REPORT

City of Welland

Northwest Welland Secondary Plan Municipal Servicing Conceptual Design Report

AUGUST 2020

TABLE OF CONTENTS

LIST OF TABLES

PAGE NO.

LIST OF FIGURES

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 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 (see 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 500 m to the south and 500 m to the north and comprises approximately 190 ha. Quaker Road bisects through the Study Area and is identified as an arterial road and all other streets are considered local roads.

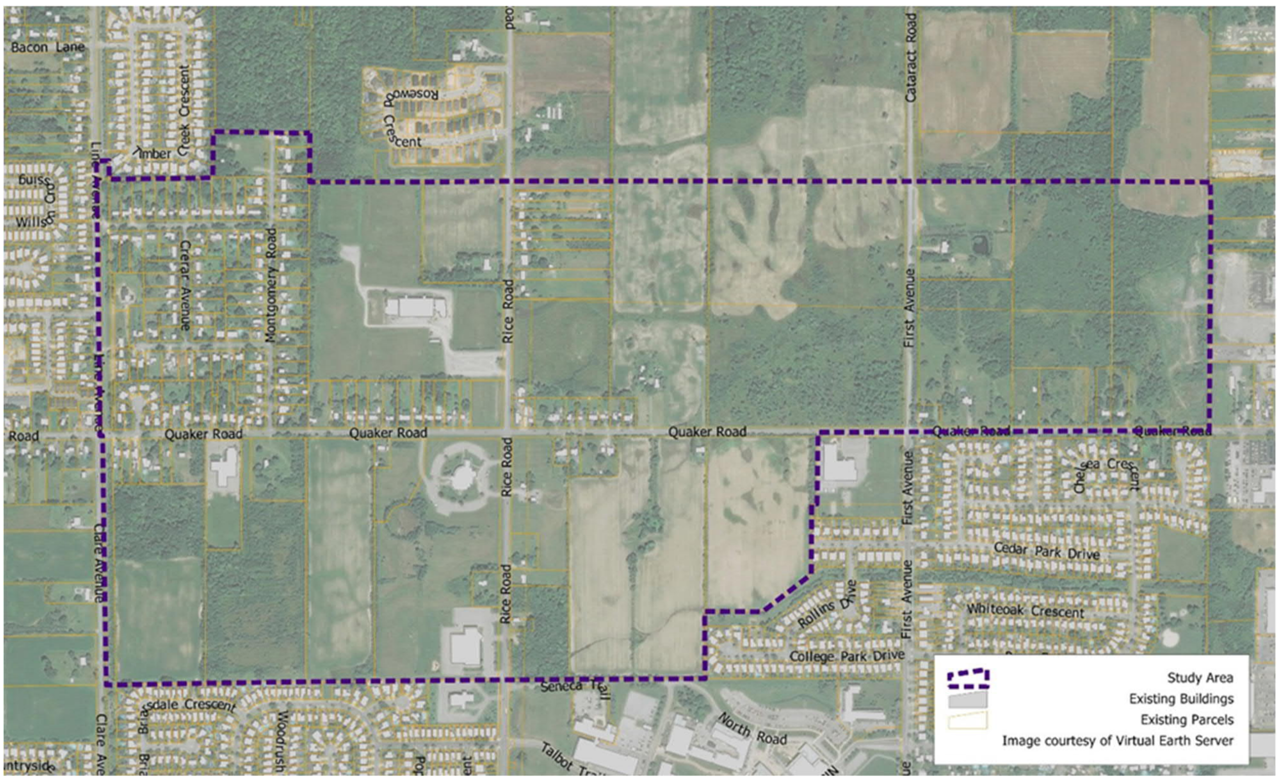


Figure 1-1: Northwest Welland Secondary Plan Study Area

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.

It is important to note that the NWSP area was not included as one of the growth areas in the Niagara Region's Master Serving Plan (2017). As such, the REGION MSP's capacity assessment for sanitary and water did not consider the impacts of growth in the NWSP area and development in this area will contribute additional demands and generate additional flows to the ones identified in the REGION MSP.

1.2 Proposed Secondary Plan

Figure 1-2 shows the preferred land uses identified for the NWSP in the Key Directions Report for the Northwest Welland Secondary Plan (prepared by SGL Planning & Design Inc., November 2019), as well as the location of a future collector road which will service the area.

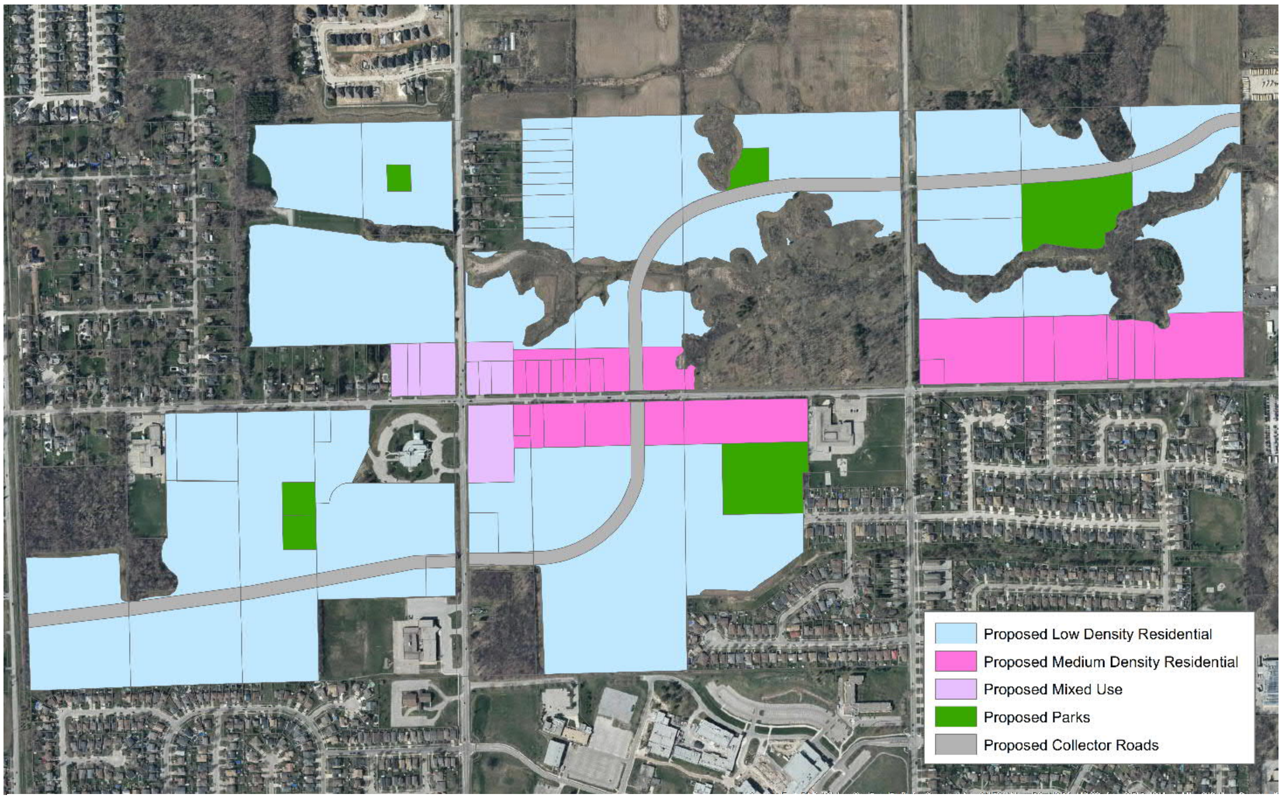


Figure 1-2: NWSP Preferred Land Use

Based on the preferred land use plan, a total proposed number of units and associated population and employment numbers were also identified in the Key Directions Report. Land use areas, projected units, populations, and employees are summarized in Table 1-1.

Table 1-1: NWSP Population by Land Use

Land Use	Area (ha)	Units	Population	Employees
Low Density Residential	83.37	1,220	4,805	0
Medium Density Residential	13.57	451	1,223	0
Mixed Use	3.20	149	404	136
Parks	5.75	-	-	-

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
Wastewater	Welland All Pipe Wastewater Model	InfoSWMM	City of Welland/ Niagara Region

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
All	Housing and properties layout/development plans for NWSP and planned local roads	To provide more accurate allocation of demands and confirm servicing strategy (pipe locations/flow directions)

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.

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 circa 1910, consists of 150 mm PVC watermain (original watermain replaced in 2002) connecting to both the 750 mm CPP on Line Avenue and the 300 mm CI on Quaker Road. There are also existing properties along Quaker Road, which are serviced off the 300 mm main.

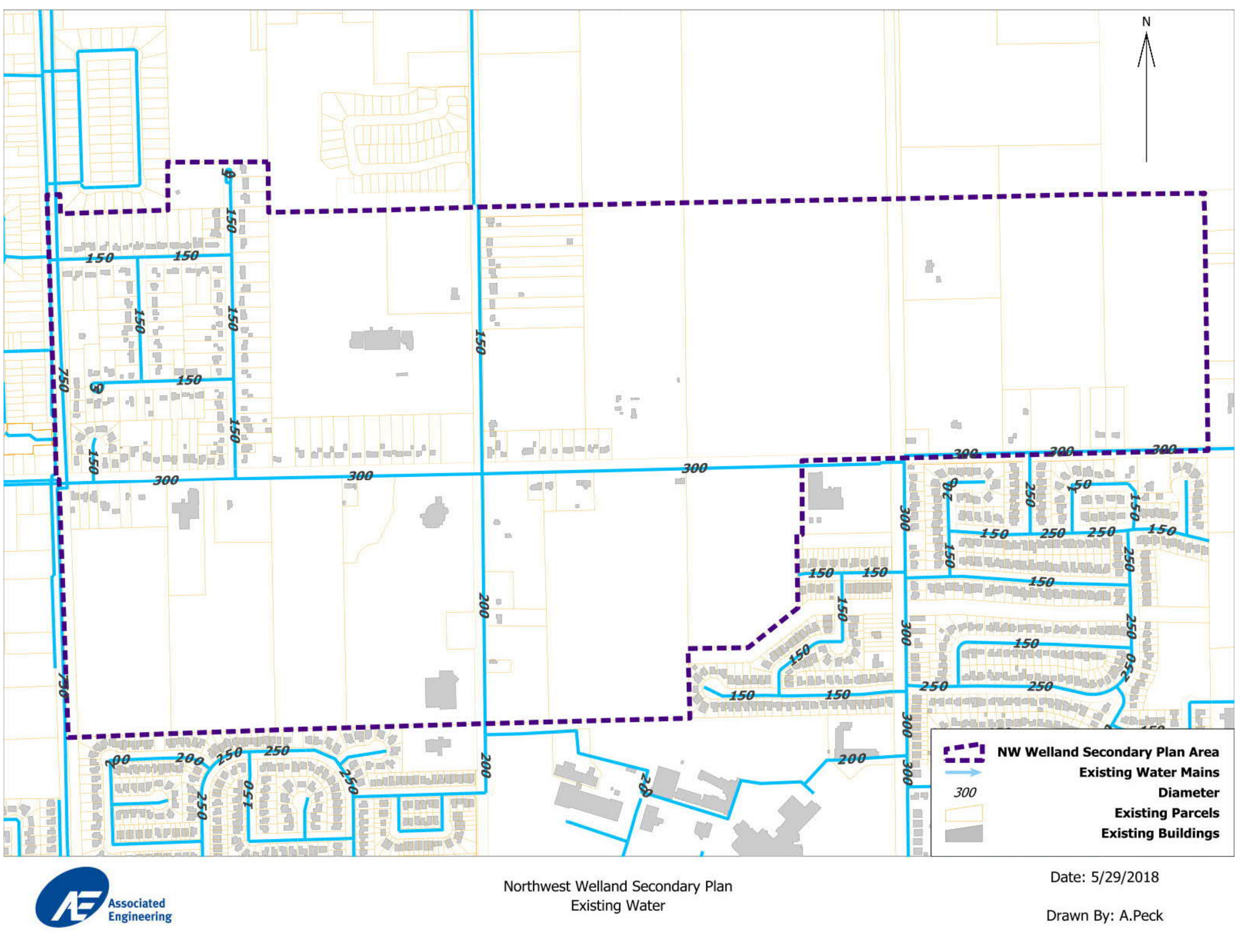


Figure 3-1: Existing Configuration of Watermains in Study Area

3.1 Design Criteria

The design criteria used for the analysis of the existing water system, includes:

- 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)
- Fireflow Requirements during MDD with 140 kPa (20 psi) residual system pressure:
  - Parks: 67 L/s
  - Low Density Residential: 67 L/s
  - Medium Density Residential 133 L/s
  - Multi-Use: 133 L/s
- Per capita demand: 320 L/cap-day
- 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: 140

3.2 Existing System Capacity

3.2.1 Existing Model

The City of Welland's existing InfoWater all pipe water model was used as the base for the completion of the assessment of the water needs for the NWSP area. The City's model includes both existing and future average day demand (ADD) and maximum day demand (MDD) extended period simulation (EPS) scenarios. The existing demand scenarios in this model were last reviewed and updated in 2018. The future demand scenarios incorporate planned future developments identified by the City of Welland.

The Niagara Region also has an Infowater all pipe water model, which was last updated for the completion of the 2016 Master Plan. This model includes future (2041) demand scenarios, incorporating future development identified by the Region during the master planning process.

Although there are overlaps between the future development growth areas included in the City of Welland and Region all pipe models, several of the identified growth areas are included in only one or the other of the two models. The City of Welland model also does not account for any growth in the Pelham system, which it feeds through the Shoalt's Reservoir, while the Region model includes the entire Pelham system and its future growth.

To provide a complete (worst-case) picture of the future state of the system prior to the addition of the NWSP area, future demands from the Region model in the growth areas not already included in the City of Welland model were incorporated into the City model. Additionally, the future outflow from Shoalt's to Pelham was updated in the City's model to match the future Shoalt's outflow in the Region model.

These revised future scenarios (ADD and MDD), along with the City's existing ADD and MDD scenarios were used as the baseline for the completion of the hydraulic analysis.

Note that no additional quality control checks were conducted on the City model. It is assumed that the model is sufficiently calibrated for the purpose of this analysis.

3.2.2 Hydraulic Analysis

3.2.2.1 Existing

A hydraulic analysis of the existing system was completed to provide a baseline level of service to compare the future system to (both with and without the NWSP area).

Figures A-1 and A-2 in Appendix A show the minimum pressure during existing ADD and MDD EPS respectively in the study limits and surrounding area. At certain locations within the study/surrounding area, existing system pressures are less than 275 kPa (40 psi). These lower pressures are due to high ground elevations (maximum of 193.1 m) and the HGL of the Shoalt's Drive Reservoir, which fluctuates between 219.0 m and 220.0 m.

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 Rice Road north of Quaker Road and the dead ends on Montgomery Road and Topham Boulevard have fire flows less than 67 L/s (the City requirement for low density residential) – these low fire flows are due to both the ground elevation and the size of the watermains supplying these hydrants. There are also other nearby areas with less than 67 L/s of available fire flow for similar reasons.

3.2.2.2 Future without NWSP

Figures A-4 and A-5 in Appendix A show the minimum pressure during future ADD and MDD EPS respectively. As these figures show, pressures at existing high ground elevation areas are further reduced. This reduction is due to the future increase in demand and is exacerbated by the current operating procedure at the WTP, where high lift pumps are shut down 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 are drawn down – this draw down is sharper and reaches a lower hydraulic grade line (HGL) in the future. Furthermore, with the current pumping scheme, in the future, the Shoalt's Drive Reservoir is not capable of recovering, with the water level continuously dropping, while Bemis is not capable of completely re-filling. Figure 3-2 shows the existing and future Shoalt's Drive Reservoir and Bemis Tank HGL during MDD EPS.

