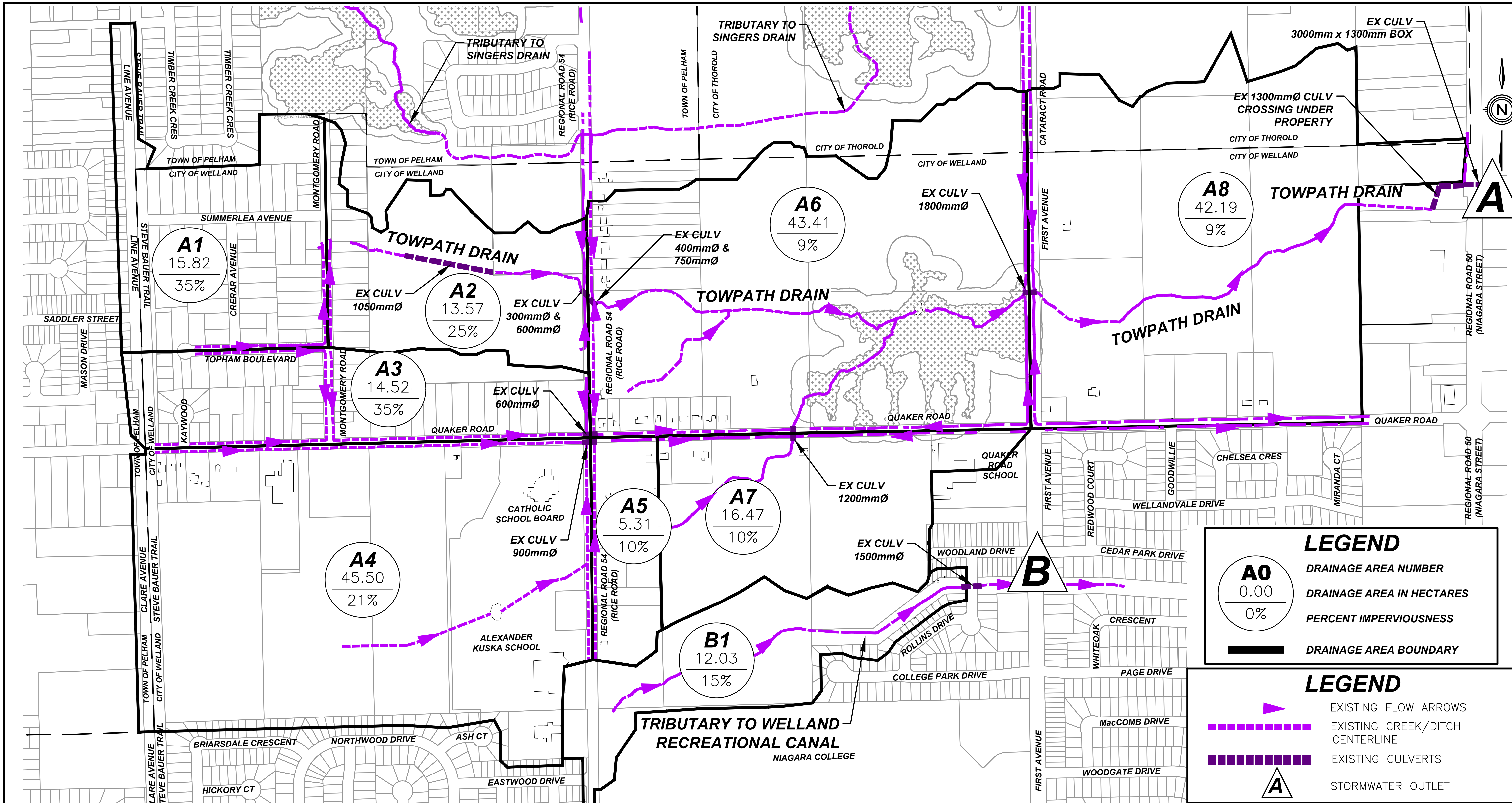
# APPENDIX B

## Northwest Welland Stormwater Management Implementation Plan - Figure 2

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# NORTHWEST WELLAND STORMWATER MANAGEMENT IMPLEMENTATION PLAN

## CITY OF WELLAND

## EXISTING STORM DRAINAGE AREA PLAN

| | |
|---|---|
| DATE | 2022-10-12 |
| SCALE | 1:7000 |
| REF No. | 21243 |
| DWG No. | FIGURE 2 |

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# APPENDIX D

## Hydroworks OGS Output Files

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# Hydroworks HD4 Output

```
*************************************************
*      Storm Water Management Sizing Model      *
*               Hydroworks, LLC                 *
*                Version 4.4                    *
*                                               *
*        Continuous Simulation Program          *
*              Based on SWMM 4.4H               *
*              Hydroworks, LLC                  *
*               Graham Bryant                   *
*                2003 - 2021                    *
*************************************************

                Developed by

*************************************************
*               Hydroworks, LLC                 *
*             Metcalf & Eddy, Inc.              *
*            University of Florida              *
*       Water Resources Engineers, Inc.         *
*      (Now Camp Dresser & McKee, Inc.)         *
*              Modified SWMM 4.4                *
*************************************************

         Distributed and Maintained by

*************************************************
*                                               *
*                Hydroworks, LLC                *
*                 888-290-7900                  *
*              www.hydroworks.com               *
*                                               *
*************************************************

*************************************************
*     If any problems occur executing this      *
*     model, contact Mr. Graham Bryant at       *
*     Hydroworks, LLC by phone at 888-290-7900  *
*     or by e-mail: support@hydroworks.com      *
*************************************************

*************************************************
*     This model is based on EPA SWMM 4.4       *
*  "Nature is full of infinite causes which     *
*   have never occurred in experience" da Vinci *
*************************************************

***************************************************
* Entry made to the Rain Block                    *
* Created by the University of Florida - 1988     *
* Updated by Oregon State University, March 2000  *
***************************************************

524/528 QUAKER ROAD
CITY OF WELLAND

HydroDome Simulation

########################################
#  Precipitation Block Input Commands  #
########################################

Station Name.........................  St. Catherines A
Station Location.....................  Ontario
Station, ISTA........................    7287
Beginning date, IYBEG (Yr/Mo/Dy)......  1971/ 1/ 1
Ending date, IYEND (Yr/Mo/Dy).........  2005/12/31
Minimum interevent time, MIT..........     1
Number of ranked storms, NPTS.........    10
NWS format, IFORM (See text)..........     1
Print storm summary, ISUM (O-No 1-Yes)     0
Print all rainfall, IYEAR (O-No 1-Yes)     0
Save storm event data on NSCRAT(1)....     0
(IFILE =0 -Do not save, =1 -Save data)
IDECID 0 - Create interface file
       1 - Create file and analyze
       2 - Synoptic analysis..........     2
Plotting position parameter, A........  0.40
Storm event statistics, NOSTAT........  1100
KODEA (from optional group B0)........     2
 = 0, Do not include NCDC cumulative values.
 = 1, Average NCDC cumulative values.
 = 2, Use NCDC cumulative value as inst. rain.
KODEPR (from optional group B0).......     0
 Print NCDC special codes in event summary:
 = 0, only on days with events.
 = 1, on all days with codes present.
 Codes: A = accumulated value, I = incomplete value,
        M = missing value,     O = other code present

********************************************************
*  Precipitation output created using the Rain block   *
*  Number of precipitation stations...        1        *
********************************************************
```

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

```
Location Station Number
-------- --------------
       1.     7287

STATION ID ON PRECIP. DATA INPUT FILE = 7287
REQUESTED STATION ID =     7287  CHECK TO BE SURE THEY MATCH.

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
Note, 15-min. data are being processed, but hourly
print-out, summaries, and statistics are based on
hourly totals only.  Data placed on interface file
are at correct 15-min. intervals.
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

###################################################
# Entry made to the Runoff Block, last updated by #
# Oregon State University, and Camp, Dresser and  #
# McKee, Inc., March 2002.                        #
###################################################
# "And wherever water goes, amoebae go along for  #
#  the ride"                      Tom Robbins     #
###################################################

                   524/528 QUAKER ROAD

                   CITY OF WELLAND

Snowmelt parameter - ISNOW......................          0

Number of rain gages - NRGAG....................          1

Horton infiltration equation used - INFILM.......         2
Maximum infiltration volume is limited to RMAXINF input on  subcatchment lines.
Infiltration volume regenerates during  non rainfall periods.

Quality is simulated - KWALTY...................          1

IVAP is negative.  Evaporation will be set to zero
    during time steps with rainfall.

Read evaporation data on line(s) F1 (F2) - IVAP..         1

Hour of day at start of storm - NHR.............          1

Minute of hour at start of storm - NMN..........          1

Time TZERO at start of storm (hours)............      1.017

Use Metric units for I/O - METRIC...............          1
 ===> Ft-sec units used in all internal computations

Runoff input print control...                             0

Runoff graph plot control....                             1

Runoff output print control..                             0

Print headers every 50 lines - NOHEAD (0=yes, 1=no)       0

Print land use load percentages -LANDUPR (0=no, 1=yes)     0

Limit number of groundwater convergence messages to 10000 (if simulated)

Month, day, year of start of storm is:             1/ 1/1971

Wet time step length (seconds).......                   300.

Dry time step length (seconds).......                   900.

Wet/Dry time step length (seconds)...                   450.

Simulation length is......                       20051231.0 Yr/Mo/Dy

Percent of impervious area with zero detention depth    25.0

Horton infiltration model being used
Rate for regeneration of infiltration = REGEN * DECAY
DECAY is read in for each subcatchment
REGEN = .........................................   0.01000

********************************************************
*   Processed Precipitation will be read from file     *
********************************************************

  #############################
  #        Data Group F1      #
  # Evaporation Rate (mm/day) #
  #############################

 JAN.  FEB.  MAR.  APR.  MAY   JUN.  JUL.  AUG.  SEP.  OCT.  NOV.  DEC.
 ----  ----  ----  ----  ----  ----  ----  ----  ----  ----  ----  ----
 0.00  0.00  0.00  2.54  2.54  3.81  3.81  3.81  2.54  2.54  0.00  0.00

*********************************************************
*        C H A N N E L   A N D   P I P E   D A T A      *
*********************************************************
```

| Input equen umber | NAMEG: Channel ID # | Drains to NGTO: | Channel Type | Width (m) | Length (m) | Invert Slope (m/m) | L Side Slope (m/m) | R Side Slope (m/m) | Intial Depth (m) | Max Depth (m) | Mann-ings "N" | Full Flow (cms) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 201 | 200 | Dummy | 0.0 | 0.0 | 0.0000 | 0.0000 | 0.0000 | 0.0 | 0.0 | 0.0000 | 0.00E+00 |

```
 ***************************************************
 *        S U B C A T C H M E N T   D A T A        *
 ***************************************************
```

*NOTE. SEE LATER TABLE FOR OPTIONAL SUBCATCHMENT PARAMETERS*

| | SUBCATCH-MENT NO. | CHANNEL OR INLET | WIDTH (M) | AREA (HA) | PERCENT IMPERV. | SLOPE (M/M) | RESISTANCE IMPERV. | FACTOR PERV. | DEPRES. IMPERV. | STORAGE(MM) PERV. | INFILTRATION RATE(MM/HR) MAXIMUM | MINIMUM | DECAY RATE (1/SEC) | GAGE NO. | MAXIMUM VOLUME (MM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 300 | 200 | 71.41 | 0.51 | 86.00 | 0.0200 | 0.015 | 0.250 | 0.510 | 5.080 | 63.50 | 10.16 | 0.00055 | 1 | 101.60000 |

```
TOTAL NUMBER OF SUBCATCHMENTS...           1
TOTAL TRIBUTARY AREA (HECTARES).        0.51
IMPERVIOUS AREA (HECTARES)......        0.44
PERVIOUS AREA (HECTARES)........        0.07
TOTAL WIDTH (METERS)............       71.41
PERCENT IMPERVIOUSNESS..........       86.00
```

```
********************************************************
*     U P S T R E A M   S T O R A G E   D A T A        *
********************************************************
```

| Storage (m3) | Flow (m3/s) |
|---|---|
| 0. | 0.000 |
| 23. | 0.049 |

```
********************************************************
*     G R O U N D W A T E R   I N P U T   D A T A      *
********************************************************
```

| SUB-CATCH NUMBER | CHANNEL OR INLET | E L E V A T I O N S GROUND (M) | BOTTOM (M) | STAGE (M) | BC (M) | TW (M) | F L O W C O N S T A N T S A1 (MM/HR-M^B1) | B1 | A2 (MM/HR-M^B2) | B2 | A3 (MM/HR-M^2) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 602 | 3.05 | 0.00 | 0.00 | 0.61 | 0.61 | 3.484E-04 | 2.600 | 0.000E+00 | 1.000 | 0.00E+00 |

```
***********************************************************
* G R O U N D W A T E R   I N P U T   D A T A (CONTINUED) *
***********************************************************
```

| SUBCAT. NO. | S O I L P R O P E R T I E S POROSITY | SATURATED HYDRAULIC CONDUCTIVITY (mm/hr) | WILTING POINT | FIELD CAPACITY | INITIAL MOISTURE | MAX. DEEP PERCOLATION (mm/hr) | PERCOLATION PARAMETERS HCO | PCO | E T P A R A M E T E R S DEPTH OF ET (m) | FRACTION OF ET TO UPPER ZONE |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .4000 | 127.000 | .1500 | .3000 | .3000 | 5.080E-02 | 10.00 | 4.57 | 4.27 | 0.350 |

```
*********************************************************
*    Arrangement of Subcatchments and Channel/Pipes     *
*********************************************************
* See second subcatchment output table for connectivity *
* of subcatchment to subcatchment flows.                *
*********************************************************
   Channel
   or Pipe
       201      No Tributary Channel/Pipes
               No Tributary Subareas....
    INLET
       200      Tributary Channel/Pipes...        201
                Tributary Subareas........        300
```

```
***********************************************************
* Hydrographs will be stored for the following   1 INLETS *
***********************************************************
           200
###################################################
#              Quality Simulation                 #
###################################################
#      General Quality Control Data Groups        #
###################################################
```

| Description | Variable | Value |
|---|---|---|
| Number of quality constituents..... | NQS....... | 1 |
| Number of land uses................ | JLAND....... | 1 |
| Standard catchbasin volume......... | CBVOL....... | 1.22 cubic meters |
| Erosion is not simulated......... | IROS........ | 0 |
| DRY DAYS PRIOR TO START OF STORM... | DRYDAY....... | 3.00 DAYS |
| DRY DAYS REQUIRED TO RECHARGE CATCHBASIN CONCENTRATION TO INITIAL VALUES.................... | DRYBSN....... | 5.00 DAYS |

```
 DUST AND DIRT
 STREET SWEEPING EFFICIENCY......... REFFDD.......     0.300

 DAY OF YEAR ON WHICH STREET
 SWEEPING BEGINS................... KLNBGN.......       120

 DAY OF YEAR ON WHICH STREET
 SWEEPING ENDS..................... KLNEND.......       270

###########################################
#     Land use data on data group J2      #
###########################################

                                                             LIMITING                       CLEANING  AVAIL.    DAYS SINCE
                                                             BUILDUP    BUILDUP  BUILDUP    INTERVAL  FACTOR       LAST
AND USE   BUILDUP EQUATION TYPE   FUNCTIONAL DEPENDENCE OF   QUANTITY   POWER    COEFF.     IN DAYS   FRACTION   SWEEPING
LNAME)           (METHOD)         BUILDUP PARAMETER(JACGUT)  (DDLIM)    (DDPOW)  (DDFACT)   (CLFREQ)  (AVSWP)    (DSLCL)
-------   ---------------------   -------------------------  --------   -------  --------   --------  -------   ---------
Urban De  EXPONENTIAL(1)                  AREA(1)           2.802E+01    0.500    67.250     30.000     0.300    30.000

##############################################
#     Constituent data on data group J3      #
##############################################

                               Total Su
                               --------
Constituent units........      mg/l
Type of units...........          0
KALC....................          2
Type of buildup calc.....    EXPONENTIAL(2)
KWASH...................          0
Type of washoff calc.....  POWER EXPONEN.(0)
KACGUT..................          1
Dependence of buildup....        AREA(1)
LINKUP..................          0
Linkage to snowmelt......   NO SNOW LINKAGE
Buildup param 1 (QFACT1).        28.020
Buildup param 2 (QFACT2).         0.500
Buildup param 3 (QFACT3).        67.250
Buildup param 4 (QFACT4).         0.000
Buildup param 5 (QFACT5).         0.000
Washoff power (WASHPO)...         1.100
Washoff coef. (RCOEF)....         0.086
Init catchb conc (CBFACT)       100.000
Precip. conc. (CONCRN)...         0.000
Street sweep effic (REFF)         0.300
Remove fraction (REMOVE).         0.000
1st order QDECAY, 1/day..         0.000
Land use number..........             1

*************************************************
* Constant Groundwater Quality Concentration(s) *
*************************************************

 Total Susp has a concentration of..    0.0000   mg/l

************************************************
* REMOVAL FRACTIONS FOR SELECTED CHANNEL/PIPES *
* FROM J7 LINES                                *
************************************************

  CHANNEL/   CONSTITUENT
     PIPE Total Susp
----------  --------
       201     0.000

*****************************************************
*     Subcatchment surface quality on data group L1 *
*****************************************************

                                 Total   Number   Input
                         Land   Gutter     of    Loading
                 Land     Use   Length   Catch-  load/ha
            No.  Usage    No.      Km    Basins   Total Su
        ------ --------  ----  -------- --------  -------
   1        300 Urban De  1         0.14      2.00  0.0E+00
   Totals (Loads in kg or other)    0.14      2.00  0.0E+00

    **********************
    *    DATA GROUP M1    *
    **********************

TOTAL NUMBER OF PRINTED GUTTERS/INLETS...NPRNT..        1
NUMBER OF TIME STEPS BETWEEN PRINTINGS..INTERV..        0
STARTING AND STOPPING PRINTOUT DATES...........         0         0

    **********************
    *    DATA GROUP M3    *
    **********************

CHANNEL/INLET PRINT DATA GROUPS......       -200

===> WARNING !! STORAGE UNIT IS FLOODING.  EXCESS VOLUME CONVEYED AS DISCHARGE
===> WARNING !! STORAGE UNIT IS FLOODING.  EXCESS VOLUME CONVEYED AS DISCHARGE
===> WARNING !! STORAGE UNIT IS FLOODING.  EXCESS VOLUME CONVEYED AS DISCHARGE
===> WARNING !! STORAGE UNIT IS FLOODING.  EXCESS VOLUME CONVEYED AS DISCHARGE
```

```
*****************************************
* Rainfall from Nat. Weather Serv. file  *
* in units of hundredths of an inch      *
*****************************************
```

524/528 QUAKER ROAD
CITY OF WELLAND

Rainfall Station St. Catherines A
State/Province Ontario

Rainfall Depth Summary (mm)

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1971. | 31. | 0. | 0. | 0. | 0. | 0. | 126. | 93. | 52. | 60. | 29. | 0. | 391. |
| 1972. | 0. | 0. | 0. | 47. | 65. | 100. | 39. | 115. | 63. | 90. | 1. | 0. | 521. |
| 1973. | 0. | 0. | 0. | 103. | 77. | 71. | 53. | 29. | 63. | 139. | 0. | 0. | 534. |
| 1974. | 0. | 0. | 0. | 67. | 105. | 62. | 50. | 31. | 74. | 37. | 110. | 0. | 536. |
| 1975. | 0. | 0. | 0. | 0. | 0. | 94. | 78. | 76. | 73. | 56. | 59. | 6. | 442. |
| 1976. | 0. | 0. | 0. | 119. | 136. | 87. | 101. | 60. | 72. | 73. | 13. | 1. | 662. |
| 1977. | 0. | 0. | 0. | 94. | 29. | 69. | 57. | 150. | 230. | 71. | 0. | 1. | 701. |
| 1978. | 0. | 0. | 0. | 72. | 43. | 72. | 43. | 86. | 156. | 95. | 0. | 0. | 567. |
| 1979. | 0. | 0. | 0. | 84. | 92. | 33. | 91. | 88. | 84. | 129. | 71. | 0. | 673. |
| 1980. | 0. | 0. | 0. | 81. | 39. | 122. | 60. | 32. | 79. | 96. | 45. | 0. | 554. |
| 1981. | 0. | 0. | 0. | 91. | 71. | 106. | 122. | 61. | 123. | 91. | 84. | 0. | 749. |
| 1982. | 0. | 0. | 0. | 28. | 65. | 97. | 36. | 66. | 82. | 25. | 143. | 0. | 544. |
| 1983. | 0. | 0. | 0. | 78. | 100. | 65. | 55. | 106. | 75. | 122. | 92. | 0. | 694. |
| 1984. | 0. | 0. | 0. | 31. | 113. | 136. | 19. | 51. | 144. | 24. | 44. | 0. | 562. |
| 1985. | 0. | 0. | 67. | 32. | 52. | 64. | 40. | 94. | 42. | 109. | 0. | 1. | 501. |
| 1986. | 0. | 0. | 0. | 93. | 113. | 60. | 85. | 83. | 98. | 80. | 43. | 65. | 719. |
| 1987. | 0. | 2. | 11. | 77. | 42. | 80. | 122. | 97. | 99. | 71. | 94. | 34. | 730. |
| 1988. | 0. | 0. | 41. | 71. | 42. | 21. | 110. | 82. | 70. | 68. | 75. | 5. | 585. |
| 1989. | 0. | 0. | 13. | 63. | 137. | 108. | 36. | 45. | 89. | 73. | 84. | 0. | 647. |
| 1990. | 0. | 2. | 38. | 99. | 124. | 44. | 68. | 95. | 56. | 112. | 96. | 0. | 735. |
| 1991. | 0. | 0. | 86. | 124. | 67. | 31. | 85. | 57. | 79. | 64. | 61. | 28. | 682. |
| 1992. | 0. | 0. | 29. | 127. | 56. | 92. | 185. | 116. | 77. | 47. | 103. | 38. | 869. |
| 1993. | 3. | 0. | 7. | 83. | 56. | 86. | 32. | 61. | 71. | 92. | 80. | 38. | 610. |
| 1994. | 0. | 0. | 44. | 88. | 105. | 124. | 48. | 77. | 117. | 15. | 0. | 15. | 633. |
| 1995. | 112. | 23. | 16. | 48. | 37. | 60. | 123. | 66. | 8. | 137. | 94. | 0. | 724. |
| 1998. | 0. | 0. | 0. | 0. | 51. | 54. | 64. | 29. | 9. | 0. | 1. | 0. | 207. |
| 1999. | 0. | 0. | 0. | 79. | 59. | 35. | 61. | 58. | 116. | 78. | 0. | 0. | 487. |
| 2000. | 0. | 0. | 0. | 123. | 134. | 216. | 51. | 0. | 0. | 0. | 10. | 0. | 534. |
| 2001. | 0. | 0. | 0. | 56. | 88. | 45. | 25. | 30. | 81. | 129. | 0. | 0. | 454. |
| 2002. | 0. | 0. | 0. | 73. | 104. | 64. | 53. | 49. | 52. | 65. | 8. | 0. | 468. |
| 2003. | 0. | 0. | 0. | 10. | 163. | 77. | 81. | 64. | 67. | 73. | 2. | 0. | 537. |
| 2004. | 0. | 0. | 0. | 131. | 126. | 99. | 115. | 40. | 88. | 17. | 0. | 0. | 616. |
| 2005. | 0. | 0. | 0. | 38. | 42. | 78. | 53. | 120. | 112. | 0. | 0. | 0. | 443. |

Total Rainfall Depth for Simulation Period 19310. (mm)

Rainfall Intensity Analysis (mm/hr)

| (mm/hr) | (#) | (%) | (mm) | (%) |
|---|---|---|---|---|
| 2.50 | 21481 | 74.6 | 6454. | 33.4 |
| 5.00 | 3585 | 12.4 | 3088. | 16.0 |
| 7.50 | 1973 | 6.8 | 2886. | 14.9 |
| 10.00 | 575 | 2.0 | 1233. | 6.4 |
| 12.50 | 389 | 1.4 | 1070. | 5.5 |
| 15.00 | 194 | 0.7 | 660. | 3.4 |
| 17.50 | 210 | 0.7 | 846. | 4.4 |
| 20.00 | 66 | 0.2 | 306. | 1.6 |
| 22.50 | 92 | 0.3 | 487. | 2.5 |
| 25.00 | 39 | 0.1 | 232. | 1.2 |
| 27.50 | 37 | 0.1 | 246. | 1.3 |
| 30.00 | 34 | 0.1 | 245. | 1.3 |
| 32.50 | 29 | 0.1 | 228. | 1.2 |
| 35.00 | 5 | 0.0 | 42. | 0.2 |
| 37.50 | 10 | 0.0 | 90. | 0.5 |
| 40.00 | 10 | 0.0 | 97. | 0.5 |
| 42.50 | 12 | 0.0 | 124. | 0.6 |
| 45.00 | 9 | 0.0 | 99. | 0.5 |
| 47.50 | 1 | 0.0 | 12. | 0.1 |
| 50.00 | 3 | 0.0 | 37. | 0.2 |
| >50.00 | 49 | 0.2 | 829. | 4.3 |

Total # of Intensities 28803

Daily Rainfall Depth Analysis (mm)

| (mm) | (#) | (%) | (mm) | (%) |
|---|---|---|---|---|
| 2.50 | 1077 | 38.9 | 1247. | 6.5 |
| 5.00 | 507 | 18.3 | 1850. | 9.6 |
| 7.50 | 326 | 11.8 | 2006. | 10.4 |
| 10.00 | 226 | 8.2 | 1958. | 10.1 |
| 12.50 | 150 | 5.4 | 1672. | 8.7 |
| 15.00 | 111 | 4.0 | 1495. | 7.7 |
| 17.50 | 100 | 3.6 | 1620. | 8.4 |
| 20.00 | 67 | 2.4 | 1260. | 6.5 |
| 22.50 | 45 | 1.6 | 958. | 5.0 |
| 25.00 | 37 | 1.3 | 881. | 4.6 |
| 27.50 | 23 | 0.8 | 609. | 3.2 |
| 30.00 | 20 | 0.7 | 575. | 3.0 |
| 32.50 | 20 | 0.7 | 631. | 3.3 |
| 35.00 | 12 | 0.4 | 405. | 2.1 |

```
 37.50      8       0.3      290.       1.5
 40.00      9       0.3      350.       1.8
 42.50      4       0.1      165.       0.9
 45.00      4       0.1      173.       0.9
 47.50      2       0.1       91.       0.5
 50.00      4       0.1      192.       1.0
>50.00     15       0.5      882.       4.6

Total # Days with Rain   2767

################################################
*      End of time step DO-loop in Runoff      *
################################################

Final Date (Mo/Day/Year)   =                  1/ 1/2006
Total number of time steps =                    2056421
Final Julian Date  =                            2006001
Final time of day  =                                 0. seconds.
Final time of day  =                               0.00   hours.
Final running time =                        306816.0000   hours.
Final running time =                         12784.0000    days.

##################################################
*     Extrapolation Summary for Watersheds       *
* # Steps ==> Total Number of Extrapolated Steps *
* # Calls ==> Total Number of OVERLND Calls      *
##################################################

 Subcatch   # Steps   # Calls  Subcatch   # Steps   # Calls  Subcatch   # Steps   # Calls
 --------   -------   -------  --------   -------   -------  --------   -------   -------
      300   6221275   1581441

##################################################
*     Extrapolation Summary for Channel/Pipes    *
* # Steps ==> Total Number of Extrapolated Steps *
* # Calls ==> Total Number of GUTNR Calls        *
##################################################

Chan/Pipe   # Steps   # Calls Chan/Pipe   # Steps   # Calls Chan/Pipe   # Steps   # Calls
 --------   -------   -------  --------   -------   -------  --------   -------   -------
      201         0         0

##############################################
*       Continuity Check for Surface Water   *
##############################################
                                                                    Millimeters over
                                                      cubic meters  Total Basin
Total Precipitation (Rain plus Snow)                       98238.     19263.
Total Infiltration                                         13663.      2679.
Total Evaporation                                           8614.      1689.
Surface Runoff from Watersheds                             76698.     15039.
Total Water remaining in Surface Storage                       0.         0.
Infiltration over the Pervious Area...                     13663.     19136.
                      --------
Infiltration + Evaporation +
Surface Runoff + Snow removal +
Water remaining in Surface Storage +
Water remaining in Snow Cover.........                     98974.     19407.
Total Precipitation + Initial Storage.                     98238.     19263.

The error in continuity is calculated as
#######################################
* Precipitation + Initial Snow Cover  *
*       - Infiltration -              *
*Evaporation - Snow removal -         *
*Surface Runoff from Watersheds -     *
*Water in Surface Storage -           *
*Water remaining in Snow Cover        *
*-------------------------------------*
* Precipitation + Initial Snow Cover  *
#######################################
Error.................................       -0.749 Percent

##############################################
*       Continuity Check for Channel/Pipes   *
##############################################
                                                                    Millimeters over
                                                      cubic meters  Total Basin
Initial Channel/Pipe Storage................                   0.         0.
Final Channel/Pipe Storage..................                   0.         0.
Surface Runoff from Watersheds..............               76698.     15039.
Baseflow....................................                   0.
Groundwater Subsurface Inflow...............                   0.         0.
Evaporation Loss from Channels..............                   0.         0.
Channel/Pipe/Inlet Outflow..................               76698.     15039.
Initial Storage + Inflow....................               76698.     15039.
Final Storage + Outflow.....................               76698.     15039.
############################################
* Final Storage + Outflow + Evaporation  - *
* Watershed Runoff - Groundwater Inflow  - *
*     Initial Channel/Pipe Storage         *
*     --------------------------------     *
*  Final Storage + Outflow  + Evaporation  *
############################################
Error.......................................      0.000 Percent

###################################################
```