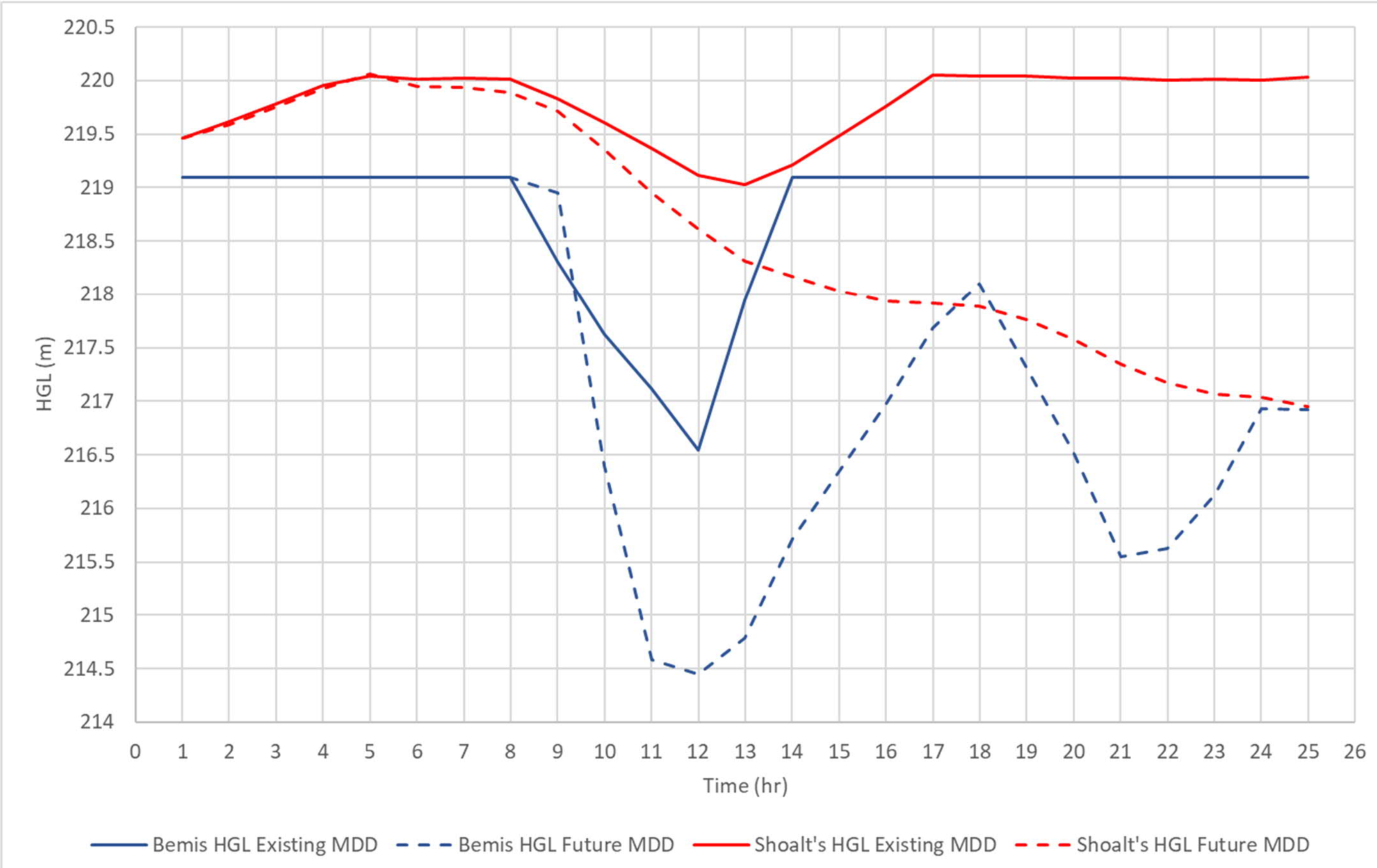


Figure 3-2: Existing and Future Tank HGL

Given the overall decrease in system pressure and the issues with recovery at the Shoalt's Drive Reservoir and Bemis Elevated Tank, alterations to the WTP operations will be required in the future. As such, modified future pumping schemes were developed for completion of this analysis. Table 3-1 shows the existing and modified future pumping schemes (on/off settings) at the WTP for both ADD and MDD.

Table 3-1: Existing and Future WTP Pump Settings

Pump	Existing ADD	Existing MDD	Updated Future ADD	Updated Future MDD
Low Flow Pump #1	Off at 0:00 On at 15:00	Off at 0:00 On at 12:00 Off at 17:00 On at 20:00	Off at 0:00 On at 12:00 Off at 23:00	Off at 0:00
Low Flow Pump #2	Off at 0:00 On at 16:00 Off at 24:00	Off at 0:00 On at 20:00	Off at 0:00 On at 20:00 Off at 24:00	Off at 0:00

Pump	Existing ADD	Existing MDD	Updated Future ADD	Updated Future MDD
High Flow Pump #1	Off at 0:00	Off at 0:00	Off at 0:00	Off at 0:00 On at 7:00 Off at 24:00
High Flow Pump #2	Off at 0:00	On at 0:00 Off at 7:00 On at 11:00 Off at 20:00 On at 24:00	On at 0:00 Off at 3:00 On at 6:00 Off at 20:00 On at 24:00	On at 0:00 Off at 2:00 On at 5:00

Figures 3-3 and 3-4 show the Shoalt's Drive Reservoir and Bemis Tank HGL during both ADD and MDD with the implementation of the updated pumping scheme. Note that, although the revised pumping scheme addresses the issues with storage recovery and improves future system pressures (see Figures A-4 and A-5 in Appendix A for ADD and MDD minimum pressures with these changes), it also reduces the daily turnover volume in the Bemis Elevated Tank, which may lead to a reduction in water quality. Further investigation is recommended to identify the optimal future operation of the Welland system to supply adequate pressure and fire flow to all existing and growth areas, not just the NWSP area.

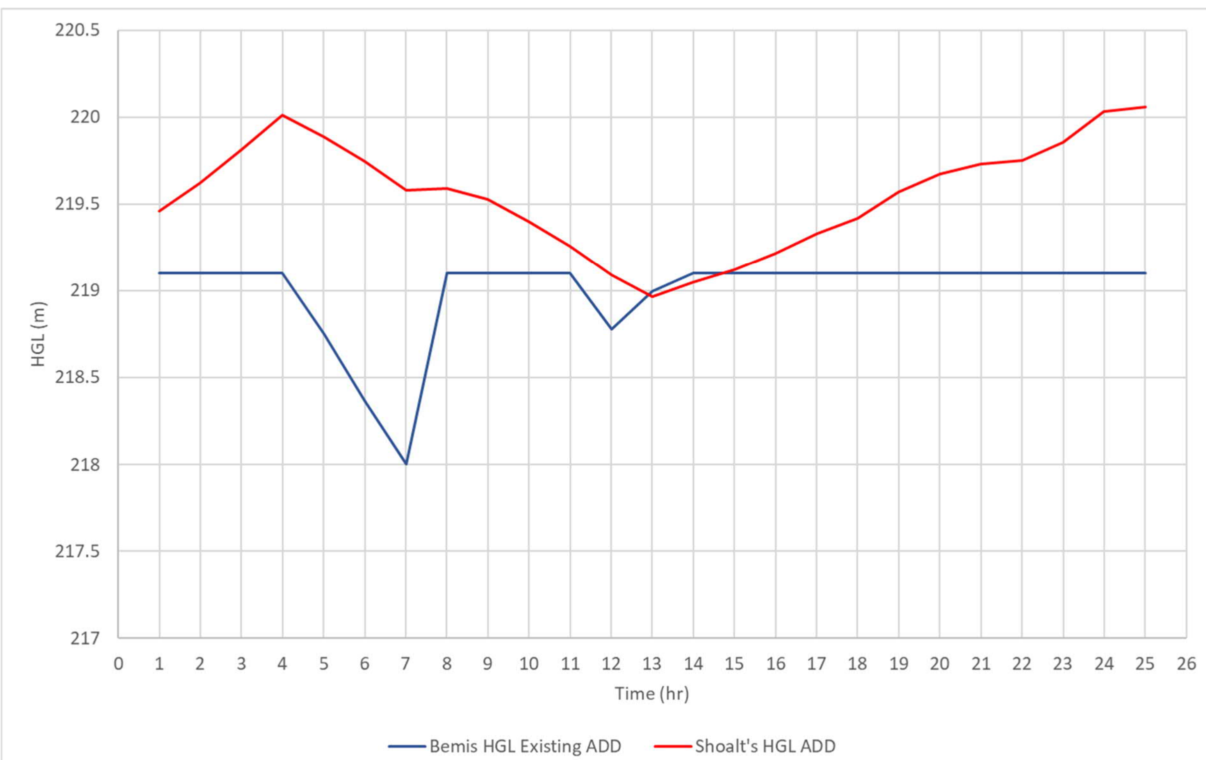


Figure 3-3: ADD Tank HGL with Modified WTP Pumping Scheme

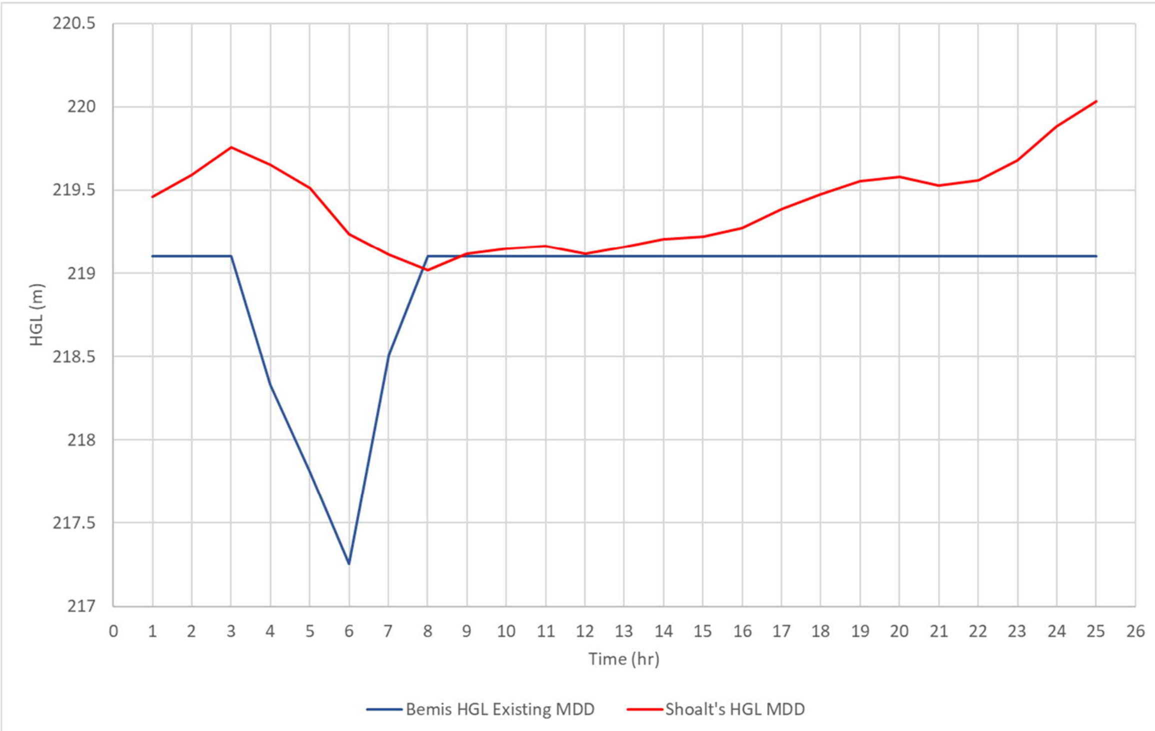


Figure 3-4: MDD Tank HGL with Modified WTP Pumping Scheme

Figure A-6 in Appendix shows the future available fire flow during MDD with the discussed changes in WTP operation implemented. As shown, these fire flows are comparable to the existing available fire flows with some minor increases.

3.3 Proposed System Requirements

3.3.1 Proposed Model

3.3.1.1 NWSP Servicing

Several pipes and junctions were added to the City of Welland all pipe model to represent future servicing of the NWSP area – these pipes and junctions are shown in Figure 3-2. Note that only significant pipes (piping along the future collector road, and piping that connects to the existing system) was included in the model. There will be additional future piping required along local roads – it is assumed that this piping will be 150 mm diameter.

Junction elevations (shown in Figure 3-5) were assigned based on the City of Welland 1 m contours. Pipe sizing shown was established as part of the hydraulic analysis (refer to Section 3.3.3).

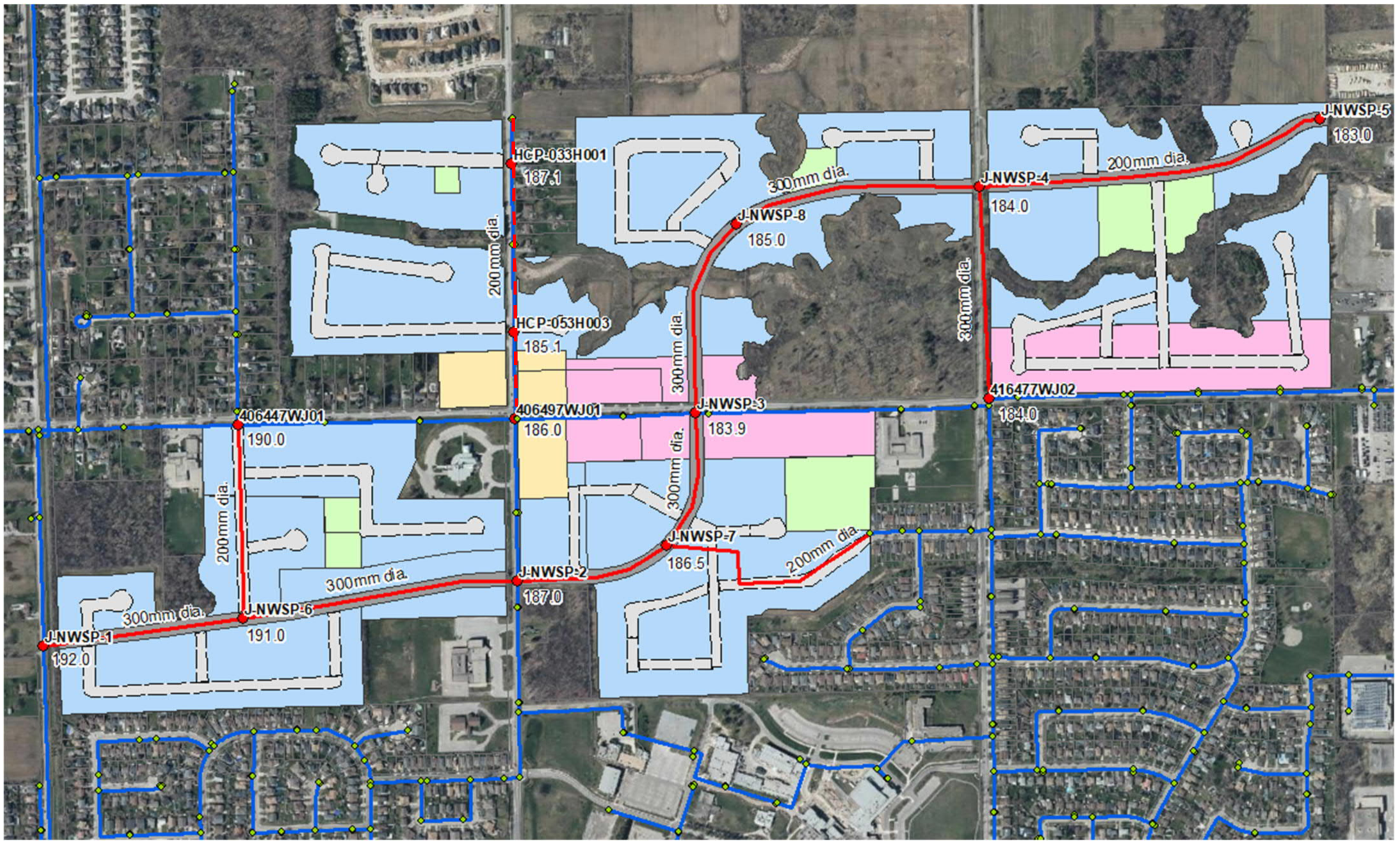


Figure 3-5: Proposed Junctions and Pipes

3.3.1.2 NWSP Demands

Table 3-2 summarizes the demands assigned within the model for the NWSP area. These demands were calculated based on the populations previously identified in Table 1-1 and design criteria noted in section 3.1.

Table 3-2: NWSP Demands

Junction ID	ADD (L/s)	MDD (L/s)	PHD (L/s)
406447WJ01	1.573	2.360	4.421
406497WJ01	2.005	3.008	5.636
HCP-033H001	1.258	1.887	3.535
HCP-053H003	1.931	2.897	5.428
J-NWSP-1	0.357	0.536	1.004
J-NWSP-2	0.591	0.887	1.661
J-NWSP-3	2.675	4.014	7.521
J-NWSP-4	5.051	7.579	14.196

Junction ID	ADD (L/s)	MDD (L/s)	PHD (L/s)
J-NWSP-5	1.07	1.606	3.008
J-NWSP-6	2.79	4.186	7.841
J-NWSP-7	3.039	4.559	8.54
J-NWSP-8	2.015	3.023	5.664
TOTAL	24.355	36.542	68.455

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. 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

The total additional storage required for the addition of the NWSP area is 1.0 ML.

Table 3-3 summarizes the total available storage identified in the Region Master Plan 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. Note that the MDD outflow from Shoalts was included in the equalization storage calculation.

Table 3-3: Available and Required Water Storage

Description	Storage (ML)
Total Available Storage	37.0
Existing Required Storage	19.2
Future Required Storage without NWSP	28.6
Future Required Storage with NWSP	29.6

3.3.3 Hydraulic Analysis

As discussed in Section 3.2.2.2, future modifications to the operation of the WTP will be required to maintain adequate pressure in the overall distribution system. As such, for the completion of the hydraulic analysis with the addition of the NWSP area, the future modified WTP pump on/off settings summarized in Table 3-1 were used.

Figures A-9 and A-10 in Appendix A show the minimum pressure during ADD and MDD EPS, and Figure A-11 shows the available fire flow, with the NWSP area serviced with the proposed watermain sizes identified on Figure 3-5.

To supply suitable fire flow to the NWSP areas that will be serviced off Rice Road (north west of Quaker Road), the existing 150 mm diameter watermain on Rice Road needs to be upgraded to 200 mm diameter. Additionally, a 300 mm diameter connection between the future NWSP collector and the existing trunk watermain at the intersection of Cataract Road and Quaker Road is required.

As the appended figures show, the addition of the NWSP area does not significantly impact the surrounding system pressures, which represent an improvement over existing system pressures and are similar to the modelled future pressures without the NWSP area. Available fire flows are also comparable to the modelled future available fire flows without the NWSP area, with some localized improvements shown in areas where the NWSP area piping provides looping. These results show that the addition of the NWSP will not significantly change the future system operation needs, although, as previously discussed in Section 3.2.2.2, the overall future system operation needs for the Welland system should be reviewed separately.