*     Continuity Check for Subsurface Water       *
***************************************************

| | cubic meters | Millimeters over Subsurface Basin |
|---|---|---|
| Total Infiltration | 0. | 0. |
| Total Upper Zone ET | 0. | 0. |
| Total Lower Zone ET | 0. | 0. |
| Total Groundwater flow | 0. | 0. |
| Total Deep percolation | 0. | 0. |
| Initial Subsurface Storage | 4663. | 914. |
| Final Subsurface Storage | 4663. | 914. |
| Upper Zone ET over Pervious Area | 0. | 0. |
| Lower Zone ET over Pervious Area | 0. | 0. |

```
******************************************
* Infiltration + Initial Storage - Final *
* Storage - Upper and Lower Zone ET -    *
* Groundwater Flow - Deep Percolation    *
* -------------------------------------- *
*     Infiltration + Initial Storage     *
******************************************
Error ...................................     0.000 Percent
```

SUMMARY STATISTICS FOR SUBCATCHMENTS
====================================

| SUBCATCH-MENT NO. | GUTTER OR INLET NO. | AREA (HA) | PERCENT IMPER. | TOTAL SIMULATED RAINFALL (MM) | PERVIOUS AREA TOTAL RUNOFF DEPTH (MM) | PERVIOUS AREA TOTAL LOSSES (MM) | PERVIOUS AREA PEAK RUNOFF RATE (CMS) | IMPERVIOUS AREA RUNOFF DEPTH (MM) | IMPERVIOUS AREA PEAK RUNOFF RATE (CMS) | TOTAL SUBCATCHMENT AREA RUNOFF DEPTH (MM) | TOTAL SUBCATCHMENT AREA PEAK RUNOFF RATE (CMS) | TOTAL SUBCATCHMENT AREA PEAK UNIT RUNOFF (MM/HR) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 300 | 200 | 0.51 | 86.019 | 262.47 | 133.258 | ******** | 0.028 | 17461.305 | 0.239 | 15035.378 | 0.267 | 190.232 |

*** NOTE *** IMPERVIOUS AREA STATISTICS AGGREGATE IMPERVIOUS AREAS WITH AND WITHOUT DEPRESSION STORAGE

SUMMARY STATISTICS FOR CHANNEL/PIPES
==============================================

| CHANNEL NUMBER | FULL FLOW (CMS) | FULL VELOCITY (M/S) | FULL DEPTH (M) | MAXIMUM COMPUTED INFLOW (CMS) | MAXIMUM COMPUTED OUTFLOW (CMS) | MAXIMUM COMPUTED DEPTH (M) | MAXIMUM COMPUTED VELOCITY (M/S) | TIME OF OCCURRENCE DAY | TIME OF OCCURRENCE HR. | LENGTH OF SURCHARGE (HOUR) | MAXIMUM SURCHARGE VOLUME (CU-M) | RATIO OF MAX. TO FULL FLOW | RATIO OF MAX. DEPTH TO FULL DEPTH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 201 | | | | 0.00 | | | | 1/ 0/1900 | 0.00 | | | | |
| 200 | | | | 0.27 | | | | 8/14/1972 | 14.25 | | | | |

TOTAL NUMBER OF CHANNELS/PIPES =     2

*** NOTE ***  THE MAXIMUM FLOWS AND DEPTHS ARE CALCULATED AT THE END OF THE TIME INTERVAL

```
#####################################################
#              Runoff Quality Summary Page          #
# If NDIM = 0 Units for:   loads     mass rates     #
#              METRIC = 1    lb        lb/sec       #
#              METRIC = 2    kg        kg/sec       #
# If NDIM = 1 Loads are in units of quantity        #
#              and mass rates are quantity/sec      #
# If NDIM = 2 loads are in units of concentration   #
#              times volume and mass rates have units#
#              of concentration times volume/second #
#####################################################
Total Su NDIM =  0
METRIC =  2
```

| | Total Su |
|---|---|
| **Inputs** | |
| 1. INITIAL SURFACE LOAD........ | 11. |
| 2. TOTAL SURFACE BUILDUP....... | 9696. |
| 3. INITIAL CATCHBASIN LOAD..... | 0. |
| 4. TOTAL CATCHBASIN LOAD....... | 0. |
| 5. TOTAL CATCHBASIN AND SURFACE BUILDUP (2+4)....... | 9696. |
| **Remaining Loads** | |
| 6. LOAD REMAINING ON SURFACE... | 4. |
| 7. REMAINING IN CATCHBASINS.... | 0. |
| 8. REMAINING IN CHANNEL/PIPES.. | 0. |
| **Removals** | |
| 9. STREET SWEEPING REMOVAL..... | 743. |
| 10. NET SURFACE BUILDUP (2-9)... | 8953. |
| 11. SURFACE WASHOFF............ | 8947. |
| 12. CATCHBASIN WASHOFF.......... | 0. |
| 13. TOTAL WASHOFF (11+12)....... | 8947. |
| 14. LOAD FROM OTHER CONSTITUENTS | 0. |
| 15. PRECIPITATION LOAD.......... | 0. |
| 15a.SUM SURFACE LOAD (13+14+15). | 8947. |
| 16. TOTAL GROUNDWATER LOAD...... | 0. |

```
16a.TOTAL I/I LOAD.............        0.
17. NET SUBCATCHMENT LOAD
    (15a-15b-15c-15d+16+16a)....     8947.
>>Removal in channel/pipes (17a, 17b):
17a.REMOVE BY BMP FRACTION......        0.
17b.REMOVE BY 1st ORDER DECAY...        0.
18. TOTAL LOAD TO INLETS........     8947.
19. FLOW WT'D AVE.CONCENTRATION  mg/l
    (INLET LOAD/TOTAL FLOW).....      117.

Percentages
-----------
20. STREET SWEEPING (9/2).......        8.
21. SURFACE WASHOFF (11/2)......       92.
22. NET SURFACE WASHOFF(11/10)..      100.
23. WASHOFF/SUBCAT LOAD(11/17)..      100.
24. SURFACE WASHOFF/INLET LOAD
    (11/18).....................      100.
25. CATCHBASIN WASHOFF/
    SUBCATCHMENT LOAD (12/17)...        0.
26. CATCHBASIN WASHOFF/
    INLET LOAD (12/18)..........        0.
27. OTHER CONSTITUENT LOAD/
    SUBCATCHMENT LOAD (14/17)...        0.
28. INSOLUBLE FRACTION/
    INLET LOAD (14/18)..........        0.
29. PRECIPITATION/
    SUBCATCHMENT LOAD (15/17)...        0.
30. PRECIPITATION/
    INLET LOAD (15/18)..........        0.
31. GROUNDWATER LOAD/
    SUBCATCHMENT LOAD (16/17)...        0.
32. GROUNDWATER LOAD/
    INLET LOAD (16/18)..........        0.
32a.INFILTRATION/INFLOW LOAD/
    SUBCATCHMENT LOAD (16a/17)..        0.
32b.INFILTRATION/INFLOW LOAD/
    INLET LOAD (16a/18).........        0.
32c.CH/PIPE BMP FRACTION REMOVAL/
    SUBCATCHMENT LOAD (17a/17)..        0.
32d.CH/PIPE 1st ORDER DECAY REMOVAL/
    SUBCATCHMENT LOAD (17b/17)..        0.
33. INLET LOAD SUMMATION ERROR
    (18+8+6a+17a+17b-17)/17.....        0.

CAUTION. Due to method of quality routing (Users Manual, Appendix IX)
quality routing through channel/pipes is sensitive to the time step.
Large "Inlet Load Summation Errors" may result.
These can be reduced by adjusting the time step(s).
Note: surface accumulation during dry time steps at end of simulation is
not included in totals.  Buildup is only performed at beginning of
wet steps or for street cleaning.

********************************************************
*            TSS Particle Size Distribution            *
********************************************************
```

| Diameter (um) | % | Specific Gravity | Settling Velocity (m/s) | Critical Peclet Number |
|---|---|---|---|---|
| 2. | 5.0 | 2.65 | 0.000003 | 0.054484 |
| 5. | 5.0 | 2.65 | 0.000017 | 0.061150 |
| 8. | 10.0 | 2.65 | 0.000043 | 0.067744 |
| 20. | 15.0 | 2.65 | 0.000267 | 0.093400 |
| 50. | 10.0 | 2.65 | 0.001629 | 0.152500 |
| 75. | 5.0 | 2.65 | 0.003548 | 0.196250 |
| 100. | 10.0 | 2.65 | 0.006044 | 0.235000 |
| 150. | 15.0 | 2.65 | 0.012234 | 0.297500 |
| 250. | 15.0 | 2.65 | 0.026615 | 0.391296 |
| 500. | 5.0 | 2.65 | 0.060604 | 0.602917 |
| 1000. | 5.0 | 2.65 | 0.111334 | 0.928988 |

```
****************************************************
*                                                  *
*               Summary of TSS Removal             *
*                                                  *
****************************************************
```

TSS Removal based on Lab Performance Curve

| Model # | Low Q Treated (cms) | High Q Treated (cms) | Runoff Treated (%) | TSS Removed (%) |
|---|---|---|---|---|
| Unavailabl | 0.049 | 0.049 | 99.0 | 68.8 |
| HD 4 | 0.049 | 0.049 | 99.0 | 75.2 |
| HD 5 | 0.049 | 0.049 | 99.0 | 80.1 |
| HD 6 | 0.049 | 0.049 | 99.0 | 83.9 |
| HD 7 | 0.049 | 0.049 | 99.0 | 87.1 |
| HD 8 | 0.049 | 0.049 | 99.0 | 89.7 |
| HD 10 | 0.049 | 0.049 | 99.0 | 93.4 |
| HD 12 | 0.049 | 0.049 | 99.0 | 95.9 |

```
****************************************************
*                                                  *
*  Summary of Annual Flow Treatmnet & TSS Removal  *
*                                                  *
****************************************************
```

**UPPER CANADA CONSULTANTS**
**ENGINEERS / PLANNERS**

HD 5

| Year | Flow Vol (m3) | Flow Treated (m3) | TSS In (kg) | TSS Rem (kg) | TSS Out (kg) | TSS Byp (kg) | Flow Treated (%) | TSS Removal (%) |
|---|---|---|---|---|---|---|---|---|
| 1971. | 17333. | 16537. | 175. | 137. | 38. | 1. | 95.4 | 77.9 |
| 1972. | 22406. | 20697. | 230. | 185. | 45. | 8. | 92.4 | 77.7 |
| 1973. | 22459. | 22459. | 251. | 201. | 51. | 0. | 100.0 | 79.8 |
| 1974. | 22797. | 22504. | 268. | 223. | 45. | 1. | 98.7 | 82.7 |
| 1975. | 19368. | 18983. | 228. | 180. | 48. | 1. | 98.0 | 78.6 |
| 1976. | 28780. | 28306. | 285. | 230. | 55. | 2. | 98.4 | 80.0 |
| 1977. | 30843. | 30302. | 275. | 210. | 65. | 2. | 98.2 | 75.9 |
| 1978. | 24766. | 24766. | 265. | 208. | 57. | 0. | 100.0 | 78.4 |
| 1979. | 29477. | 29068. | 300. | 244. | 57. | 1. | 98.6 | 80.7 |
| 1980. | 23817. | 23716. | 286. | 230. | 57. | 0. | 99.6 | 80.1 |
| 1981. | 32904. | 32771. | 317. | 258. | 58. | 0. | 99.6 | 81.5 |
| 1982. | 23208. | 23208. | 260. | 212. | 48. | 0. | 100.0 | 81.6 |
| 1983. | 30532. | 30327. | 330. | 264. | 66. | 1. | 99.3 | 79.8 |
| 1984. | 24642. | 24642. | 255. | 202. | 53. | 0. | 100.0 | 79.4 |
| 1985. | 21497. | 21497. | 254. | 204. | 50. | 0. | 100.0 | 80.4 |
| 1986. | 31331. | 31331. | 345. | 280. | 65. | 0. | 100.0 | 81.1 |
| 1987. | 32289. | 32020. | 345. | 279. | 66. | 1. | 99.2 | 80.8 |
| 1988. | 25812. | 25628. | 290. | 237. | 53. | 0. | 99.3 | 81.6 |
| 1989. | 28493. | 28160. | 277. | 228. | 48. | 1. | 98.8 | 82.3 |
| 1990. | 32342. | 32274. | 354. | 294. | 60. | 1. | 99.8 | 82.8 |
| 1991. | 30277. | 30042. | 330. | 269. | 61. | 1. | 99.2 | 81.2 |
| 1992. | 38557. | 38538. | 378. | 300. | 78. | 0. | 99.9 | 79.3 |
| 1993. | 26233. | 26233. | 330. | 273. | 56. | 0. | 100.0 | 82.9 |
| 1994. | 27840. | 26813. | 263. | 209. | 55. | 4. | 96.3 | 78.2 |
| 1995. | 32481. | 32232. | 315. | 250. | 66. | 2. | 99.2 | 78.7 |
| 1998. | 8463. | 8463. | 127. | 100. | 27. | 0. | 100.0 | 78.9 |
| 1999. | 20684. | 20678. | 249. | 197. | 52. | 0. | 100.0 | 79.3 |
| 2000. | 23826. | 23808. | 210. | 160. | 51. | 0. | 99.9 | 75.8 |
| 2001. | 18857. | 18857. | 203. | 169. | 34. | 0. | 100.0 | 83.3 |
| 2002. | 19690. | 19690. | 238. | 194. | 45. | 0. | 100.0 | 81.3 |
| 2003. | 22383. | 22383. | 244. | 193. | 50. | 0. | 100.0 | 79.4 |
| 2004. | 26804. | 26804. | 247. | 194. | 52. | 0. | 100.0 | 78.8 |
| 2005. | 19174. | 18579. | 188. | 142. | 46. | 2. | 96.9 | 74.9 |

```
****************************************************
*                                                  *
*      Summary of Toronto Rainfall Intensities     *
*                                                  *
****************************************************
```

| Rainfall Intensity (mm/h) | Flow (L/s) | Percentage % |
|---|---|---|
| 1.50 | 1.8 | 31.5 |
| 2.25 | 2.7 | 10.9 |
| 3.00 | 3.6 | 8.1 |
| 3.75 | 4.5 | 6.1 |
| 4.75 | 5.7 | 6.5 |
| 5.75 | 6.9 | 5.2 |
| 8.00 | 9.6 | 7.8 |
| 10.00 | 12.0 | 4.5 |
| 15.50 | 18.6 | 8.0 |
| 23.25 | 27.8 | 11.4 |

```
****************************************************
*  Summary of Quantity and Quality Results at      *
*  Location       200  INFlow in cms.              *
*  Values are instantaneous at indicated time step *
****************************************************

  524/528 QUAKER ROAD
 CITY OF WELLAND

     Date     Time        Flow   Total Su
 Mo/Da/Year  Hr:Min       cum/s  mg/l
 ----------  -------    -------  --------
Flow wtd means.....       0.001      117.
Flow wtd std devs..       0.003      119.
Maximum value......       0.267     1215.
Minimum value......       0.000        0.
Total loads........      76395.     8941.
                        Cub-Met  KILOGRAM

===> Runoff simulation ended normally.

===> SWMM 4.4    simulation ended normally.
     Always check output file for possible warning messages.

*******************************************************
*       SWMM 4.4    Simulation Date and Time Summary  *
*******************************************************
* Starting Date... August     13, 2025                *
*          Time...         15:51:14.737               *
*   Ending Date... August     13, 2025                *
*          Time...         15:51:17.829               *
*  Elapsed Time...               0.052 minutes.       *
*  Elapsed Time...               3.092 seconds.       *
*******************************************************
```

# APPENDIX E

## Sample OGS Inspection Report

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

**SAMPLE INSPECTION REPORT**

---

**Owner:**

**Location:** 524/528 Quaker Road Welland

**Manhole Oil/Grit Separator:** HD5

**Type of Inspection** ☐ Monthly ☐ Annually ☐ Special

**Inlet/Outlet Information**

| | Inlet | | Outlet | |
|---|---|---|---|---|
| Clear of Debris | ☐ Yes | ☐ No | ☐ Yes | ☐ No |
| Build Up of Sediment | ☐ Yes | ☐ No | ☐ Yes | ☐ No |

Action Taken:

**Sediment Tank Information**

A. Manhole Sump Depth: ± m from cover rim (to be as-constructed verified)

B. Measurement from Rim to Sediment Level m

C. Depth of Sediment: m (A - B)

Note: If the measured depth of sediment is greater than **200mm** then sediment removal is required.

**Presence of Contaminants**

| | | | | |
|---|---|---|---|---|
| Oil | ☐ Yes | ☐ No | Depth | m |
| Foam | ☐ Yes | ☐ No | Depth | m |

Action Taken:

**Name of Regulatory Agency** Telephone No.:

Transaction No.:

**Name of Licensed Waste Management Collector** Telephone No.:

Transaction No.:

Owner Notification ☐ Yes ☐ No Other:

Time: Date:

Name of Inspector:

Signed: Date:

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

# APPENDIX F

## NW Welland Secondary Plan Municipal Servicing Conceptual Design Report (Associated Engineering, June 2024)

REPORT

# City of Welland

# Northwest Welland Secondary Plan
# Municipal Servicing
# Conceptual Design Report

JUNE 2024

# REVISIONS PAGE

| Northwest Welland Secondary Plan<br>Municipal Servicing<br>Conceptual Design Report | |
|---|---|
| Client: | Engineer: |
| Upper Canada Consultants | Associated Engineering (Ont.) Ltd. |

| Revision/ Issue | Date | Description | Prepared by/ Reviewed by | Client Review |
|---|---|---|---|---|
| 1 | 2023-11-22 | Municipal Servicing Report_v1 | AL & BB/ RC & MG | |
| 2 | 2023-12-18 | Municipal Servicing Report_v2 | AL & BB/ RC & MG | |
| 3 | 2024-03-26 | Municipal Servicing Report_v3 | AL & BB/ RC & MG | |
| 4 | 2024-06-07 | Municipal Servicing Report_v4 | AL & BB/ RC & MG | |
| 5 | 2024-06-24 | Municipal Servicing Report_v5 | AL & BB/ RC & MG | |
| | Click or tap to enter a date. | | | |
| | Click or tap to enter a date. | | | |
| | | | | |

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# 1 INTRODUCTION

The City of Welland identified the development of the Northwest Secondary Plan as a priority to provide for detailed land use planning policies for a mix of uses, including policies that address infrastructure requirements, and natural and cultural heritage considerations. The Northwest Welland Secondary Plan (NWSP) will guide future growth and development within the study area. This report (previously issued May 2021) reviews background information and provides capacity analysis for existing water, sanitary, and storm sewer servicing in the study area. In addition, an initial assessment was completed for proposed conceptual water, sanitary, and storm servicing. These analyses were used to develop general recommendations for municipal water, sanitary, and storm servicing requirements in the Secondary Area.

## 1.1 Study Area

The study area (Figure 1-1) includes the land within the urban area boundary of Welland that is bounded by Clare Avenue to the west, Niagara Street to the east, land on the south side of Quaker Road to a depth of approximately 500m to the south and 500m to the north and comprises approximately 190ha. Quaker Road bisects through the Study Area and is identified as an arterial road and all other streets are considered local roads.

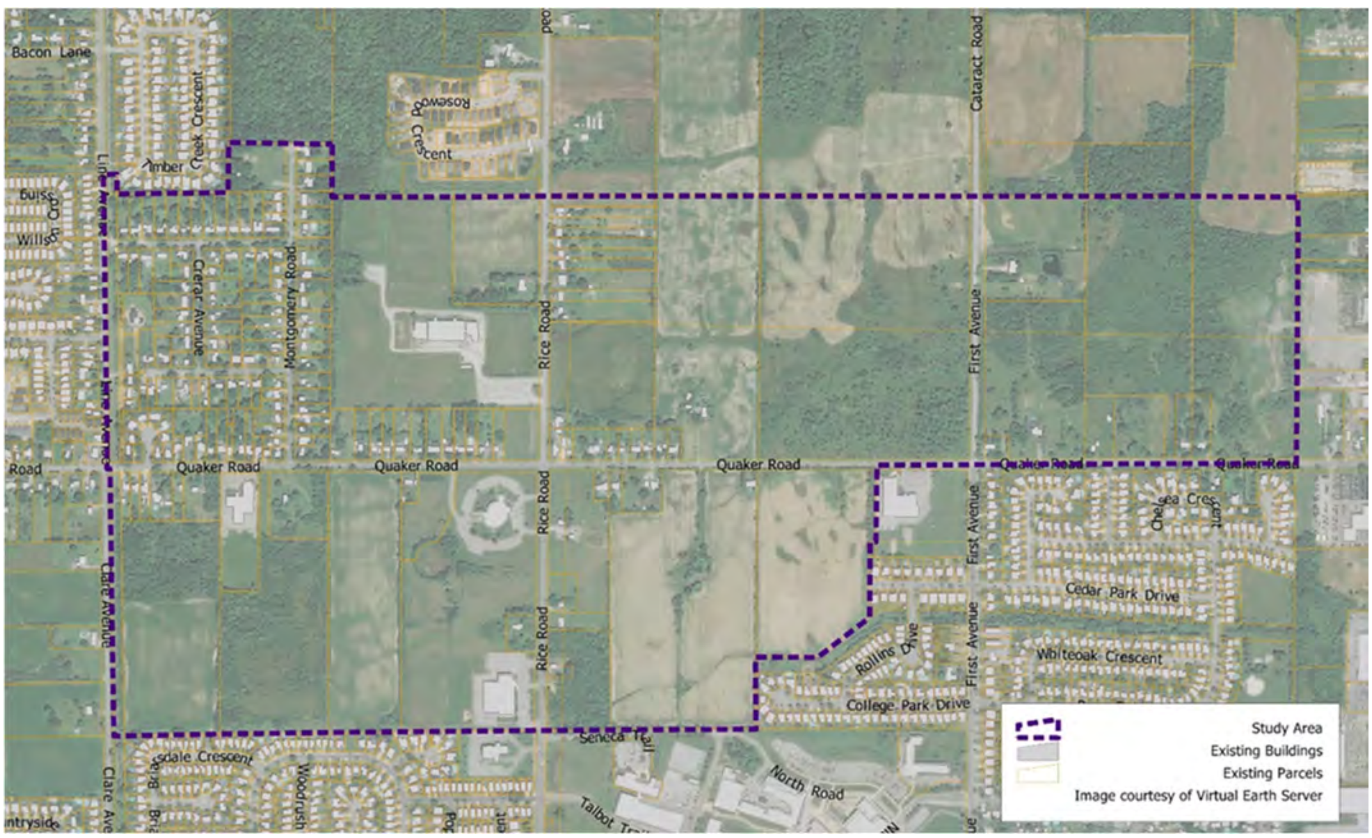



Figure 1-1: Northwest Welland Secondary Plan Study Area

Existing land uses are primarily residential, institutional, agricultural, and open space. Currently, municipal services for water, sanitary and storm exist in parts of the NWSP area, which will be leveraged to accommodate the NWSP area.

## 1.2 Proposed Secondary Plan

Figure 1-2 shows the proposed NWSP layout provided by Upper Canada Consultants (September 2023). Based on the proposed layout, population and unit numbers for each development block were also provided by Upper Canada Consultants. Projected units and populations are summarized in Table 1-1.

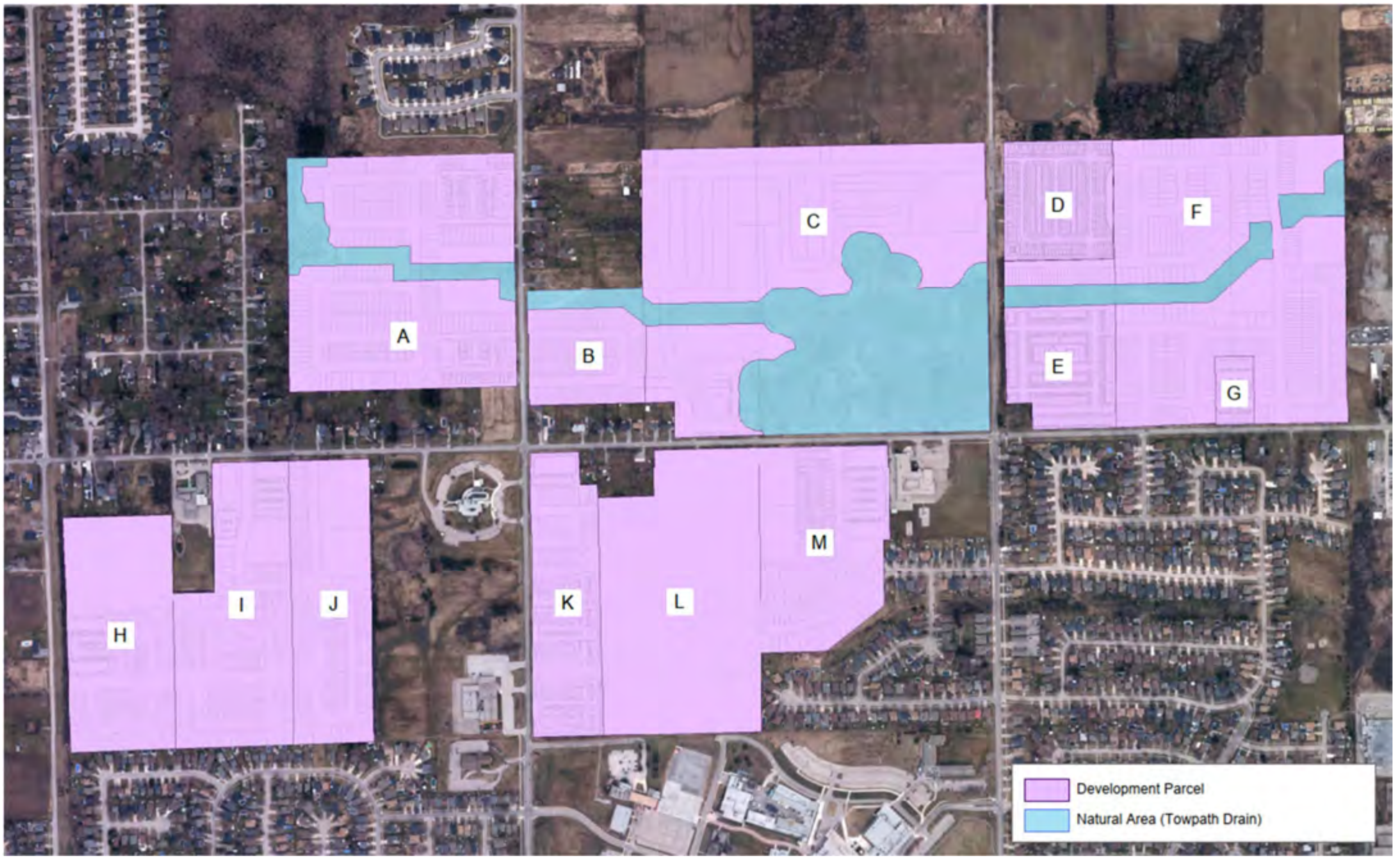



Figure 1-2: NWSP Proposed Population and Unit Plan

Table 1-1: NWSP Population and Unit Numbers

| Block Number | Area (ha) | Units | Population (+/-) |
|---|---|---|---|
| A | 13.25 | 386 | 1,081 |
| B | 3.36 | 114 | 319 |
| C | 18.15 | 800 | 2,240 |
| D | 4.05 | 360 | 1,008 |
| E | 4.77 | 401 | 1,123 |
| F | 17.71 | 403 | 1,128 |
| G | 0.80 | 96 | 269 |

| Block Number | Area (ha) | Units | Population (+/-) |
|---|---|---|---|
| H | 8.40 | 226 | 633 |
| I | 8.79 | 227 | 636 |
| J | 7.04 | 162 | 454 |
| K | 5.73 | 439 | 1,229 |
| L | 13.02 | 500 | 1,400 |
| M | 7.05 | 236 | 661 |

# 2 BACKGROUND INFORMATION

## 2.1 Sources

Table 2-1 provides a list of sources used to aid in completing the analysis of water, wastewater, and stormwater servicing for the NWSP area.

Table 2-1: Water, Sanitary and Storm Data Sources

| System | Description | File Type(s) | Author(s) |
|---|---|---|---|
| All | City of Welland Northwest Area Planning and Servicing Study Municipal Class EA | PDF | Earth Tech |
| All | 1m Elevation Contours | SHP | City of Welland |
| All | City of Welland GIS Data | GIS | City of Welland |
| All | City of Welland Official Plan | PDF | Dillon Consulting |
| All | Key Directions Report for the Northwest Welland Secondary Plan Area | PDF | SGL |
| All | City of Welland Municipal Standards, 2013 | PDF | City of Welland |
| Water/Wastewater | 2016 Water and Wastewater Master Servicing Plan Update Hydraulic Model for City of Welland, May 2017 | PDF | GM Blue Plan |
| Water | Welland Water Model (part of the Niagara Region Water Model for the 2017 Niagara Region Master Servicing Plan), 2017 | InfoWater | Niagara Region |
| *Water | City of Welland All Pipe Water Model | InfoWater | City of Welland |
| Water | Design Guidelines for Drinking-Water Systems, 2008 | PDF | MECP |
| Water | City of Welland Fire Flow Requirements – By Building Zone | PDF | AE |

| System | Description | File Type(s) | Author(s) |
|---|---|---|---|
| *Wastewater | Welland All Pipe Wastewater Model | InfoSWMM | City of Welland/ Niagara Region |
| *Wastewater | City of Welland Pollution Prevention Control Plan Update & Wastewater Master Servicing Plan, 2020 | PDF | GM Blue Plan |
| *Wastewater | Niagara Region Water and Wastewater Master Servicing Plan Update, 2021 | PDF | GM Blue Plan |
| *Storm | Northwest Welland Stormwater Management Implementation Plan, 2022 | PDF | Upper Canada Consultants |

*additional/updated data sources since May 2021 Report

## 2.2 Data Gaps

Data gaps are presented in Table 2-2, which summarizes missing, relevant information that would provide a clearer picture of the existing and future needs of the systems in future steps of this process (i.e. confirmation of criteria to be used in future design of systems).

Table 2-2: Data Gaps

| System | Data Gaps | Justification |
|---|---|---|
| All | Detailed topographic survey | To confirm elevations for servicing |

# 3 WATER

Water servicing in the Niagara Region is a two-tiered approach; Niagara Region has jurisdiction over the drinking water supply for homes and businesses throughout the Region and is responsible for treatment, storage, pumping, and trunk watermains. The City of Welland is responsible for the local distribution system.

Currently, the area surrounding the proposed development is pipe fed from the Welland Water Treatment Plant (WTP) to the Shoalt's Drive Reservoir and surrounding area. During periods where the WTP is offline, the area is predominately supplied by gravity from the Shoalt's Reservoir. The Welland system also has an elevated storage tank (Bemis) located in the southern portion of the distribution system.

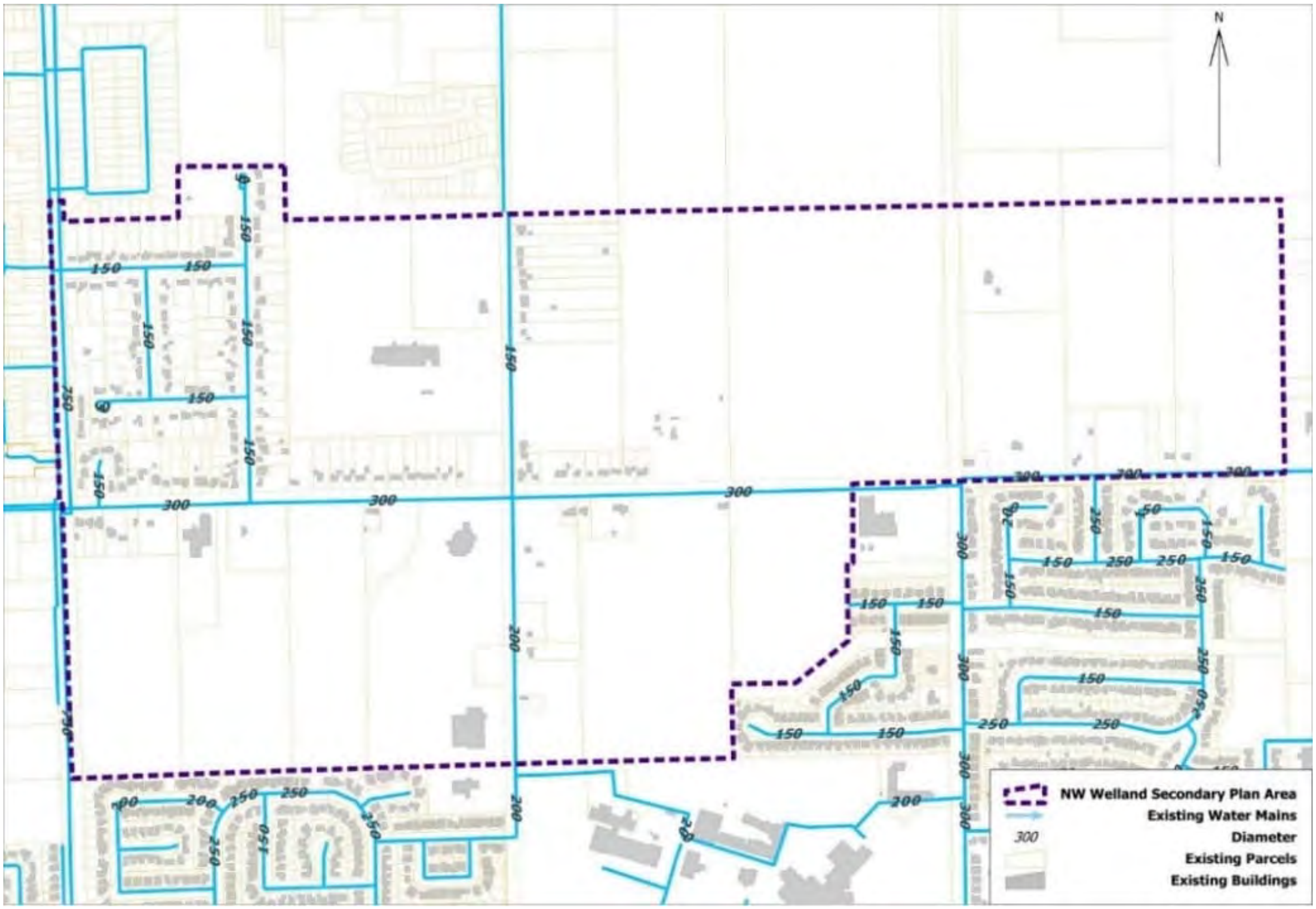



Figure 3-1: Existing Watermains Configuration in Study Area

The existing system configuration within the study area, including existing pipe diameters, is shown in

Figure 3-1. Within this area there is a small existing development east of Line Avenue and north of Quaker Road. This area, which was built in 2002, consists of 150mm PVC watermain connecting to both the 750mm CPP on Line Avenue to the west and the 300mm CI on Quaker Road to the south. In addition, there is a 150mm existing main on Rice Road (north of Quaker Road) which appears to serve few properties. There are also existing properties along Quaker Road, which are serviced off the 300mm main.

## 3.1 Design Criteria

The design criteria used for the analysis of the water distribution system includes the following:

- Target normal operating pressures:
  - Preferred system pressure between 350 kPa to 550 kPa (50 to 80 psi)
  - Minimum system pressure to be greater than 275 kPa (40 psi)
  - Maximum system pressure to be less than 700 kPa (100 psi)
- Fire flow requirements during MDD with 140 kPa (20 psi) residual system pressure:

    - Parks: 67 L/s
    - Low Density Residential (Single Family Residential): 67 L/s
    - Medium Density Residential (Townhomes): 133 L/s
    - Multi-Use: 133 L/s
- Per capita demand: 240 L/cap-day (Based on City design criteria)
- Peaking factors as per the City of Welland Model, as follows:
    - Maximum Day Demand peaking factor: 1.5
    - Peak Hour Demand peaking factor: 1.87 (2.81 x Average Day Demand)
- ADD and MDD demand patterns as per City of Welland Model
- C-Factor for new pipes: 135 (Based on the City design standard)

### 3.1.1 Water Demands

Table 3-1 summarizes the new demands assigned within the model for the NWSP area. These demands were calculated based on the newly proposed populations/units previously identified in Table 1-1 and design criteria noted in Section 3.1.

Table 3-1: New NWSP Demands

| Junction ID | ADD (L/s) | MDD (L/s) | PHD (L/s) |
|---|---|---|---|
| 814 | 0.89 | 1.33 | 2.49 |
| 951 | 3.89 | 5.83 | 10.93 |
| 1700 | 0.75 | 1.12 | 2.10 |
| 3952 | 1.76 | 2.64 | 4.94 |
| 8338 | 1.50 | 2.25 | 4.22 |
| 8622 | 3.41 | 5.12 | 9.59 |
| 8623 | 2.07 | 3.11 | 5.83 |
| J-FUT-47 | 2.80 | 4.20 | 7.87 |
| J_NWSP_4 | 1.26 | 1.89 | 3.55 |
| J_NWSP_6 | 1.50 | 2.25 | 4.22 |
| J_NWSP_8 | 2.07 | 3.11 | 5.83 |
| J_NWSP_9 | 2.07 | 3.11 | 5.83 |
| J_NWSP_10 | 3.12 | 4.68 | 8.77 |
| J_NWSP_15 | 1.84 | 2.76 | 5.16 |
| J_NWSP_20 | 3.13 | 4.70 | 8.81 |
| J-FUT-49 | 1.77 | 2.65 | 4.97 |

| Junction ID | ADD (L/s) | MDD (L/s) | PHD (L/s) |
|---|---|---|---|
| Total Demand | 33.84 | 50.77 | 95.11 |

## 3.2 Model Updates and Existing System Conditions

An InfoWater Model (WELLAND_WATER_2023, dated October 23, 2023) provided by the City was used for the analysis. The City's model includes both existing and future Average Day Demand (ADD) and Maximum Day Demand (MDD) extended period simulation scenarios. Model data sets suggest that the existing demand scenarios in the model were last reviewed and updated in 2022. The earlier study completed for this development reviewed and commented on the Niagara Region & City of Welland InfoWater models for their future development growth, providing an insight into the future development areas of the region. It has been assumed that this information still applies despite the time passed since that report.

During the development of this study, City noted that there were two errors in the existing model scenarios that should be rectified and therefore, the analysis was updated with the following changes/corrections.

- The size of the watermain, dead end on Montogomery Road where hydrant was connected, was changed from 50mm to 150mm pipe.
- The connection to the intersection of the Regional trunk main at Line Avenue and Summerlea Avenue was opened in the model.
- Recent discussions with the City indicated that the watermain along Quaker Road from Clare Avenue to Rice Road is currently being replaced with a new 300mm watermain and therefore, this portion of pipe was upsized and a C-factor of 135 was assigned in the model to reflect the upgrade.
- The connection (IW pipe ID – 2377) between the 750mm Region trunk main on Clare Avenue N and the 300mm watermain on Quaker Road was opened in the model.

Other than the above noted model updates, no quality control checks were conducted on the City's model; it was assumed that the model is sufficiently calibrated for the purpose of this analysis and is indicative of the current system.

Figures for this section can be found in Appendix A. Table 3-2 shows the existing and current future pumping schemes from the City's model (on/off settings) at the WTP for both ADD and MDD scenarios. No changes were made to these settings for the development analysis.

Table 3-2: Existing and Future WTP Pump Settings – City's InfoWater Model

| Pump | Existing ADD | Existing MDD | Future ADD | Future MDD |
|---|---|---|---|---|
| Low Flow Pump #1 | On at 0:00<br>Off at 6:00 | Off at 0:00 | Off at 0:00<br>On at 11:00 | Off at 0:00<br>On at 20:00<br>Off at 22:00 |
| Low Flow Pump #2 | Off at 0:00 | Off at 0:00 | Off at 0:00<br>On at 20:00 | Off at 0:00 |

| Pump | Existing ADD | Existing MDD | Future ADD | Future MDD |
|---|---|---|---|---|
| High Flow Pump #1 | Off at 0:00<br>On at 13:00 | On at 0:00<br>Off at 7:00 | On at 0:00 | On at 0:00<br>Off at 2:00<br>On at 5:00 |
| High Flow Pump #2 | Off at 0:00 | Off at 0:00<br>On at 12:00 | On at 0:00<br>Off at 3:00<br>On at 6:00<br>Off at 20:00 | On at 0:00<br>Off at 2:00<br>On at 5:00 |

### 3.2.1 Current Hydraulic Conditions

A hydraulic analysis of the existing system was completed to provide a baseline level of service to compare to the future development scenarios.

Figures A-1 and A-2 show the minimum pressure during existing ADD and MDD in the study limits and surrounding area. At certain locations within the study area, pressures are lower than the required minimum pressure of 275 kPa (40 psi). These low-pressure nodes are in proximity to the Shoalt's reservoir and occur during peak periods; simulation time 11am to 12 noon for ADD and 10am to 11am for MDD. The observed minimum pressures in this portion of the study area for ADD and MDD are 239 kPa and 234 kPa respectively and are thought to be due to high ground elevations (maximum of 193m) and fluctuations of the Shoalt's Drive Reservoir head (between 217.5m and 219.0m). As to be expected during higher demands, more low-pressure nodes were observed in the surrounding study area during MDD scenario than ADD. There were also few low-pressure nodes observed in the other future growth areas of the system.

Figure A-3 shows the available fire flow during MDD at a residual pressure of 140 kPa (20 psi). Certain portions of the study area, specifically watermains along the Rice Road and Topham Boulevard have available fire flows less than 67 L/s (the City standard for single family residential). However, the new 300mm watermain upgrade along Quaker Road (from Clare Avenue to Rice Road) improves fire flows along Quaker Road, Montgomery Road and in Summerlea Avenue. The dead ends of the watermains in this portion of the area still indicated low fire flows (< 67 L/s).

The low availability of fire flows is due to both the high ground elevation and the size of the watermains supplying these hydrants.

### 3.2.2 Future Conditions without NWSP Development

In the existing model from the City, it was observed that the future model scenario included NWSP infrastructure and demands based on the previous study. A total of 48.7 L/s for future ADD and 73.1 L/s for future MDD was allocated in the NWSP region at the model junctions summarized below in Table 3-3.

Table 3-3: Identified Previous NWSP Demands from the City's Model

| Junction ID | Future ADD (L/s) | Future MDD (L/s) |
|---|---|---|
| 3952 | 1.00 | 1.07 |
| 567 | 3.15 | 4.72 |
| 812 | 2.52 | 3.77 |
| 815 | 3.86 | 5.79 |
| 818 | 4.01 | 6.02 |
| 8622 | 1.18 | 1.77 |
| 8623 | 5.35 | 8.03 |
| J-FUT-47 | 10.10 | 15.16 |
| J-FUT-48 | 2.14 | 3.21 |
| J-FUT-49 | 5.58 | 8.37 |
| J-FUT-50 | 6.08 | 9.12 |
| J-FUT-51 | 4.03 | 6.05 |
| Total Demand | 49.00 | 73.08 |

To prevent "doubling up" on NWSP demands, the previously proposed infrastructure for NWSP has been removed from the future analysis.

Figures A-4 and A-5 show the minimum pressure during future ADD and MDD, without the NWSP development. As these figures show, a significant improvement in pressures was noted in the surrounding study area when compared to the existing scenarios, with only a small number of low-pressure nodes noted. This is due to the change in the pumping procedure at the WTP for the future scenario.

Figures 3-2 and 3-3 below show the hydraulic grade (HG) for Shoalt's and Bemis tanks for the existing and future MDD Scenarios. The pumping operating procedure at the WTP for the existing scenario shuts down the pumps mid-morning, coinciding with periods of higher system demand. During this mid-morning WTP shutdown, both the Shoalt's Drive Reservoir and the Bemis Elevated Tank levels are drawn down; this draw down is sharp and reaches its lowest hydraulic grade level (HG) around noon. However, with the current future pumping scheme at WTP, the HG at Shoalt's and Bemis shows a sustained hydraulic head after 6 am showing improved pressures in the surrounding study area.

The future pumping schemes in the model for ADD and MDD scenarios showed improved pressures surrounding the study area which appeared to resolve most of the low-pressure nodes that were highlighted in existing scenarios.  A few low-pressure nodes (250 kPa to 261kPa) still persisted surrounding the study area particularly nodes close to the Shoalt's reservoir.

An attempt was made to assess the future system by changing the current future pumping scheme for MDD scenario by altering the pumping hours at pump H-1 (On at 0:00 and Off at 2:00) which showed improved pressures in the reservoir area but not completely eliminated. As modification of pumping schemes is outside of the scope of this analysis, this would need to be confirmed by the City when adjusting the overall system configuration and settings.

Figure A-6 shows the available fire flow during future MDD prior to the proposed development. Parts of the surrounding study area on the south and east sides showed sufficient fire flows as required for multi-family residential housing (133 L/s) however, the nodes on the Rice Road watermain have less than the design standard of 133 L/s. Most of the Shoalt's reservoir area showed adequate fire flows with the new 300mm watermain upgrade in Quaker Road and by opening the 750mm Region trunk main interconnection in Clare Avenue N with the exception of the dead-end locations.

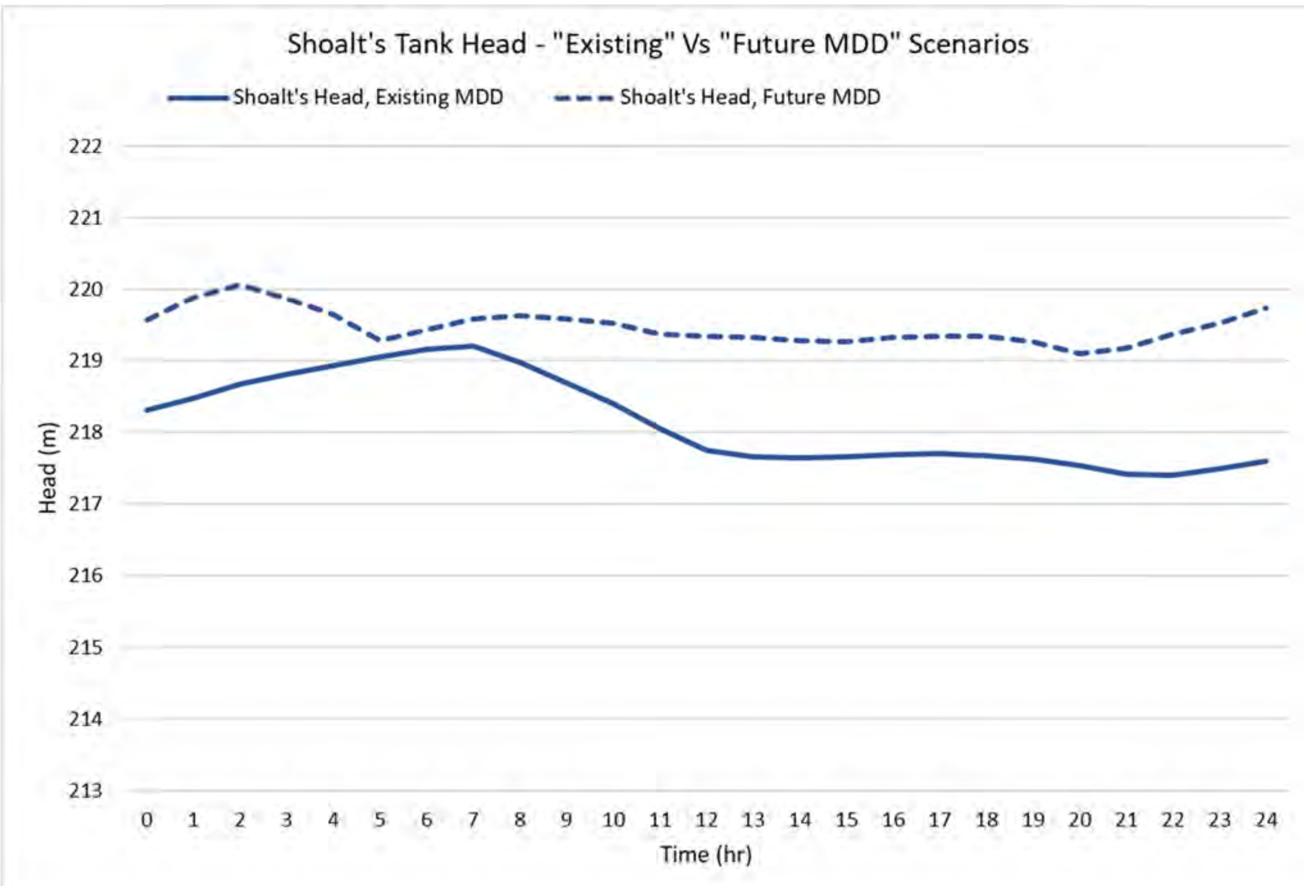



Figure 3-2: Shoalt's Tank Head – Existing and Future MDD Scenarios (without NWSP)

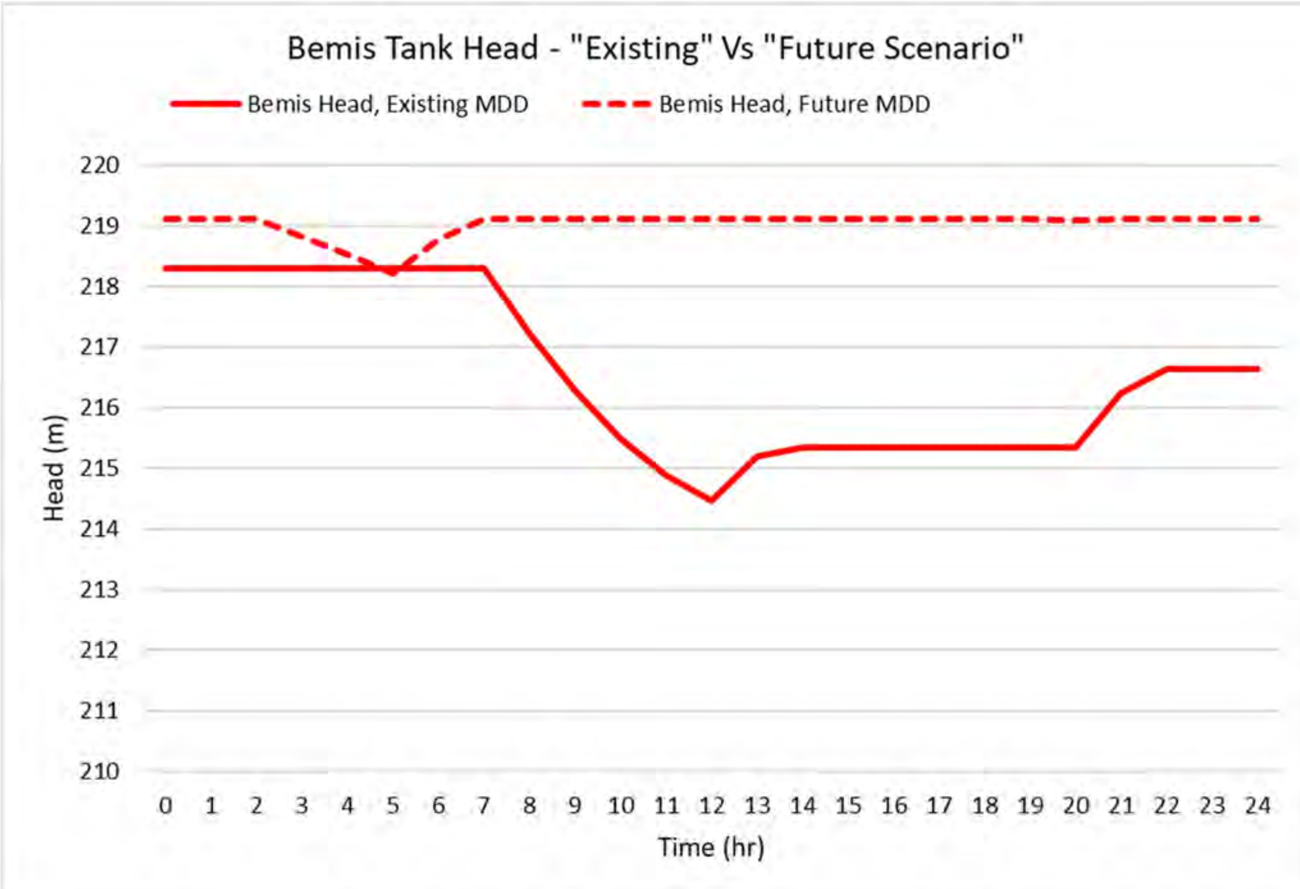



Figure 3-3: Bemis Tank Head – Existing and Future MDD Scenarios (without NWSP)

## 3.3 Proposed System Requirements

Several pipes and junctions were added to the City of Welland InfoWater model to represent future servicing of the NWSP area. The proposed pipe routing is laid based on the new NWSP site layout as shown in Figure 1-2 in Section 1.0 of this report. As the existing 300mm main on Quaker Road acts as a main supply line for this study area, the proposed mains for NWSP were mainly branched and looped out from this main to service the proposed development. Note that only significant pipes that will connect the NWSP site were included in the model. There will be additional future piping required along local roads upon finalization of the site layout.

Junction elevations for the newly added nodes in the study area were assigned based on the City of Welland 1 m contours. Pipe sizing for the major loops shown in Figure 3-4 was established as part of the hydraulic analysis to achieve the required fire flow of 133 L/s as needed for the medium density residential. New piping is shown in bold red; existing piping in blue.