The appended figures also show that the normal operating pressures in the portion of the NWSP area south of Quaker Road and west of Rice Road do not meet the design criteria of 275 kPa (40 psi). The low pressure in this portion of the NWS area is due to its elevation and no modification to pipe sizing or location would increase these pressures to above the 275 kPa requirement. The elevation of the area rises from east to west with the maximum elevation in this section reaching 192.0 m. To provide pressures that meet or exceed the 275 kPa requirement, the elevation of this area would need to be reduced to approximately 190 m. The pressures in the remainder of the NWSP area meet or exceed the design criteria.

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 under the Recreational Canal and the Welland River to a gravity sewer on Woodlawn Road, 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.

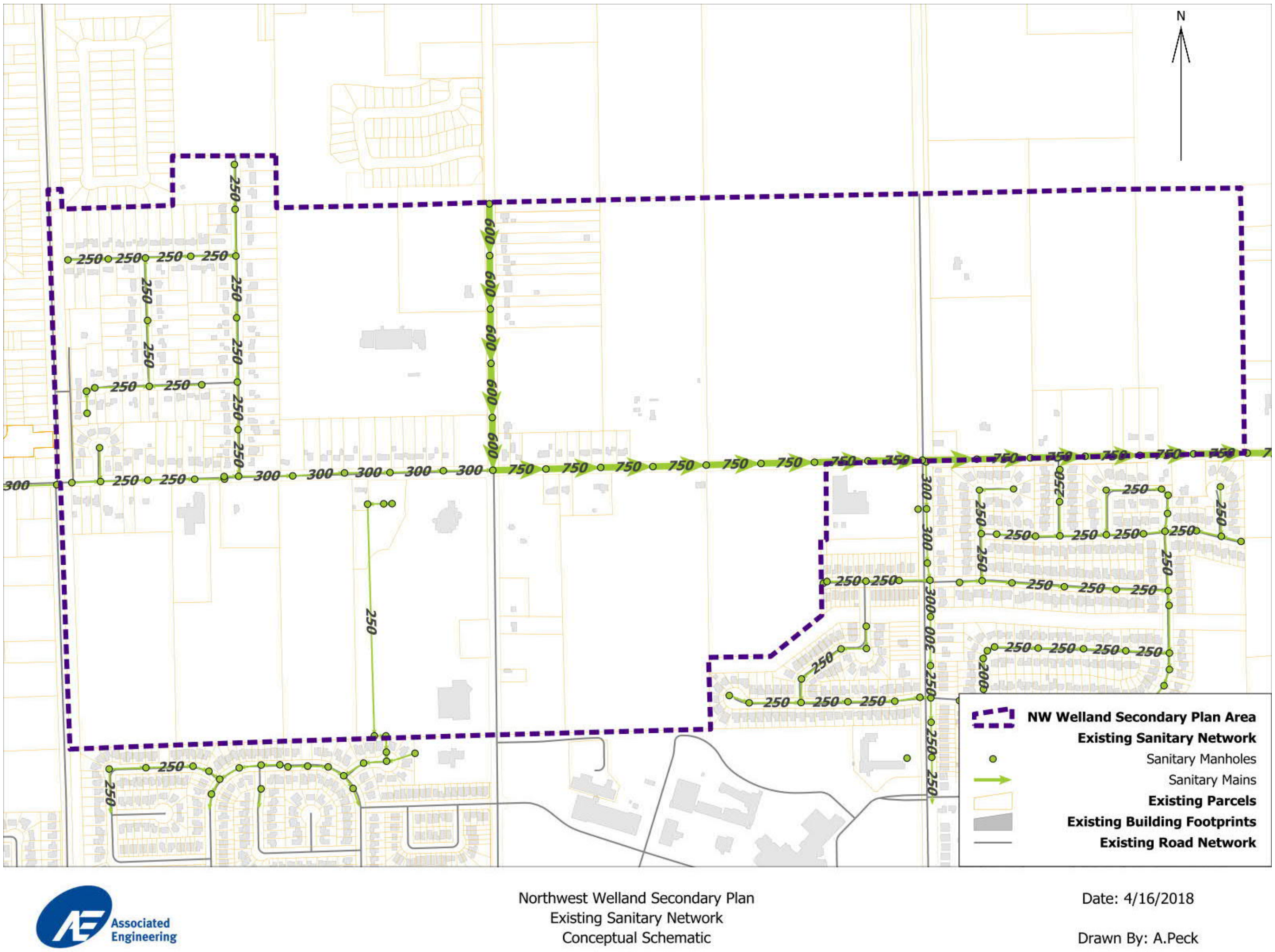


Figure 4-1: Schematic of Existing Sanitary System in NWSP Study Area

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 MSP identified a future connection along Quaker Road from Line Avenue to Rice Road, which would redirect a portion of the flows from Pelham (north-west of Line Avenue) to the Quaker Road trunk sewer, and ultimately the Towpath SPS. Given this possible significant change in flows through the Quaker Road trunk sewer, the available capacity of this sewer was reviewed both with and without this future 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 157 to 3,324 L/s without the Line Avenue connection and from 102 to 3,196 L/s with the Line Avenue connection.

4.2.2 Towpath SPS and Forcemain

The REGION MSP identified that Towpath SPS has existing additional available pumping capacity of approximately 30 L/s based on existing design peak wet weather flows. Although existing pumping capacity appears sufficient for existing flows, the REGION MSP identified that Towpath SPS will exceed current pumping capacities by 2041 due to both growth north of the study area and the addition of the Line Avenue connection. As such, the REGION MSP identified a capital project to upgrade the Towpath station during the timeframe of 2022 – 2031 from 150 L/s to 300 L/s (WW-SPS-037).

The results from the City's all pipe InfoSWMM model indicated that the future peak inflow to the Towpath SPS will be 220 L/s without Line Avenue connection and 348 L/s with the Line Avenue connection.

The REGION MSP also indicates that the existing Towpath SPS forcemain has current and projected surplus capacity. The REGION MSP identified approximately 764 L/s of projected future surplus capacity in the Towpath SPS forcemain.

4.2.3 Welland WWTP

The REGION MSP identified that the existing Welland WWTP has surplus capacity available to treat existing and future flows at the plant, with the plant not reaching 80% capacity within the 2041 time horizon.

4.3 Proposed System Requirements

4.3.1 NWSP Sanitary Drainage Areas and Proposed Collection System

Figure 4-2 shows the approximate location of future trunk sanitary gravity sewer within the NWSP area and the location where this trunk will connect to the existing trunk sewer on Quaker Road. Figure 4-2 also shows identifying numbers for the individual NWSP drainage areas, which are referenced in the sewer design sheets. Design sheets for the proposed sanitary sewers both with and without the Line Avenue connection are attached in Appendix B. Note that the inverts and pipe lengths assigned to the existing trunk sewer in the proposed design sheet are from the City's InfoSWMM model. Existing peak flows into the trunk sewer, input at existing manhole locations in the design spreadsheet, are also as per the City's InfoSWMM model. Note that, it is assumed that any other sanitary sewer required on future roads servicing the NWSP area, will be 200 mm diameter.

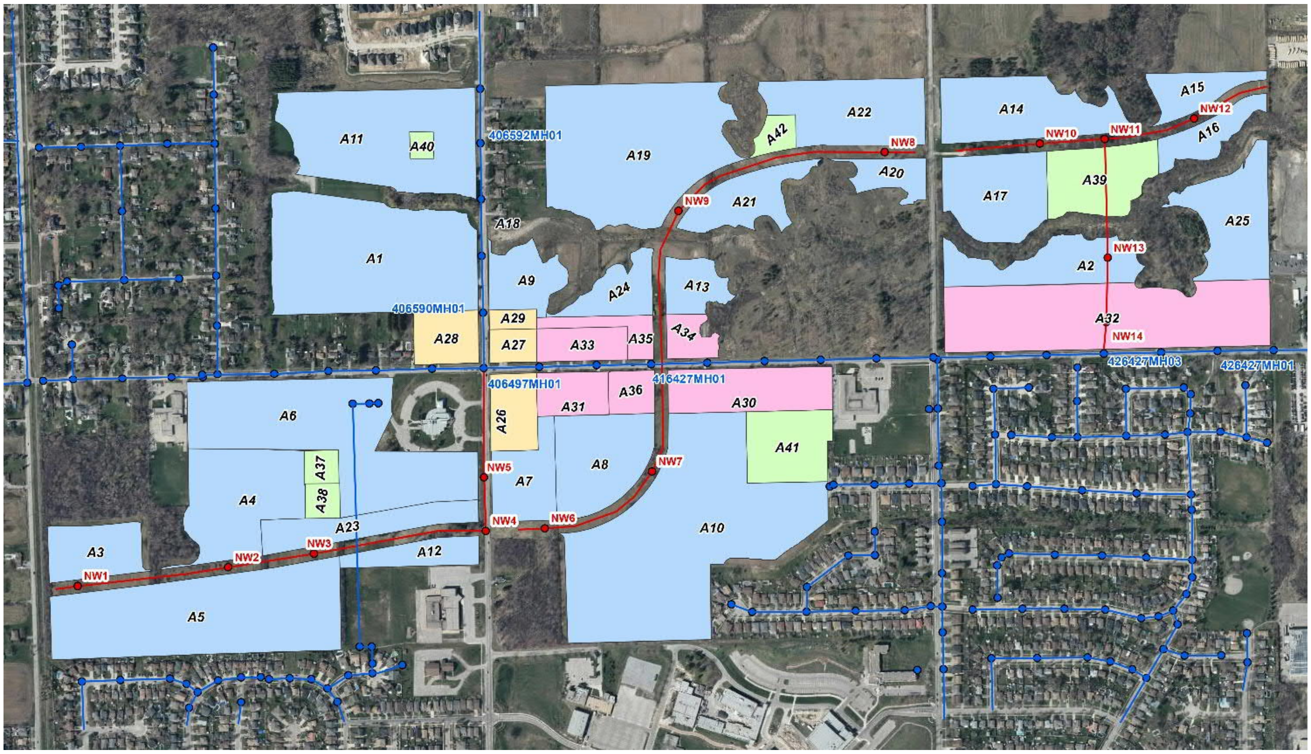


Figure 4-2: Proposed Sanitary System and Drainage Areas

As shown in the appended design sheets, the NWSP drainage area contributes overall an additional 96 L/s of peak flow to the Quaker Road trunk sewer, which has sufficient capacity to accept this flow both with and without the future Line Avenue connection. Should future studies, such as the City MSP currently underway, determine that upgrades are required to the Quaker Road trunk sewer due to a higher I/I influence than is included in the existing InfoSWMM model/Region MSP, these upgrades will need to allow for the additional 96 L/s of peak flow that will be directed to this sewer from the NWSP area.

4.3.2 Towpath SPS and Forcemain

The Welland NWSP area will contribute an additional 96 L/s of peak flow to the Towpath SPS, which was not accounted for in REGION MSP's flow estimations. As previously noted, the REGION MSP identified a planned future upgrade to this SPS. The addition of the NWSP area may change the timing and capacity requirement of the proposed upgrade, depending on if/when this area is developed, and if/when the Line Avenue connection is made.

It is anticipated that the Towpath SPS forcemain has sufficient existing and future capacity to accommodate flows from the Welland NWSP area.

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 without the plant reaching 80% capacity in 2041.

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 upgrade should consider 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. 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.

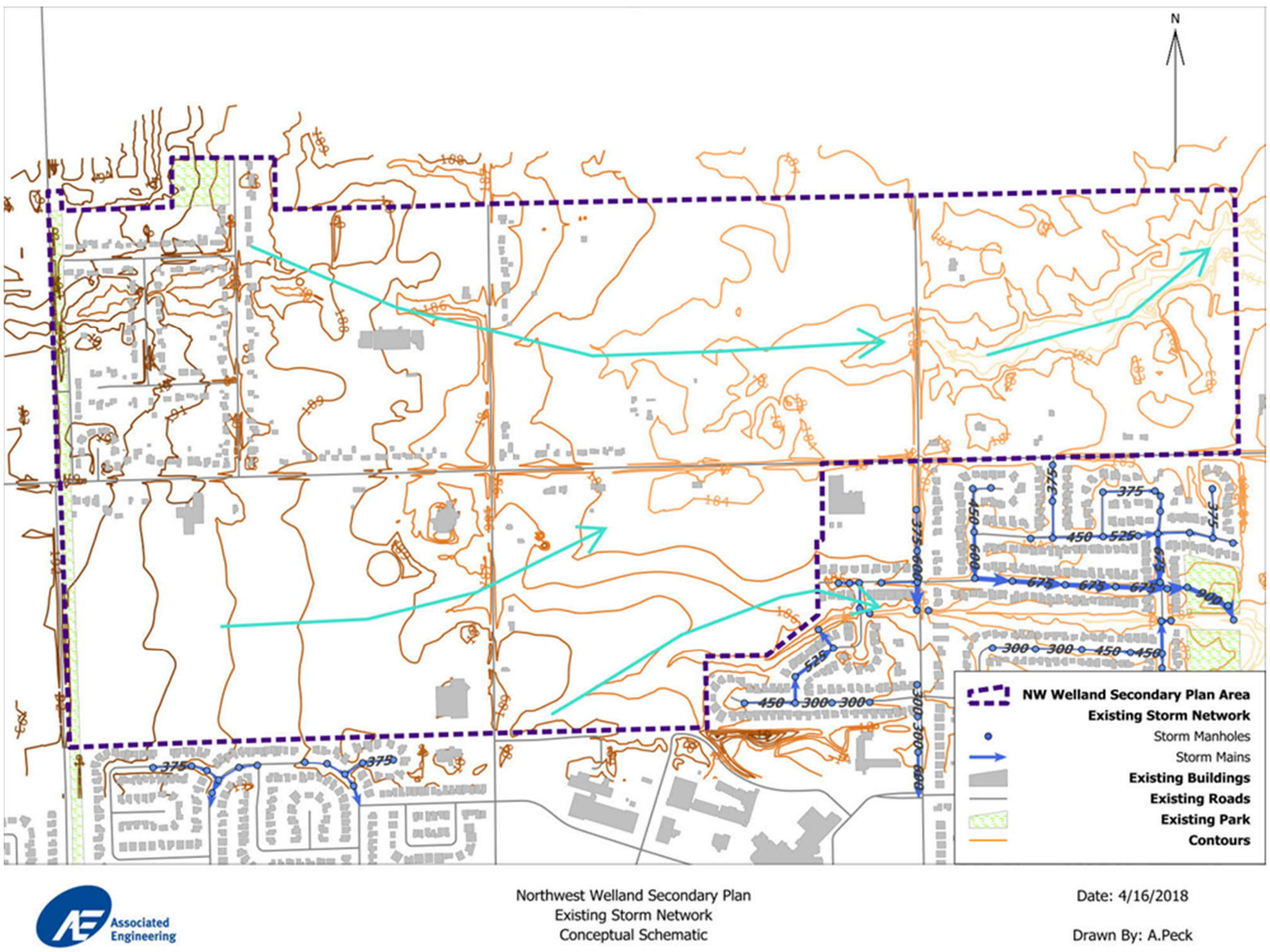


Figure 5-1: Schematic of Existing Stormwater Drainage Path

5.1 Design Criteria

The overall storm water management plan for the NWSP area is being developed by Aquafor Beech. 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 of:
  - Parks = 0.20
  - Low Density Residential = 0.40
  - Medium Density Residential = 0.65
  - Multi-Use = 0.65

Note that the City is currently in the process of updating their design standards, including updates to their IDF curves, which should be incorporated into the detailed design of the storm system.

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 Storm Water Management Pond Locations

The storm water management plan developed by Aquafor Beech identified approximate locations for six (6) storm ponds, which will outlet to the existing drainage channel north of Quaker Road. The intent of the storm water management plan is that all runoff from the proposed NWSP area will be directed to these storm pond locations through new gravity sewer installed on the future collector and local roads.

The approximate location of these proposed storm ponds is shown on the Proposed Pond Locations figure from the Aquafor Beech Stormwater Management Plan (February 2020), 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 shows the approximate location of future trunk storm gravity sewers within the NWSP area and the approximate location where these gravity sewers will outlet to the proposed storm ponds. 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 and general trunk sizing on the future collector road. 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 450 mm.