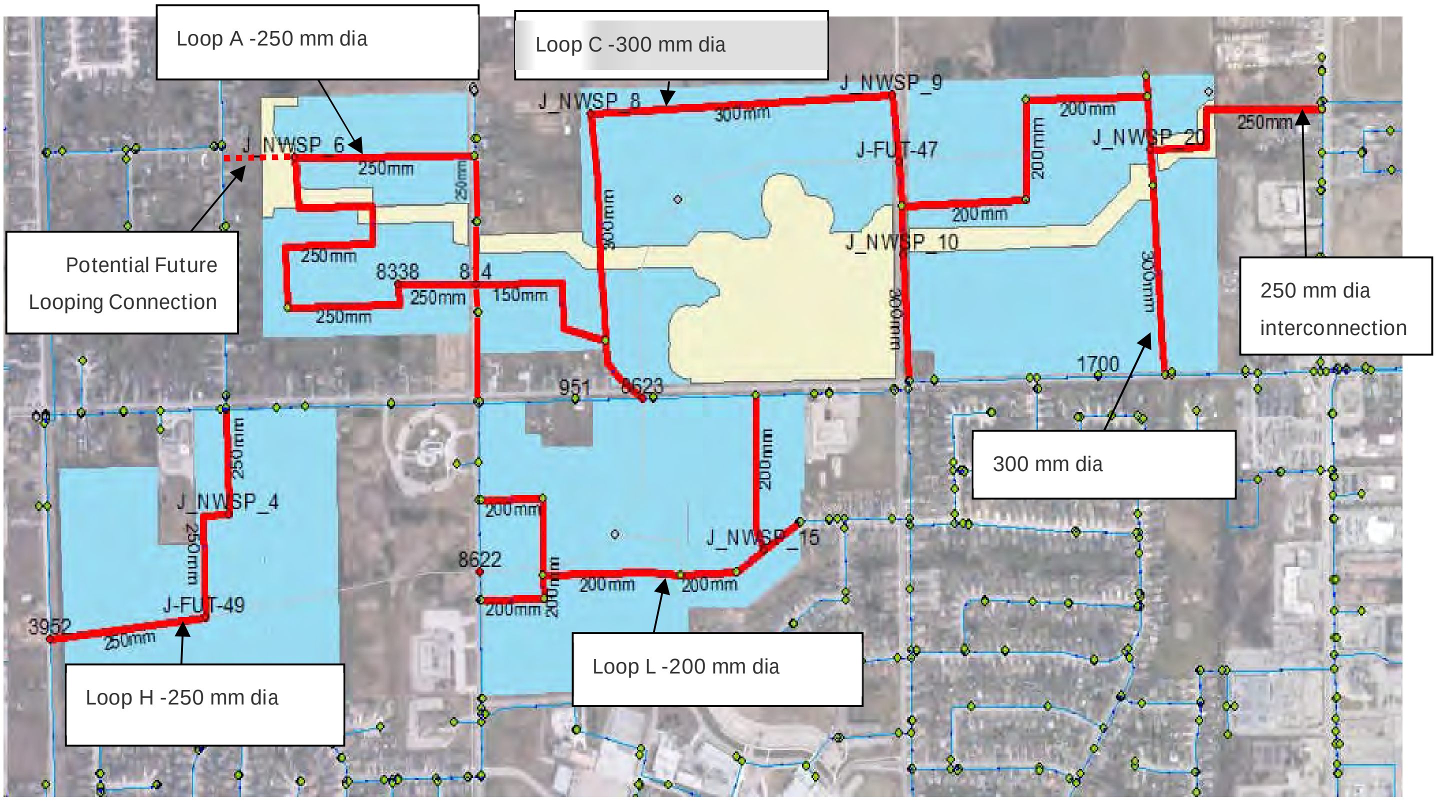



Figure 3-4: Proposed Infrastructure for NWSP Development

### 3.3.1 Hydraulic Analysis

The development demands for the proposed NWSP development were added to the Futures ADD and MDD scenarios in the model. The hydraulic analysis then was carried out with NWSP future demands to identify the impact of this proposed development on the future system and to confirm the pipe sizing and servicing requirements to support the future NWSP development.

Figures A-7 and A-8 show the minimum available pressures during ADD and MDD EPS, and Figure A-9 shows the available fire flows, with the NWSP area serviced with the proposed watermain sizes identified.

As these figures show, the addition of NWSP area to the future system does not significantly impact the surrounding system pressures, instead the proposed servicing has shown improved pressures over Future ADD and MDD when no NWSP development was added. As with the other modelled scenarios, there are existing low-pressure nodes near Shoalt's Drive Reservoir area, however no exacerbation of low pressures was noted when the NWSP development was added.

Figure A-9 shows most of the NWSP study area meets fire flow requirements of 133 L/s that is required for medium density housing with the following pipe servicing requirements.

The major watermain loops (Loop A, C, H and L) that are proposed to service the future NWSP development are shown in Figure 3-4 above. The pipe routing and sizing was identified based on the current site layout provided by the developers and to achieve the design fire flow of 133 L/s throughout the study area. Should a change in the NWSP site layout occur in the future, a review of the analysis may be required to re-confirm the pipe sizes and servicing options. Furthermore, additional modelling may be required in the future to assess the extent of the overall system that is required to be constructed to facilitate each development block on a project-by-project basis.

To supply the required fire flow (133 L/s) to the northwest portion of the NWSP, specifically, the development that is planned west of Rice Road, an upgrade of Rice Road watermain and as well as the new water mains installed in this area should be a minimum of 250mm as shown as Loop A. With this upgrade, the fire flows in the area were improved and vary from 138 L/s to 213 L/s. It is also noted that a potential future looping connection between the northwest portion of the NWSP and the existing watermain on Montgomery Road can be considered based on final development details and servicing requirements within the area.

A new 300mm watermain loop, Loop C will be required to supply the C-block of the NWSP planned development. In addition, a new interconnection with 250mm watermain connecting the NWSP development to the watermain in Niagara Street on the eastern side is also made to improve the fire flows in the area.

Two major watermain loops with 200mm and 250mm, Loop L and Loop H respectively will be required for the southern portion of the NWSP, to provide the required fire flow of 133 L/s in this area. Without the Loop L, the development blocks K and M were not able to achieve the design fire flows of 133 L/s.

Overall, the proposed NWSP development shows improved operating pressures except in the low-pressure areas previously identified. Improved fire flows were also noted around the NWSP study area with the proposed pipe servicing, both within and outside the development boundaries.

### 3.3.2 Storage Requirements Review

A review of the City of Welland's overall storage capacity and existing and future storage requirements was conducted to determine the impact of the NWSP area on future storage needs. As per the MECP Design Guidelines for Drinking Water Systems, storage requirements for a water distribution system are as follows:

- Equalization Storage (A) = 25% of Maximum Day Demand
- Fire Storage (B) = 378 L/s for 6 hours (Based on MECP Equivalent Population Fire Flow Requirement)
- Emergency Storage (C) = 25% of A +B

Table 3-4 summarizes the total available storage identified in the Region Master Plan (as used in the previous report) and the calculated existing and future storage needs for the system based on the City of Welland model demands. As shown, there is sufficient storage in the Welland system to allow for the addition of the NWSP area. The total additional storage required for the addition of the NWSP area is 1.4 ML.

Table 3-4: Available and Required Water Storage

| Description | Storage (ML) |
|---|---|
| Total Available Storage | 37.0 |
| Existing Required Storage | 19.7 |
| Future Required Storage without NWSP (a) | 26.5 |

| Description | Storage (ML) |
|---|---|
| Future Required Storage with NWSP (b) | 27.9 |
| Required Additional Storage for NWSP (b-a) | 1.4 |

# 4 SANITARY

Sanitary servicing in Niagara Region is based on a two-tiered approach. The Region is responsible for the wastewater treatment plants, trunk sewers, pumping stations and forcemains. The City of Welland is responsible for the local gravity sewer system.

The sanitary sewage from the NWSP area will ultimately be treated at the Welland Wastewater Treatment Plant (WWTP). This WWTP services the City of Welland, Town of Pelham, and the Port Robinson area of the City of Thorold.

The existing sanitary services in the NWSP area includes a regional main down Rice Road, local main in the Montgomery subdivision, and local and regional (trunk) sanitary sewer along Quaker Road. Primary sanitary sewage flows south down Rice Road, and then east down Quaker Road to Towpath Road. Sanitary sewage then flows northeast along Towpath Road to Towpath Sewage Pumping Station (SPS). Towpath SPS receives gravity flow from the regional trunk sanitary sewer along Quaker Road and flows from Hurricane Road SPS (Rice Road). Sewage from Towpath SPS is pumped through a forcemain across the Welland River to a gravity system, which ultimately flows to the Welland WWTP. A schematic of the existing sanitary servicing within the NWSP study area is provided in Figure 4-1.

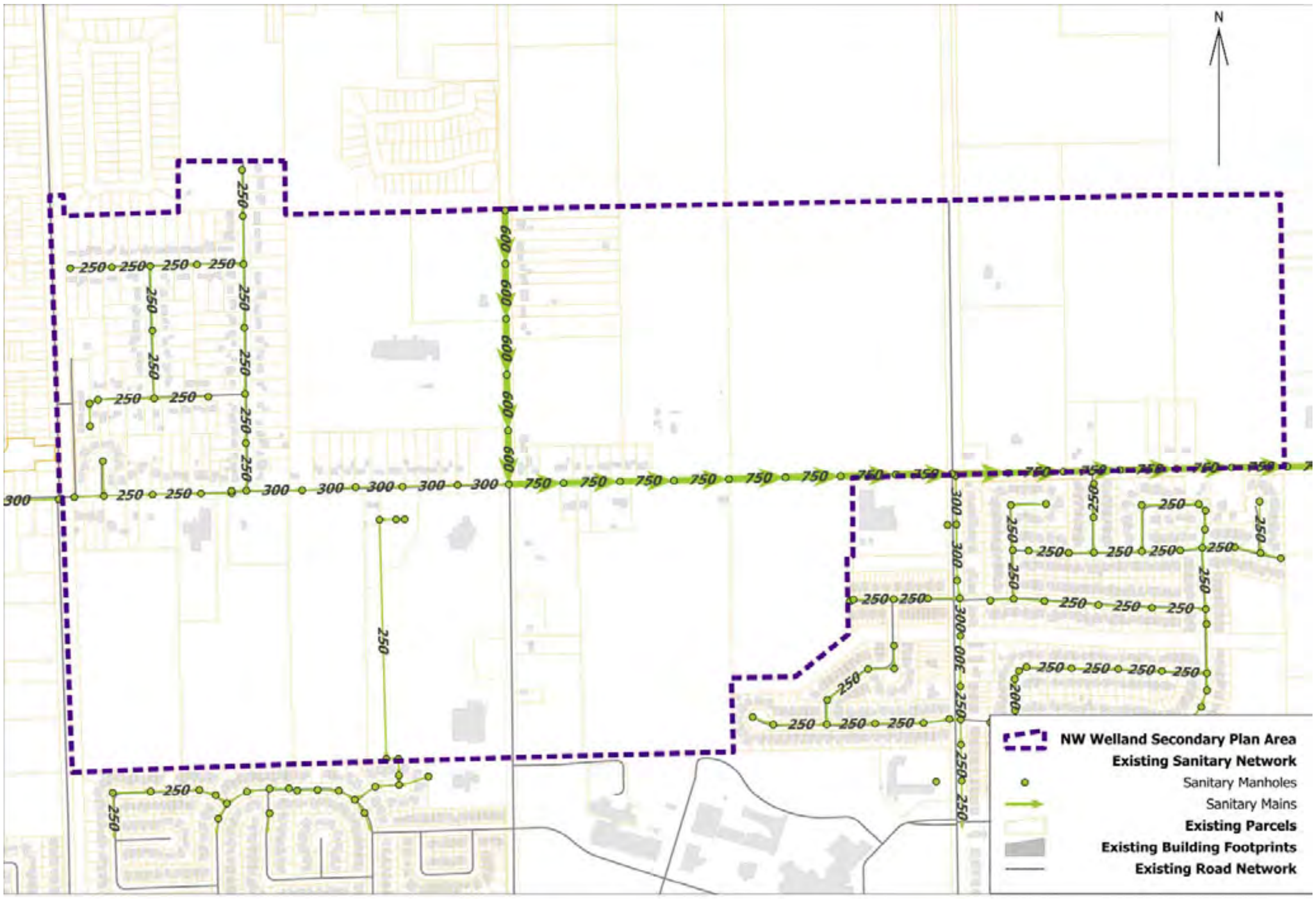



Figure 4-1: Schematic of Existing Sanitary System in NWSP Study Area

## 4.1 Design Criteria

Existing and future peak flows conveyed by the trunk sewer on Quaker Road to the Towpath SPS were assumed to be equivalent to the flows represented in the City's all-pipe InfoSWMM model.

Additional flows contributed to the Quaker Road trunk sewer, and ultimately the Towpath SPS, by the NWSP area were calculated using the following design criteria:

- Extraneous flows = 0.286 L/s/ha
- Roughness coefficient = 0.013
- Residential per capita flow rate (for sewage generation) = 275 L/cap/day
- Peaking factor = Calculated based on Harmon formula with values between 2.0 and 4.0

## 4.2 Existing System Capacity

### 4.2.1 Trunk Sewer

The available capacity of the existing trunk sewer along Quaker Road from Rice Road to the Towpath SPS was reviewed using the City's all pipe InfoSWMM model.

Currently Line Avenue is the break point in the collection system, with areas west of Line Avenue flowing west and then south, contributing to the Welland WWTP drainage area. However, the Region Master Servicing Plan Update (MSPU) identified a new 600mm diameter connection (WW-SS-002) along Quaker Road from Line Avenue to Rice Road, which would redirect approximately 130L/s of flows from Pelham (north-west of Line Avenue) to the Quaker Road trunk sewer, and ultimately the Towpath SPS. Given this change in flows through the Quaker Road trunk sewer, the available capacity of this sewer was reviewed with this new connection. This completed available capacity assessment, based on the InfoSWMM model outputs, is attached in Appendix B. In general, the Quaker Road trunk sewer has significant available capacity – with future available capacity ranging from 100L/s to 3,194L/s with the new Line Avenue connection.

### 4.2.2 Towpath SPS and Forcemain

The Region MSPU identified that Towpath SPS has existing and future deficiencies based on existing and design peak wet weather flows. As such, the Region MSPU identified a capital project to upgrade the Towpath SPS during the timeframe of 2022 – 2026 from 118L/s to 600L/s (WW-SPS-037).

The Region MSPU also indicates that the existing Towpath SPS forcemain has current capacity; however, will have a projected capacity deficit for 2051 growth. There is already a constructed 600mm diameter forcemain that can be commissioned in line with Towpath upgrades, as identified in the Region MSPU capital projects during the timeframe of 2032-2036 (WW-FM-022).

### 4.2.3 Welland WWTP

The Region MSPU identified that the existing Welland WWTP has surplus capacity available to treat existing and future flows at the plant, with the plant reaching 80% capacity around the 2041 time horizon.

## 4.3 Proposed System Requirements

### 4.3.1 NWSP Sanitary Drainage Areas and Proposed Collection System

As requested, two sanitary servicing options were prepared and reviewed for feasibility for the NWSP area, including: 1) development blocks on the east and west side of First Avenue are connected to a new city trunk located on First Avenue and 2) development blocks on the east and west side of First Avenue are connected through the development blocks to a new city trunk located on Quaker Road.

Figure 4-2 and Figure 4-3 (also provided in Appendix B as Figure B-1 and B-2, respectively) show the approximate location of future city trunk sanitary gravity sewers within the NWSP area and the location where the city trunks will connect to the existing Region trunk sewer on Quaker Road for each servicing option. Figure 4-2 and Figure 4-3 also show identifying numbers for the individual NWSP drainage areas, which are referenced in the sewer design sheets provided in Appendix B.

The design sheets for the proposed sanitary sewers have been prepared with the new Line Avenue connection included. Note that the inverts and pipe lengths assigned to the existing trunk sewer in the proposed design sheets are from the City's InfoSWMM model. Existing peak flows into the trunk sewer, input at existing manhole locations in the design sheets, are also as per the City's InfoSWMM model. All inverts and pipe lengths of the proposed city trunk sewers have been assigned based on preliminary modeling and the existing ground contours of the area. Note that, it is assumed that any other sanitary sewer required on future local roads servicing the NWSP area, will be 200 mm diameter.

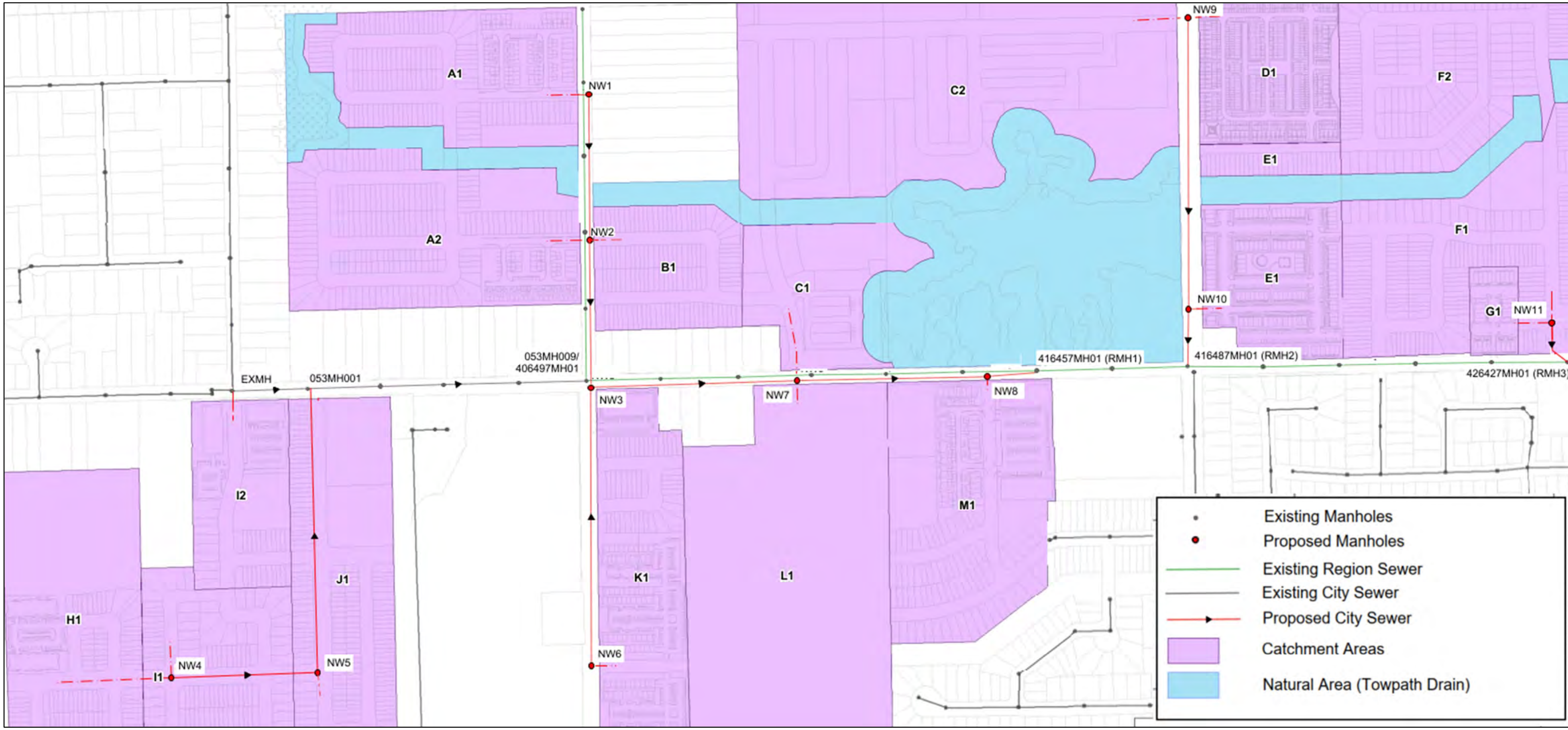


Figure 4-2: Proposed Sanitary System and Drainage Areas – Option 1

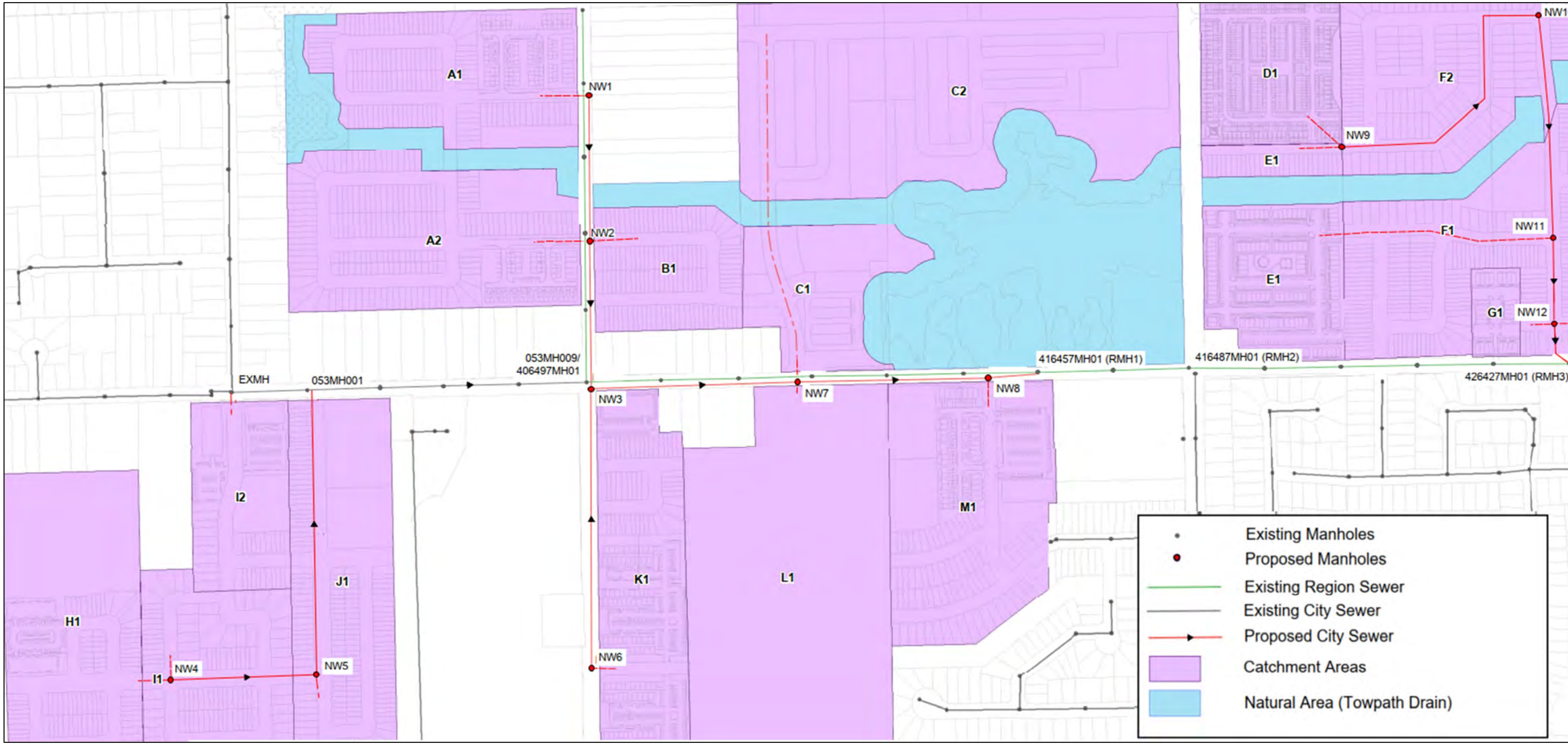



Figure 4-3: Proposed Sanitary System and Drainage Areas – Option 2

For servicing Option 2, the proposed trunk sewer within the quadrant east of First Avenue and north of Quaker Road (from NW10 to NW11) must cross the proposed Towpath Drain. For this preliminary assessment, using the existing ground contours and referencing the Towpath Drain Re-Alignment drawing package (Upper Canada Consultants, 2022) it appears that the proposed trunk sewer will be in direct conflict with the proposed box culvert and new creek bottom, making this servicing option not achievable. Further review and confirmation, based on proposed development details, will be required to determine viability of this servicing option moving forward.

As shown in the appended design sheets, the NWSP drainage area contributes overall an additional 143.3L/s of peak flow to the Quaker Road trunk sewer. Based on the capacity review of the existing trunk sewer on Quaker Road (provided in Appendix B), there are two (2) pipe segments that have an available capacity below 143L/s. The first pipe segment (19001376) is located between Rice Road and RMH1 (as shown on Figures 4-2 and 4-3 above). Since this segment will only receive an additional 27L/s sanitary flow from the NWSP area, this segment is not a concern. The second pipe segment (19001405) is located further downstream on Towpath Road between Grisdale Road and the Towpath Road SPS. Model analysis indicates this segment has 100L/s of available capacity with the Line Avenue trunk sewer connection. Further review and confirmation of available capacity within this segment should be completed prior to full build out of the NWSP area.

Although the phasing of future development within the NWSP area is not currently known, the proposed layout of this area and the associated sanitary design is such that the individual quadrants (defined as: areas west of Rice Road and north of Quaker Road (catchment area A); areas west of Rice Road and south of Quaker Road (catchment areas H, I, J); areas east of Rice Road and south of Quaker Road (catchment areas K, L, M); areas east of Rice Road and north of Quaker Road (catchment areas B, C1); areas east of First Avenue and north of Quaker Road (catchment areas D, E, F, G); and areas west of First Avenue (catchment area C2)) can mostly be developed independently of each other. Several exceptions to this include:

- the proposed city trunk sewer on Quaker Road (from NW3 to RMH1) must be constructed prior to development of catchment area A, catchment area B and catchment area K occurring;
- a portion of the proposed city trunk sewer on Quaker Road (from NW7 to RMH1) must be constructed prior to any development occurring within catchment areas C1 (and C2 for servicing Option 2), L, and M.
- for servicing Option 1, the proposed city trunk sewer on First Avenue (from NW9 to RMH2) must be constructed prior to development within catchment areas C2, D, and E.

The remainder of the city trunk sewers within each development quadrant should be constructed as development occurs in that quadrant starting from the downstream end.

Alternatively, to eliminate duplication of trunk infrastructure along Quaker Road and Rice Road, additional connections can be considered directly to the regional trunk main in order to eliminate the need for a ‘local’ trunk system. This approach would also eliminate most of the phasing exceptions noted above, as the local trunk would not need to be constructed.

### 4.3.2 Towpath SPS and Forcemain

The Welland NWSP area will contribute an additional 143.3L/s of peak flow to the Towpath SPS. As previously noted, the Region MSPU identified a planned upgrade to this SPS. The SPS upgrades will be required to address existing and future capacity and will be required to be completed before significant development can occur within the NWSP area.

The Towpath SPS forcemain has sufficient existing and future capacity to accommodate flows from the Welland NWSP area, provided the constructed 600mm diameter forcemain is commissioned prior to 2051 flows and build-out.

### 4.3.3 Welland WWTP and Downstream System

As previously noted, the Welland WWTP currently has a capacity surplus, and the NWSP area can be added. The Region MSPU did indicate the plant will reach 80% capacity around 2041. The post-2051 flows are expected to exceed the plant capacity; however, the plant can accommodate flows to 2051.

Additionally, the trunk sewer that the Towpath SPS forcemain discharges to has available capacity between the discharge point and the WWTP to accept an increase in flow. The design of the future Towpath SPS upgrade should confirm the capacity of the downstream trunk sewer when determining SPS outflow rates.

# 5 STORM

The existing NWSP area topography is quite flat and drains in a west to east direction. The land use is mainly pasture/ agricultural land interspersed with country residential homes. The plan area is significantly developed all around the boundary as well as within the plan area itself. The west side of the study area is already developed with country residential homes. There are two (2) major drainage channels that flow through the site – Towpath Drain within the northern portion of the development area and a tributary to Welland Recreational Canal within the southern portion of the development area. These two (2) channels are identified by the Niagara Peninsula Conservation Authority (NPCA) as requiring approval for any development draining to the channels. The existing stormwater drainage paths are shown in Figure 5-1.