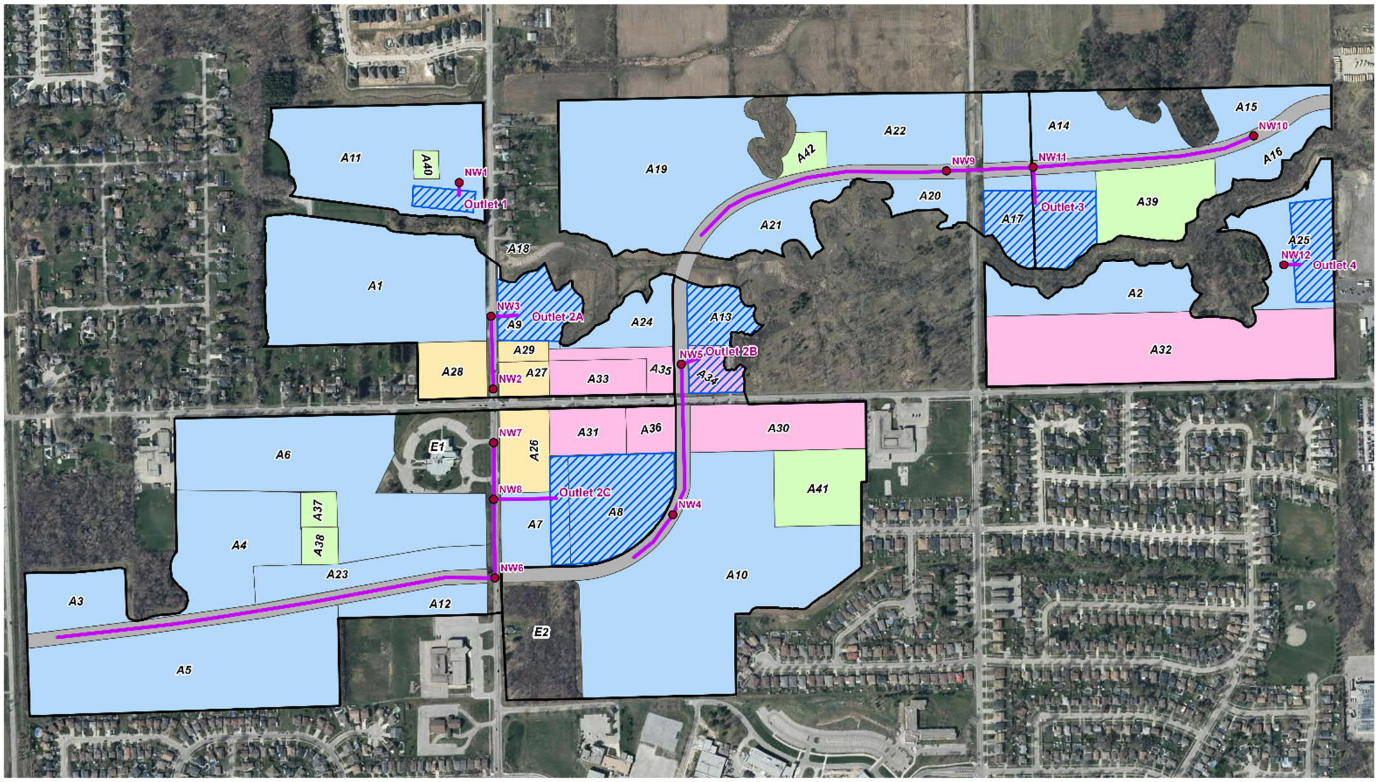


Figure 5-2: Proposed Storm System and Drainage Areas

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.

Table 5-1: Required Outlet Size

Outlet #	Size (mm)
Outlet 1	600
Outlet 2A	1200
Outlet 2B	1200
Outlet 2C	1500
Outlet 3	1200
Outlet 4	1200

Note that pipe slopes identified in the design spreadsheet 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. However, due to the required outlet elevations (100-year flood levels), it was determined that suitable cover cannot be achieved in certain areas with the existing ground elevations – fill will be required to service these areas. Figure 5-3 shows the locations that will require fill. The volume of required fill will be dependent on the final road and lot layout, as well as the final location of the proposed storm ponds. In general, the areas shown as requiring fill in Figure 5-3 need to be raised between 0.2 to 1.0 m.

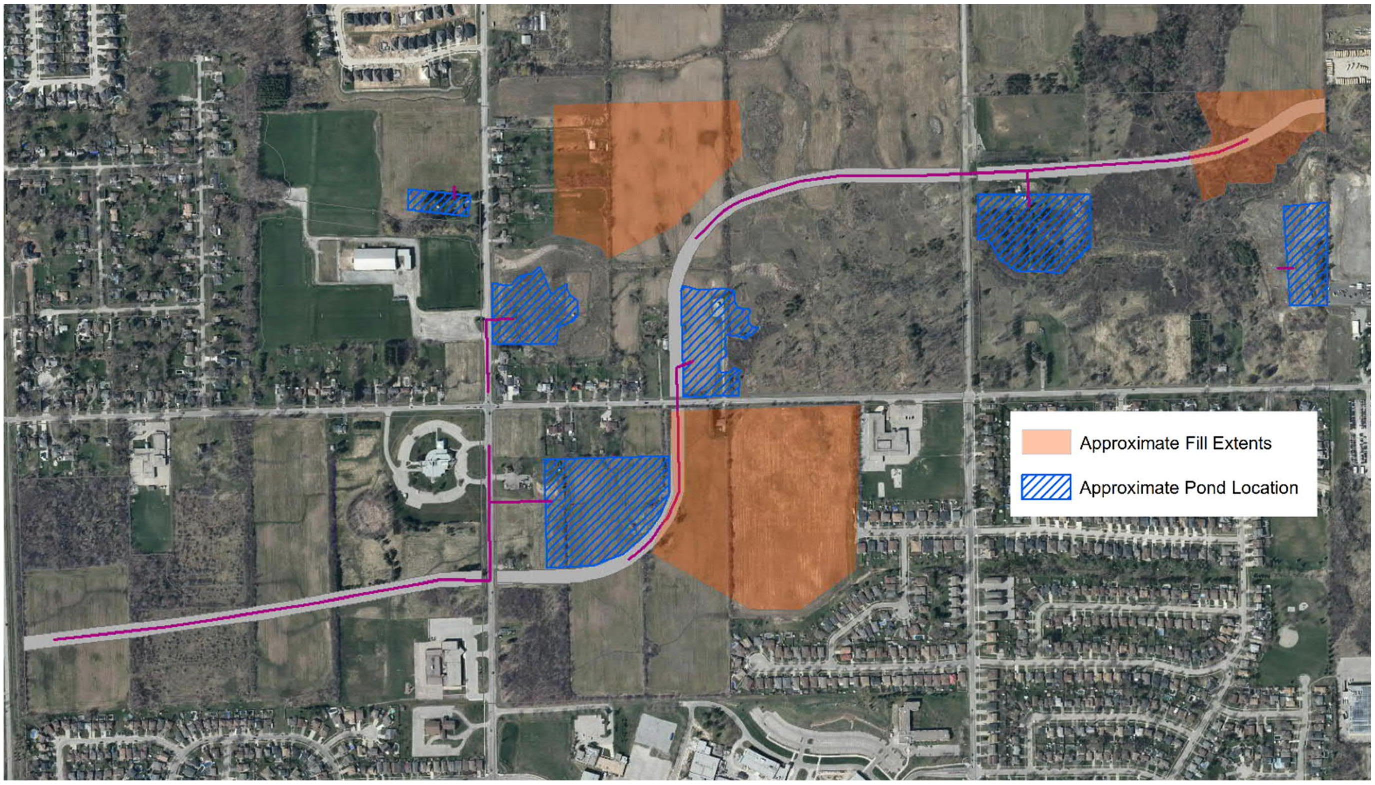


Figure 5-3: Approximate Extent of Required Fill

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 Cataract Road) are included in this estimate. Additionally, the cost for adding/removing fill to adjust the overall grade of the NWSP area is not included. 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 Servicing	Watermain (150 mm to 300 mm), including all services, valves, and hydrants	$8,276,600
Sanitary Collection Servicing	Sanitary Sewer (200 mm to 300 mm), including all laterals and structures	$10,599,600
Storm Collection Servicing	Storm Sewer (450mm to 1200 mm), including all structures	$9,298,800
Sub-total	Water/Sanitary/Storm	$28,175,000

Item	Scope of Work	Cost
Engineering	10% of Capital	$4,226,400
Contingency	15% of Capital	$2,817,600
TOTAL		$35,219,000

7 CONCLUSIONS

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

Water:

- Currently the drinking water system is operated with a mid-morning shutdown at the WTP. Operating the WTP in this manner in the future will result in issues both with maintaining adequate system pressure and with re-filling the Bemis Elevated Tank and the Shoalt's Drive Reservoir. These issues are not due to the addition of the NWSP area but are caused by the overall anticipated growth in the system (both growth identified in the REGION MSP and other growth identified by the City of Welland). For this assessment, modifications to the WTP operations (changes to pump on/off settings) were made to improve system pressures and address water storage cycling issues. However, the overall future system operation needs for the Welland system should be reviewed in a separate study.
- The addition of the NWSP area will have minimal to no impact on surrounding system pressures and available fire flows.
- The existing system has sufficient storage to allow for the addition of the NWSP area and all other future growth currently identified
- Elevations in the portion of the NWSP area south of Quaker Road and west of Rice Road are too high (maximum of 192 m) in relation to the system HGL to meet the minimum pressure requirement of 275 kPa (40 psi) during normal operating conditions. To provide pressures that meet or exceed the 275 kPa requirement, the elevation of this area would need to be reduced to approximately 190 m. The remainder of the NWSP area can be serviced by the existing system at pressures that meet or exceed the minimum requirement.
- The existing 150 mm diameter watermain on Rice Road north of Quaker Road needs to be upgraded to 200 mm diameter to supply the required fire flow (67 L/s) to the portion of the NWSP area north of Quaker Road and West of Rice Road.
- Future watermain along the collector road and connections to the existing system from the NWSP areas will range in size from 200 mm to 300 mm (see Figure 3-5). Watermain sizing should be confirmed during design.
- An additional connection (300 mm) to the existing system at the intersection of Quaker Road and Cataract Road is required to service the area.

Sanitary:

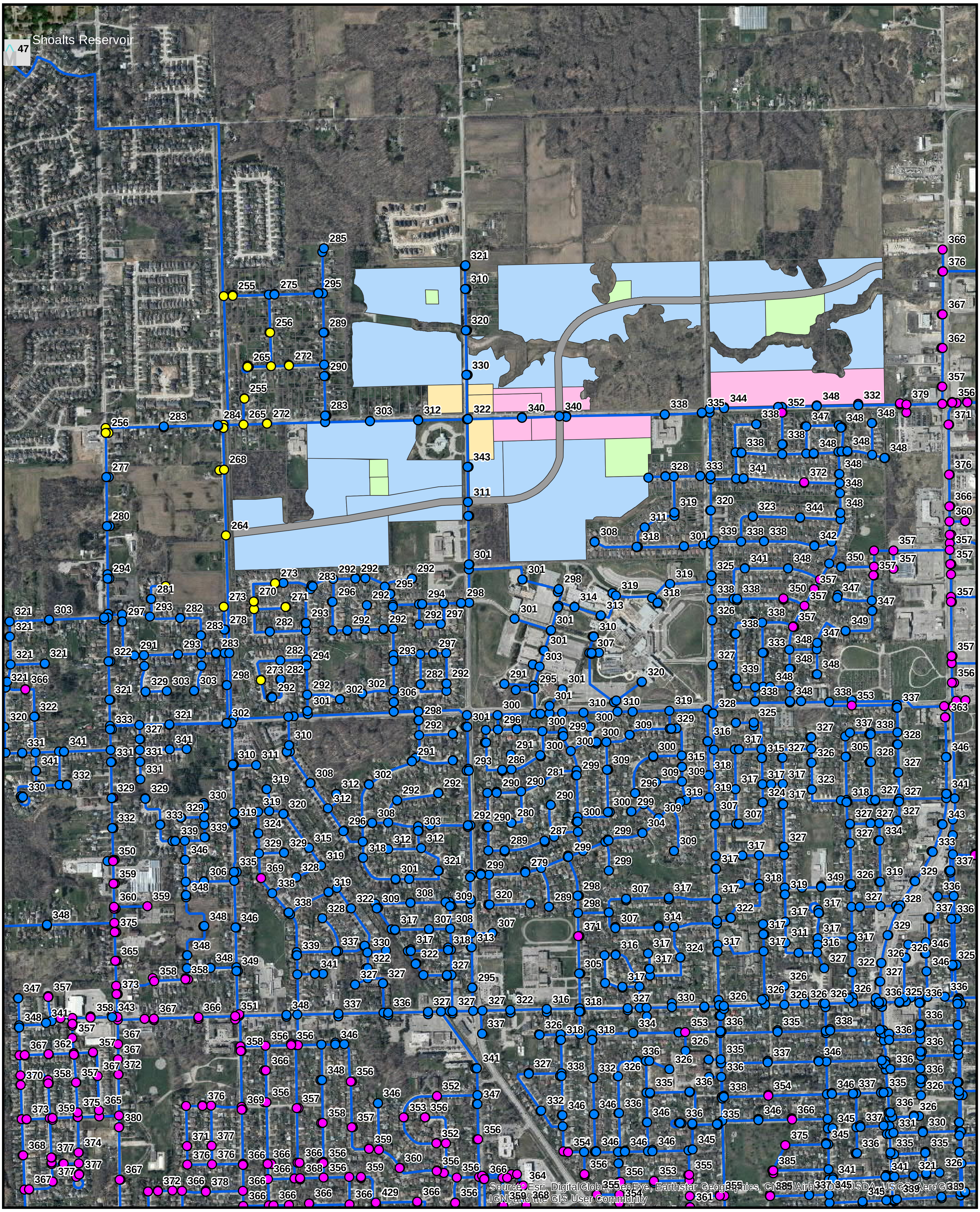
- The existing trunk along Quaker Road, which conveys flows to the Towpath SPS, has sufficient capacity to accept the additional 96 L/s peak flow generated by the NWSP area in all future scenarios.
- The Towpath SPS was identified in the REGION MSP as requiring a future upgrade due to both growth north 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 addition of the NWSP area may change the timing and capacity requirement of the proposed upgrade at the Towpath SPS, depending on if/when this area is developed, and if/when the Line Avenue connection is made.

- The Towpath SPS forcemain has sufficient existing and future capacity to accommodate flows from the Welland NWSP area.
- 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 upgrade should consider the capacity of the downstream trunk sewer when determining SPS outflow rates.
- 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 300 mm diameter. Sizing should be confirmed during design.

Storm:

- The storm water management plan developed by Aquafor Beech identified approximate locations for six (6) new storm water ponds to service the NWSP area. Gravity sewers along the future local and collector roads will direct runoff to these pond locations. Outlet sizing for the ponds will range from approximately 600 mm diameter to 1500 mm diameter. Sizing should be confirmed during design.
- The identified required outlet elevations (100-year flood levels) are high relative to the ground elevation of certain portions of the NWSP area. Fill will be required in these lower areas (see Figure 5-3) to allow the installation of gravity sewers.

APPENDIX A - WATER



Legend

Minimum Pressure

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

Existing Watermain

Proposed Watermain

Existing Watermain
To Be Replaced

Proposed Land Use

- Low Density Residential
- Medium Density Residential
- Mixed Use
- Parks

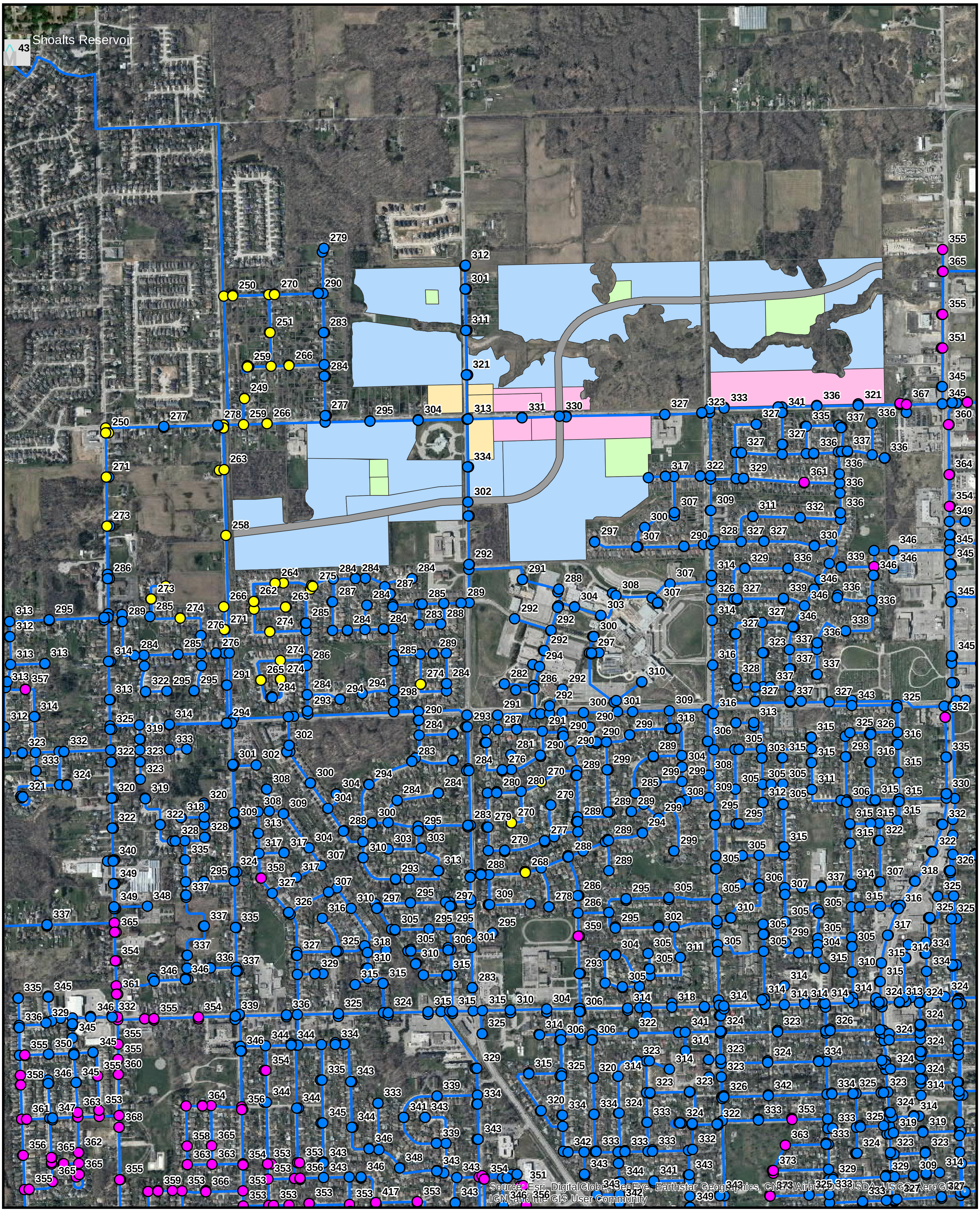
Associated Engineering

CANADA BEST MANAGED COMPANIES
Platinum member

Northwest Secondary Plan
Municipal Servicing

Existing Min Pressure during ADD EPS

Project No.: **2018-5190**	**Figure A-1**
Date.: **January 2020**	



Legend

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

- Existing Watermain
- Proposed Watermain
- Existing Watermain To Be Replaced

Proposed Land Use
- Low Density Residential
- Medium Density Residential
- Mixed Use
- Parks