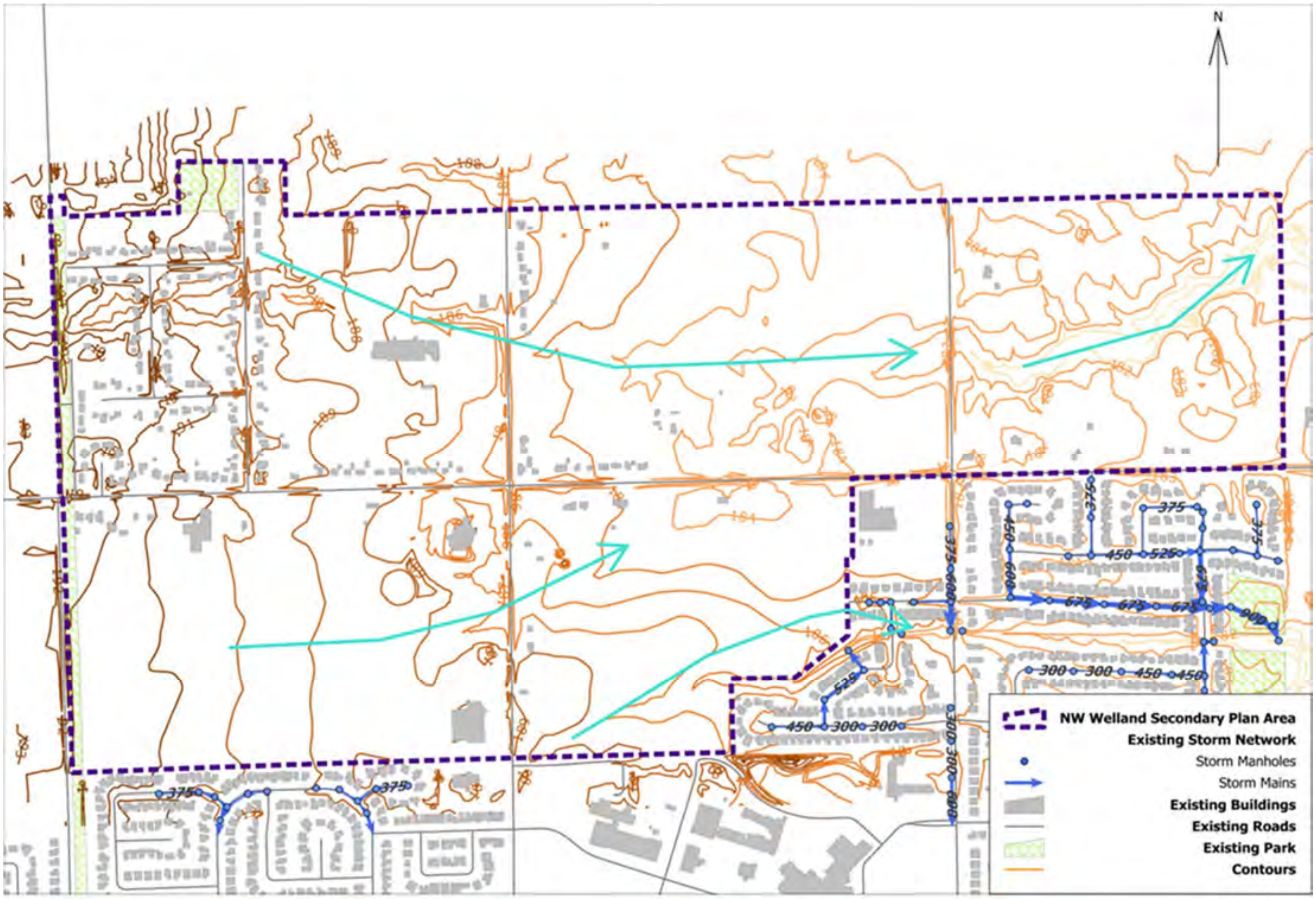



Figure 5-1: Schematic of Existing Stormwater Drainage Path

## 5.1 Design Criteria

The overall stormwater management plan for the NWSP area was initially developed by Aquafor Beech (2020) and updated and refined by Upper Canada Consultants (2022). The focus of this report is the identification of gravity sewer servicing requirements. The following design criteria were used in identifying these servicing requirements:

- Pipes were sized using the rational method with the City of Welland's 5-Year IDF curve values (a = 830, b =0.777, c = 7.3)
- Friction factor = 0.013
- Run-off coefficients (as per City of Welland's Design Standards) of:
  - Low Density Residential (i.e.: Single Family) = 0.40
  - Medium Density Residential (i.e.: Semi-Detached) = 0.50
  - High Density Residential (i.e.: Townhouses) = 0.60

## 5.2 Existing System Capacity

Since the proposed servicing, which is the focus of this report, will not leverage any existing gravity storm sewers in the area, no review of existing system capacity was conducted.

## 5.3 Proposed System Requirements

### 5.3.1 Proposed Stormwater Management Pond Locations

The stormwater management plan developed by Upper Canada Consultants identified approximate locations for eight (8) storm ponds, which will outlet to the Towpath Drain (channel north of Quaker Road), while one (1) storm pond will outlet to the tributary to Welland Recreational Canal (channel south of Quaker Road). The intent of the stormwater management plan is that all runoff from the proposed NWSP area will be directed to these storm pond locations through new gravity sewers installed on existing and future roads.

The approximate location of these proposed storm ponds is shown on the Ultimate Stormwater Management Plan figure from the Upper Canada Consultants Stormwater Management Implementation Plan (October 2022), which is included in Appendix C for reference. These pond locations were used to identify approximate outlet locations for the gravity sewers that will be required to service the NWSP area.

### 5.3.2 Proposed Gravity Sewers

Figure 5-2 (also provided in Appendix C as Figure C-2) shows the approximate location of future trunk storm gravity sewer outlets to the proposed storm ponds within the NWSP area. Figure 5-2 also shows identifying numbers for the individual NWSP drainage areas, which are referenced in the sewer design sheet found in Appendix C. Note, the design sheet was used primarily to identify outlet pipe sizing. Pipe sizes/lengths for the remainder of the future system were also approximated for preliminary costing (see Section 6), with a conservative assumption of a minimum pipe size of 450mm.

Based on the results of the completed sewer design sheet found in Appendix C, Table 5-1 shows the identified required outlet sizes for each approximate pond location.

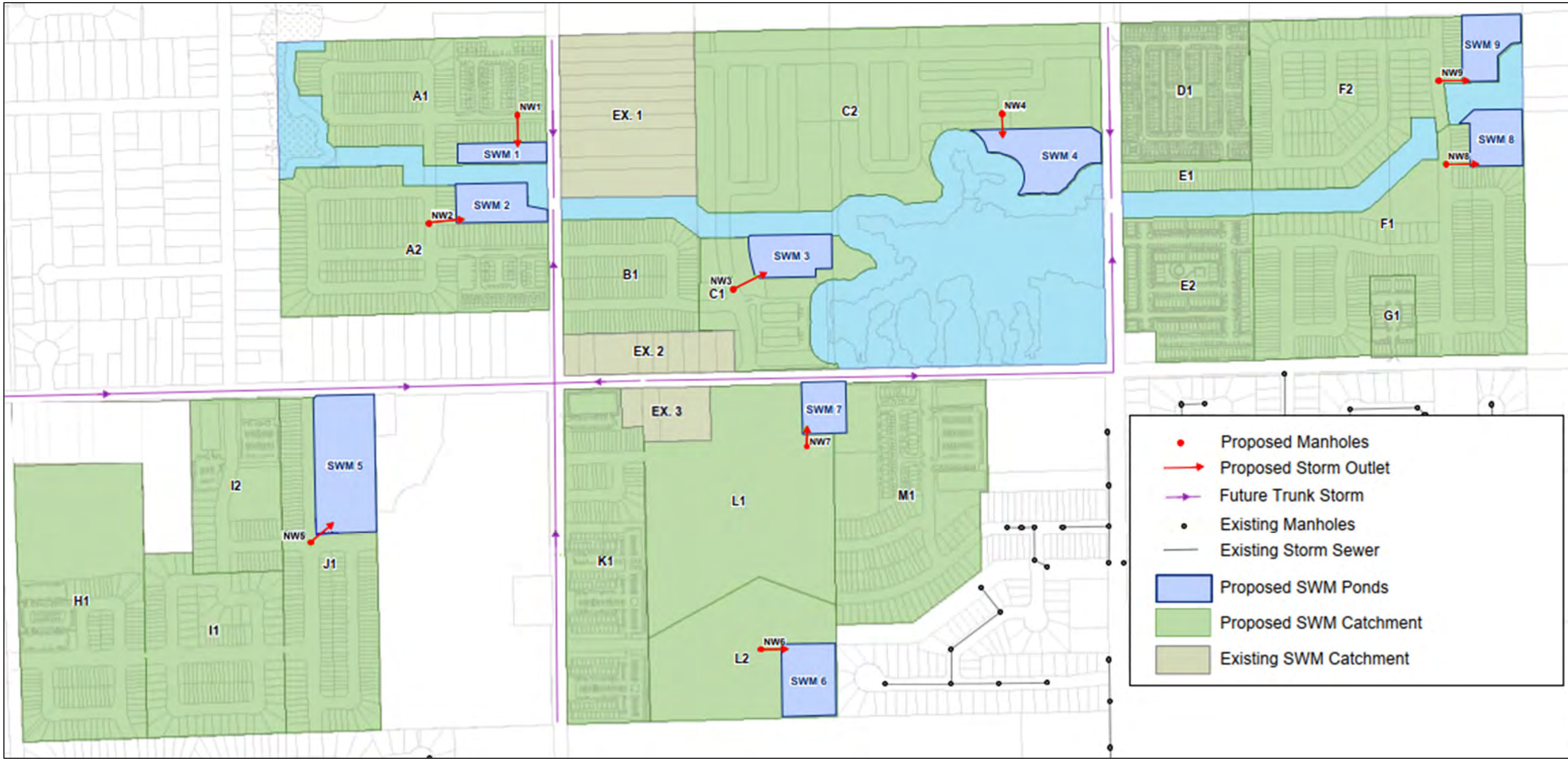


Figure 5-2: Proposed Storm System and Drainage Areas

Table 5-1: Required Outlet Size

| Outlet # | Size (mm) |
|---|---|
| SWM1 | 900 |
| SWM2 | 900 |
| SWM3 | 1050 |
| SWM4 | 1200 |
| SWM5 | 1350 |
| SWM6 | 750 |
| SWM7 | 1350 |
| SWM8 | 1200 |
| SWM9 | 1200 |

Note that pipe slopes identified in the design sheet were assigned based on the existing ground contours for the area and the required outlet elevations, with the intent of ensuring suitable cover over all proposed pipes.

# 6 PRELIMINARY COSTING

Preliminary costing for the conceptual water, sanitary, and stormwater servicing is provided in Table 6-1. Note – neither road works, utilities (including hydro, gas and communications servicing), nor restoration cost (asphalt) for works proposed on existing roads (Rice Road, Quaker Road, and First Avenue) are included in this estimate. A more detailed breakdown of these preliminary cost estimates can be found in Appendix D.

Table 6-1: Preliminary Cost Estimate for Municipal Servicing

| Item | Scope of Work | Cost |
|---|---|---|
| Water Distribution System | Watermain (150mm to 300mm) including services, valves, and hydrants | $26,366,775 |
| Sanitary Collection Servicing | Sanitary Sewer (200mm to 450mm), including laterals and structures | $36,657,195 |
| Storm Collection Servicing | Storm Sewer (450mm to 1350mm), including structures | $19,136,475 |
| Sub-total | Water/Sanitary/Storm | $82,160,445 |
| Engineering | 10% of Capital | $8,216,200 |
| Contingency | 15% of Capital | $12,324,200 |
| TOTAL | | $102,700,845 |

# 7 CONCLUSIONS

The conclusions from the water, sanitary, and storm servicing capacity assessments are as follows:

Water:

- Proposed pipe servicing for the NWSP development is sized based on the design fire flow criteria of 133 L/s which are provided in Section 3. These include:
  - To supply fire flows for the northwest portion of NWSP development, the existing Rice Road watermain and the new infrastructure west of Rice Road (Loop A), should be a minimum of 250mm in diameter.
  - To supply water and adequate fire flows to the south-west portion of the development, a new 250mm diameter interconnection (Loop-H) is required to connect the existing 750mm regional trunk main on Clare Avenue to the new 300mm main on Quaker Road.
  - Loop C (300mm dia) for block C of NWSP and Loop L (200mm dia) for blocks K, L and M are required to provide the adequate fire flows.
  - A new 250mm watermain interconnection connecting the NWSP development to the Niagara Street Watermain on the east side will also be required to support the required fire flows.
- The addition of the NWSP development to the City's system does not negatively impact the surrounding system, and instead should improve pressures and fire flows in the area.
- The existing system has sufficient storage to support the future NWSP development.
- The proposed development does not negatively impact the existing low-pressure areas identified near Shoalt's Reservoir.

Sanitary:

- The existing trunk along Quaker Road, which conveys flows to the Towpath SPS, has sufficient capacity to accept the additional 143.3 L/s peak flow generated by the NWSP area, with the exception of pipe segment 19001405 on Towpath Road between Grisdale Road and the Towpath Road SPS. Model results indicate this segment has only 100L/s of available capacity.
- The Towpath SPS was identified in the Region MSPU as requiring an upgrade due to both growth north of the study area and the redirection of a portion of the flows from Pelham (north-west of Line Avenue) to the Towpath SPS through the Quaker Road trunk sewer. The timing of the Towpath SPS upgrade is 2022-2026 and will be required to be completed before significant development can occur within the NWSP area.
- The Towpath SPS forcemain has sufficient existing capacity; however, will have a projected capacity deficit for 2051 growth. There is already a constructed 600mm diameter forcemain that will require commissioning in line with Towpath SPS upgrades during the timeframe of 2032-2036 (WW-FM-022).
- The trunk sewer that the Towpath SPS forcemain discharges to has available capacity between the discharge point and the WWTP to accept an increase in flow.
- The WWTP has sufficient capacity to allow for the addition of the NWSP area.
- Future sanitary sewer sizing will range from 200 mm diameter to 450 mm diameter. Sizing to be confirmed during design.
- The phasing of future development within the NWSP area is not currently known; however, the proposed layout of this area is such that the individual quadrants (defined as: areas west of Rice Road and north of Quaker Road; areas west of Rice Road and south of Quaker Road; areas east of Rice Road and south of Quaker Road; areas east of Rice Road and north of Quaker Road; areas east of First Avenue and north of

Quaker Road; and areas west of First Avenue) can mostly be developed independently of each other, with exceptions noted below.

- The proposed city trunk sewer on Quaker Road (from NW3 to RMH1) must be constructed prior to development west of Rice Road, north of Quaker Road, and lands fronting the east side of Rice Road both north and south of Quaker Road.
- A portion of the proposed city trunk sewer on Quaker Road (from NW7 to RMH1) must be constructed prior to any development occurring east of Rice Road and west of First Avenue.
- For servicing Option 1, the proposed city trunk sewer on First Avenue (from NW9 to RMH2) must be constructed prior to development occurring immediately east and west of First Avenue.

- Alternatively, to eliminate duplication of trunk infrastructure along Quaker Road and Rice Road, additional connections can be considered directly to the regional trunk main in order to eliminate the need for a 'local' trunk system and most of the phasing exceptions noted above.

Storm:

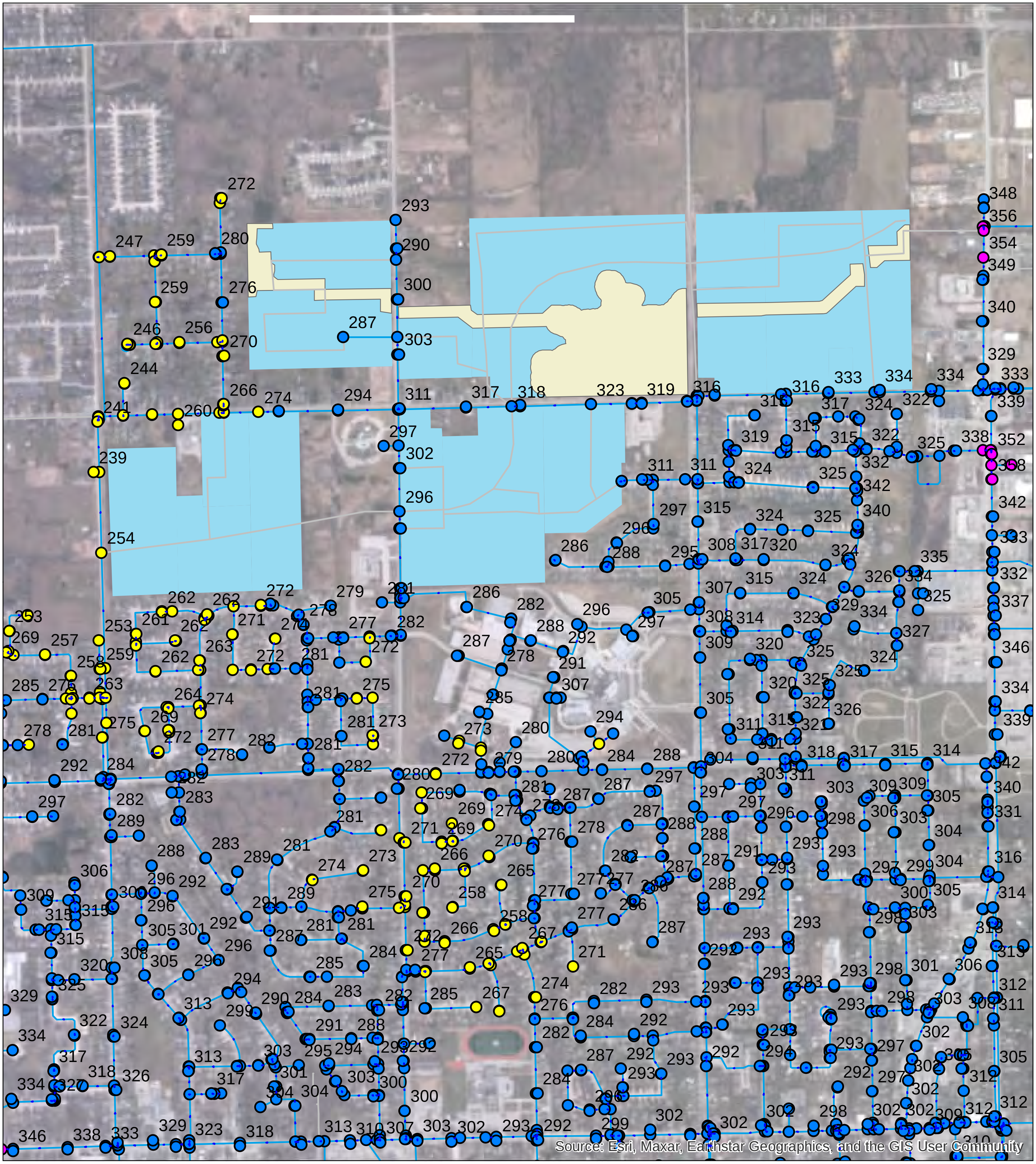
- The stormwater management plan developed by Upper Canada Consultants identified approximate locations for nine (9) new storm water ponds to service the NWSP area. Gravity sewers along the existing and future roads will direct runoff to these pond locations. Outlet sizing for the ponds will range from approximately 750 mm diameter to 1350 mm diameter. Sizing to be confirmed during design.

Respectfully Submitted by,

Andrea LaPlante, P.Eng.
Project Manager

LICENSED PROFESSIONAL ENGINEER
A. O. LAPLANTE
100156210
2024-06-24
PROVINCE OF ONTARIO

# APPENDIX A - WATER




**Minimum Pressure (kPa)**

- < 140 kPa
- 140 - 275 kPa
- 275 - 350 kPa
- 350 - 550 kPa
- 550 - 700 kPa
- >700 kPa

Existing Watermain

Proposed Development

Associated Engineering

BEST MANAGED COMPANIES Platinum member

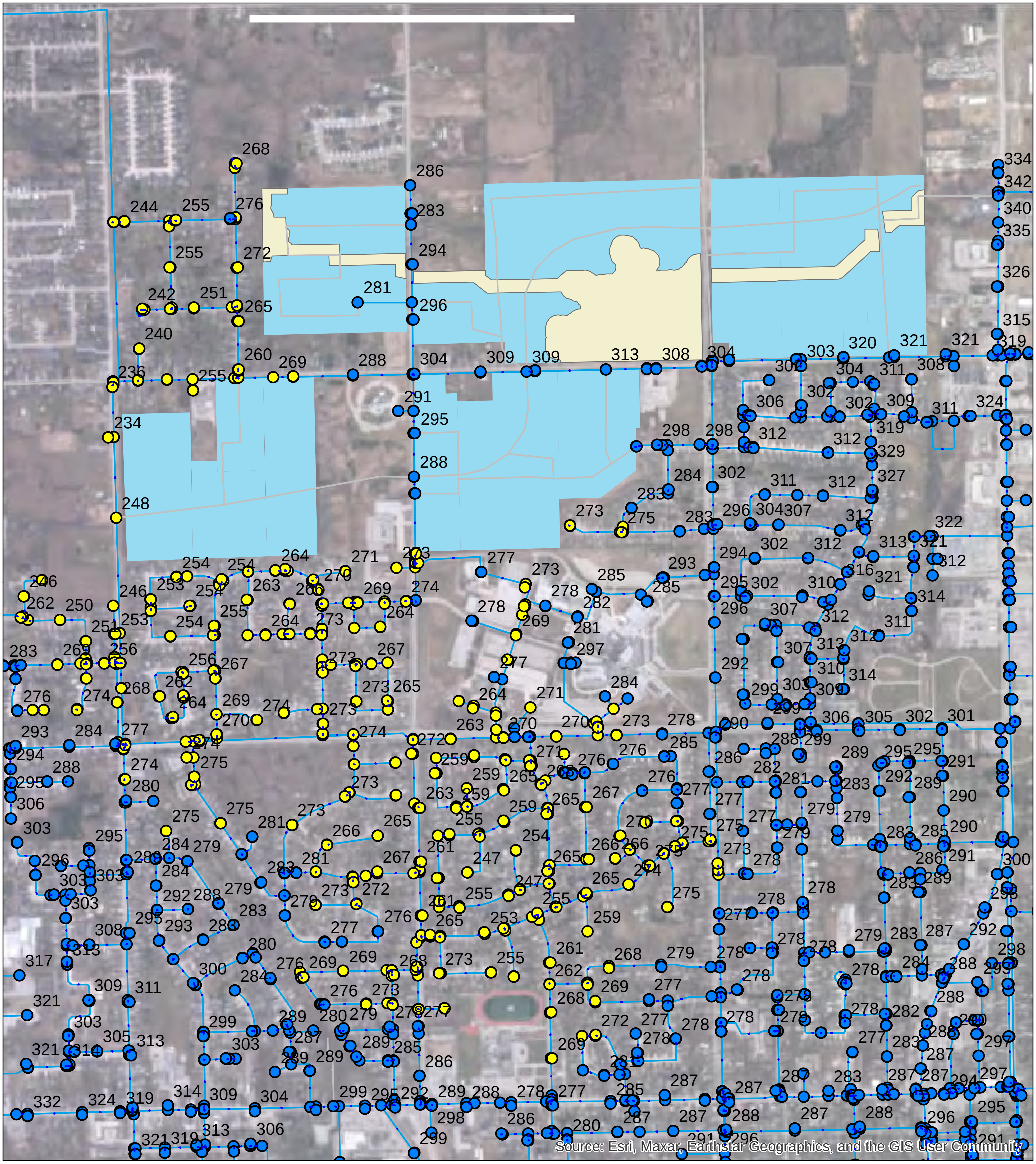
**Northwest Secondary Paln Municipal Servicing**

**Existing ADD: Minimum Pressures**

**Project No: 2023-5773**

**Date: March 2024**

**Figure A-1**




**Minimum Pressure (kPa)**

- < 140 kPa
- 140 - 275 kPa
- 275 - 350 kPa
- 350 - 550 kPa
- 550 - 700 kPa
- >700 kPa

Existing Watermain

Proposed Development

Associated Engineering

BEST MANAGED COMPANIES Platinum member

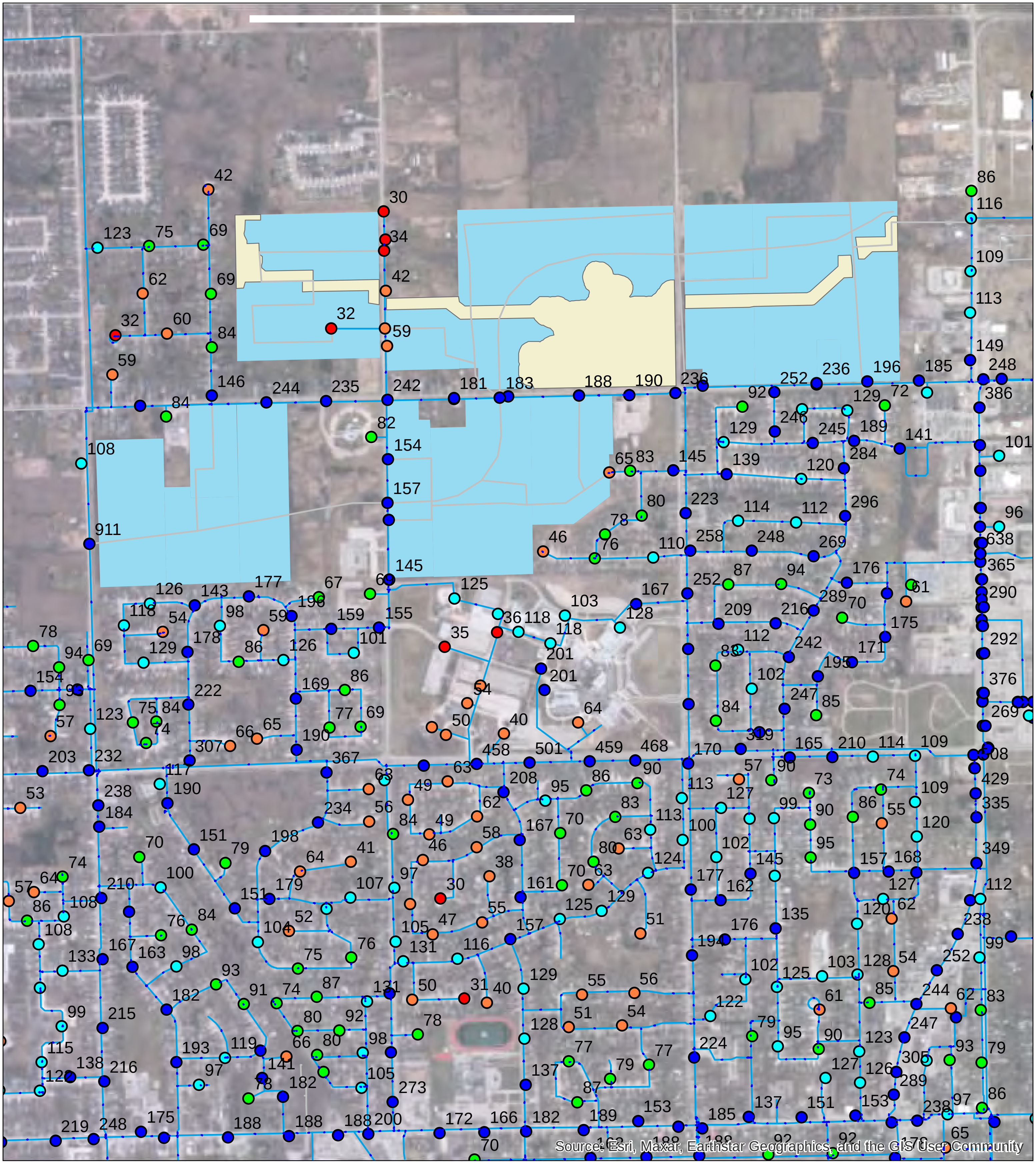
**Northwest Secondary Paln Municipal Servicing**

**Existing MDD: Minimum Pressures**

**Project No: 2023-5773**

**Date: March 2024**

**Figure A-2**




**Available Fire Flows (L/s)**

- < 37 L/s
- 37 - 67 L/s
- 67 - 95 L/s
- 95 - 133 L/s
- > 133 l/s

Existing Watermain

Proposed Development

Associated Engineering

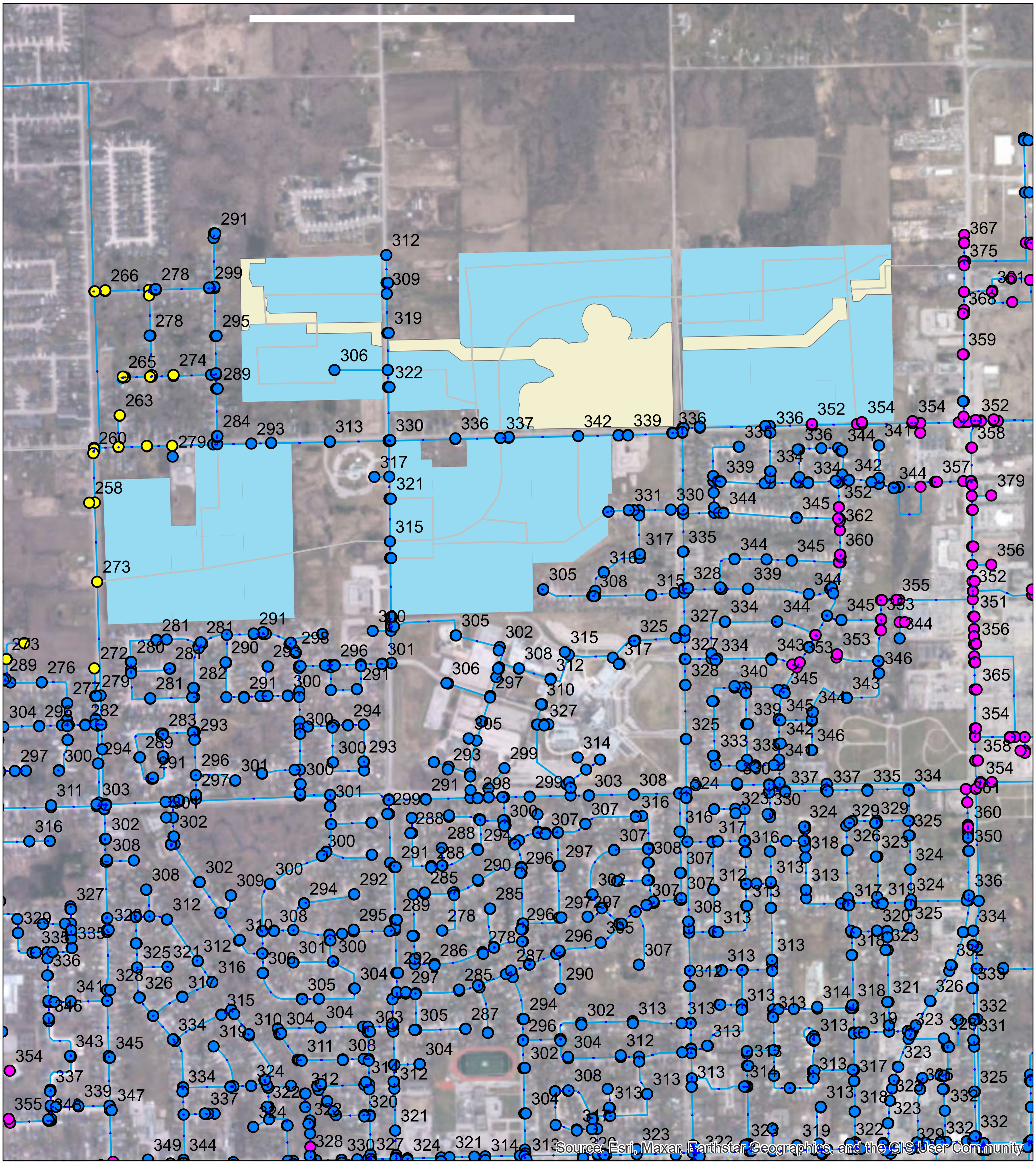
BEST MANAGED COMPANIES
Platinum member

**Northwest Secondary Paln Municipal Servicing**

**Existing MDD+FF: Available Fire Flows (L/s)**

**Project No: 2023-5773**
**Date: March 2024**

**Figure A-3**




**Minimum Pressure (kPa)**

- < 140 kPa
- 140 - 275 kPa
- 275 - 350 kPa
- 350 - 550 kPa
- 550 - 700 kPa
- >700 kPa

Existing Watermain

Proposed Development

N

Associated Engineering

BEST MANAGED COMPANIES

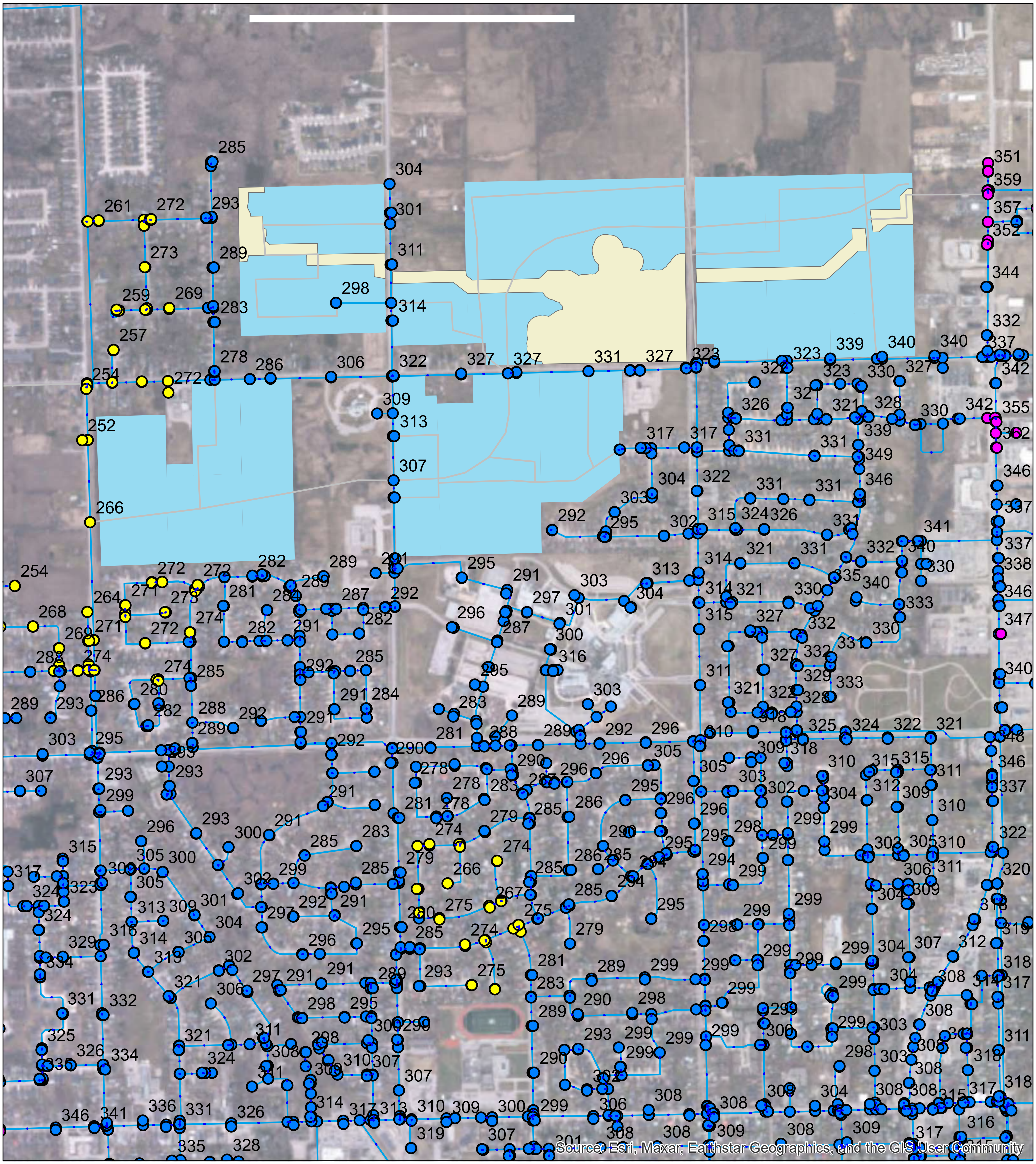
**Northwest Secondary Paln Municipal Servicing**

**Future ADD without NWSP: Minimum Pressures**

**Project No: 2023-5773**

**Date: March 2024**

**Figure A-4**




**Minimum Pressure (kPa)**

- < 140 kPa
- 140 - 275 kPa
- 275 - 350 kPa
- 350 - 550 kPa
- 550 - 700 kPa
- >700 kPa

Existing Watermain

Proposed Development

N

Associated Engineering

BEST MANAGED COMPANIES

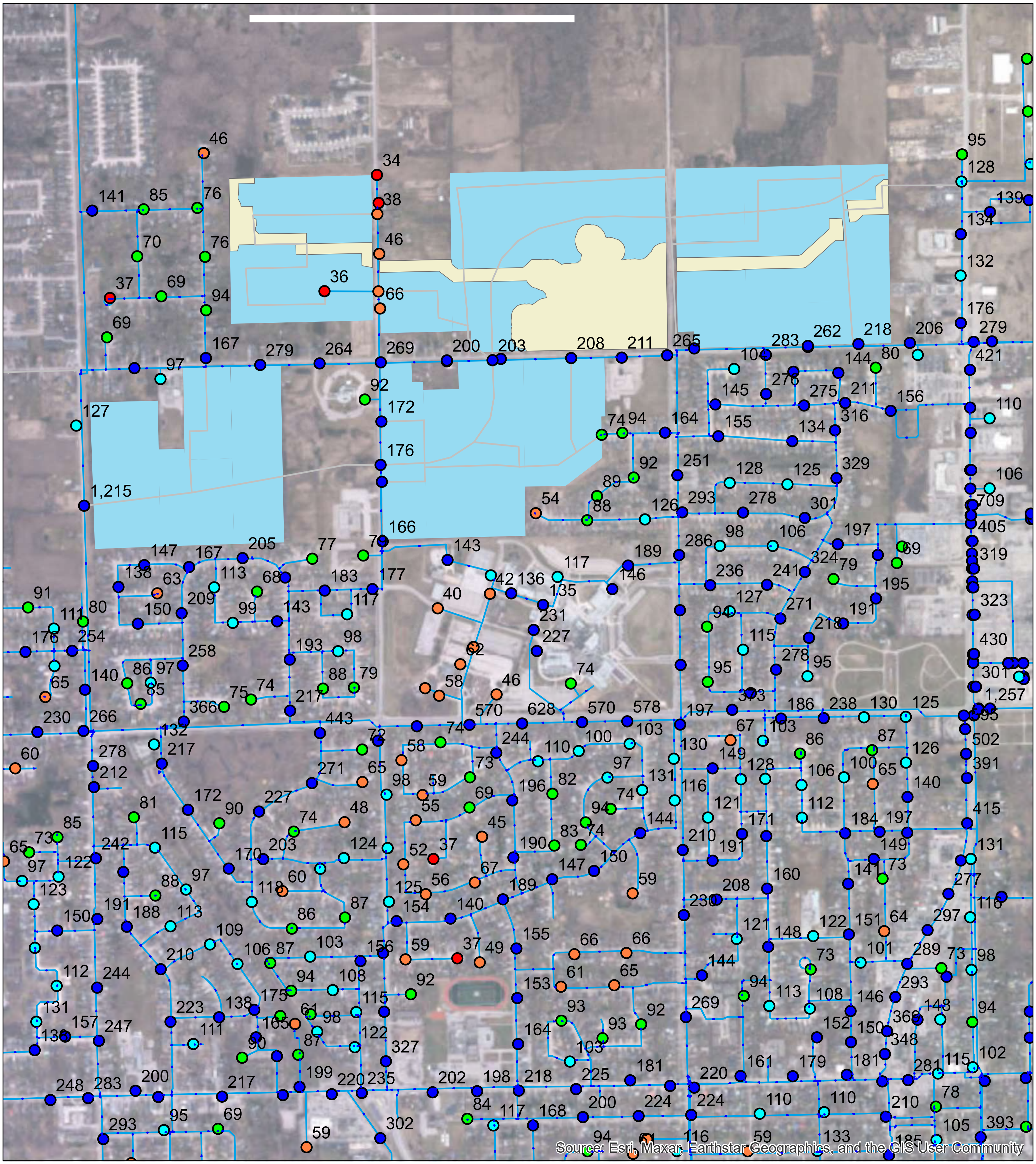
**Northwest Secondary Paln Municipal Servicing**

**Future MDD without NWSP: Minimum Pressures**

**Project No: 2023-5773**

**Date: March 2024**

**Figure A-5**




**Available Fire Flows (L/s)**

- < 37 L/s
- 37 - 67 L/s
- 67 - 95 L/s
- 95 - 133 L/s
- > 133 l/s

Existing Watermain

Proposed Development

N

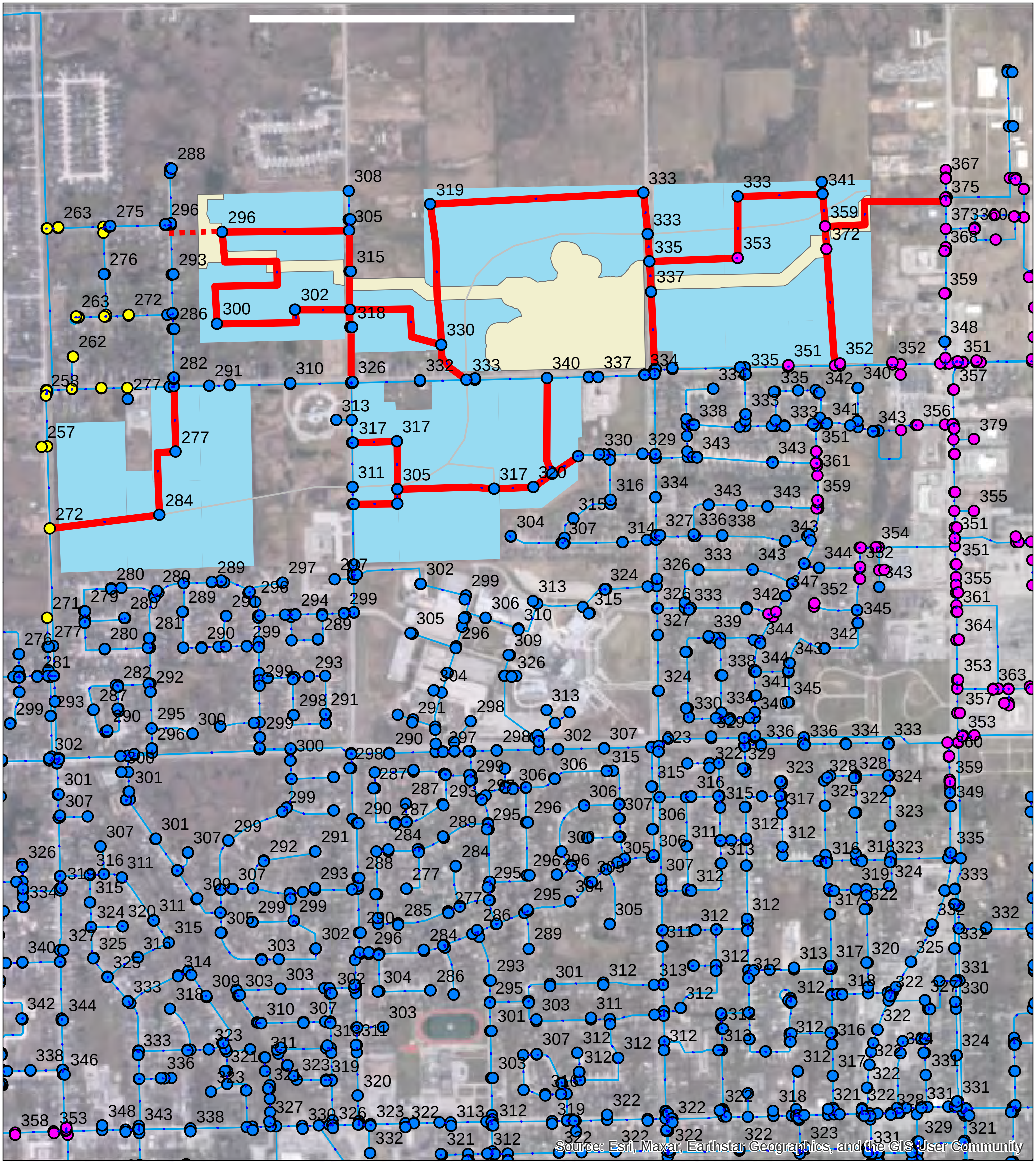
Associated Engineering

BEST MANAGED COMPANIES

**Northwest Secondary Paln Municipal Servicing**

**Future MDD+FF without NWSP : Available Fire Flows**

| | |
|---|---|
| **Project No: 2023-5773** | **Figure A-6** |
| **Date: March 2024** | |




**Minimum Pressure (kPa)**

- < 140 kPa
- 140 - 275 kPa
- 275 - 350 kPa
- 350 - 550 kPa
- 550 - 700 kPa
- >700 kPa

Existing Watermain

Proposed Development

Proposed Pipes for NWSP Development

Potential Future Looping

Associated Engineering

Best Managed Companies — Platinum member

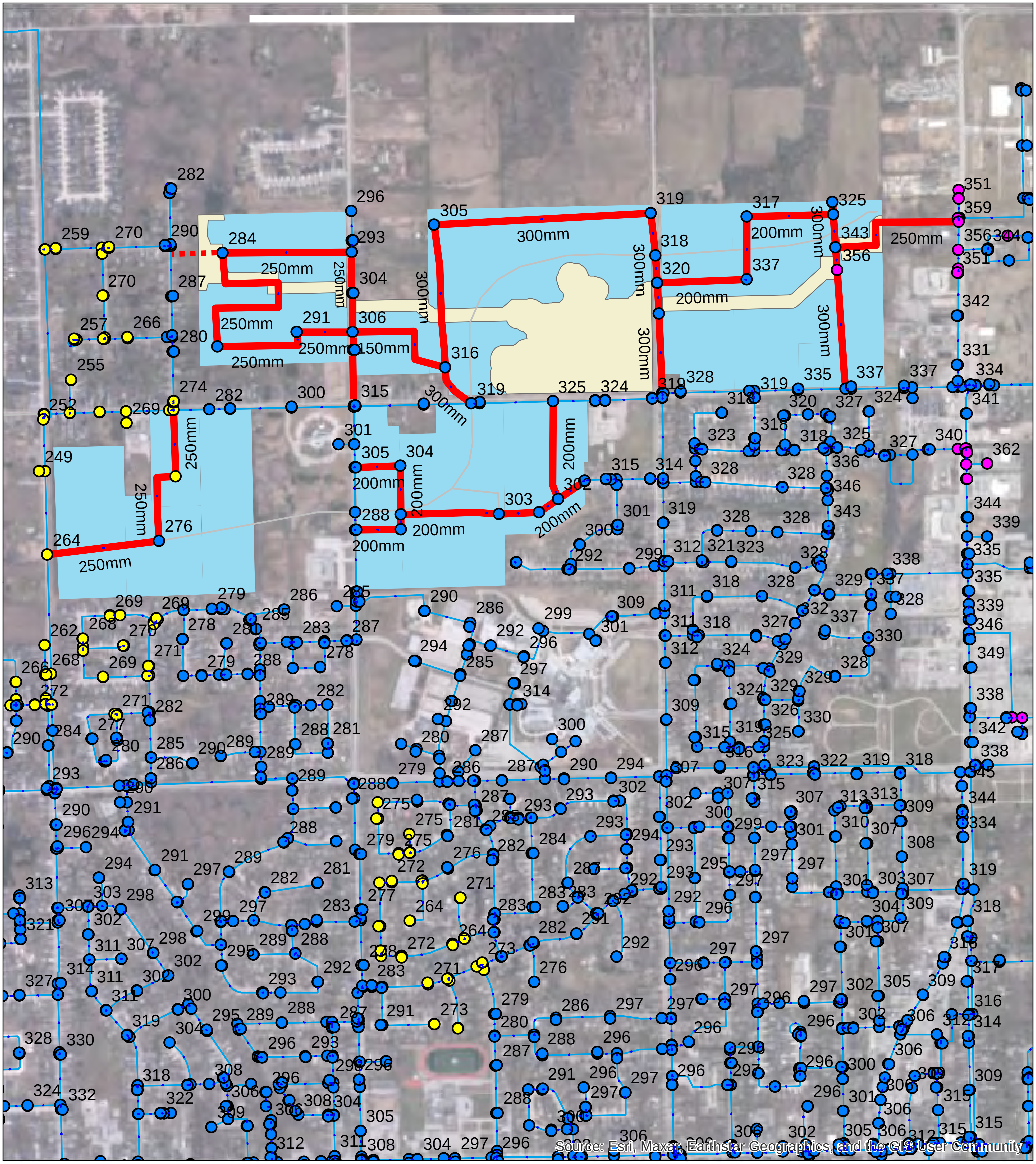
**Northwest Secondary Paln Municipal Servicing**

**Future ADD with NWSP: Minimum Pressures**

**Project No: 2023-5773**

**Date: March 2024**

**Figure A-7**




**Minimum Pressure (kPa)**

- < 140 kPa
- 140 - 275 kPa
- 275 - 350 kPa
- 350 - 550 kPa
- 550 - 700 kPa
- >700 kPa

Existing Watermain

Proposed Development

Proposed Pipes for NWSP Development

Potential Future Looping

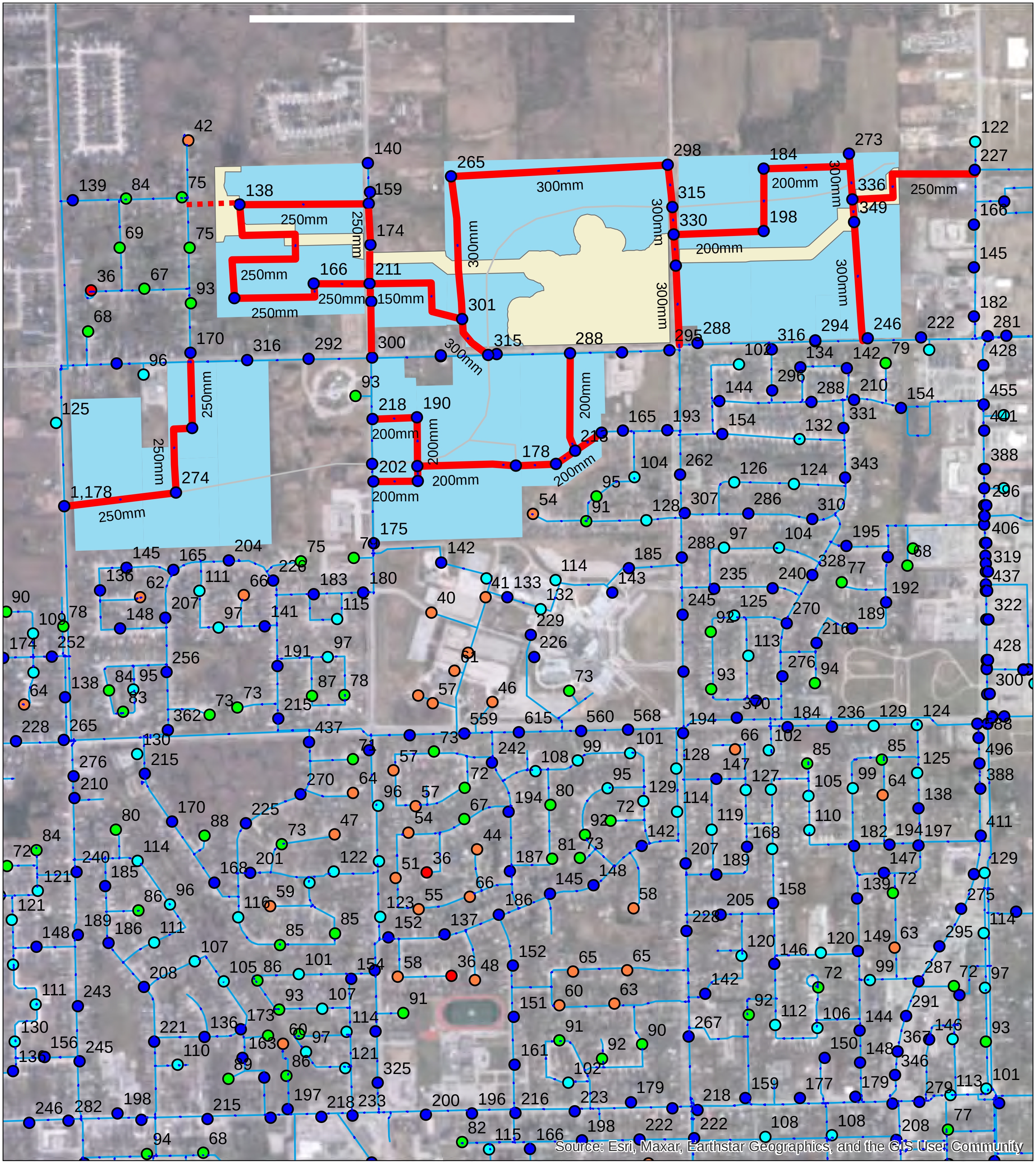
Associated Engineering

BEST MANAGED COMPANIES Platinum member

**Northwest Secondary Paln Municipal Servicing**

**Future MDD with NWSP: Minimum Pressures**

| | |
|---|---|
| **Project No: 2023-5773** | **Figure A-8** |
| **Date: March 2024** | |




**Available Fire Flows (L/s)**

- < 37 L/s
- 37 - 67 L/s
- 67 - 95 L/s
- 95 - 133 L/s
- > 133 l/s

Existing Watermain

Proposed Development

Proposed Pipes for NWSP Development

Potential Future Looping

Associated Engineering

BEST MANAGED COMPANIES Platinum member

**Northwest Secondary Paln Municipal Servicing**

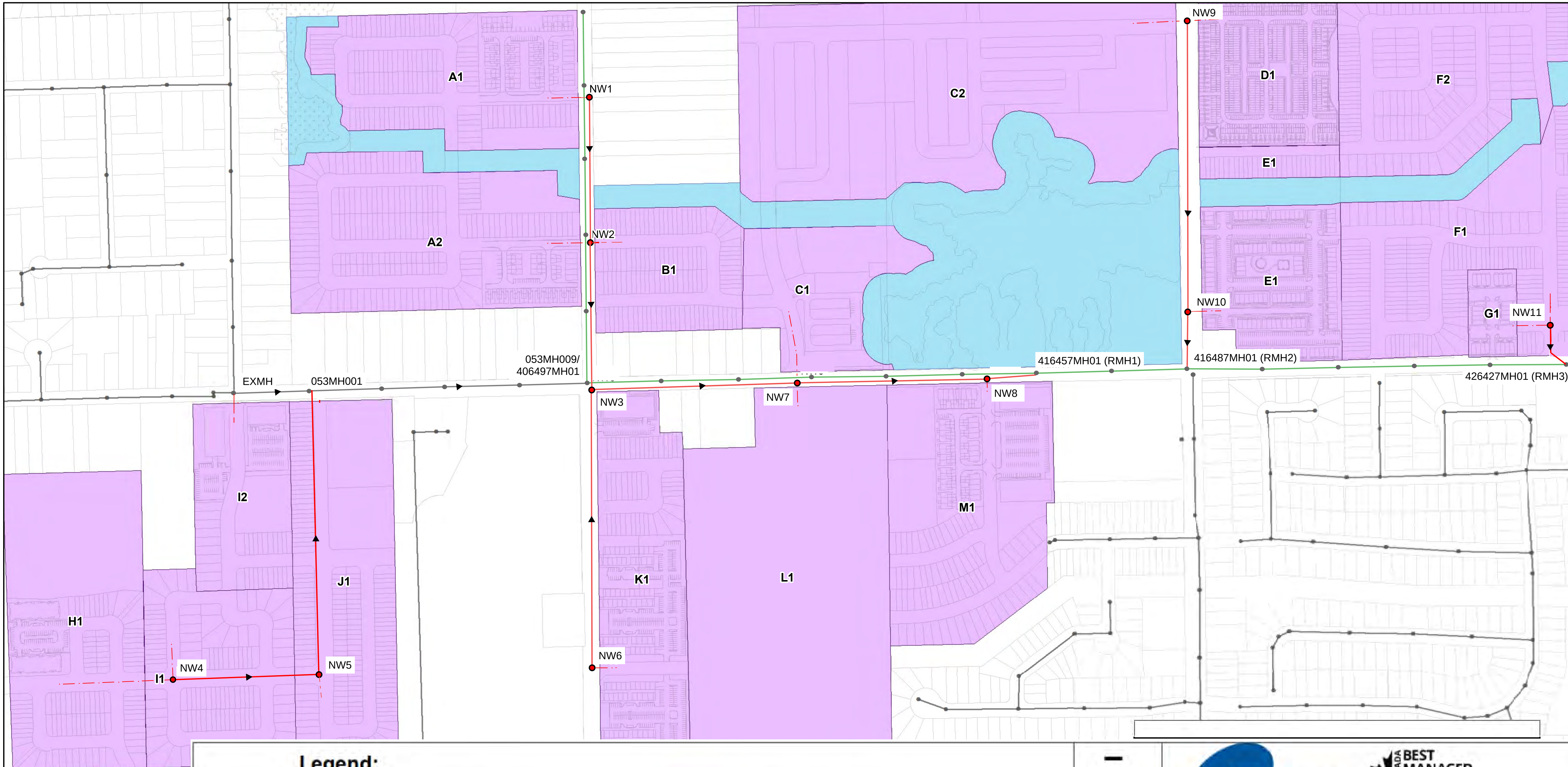
**Future MDD with NWSP: Available Fire Flows (L/s)**

| | |
|---|---|
| **Project No: 2023-5773** | **Figure A-9** |
| **Date: March 2024** | |