Associated Engineering
BEST MANAGED COMPANIES
Platinum member

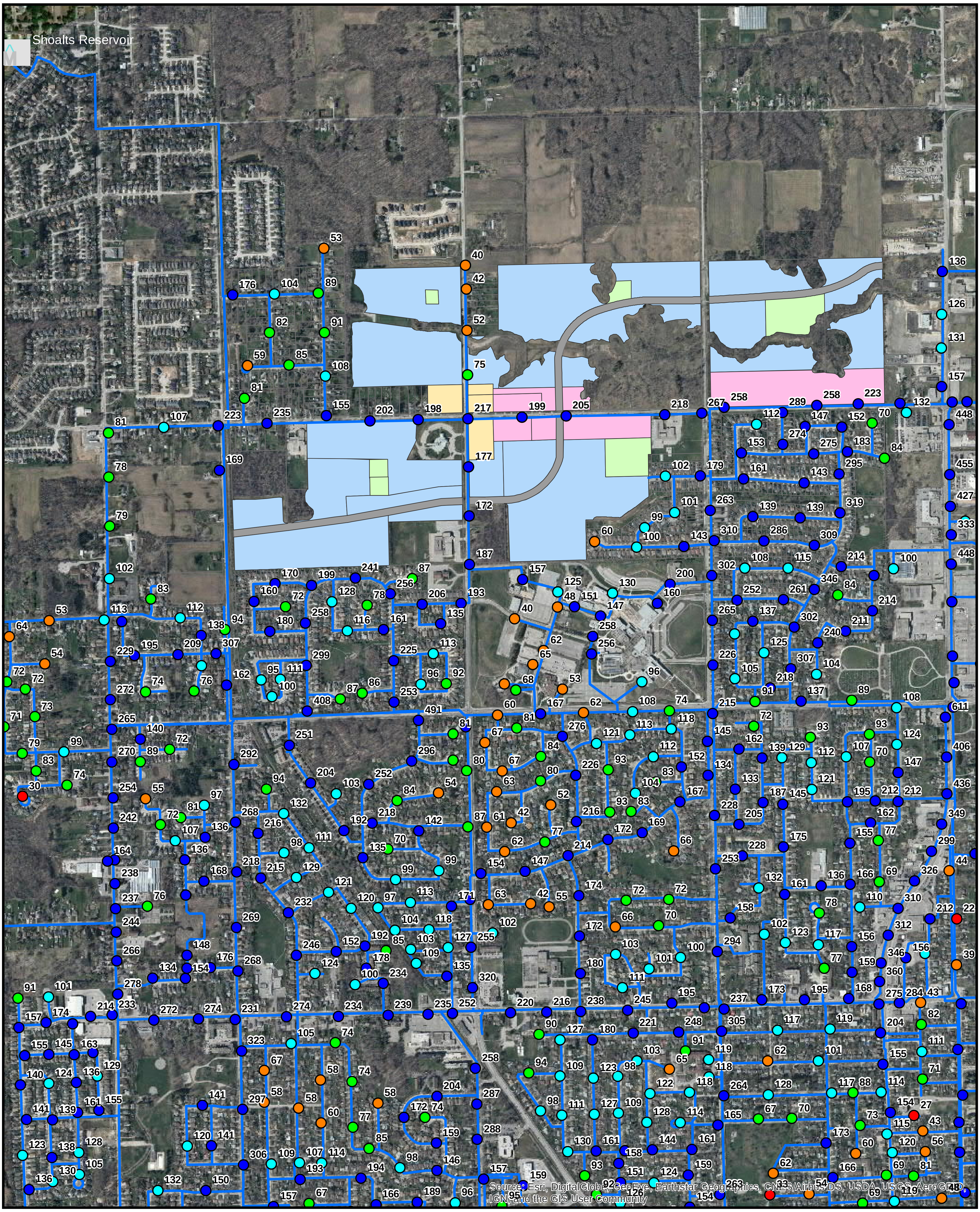
Northwest Secondary Plan Municipal Servicing

Existing Min Pressure during MDD EPS

Project No.: **2018-5190**

Date.: **January 2020**

Figure A-2



Legend

Available Fire Flow

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

Existing Watermain

Proposed Watermain

Existing Watermain To Be Replaced

Proposed Land Use

- Low Density Residential
- Medium Density Residential
- Mixed Use
- Parks

Associated Engineering

CANADA'S BEST MANAGED COMPANIES Platinum member

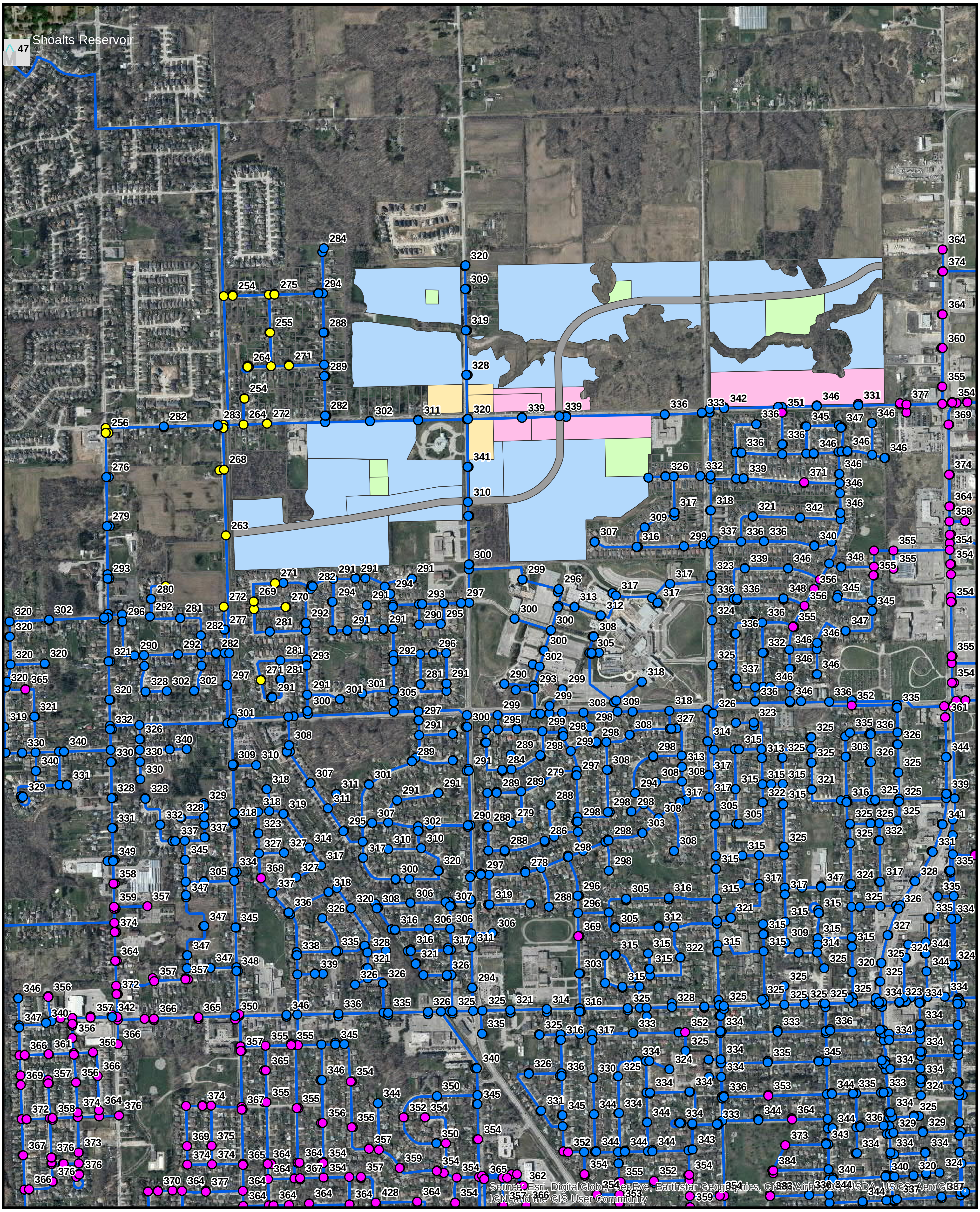
Northwest Secondary Plan Municipal Servicing

Existing Available Fire Flow during MDD

Project No.: **2018-5190**

Date.: **January 2020**

Figure A-3



Legend

Minimum Pressure		Proposed Land Use
< 140 kPa	Existing Watermain	Low Density Residential
140 - 275 kPa	Proposed Watermain	Medium Density Residential
275 - 350 kPa	Existing Watermain To Be Replaced	Mixed Use
350 - 550 kPa		Parks
550 -700 kPa		
> 700 kPa		

Associated Engineering

BEST MANAGED COMPANIES CANADA Platinum member

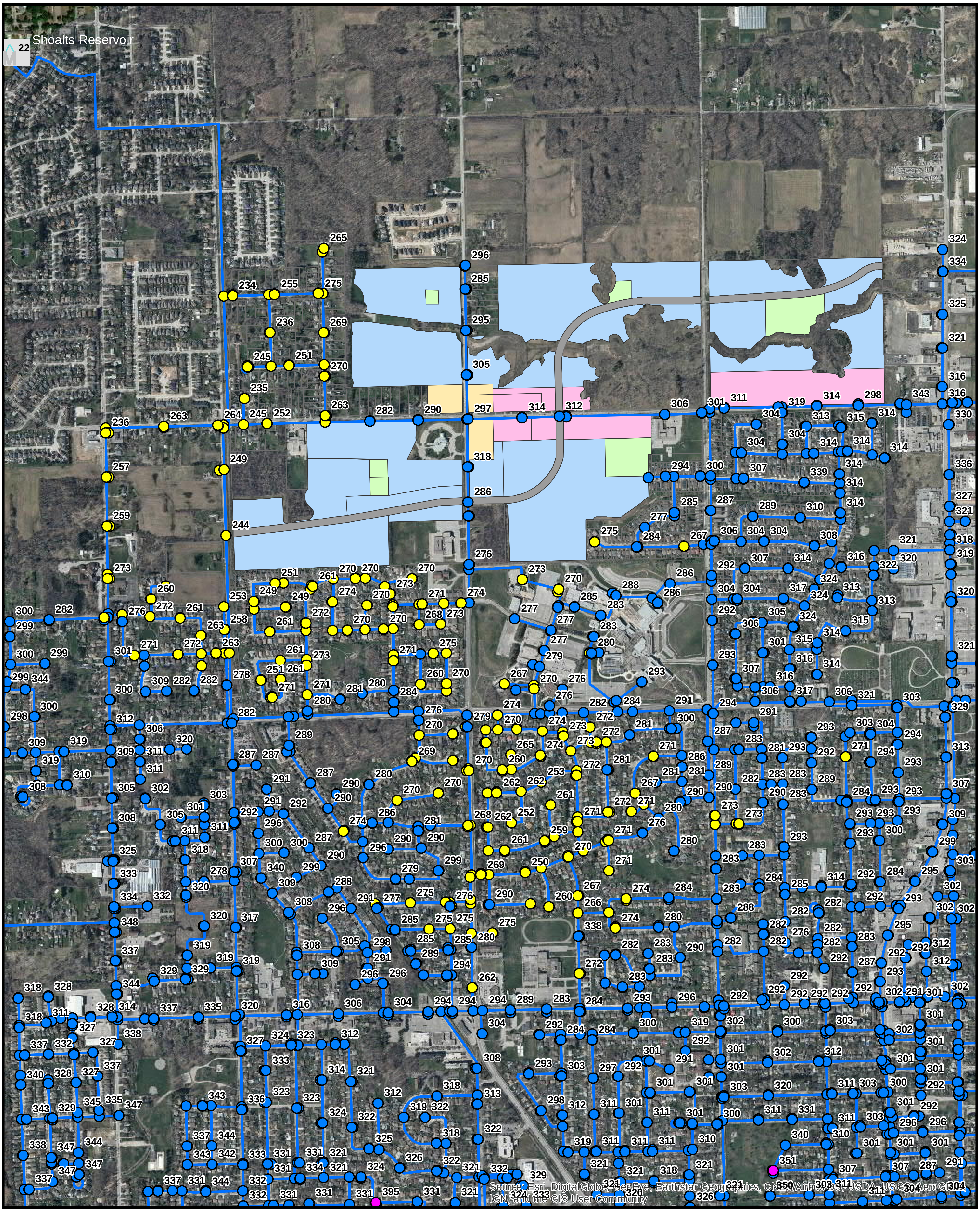
Northwest Secondary Plan Municipal Servicing

Future Min Pressure during ADD EPS without NWSP and without Modifications to WTP Pumping Scheme

Project No.: **2018-5190**

Date.: **January 2020**

Figure A-4



Legend

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

- Existing Watermain
- Proposed Watermain
- Existing Watermain To Be Replaced

Proposed Land Use
- Low Density Residential
- Medium Density Residential
- Mixed Use
- Parks

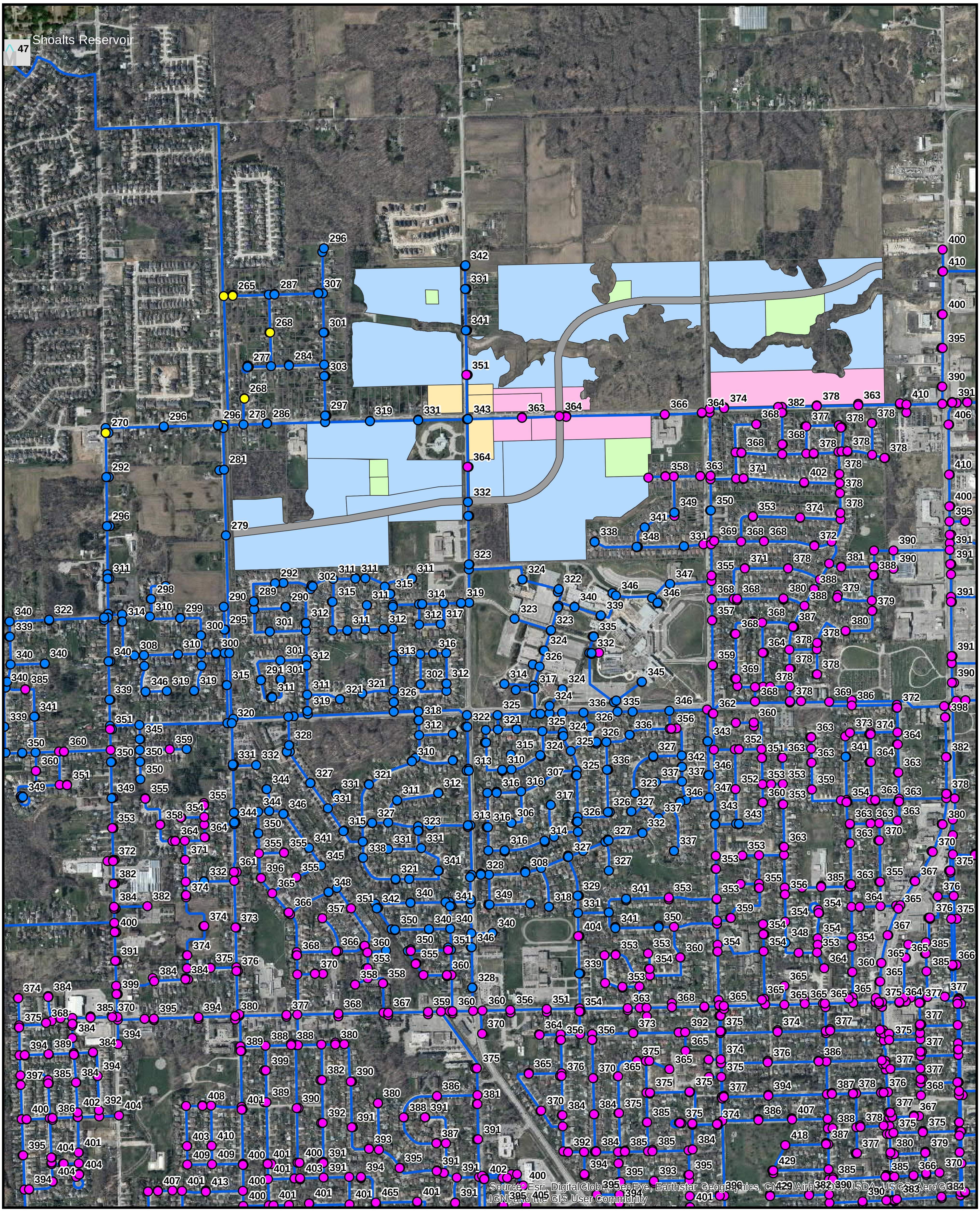
Associated Engineering

BEST MANAGED COMPANIES Platinum member

Northwest Secondary Plan Municipal Servicing

Min Pressure during MDD EPS without NWSP and without Modifications to WTP Pumping Scheme