# APPENDIX B - SANITARY

Northwest Secondary Plan
Municipal Servicing
2041 Quaker Road to Towpath SPS Trunk Sewer Available Capacity

| Pipe Segment ID | Full Flow Capacity (L/s) | 2041 without Line Avenue Connection | | 2041 with Line Avenue Connection | |
|---|---|---|---|---|---|
| | | Peak Flow 2041 (L/s) | Available Capacity (L/s) | Peak Flow 2041 (L/s) | Available Capacity (L/s) |
| 19001374 | 608 | 146 | 462 | 276 | 332 |
| 19001375 | 547 | 146 | 401 | 276 | 271 |
| 19001376 | 383 | 147 | 236 | 277 | 106 |
| 19001377 | 495 | 147 | 348 | 277 | 218 |
| 19001378 | 446 | 147 | 299 | 277 | 169 |
| 19001366 | 282 | 125 | 157 | 124 | 158 |
| 19001367 | 327 | 126 | 201 | 125 | 202 |
| 19001365 | 313 | 124 | 189 | 124 | 189 |
| 19001364 | 370 | 124 | 246 | 123 | 247 |
| 19001363 | 353 | 123 | 230 | 122 | 231 |
| 19001379 | 639 | 147 | 492 | 277 | 362 |
| 19001380 | 623 | 147 | 476 | 277 | 346 |
| 19001381 | 540 | 148 | 392 | 278 | 262 |
| 19001382 | 729 | 148 | 581 | 278 | 451 |
| 19001383 | 452 | 148 | 304 | 278 | 174 |
| 19001384 | 720 | 149 | 571 | 279 | 441 |
| 19001385 | 747 | 149 | 598 | 279 | 468 |
| 19001386 | 638 | 149 | 489 | 279 | 359 |
| 19001387 | 588 | 149 | 439 | 279 | 309 |
| 19001388 | 638 | 150 | 488 | 280 | 358 |
| 19001389 | 816 | 150 | 666 | 280 | 536 |
| 19001390 | 671 | 170 | 501 | 300 | 371 |
| 19001391 | 731 | 170 | 561 | 300 | 431 |
| 19001392 | 718 | 170 | 548 | 300 | 418 |
| 19001393 | 731 | 170 | 561 | 300 | 431 |
| 19001394 | 717 | 170 | 547 | 300 | 417 |
| 19001395 | 714 | 170 | 544 | 300 | 414 |
| 19001396 | 733 | 170 | 563 | 300 | 433 |
| 19001397 | 844 | 170 | 674 | 300 | 544 |
| 19001398 | 708 | 170 | 538 | 300 | 408 |
| 19001399 | 740 | 170 | 570 | 300 | 440 |
| 19001400 | 718 | 170 | 548 | 300 | 418 |
| 19001401 | 718 | 170 | 548 | 300 | 418 |
| 19001402 | 918 | 170 | 748 | 300 | 618 |
| 19001403 | 917 | 170 | 747 | 300 | 617 |
| 19001404 | 907 | 170 | 737 | 300 | 607 |
| 19001405 | 401 | 171 | 230 | 301 | 100 |
| 19001406 | 923 | 171 | 752 | 301 | 622 |
| 19001407 | 1143 | 177 | 966 | 307 | 836 |
| 19001408 | 914 | 177 | 737 | 307 | 607 |
| 19001409 | 914 | 177 | 737 | 307 | 607 |
| 19001410 | 912 | 177 | 735 | 307 | 605 |
| 19001411 | 914 | 177 | 737 | 307 | 607 |
| 19001412 | 1125 | 220 | 905 | 350 | 775 |
| 19001413 | 889 | 220 | 669 | 350 | 539 |
| 19001519 | 3470 | 220 | 3250 | 350 | 3120 |
| 19001520 | 3544 | 220 | 3324 | 350 | 3194 |




**Legend:**

- Existing Manholes
- Proposed Manholes
- Existing Region Sewer
- Existing City Sewer
- Proposed City Sewer
- Catchment Areas
- Natural Area (Towpath Drain)

Associated Engineering

BEST MANAGED COMPANIES Platinum member

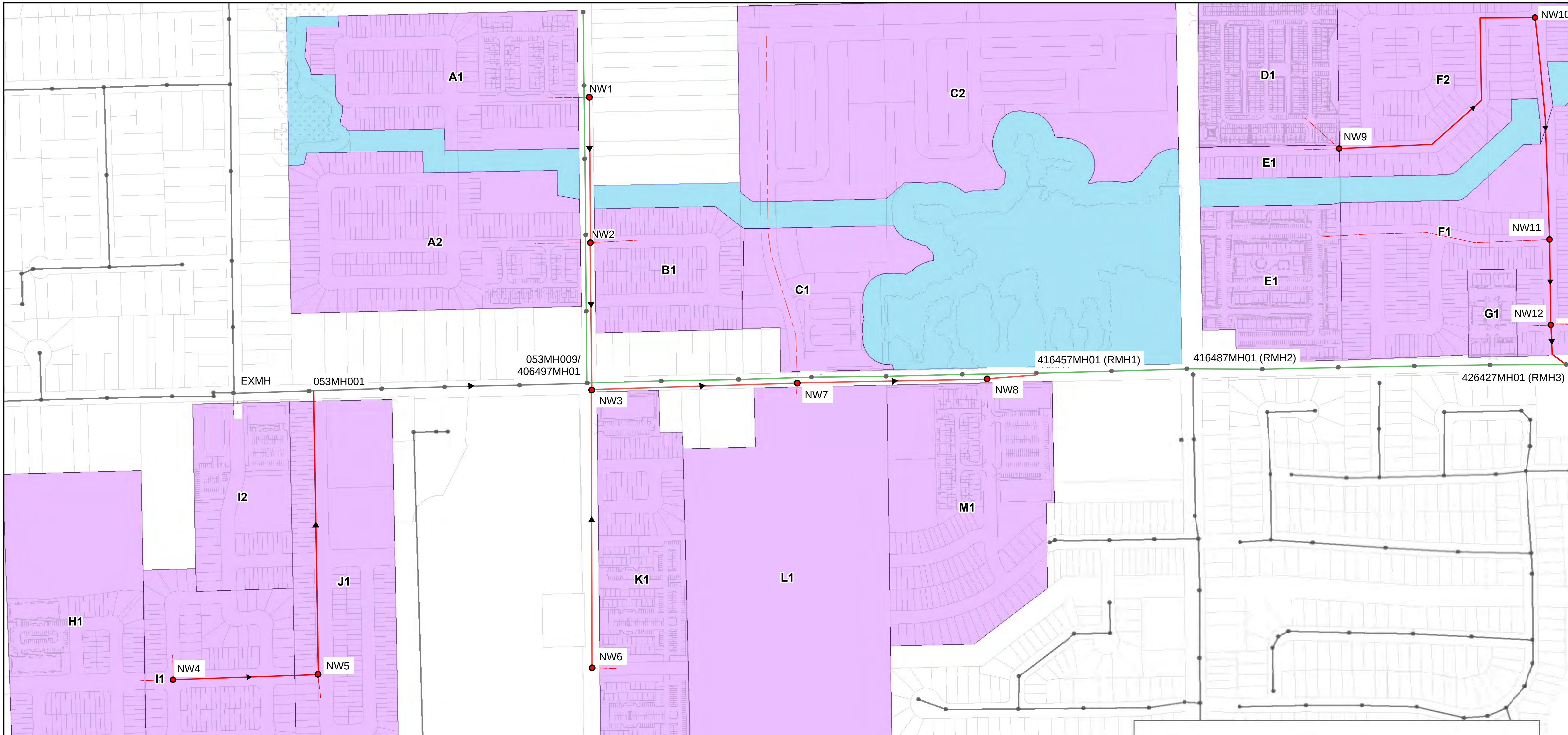
**Northwest Secondary Plan**
**Municipal Servicing**

**Sanitary Sewer Design - Option 1**

**Project No: 2023-5773**

**Date: March 2024**

**Figure B-1**




**Legend:**

- Existing Manholes
- Proposed Manholes
- Existing Region Sewer
- Existing City Sewer
- Proposed City Sewer
- Catchment Areas
- Natural Area (Towpath Drain)

Associated Engineering

BEST MANAGED COMPANIES CANADA

Platinum member

**Northwest Secondary Plan**
**Municipal Servicing**

**Sanitary Sewer Design - Option 2**

**Project No: 2023-5773**

**Date: March 2024**

**Figure B-2**

# SANITARY SEWER DESIGN SHEET

**Design Option - 1**

**Project:** Welland Northwest Secondary Plan
**Location:**

**Roughness Coefficient (n) =** 0.013
**Residential Per Capita Flow Rate =** 0.00318287 L/cap/s (275 L/cap/day)
**Infiltration Rate=** 0.286 L/s/ha

Associated Engineering

| LOCATION | | | | INVERTS | | LENGTH | NWSP POPULATION AND FLOW DATA | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESCRIPTION | DRAINAGE AREA | MANHOLE | | U/S | D/S | LENGTH | AREA | POP | CUMULATIVE AREA | CUMULATIVE POP. Served | AVG. DAILY FLOW | PEAKING FACTOR (PF = 1+14/(4+P^1/2)) |
| STREET | ID | FROM | TO | | | m | (ha) | (ppl) | (ha) | (ppl) | (l/s) | (dmnl) |
| Rice Road (N of Quaker) | A1 | NW1 | NW2 | 182.30 | 181.02 | 200 | 6.0 | 532 | 6.0 | 532 | 1.69 | 3.96 |
| Rice Road (N of Quaker) | A2, B1 | NW2 | NW3 | 181.02 | 180.10 | 197 | 10.6 | 868 | 16.6 | 1400 | 4.46 | 3.70 |
| Kaywood Crt. | | | | 188.89 | 188.47 | 65 | 0.5 | 15 | 0.5 | 15 | 0.05 | 4.00 |
| Quaker Road (School/Daycare) | | | | | | | 1.6 | 500 | 1.6 | 500 | 0.36 | 3.97 |
| Montgomery (end to Summerlea) | | | | 186.53 | 186.10 | 179 | 3.0 | 25 | 3.0 | 25 | 0.08 | 4.00 |
| Topham/Crerar/Summerlea | | | | 188.66 | 186.12 | 420 | 10.9 | 148 | 10.9 | 148 | 0.47 | 4.00 |
| Montgomery (Summerlea to Quaker) | | | EXMH | 186.08 | 185.03 | 423 | 5.7 | 78 | 19.6 | 250 | 0.80 | 4.00 |
| Quaker Road (Line to Kaywood) | | | | 188.89 | 188.42 | 53 | 0.7 | 13 | 0.7 | 13 | 0.04 | 4.00 |
| Quaker Road (Kaywood to Montgomery) | | | EXMH | 188.41 | 184.55 | 270 | 3.4 | 38 | 4.6 | 565 | 2.15 | 3.95 |
| Quaker Road (W of Rice) | I2 | EXMH | 053MH001 | 184.52 | 183.93 | 104 | 3.4 | 330 | 27.6 | 1145 | 4.00 | 3.76 |
| NWSP (W of Rice, S of Quaker) | H1, I1 | NW4 | NW5 | 186.40 | 185.40 | 210 | 13.8 | 938 | 13.8 | 938 | 2.99 | 3.82 |
| NWSP (W of Rice, S of Quaker) | J1 | NW5 | 053MH001 | 185.40 | 183.90 | 389 | 7.0 | 454 | 20.8 | 1392 | 4.43 | 3.70 |
| Quaker Road (W of Rice) | - | 053MH001 | 053MH009 / 406497MH01 | 183.88 | 181.64 | 385 | 3.5 | 33 | 51.9 | 2570 | 8.54 | 3.50 |
| Rice Road (S of Quaker) | K1 | NW6 | NW3 | 184.50 | 180.10 | 387 | 5.7 | 1229 | 5.7 | 1229 | 3.91 | 3.74 |
| Quaker Road (Rice to W of First) | - | NW3 | NW7 | 180.10 | 179.24 | 287 | - | - | 22.4 | 2629 | 8.37 | 3.49 |
| Quaker Road (Rice to W of First) | C1, L1 | NW7 | NW8 | 179.24 | 178.72 | 261 | 16.6 | 1842 | 39.0 | 4471 | 14.23 | 3.29 |
| Quaker Road (Rice to W of First) | M1 | NW8 | 416457MH01 (RMH1) | 178.72 | 178.58 | 69 | 7.1 | 661 | 46.0 | 5132 | 16.33 | 3.23 |
| Flows from Hurricane SPS/Rice Road (North) | - | - | 053MH009 / 406497MH01 | - | - | - | - | - | - | - | - | - |
| Flows from West of Quaker and Rice (from Line Ave) | - | - | 053MH009 / 406497MH01 | - | - | - | - | - | - | - | - | - |
| Quaker Road (Region Trunk E of Rice) | - | 053MH009 / 406497MH01 | 416457MH01 (RMH1) | 179.94 | 178.58 | 618 | - | - | 51.9 | 2570 | 8.54 | 3.50 |
| Quaker Road (W of First to First) | - | 416457MH01 (RMH1) | 416487MH01 (RMH2) | 178.58 | 178.25 | 207 | - | - | 98.0 | 7702 | 24.87 | 3.07 |
| First Ave (N of Quaker) | C2, D1, F2 | NW9 | NW10 | 179.40 | 178.41 | 393 | 26.1 | 3223 | 26.1 | 3223 | 10.26 | 3.42 |
| First Ave (N of Quaker) | E1 | NW10 | 416487MH01 (RMH2) | 178.41 | 178.25 | 80 | 4.8 | 1123 | 30.9 | 4346 | 13.83 | 3.30 |
| Quaker Road (First to W of Niagara) | - | 416487MH01 (RMH2) | 426427MH01 (RMH3) | 178.25 | 177.07 | 521 | - | - | 128.9 | 12048 | 38.70 | 2.87 |
| NWSP (N of Quaker, E of First) | F1, G1 | NW11 | 426427MH01 (RMH3) | 177.29 | 177.07 | 50 | 10.9 | 980 | 10.9 | 980 | 3.12 | 3.81 |
| Quaker Road (W of Niagara to Towpath) | - | 426427MH01 (RMH3) | 436437MH03 | 177.07 | 171.78 | 1320 | - | - | 139.8 | 13028 | 41.82 | 2.84 |
| Towpath (to SPS) | - | 436540MH01 | 446525MH01 | 171.05 | 169.40 | 1002 | - | - | 139.8 | 13028 | 41.82 | 2.84 |

| | NWSP POPULATION AND FLOW DATA | | | EX TRUNK FLOW | | TOTAL (NWSP + EX) | SEWER DESIGN | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESCRIPTION | PEAK FLOW (NO INFIL.) | INFILT. FLOW | PEAK FLOW (W/ INFIL.) | ADDITIONAL PEAK FLOW (FROM MODEL) | CUMULATIVE PEAK FLOW (FROM MODEL) | TOTAL PEAK FLOW | PIPE SIZE | ACTUAL SLOPE | APPROX. CRITICAL SLOPE | DESIGN SLOPE | Act. Dia. | PIPE AREA | HYD. RAD. | FULL FLOW VELOCITY | FULL FLOW CAPACITY | PERCENT FULL | CAPACITY CHECK | ACTUAL VELOCITY |
| STREET | (L/s) | (L/s) | (L/s) | (L/s) | | (L/s) | (mm) | (%) | (%) | (%) | ( mm) | ( $m^2$) | ( m) | (m/s) | (L/s) | (%) | | (m/s) |
| Rice Road (N of Quaker) | 6.71 | 1.72 | 8.43 | 0.0 | 0.0 | **8.4** | 200 | 0.64 | 1.54 | 0.64 | 203.2 | 0.032 | 0.051 | 0.84 | **27.4** | 30.8 | OK | 0.65 |
| Rice Road (N of Quaker) | 16.49 | 4.76 | 21.25 | 0.0 | 0.0 | **21.2** | 250 | 0.47 | 1.43 | 0.47 | 254.0 | 0.051 | 0.064 | 0.84 | **42.5** | 50.0 | OK | 0.74 |
| Kaywood Crt. | 0.19 | 0.14 | 0.33 | 0.0 | 0.0 | **0.3** | 200 | 0.65 | 1.54 | 0.65 | 203.2 | 0.032 | 0.051 | 0.85 | **27.6** | 1.2 | OK | 0.20 |
| Quaker Road (School/Daycare) | 1.41 | 0.47 | 1.88 | 0.0 | 0.0 | **1.9** | | | | | | | | | | | | |
| Montgomery (end to Summerlea) | 0.32 | 0.86 | 1.18 | 0.0 | 0.0 | **1.2** | 250 | 0.24 | 1.43 | 0.24 | 254.0 | 0.051 | 0.064 | 0.60 | **30.4** | 3.9 | OK | 0.24 |
| Topham/Crerar/Summerlea | 1.88 | 3.12 | 5.00 | 0.0 | 0.0 | **5.0** | 250 | 0.60 | 1.43 | 0.60 | 254.0 | 0.051 | 0.064 | 0.95 | **48.1** | 10.4 | OK | 0.53 |
| Montgomery (Summerlea to Quaker) | 3.18 | 5.61 | 8.79 | 0.0 | 0.0 | **8.8** | 250 | 0.25 | 1.43 | 0.25 | 254.0 | 0.051 | 0.064 | 0.61 | **31.0** | 28.3 | OK | 0.46 |
| Quaker Road (Line to Kaywood) | 0.16 | 0.20 | 0.36 | 0.0 | 0.0 | **0.4** | 200 | 0.89 | 1.54 | 0.89 | 203.2 | 0.032 | 0.051 | 1.00 | **32.3** | 1.1 | OK | 0.21 |
| Quaker Road (Kaywood to Montgomery) | 8.50 | 1.32 | 9.82 | 0.0 | 0.0 | **9.8** | 250 | 1.43 | 1.43 | 1.43 | 254.0 | 0.051 | 0.064 | 1.46 | **74.2** | 13.2 | OK | 0.88 |
| Quaker Road (W of Rice) | 15.05 | 7.90 | 22.95 | 0.0 | 0.0 | **22.9** | 300 | 0.57 | 1.34 | 0.57 | 304.8 | 0.073 | 0.076 | 1.04 | **76.2** | 30.1 | OK | 0.80 |
| NWSP (W of Rice, S of Quaker) | 11.40 | 3.94 | 15.34 | 0.0 | 0.0 | **15.3** | 200 | 0.48 | 1.54 | 0.48 | 203.2 | 0.032 | 0.051 | 0.73 | **23.7** | 64.7 | OK | 0.69 |
| NWSP (W of Rice, S of Quaker) | 16.41 | 5.96 | 22.36 | 0.0 | 0.0 | **22.4** | 250 | 0.39 | 1.43 | 0.39 | 254.0 | 0.051 | 0.064 | 0.76 | **38.7** | 57.7 | OK | 0.70 |
| Quaker Road (W of Rice) | 29.87 | 14.86 | 44.72 | 0.0 | 0.0 | **44.7** | 300 | 0.58 | 1.34 | 0.58 | 304.8 | 0.073 | 0.076 | 1.05 | **76.8** | 58.2 | OK | 0.97 |
| Rice Road (S of Quaker) | 14.63 | 1.64 | 16.27 | 0.0 | 0.0 | **16.3** | 200 | 1.14 | 1.54 | 1.14 | 203.2 | 0.032 | 0.051 | 1.13 | **36.5** | 44.5 | OK | 0.96 |
| Quaker Road (Rice to W of First) | 29.21 | 6.40 | 35.60 | 0.0 | 0.0 | **35.6** | 300 | 0.30 | 1.34 | 0.30 | 304.8 | 0.073 | 0.076 | 0.76 | **55.3** | 64.4 | OK | 0.71 |
| Quaker Road (Rice to W of First) | 46.81 | 11.15 | 57.96 | 0.0 | 0.0 | **58.0** | 375 | 0.20 | 1.25 | 0.20 | 381.0 | 0.114 | 0.095 | 0.72 | **81.8** | 70.9 | OK | 0.69 |
| Quaker Road (Rice to W of First) | 52.83 | 13.17 | 66.00 | 0.0 | 0.0 | **66.0** | 450 | 0.20 | 1.17 | 0.20 | 457.2 | 0.164 | 0.114 | 0.81 | **133.0** | 49.6 | OK | 0.71 |
| Flows from Hurricane SPS/Rice Road (North) | - | - | - | 97.7 | 97.7 | **97.7** | - | - | - | | - | - | - | - | **-** | **-** | **-** | |
| Flows from West of Quaker and Rice (from Line Ave) | - | - | - | 79.1 | 79.1 | **79.1** | - | - | - | | - | - | - | - | **-** | - | - | - |
| Quaker Road (Region Trunk E of Rice) | 29.87 | 14.86 | 44.72 | 0.0 | 176.8 | **221.5** | 750 | 0.22 | 0.99 | 0.22 | 762.0 | 0.456 | 0.191 | 1.19 | **544.8** | 40.7 | OK | 1.00 |
| Quaker Road (W of First to First) | 76.26 | 28.02 | 104.29 | 0.0 | 176.8 | **281.1** | 750 | 0.16 | 0.99 | 0.16 | 762.0 | 0.456 | 0.191 | 1.02 | **464.6** | 60.5 | OK | 0.95 |
| First Ave (N of Quaker) | 35.04 | 7.47 | 42.51 | 0.0 | 0.0 | **42.5** | 375 | 0.25 | 1.25 | 0.25 | 381.0 | 0.114 | 0.095 | 0.80 | **91.5** | 46.5 | OK | 0.69 |
| First Ave (N of Quaker) | 45.66 | 8.83 | 54.49 | 0.0 | 0.0 | **54.5** | 375 | 0.20 | 1.25 | 0.20 | 381.0 | 0.114 | 0.095 | 0.72 | **81.8** | 66.6 | OK | 0.68 |
| Quaker Road (First to W of Niagara) | 111.23 | 36.86 | 148.09 | 3.0 | 179.8 | **327.9** | 750 | 0.23 | 0.99 | 0.23 | 762.0 | 0.456 | 0.191 | 1.22 | **557.0** | 58.9 | OK | 1.13 |
| NWSP (N of Quaker, E of First) | 11.87 | 3.13 | 15.00 | 0.0 | 0.0 | **15.0** | 200 | 0.44 | 1.54 | 0.44 | 203.2 | 0.032 | 0.051 | 0.70 | **22.7** | 66.1 | OK | 0.67 |
| Quaker Road (W of Niagara to Towpath) | 118.77 | 39.99 | 158.76 | 28.8 | 208.6 | **367.4** | 750 | 0.40 | 0.99 | 0.40 | 762.0 | 0.456 | 0.191 | 1.61 | **734.5** | 50.0 | OK | 1.42 |
| Towpath (to SPS) | 118.77 | 39.99 | 158.76 | 98.1 | 306.7 | **465.5** | 900 | 0.16 | 0.93 | 0.16 | 914.4 | 0.657 | 0.229 | 1.15 | **755.4** | 61.6 | OK | 1.07 |

**Notes:**
1. Residential design flows as per UCC
2. Slopes approximate; calculated based on length
3. Infiltration rate is 0.286 as per Region Master Plan Update 2021
4. Peak Factors for NWSP Flows as per Harmon's Formula
5. Population for NWSP as per UCC
6. All other peak flows as per All Pipe Model
7. Assume population density for existing residential single family home is 2.5p/household
8. School and daycare flows as per Building Code Table 8.2.1.3.B

## SANITARY SEWER DESIGN SHEET

**Design Option - 2**

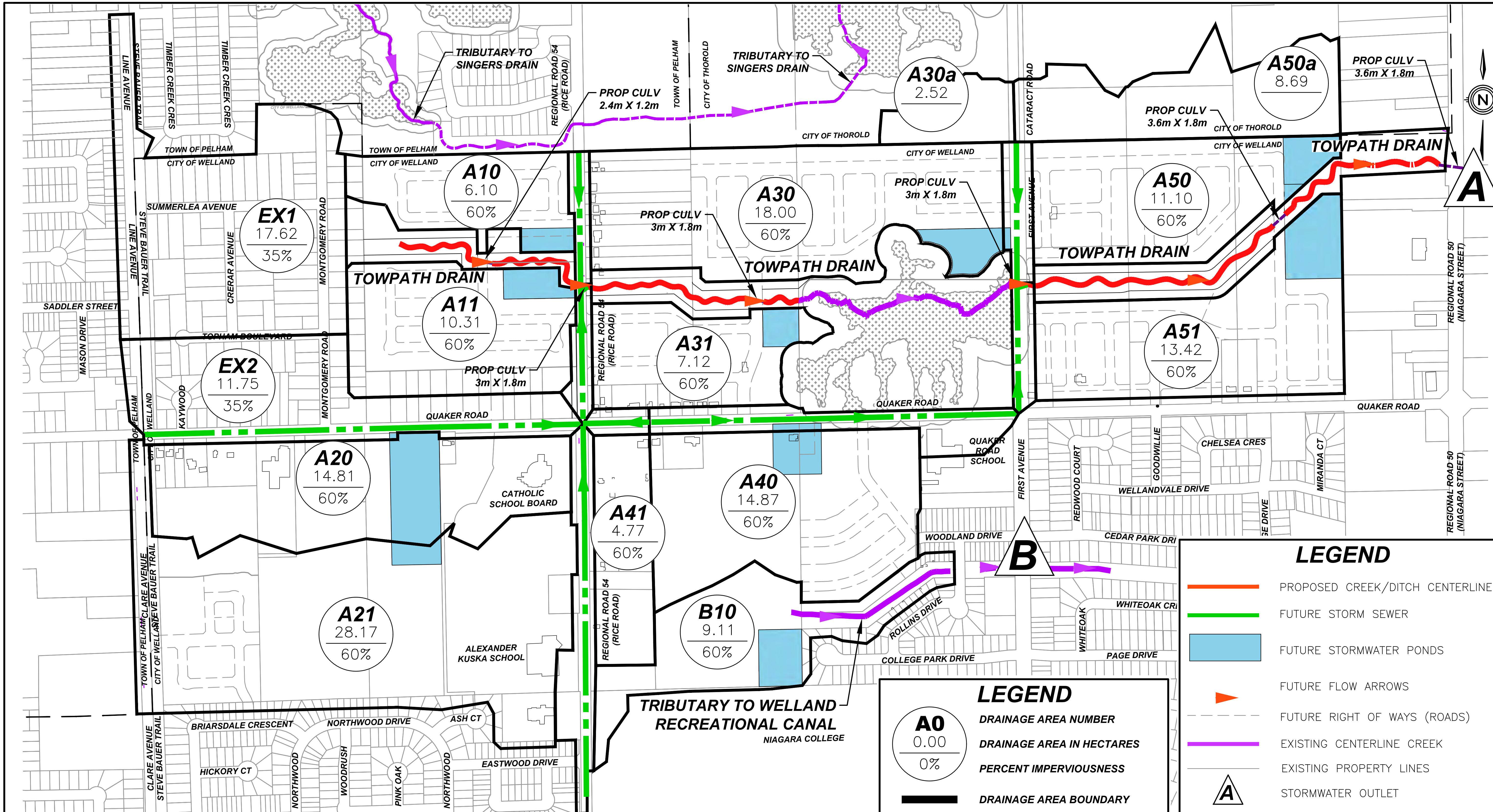
**Project:** Welland Northwest Secondary Plan
**Location:**

**Roughness Coefficient (n) =** 0.013
**Residential Per Capita Flow Rate =** 0.00318287 L/cap/s (275 L/cap/day)
**Infiltration Rate=** 0.286 L/s/ha

| LOCATION | | | | | | | NWSP POPULATION AND FLOW DATA | | | | | | | | | EX TRUNK FLOW | | TOTAL (NWSP + EX) | SEWER DESIGN | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESCRIPTION | DRAINAGE AREA | MANHOLE | | INVERTS U/S | INVERTS D/S | LENGTH | AREA | POP | CUMULATIVE AREA | CUMULATIVE POP. Served | AVG. DAILY FLOW | PEAKING FACTOR (PF = 1+14/(4+P^1/2)) | PEAK FLOW (NO INFIL.) | INFILT. FLOW | PEAK FLOW (W/ INFIL.) | ADDITIONAL PEAK FLOW (FROM MODEL) | CUMULATIVE PEAK FLOW (FROM MODEL) | TOTAL PEAK FLOW | PIPE SIZE | ACTUAL SLOPE | APPROX. CRITICAL SLOPE | DESIGN SLOPE | Act. Dia. | PIPE AREA | HYD. RAD. | FULL FLOW VELOCITY | FULL FLOW CAPACITY | PERCENT FULL | CAPACITY CHECK | ACTUAL VELOCITY |
| STREET | ID | FROM | TO | | | m | (ha) | (ppl) | (ha) | (ppl) | (l/s) | (dmnl) | (L/s) | (L/s) | (L/s) | (L/s) | | (L/s) | (mm) | (%) | (%) | (%) | ( mm) | ( $m^2$) | ( m) | (m/s) | (L/s) | (%) | | (m/s) |
| Rice Road (N of Quaker) | A1 | NW1 | NW2 | 182.30 | 181.02 | 200 | 6.0 | 532 | 6.0 | 532 | 1.69 | 3.96 | 6.71 | 1.72 | 8.43 | 0.0 | 0.0 | **8.4** | 200 | 0.64 | 1.54 | 0.64 | 203.2 | 0.032 | 0.051 | 0.84 | **27.4** | 30.8 | OK | 0.65 |
| Rice Road (N of Quaker) | A2, B1 | NW2 | NW3 | 181.02 | 180.10 | 197 | 10.6 | 868 | 16.6 | 1400 | 4.46 | 3.70 | 16.49 | 4.76 | 21.24 | 0.0 | 0.0 | **21.2** | 250 | 0.47 | 1.43 | 0.47 | 254.0 | 0.051 | 0.064 | 0.84 | **42.5** | 50.0 | OK | 0.74 |
| Kaywood Crt. | | | | 188.89 | 188.47 | 65 | 0.5 | 15 | 0.5 | 15 | 0.05 | 4.00 | 0.19 | 0.14 | 0.33 | 0.0 | 0.0 | **0.3** | 200 | 0.65 | 1.54 | 0.65 | 203.2 | 0.032 | 0.051 | 0.85 | **27.6** | 1.2 | OK | 0.20 |
| Quaker Road (School/Daycare) | | | | | | | 1.6 | 500 | 1.6 | 500 | 0.36 | 3.97 | 1.41 | 0.47 | 1.88 | 0.0 | 0.0 | **1.9** | | | | | | | | | | | | |
| Montgomery (end to Summerlea) | | | | 186.53 | 186.10 | 179 | 3.0 | 25 | 3.0 | 25 | 0.08 | 4.00 | 0.32 | 0.86 | 1.18 | 0.0 | 0.0 | **1.2** | 250 | 0.24 | 1.43 | 0.24 | 254.0 | 0.051 | 0.064 | 0.60 | **30.4** | 3.9 | OK | 0.24 |
| Topham/Crerar/Summerlea | | | | 188.66 | 186.12 | 420 | 10.9 | 148 | 10.9 | 148 | 0.47 | 4.00 | 1.88 | 3.12 | 5.00 | 0.0 | 0.0 | **5.0** | 250 | 0.60 | 1.43 | 0.60 | 254.0 | 0.051 | 0.064 | 0.95 | **48.1** | 10.4 | OK | 0.53 |
| Montgomery (Summerlea to Quaker) | | | EXMH | 186.08 | 185.03 | 423 | 5.7 | 78 | 19.6 | 250 | 0.80 | 4.00 | 3.18 | 5.61 | 8.79 | 0.0 | 0.0 | **8.8** | 250 | 0.25 | 1.43 | 0.25 | 254.0 | 0.051 | 0.064 | 0.61 | **31.0** | 28.3 | OK | 0.46 |
| Quaker Road (Line to Kaywood) | | | | 188.89 | 188.42 | 53 | 0.7 | 13 | 0.7 | 13 | 0.04 | 4.00 | 0.16 | 0.20 | 0.36 | 0.0 | 0.0 | **0.4** | 200 | 0.89 | 1.54 | 0.89 | 203.2 | 0.032 | 0.051 | 1.00 | **32.3** | 1.1 | OK | 0.21 |
| Quaker Road (Kaywood to Montgomery) | | | EXMH | 188.41 | 184.55 | 270 | 3.4 | 38 | 4.6 | 565 | 2.15 | 3.95 | 8.50 | 1.32 | 9.82 | 0.0 | 0.0 | **9.8** | 250 | 1.43 | 1.43 | 1.43 | 254.0 | 0.051 | 0.064 | 1.46 | **74.2** | 13.2 | OK | 0.88 |
| Quaker Road (W of Rice) | I2 | EXMH | 053MH001 | 184.52 | 183.93 | 104 | 3.4 | 330 | 27.6 | 1145 | 4.00 | 3.76 | 15.05 | 7.90 | 22.95 | 0.0 | 0.0 | **22.9** | 300 | 0.57 | 1.34 | 0.57 | 304.8 | 0.073 | 0.076 | 1.04 | **76.2** | 30.1 | OK | 0.80 |
| NWSP (W of Rice, S of Quaker) | H1, I1 | NW4 | NW5 | 186.40 | 185.40 | 210 | 13.8 | 938 | 13.8 | 938 | 2.99 | 3.82 | 11.40 | 3.95 | 15.35 | 0.0 | 0.0 | **15.3** | 200 | 0.48 | 1.54 | 0.48 | 203.2 | 0.032 | 0.051 | 0.73 | **23.7** | 64.7 | OK | 0.69 |
| NWSP (W of Rice, S of Quaker) | J1 | NW5 | 053MH001 | 185.40 | 183.90 | 389 | 7.0 | 454 | 20.8 | 1392 | 4.43 | 3.70 | 16.41 | 5.96 | 22.37 | 0.0 | 0.0 | **22.4** | 250 | 0.39 | 1.43 | 0.39 | 254.0 | 0.051 | 0.064 | 0.76 | **38.7** | 57.7 | OK | 0.70 |
| Quaker Road (W of Rice) | - | 053MH001 | 053MH009 / 406497MH01 | 183.88 | 181.64 | 385 | 3.5 | 33 | 52.0 | 2571 | 8.54 | 3.50 | 29.87 | 14.86 | 44.73 | 0.0 | 0.0 | **44.7** | 300 | 0.58 | 1.34 | 0.58 | 304.8 | 0.073 | 0.076 | 1.05 | **76.8** | 58.2 | OK | 0.97 |
| Rice Road (S of Quaker) | K1 | NW6 | NW3 | 184.50 | 180.10 | 387 | 5.7 | 1229 | 5.7 | 1229 | 3.91 | 3.74 | 14.63 | 1.64 | 16.27 | 0.0 | 0.0 | **16.3** | 200 | 1.14 | 1.54 | 1.14 | 203.2 | 0.032 | 0.051 | 1.13 | **36.5** | 44.5 | OK | 0.96 |
| Quaker Road (Rice to W of First) | - | NW3 | NW7 | 180.10 | 179.24 | 287 | - | - | 22.4 | 2629 | 8.37 | 3.49 | 29.21 | 6.39 | 35.60 | 0.0 | 0.0 | **35.6** | 300 | 0.30 | 1.34 | 0.30 | 304.8 | 0.073 | 0.076 | 0.76 | **55.3** | 64.4 | OK | 0.71 |
| Quaker Road (Rice to W of First) | C1, C2, L1 | NW7 | NW8 | 179.24 | 178.72 | 261 | 31.2 | 3640 | 53.5 | 6269 | 19.95 | 3.15 | 62.90 | 15.31 | 78.21 | 0.0 | 0.0 | **78.2** | 450 | 0.20 | 1.17 | 0.20 | 457.2 | 0.164 | 0.114 | 0.81 | **133.0** | 58.8 | OK | 0.75 |
| Quaker Road (Rice to W of First) | M1 | NW8 | 416457MH01 (RMH1) | 178.72 | 178.58 | 69 | 7.1 | 661 | 60.6 | 6930 | 22.06 | 3.11 | 68.61 | 17.32 | 85.94 | 0.0 | 0.0 | **85.9** | 450 | 0.20 | 1.17 | 0.20 | 457.2 | 0.164 | 0.114 | 0.81 | **133.0** | 64.6 | OK | 0.77 |
| Flows from Hurricane SPS/Rice Road (North) | - | - | 053MH009 / 406497MH01 | - | - | - | - | - | - | - | - | - | - | - | - | 97.7 | 97.7 | **97.7** | - | - | - | | - | - | - | - | **-** | **-** | **-** | |
| Flows from West of Quaker and Rice (from Line Ave) | - | - | 053MH009 / 406497MH01 | - | - | - | - | - | - | - | - | - | - | - | - | 79.1 | 79.1 | **79.1** | - | - | - | | - | - | - | - | **-** | - | - | - |
| Quaker Road (Region Trunk E of Rice) | - | 053MH009 / 406497MH01 | 416457MH01 (RMH1) | 179.94 | 178.58 | 618 | - | - | 52.0 | 2571 | 8.54 | 3.50 | 29.87 | 14.86 | 44.73 | 0.0 | 176.8 | **221.5** | 750 | 0.22 | 0.99 | 0.22 | 762.0 | 0.456 | 0.191 | 1.19 | **544.8** | 40.7 | OK | 1.00 |
| Quaker Road (W of First to W of Niagara) | - | 416457MH01 (RMH1) | 426427MH01 (RMH3) | 178.58 | 177.07 | 728 | - | - | 112.5 | 9500 | 30.59 | 2.98 | 91.07 | 32.18 | 123.26 | 3.0 | 179.8 | **303.1** | 750 | 0.21 | 0.99 | 0.21 | 762.0 | 0.456 | 0.191 | 1.17 | **532.2** | 56.9 | OK | 1.07 |
| NWSP (N of Quaker, E of First) | D1, E1 | NW9 | NW10 | 179.99 | 178.32 | 408 | 4.9 | 1089 | 4.9 | 1089 | 3.47 | 3.78 | 13.09 | 1.40 | 14.49 | 0.0 | 0.0 | **14.5** | 200 | 0.41 | 1.54 | 0.41 | 203.2 | 0.032 | 0.051 | 0.68 | **21.9** | 66.1 | OK | 0.64 |
| NWSP (N of Quaker, E of First) | F2 | NW10 | NW11 | 178.32 | 177.40 | 306 | 7.4 | 417 | 12.3 | 1506 | 4.79 | 3.68 | 17.64 | 3.53 | 21.17 | 0.0 | 0.0 | **21.2** | 250 | 0.30 | 1.43 | 0.30 | 254.0 | 0.051 | 0.064 | 0.67 | **34.0** | 62.3 | OK | 0.63 |
| NWSP (N of Quaker, E of First) | E2, F1 | NW11 | NW12 | 177.40 | 177.17 | 117 | 14.2 | 1753 | 26.5 | 3259 | 10.37 | 3.41 | 35.39 | 7.58 | 42.97 | 0.0 | 0.0 | **43.0** | 375 | 0.20 | 1.25 | 0.20 | 381.0 | 0.114 | 0.095 | 0.72 | **81.8** | 52.5 | OK | 0.64 |
| NWSP (N of Quaker, E of First) | G1 | NW12 | 426427MH01 (RMH3) | 177.17 | 177.07 | 50 | 0.8 | 269 | 27.3 | 3528 | 11.23 | 3.38 | 37.97 | 7.81 | 45.78 | 0.0 | 0.0 | **45.8** | 375 | 0.20 | 1.25 | 0.20 | 381.0 | 0.114 | 0.095 | 0.72 | **81.8** | 56.0 | OK | 0.65 |
| Quaker Road (W of Niagara to Towpath) | - | 426427MH01 (RMH3) | 436437MH03 | 177.07 | 171.78 | 1320 | - | - | 139.8 | 13029 | 41.82 | 2.84 | 118.77 | 39.99 | 158.77 | 28.8 | 208.6 | **367.4** | 750 | 0.40 | 0.99 | 0.40 | 762.0 | 0.456 | 0.191 | 1.61 | **734.5** | 50.0 | OK | 1.42 |
| Towpath (to SPS) | - | 436540MH01 | 446525MH01 | 171.05 | 169.40 | 1002 | - | - | 139.8 | 13029 | 41.82 | 2.84 | 118.77 | 39.99 | 158.77 | 98.1 | 306.7 | **465.5** | 900 | 0.16 | 0.93 | 0.16 | 914.4 | 0.657 | 0.229 | 1.15 | **755.4** | 61.6 | OK | 1.07 |

**Notes:**
1. Residential design flows as per UCC
2. Slopes approximate; calculated based on length
3. Infiltration rate is 0.286 as per Region Master Plan Update 2021
4. Peak Factors for NWSP Flows as per Harmon's Formula
5. Population for NWSP as per UCC
6. All other peak flows as per All Pipe Model
7. Assume population density for existing residential single family home is 2.5p/household
8. School and daycare flows as per Building Code Table 8.2.1.3.B

# APPENDIX C - STORM



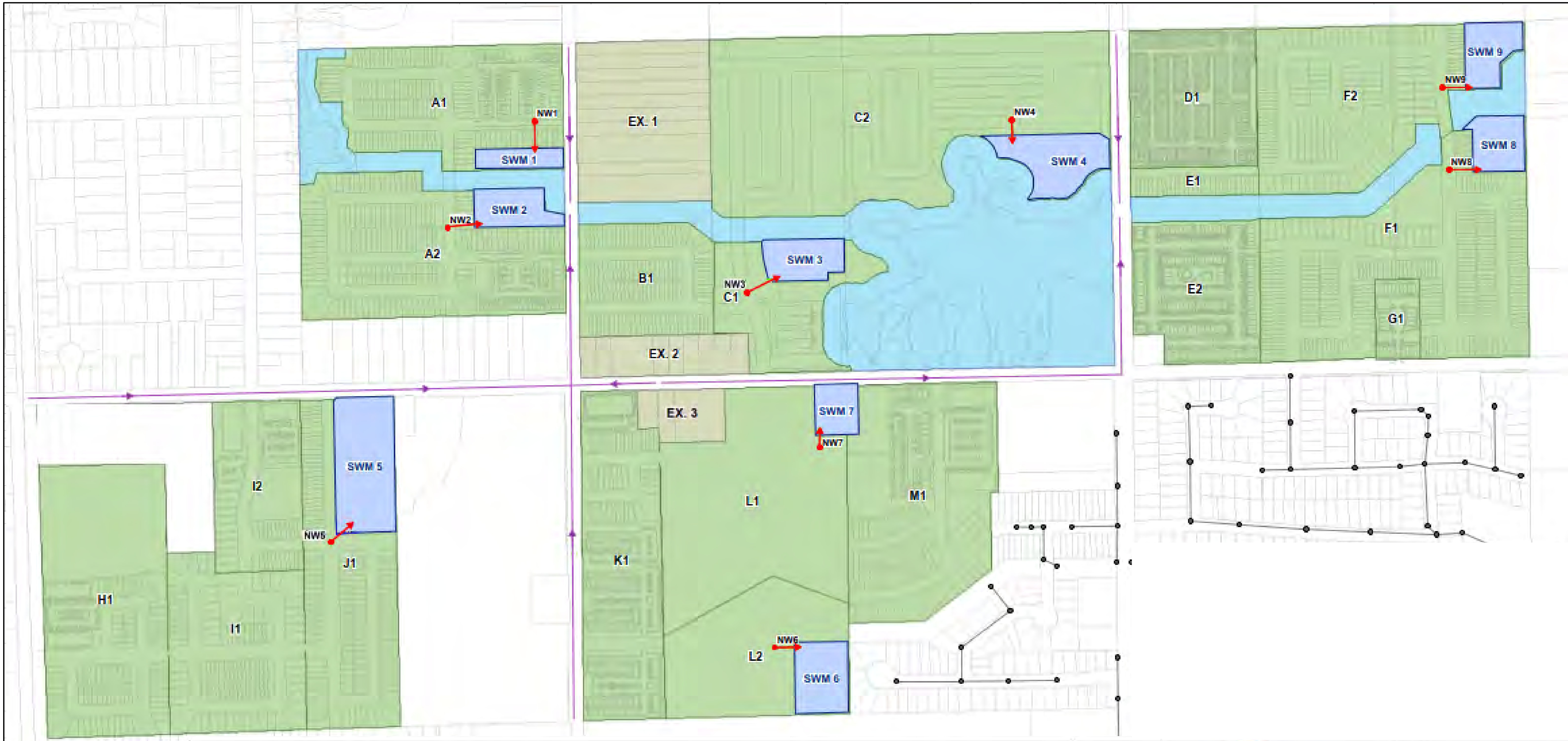

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

# NORTHWEST WELLAND STORMWATER MANAGEMENT IMPLEMENTATION PLAN

CITY OF WELLAND

## ULTIMATE STORMWATER MANAGEMENT PLAN

| | |
|---|---|
| DATE | 2022-10-12 |
| SCALE | 1:7000 |
| REF No. | 21243 |
| DWG No. | FIGURE 10 |




## Legend:

- Proposed Manholes
- Proposed Storm Outlet
- Future Trunk Storm
- Existing Manholes
- Existing Storm Sewer
- Proposed SWM Ponds
- Proposed SWM Catchment
- Existing SWM Catchment

Associated Engineering

BEST MANAGED COMPANIES CANADA Platinum member

**Northwest Secondary Plan**
**Municipal Servicing**

**Storm Sewer Design**

**Project No: 2023-5773**

**Date: November 2023**

**Figure C-2**

# STORM SEWER DESIGN SHEET

Associated Engineering — GLOBAL PERSPECTIVE. LOCAL FOCUS.

Q=2.78AiR    Storm Event = 5.00 Years

A = Area (ha)    a = 830    b = 0.777    c = 7.3

R = Runoff Coefficient

$T_c$ = Time of Concentration    n = 0.013

i = Avg Rainfall Intensity (mm/hr) = a / $(T_c+c)^b$

## Northwest Secondary Plan
## Municipal Servicing

JOB No.: 2023-5773

| DEVELOPMENT DATA | | | | DESIGN DATA | | | | | | PIPE DATA | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AREA NO | FROM | TO | AREA (ha) | RUNOFF COEFF. R | A * R | ACCUM A * R | TIME OF CONC. (min) | INTENSITY i (mm/hr) | PEAK FLOW (l/s) | PIPE DIA (mm) | SLOPE (%) | CRITICAL SLOPE (%) | DESIGN SLOPE (%) | LENGTH (m) | FLOW FULL (l/s) | VEL FULL (m/s) | TRAVEL TIME (min) | % FULL |
| **Pond 1** | | | | | | | | | | | | | | | | | | |
| A1 | NW1 | SWM 1 | 5.70 | 0.53 | 3.006 | 3.006 | 12.00 | 83.21 | **695.399** | 900 | 0.20 | 0.93 | 0.20 | 40 | **809.60** | 1.27 | 0.52 | 85.89 |
| | | | | | | | | | | | | | | | | | | |
| **Pond 2** | | | | | | | | | | | | | | | | | | |
| A2 | NW2 | SWM2 | 7.33 | 0.52 | 3.775 | 3.775 | 12.00 | 83.21 | **873.297** | 900 | 0.30 | 0.93 | 0.30 | 40 | **991.55** | 1.56 | 0.43 | 88.07 |
| | | | | | | | | | | | | | | | | | | |
| **Pond 3** | | | | | | | | | | | | | | | | | | |
| B1, Ex.2, C1 | NW3 | SWM3 | 8.50 | 0.49 | 4.193 | 4.193 | 12.00 | 83.21 | **969.880** | 1050 | 0.30 | 0.89 | 0.30 | 40 | **1495.68** | 1.73 | 0.39 | 64.85 |
| | | | | | | | | | | | | | | | | | | |
| **Pond 4** | | | | | | | | | | | | | | | | | | |
| Ex. 1, C2 | NW4 | SWM4 | 18.00 | 0.50 | 9.034 | 9.034 | 15.00 | 74.38 | **1867.971** | 1200 | 0.30 | 0.85 | 0.30 | 40 | **2135.42** | 1.89 | 0.35 | 87.48 |
| | | | | | | | | | | | | | | | | | | |
| **Pond 5** | | | | | | | | | | | | | | | | | | |
| H1, I1, I2, J1 | NW5 | SWM5 | 21.77 | 0.51 | 11.131 | 11.131 | 15.00 | 74.38 | **2301.570** | 1350 | 0.30 | 0.81 | 0.30 | 40 | **2923.42** | 2.04 | 0.33 | 78.73 |
| | | | | | | | | | | | | | | | | | | |
| **Pond 6** | | | | | | | | | | | | | | | | | | |
| L2 | NW6 | SWM6 | 3.88 | 0.50 | 1.940 | 1.940 | 12.00 | 83.21 | **448.794** | 750 | 0.30 | 0.99 | 0.30 | 40 | **609.77** | 1.38 | 0.48 | 73.60 |
| | | | | | | | | | | | | | | | | | | |
| **Pond 7** | | | | | | | | | | | | | | | | | | |
| K1, Ex.3, L1, M1 | NW7 | SWM7 | 22.90 | 0.53 | 12.041 | 12.041 | 15.00 | 74.38 | **2489.732** | 1350 | 0.30 | 0.81 | 0.30 | 40 | **2923.42** | 2.04 | 0.33 | 85.17 |
| | | | | | | | | | | | | | | | | | | |
| **Pond 8** | | | | | | | | | | | | | | | | | | |
| E2, F1, G1 | NW8 | SWM8 | 14.31 | 0.53 | 7.634 | 7.634 | 15.00 | 74.38 | **1578.491** | 1200 | 0.30 | 0.85 | 0.30 | 116 | **2135.42** | 1.89 | 1.02 | 73.92 |
| | | | | | | | | | | | | | | | | | | |
| **Pond 9** | | | | | | | | | | | | | | | | | | |
| D1, E1, F2 | NW9 | SWM9 | 13.14 | 0.53 | 6.975 | 6.975 | 15.00 | 74.38 | **1442.229** | 1200 | 0.30 | 0.85 | 0.30 | 116 | **2135.42** | 1.89 | 1.02 | 67.54 |
| | | | | | | | | | | | | | | | | | | |

# APPENDIX D - COST ESTIMATE DETAIL

Northwest Welland Secondary Plan
Municipal Servicing

Preliminary Cost Estimate

| Watermain | | | | |
|---|---|---|---|---|
| Item | Quantity | Unit | Unit Price | Cost |
| 150mm PVC DR18 Watermain | 8420 | m | $455 | $3,831,100 |
| 150mm Gate Valve & Box | 92 | each | $3,250 | $299,000 |
| 200 mm PVC DR18 Watermain | 1645 | m | $520 | $855,400 |
| 200mm Gate Valve & Box | 20 | each | $4,225 | $84,500 |
| 250 mm PVC DR18 Watermain | 2480 | m | $620 | $1,537,600 |
| 250mm Gate Valve & Box | 24 | each | $5,200 | $124,800 |
| 300mm PVC DR18 Watermain | 1985 | m | $845 | $1,677,325 |
| 300mm Gate Valve & Box | 22 | each | $7,150 | $157,300 |
| Water Services | 4350 | each | $2,600 | $11,310,000 |
| Hydrants | 97 | each | $9,750 | $945,750 |
| Connect to Existing | 13 | each | $6,500 | $84,500 |
| Granular A | 87500 | t | $35 | $3,062,500 |
| Other General Construction | 1 | LS | $2,397,000 | $2,397,000 |
| Subtotal | | | | $26,366,775 |
| Contingency (15% of subtotal) | | | | $3,955,100 |
| Engineering (10% of subtotal) | | | | $2,636,700 |
| Total | | | | $32,958,575 |
| Rounded Total | | | | $33,000,000 |

| Sanitary Sewer | | | | |
|---|---|---|---|---|
| Item | Quantity | Unit | Unit Price | Cost |
| 200mm PVC DR35 | 13,620 | m | $490 | $6,673,800 |
| 250mm PVC DR35 | 586 | m | $585 | $342,810 |
| 375mm PVC DR35 | 734 | m | $975 | $715,650 |
| 450mm PVC DR35 | 69 | m | $1,175 | $81,075 |
| Maintenance Hole Structure | 134 | each | $13,000 | $1,742,000 |
| Sanitary Laterals | 4,350 | each | $3,900 | $16,965,000 |
| Connect to Existing Trunk | 3 | each | $6,500 | $19,500 |
| Granular A | 176,700 | t | $35 | $6,184,500 |
| Flush & CCTV (end of construction) | 15,009 | m | $20 | $300,180 |
| Flush & CCTV (end of maintenance) | 15,009 | m | $20 | $300,180 |
| Other General Construction | 1 | LS | $3,332,500 | $3,332,500 |
| Subtotal | | | | $36,657,195 |
| Contingency (15% of subtotal) | | | | $5,498,600 |
| Engineering (10% of subtotal) | | | | $3,665,800 |
| Total | | | | $45,821,595 |
| Rounded Total | | | | $45,900,000 |

Northwest Welland Secondary Plan
Municipal Servicing

Preliminary Cost Estimate

| Storm Sewer | | | | |
|---|---|---|---|---|
| 450mm PVC DR35 Ultra Rib | 2204 | m | $455 | $1,002,820 |
| 525mm PVC DR35 Ultra Rib | 2515 | m | $520 | $1,307,800 |
| 600mm CONC | 2661 | m | $585 | $1,556,685 |
| 675mm CONC | 81 | m | $815 | $66,015 |
| 750mm CONC | 902 | m | $1,025 | $924,550 |
| 825mm CONC | 554 | m | $1,175 | $650,950 |
| 900mm CONC | 1015 | m | $1,380 | $1,400,700 |
| 1050mm CONC | 941 | m | $1,775 | $1,670,275 |
| 1200mm CONC | 332 | m | $2,190 | $727,080 |
| 1350mm CONC | 80 | m | $2,795 | $223,600 |
| 1200mm Diameter MH | 68 | each | $13,000 | $884,000 |
| 1500mm Diameter CBMH | 13 | each | $18,200 | $236,600 |
| 1800mm Diameter CBMH | 18 | each | $20,800 | $374,400 |
| 2400mm Diameter CBMH | 2 | each | $24,700 | $49,400 |
| Catchbasin | 380 | each | $4,175 | $1,586,500 |
| Catchbasin leads | 1900 | m | $490 | $931,000 |
| Granular A | 95800 | t | $35 | $3,353,000 |
| Flush & CCTV (end of construction) | 11285 | m | $20 | $225,700 |
| Flush & CCTV (end of maintenance) | 11285 | m | $20 | $225,700 |
| Other General Construction | 1 | LS | $1,739,700 | $1,739,700 |
| Subtotal | | | | $19,136,475 |
| Contingency (15% of subtotal) | | | | $2,870,500 |
| Engineering (10% of subtotal) | | | | $1,913,700 |
| Total | | | | $23,920,675 |
| Rounded Total | | | | $24,000,000 |