Project No.: **2018-5190**	**Figure A-5**
Date.: **January 2020**	



Legend

Minimum Pressure

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

Existing Watermain

Proposed Watermain

Existing Watermain To Be Replaced

Proposed Land Use

- Low Density Residential
- Medium Density Residential
- Mixed Use
- Parks

Associated Engineering

BEST MANAGED COMPANIES CANADA Platinum member

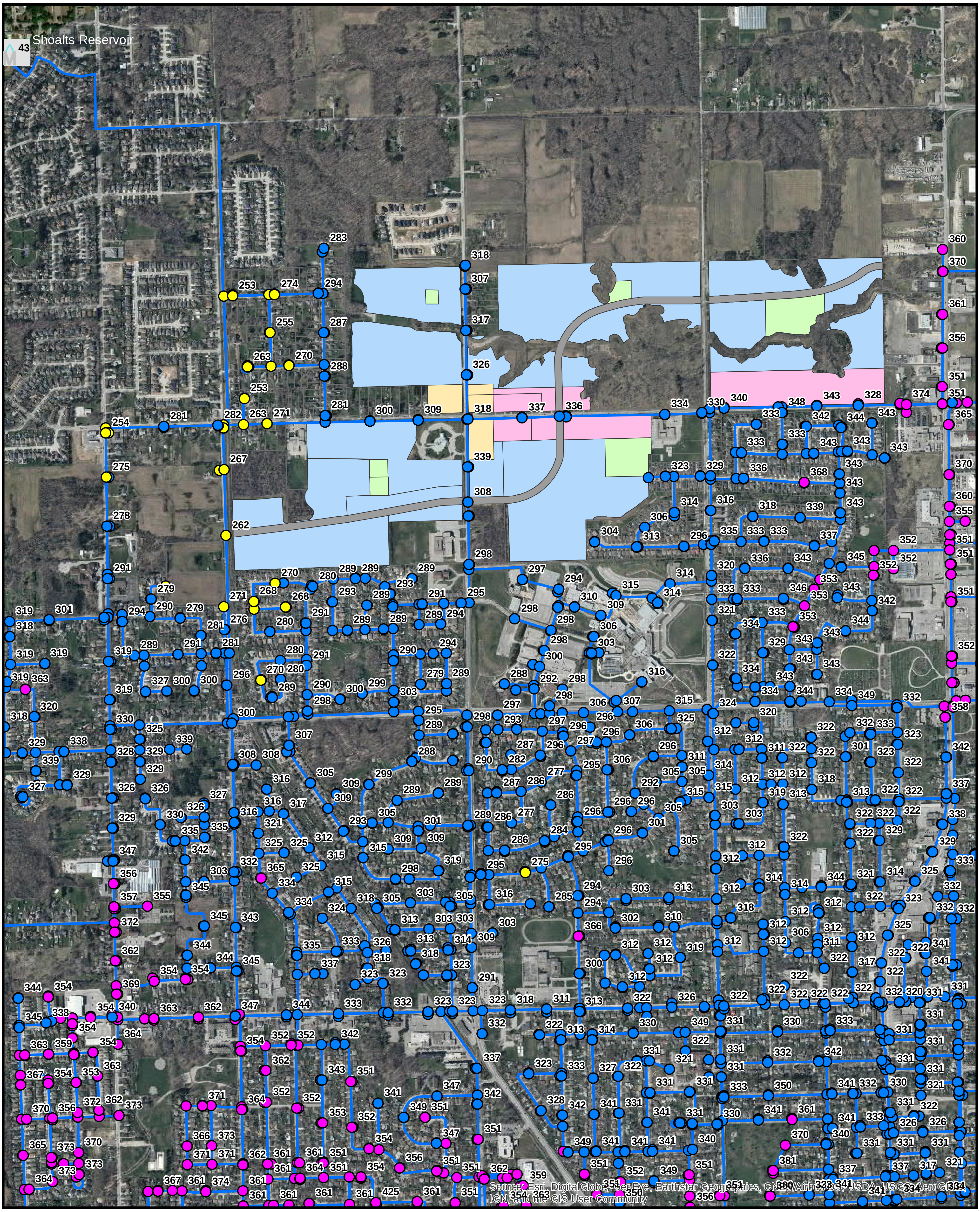
Northwest Secondary Plan Municipal Servicing

Future Min Pressure during ADD EPS without NWSP and with Modifications to WTP Pumping Scheme

Project No.: **2018-5190**

Date.: **January 2020**

Figure A-6



Legend

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

Existing Watermain

Proposed Watermain

Existing Watermain To Be Replaced

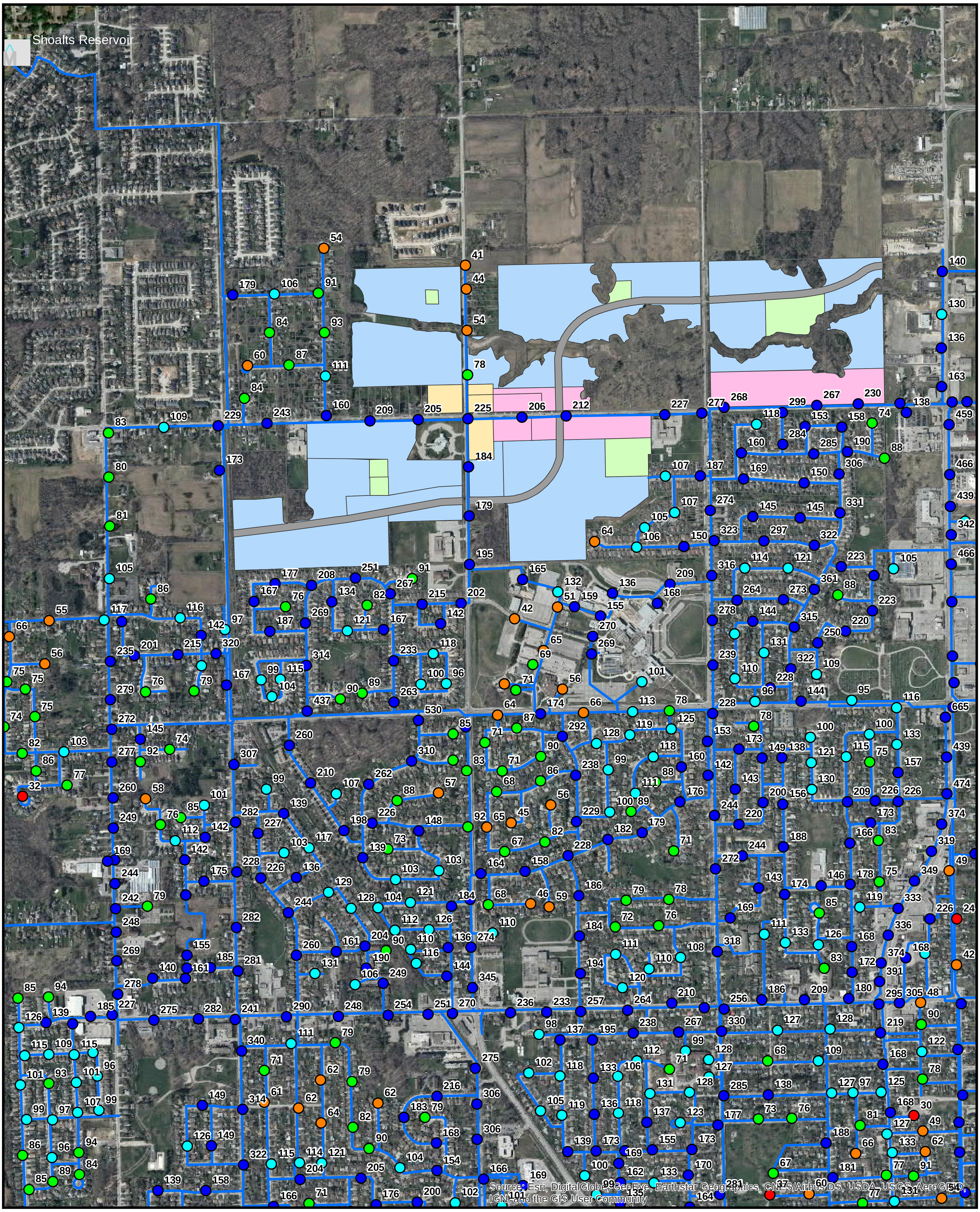
Proposed Land Use
- Low Density Residential
- Medium Density Residential
- Mixed Use
- Parks

Associated Engineering
BEST MANAGED COMPANIES Platinum member

Northwest Secondary Plan Municipal Servicing

Future Min Pressure during MDD EPS without NWSP and with Modifications to WTP Pumping Scheme

Project No.: **2018-5190**	**Figure A-7**
Date.: **January 2020**	



Legend

Available Fire Flow

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

Existing Watermain

Proposed Watermain

Existing Watermain To Be Replaced

Proposed Land Use

- Low Density Residential
- Medium Density Residential
- Mixed Use
- Parks

Associated Engineering

CANADA'S BEST MANAGED COMPANIES Platinum member

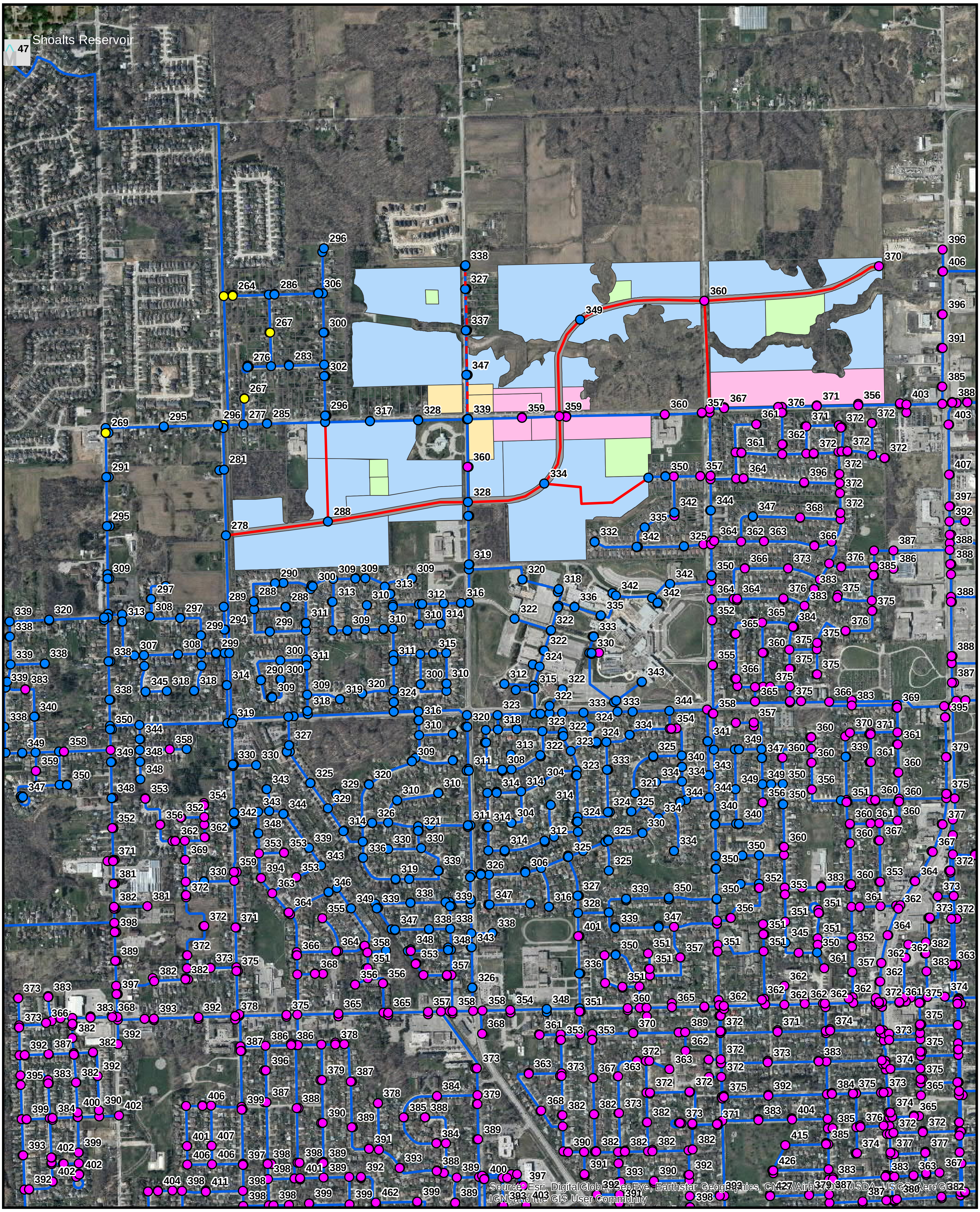
Northwest Secondary Plan Municipal Servicing

Available Fire Flow during MDD without NWSP and with Modifications to WTP Pumping Scheme

Project No.: **2018-5190**

Date.: **January 2020**

Figure A-8



Legend

Minimum Pressure

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

- Existing Watermain
- Proposed Watermain
- Existing Watermain To Be Replaced

Proposed Land Use

- Low Density Residential
- Medium Density Residential
- Mixed Use
- Parks

Associated Engineering

BEST MANAGED COMPANIES CANADA Platinum member

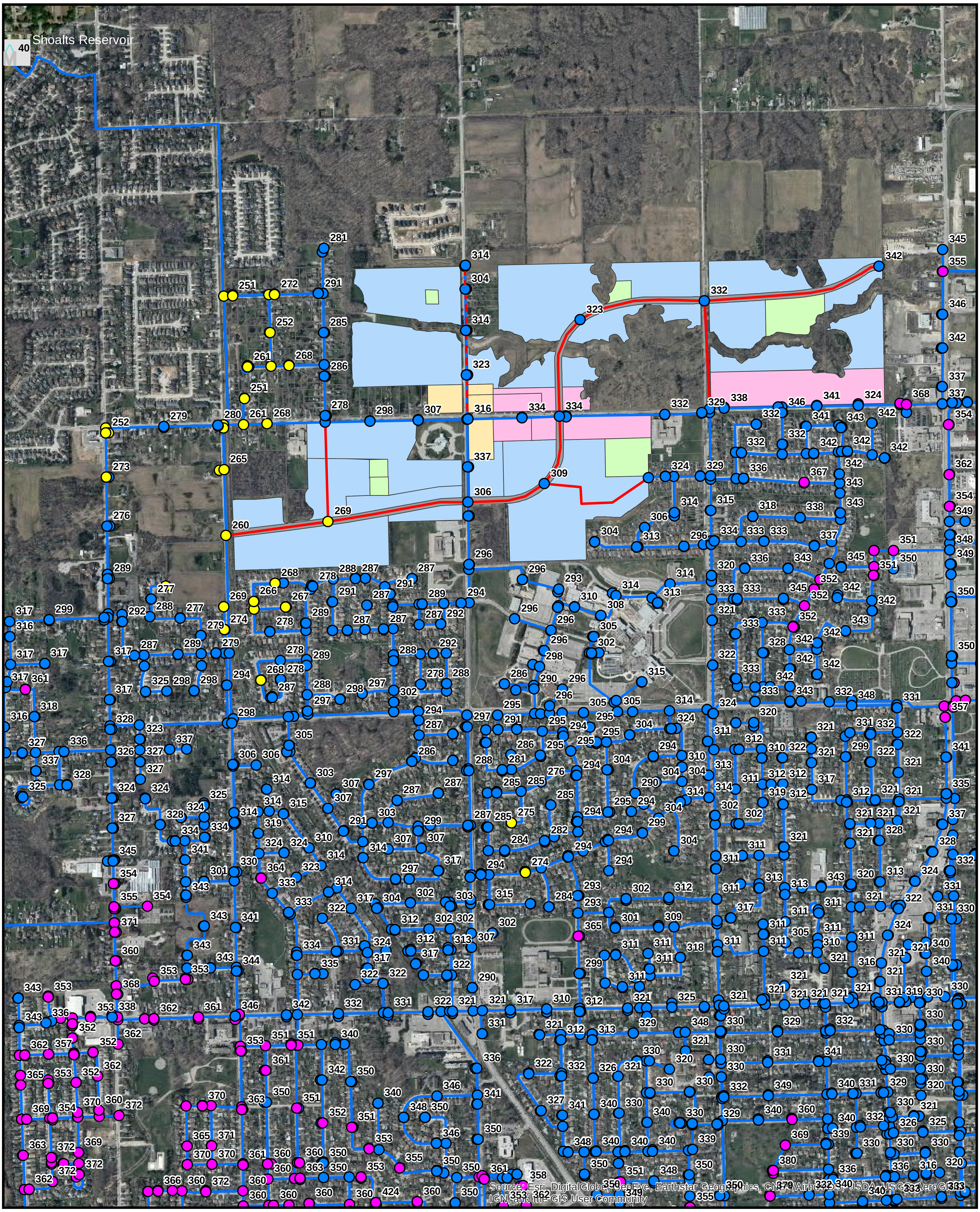
Northwest Secondary Plan Municipal Servicing

Future Min Pressure during ADD EPS with NWSP and Modifications to WTP Pumping Scheme

Project No.: **2018-5190**

Date.: **January 2020**

Figure A-9



Legend

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

- Existing Watermain
- Proposed Watermain
- Existing Watermain To Be Replaced

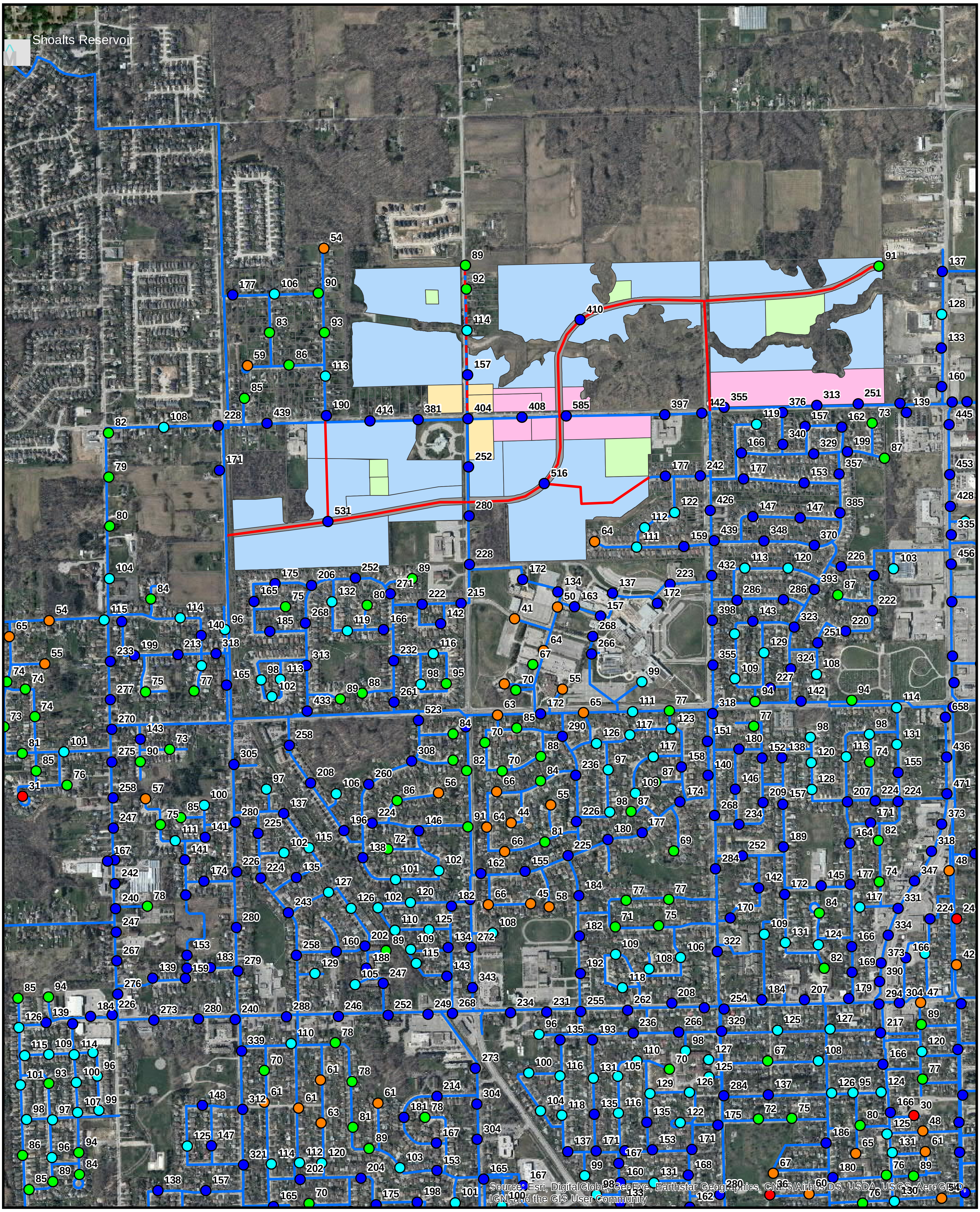
Proposed Land Use
- Low Density Residential
- Medium Density Residential
- Mixed Use
- Parks

Associated Engineering
BEST MANAGED COMPANIES Platinum member

Northwest Secondary Plan Municipal Servicing

Future Min Pressure during MDD EPS with NWSP and Modifications to WTP Pumping Scheme

Project No.: **2018-5190**	**Figure A-10**
Date.: **January 2020**	



Legend

Available Fire Flow

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

- Existing Watermain
- Proposed Watermain
- Existing Watermain To Be Replaced

Proposed Land Use

- Low Density Residential
- Medium Density Residential
- Mixed Use
- Parks

Associated Engineering

BEST MANAGED COMPANIES CANADA Platinum member

Northwest Secondary Plan Municipal Servicing

Future Available Fire Flow during MDD with NWSP and Modifications to WTP Pumping Scheme

Project No.: **2018-5190**

Date.: **January 2020**

Figure A-11

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	273	335
19001375	547	146	401	274	273
19001376	383	147	236	274	109
19001377	495	147	348	274	221
19001378	446	147	299	274	172
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	274	365
19001380	623	147	476	274	349
19001381	540	148	392	275	265
19001382	729	148	581	275	454
19001383	452	148	304	276	176
19001384	720	149	571	276	444
19001385	747	149	598	277	470
19001386	638	149	489	277	361
19001387	588	149	439	277	311
19001388	638	150	488	277	361
19001389	816	150	666	278	538
19001390	671	170	501	297	374
19001391	731	170	561	297	434
19001392	718	170	548	297	421
19001393	731	170	561	297	434
19001394	717	170	547	297	420
19001395	714	170	544	297	417
19001396	733	170	563	298	435
19001397	844	170	674	297	547
19001398	708	170	538	297	411
19001399	740	170	570	297	443
19001400	718	170	548	297	421
19001401	718	170	548	297	421
19001402	918	170	748	297	621
19001403	917	170	747	297	620
19001404	907	170	737	297	610
19001405	401	171	230	299	102
19001406	923	171	752	299	624
19001407	1143	177	966	305	838
19001408	914	177	737	305	609
19001409	914	177	737	305	609
19001410	912	177	735	305	607
19001411	914	177	737	305	609
19001412	1125	220	905	348	777
19001413	889	220	669	348	541
19001519	3470	220	3250	348	3122
19001520	3544	220	3324	348	3196

SANITARY SEWER DESIGN SHEET - with Line Aveune Connection

Date: 15-May-20 **Project:** Welland Northwest Secondary Plan
Design By: SKM
Checked By:

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							NWSP POPULATION AND FLOW DATA								
DESCRIPTION	DRAINAGE AREA	MANHOLE		INVERTS		LENGTH	AREA	POP	CUMULATIVE		AVG. DAILY FLOW	PEAKING FACTOR (PF = 1+14/(4+P^1/2))	PEAK FLOW (NO INFIL.)	INFILT. FLOW	PEAK FLOW (W/ INFIL.)
				U/S	D/S				AREA	POP. Served					
STREET	ID	FROM	TO			m	(ha)	(ppl)	(ha)	(ppl)	(l/s)	(dmnl)	(L/s)	(L/s)	(L/s)
Flows from Hurricane SPS/Rice Road (North)	-	-	406592MH01	-	-	-	-	-	-	-	-	-	-	-	-
Rice Road (N of Quaker)	A11, A40	406592MH01	406590MH01	180.23	179.85	387	6.1	339	6.1	339	1.08	4.00	4.32	1.74	6.07
Rice Road (N of Quaker to Quaker)	A1, A9, A18, A29	406590MH01	406497MH01	179.72	179.55	101	9.3	573	15.4	912	2.90	3.83	11.11	4.42	15.53
Flows from West of Quaker and Rice	-	-	406497MH01	-	-	-	-	-	-	-	-	-	-	-	-
NWSP (W of Rice, S of Quaker)	A3	NW1	NW2	188.75	186.43	278	1.7	96	1.7	96	0.31	4.00	1.23	0.48	1.70
NWSP (W of Rice, S of Quaker)	A4	NW2	NW3	186.43	185.90	159	3.7	215	5.4	311.5	0.99	4.00	3.97	1.55	5.51
NWSP (W of Rice, S of Quaker)	A5, A12, A23	NW3	NW4	185.90	185.20	319	10.4	599	15.8	910.2	2.90	3.83	11.08	4.52	15.60
Rice Road (S of Quaker)	-	NW4	NW5	185.20	185.01	98	-	-	15.8	910.2	2.90	3.83	11.08	4.52	15.60
Rice Road (S of Quaker to Quaker)	A6, A26, A37, A38	NW5	406497MH01	185.01	179.36	200	9.4	631	25.2	1541	4.90	3.67	18.01	7.20	25.21
Quaker Road (Rice to W of Cataract)	A27, A28, A31, A33	406497MH01	416427MH01	179.36	178.96	307	3.7	470	44.4	2923	9.30	3.45	32.12	12.69	44.81
NWSP (E of Rice, S of Quaker)	A7	NW6	NW7	183.37	181.73	235	1.7	98	1.7	98	0.31	4.00	1.25	0.49	1.74
NWSP (E of Rice, S of Quaker)	A8, A10, A41	NW7	416427MH01	181.73	178.96	199	16.2	820	17.9	918	2.92	3.82	11.18	5.13	16.30
NWSP (E of Cataract, N of Quaker)	A20, A21, A22, A42	NW8	NW9	181.29	179.94	408	6.3	339	6.3	339	1.08	4.00	4.31	1.81	6.12
NWSP (E of Cataract, N of Quaker)	A13, A19, A24	NW9	416427MH01	179.94	178.98	290	10.0	575	16.3	914	2.91	3.82	11.12	4.66	15.79
Quaker Road (W of Cataract to W of Niagara)	A30, A34, A35, A36	416427MH01	426407MH03	178.96	177.58	830	4.5	403	83.1	5158	16.42	3.23	53.07	23.76	76.83
NWSP (W of Cataract, N of Quaker)	A14, A17	NW10	NW11	179.74	179.01	118	6.1	351	6.1	351	1.12	4.00	4.47	1.74	6.22
NWSP (W of Cataract, N of Quaker)	A15, A16	NW12	NW11	179.57	179.01	169	2.3	130	2.3	130	0.41	4.00	1.65	0.64	2.30
NWSP (W of Cataract, N of Quaker)	A39	NW11	NW13	178.91	178.50	216	2.3	0	10.6	481	1.53	3.98	6.10	3.04	9.15
NWSP (W of Cataract, N of Quaker)	A2	NW13	NW14	178.50	177.98	116	2.4	140	13.1	621	1.98	3.92	7.76	3.74	11.50
NWSP (W of Cataract, N of Quaker)	A32	NW14	426407MH03	177.98	177.58	58	7.0	634	20.1	1255	4.00	3.73	14.92	5.75	20.67
NWSP (W of First, N of Quaker)	-	426407MH03	426427MH01	177.58	177.10	208	-	-	103.2	6413	20.41	3.14	64.16	29.51	93.67
Quaker Road (W of Niagara to Towpath)	A25	426427MH01	436437MH03	177.10	171.78	1320	2.8	159	105.9	6572	20.92	3.13	65.53	30.30	95.83
Towpath (to SPS)	-	436540MH01	446525MH01	171.05	169.40	1002	-	-	105.9	6572	20.92	3.13	65.53	30.30	95.83

LOCATION	EX TRUNK FLOW		TOTAL (NWSP + EX)	SEWER DESIGN											
DESCRIPTION	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)	(mm)	(%)	(%)	(%)	(mm)	(m^2)	(m)	(m/s)	(L/s)	(%)		(m/s)
Flows from Hurricane SPS/Rice Road (North)	125.0	125.0	**125.0**	-	-	-		-	-	-	-	**-**	-	-	
Rice Road (N of Quaker)	0.0	125.0	**131.1**	600	0.10	1.07	0.10	609.6	0.292	0.152	0.69	**202.6**	64.7	OK	0.66
Rice Road (N of Quaker to Quaker)	0.0	125.0	**140.5**	600	0.17	1.07	0.17	609.6	0.292	0.152	0.90	**264.1**	53.2	OK	0.81
Flows from West of Quaker and Rice	147.0	147.0	**147.0**	-	-	-		-	-	-	-	**-**	-	-	-
NWSP (W of Rice, S of Quaker)	0.0	0.0	**1.7**	200	0.84	1.54	0.84	203.2	0.032	0.051	0.97	**31.4**	5.4	OK	0.44
NWSP (W of Rice, S of Quaker)	0.0	0.0	**5.5**	200	0.33	1.54	0.33	203.2	0.032	0.051	0.61	**19.7**	28.0	OK	0.46
NWSP (W of Rice, S of Quaker)	0.0	0.0	**15.6**	300	0.22	1.34	0.22	304.8	0.073	0.076	0.65	**47.3**	33.0	OK	0.51
Rice Road (S of Quaker)	0.0	0.0	**15.6**	300	0.19	1.34	0.19	304.8	0.073	0.076	0.60	**44.0**	35.5	OK	0.48
Rice Road (S of Quaker to Quaker)	0.0	0.0	**25.2**	300	2.82	1.34	1.34	304.8	0.073	0.076	1.60	**117.0**	21.6	OK	1.11
Quaker Road (Rice to W of Cataract)	0.0	272.0	**316.8**	750	0.13	0.99	0.13	762.0	0.456	0.191	0.92	**418.8**	75.7	OK	0.90
NWSP (E of Rice, S of Quaker)	0.0	0.0	**1.7**	200	0.70	1.54	0.70	203.2	0.032	0.051	0.88	**28.6**	6.1	OK	0.42
NWSP (E of Rice, S of Quaker)	0.0	0.0	**16.3**	200	1.39	1.54	1.39	203.2	0.032	0.051	1.24	**40.3**	40.4	OK	1.03
NWSP (E of Cataract, N of Quaker)	0.0	0.0	**6.1**	200	0.33	1.54	0.33	203.2	0.032	0.051	0.61	**19.7**	31.1	OK	0.47
NWSP (E of Cataract, N of Quaker)	0.0	0.0	**15.8**	200	0.33	1.54	0.33	203.2	0.032	0.051	0.61	**19.7**	80.3	OK	0.60
Quaker Road (W of Cataract to W of Niagara)	3.0	275.0	**351.8**	750	0.17	0.99	0.17	762.0	0.456	0.191	1.05	**478.9**	73.5	OK	1.03
NWSP (W of Cataract, N of Quaker)	0.0	0.0	**6.2**	200	0.62	1.54	0.62	203.2	0.032	0.051	0.83	**26.9**	23.1	OK	0.59
NWSP (W of Cataract, N of Quaker)	0.0	0.0	**2.3**	200	0.33	1.54	0.33	203.2	0.032	0.051	0.61	**19.7**	11.7	OK	0.35
NWSP (W of Cataract, N of Quaker)	0.0	0.0	**9.1**	300	0.19	1.34	0.19	304.8	0.073	0.076	0.60	**44.0**	20.8	OK	0.41
NWSP (W of Cataract, N of Quaker)	0.0	0.0	**11.5**	300	0.45	1.34	0.45	304.8	0.073	0.076	0.93	**67.7**	17.0	OK	0.60
NWSP (W of Cataract, N of Quaker)	0.0	0.0	**20.7**	300	0.69	1.34	0.69	304.8	0.073	0.076	1.15	**83.8**	24.7	OK	0.83
NWSP (W of First, N of Quaker)	0.0	275.0	**368.7**	750	0.23	0.99	0.23	762.0	0.456	0.191	1.22	**557.0**	66.2	OK	1.16
Quaker Road (W of Niagara to Towpath)	23.0	298.0	**393.8**	750	0.40	0.99	0.40	762.0	0.456	0.191	1.61	**734.5**	53.6	OK	1.45
Towpath (to SPS)	50.0	348.0	**443.8**	900	0.16	0.93	0.16	914.4	0.657	0.229	1.15	**755.4**	58.8	OK	1.06

Notes:
1. Residential design flows as per UCC
2. Diameters as per All Pipe Model
3. Slopes approximate as per All Pipe Model (calculated based on length)
4. Infiltration rate is 0.286 as per Region Master Plan 2017
5. Peak Factors for NWSP Flows as per Harmon's Formula
6. Population for NWSP Calculated Based on Area and Population Density for Land Use
7. All other peak flows as per All Pipe Model
8. Design slope is the minimum of actual slope and approximate critical slope and is used to calculate full flow velocity

SANITARY SEWER DESIGN SHEET - without Line Avenue Connection

Date: 15-May-20
Design By: SKM
Checked By:

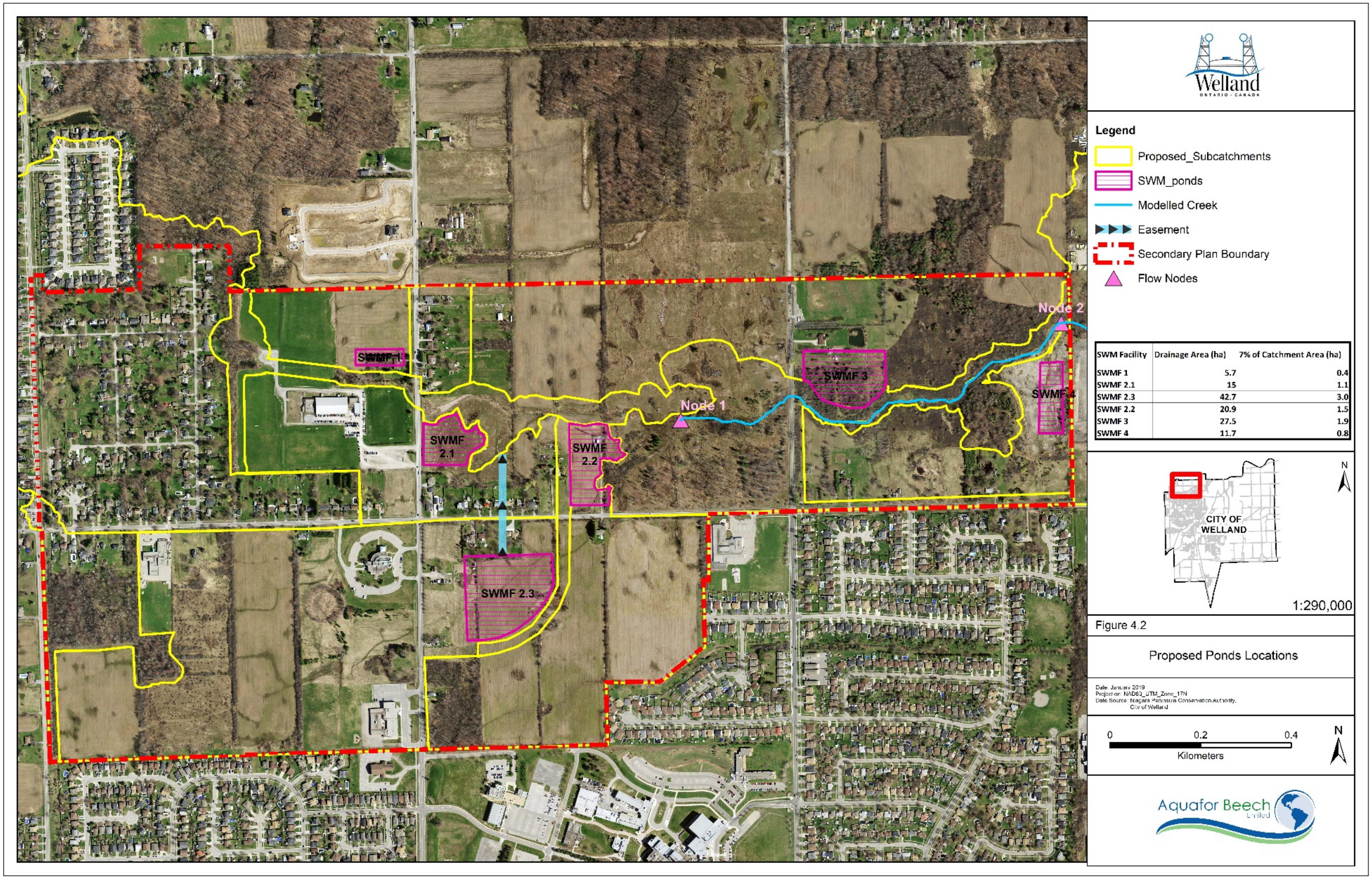
Project: Welland Northwest Secondary Plan

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)
Flows from Hurricane SPS/Rice Road (North)	-	-	406592MH01	-	-	-	-	-	-	-	-	-	-	-	-	125.0	125.0	**125.0**	-	-	-		-	-	-	-	**-**	**-**	**-**	
Rice Road (N of Quaker)	A11, A40	406592MH01	406590MH01	180.23	179.85	387	6.1	339	6.1	339	1.08	4.00	4.32	1.74	6.07	0.0	125.0	**131.1**	600	0.10	1.07	0.10	609.6	0.292	0.152	0.69	**202.6**	64.7	OK	0.66
Rice Road (N of Quaker to Quaker)	A1, A9, A18, A29	406590MH01	406497MH01	179.72	179.55	101	9.3	573	15.4	912	2.90	3.83	11.11	4.42	15.53	0.0	125.0	**140.5**	600	0.17	1.07	0.17	609.6	0.292	0.152	0.90	**264.1**	53.2	OK	0.81
Flows from West of Quaker and Rice	-	-	406497MH01	-	-	-	-	-	-	-	-	-	-	-	-	19.0	19.0	**19.0**	-	-	-		-	-	-	-	**-**	-	-	-
NWSP (W of Rice, S of Quaker)	A3	NW1	NW2	188.75	186.43	278	1.7	96	1.7	96	0.31	4.00	1.23	0.48	1.70	0.0	0.0	**1.7**	200	0.84	1.54	0.84	203.2	0.032	0.051	0.97	**31.4**	5.4	OK	0.44
NWSP (W of Rice, S of Quaker)	A4	NW2	NW3	186.43	185.90	159	3.7	215	5.4	311.5	0.99	4.00	3.97	1.55	5.51	0.0	0.0	**5.5**	200	0.33	1.54	0.33	203.2	0.032	0.051	0.61	**19.7**	28.0	OK	0.46
NWSP (W of Rice, S of Quaker)	A5, A12, A23	NW3	NW4	185.90	185.20	319	10.4	599	15.8	910.2	2.90	3.83	11.08	4.52	15.60	0.0	0.0	**15.6**	300	0.22	1.34	0.22	304.8	0.073	0.076	0.65	**47.3**	33.0	OK	0.51
Rice Road (S of Quaker)	-	NW4	NW5	185.20	185.01	98	-	-	15.8	910.2	2.90	3.83	11.08	4.52	15.60	0.0	0.0	**15.6**	300	0.19	1.34	0.19	304.8	0.073	0.076	0.60	**44.0**	35.5	OK	0.48
Rice Road (S of Quaker to Quaker)	A6, A26, A37, A38	NW5	406497MH01	185.01	179.36	200	9.4	631	25.2	1541	4.90	3.67	18.01	7.20	25.21	0.0	0.0	**25.2**	300	2.82	1.34	1.34	304.8	0.073	0.076	1.60	**117.0**	21.6	OK	1.11
Quaker Road (Rice to W of Cataract)	A27, A28, A31, A33	406497MH01	416427MH01	179.36	178.96	307	3.7	470	44.4	2923	9.30	3.45	32.12	12.69	44.81	0.0	144.0	**188.8**	750	0.13	0.99	0.13	762.0	0.456	0.191	0.92	**418.8**	45.1	OK	0.79
NWSP (E of Rice, S of Quaker)	A7	NW6	NW7	183.37	181.73	235	1.7	98	1.7	98	0.31	4.00	1.25	0.49	1.74	0.0	0.0	**1.7**	200	0.70	1.54	0.70	203.2	0.032	0.051	0.88	**28.6**	6.1	OK	0.42
NWSP (E of Rice, S of Quaker)	A8, A10, A41	NW7	416427MH01	181.73	178.96	199	16.2	820	17.9	918	2.92	3.82	11.18	5.13	16.30	0.0	0.0	**16.3**	200	1.39	1.54	1.39	203.2	0.032	0.051	1.24	**40.3**	40.4	OK	1.03
NWSP (E of Cataract, N of Quaker)	A20, A21, A22, A42	NW8	NW9	181.29	179.94	408	6.3	339	6.3	339	1.08	4.00	4.31	1.81	6.12	0.0	0.0	**6.1**	200	0.33	1.54	0.33	203.2	0.032	0.051	0.61	**19.7**	31.1	OK	0.47
NWSP (E of Cataract, N of Quaker)	A13, A19, A24	NW9	416427MH01	179.94	178.98	290	10.0	575	16.3	914	2.91	3.82	11.12	4.66	15.79	0.0	0.0	**15.8**	200	0.33	1.54	0.33	203.2	0.032	0.051	0.61	**19.7**	80.3	OK	0.60
Quaker Road (W of Cataract to W of Niagara)	A30, A34, A35, A36	416427MH01	426407MH03	178.96	177.58	830	4.5	403	83.1	5158	16.42	3.23	53.07	23.76	76.83	3.0	147.0	**223.8**	750	0.17	0.99	0.17	762.0	0.456	0.191	1.05	**478.9**	46.7	OK	0.91
NWSP (W of Cataract, N of Quaker)	A14, A17	NW10	NW11	179.74	179.01	118	6.1	351	6.1	351	1.12	4.00	4.47	1.74	6.22	0.0	0.0	**6.2**	200	0.62	1.54	0.62	203.2	0.032	0.051	0.83	**26.9**	23.1	OK	0.59
NWSP (W of Cataract, N of Quaker)	A15, A16	NW12	NW11	179.57	179.01	169	2.3	130	2.3	130	0.41	4.00	1.65	0.64	2.30	0.0	0.0	**2.3**	200	0.33	1.54	0.33	203.2	0.032	0.051	0.61	**19.7**	11.7	OK	0.35
NWSP (W of Cataract, N of Quaker)	A39	NW11	NW13	178.91	178.50	216	2.3	0	10.6	481	1.53	3.98	6.10	3.04	9.15	0.0	0.0	**9.1**	300	0.19	1.34	0.19	304.8	0.073	0.076	0.60	**44.0**	20.8	OK	0.41
NWSP (W of Cataract, N of Quaker)	A2	NW13	NW14	178.50	177.98	116	2.4	140	13.1	621	1.98	3.92	7.76	3.74	11.50	0.0	0.0	**11.5**	300	0.45	1.34	0.45	304.8	0.073	0.076	0.93	**67.7**	17.0	OK	0.60
NWSP (W of Cataract, N of Quaker)	A32	NW14	426407MH03	177.98	177.58	58	7.0	634	20.1	1255	4.00	3.73	14.92	5.75	20.67	0.0	0.0	**20.7**	300	0.69	1.34	0.69	304.8	0.073	0.076	1.15	**83.8**	24.7	OK	0.83
NWSP (W of First, N of Quaker)	-	426407MH03	426427MH01	177.58	177.10	208	-	-	103.2	6413	20.41	3.14	64.16	29.51	93.67	0.0	147.0	**240.7**	750	0.23	0.99	0.23	762.0	0.456	0.191	1.22	**557.0**	43.2	OK	1.04
Quaker Road (W of Niagara to Towpath)	A25	426427MH01	436437MH03	177.10	171.78	1320	2.8	159	105.9	6572	20.92	3.13	65.53	30.30	95.83	23.0	170.0	**265.8**	750	0.40	0.99	0.40	762.0	0.456	0.191	1.61	**734.5**	36.2	OK	1.30
Towpath (to SPS)	-	436540MH01	446525MH01	171.05	169.40	1002	-	-	105.9	6572	20.92	3.13	65.53	30.30	95.83	50.0	220.0	**315.8**	900	0.16	0.93	0.16	914.4	0.657	0.229	1.15	**755.4**	41.8	OK	0.97

Notes:
1. Residential design flows as per UCC
2. Diameters as per All Pipe Model
3. Slopes approximate as per All Pipe Model (calculated based on length)
4. Infiltration rate is 0.286 as per Region Master Plan 2017
5. Peak Factors for NWSP Flows as per Harmon's Formula
6. Population for NWSP Calculated Based on Area and Population Density for Land Use
7. All other peak flows as per All Pipe Model

APPENDIX C - STORM



SWM Facility	Drainage Area (ha)	7% of Catchment Area (ha)
SWMF 1	5.7	0.4
SWMF 2.1	15	1.1
SWMF 2.3	42.7	3.0
SWMF 2.2	20.9	1.5
SWMF 3	27.5	1.9
SWMF 4	11.7	0.8

Figure 4-2: Proposed Ponds Locations

STORM SEWER DESIGN SHEET

Associated Engineering — GLOBAL PERSPECTIVE. LOCAL FOCUS.

Q=2.78AiR	Storm Event = 5.00	Years	**Northwest Secondary Plan**	DESIGNED BY:	SKM
A = Area (ha)	a	b	c	CHECKED BY:	
R = Runoff Coefficient	830	0.777	7.3	JOB No.:	20185190
T_c = Time of Concentration	n = 0.013		**Municipal Servicing**	DATE:	May 10 2020
i = Avg Rainfall Intensity (mm/hr) = a / $(T_c+c)^b$					

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																		
A11, A40	NW19	OUTLET 1	5.70	0.39	2.241	2.241	12.00	83.21	**518.433**	600	2.00	1.07	1.07	10.00	**634.27**	2.24	0.07	81.74
Pond 2A																		
A28, A29, A27, A33, A35, A24	NW2	NW3	4.97	0.59	2.916	2.916	15.00	74.38	**602.841**	825	0.25	0.96	0.25	124.00	**717.72**	1.34	1.54	83.99
A1, A9	NW3	Outet 2A	10.03	0.40	4.012	6.928	16.54	70.62	**1360.012**	1200	0.25	0.85	0.25	10.00	**1949.37**	1.72	0.10	69.77
Pond 2B																		
A10, A41, E2	NW4	NW5	16.80	0.38	6.321	6.321	15.00	74.38	**1306.959**	825	1.00	0.96	0.96	300.00	**1406.14**	2.63	1.90	92.95
A30, A34, A13	NW5	Outlet 2B	4.10	0.59	2.408	8.729	16.90	69.80	**1693.720**	1200	0.30	0.85	0.30	10.00	**2135.42**	1.89	0.09	79.32
Pond 2C																		
A3, A5, A4, A37, A38, A23, A12	NW6	NW8	18.90	0.39	7.400	7.400	15.00	74.38	**1530.107**	900	1.00	0.93	0.93	135.00	**1747.84**	2.75	0.82	87.54
A26, A31, A36, E1	NW7	NW8	5.80	0.53	3.070	3.070	10.00	90.60	**773.214**	675	1.00	1.03	1.00	100.00	**840.59**	2.35	0.71	91.98
A6, A7, A8	NW8	Outlet 2C	18.00	0.40	7.200	17.670	15.82	72.32	**3552.681**	1500	0.30	0.79	0.30	15.00	**3871.78**	2.19	0.11	91.76
Pond 3																		
A19, A21, A42, A22, A20	NW9	NW11	15.10	0.39	5.950	5.950	18.00	67.43	**1115.360**	900	0.45	0.93	0.45	90	**1214.39**	1.91	0.79	91.85
A15, A16, A39. A14	NW10	NW11	9.60	0.35	3.380	3.380	12.00	83.21	**781.919**	825	0.45	0.96	0.45	90	**962.92**	1.80	0.83	81.20
A17	NW11	Outlet 3	2.80	0.40	1.120	10.450	18.79	65.85	**1912.904**	1200	0.35	0.85	0.35	10	**2306.52**	2.04	0.08	82.93
Pond 4																		
A2	NW12	Outlet 4	11.70	0.55	6.430	6.430	16.00	71.89	**1284.986**	1200	0.20	0.85	0.20	116	**1743.57**	1.54	1.25	73.70

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	6510	m	$220	$1,432,200
150mm Gate Valve & Box	30	each	$1,600	$48,000
200 mm PVC DR18 Watermain	1950	m	$260	$507,000
200mm Gate Valve & Box	11	each	$2,500	$27,500
300mm PVC DR18 Watermain	2540	m	$310	$787,400
300mm Gate Valve & Box	15	each	$3,500	$52,500
Water Services	1820	each	$2,000	$3,640,000
Hydrants	74	each	$5,500	$407,000
Connect to Existing	6	each	$5,000	$30,000
Granular A	39500	t	$15	$592,500
Other General Construction	1	LS	$752,500	$752,500
Subtotal				$8,276,600
Contingency (15% of subtotal)				$1,241,500
Engineering (10% of subtotal)				$827,700
Total				$10,345,800
Rounded Total				$10,400,000

Sanitary Sewer				
Item	Quantity	Unit	Unit Price	Cost
200mm PVC DR35	8,900	m	$205	$1,824,500
300mm PVC DR35	1,250	m	$250	$312,500
1200mm Diameter MH	71	each	$6,000	$426,000
Sanitary Laterals	1,820	each	$3,000	$5,460,000
Connect to Existing Trunk	4	each	$5,000	$20,000
Granular A	85,900	t	$15	$1,288,500
Flush & CCTV (end of construction)	10,150	m	$15	$152,250
Flush & CCTV (end of maintenance)	10,150	m	$15	$152,250
Other General Construction	1	LS	$963,600	$963,600
Subtotal				$10,599,600
Contingency (15% of subtotal)				$1,590,000
Engineering (10% of subtotal)				$1,060,000
Total				$13,249,600
Rounded Total				$13,300,000

Preliminary Cost Estimate

Storm Sewer				
Item	Quantity	Unit	Unit Price	Cost
450mm PVC DR35 Ultra Rib	2170	m	$350	$759,500
525mm PVC DR35 Ultra Rib	1150	m	$400	$460,000
600mm CONC	2000	m	$450	$900,000
675mm CONC	730	m	$500	$365,000
750mm CONC	1380	m	$600	$828,000
825mm CONC	790	m	$700	$553,000
975mm CONC	610	m	$800	$488,000
1050mm CONC	240	m	$1,000	$240,000
1200mm CONC	550	m	$1,200	$660,000
1500mm CONC	110	m	$1,500	$165,000
1200mm Diameter MH	71	each	$6,000	$426,000
1500mm Diameter MH	37	each	$10,000	$370,000
1800mm Diameter MH	15	each	$12,000	$180,000
2400mm Diameter MH	6	each	$16,000	$96,000
Catchbasin	330	each	$1,600	$528,000
Catchbasin leads	1650	m	$160	$264,000
Granular A	58600	t	$15	$879,000
Flush & CCTV (end of construction)	9730	m	$15	$145,950
Flush & CCTV (end of maintenance)	9730	m	$15	$145,950
Other General Construction	1	LS	$845,400	$845,400
Subtotal				$9,298,800
Contingency (15% of subtotal)				$1,394,900
Engineering (10% of subtotal)				$929,900
Total				$11,623,600
Rounded Total				$11,700,000